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THE PHYSICS OF NEW CLEAN ENERGIES AND FUELS ACCORDING TO HADRONIC MECHANICS

Ruggero Maria Santilli
President
The Institute for Basic Research

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SPECIAL ISSUE
Twenty Two Years of Research
Extending Quantum Mechanics for
New Industrial & Energy Products

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THE PHYSICS OF NEW CLEAN ENERGIES AND FUELS ACCORDING TO HADRONIC MECHANICS

By Ruggero Maria Santilli
of the Institute for Basic Research

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EDITORIAL COMMENTS

This issue should be of special interest to the NEW-ENERGY COMMUNITY of doers and scholars. Prof. Ruggero Maria Santilli (President, Institute for Basic Research; Editor-in-Chief for ALGEBRAS, GROUPS AND GEOMETRIES, HADRONIC JOURNAL, and HADRONIC J. SUPPLEMENT; and Editor of INTERN. J. PHYSICS, BALKAN J. of GEOMETRY and its APPLICATIONS) has provided this journal with a five-paper summary of his life's work.

The basic concepts of Santilli's work are: Quantum Mechanics is valid for distributed matter where elementary particles can be treated as mathematical points but must be modified in atomic nuclei where various elementary particles cannot properly be treated as point sources. After 22 years of diligent study, Santilli and other mathematicians, scientists, and experimentalists have developed Hadronic Mechanics. The outgrowth of Hadronic Mechanics, as presented in this issue, more fully and accurately describes various nuclear and molecular processes. Especially, the complex nuclei and their forces can be described without loss of application of well-known physical laws. This achievement has led to a nuclear and molecular theory that is of great importance to the New-Energy Community. Santilli's nuclear theory, for example, predicts that under proper photon (or proton) bombardment unstable nuclei can be transmuted directly into stable nuclei. This combination of Santilli's theory and the unusual and unexpected results from Trenergy's experimental work in low-energy transmutation has resulted in the beginnings of mutual cooperation among Dr. Santilli and his staff and the work of Dr. S-X Jin (chief scientist for Trenergy, Inc., Salt Lake City, Utah) and his associates (including this editor). Santilli's work is not limited to transmutation.

Dr. Santilli and his colleagues, with their development of Hadronic Mechanics, have provided the FIRST theory for the understanding of new energies. This theory is mathematically and physically consistent, verifies existing physical laws (e.g., Pauli's principle, etc.) so that the theory will survive academic challenges and detailed study. This work provides the basis for the evaluation and further development of a considerable body of experimental discoveries of new energies and new fuels, and most important, this theory has specific predictions of practical concepts for the actual construction of efficient new-energy-producing machines.

The *Journal of New Energy* is pleased to provide, in one volume, these five summary papers by Professor Santilli, on Hadronic Mechanics, as a rational basis for understanding the important role of both nuclear and molecular-level processes in new-energy developments. Please note that this work will be included in the next issue of the CD-ROM, The Science of the Future Began Yesterday. This CD-ROM will contain the full text of all issues of the *Journal of New Energy* including this issue; the Proceedings of the 1999 INE Conference (August 27-28, 1999, Salt Lake City, Utah); and a special issue on the New Maxwell-Electromagnetic Equations; and, in addition, complete bibliographic references and the complete text of all articles or reviews printed in *Fusion Facts* and in *New Energy News* for the past ten years.

Please note the important announcement, for the first time, that MagneGas™, a new fuel, has a coefficient of performance (COP) of 1.69. (See Paper V, Section 3.12, page 286.) MagneGas™ is a

combustible gas produced using a specially-controlled D.C. arc within liquid wastes (such as spent radiator coolants and other polluting materials). This gas would normally be expected to have a COP of 0.2 or 0.3, however, as an application of Hadronic Mechanics this gas has achieved a COP of 1.69. This achievement by the use of Hadronic Mechanics is expected to improve the efficiency of other new-energies. This new fuel has been developed by Dr. Santilli and the technical staff of Toups Technology Licensing, Inc., a public company located in Largo, Florida. This exciting new product is the forerunner of other new fuels and new energy sources that will be developed in the future, based on use of Hadronic Mechanics.

For further information about this new fuel, please contact Mr. Leon Toups, president of Toups Technology Licensing, Inc. at 727-548-0918 or by fax at 727-549-8138 or visit the website www.toupstech.com.

THE PHYSICS OF NEW CLEAN ENERGIES AND FUELS ACCORDING TO HADRONIC MECHANICS *

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ABSTRACT

This is a series of five papers reporting, in a language accessible to the general scientific audience, systematic research on new energies and fuels conducted at the particle, nuclear, and molecular levels, which were initiated by R. M. Santilli at Harvard University in 1978 under DOE contracts ER-78-S-02-47420.A000, AS02-78ER04742, DE-ACO2-80ER10651; continued by Santilli and several mathematicians, theoreticians, and experimentalists at The Institute for Basic Research and at various other institutions under DOE contracts DE-ACO2-80ER-10651.A001, and DE-ACO2-80ER10651.A002; subsequently continued under financial support by Hadronic Press, Inc., Nonantum, Massachusetts; and more recently completed under logistic and financial support by Toups Technology Licensing, a public company in Largo, Florida. In particular, Toups Technology Licensing permitted the conduction of the important tests and measurements presented in Paper V, which lead to the identification of *new clean energies,* which do not release harmful radiations or leave dangerous waste, as well as *new clean fuels,* which resolve the alarming environmental problems caused by fossil fuels.

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THE PHYSICS OF NEW CLEAN ENERGIES AND FUELS ACCORDING TO HADRONIC MECHANICS, PAPER I: INSUFFICIENCIES OF QUANTUM MECHANICS[1]

Ruggero Maria Santilli[2]

ABSTRACT

This is the first of a series of five articles outlining systematic research on new energies and fuels at the particle, nuclear, and molecular levels, initiated by the author at Harvard University in 1978 under DOE support, and then continued by numerous scientists at various Institutions. This paper begins with the statement of objectives of the series: the identification of the basic physical laws and related technological realizations of energies and fuels which: are *new*, in the sense that they cannot be predicted and treated via quantum mechanics; are *clean*, in the sense that they do not produce radiations, waste, or exhausts harmful to humans and the environment; and are *real*, in the sense that they are realizable with current technologies in a way having practical, thus industrial and consumer value. This paper then provides a systematic presentation of the limitations of quantum mechanics in particle physics, nuclear physics, superconductivity, chemistry, biology, astrophysics, and cosmology. These limitations are a necessary pre-requisite for the presentation of a generalization (also called covering) of quantum mechanics known as *hadronic mechanics*, whose study was initiated precisely under the indicated DOE contracts. Hadronic mechanics will be outlined in subsequent papers of this series, and applied for the identification of the physical laws of new energies and fuels, as well as of specific new embodiments for their practical realization.

1. INTRODUCTION

1.1. The Fundamental Open Problem of the Emerging New Energies.

Undoubtedly, a most significant development of the final part of this millennium has been the emergence of various forms of *new clean energies*, that is, new energies without the harmful radiations and waste released by nuclear power plants, and without the environmentally harmful combustion exhausts of fossil fuels.

Without any claim of completeness due to the variety of the ongoing research, I quote:

1) Clear experimental evidence on the existence of stimulated nuclear transmutation in biology, whose studies initiated in the past century (see, e.g., Refs. [1a] and quoted literature);

2) The emergence of clear possibility to obtain energy via cavitation effects in ordinary water by various researchers [1b];

3) The celebrated electrolytic cell by M. Fleishmann and S. Pons [1c], for instance, in the realization by Y. Arata and Y.-C. Zhang described in the recent article by M. Carrell [1d];

4) The Patterson fuel cell [1e];

3) The catalytic fusion of deuterium into Helium by L. C. Case [1f];

4) The exploding water mist known since the earlier part of this century and recently studied

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by P. Graneau and his associates [1g];

5) Nuclear augmented combustions based on the Lithium studied by R H. R. Kaplin [1h];

6) The fission based on proton-Lithium reactions studied by W. D. Gwinn *et al.* [1i];

7) High density charge clusters studied by K. Shoulders (1j), S.-X. Jin and H. Fox [1k], *et al.*;

8) The new non-fossil combustible gases called AquaFuel™ and MagneGas™ developed by Toups Technology Licensing (TTL) of Largo, Florida [1l];

9) The hadronic energy studied by R. M. Santilli based on mechanisms at the level of nuclear constituents (hadrons), rather than nuclei [1m]; and several other new energies.

The fundamental open problem of all the above studies, for which they are rejected by the scientific establishment, is that *research on new clean energies currently lacks a quantitative scientific treatment.*[3]

In fact, most of the new energies *are not* predicted by quantum mechanics, the discipline most accepted at this time. Moreover, a quantitative treatment of the new energies with a new discipline that is as consistent as quantum mechanics does not exist prior to this series of papers. The lack of acceptance by the scientific establishment is, then, an unavoidable consequence.

A symptomatic illustration of the current status of the field is the statement made by Nobel Laurate Murray Gell-Mann during a recent lecture at Portland State University: "Cold fusion is theoretically impossible, and there are no experimental findings that indicate it exists."

After achieving a position at Harvard University under support from the Department of Energy, I left academia as a necessary condition to conduct the studies outlined in these articles (see a chronology of the events in Refs. [2a,2b]). Therefore, I am one of the last persons that may agree with Murray Gell-Mann on the status of particle physics in general, and on his quark conjecture, in particular.

Yet, we must all agree for objectivity with the first part of Gell-Mann's statement: "Cold fusion is theoretically impossible," of course, when referred to established doctrines as Gell-Mann tacitly did. Lacking a quantitative theoretical representation (in the sense of footnote[3]), the scientific establishment has no other alternative than that of dismissing the new field. Lack of consideration of available experimental evidence is then a mere consequence, as seen from the viewpoint of the scientific establishment.

The main aspect which was carefully avoided by Murray Gell-Mann, and does not appear to have received due consideration in the literature of the new energies, is that *new energies in general, and cold fusion in particular, are incompatible with Einstein's special relativity, as we shall see in Sect. 3.1. That incompatibility is the real political problem of the new energies vis-a-vis the academic-governmental establishment.* Therefore, for all orthodox physicists with sufficient technical knowledge, the mere "consideration" of experimental evidence on the new energies is, *de facto*, an admission of doubt on the exact validity of the beloved special relativity, with consequential automatic expulsion from the academic-governmental belief structure.

It is notorious that some official journals of physical societies systematically reject new experimental evidence which is not corroborated by quantitative theoretical studies. In addition to denouncing the anti-scientific character of this widespread practice, the best we can do to change it is to provide new quantitative theoretical representations of the new experiments (in the sense of footnote[3]).

As an explicit example, Murray Gell-Mann is not in a position to accept research which does not possess a quantitative theoretical representation, because the research may imply, directly or indirectly, a violation of established, fundamental physical laws. Therefore, new experimental results often raise basic questions, which are generally used as reasons for scientific caution in editorial processing or in public statements by the physics establishment.

The first objective of this series of paper is that of providing *a rigorous, consistent, and*

[3] By "quantitative scientific treatment" I mean a representation via a theory which: 1) is mathematically consistent; 2) is in agreement with established physical laws, such as conservation laws, Pauli's exclusion principle, Heisenberg's uncertainties, etc. (until experimentally disproved in clear terms); and 3) permits numerical predictions which are invariant under the time evolution of the theory itself (as well as other basic symmetries) and which can be verified with experiments.

invariant theory for the systematic scientific study of new clean energies. As will be shown, such a theory results to be a broadening (also called covering) of quantum mechanics, yet verifies all conventional quantum laws, such as: total conservation laws, Pauli's exclusion principle, Heisenberg's uncertainties, causality, etc. The availability of such a theory will then void the primary objections against new clean energies by Gell-Mann, and the physics establishment.

Another objective of this series of papers is to identify the specific physical laws, conditions, and geometries under which the new clean energies are possible, as predicted by the covering theory. This identification is another mandatory requirement for serious scientific studies of new clean energies, evidently because no serious research on the improvement of the energy release can be conducted in their absence.

The knowledge acquired in this way will be applied to the identification of the best possible technological realizations of said physical laws, conditions, and geometries, as a prerequisite for the improvement of the efficiency of new clean energies.

Another major development on the final part of this millennium has been the increasing general awareness of alarming environmental problems caused by the current very large combustion of fuels of fossil origin, which include: excessive carcinogenic substances in the combustion exhausts; depletion of oxygen in our atmosphere; the "green house effect" caused by excessive emissions of carbon dioxides; and other serious environmental problems.

Since we do not have alternative natural resources for acceptable new fuels, the above problems have created the need to search for new technologies capable of producing environmentally acceptable new fuels, that is, fuels with: a dramatic reduction of carcinogenic substances in the exhausts; a positive oxygen balance (in the sense of emitting more oxygen than the amount used for combustion); and carbon dioxide content in the exhausts down to levels controllable via chemical means, such as the currently available CO_2-absorbing sponges.

The studies reported in this series of papers were initiated over two decades ago for the dual objective of searching for new clean energies and fuels, because the sole solution of only one of these two problems would leave unresolved major environmental problems.

As will be shown, the new technologies needed for the production of new clean energies also apply to the production of new clean fuels. Therefore, the search for new clean energies and fuels can be conducted via the search for unified scientific treatments, unified physical laws, and unified technological realizations.

In closing these introductory comments, permit me to express my conviction that no significant advancement on the fundamental needs of society for new clean energies and fuels is possible without a joint consideration of problems of scientific ethics and accountability in a way known by the public [2]. This profile is generally absent in research. However, it is mandated in this case by the existence of organized academic-governmental interests on established doctrines, while real advances on new clean energies and fuels require the surpassing of said doctrines. The joint consideration of issues pertaining to scientific ethics and accountability is then necessary for any serious appraisal of advances.

An effective illustration is given by known extreme oppositions against research on cold fusion following the announcement by Fleishmann and Pons in 1989, as voiced by various famous physicists at leading academic institutions, subsequently backed by governmental agencies. A joint open appraisal, in a way known to the public, of issues pertaining to scientific ethics and accountability at the voicing of said objections, would have established that: 1) The scientists opposing research on "cold fusion" were receiving large public funds for research on the "hot fusion"; 2) Half a century of research and the expenditure of hundred of billions of dollars in public funds have established the lack of practical value of the "hot fusion" beyond any possible doubt; 3) By comparison, research in "cold fusion" had been initiated (and conducted ever since) with private funds, the experimental evidence already as available in 1989 was significant, and the topic should deserve serious interest by any true scientist due to the indicated societal needs for new clean energies.

In conclusion, the conduction of a public investigation on issues pertaining to scientific

ethics and accountability at the time of the initiation of strong oppositions against research on "cold fusion", would have revealed the existence of serious ethical problems in the research on "hot fusion", and no comparatively meaningful problem in the research on the "cold fusion". The absence of a publicly conducted investigation on scientific ethics and accountability had, instead, the opposite result we all know: the widespread perception by the public of problems of scientific ethics in the research on "cold fusion", without any awareness of corresponding serious problems in the research on "hot fusion".

It is an easy prediction that organized interests on pre-existing doctrines in academia and government will abuse again the authority of their institutions to voice strong oppositions against future announcements of major advances in new clean energies and fuels, since said interests have remained completely unchanged since 1989.

In a scenario of this nature, advances in new clean energies an fuels will crucially depend on the capability by the community of researchers in the field to learn from past occurrences, and initiate vigorous public investigations on problems of scientific ethics and accountability immediately following any voicing of objections by leading physicists at leading academic institutions or governmental agency.

Unfounded academic objections against serious scientific studies on the much needed new clean energies and fuels are also the reason for a historical shift in the U.S.A., as well as abroad, on the conduction of truly innovative research, from the traditional academic-governmental complex to corporations. As an example, qualified research on "new" basic advances (that is, advanced beyond Einstein's special relativity) is often not possible today at Princeton University, Harvard University, the California Institute of Technology, and similar institutions. Such investigations are nowadays solely supported by corporations.

Unfounded academic rejections are also the reason why the scientific function of Journals such as *Journal of New Energy* is invaluable, because the publications of qualified scientific papers would not be otherwise permitted in journals controlled by by the contemporary academic-governmental community (as shown in [2a] and documented in [2b]).

1.2. Definition of New Energies.

In these papers I am interested in studying energies and fuels as per the following:

> *DEFINITION 1.2.1: Energies and fuels are hereon said to be: "new," if and only if they cannot be predicted and treated via quantum mechanics, chemistry, superconductivity, or other established disciplines; "clean," in the sense that they do not produce radiations, waste, or exhausts harmful to humans and the environment; and " real," when they are realizable with current technologies in a way having practical, therefore, industrial and consumer value.*

The first four papers of this series are primarily devoted to the study of new clean energies at various levels. The study of new clean fuels will be conducted in Paper V, although it will require indeed all the preceding knowledge, as will be shown.

To begin, I am interested in quantitative theoretical studies of new forms of energy whose Coefficient of Performance (COP) is over-unity:

$$COP^{Out}_{In} = \frac{E_{Out}}{E_{In}} > 1 \qquad (1.2.1)$$

Third, I am interested in identifying physical conditions under which the above over-unity can be either established with new equipment, or improved for the case of existing new energies.

To begin, it is important to dispel a number of misconceptions regarding the above identified

new energies.

All conceivable forms of energy permitted by established disciplines have been subjected to systematic studies conducted by thousands of scientists throughout this century. The hope that these theories could still permit the discovery of basically "new" energies is so remote as to discourage any interest on my part, and motivate my admiration for colleagues attempting that route.

I should also warn innovative researchers against attempting the representation of "new" energies with "pre-existing" doctrines. To my best knowledge, all attempts along those lines have degenerated into a number of controversies, for which reason they are rejected by both innovative and orthodox physicists alike.

An illustration is given by the over-unity of the exploding water mist, whose existence has been established beyond scientific doubt [1g]. The conventional interpretation of this evidence is stated as due to conventional molecular effects. The data are generally rejected, because the mist explodes with a thunder stronger than that produced by the equivalent amount of dynamite. The conventional "explanation" is then easily established by calculations to be implausible, not only because numerically insufficient to explain all data, but also because the final temperature of the system is essentially the same as the original one.

Similar unsettled controversies result for other cases of "explanations" of "new" energies via pre-established doctrines. It is time for both innovative and orthodox scientists to acknowledge that "new" energies as per Definition 1.2.1. require "new" theories.

I should also warn orthodox physicists that the belief in the "final" character of quantum mechanics is no longer accepted by a large percentage of their own orthodox peers. As shall be shown, most physicists are nowadays engaged in one or another *generalization* of quantum mechanics, such as quantum deformations, string theories, supersymmetries, etc., although none of them has seen any practical application, and none is in sight to my best knowledge.

Another misconception I would like to dispel is a rather widespread belief that over-unity implies the violation of the principle of conservation of energy. The complete scientific formulation of the energy balance requires the necessary inclusion of *all* energies, and not only the output and input energies, as in Eq. (1.2.1).

In particular, the *total output energy* $E_{Tot,Out}$ is the sum of the output energy as in Eq. (1.1.1) plus all internal losses due to heat, dispersions, etc., while the *total input energy* $E_{Tot,In}$ is the sum of the outside energy supplied to the systems (say, the electrical energy), plus the internal energy of the system itself. It is easy to see that the ratio is always *smaller* than unity, because of our inability to account for all possible losses:

$$COP_{Tot} = \frac{E_{Tot,\,Out}}{E_{Tot,\,In}} = \frac{E_{Out} + E_{Losses}}{E_{In} + E_{System}} < 1 . \tag{1.2.2}$$

The over-unity as per Eq. (1.2.1) is therefore fully compatible with the principle of conservation of energy, because it deals only with parts of the total energies.

The most effective way to establish the latter possibility is by recalling that *over-unity energies (according to the above definition) are fully permitted by quantum mechanics.* A notorious example is that of nuclear power plants which have a COP^{Out}_{In} of the order of 100,000, but always such that the COP_{Tot} remains smaller than one when the intrinsic energy of the system (this time given by the fissionable nuclei) is included:

$$\frac{E_{Out,Nuclear}}{E_{In,Nuclear}} \approx 10{,}000 , \tag{1.2.3a}$$

$$\frac{E_{Tot,\,Out}}{E_{Tot,\,In}} = \frac{E_{Out} + E_{Losses}}{E_{In} + E_{Nuclei}} < 1 . \qquad (1.2.3b)$$

As an example, in the transition from a nuclear power plant to cavitation, explosion of water mists, or Magnegas, we merely replace the internal energy of fissionable nuclei with the internal energy of the water. The novelty is that the latter needs to be studied with *new theories* for a complete energy identification, as will be shown.

In short, the over–unity character of new energies is fully plausible because compatible with existing physical laws, and, therefore, deserving quantitative studies.

1.3. Statement of Objectives.

The primary scope of these papers is to outline a quantitative theoretical representation of new energies (in the sense of footnote[3]) which is permitted by a generalization of quantum mechanics called *hadronic mechanics,* which I originally proposed in 1978 when at Harvard University under DOE support [3a]. Hadronic mechanics was subsequently studied by numerous mathematicians, theoreticians, and experimentalists (see monographs [3b,3c] and references quoted therein), and has recently achieved operational maturity in refereed journals of the establishment (see memoirs [3d–3f]).

The representation of new energies via hadronic mechanics has the following main features: 1) It is mathematically consistent; 2) It verifies all conventional physical laws; 3) It is invariant under the time evolution of the theory as well as all applicable symmetries; 4) It already possesses numerous applications and experimental verifications following specific numerical predictions; and 5) It is a "covering" of quantum mechanics in the sense of admitting the latter as a simple particular case.

The primary objectives of these papers are: 1) achievement of a representation of, at least, some of the emerging new energies via hadronic mechanics; 2) identification of the conditions under which new energies are possible and, 3) use of the knowledge acquired in this way to propose specific new practical realizations or specific possibility of improving the COP^{Out}_{In} for existing new energies.

For instance, after achieving a quantitative representation of plausible conditions under which the deuterium can be stimulated to synthesize the Helium, we shall identify specific treatments of the heavy water under which the efficiency of the process has a realistic possibility of being increased.

Needless to say, I am referring to possibilities submitted to interested colleagues for independent appraisals. Nevertheless, if quantitative representations achieve full maturity in due time following all necessary improvements and independent contributions, the current laborious process of trials and errors in the study of new energies will be replaced by operational research.

Quantitative studies on new energies via hadronic mechanics require the necessary consideration of the following seven main aspects:

1) IDENTIFICATION OF THE INSUFFICIENCIES OF QUANTUM MECHANICS IN VARIOUS FIELDS. Rather than being a "final" theory for all possible conditions existing in the universe, quantum mechanics possesses well defined boundaries of applicability within which the theory is valid, but beyond which the theory is generally *approximate* or *inapplicable* (rather than being "violated"). These insufficiencies have a fundamental relevance for new energies, because they are an evident prerequisite for possible novelty. These insufficiencies are some of "the best kept scientific secrets" of the establishment because, even though discussed and at times admitted in academic corridors, they are never mentioned in the orthodox literature. These insufficiencies are known to researchers in new energies. Nevertheless, for completeness, in the next sections I shall review insufficiencies of quantum mechanics which are particularly important for new energies. A more

technical identification and resolution of these insufficiencies will be provided in the following papers.

2) INCONSISTENCIES OF EXISTING GENERALIZED THEORIES. When faced with the evidence of the limitations of quantum mechanics, a general tendency is that of suggesting the use of one or another of the numerous broader theories that have been attempted during this century. Another "best kept scientific secret" is that these broader theories are afflicted by physical inconsistencies so severe as to prevent their use in practical applications. In fact, they generally violate the fundamental condition of invariance of the basic units, data elaboration, and numerical results, thus having no known physical meaning. Serious quantitative studies of new energies, therefore, require at least a knowledge of these inconsistencies which are outlined in Paper II. In particular, these inconsistencies show how difficult is the task of identifying a mathematically and physically consistent generalization of quantum mechanics.

3) NEED FOR NEW MATHEMATICS. It has been established in the mathematical literature (see, e.g., Ref. [3e]) that the achievement of invariance for physical conditions outside the arena of applicability of quantum mechanics requires *new mathematics* specifically constructed for that purpose: that is, new numbers and fields, new vector and Hilbert spaces, new algebras and geometries, etc. No serious quantitative studies of the new energies can be done without an outline of this new mathematics, which is presented in Paper II.

4) OUTLINE OF HADRONIC MECHANICS. The rudiments of the new mechanics are presented in Paper II jointly with an outline of its application to generalizations of other disciplines, such as quantum chemistry. In paper II is also presented a simple method for the construction of concrete applications of hadronic mechanics, which consists of the systematic application of nonunitary transforms to conventional quantum models. As indicated earlier, studies on the construction of hadronic mechanics over the past two decades have been quite vast[4]. In these papers I can outline only the most salient aspects and refer to Refs [3] for technical descriptions.

5) AVAILABLE APPLICATIONS AND EXPERIMENTAL VERIFICATIONS OF HADRONIC THEORIES. Another mandatory aspect for a serious appraisal of the studies presented herein, is a knowledge that hadronic mechanics already has numerous applications and experimental verifications in a variety of fields. An outline of these verifications, presented in Papers III, IV. and V, provides the necessary credibility for the application of hadronic mechanics to new energies.

6) PHYSICAL LAWS OF NEW ENERGIES. Upon the presentation of the preceding results, I shall identify the physical laws of new energies as per Definition 1.2.1 in the form predicted by hadronic mechanics. This study is conducted in Paper III for the particle level, in Paper IV for the nuclear level, and in Paper V for the molecular level.

7) STUDY OF SPECIFIC FORMS OF NEW ENERGIES. As illustrations, I shall present some of the existing new energies, as well as identify new forms of energy as predicted by hadronic mechanics. I shall then indicate possible ways of improving the efficiency of new energies, attempt alternative realizations, and submit specific embodiments for new forms of energy. This final task shall be presented in Paper III at the particle level, Paper IV at the nuclear level, and Paper V at the molecular level.

In conclusion, the first and perhaps most important point I have learned in over two decades of studies is that, *new energies cannot be studied at the individual level in which they may appear to occur, because they require a systematic study of the totality of possible contributions at each*

[4] Hadronic mechanics has been studied in over 1,000 papers in various fields, in some 15 monographs, and over 40 volumes of conference proceedings, resulting in a total of over 10,000 pages of published research.

individual particle, nuclear, and molecular level.

We shall present in Papers III, IV, and V, the concept that the insufficiency of existing new energies is due to the lack of scientific knowledge of the physical laws and conditions under which they are possible. In addition, insufficient consideration and quantitative treatment is given to all the effects that contribute to the realization of the new energies being considered.

The studies presented in these papers are at their infancy and much remains to be done. I will. therefore, have achieved my objectives if I stimulate the interest of experts in new energies to continue studies along these lines. I would be grateful for any constructive criticism on the technical content of these papers, or on insufficiencies of its literature for immediate correction in future presentations.

I do not claim the representation of new energies via hadronic mechanics to be the only viable one. In fact, real scientific inquiries (those outside controlling academic interests) are known to be polyhedric, because each theory can at best contain only a partial truth.

Other quantitative representations of new energies as per Definition 1.2.1 are encouraged, but under the conditions that: 1) they are based on theories broader than quantum mechanics; 2) are proved to be as invariant as quantum and hadronic mechanics at all levels; and, as a necessary condition to avoid exiting science for plagiarisms and other illegalities; 3) they are rigorously proved to be inequivalent to hadronic mechanics, i.e., they are outside the class of equivalence of hadronic mechanics which, as we shall see in Paper II, is that characterized by all infinitely possible, single- or multi-valued, nonlinear, nonlocal, and nonunitary transforms.

2. INSUFFICIENCIES OF QUANTUM MECHANICS IN VARIOUS FIELDS

2.1. Conditions of Validity of a Given Theory.

History of science teaches that physics and all other quantitative sciences will never achieve "final theories." No matter how good any given theory may appear at a given time, its subsequent replacement with a broader theory for more general conditions is inevitable.

Moreover, physics and all quantitative sciences, in general, have an absolute standard of value: the experimental verification. The validity of a theory can therefore be inferred solely from its capability to explain experimental data. The inverse posture of denying experimental evidence just because it does not conform to pre-existing theories, is not scientific.

Experiments have their own standards of value; the more basic the law or property to be tested, the more important the experiment. As a result, the appraisal of the validity of a theory is primarily based on the verification of primary basic laws or properties, with lesser relevance carried by less relevant tests.

Representations themselves have their own standard of values because, to be scientifically credible, they have to occur *directly from the basic axioms of the theory considered* without mathematical manipulations or the customary introduction of *ad hoc* parameters to adapt existing experimental data to pre-existing theories.

In these papers, therefore, the following definition is used:

> *DEFINITION 2.1.1: A given theory is said to be "valid" if and only if: 1) it represents "all" experimental data of the field considered; 2) all such representations are "exact"; and 3) the representations occur without the introduction of physically unmotivated parameters. If any given theory represents the experimental data only in part, it is said to be "approximately valid". If any given theory violates one or all of the above requirements, it is said to be "inapplicable" (rather than "violated") because not constructed for the considered experimental conditions.*

The "historical curve" of a given theory is essentially the following. Founders generally

submit their theories for well-defined physical conditions, often called "original arena of applicability" of the given theory. For instance, quantum mechanics was conceived and constructed to represent the Hydrogen atom, which is therefore its original arena of applicability; the special theory of relativity was historically proposed to represent particles which can be well approximated as being point-like when moving in the homogeneous and isotropic vacuum; general relativity was originally submitted to represent gravitation for the representation of point masses in vacuum; etc.

When new theories are initially presented, they are generally dismissed by organized academic interests of the time, and claimed to be figments of imaginations. It is well documented that this initial dismissal happened to quantum mechanics, and both the special and the general relativities at the time of their birth.

Subsequently, theories based on sound assumptions generally receive experimental verifications, after which they become accepted by the academic establishment.

With the passing of time, all important problems of the original arena of applicability of a given theory become exhausted. A rather natural historical process is therefore that of attempting the application of the theory for conditions beyond those of its original conception.

At that juncture it is a widespread practice to *modify* the theory to represent the new conditions and then claim that the theory is still valid. These adaptations are generally done with the introduction of *ad hoc* parameters which have no known or otherwise conceivable physical meaning.

At that event, there is the transition from science to academic politics. In fact, whether orthodox or not, to be "scientific", any paper on a theory requiring unknown parameters for the representation of given experimental data must explicitly state the "approximate character" of the theory itself. If there is silence on this fundamental point, the paper violates basic tenets of scientific ethics, no matter how important is the author's affiliation or the journal publishing the article.

The unknown parameters which are introduced to explain experimental facts precisely characterize the *deviation* of the theory from the experimental evidence at hand. After all, to be valid, a theory must represent the experimental data from its basic axioms without any modification (Definition 2.1.1). Lack of implementation of these scientific procedures in *publications*, creates clear problems of scientific ethics.

As will be shown, there are too many adulterations of rigorous scientific proceedings aimed at the adaptation of quantum mechanics and other established theories to experimental facts.

The final stages of an established theory are generally marked by excesses perpetrated by organized interests in academia, yet are tolerated by our society because of the perceived credibility and power of their institutions.

Some of the schemes include suppressing, discrediting, or jeopardizing the scientific process on new theories via the disqualification of the researchers, the dismissal of novel experimental evidence, the opposition to undesired basic experiments and other misbehavior (see Refs. [2] for unreassuring cases and their documentations). Other schemes imply sheer adulterations of experimental data, deceptions under public support and other manifest violation of the Civil and Criminal Codes of Laws perpetrated at high ranking institutions under protracted impunity because of their unfortunate tolerance by our permissive societies.

Currently, quantum mechanics, the special and general relativities are clearly in their final stages depicted above. The new energies are emerging in this scientific environment, thus being the victims of scientific denials by opposing academic interests. This academic denial is the reason why really innovative advances can only be reached by the joint consideration of issues pertaining to scientific ethics.

Judging from my personal experience as well as that of numerous other colleagues, it is a truism that *the most unscientific aspect of our contemporary societies is the current scientific process.*

In this section, I shall attempt to provide readers with elements useful to reach an independent judgment on the exact or only approximate validity of quantum mechanics, the special and the general relativities. I will have achieved my task if I succeed in showing that *the problem of*

the theories that are valid for new energies is an open issue at this time. True research is not conducted with arrogant claims of universal validity of old doctrines, and should be based on the humble statement: *we do not know.*

2.2. Insufficiencies of Quantum Mechanics in Atomic Physics.

Quantum mechanics (see, e.g., textbook [4] and references quoted therein) is one of the most majestic disciplines constructed in this century, with applications, implications, and verifications in virtually all scientific branches.

Some of the important features of the theory are: its remarkable axiomatic consistency characterized by the mutual compatibility of all the various formulations; its verification of all basic physical laws of the particle world experimentally established to date; and the capability to predict numerical results which are invariant under the time evolution of the theory.

Despite these clearly historical results, quantum mechanics cannot possibly be a "final theory" because it admits of clear insufficiencies in its conceptual, mathematical, and experimental foundations, as it is the fate of all scientific theories (including the generalized theories presented in these papers). The only issue which can be scientifically debated is the selection of a covering theory admitting quantum mechanics as a particular case, yet applying for more general conditions.

The main objective of this Paper I is to identify the insufficiencies of nonrelativistic and relativistic quantum mechanics that have a direct bearing on new energies, and point out the physical conditions beyond which the theory can only be claimed to be *approximately valid* as per Definition 2.1.1. These insufficiencies will then be the foundations of our subsequent studies.

This presentation is warranted by the fact that the insufficiencies of quantum mechanics are known to experts in the field, because myself and several others have discussed them with colleagues in "leading" academic institutions verbally and in personal correspondence. Yet, these insufficiencies are "the best kept secret of the trade" because never presented in Ph. D. courses or in technical papers.

The first authoritative doubts on the final character of quantum mechanics were expressed by Albert Einstein and his group. In fact, Einstein, Podolsky and Rosen (E-P-R) [5a] in 1935 presenting the view that quantum mechanics is "incomplete", a view which is nowadays known as the *historical E-P-R argument* (see also the historical account by J. von Neumann [5b]). Numerous "completions" of quantum mechanics were then attempted throughout this century, without achieving consistency and maturity for applications.

In these papers I shall show that hadronic mechanics has achieved a consistent "completion" of quantum mechanics precisely along the historical E-P-R argument (the reader interested in a preview may study paper [5c], specifically, on that topic). I shall then outline available applications and experimental verifications. Comprehensive presentations and related literature are available in Refs. [3].

Quantum mechanics is exact for the ground state of the hydrogen atom because, in accordance with Definition 2.1.1, it represents the *totality* of the experimental data in an *exact* way.

On strict scientific grounds, *quantum mechanics cannot be considered as exact for the excited states of the hydrogen atom because of a number of unsettled insufficiencies for quantum numbers greater than two.* For instance, the disagreement between the predictions of quantum mechanics and the experimental data for the Lamb shift in the 3S state of the hydrogen atom is of the order of 20% [6a,6b].

Disagreements up to 50% exist between the predictions of quantum mechanics and the experimental data of the cross section of electrons scattering on hydrogen molecule [6c,6f].

In the transition from the hydrogen atom to multi-electron systems, the insufficiencies of quantum mechanics become much greater. Well known in this respect is the dissident voice by J. Slater [6g] who, for that reason, was kept outside the physics establishment.

More specifically, *quantum mechanics cannot be claimed to be exact for all atoms heavier than the hydrogen* because of its inability to represent *all* data in an *exact* way.

Experimental evidence establishes that the two electrons of the helium atom orbit together, not in a disjoint form, but in a "correlated" form, i.e., they can couple in a singlet[5] quasi-particle bound state as in Fig. 1. The inability of quantum mechanics to represent this occurrence is evident because, according to that theory, two identical electrons cannot possibly form a bound state due to the known repulsive Coulomb force.

More specifically, the insufficiency rests in the inability of quantum mechanics to provide a quantitative explanation of Pauli's exclusion principle which is generally *assumed* as a pillar of the theory without any explanation. In fact, quantum mechanics has been unable to provide a quantitative-mathematical representation of the reason why two electrons cannot occupy the same orbit with the same quantum numbers, and are admitted only when they have different quantum numbers, such as spin antiparallel.

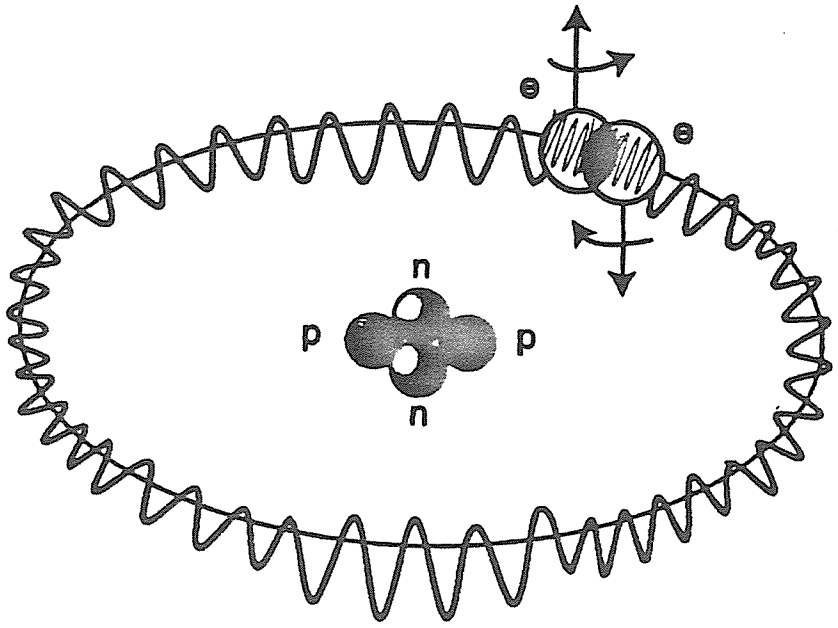

FIGURE 1: A schematic view of the inability by quantum mechanics to explain the correlation/coupling of the two electrons in the Helium atom and, more precisely, the inability to explain the underlying Pauli's exclusion principle.

The inability of quantum mechanics to explain Pauli's exclusion principle is due to the fact that the "exclusion" can only occur via interactions. The only interactions representable via quantum mechanics are those via the addition of a potential energy to the Hamiltonian. The problem is that any attempt along these lines is bound to be in dramatic disagreement with reality because the added potential alters all the spectroscopic lines that are known with extreme precision.

In short, the sole possible interpretation of Pauli's principle requires "interactions at-a-distance without energy exchange", a notion dramatically beyond any possible quantitative treatment by quantum mechanics.

As we shall see, besides verifying Pauli's principle in its entirety, hadronic mechanics permits its first known interpretation precisely because it introduces a new class of interactions, without energy exchange, that are represented with anything *except* the Hamiltonian.

Quantum mechanics represents the radiation emitted by the hydrogen atom with an

[5] Singlet couplings for particles with spin 1/2 (as is the case of electrons) are referred to the case when the two spin orientations are anti-parallel as necessary in this case from Pauli's exclusion principle, while triplet states refer to the case when the two spins are parallel. The word "singlet" denotes the existence of only one possible total spin, zero. The word "triplet" denotes instead the existence of three possible total spin orientations +1, 0 and -1.

incredible accuracy, while in the transition to the Helium we begin to see spectroscopic deviations from the predictions of the theory. These deviations increase with the increase of the size of the atoms.

At this point, supporters of quantum mechanics resort to all sort of machinations in an attempt to adapt physical reality to their beloved theory. This adaptation is generally achieved via sheer political manipulations deprived of scientific content, such as the admission of a combination of *different* orbits for the spectrum emitted by *one* orbit, the introduction of unknown parameters "to make things fit" and other schemes.

The final test recommended to researchers in new energies to ascertain whether a supporter of the validity of quantum mechanics for all atoms is in good faith or not, is to let him/her "face the Sun", that is, ask the exact representation via quantum mechanics of the spectrum of electromagnetic waves emitted by the Sun. This is a known impossibility because the Sun emits a seemingly infinite spectrum while we know only those of a finite number of atoms.

In summary, numerous, clear, incontrovertible and independent insufficiencies establish the historical E-P-R "incompleteness" of quantum mechanics in atomic physics beyond scientific or otherwise *credible* doubts.

2.3. Insufficiencies of Quantum Mechanics in Nuclear Physics

Nuclear physics is another field in which quantum mechanics has made historical contributions (see, e.g., the historical references [7a-7c], the more recent textbooks [7d,7e], and others easily identifiable).

Nevertheless, the insufficiencies of quantum mechanics in nuclear physics are greater than those in atomic physics. These insufficiencies are also known to experts in the field, as I can personally testify during my stays at MIT, Harvard University, and similar institutions, but said insufficiencies are equally unavailable in the technical literature, and are carefully avoided in Ph. D. courses.

It is evident that the insufficiencies of quantum mechanics in nuclear physics have a truly fundamental role for quantitative studies on new energies, as we shall see, in detail, in subsequent papers. In this section I shall identify introductory insufficiencies. More technical insufficiencies and their resolution will be presented in Paper III.

The only scientifically correct statement which can be made at this writing is that quantum mechanics provides a *good approximation* of the nuclear structure, but it *cannot* be claimed to be *exact* in that field because the theory failed to represent in an exact way *all* nuclear characteristics beginning with the lightest nucleus, the deuteron.

In fact, quantum mechanics has been unable to reach an exact representation of total nuclear magnetic moments, beginning with that of the deuteron despite numerous attempts conducted by numerous physicists throughout this century (and a river of public money). This insufficiency is clearly stated in Ref. [7c], p. 31, while the claims of valid representations of nuclear magnetic moments ventured in more recent treatises, such as that by A. de Shalit and H. Feshbach [7d] have no scientific credibility, as we shall see in this section.

Today, quantum mechanics still misses 2.3% of the numerical value of the nonrelativistic treatment of the magnetic moment of the simplest possible nucleus, the *deuteron*, as one can see in Ref. [7c], p. 109 or Ref. [7d], p. 61.

Progressively larger deviations, to the order of 30% and more, exist in the representation of the magnetic moment of bigger nuclei. These deviations grow to truly large percentages for the heaviest nuclei. Similar insufficiencies of quantum mechanics also exist in the representation of other nuclear data. As we shall see, the additional insufficiencies of quantum mechanics in nuclear physics are also crucial for quantitative studies of new energies via more appropriate theories.

The reason for the impossibility of quantum mechanics to represent exactly total nuclear magnetic moments is known by experts in the field, although it is not generally disclosed in the

technical literature. The Founders of nuclear physics, such as E. Fermi [7a], L. Rosenfeld [7b] and others had already identified this shortcoming in the 1940's and suggested as the most logical explanation that *when protons and neutrons (collectively called nucleons) became members of a nuclear structure, they experience a deformation of their shape (charge distribution) due to the intense nuclear forces. Such deformation implies an alteration of the intrinsic magnetic moments of the particles* (one may inspect this statement in p. 31 of Ref. [7c]). This conception is today known as "the (forgotten) historical hypothesis" on the deformability of nucleons.

This historical hypothesis can be easily identified at the classical level. In fact, any charged and spinning sphere possesses a magnetic moment along the direction of spin. All modifications of the *shape* of the sphere imply a necessary alteration of the magnetic moment. Note that these alterations can occur without any change of the intrinsic angular momentum.

Nuclear magnetic moments cannot be exactly represented by quantum mechanics because: 1) the theory assumes the conventional values of the intrinsic magnetism of protons and neutrons when the particles are isolated in vacuum; 2) the theory cannot represent extended, nonspherical and deformable particles; and 3) any possible alteration of the intrinsic characteristics of particles in vacuum is prohibited by the basic pillars of the theory, the spacetime symmetries. The Founders of nuclear physics then argued that, if the intrinsic magnetic moments are changed in nuclear conditions due to deformations, an exact representation of total nuclear magnetic moments is expected, a prediction that has turned out to be correct (see Paper III).

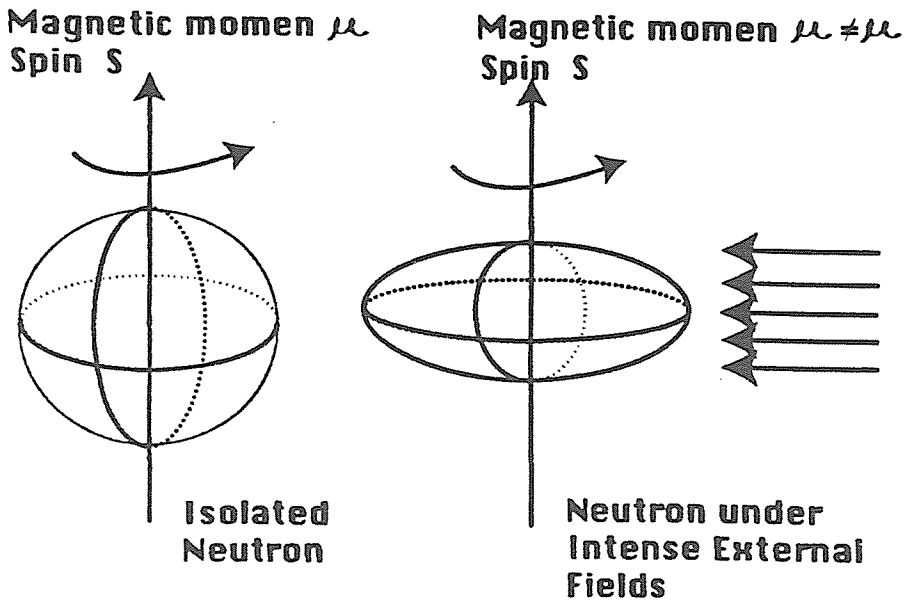

FIGURE 2. A schematic view of "the historical hypothesis" formulated by the Founders of nuclear physics in the 1940's as needed to represent total nuclear magnetic moments, according to which protons and neutrons experience a deformation of their charge distribution when members of a nuclear structure with consequential alteration of their *intrinsic* magnetic moment under conventional values of the spin. This representation is strictly impossible for quantum mechanics for various reasons, resulting in the impossibility for the theory to reach an exact representation of total nuclear magnetic moments.

Note that the deformation of the charge distribution of protons and neutrons when members of a nuclear structure is quite plausible because these distributions are extended and subjected to very intense nuclear forces (perfectly rigid bodies exist in academia but certainly not in the

physical reality). Moreover, the alteration of the intrinsic magnetic moment due to the deformation of shape is established at the classical level (indicated above), as well as at the atomic level (for the magnetic polarization of electron orbits).

Note also that the alteration of the intrinsic magnetic moment of protons and neutrons is fully compatible with the *conventional* value of spin 1/2, Pauli's exclusion principle, and other physical laws. We are referring to a deformation of shape *without* altering the intrinsic angular momentum (spin), as one can see beginning at the classical level.

Following the view presented in Ref. [7c], it was understood that the above "historical hypothesis" *cannot* be represented via quantum mechanics for numerous different reasons, such as the fact that: *all* deformations are strictly incompatible with quantum mechanics because they would imply the violation, for instance, of its fundamental rotational symmetry (which is solely valid for absolutely *rigid bodies*, as well known); the deformation is not allowed by another pillar of quantum mechanics, the Poincaré symmetry; and for several other technical reasons.

All these facts establish the *impossibility* for quantum mechanics to reach an *exact* representation of *all* total nuclear magnetic moments, with small deviations for small nuclei and large deviations for large nuclei.

The most familiar scheme perpetrated by orthodox academia is that of representing the deuteron *as a mixture of the ground state and excited states*. As an example, one can read in Ref. [7c], p. 108, that the deviation of the prediction of quantum mechanics from the experimental value of the deuteron magnetic moment is a "direct measure" of the admission of the D-state, in addition to the ground state, with similar statement available in Ref. [7d]. The more recent Ref. [7e] claims that the addition of further states can reduce the deviation of nonrelativistic quantum mechanics from the magnetic moment of the deuteron to about 1%.

In my view, the interpretation of the deuteron as a mixture of different states is a political machination without scientific content for various reasons. The experimental value of the magnetic moment of the deuteron is measured for the nucleus in its stable ground state and definitely not for a conjectural mixture of different energy levels.

Moreover, one of the pillars of quantum mechanics is the stability of the individual energy levels of a stable bound state when unperturbed. The admission of a mixture of different energy levels for the unperturbed deuteron is therefore against a very pillar of quantum mechanics.

Also, another foundation for which the notion of "quantum" was born is that transitions from different states require the emission or the absorption of energy. The conjectural belief in the orthodox nuclear physics literature that the deuteron admits mixtures of different states without emission-absorption of energy, then implies the exiting of the boundaries of science.

After seeing the impossibility of achieving a scientific representation of nuclear magnetic moments via *nonrelativistic* quantum mechanics, a more serious scientific deception is perpetrated by the claim that *relativistic* quantum treatments can resolve the issue (see, e.g., Ref. [7f] and papers quoted therein). To begin, nonrelativistic quantum mechanics provides a very good approximation of the ground state of the hydrogen atom in which the electrons are known to move at relativistic speeds with relativistic corrections providing numerically small changes which, for that reason, are called "fine".

In the transition to the deuteron, it is well known that its proton and neutron constituents positively move at nonrelativistic speeds due to their mass 2,000 times bigger than that of the electron. The very claim that relativistic quantum mechanics can resolve the missing macroscopic percentages at the nonrelativistic level is a calculated scientific deception, because experts know well that, in the latter case too, relativistic corrections can be at best very small.

After realizing the above numerical limitations, orthodox physicists keep adding more energy levels over those conjectured at the nonrelativistic level. The point is that, to qualify as "experts", these authors must know that such an assumption implies the violation of the basic pillars of the beloved theory they want to salvage.

But let us assume that, as a result of machinations and deceptions, the magnetic moment of the deuteron is finally represented. Fine. *What happens to all remaining nuclei?*

When orthodox physicists look happy because of the personal belief that the magnetic

moment of the deuteron can be well represented with their theory, true scientists should ask them the representation of the magnetic moment of *heavy* nuclei, such as the zirconium. Their silence is an acknowledgment of the impossibility of such a task, no matter whether one uses nonrelativistic or relativistic quantum mechanics or quantum field theory.

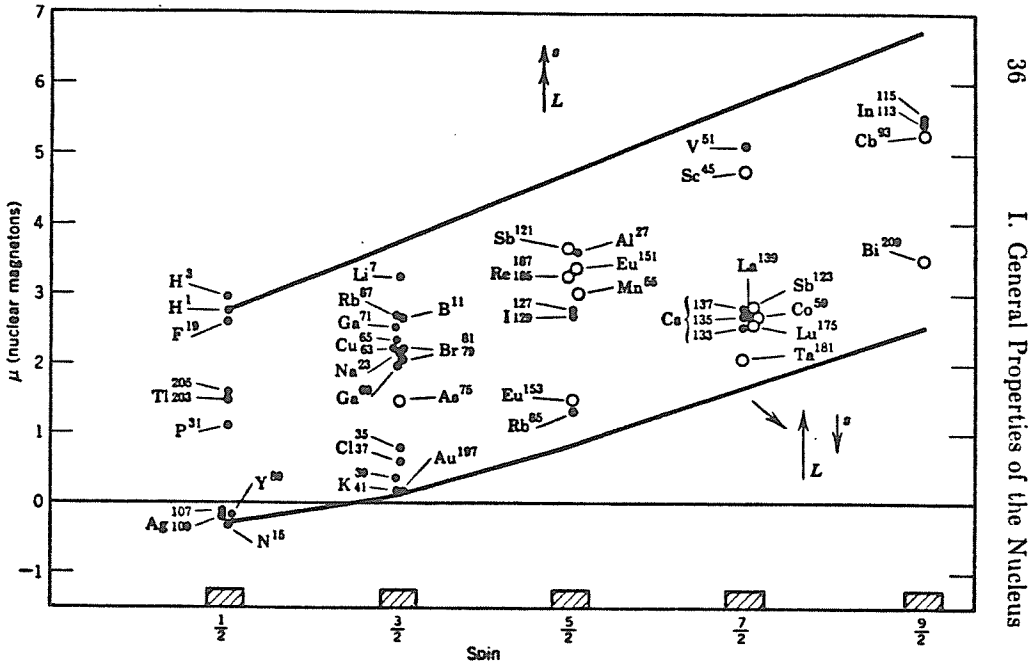

FIGURE 3: A schematic view of the experimental values of total nuclear magnetic moments from Ref. [7a] which fail to follow the predictions of quantum mechanics, and are instead contained within minima and maxima called the *Schmidt limits.* In essence, the known values of the intrinsic magnetic moments of protons and neutrons and the quantum mechanical rules of their additions as valid in the atomic structure *do not* yield the experimental value of total nuclear magnetic moments. Therefore, the Schmidt limits of this figure represent precisely the *deviations* of the numerical predictions of quantum mechanics from the experimental data on nuclear magnetic moments (see Ref. (7a) for details).

Other, more audacious orthodox physicists venture the personal belief that the problems of quantum mechanics for nuclear magnetic moments are "nonexistent" (a most frequently used word by organized interests in nuclear physics) because the correct nuclear structure is that in terms of *quarks* and, therefore, the correct theory is Quantum Chromo Dynamics (QCD) (see, e.g., Ref. [8] and literature quoted therein).

For readers not familiar with the horrendous conditions of particle physics, the occurrence is due to the plethora of unresolved inconsistencies of the hypothesis that quarks are physical constituents of hadrons, such as lack of confinement, impossibility to define gravity, and other truly huge inconsistencies (see next section). At any rate, QCD is a *nonlinear theory,* which means that nobody can calculate *exact* solutions. When orthodox experts claim that the problems in nuclear physics are resolved by quark theories, they should do so in full knowledge that no exact calculation

is possible.

The conjectural orbits of the conjectural quarks can only be very small (not bigger than 1 fm = 10^{-13} cm). The polarizations of these orbits are known to yield, at best, contributions to the magnetic moment of the nucleons of the order of 10^{-5}, thus being grossly insufficient to permit a scientific representation.

In short, the insufficiencies of quantum mechanics are *multiplied,* rather than decreased, in the transition from the real nucleons to the imaginary quarks.

Researchers in new energies should know that, for reasons we shall see in details later on, *quark conjectures are, by far, the worst political obstacles against quantitative studies of new energies.*

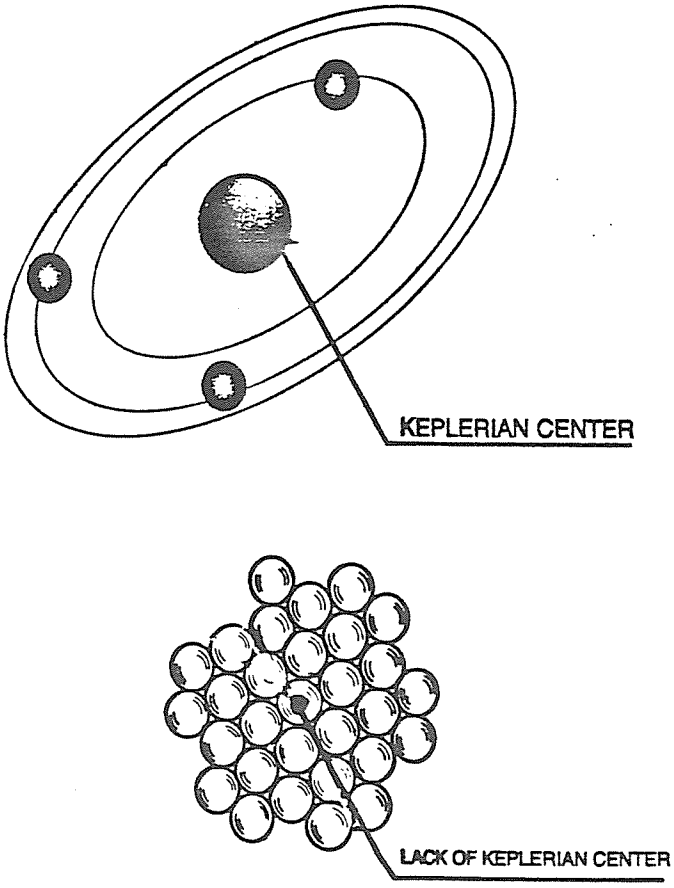

FIGURE 4: A schematic view of the primary differences between the atomic and the nuclear structure: the former constitutes a Keplerian systems with the heaviest constituents in the center, while the latter does not constitutes a Keplerian system and does not possess a Keplerian nucleus. This structural difference has truly fundamental implications inasmuch as it implies that the spacetime symmetries of the former *cannot* be exactly valid for the latter. As a consequence, a theory which is valid for the Keplerian structure of atoms *cannot* be exactly valid for the non-Keplerian structure of nuclei.

By comparison, as we shall see in Paper IV, via a simple quantitative representation of the historical hypothesis on the deformability of protons and neutrons, hadronic mechanics achieves an *exact* representation of the magnetic moments of *all* nuclei *in their ground state.*

In summary, a scheme in nuclear physics has been going on for half a century on the lack of representation of *all* nuclear magnetic moments with nonrelativistic quantum mechanics. When

passing to relativistic and QCD extensions there is a multiplication, rather than a solution, of the insufficiencies. The problems of scientific accountability are aggravated by the suppression of exact representations reached via more general theories such as hadronic mechanics.

A more unreassuring aspect is that the insufficiencies of quantum mechanics for nuclear magnetic moments are only the beginning, because greater insufficiencies exist for other aspects of nuclear physics we shall discuss more technically in Paper III.

Another *impossibility* for quantum mechanics to be *exact* in nuclear physics is visually established by the evidence that, unlike atoms, *nuclei do not have nuclei* [3c].

The pillar of nonrelativistic (relativistic) quantum mechanics, from which all results can be uniquely and unambigously derived is the fundamental Galilei (Poincaré) symmetry of the Minkowskian spacetime. When subjected to computer visualization, these symmetries characterizes the historical *Keplerian systems,* that is, systems possessing the *heaviest member in the center* (the Keplerian nucleus), with lighter constituents orbiting around it. This is precisely the structure of atoms, thus confirming the good approximation of quantum mechanics for the atomic structure.

By comparison, a basic characteristic of nuclei is that of having no Keplerian nucleus at all, and being instead composed by a number of extended protons and neutrons in *contact* with each other. In fact, nuclei admit in their center a particle which has essentially the same mass as that of all other constituents, which is impossible for a Keplerian system.

This evidence is sufficient to guarantee the lack of exact validity for the nuclear structure of the mechanics which is valid for the structure of the hydrogen atom. The only way to achieve an exact representation of nuclei as they are in the physical reality is to *modify the Galilei and Poincaré symmetries in such a way to suppress the Keplerian nucleus.* This is a major structural modification of the theory, technically characterized by the fact that the modified symmetry is no longer isomorphic to the original symmetry, thus establishing clear insufficiencies of quantum mechanics in nuclear physics.

When supporters of quantum mechanics are faced with this additional evidence, they retort to additional machinations. A most familiar one is the statement that the correct theory of nuclear physics is not quantum mechanics, but quantum field theory (see, e.g., Ref. [8] and literature quoted therein) at which level orthodox physicists claim the problem of the lack of Keplerian center is resolved.

To qualify as "experts", physicists must know that the insufficiencies of quantum mechanics in nuclear physics are *multiplied* when passing to quantum field theory.

In summary, publications based on the exact use of the Galilean and Poincaré symmetries for the nuclear structure without a clear identification of their approximate character constitute scientific lie.

By far the biggest insufficiency of quantum mechanics in nuclear physics occurs for the nuclear force. As it is well known, quantum mechanics can only represent *action-at-a-distance forces derivable from a potential.* As a result, the representation of the nuclear force attempted throughout this century has been that via potentials.

The studies initiated in the early 1940's via the use of *central potentials* as occurring in the atomic structure (i.e., potential solely depending on the magnitude of the mutual distances r of the nuclear constituents). It soon emerged that central potentials were insufficient to represent experimental data. New, non-central potentials were then invented and added to the central ones, but they too failed to represent experimental data, thus requiring the introduction of newer and newer potentials.

By following this historical process we reach the current situation whereby quantum mechanics attempts to represent the nuclear force via the use of a Hamiltonian with an unreasonably large number of potentials [7d]:

$$H_{Nuclear} = \sum p_k^2/2m_k + V_1 + V_2 + V_3 + V_4 + V_5 + V_6 +$$

$$V_7 + V_8 + V_9 + V_{10} + V_{11} + V_{12} + \ldots \qquad (2.3.1)$$

The unreassuring reality is that, following attempts throughout three-quarters of a century, quantum mechanics still misses a real understanding of the nuclear force. Therefore, efforts based on the addition of even more potentials are not longer scientific.

Unlike the case of the atomic structure, the nuclear constituents are in a state not only of "contact" with each other, but also in conditions of mutual penetration of their charge distributions for an average of 10^{-3} parts of the nucleonic volume (as established by comparing the experimental data on the volumes of nuclei and nucleons). But nucleons are some of the densest objects measured in laboratory by mankind. It follows that their mutual penetration in the nuclear structure requires the presence of "contact interactions" which, by conception, have *"zero range"*. As such they *are not action-at-a-distance,* thus being *beyond any hope of scientific representation via potentials.*

A topic of direct relevance for new energies is the deplorable condition on stimulated nuclear transmutations, where the scientific process has been and continues to be disrupted by opposing interests. As detailed in Paper III of this series, quantum mechanics does not predict that structures with the same charge, whether electrons or nuclei, can be "fused" into a new stable bound state at ordinary conditions available in our environment.

However, clear experimental evidence establishes the capability of electrons to bond together at ordinary conditions, as proved to be the case for: the Cooper pair in superconductivity; recent studies on the valence bond; charge clusters studied by Shoulders [1j], Jin and Fox [1k], *et al.*; ball lightnings visible to the naked eyes; and other events.

Since experimental evidence establishes that particles with the same charge, such as the electrons, can indeed bond themselves into stable state, the plausibility that nuclei can do the same at ordinary conditions is beyond any scientific or otherwise credible doubt, because physical laws are independent of the sign of the charge, or the numerical value of the mass.

As we shall see in Paper III, IV and V, the achievement of an actual, *attractive* force among the *identical* electrons in the Cooper pair, valence bonds, charge clusters, etc., requires the necessary inclusion of *nonpotential interactions,* which, in turn, can be solely represented via a *nonunitary time evolutions,*

This occurrence will provide the final evidence that *the bonding at ordinary conditions of states with the same charges, whether electrons or nuclei, is structurally beyond any hope of scientific treatment via quantum mechanics, including stimulated nuclear transmutations and all new energies, thus requiring the use of hadronic mechanics.*

A similar occurrence holds for the contemporary method of dating old objects via C^{14}, such as the dating of the *Sacred Shroud* in Turin, Italy. As the reader may know, current dating via C^{14} of the Sacred Shroud indicates its apparent origin in the 1400's, while one obtains a date back to Christ's time when using pollen and other means. The information absent in the official releases of such a carbon-dating' is that the method is subject to a number of personal beliefs by the experimenters, most notably, the belief that no possible event through the ages (such as radiation, fire, etc.) could possibly decrease or increase the number of C^{14} nuclei.

However, the indicated personal beliefs are disproved by the carbon-dating of certain Egyptian mummies whose age turns out ot be much younger than that established by archeological evidence. In turn, such dramatic differences *are* concrete experimental evidence of stimulated nuclear transmutations, which in this case, *increase* the number of C^{14} through the ages.

Note that *the very existence of C^{14} in our planet is anomalous, because these nuclei are unstable with a half -life of 5,730 years. Therefore, with the passing of the ages, all C^{14} on Earth should have disappeared millions of years ago. The very existence today of C^{14} in our planet is experimental evidence of a process capable of stimulating its synthesis.*

As it will be shown in Papers IV and V, *the most likely candidate for the synthesis of C^{14} is lightning via the use of individual or clusters of electrons (1j,1k) on nitrogen,* according to the basic reaction:

$$\text{Stimulated Electron Capture} + {}_7N^{14} \rightarrow {}_6C^{14} + \text{heat}, \qquad (2.3.2)$$

which is again prohibited by quantum mechanics under ordinary conditions, but which is predicted and quantitatively treatable by hadronic mechanics.

In particular, the origin of thunder, which is dramatically unexplained to this day, turns out to be direct experimental evidence of the creation by lightnings of stimulated nuclear transmutations such as Eq. (2.3.2) and others (see Paper IV). In fact, explicit calculations establish that only stimulated nuclear transmutations can provide an instantaneous amount of energy in such large amounts needed to explain thunder.

In conclusion, the current carbon-dating of the Sacred Shroud of Turin has no scientific credibility for various reasons, such as: 1) The dating is directly disproved by similar dating of very old Egyptian mummies whose age based on archeological evidence is simply incontrovertible; 2) The dating is based on the personal beliefs by the experimenters of the final character of quantum mechanics which prevent nuclear transmutations producing C^{14}; 3) The dating is further disproved by the mere presence of the Sacred Shroud in the vicinity of lighting with consequential *increase* of the number of C^{14} predicted by hadronic mechanics and *decrease* of its age; and other aspects.

Also, I would like to indicate the existence of similar deplorable conditions in another open problem of major social relevance, the disposal of extremely radioactive nuclear waste produced by nuclear power plants.

In the U. S. we have about 60,000 tons of highly radioactive waste (an apparently bigger amount exists in Europe); nuclear power plants have reached the limit of safe storage; and the waste keeps accumulating at the rate of about 6,000 tons per year.

The sole solution supported for decades by the U. S., European and other governments is that of transporting and storing this highly radioactive waste in a common dumping area. However, some of the radioactive nuclei of the waste have an average half life of 100,000 years. No matter how safe they may appear to be today, containers cannot possibly assure safety over such long period of time. Moreover, the indicated governmental policy implies the necessary transportation of large tonnages of highly radioactive waste in public streets. This policy has been the subject of fierce opposition by residents near the selected dumping sites, and by citizens and scientists at large.

It is evident that, in a scenario of this nature and dimension, the *only* possible solution is *scientific*, rather than political. The problem consists in the identification of *new means to stimulate the decay of the nuclear waste, by reducing their half life from hundreds of thousands of years down to days or hours.* Once this stimulated decay is performed within a protective environment, such as inside nuclear pools, the end results of the decay will be ordinary, light, stable, elements, thus achieving a "recycling" of the nuclear waste.

The above scientific task is prohibited by quantum mechanics, on numerous grounds, *e.g.*, the prediction by Einstein's special relativity and its underlying basic symmetry, the Poincaré symmetry, that the life of unstable nuclei cannot be changed under ordinary conditions. The dependance by government and academia on established theories explains the lack of any *scientific* solution of the problem of nuclear waste until now.

However, as shown in Paper III, *hadronic mechanics does indeed predict a number of new means with which radioactive nuclear waste can be stimulated to decay, while allowing the improvement of the efficiency of pre-existing methods, such as those based on charge clusters, large nuclear deformations, and other methods.*In the final analysis, the nuclei here considered are *very large* and *naturally unstable.* The plausibility of suitable means to accelerate their decay is beyond doubt.

Most intriguingly, the new equipment predicted by hadronic mechanics is expected to be sufficiently small to be usable by nuclear power companies in their own plants, *e.g.*, in the existing reactor pools, thus avoiding the transportation and storage of the waste, which has been predicted by our government to cost 230 *billion* dollars for the first five years of operation.

As shown in Paper III, the most fundamental point remains the same: the belief in the final character of quantum mechanics implies the impossibility of a *scientific* solution of the problem of nuclear waste, while the broader hadronic mechanics predicts a number of concrete *new* means to the stimulation of its decay.

It is my opinion that the problem of nuclear waste is, by far, the most important aspect supporting serious applied research on hadronic mechanics, because of evident political, scientific, and industrial advantages, the latter being given by the possible birth, in due time, of the new multi-million dollar industry for the development, production and sale of the new recycling equipment throughout the world.

In conclusion, the occurrences outlined in this section establish the validity of the historic E-P-R "incompleteness" of quantum mechanics in nuclear physics beyond scientific doubt. There is no doubt that quantum mechanics has permitted outstanding advances in nuclear physics during this century. Yet, physics will never achieve final theories, and the advent of a broader theory more suited for deeper studies of nuclear phenomena is only a matter of time.

2.4. Insufficiencies of Quantum Mechanics in Particle Physics.

As the complexity of the physical systems increase, the insufficiencies of quantum mechanics become greater.

We have seen before that in the transition from atomic to nuclear structures the insufficiencies of quantum mechanics increase. Along the same lines, in the transition from the structure of nuclei to the structure of strongly interacting particles (called hadrons, see, e.g., Ref. [8]), the insufficiencies of quantum mechanics became even greater. These new insufficiencies are also known to experts, as I can personally testify. Yet they are not openly treated in the technical literature, or presented in Ph. D. courses, thus warranting a conceptual outline in this section for a more technical treatment in Paper III.

The insufficiencies of quantum mechanics in particle physics have a role for quantitative studies of new energies perhaps deeper than the insufficiencies in nuclear physics. This is due to the fact that new energies originate precisely at the *particle* level. Any claim of "final" character of quantum mechanics in particle physics would therefore deny the very notion of "new" energies as per Definition 1.2.1.

As it is the case for nuclei, hadrons also do not possess the Keplerian structure necessary for the exact applicability of the fundamental Poincaré symmetry. Moreover, nuclei increase in size with the increase in the number of constituents. On the contrary, all hadrons have approximately the same size (the radius of their charge distribution) which is of the order of 1 fm = 10^{-13} cm which remains constant with the increase of their mass. This value coincides with the radius of the wavepacket of any massive particle. As a result, the constituents of hadrons have a wavepacket which is of the same order of magnitude of the size of the hadrons themselves.

It follows that, while the nuclear constituents are in conditions of *partial* (generally small) mutual penetration, the hadronic constituents are instead in conditions of *total* mutual penetration, each one inside all others. These conditions establish the impossibility for quantum mechanics to be exactly valid for the hadronic structure.

As we shall see in detail in Paper II, the latter conditions imply the inapplicability of the *mathematical foundations* of quantum mechanics, let alone the theory itself, including the inapplicability of: the underlying topology (because notoriously local while deep wave-overlappings are nonlocal); the basic vector spaces (because notoriously linear while deep wave-overlappings are nonlinear); the basic axioms (because they are purely potential while deep wave-overlapping requires contact nonpotential effects); and other reasons.

The arena of original conception of quantum mechanics, the atomic structure, is essentially *empty* due to the large mutual distances of the constituents, while hadrons are some of the densest objects measured in laboratory until now. The idea that a discipline conceived for the former can be exactly valid for the latter has no scientific credibility.

Supporters of quantum mechanics voice the great successes achieved by *quark models* in predicting new hadrons. In reality, this success occurred for the *Mendeleev-type classification* of hadrons into families, while we are considering here the *different* (yet complementary) problem of the *structure* of each hadron in a unitary multiplet.

I believe that the unitary, Mendeleev-type classification of hadrons into families achieved by the (color) SU(3) model has a final character. By contrast, I believe that quarks are mere mathematical representations in the mathematical unitary space which cannot be defined in our spacetime. Therefore, I do not believe that quarks are physical *elementary* particles in our spacetime.

I was among the very first authors to indicate back in 1981 [9a] the impossibility for quarks to be elementary constituents of hadrons, a notion which is now acquiring rather general acceptance, evidently without any quotation of my first presentation [9a]. The reason is that, once quarks are admitted as being *composite,* the problem of the real, physical, elementary constituents of hadrons is admitted as being fundamentally open, thus requiring a more realistic theory.

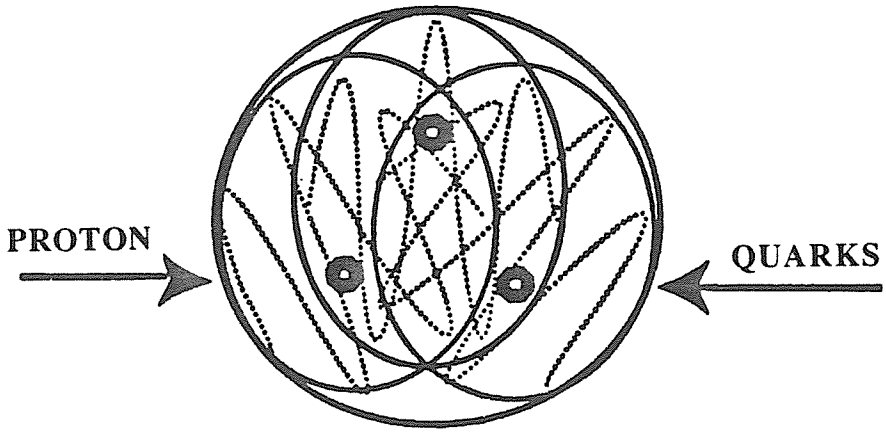

FIGURE 5: A schematic view of the contemporary conjecture according to which a proton is composed by three constituents which cannot be physically isolated in laboratory, called *quarks* (where we have ignored gluons and other aspects for simplicity). Even though quarks are believed to have *point-like charges* as the electrons, to be physical particles they must have *extended wavepackets* whose size is essentially the same as that of the entire proton, thus resulting in a structure with the total mutual penetration of the constituents. The lack of a Keplerian center then renders inapplicable the basic spacetime symmetries and related mechanics valid for atoms. Additional reasons studied in Paper II (related to the hyperdense character of the hadronic structure) imply the impossibility for a mechanics valid for the virtually empty atomic structure to be exactly valid for the hyperdense hadronic structure.

The dichotomy classification vs structure is the result of a historical teaching which is generally ignored at "leading" academic institutions. In fact, atoms required *two different yet complementary models,* the Mendeleev classification into families and the different, yet compatible structure of each atom of a given family via quantum mechanics.

Note in particular that the solution of the *structure* of the atoms required a *new mechanics,* i.e., quantum mechanics (where the novelty is referred over the Newtonian mechanics of that time), as well as *new mathematics,* i.e., the first use in physics of Hilbert spaces over complex numbers. Similar historical teachings emerged for the classification and structure of nuclei and molecules.

Studies via quarks theories have completely ignored the above historical teachings, and attempted to solve both, the classification and structure of hadrons, via one single model, that based on the hypothesis that the regular representations of SU(3) are physical particles. In so doing, the studies did reach splendid achievements in the *classification,* but at the price of a plethora of

inconsistencies and mounting controversies for the complementary problem of *structure*.

A systematic study of these aspects has been done by the authors in Refs. [3,9].

First, there is the historical *lack of confinement of quarks* (which is needed from their lack of existence as isolated particles) [9a]. A rigorous confinement (defined as the identically null probability of tunnel effects of free quarks) is directly incompatible with a pillar of quantum mechanics, Heisenberg's uncertainty principle, according to which any particle near a potential barrier has a finite probability of tunneling free.

Secondly, it has been proved that *matter made up of quarks cannot have gravity* [9b]. In fact, gravity can only be defined in our spacetime, while quarks are solely defined in the mathematical unitary space without any possible rigorous presence in our spacetime (technically established by the O'Raifeartaigh theorem).

The possibility of combining spacetime and internal symmetries via the so-called supersymmetries has been studied as a possible resolution of the above impasse. However, in so doing the problematic aspects *increase*, rather than decrease. This is due to the fact that supersymmetries predict a large variety of new particles none of which has been experimentally established. Moreover, as shown in Paper II, supersymmetries are afflicted by "catastrophic physical inconsistencies" (technically due to the fact that their time evolution is *nonunitary*, thus implying the clack of invariance of units used for measurements, observable, and numerical results). These occurrences exclude any possibility of consistently mixing spacetime and internal symmetries in the hope of avoiding dramatic inconsistencies in the currently prevailing hypothesis that quarks are physical particles.

The claim that quarks have "masses" and, therefore, can characterize gravity, also has no scientific ground or credibility. According to Einstein's special relativity, a necessary condition for any mass to be physical (i.e., to exist in our spacetime), is that it must be the eigenvalue of the second-order Casimir invariant of the Poincaré symmetry. This basic condition is grossly violated for quarks because they are known *not* to be representable with the Poincaré symmetry owing to their fractional charges and other technical reasons.

As a result, on real scientific grounds quark "masses" are *mere mathematical parameters in the mathematical unitary space* with no connection to physical masses known to me.

A discipline which leads to matter without gravity when applied to the structure of protons, neutrons and all hadrons, simply cannot be considered as a final theory outside organized academic interests, and, in any case, will not pass the test of time. The only open scientific issue is the identification of the *generalization* of quantum mechanics which is applicable to the structure of the hyperdense hadrons.

Readers should be aware that *quarks are the worst enemy of new energies for various technical reasons we shall review in the subsequent papers.* In fact, the acceptance of quarks as physical constituents of protons and neutrons implies the suppression of numerous mechanisms for new energies which are otherwise possible under more plausible structural assumptions.

The most visible case is the neutron, which is one of the largest reservoirs of new clean energies available to mankind (since it is naturally unstable when isolated and releases electrons with up to 0.8 Mev energy which is about 100,000 times the energy of the electrons hitting a computer screen).

Suppose that the constituents of the neutron are the hypothetical quarks. No possibility whatever then exists to utilize the energy contained inside neutrons, as generally admitted by orthodox and non-orthodox physicists.

However, suppose that Rutherford's original conception is correct, namely, that the neutron is composed by a proton with an electron totally "compressed" in its hyperdense interior. As shown in Paper III, the latter assumption readily permits the possible utilization of the energy inside neutrons by stimulating its decay via resonance mechanisms exiting the internal electron according to means that are under Patent Pending.

The main point remains always the same: the assumption of quantum mechanics as the final theory prevents any possibility of utilizing the energy inside the neutron, because of historical incompatibilities with Rutherford's hypothesis. On the contrary, as shown in Paper III, hadronic

mechanics has achieved a full compatibility with Rutherford's hypothesis, thus permitting the study of new energies.

Quantum mechanics has additional insufficiencies in virtually all aspects of particle physics, besides that of the structure of hadrons indicated above. As a matter of fact, the insufficiencies are so numerous, as to render impossible their review here because their study would be too long. Some basic insufficiencies are: the exact-numerical representations of the behavior of the meanlives of unstable hadrons with energy; the Bose-Einstein correlation and condensation; the scattering theory and its application to deep inelastic events; and numerous others.

A general attitude is that of: 1) throwing in parameters of physical unknown origin; 2) claiming that, in this way, the experimental results are fully compatible with quantum mechanics; and 3) abstaining from the indication that the unknown parameters are precisely a measure of the *deviation* of the data from the theory.

For brevity, I refer the reader interested in these additional limitations to Sect. 15 of memoir [3d] and Refs. [3b,3c]. Note that only *one* problematic aspect would be sufficient to justify the construction of a covering of quantum mechanics.

All the above occurrences establish the historical E-P-R "incompleteness" of quantum mechanics in particle physics beyond any possible credible doubt.

2.5. Insufficiencies of Quantum Mechanics in Superconductivity.

The insufficiencies of quantum mechanics in superconductivity (see, e.g., Ref. [10]) are quite similar to those for the structure of the helium. As we shall see, these limitations are particularly important for quantitative studies of new energies.

Superconductivity exhibits the presence of the *Cooper pair* which is composed by *two identical electrons in singlet coupling which are bonded together so tightly that they even tunnel together through a potential barrier.* This occurrence is structurally equivalent to the correlation/bond of the two electrons of the helium.

It is evident that quantum mechanics cannot be claimed to be exactly valid for the Cooper pair. Since the electrons are *identical,* quantum mechanics cannot possibly predict any bound state among them because of the repulsive Coulomb force. The insufficiencies of quantum mechanics in superconductivity then become self-evident for scholars in good faith.

At this point the supporters of the final character of quantum mechanics venture the existence of a good quantum mechanical description of superconductivity [9]. A scrutiny of this description reveals that it is based on the *density matrix*, that is, the model is of *statical character* describing *a large number of Cooper pairs.*

On the contrary, the problem considered above is that of the binding of *two* electrons against their repulsive Coulomb force. Any claim that quantum mechanics can achieve a representation of this physical reality is in error.

Moreover, quantum mechanics achieves a statistical description of an ensemble of Cooper pairs by postulating the existence of a new particle called "phonon" which is highly controversial and far from being independently established in particle physics.

As indicated by the Greek meaning of the name, the notion of "phonon" can indeed be introduced for *sounds propagating in our atmosphere.* Their counterpart in the particle world is that of "photons", namely, *quanta of energy propagated by empty space* (vacuum). To achieve a statistical representation of superconductivity, "phonons" have to be different than "photons", yet have to propagate in empty space as necessary for all quantum interactions (which are based precisely on the exchange of a virtual or physical particle). The conjectural-unverified character of the description of superconductivity according to quantum mechanics, and the need for a more adequate theory is then beyond credible doubt.

In summary, clear experimental evidence establishes the historical E-P-E "incompleteness" of quantum mechanics in superconductivity as well.

2.6. Insufficiencies of Quantum Mechanics in Gravitation, Astrophysics and Cosmology.

Similar, although technically more involved, insufficiencies exist for quantum mechanics when applied to other fields. For instance, in astrophysics we have the following unsolved problems: the energy balance of the universe computed via quantum mechanics requires a large "missing mass" which cannot be accounted for by intergalactic dust or any other known entity; quantum mechanics predicts that Earth is bombarded by about 10^{20} neutrino/cm^2 *none* of which has been detected to date in a truly final way; we are unable to reach a final understanding of the cosmological quasars redshift, particularly for quasars that are at rest with their associated galaxies according to clear gamma spectroscopic evidence, yet have dramatically different redshifts which would imply their being far apart with very different speeds; and other basic problems which have no apparent hope of solution via quantum mechanics.

In cosmology the insufficiencies of quantum mechanics also emerge rather forcefully because of various problems which have remained unsolved throughout this century, such as those of the "dark matter" , the "missing mass", and others.

More technically, the insufficiencies in cosmology are due to the failure of quantum mechanics to achieve a unification of all interactions. Einstein himself failed to achieve such a unification. In turn, the lack of a unified theory implies a number of cosmological inconsistencies, such as the notion of time becomes dependent on the assumed interaction, while a single notion of time would be admitted by a unified theory.

It should be indicated that truly novel advances in astrophysics will unquestionably be valuable for the study of **new energies.** For example, possible mechanisms removing the "missing mass", or eliminating the unobserved solar neutrinos would likely be applicable to new forms of energy.

All the above insufficiencies establish the lack of completion of quantum mechanics in astrophysics and cosmology as well.

2.7. Insufficiencies of Quantum Mechanics in Chemistry.

Quantum chemistry (see, e.g., Ref. [11] and literature quoted therein) constitutes another majestic achievement of this century which has produced practical benefits to mankind of everyday use.

Yet, it is the fate of all quantitative sciences, thus including chemistry, to never admit a "final theory". In this section I shall briefly outline the insufficiencies of quantum mechanics in chemistry, because they are particularly important for serious scientific studies

Again, these limitations are known to experts in the field, as I can personally testify, although their presentation is carefully avoided in technical publications or in Ph.D. courses, particularly in those at the so-called "high ranking" institutions. A review of these limitations is a necessary prerequisite for quantitative studies on new energies.

I have indicated before the importance for new energies of the insufficiencies of quantum mechanics in particle, nuclear and atomic physics. This presentation would be incomplete without the corresponding insufficiencies in chemistry because they play a truly crucial role for new energies.

The first insufficiencies of quantum chemistry are a direct consequence of the assumption of quantum mechanics as the underlying theory. Quantum mechanics is well known to represent systems which are: *time reversal invariant* (that is, their image under time reversal is physical), *perfectly rigid,* and solely admitting potential, action-at-a-distance interactions. These conditions are necessary for the original objectives of the theory, a representation of the atomic structure or the structure of crystals, which are indeed reversible, perfectly rigid and entirely potential.

These basic properties become a drawback for certain objectives of quantum chemistry, such as quantitative representations of *chemical reactions* which are notoriously *irreversible* (that is, their image under time reversal violates the principle of conservation of the energy or other law). At this point in our analysis the belief of the exact character of quantum mechanics implies the exiting of the boundaries of science. In fact, no final scientific representation of irreversible processes can be claimed without a theory whose basic axioms are structurally irreversible, which is an evident impossibility for quantum mechanics and chemistry.

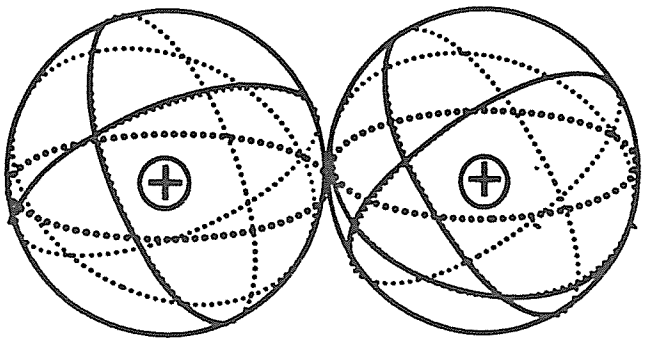

FIGURE 6. A schematic view of the conception of molecular bonds according to quantum mechanics and chemistry for which *neutral* atoms are just put together resulting in a bond while preserving their individuality. The insufficiency of such a view to represent the very strong attractive forces among the atoms of a molecular bond are beyond *credible* doubt. The reader is suggested to examine this occurrence, namely the fact that the very contemporary conception of molecular structure is basically insufficient. In this way the reader can begin to see the far reaching possible implications for new energies.

What is lesser known is that quantum chemistry also possesses serious insufficiencies in the description of of the simplest possible *reversible* structures, such as the hydrogen molecule, let alone the structure of more complex molecules such as:

1) Quantum chemistry has not identified a force sufficiently strong to really account for the molecular bond as it occurs in nature. In fact, the atoms of a molecular bond are *neutral*, in which case *the average of all forces among the molecular constituents is identically null without any resulting attraction.* Quantum chemistry tries to represent molecular bonds via "exchange forces" according to which the valence electrons of different atoms are exchanged, but these forces are well known from nuclear physics to be very small and, therefore, they are insufficient to represent the strong forces between the atoms of a molecular bond. Other attempted forces, such as van der Waals forces, also fail to provide the attractive force of the strength necessary to explain molecular bonds;

2) Quantum chemistry admits an arbitrary number of atoms in the hydrogen molecule, thus being dramatically against experimental evidence. This is proved beyond reasonable doubt because quantum chemistry attempts to represent molecular bonds via some of the forces first identified in nuclear physics, such as the exchange and van der Waals forces. These forces were conceived for an *arbitrary number of constituents* as a necessary condition to represent nuclear structures (which have a number of constituents from two to 100). These nuclear arguments are evidently extendable to molecular bonds, thus providing rigorous proof of the admission of an arbitrary number of hydrogen atoms in the H_2 and H_2O molecules, in dramatic disagreement with the physical reality.

3) Quantum chemistry has been unable to achieve an exact representation of the binding energy of the hydrogen molecule via unadulterated first principles. In fact, there is a historical 2% still missing despite efforts conducted throughout this century by a large number of chemists.

Recently, a few attempts have managed to improve the accuracy. However, as we shall see in Paper III, they imply a necessary *structural alteration of the basic axioms of quantum chemistry* which is euphemistically called by academia "Coulomb screening" while its real meaning is that of a structural alteration of the Coulomb law at the foundation of quantum mechanics, and consequential exiting of the boundaries of science.

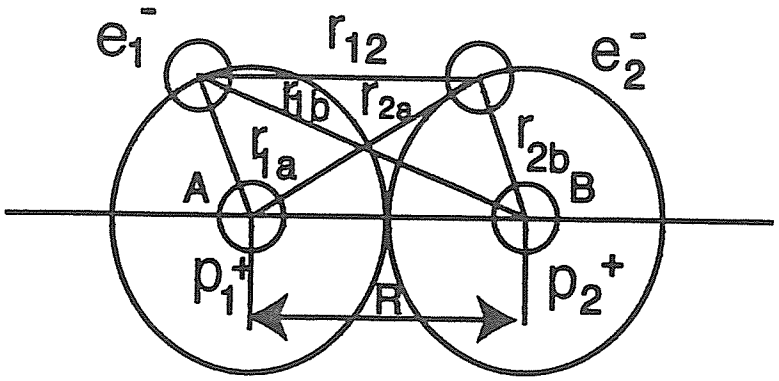

FIGURE 7. A schematic view of the null value of the average force among two hydrogen atoms, and the consequential insufficiency of the force in molecular bonds of current models (see Paper V for details).

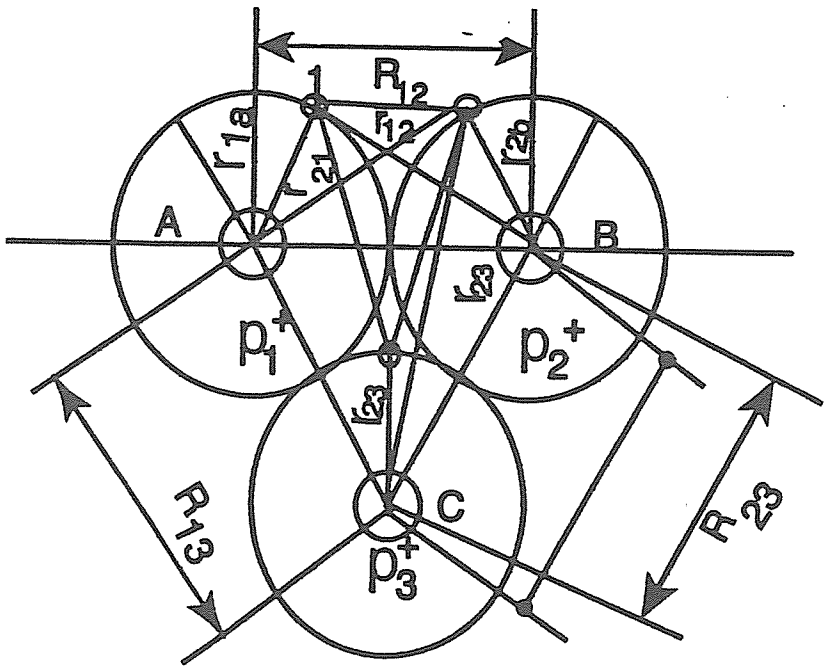

FIGURE 8: A schematic view of the admission of an arbitrary number of hydrogen atoms in the H-molecule, contrary to experimental evidence. This situation persists under the admission of exchange, van der Waals and other forces of nuclear type currently used in quantum chemistry (see Paper V for details).

4) Quantum chemistry cannot provide a meaningful representation of thermodynamic aspects. In fact, the value of 2% missing in the representation of binding energies is misleadingly low, because

in reality it corresponds to about 950 Kcal/mole while an ordinary thermodynamic reaction takes an average of 20 Kcal/mole. In thermochemical reactions quantum chemistry can therefore be off by a factor as great as 50.

5) Quantum chemistry has been unable to reach an exact representation of the electric and magnetic dipole and multipole moments of the hydrogen and other molecules. These representations lack a few percentages for the hydrogen molecule and larger percentages for bigger molecules, to such an extent that they have at times the *wrong sign* (see, e.g., Ref. [11b], p. 22). Moreover, as we shall see in subsequent papers, current models of molecular bonds imply the capability by the hydrogen and water in their liquid state to be fully ferromagnetic, which is also contrary to physical reality (see also ref. [11b] for available experimental values of the *diamagnetic* character of water).

6) Computer usages in quantum chemical calculations require excessively long periods of time. This occurrence is due to the slow convergence of conventional quantum series and has persisted to this day, despite the availability of more powerful computers.

7) Quantum chemistry has been unable to explain the "correlation energy" which is advocated for the missing percentages of the binding energies.

8) Orbital theories work well at qualitative and semi-empirical levels, but they remain afflicted by yet unresolved problems, such as the correlation among many electrons as compared to the evidence that the correlation occurs mainly for *electron pairs.*

9) Representation of 100% of the experimental data can only occur with the introduction of a number of empirical parameters which lack a physical or chemical meaning and motivation. They are in effect a measure of the *deviation* of quantum chemistry from reality.

10) Other traditional methods, such as configuration interactions (CI), are capable of improved accuracy via a sufficiently large Gaussian screening of the Coulomb potential. However, the latter constitute a structural deviation from the axioms of the theory. In addition, they require unacceptable amounts of computational resources and time due to the very large number of configurations needed for exact results.

The above evidence, studied in technical details in Paper V, establishes the insufficiencies of quantum chemistry for a deeper understanding of molecular structures beyond credible or otherwise scientific doubts. As we shall see, their possible resolutions are at the foundations of quantitative studies on new energies.

2.8. Insufficiencies of Quantum Mechanics in Biology.

Any belief of the exact validity of quantum mechanics in biology would simply be beyond scientific decency. This is due to the fact that the discrepancies between the predictions of quantum mechanics and the evidence in biology are so large to challenge any attempt at expected reconciliations.

These insufficiencies are also important for the new energies because the latter include various biological aspects.

Quantum mechanics is structurally reversible and can represent only perfectly rigid systems, as well known. As a consequence, the assumption of quantum mechanics in biology would imply that our body is perfectly eternal and perfectly rigid, without any possibility of introducing *ad hoc* parameters or other schemes that could resolve the occurrence.

To begin, one of the pillars of quantum mechanics is the verification of total conservation laws, for which Heisenberg's equation of motion became established. In fact, for an arbitrary quantity A we have:

$$i\, dA/dt = AH - HA, \tag{2.8.1}$$

where H is the total energy, for which $i\, dH/dt = HH - HH \equiv 0$.

One of the fundamental needs for a scientifically credible representation of biological structures is instead that of *the time-rate-of-variations of physical characteristics* such as size,

weight, density, etc. In fact, unlike atomic systems for which quantum mechanics was built, biological systems *age*, thus changing in time.

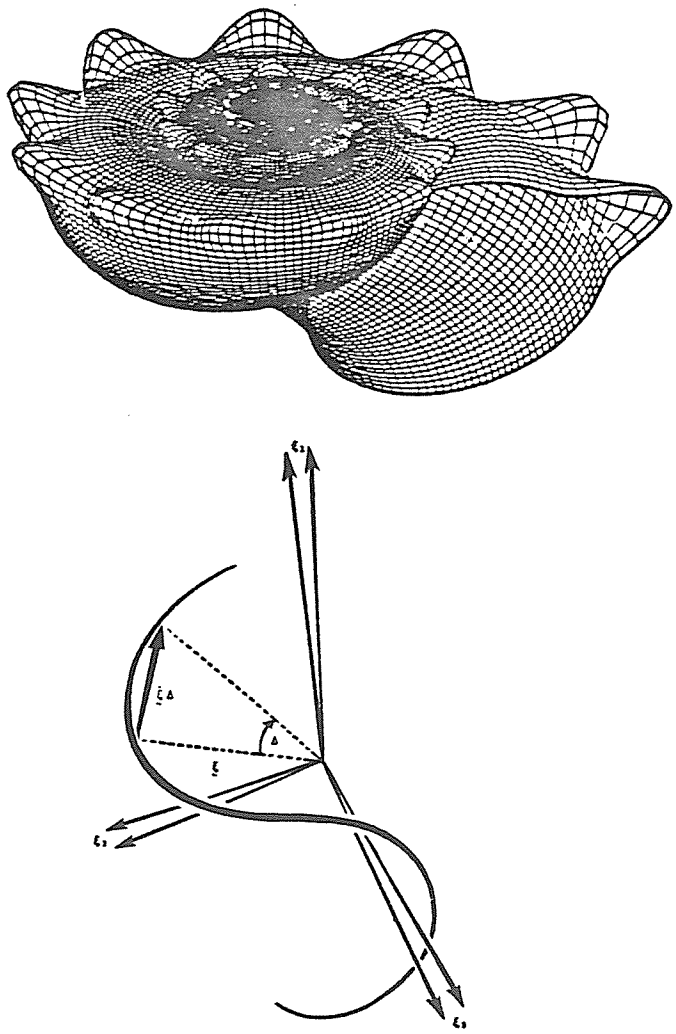

FIGURE 9: A computer visualization of the *shape* of a sea shell, the *Angaria delphinium* from Ref. [3f] based on the geometric axioms of quantum mechanics, those of the Euclidean geometry. As one can see, the representation is rather accurate. Nevertheless, the same visualization becomes grossly in contradiction with evidence when extended to the *growth in time* of the same sea shell. The correct representation of the growth requires a 3×3-dimensional space, i.e., the doubling of our conventional Cartesian coordinates which, as such, is *multivalued*. But this mathematical representation has to be compatible with our 3-dimensional *perception* of the sea shall. This basic task is fulfilled by the hyperstructures indicated in Paper II (see monograph [3f] for details).

The irreconcilable incompatibility between the *variations in time* of biological structures and the *conservation in time* of quantum mechanics systems as per Eq. (2.8.1) is beyond any *credible* doubt.

When passing to more specific cases, the insufficiencies of quantum mechanics appear even more forcefully. As an example, quantum mechanics can represent well the *shape* of sea shells, but not their *growth in time*. In fact, computer simulations have shown that, when the geometric axioms of quantum mechanics are imposed as exactly valid (those of the Euclidean geometry), the sea shell first grows in a deformed way and then cracks during its growth (see Ref. [3f]).

The latter results should not be surprising, again, because the growth of sea shell is an *irreversible* process while the geometric axioms of quantum mechanics are perfectly reversible, as indicated earlier.

In summary, I hope to have shown in the preceding sections that the insufficiencies, limitations and consequential "incompleteness" of quantum mechanics postulated by Einstein, Podolsky and Rosen [5a] in 1935 begin to emerge in the hydrogen and helium atoms, and then grow with the increasing complexity of the systems considered, to such a level that the claim of exact validity of quantum mechanics for biological structures is not expected.

3. INSUFFICIENCIES OF SPECIAL AND GENERAL RELATIVITIES

3.1. Statement of Objectives

The numerous insufficiencies of nonrelativistic and relativistic quantum mechanics in various fields outlined in the preceding sections have a preliminary value for new energies.

The reason is well known to experts. Physics is a discipline which admits its reduction to ultimate and primitive formulations known under the name of *relativities*, and their spacetime symmetries known under the name of *rotational, Lorentz and Poincaré symmetries*.

The incompatibilities between the new energies and Einstein's relativities are, by far, the most important aspect of this Paper I.

3.2. Insufficiencies of Special Relativity.

At first look, it appears that the special theory of relativity[6] is *exactly valid* in the arena of its original conception, as clearly identified in the limpid writings of the Founders. It is that of particles that can be well approximated as being point-like when moving in empty space (vacuum) under action-at-a-distance interactions. The relativity is verified on a daily basis in several particle accelerators around the world which provide the ideal conditions of applicability of relativity.

Numerous authors disagree with the above view (see, e.g., H. E. Wilhelm [12b] and quoted references) and claim that the special relativity is invalid even in the arena of its original conception. In essence, it is now rather universally admitted that the propagation of electromagnetic waves requires that the vacuum (also called universal substratum or aether) is a physical medium, that is a medium possessing physical characteristics such as rigidity.

Wilhelm's generalized electrodynamics and quantum mechanics based on a preferred cosmic reference frame remove all inconsistencies known for an observer in a Lorentz covariant physics [12b,12c].

The naive objection of the past century on the "aethereal wind" (namely, the "wind" experienced by Earth in its motion within the expected universal medium) is easily resolved because elementary particles which compose a body are themselves oscillations of the aether. Thus, when we move a body, we move absolutely nothing remotely resembling a solid. We merely move the oscillations of the aether characterizing particles from one region to another of the medium, thus implying lack of any possible "wind".

[6] The theory is politically called "Einstein's special relativity" while the correct scientific name is the *Lorentz-Poincaré-Einstein special relativity* because of well-known and fundamental contributions by Lorentz and Poincaré *prior* to those by Einstein. For historical accounts on the contributions by Poincaré to the special relativity, one may consult Ref. [11a].

In turn, the admission of the vacuum as a universal physical medium requires the existence of a *privileged reference frame* which, as well known, is against the basic axioms of special relativity.

A fundamental problem is therefore the *generalization* of the special relativity into a formulation which, while preserving the current experimental verifications, admits a universal, privileged, reference frame, that of the universal substratum.

An aspect important for new energies is the ongoing extension of the validity of the relativity dramatically beyond those of its original conception, up to the contemporary claim of universal validity of relativity for all conceivably possible relativistic conditions existing in the universe, without a serious critical scrutiny and by refusing even to inspect dissident experimental information [2].

The above controversy is deeply dependent on the historical distinction between:

1) *the exterior dynamical problem,* consisting of point-like particles moving in vacuum, and

2) *the interior dynamical problem,* consisting of extended, nonspherical and deformable particles moving within a physical medium.

It is easy to see that *the arena of exact validity of the special relativity is that of the exterior problem, while the conditions of its inapplicability (as per Definition 2.1.1) are those of the interior dynamical problems.*

The reasons for the above conclusion are rather numerous, such as [12d]:

a) Special relativity can only represent perfectly rigid and perfectly spherical particles, as is well known[7], while particles in interior conditions are *extended, nonspherical (say, spheroidal) and deformable,* thus implying the inapplicability of the physical foundations of the relativity for the interior problem;

b) *The interactions of interior dynamical problems are variationally nonselfadjoint* (i.e., they violate the conditions to admit a Lagrangian or a Hamiltonian), while the special relativity can only represent potential forces by conception, thus implying the inapplicability of the analytic foundations of the theory;

c) The topology of interior problems is strictly *nonlocal* (e.g., extended over a finite volume), while the topology of the special relativity (e,g. the Zeeman topology of the Minkowski space) is strictly *local* (i.e., solely applicable to a finite sumner of isolate points), as well known, thus implying the inapplicability of the mathematical foundations of the relativity; and other reasons [11c].

All the insufficiencies of quantum mechanics identified in the preceding sections are insufficiencies of the special relativity.

As a specific example, the "historical hypothesis" on the deformability of the charge distribution of nucleons when members of a nuclear structure (Fig. 3) was identified at the very birth of nuclear physics, as recalled earlier. This is a direct insufficiency of the special relativity, because the inability to represent deformations is known since the inception of special relativity.

Moreover, there has been the emergence of clear experimental evidence incompatible with the special relativity, among which I recall:

A) *Speeds bigger than the speed of light in vacuum* c_0 *have been experimentally established* [13] *and are nowadays physical reality, in disagreement with the celebrated "principle of universal constancy of the speed of light".*[8] In fact, recent experiments have established the existence of

[7] At the classical level and that of first quantization the special relativity can only represent point-like particles, while at the level of second quantization the relativity can only represent via the form factor *perfectly rigid and perfectly spherical shapes* as a necessary condition not to violate a pillar of the special relativity, the rotational symmetry.

[8] In the spirit of true Founders, Lorentz was one of the first to consider the experimental reality that the speed of light in our atmosphere is smaller than that in vacuum, and made the first attempt to generalize his celebrated symmetry, from the invariance of the speed in vacuum c_0 to a smaller speed $c < c_0$. With the advent of "Einstein's special relativity" this beautiful teaching was suppressed in favor of the universal constancy of the speed of light c_0 and academic machinations on the representation of lower speeds c via "photons scattering among the molecules of the atmosphere". Physics is a quantitative science which, despite political problems, eventually has always managed to establish the truth. The recent experimental evidence on speeds bigger than that of light in vacuum [13] therefore

photons propagating through certain guides at speeds bigger than that of light in vacuum (called *superluminal speeds*); large masses in astrophysical explosions have been measured several times at speeds bigger than that of light in vacuum.

B) *Additional experiments have established departures from the relativistic law of time contraction* $\tau = \tau_0 (1 - v^2/c_0^2)^{-1/2}$ [14] .These experiments deal with the measure of the behavior of the meanlives of unstable particles with speed, and other events.

C) *Experimental data for the Bose-Einstein Correlation and Condensations can only be fit with unknown parameters (one of them is euphemistically called the "chaoticity parameter") which in reality characterize the deviations from the basic axioms of the theory* [15] (in this case, that of expectation values, see Paper III for details and references).

As we shall see, all new forms of energies as per Definition 1.2.1 constitute interior dynamical problems. As such, on rigorous scientific grounds, Einstein's special relativity is "inapplicable" (and not "violated") for new energies, because the inapplicability of the relativity for the interior conditions considered is beyond any possible doubt.

3.3. Inconsistencies of General Relativity.

Some (but not all) researchers in new energies may believe that gravitation has nothing to do with their field. I disagree, because of the general trend during this century of passing to the general relativity all problems not solvable at the level of the special relativity (see, e.g., Ref. [16a].

It is therefore essential for researchers in new energies to have some awareness that, while the special relativity at least possesses some clear conditions of physical applicability and an axiomatic structure of unquestionable consistency, the general theory of relativity has been, by far, one of the most controversial theories in the history of science, with such a large number of basic unsolved problems to prevent any scientific claim of consistency [2].

After studying the issue on technical grounds for three decades, I became convinced that *the general theory of relativity is fundamentally flawed and physically inconsistent.* One of the (too many) reasons is the following property proved in memoir [3d]:

> *THEOREM 3.3.1: All physical theories with curvature do not possess invariant units of time, space, energy, etc., and, therefore, they cannot be applied to experiments in any physically meaningful way.*

Readers can easily see the roots of the occurrence. The transition from the Minkowski metric = $(m_{\mu\nu})$ = Diag. (1, 1, 1, -1) to the Riemannian metric $g_{\mu\nu}(x)$, $\mu, \nu = 1, 2, 3, 0$, $x = (r, x^0)$, $x^0 = c_0 t$, is necessarily characterized by a *noncanonical* transform at the classical level and by *nonunitary* transforms at the operator level (because the original metric is not preserved by assumption). But noncanonical and nonunitary transforms do not preserve the basic units by their very conception. The lack of any possible physical meaning of the general relativity then follows.

As a concrete example, the actual measurement of a length is not consistently possible via the general relativity because the length of a stationary meter varies in time. The explanation put forward by orthodox physicists is that the entire universe changes jointly with the meter, thus permitting consistent measurements. This explanation is easily dismissed as such. In fact, general relativity is a *local* theory which, as such, cannot possibly be applied to a far away galaxy or quasar. No meaningful measurement of the distance of a far away galaxy is therefore possible for a local observer on Earth whose stationary meter changes in time. The same applies for all other

constitutes a condemnation of one century of suppression of due scientific process on a truly basic physical issue. In fact, the measure of speeds bigger than that of light in vacuum has disqualified as academic manipulations the use of photons scattering among molecules which were imposed via academic power to provide the appearance of salvaging a beloved theory. These machinations never had any credibility because, say, a *classical* radio wave with one meter in wavelength traveling in our atmosphere at a speed $c < c_0$ simply cannot be reduced in any credible way to photons *in second quantization* scattering among molecules.

measurements.

Theorem 3.3.1 essentially rules out the use of all possible curved spaces for any physically meaningful application. I should indicate here that Theorem 3.3.1 merely formalizes known basic inconsistencies of the notion of curvature.

As an example, it is well known since the early part of this century, that *general relativity predicts a bending of light in a gravitational field which is twice that experimentally detected.* The first bending is due to the claim that "curvature bends light". The second bending is due to the fact that light carries energy which is notoriously attracted by any gravitational field, whether flat or curved.

Along the same lines, *general relativity predicts double the displacement of masses due to gravity, one for curvature and one for Newtonian attraction.*

Equally known is the impossibility for the general relativity to represent the free fall of bodies in a gravitational field. On one side, general relativity reduces gravitational attraction to *curvature,* while on the other side the free fall occurs along a *straight line.* The very notion of gravitational attractions along radial directions is therefore outside the representational capabilities of general relativity.

All these inconsistencies see their climax in Einstein's conception of gravitation, which reduces the gravitational field in the outside of a massive body with null total charge and magnetic moments to pure curvature, that is, to a pure Riemannian metric $g_{\mu\nu}(x)$ characterized by the field equations without source [16a]:

$$G_{\mu\nu} = R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R = 0 . \qquad (3.3.1)$$

The inconsistencies of the above conception of gravitation are serious and numerous, such as:

I) Theory (3.3.1) can be easily proved to be noncanonical at the classical level and nonunitary at the operator level. As such, it admits no invariant numerical prediction, thus being deprived of any possible real physical content [3d].

II) Theory (3.3.1) is irreconcilably incompatible with the primary electromagnetic origin of mass [16b]. In fact, the mass of all particles, whether charged or neutral is of primary electromagnetic nature, as well established in particle physics [8]. Therefore, all particles admit an electromagnetic field $F_{\mu\nu}$ in their outside with an energy-momentum tensor $T_{\mu\nu}$ which is of first-order in magnitude, which is against the null value of the right hand side of Eqs. (3.3.1). Ref. [16b] established this fact to be the case also for neutral particles such as the π^0 meson.This inconsistency is so strong that, either one accepts Einstein's field equations (3.3.1), in which case one must reconstruct particle physics from its foundations (the electromagnetic interactions), or one accepts contemporary particle physics, in which case Eqs. (3.3.1) must be abandoned.

III) Independently from the above, field equations (3.3.1) are incompatible with the *forgotten Freud identify* [16c]. The history of this identity is a good indication of the condition of research in gravitation. The Riemannian geometry was born with *five* basic identities, all known in the early part of this century. Rather mysteriously, these identities have been reduced to *four,* as claimed in the virtual entire literature in gravitation of this century (see, e.g., Ref. [16a]). The unreassuring aspect is that, in his celebrated book on the special and general relativity, Pauli [16d] identified the fifth identity by Freud in all details with various comments, as everybody can verify. Now, every word stated by Pauli has been studied by countless scholars in extreme details. Even ignoring Freud's original work [16c] and other quotations of the early part of this century, the idea that Pauli's treatment of the Freud identify could escape the attention of all subsequent physicists has no credibility. What is the credible reason of the unusual absence of a basic geometric identify in presentations that are claimed to be as comprehensive as possible? The most plausible reason is that *the Freud identify of the Riemannian geometry is incompatible with Einstein's conception of gravitation according to Eqs. (3.3.1) and, as such, it was omitted.* In fact, the Freud identity does reproduce the left-hand-side of Eqs. (3.3.1), but requires the presence in the right-hand-side of two tensors, in evident disagreement with Einstein's field equations (3.3.1). Note the compatibility of the need for a source tensor from the Freud identity in full agreement with preceding need II.

IV) A rather long list of additional, independent inconsistencies of Eqs. (3.3.1) have been identified by H. Yilmaz over three decades of research (see Ref. [16d] and quoted literature). Yilmaz's inconsistencies have remained un-addressed by most orthodox physicists. I here list some of the inconsistencies Yilmaz published in various refereed journals: a) *Einstein's general relativity is incompatible with the special relativity,* because, contrary to popular beliefs, the Minkowskian limit of total conservation laws as characterized by Eqs. (3.3.1) only yields the conservation of the total mass and not of the total four-momentum; b) *Einstein's gravitation is incompatible with Newtonian mechanics* because, also contrary to popular beliefs, the Euclidean limit of Eqs. (3.3.1) *is not* Newtonian mechanics, but rather Hooke's mechanics (this is a mechanics in which the Sun has infinite inertia, thus violating the principle of action and reaction); c) *Einstein's gravitation is incompatible with experimental tests in gravitation* because, also contrary to popular beliefs, Eqs. (3.3.1) do indeed represent the 43" correction in the advancement of the perihelium of Mercury, but they miss the much more important Newtonian term of 532"; d) *Einstein's gravitation was conceived to be a one-body theory (representing the motion of one body in a gravitational field), thus being unable to represent many-body systems* for various technical reasons; e) *Einstein's gravitation is incompatible with quantum mechanics,* for numerous reasons, such as the fact that the former admits a Hamiltonian identically null, while the latter requires a non-null Hamiltonian for any consistent formulation.

V) Einstein's gravitation is incompatible with other interactions for matter and, independently, for antimatter [16f]. In fact, Einstein's gravitation is incompatible with the electromagnetic and strong interactions *for matter* because the latter verify the fundamental Poincaré symmetry, while the former does not. Huge independent inconsistencies occur for *antimatter* because antimatter is solely treated via negative-definite energies for electromagnetic and strong interactions, while field equations (3.3.1) solely admit positive-definite energies. The quantization of classical "antiparticles" characterized by positive energy then cannot possibly yield an antiparticle, but merely a particle with the reversed sign of the charge [9b]. Under these premises, one can easily see the reasons why all attempts at unified theories with Einstein's gravitation have failed, beginning with the unsuccessful efforts conducted by Einstein himself and a *plethora* of followers.

Also significant is the fact that all attempts at the achievement of a *quantum mechanical description of gravitation* conducted throughout this century have failed because of a host of fundamental inconsistencies. The identically null value of the Hamiltonian for Riemannian gravitation mentioned earlier is only one of them. Additional serious problems are given by the impossibility to reach particle properties equivalent to those of the physical reality, the lack of a well-defined notion of observability via Hermiticity preserved at all times, lack of consistent conjugations, such as the CTP theorem, and others.

As a result, the scientifically important issue nowadays is the identification of the *generalization* of quantum mechanics which allows a consistent representation of *gravity,* a topic in which I have spent a number of years of my research life.

By no means the above list exhausts all major inconsistencies of general relativity, because additional major inconsistencies have been identified in refereed technical journals.

As an additional example, the entire theory of gravitational collapse, black holes, big bang and all that has been constructed under the *tacit* belief that the Riemannian geometry is *exactly* valid for the interior physical conditions of gravitational collapse.

However, a star undergoing gravitational collapse is not made up of ideal isolated points (as necessary for a mathematically and physically consistent application of the Riemannian geometry), but rather of hyperdense extended hadrons in conditions of total mutual penetration and compression in large numbers into small regions of space. The idea that a geometry, such as the Riemannian geometry, solely conceived for the description of one massive point moving in vacuum, could exactly describe the indicated conditions of gravitational collapse is farfetched. In fact, the above interior conditions imply the need for the most general possible geometry which is irreversible in its geometric axioms, nonlinear in the *velocities* and wavefunctions, and nonlocal,

thus being dramatically different than the rather simplistic Riemannian geometry.

Additional inconsistencies of the general relativity have been identified by G. H. Keswani [16h] who has shown that Einstein made a number of errors in the calculations of the shift of the perihelium of Mercury, which should be 43 seconds per terrestrial century, while it is in reality predicted by general relativity to be 108 seconds (see Ref. [16h], p. 293 for the calculations as well as for other problematic aspects).

The above disagreements should not be surprising for experts in general relativity independent from organized interests in the field. In fact, the gravitational equations are highly *nonlinear,* thus not solvable in a unique and unambiguous way. The solutions then depend on the assumed approximation, with dramatically different and incompatible results, such as the claim throughout this century by leading "experts" that the precession of the perihelium of Mercury is a clear "experimental verification of the general relativity", as compared to the valid and plausible proof by Kaswani that this is not the case [16h].

In conclusion, claims by orthodox physicists that insufficiencies at the relativistic level can be resolved at the gravitational level, have no scientific credibility or foundation.

For these reasons, real research on really basic open problems of contemporary science is mainly conducted nowadays outside academia, thanks to a novel and potentially historical support by the corporate industry, which recognizes the potentially enormous economic and societal benefits expected from truly innovative scientific inquiries.

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NOTE

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THE PHYSICS OF NEW CLEAN ENERGIES AND FUELS ACCORDING TO HADRONIC MECHANICS, PAPER II: THE NEW MECHANICS[1]

Ruggero Maria Santilli[2]

ABSTRACT

This is the second of a series of five articles outlining systematic research on new energies and fuels at the particle, nuclear, and molecular levels, initiated by the author at Harvard University in 1978 under DOE support, and then continued by numerous scientists at various Institutions. Paper I identified the new energies studies in this series, as those not being predictable and treatable by quantum mechanics. Paper I then presented an outline of the numerous insufficiencies of quantum mechanics in particle physics, nuclear physics, superconductivity, chemistry, biology, astrophysics and cosmology. This Paper II is devoted to the outline of the broader covering mechanics used in these studies, called *hadronic mechanics,* originally proposed by the author in 1978 jointly with its basic equations and related new mathematics, and subsequently developed by numerous mathematicians, theoreticians, and experimentalists, which has now reached operational maturity for applications in the industry. The paper begins with a review of the catastrophic inconsistencies suffered by all theories with a nonunitary structure due to their lack of invariant, with consequential need of new mathematics for their invariant resolution. The paper then outlines three, progressively generalized, new mathematics called *iso-, geno- and hyper-mathematics,* which have been constructed for the invariant treatment of nonunitary theories representing closed-isolated-reversible, open-nonconservative-irreversible, and multi-valued-irreversible systems, respectively. The paper then presents an outline of the *nonrelativistic and relativistic, iso-, geno-, and hyper-branches of hadronic mechanics,* with particular emphasis to: the identity of quantum and hadronic mechanics at the abstract, realization free level; the verification by hadronic mechanics of all conventional quantum laws, such as Heisenberg's uncertainties, Pauli's exclusion principle, causality, etc., only expressed via a broader formalism; and methods for the very simple construction of concrete hadronic models accessible to all, which consist of simple nonunitary transforms of quantum models. The paper includes a detailed proof of the *direct universality of hadronic mechanics,* that is, its admission in an axiomatically consistent and invariant way of all infinitely-possible, nonlinear, nonlocal, and nonpotential theories with nonunitary time evolution (universality), directly in the frame of the experimenter (direct universality). Experimental verifications in particle physics, nuclear physics, chemistry and other fields will be presented in Papers III, IV and V, respectively.

1. INTRODUCTION

This is the second of a series of five articles outlining systematic research on new energies and fuels at the particle, nuclear, and molecular levels, initiated by the author at Harvard University in 1978 under DOE support, and then continued by several researchersat various Institutions.

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In Ref. [1], hereinafter denoted Paper I, I have presented numerous insufficiencies of quantum mechanics establishing beyond scientific doubt the need for a broader theory (this was Objective 1 of Sect. I-1.3).

In this Paper II, I outline Objectives 2, 3 and 4 of Sect. I-1.3, namely, the general inconsistency of broader theories and the need for a novel mathematics. I then present the main structural lines of a generalization-covering of quantum mechanics called *hadronic mechanics* [I-3] which was built precisely to resolve the *insufficiencies* of quantum mechanics of Paper I as well as the *inconsistencies* of other generalizations.

A main objective of this paper is to outline the basic *formalism* of the new mechanics used in subsequent papers for quantitative studies of new clean energies and fuels, with particular reference to: the need for the new mechanics; its mathematical consistency; its verification of known physical laws (although derived from a broader formalism); its uniqueness and invariance; and its universality foir all noncanonical or nonunitary theories. Existing applications, experimental verifications and applications to the emerging new energies shall be presented in subsequent papers of this series.

The reader is warned not to feel disoriented by the new mathematics, because I provide in Sect. 10 simple rules for the explicit construction of the theory accessible to anybody with a rudimentary knowledge of quantum mechanics. These results will render the applications of the new theory quite simple, as the reader will find in the next papers. The formulation via the new mathematics is essentially needed for consistency and rigor.

Moreover, the reader should not spend excessive effort to "understand hadronic mechanics", because its value is essentially pragmatic, and reduced to its practical effectiveness. To be explicit in this important point, I must confess that, despite decades of studies. I cannot honestly claim that I "understood" the Hilbert spaces of quantum mechanics, because their infinite dimensions are beyond the capacity of the human mind. The point is that my inability to "understand" the mathematics of quantum mechanics is irrelevant. The important aspect is that the quantum formalism works well within the conditions of its applicability.

Essentially the same pragmatic approach is suggested for the more general formalism of hadronic mechanics. In fact, even though I proposed it, I cannot claim to "understand" the hyper-Hilbert spaces with multi-valued warps each possessing infinite-dimensions. The important point is that the hadronic formalism works better than the quantum formalism for broader physical conditions, while admitting the latter as a particular case for simpler physical conditions.

Another misconception is that hadronic mechanics is intended to "eliminate" quantum mechanics. The emphasis of Paper I has been that of identifying the *limitations* of quantum mechanics, and not its "inconsistencies".

Rather than "eliminating" quantum mechanics, in this Paper II, I assume it instead as the very foundations of the generalized theory. In fact, hadronic mechanics merely provides a "completion" of quantum mechanics much along the historical argument by Einstein, Podolsky and Rosen [I-5a].

More specifically, I assume that quantum mechanics is valid at long distances under which particles and their wavepackets can be sufficiently well approximated as being point-like. I then assume that the theory needs a "completion" *only at short distances* of the order of 1 fm = 10^{-13} cm for which the extended character of the wavepackets cannot be ignored. The very meaning of the name "hadronic mechanics" is that of representing hadrons and their strong interactions whose size and range are precisely of the order of 1 fm. We reach in this way the following:

MAIN ASSUMPTION 1.1: Quantum mechanics is assumed to be valid for all distances sufficiently bigger than 1 fm (= 10^{-13} cm), while for distances of the order of 1 fm or less, hadronic mechanics is assumed to provide a better approximation.

As indicated at the beginning of Sect. I-2, despite the insufficiencies, the axiomatic consistency of quantum mechanic is "majestic". I am here referring to the mathematical, theoretical and experimental compatibility of the various articulated formulations composing the theory.

The abandonment of such an axiomatic structure, as done by other generalizations (see Sect.

4) creates the rather serious problems of identifying new axioms, proving their consistency and establishing them experimentally *before* any application may acquire a physical value. These tasks are of such a complexity to go outside the lifetime of any research groups. We, therefore, require the following:

> *MAIN ASSUMPTION 1.2: All abstract axioms of quantum mechanics are assumed as being everywhere valid, including in the interior of the hadronic horizon. Hadronic mechanics is therefore constructed in such a way to merely provide "new realizations" of established quantum axioms.*

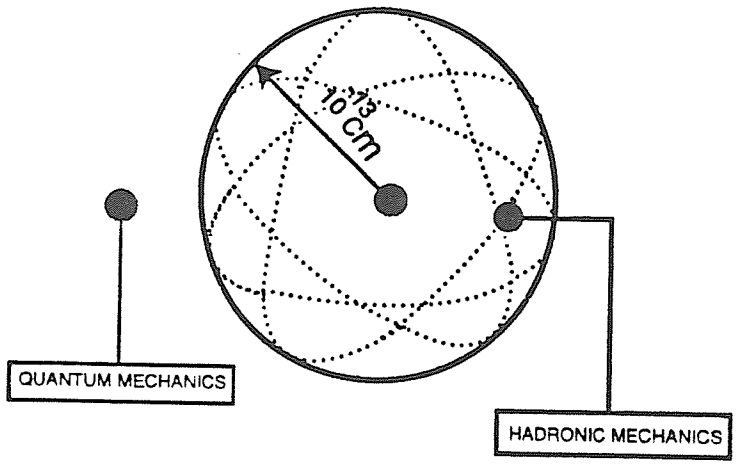

FIGURE 1: A schematic view of the *hadronic horizon*, namely, of the sphere of mutual distances of particles with radius 1 fm outside which quantum mechanics is accepted as valid and inside which hadronic mechanics is adopted.

Another criticism of hadronic mechanics generally due to insufficient technical knowledge (or bad faith) is that the experimental validity of conventional quantum laws and principles (such as Heisenberg's uncertainty principle, Pauli's exclusion principle, causality, probability laws, etc.) is evidence of the *sole* applicability of quantum mechanics.

This criticism is met with the following:

> *MAIN ASSUMPTION 1.3: When properly formulated and restricted to closed-isolated systems verifying conventional total conservation laws, conventional quantum laws and principles are assumed to be exact everywhere including in the interior of the hadronic horizon.*

As will be shown, hadronic mechanics verifies indeed all known physical laws, including total conservation laws, Heisenberg's uncertainties, Pauli's exclusion principle, etc., although they are derived from a broader formalism. In different terms, we shall see in this Paper II that the *same* physical laws are admitted by *two* different theories.

The verification of known physical laws is also important for credibility because no deviation from these laws has been experimentally established at this writing in a final form *for closed-isolated systems*, such as particle reactions examined in their center-of-mass.

As we shall see, the case of the physical laws for *open-nonconservative systems* (i.e., systems interacting with another system considered as external), is dramatically different, e.g., because of the lack of validity of conservation laws by assumption, consequential inapplicability of conventional symmetries, and consequential collapse of the entire physical structure of quantum mechanics. After all, the latter theory was conceived for closed-isolated systems strictly verifying the conservation laws of all total quantities and, as such, it cannot be claimed to be applicable to

open-nonconservative systems.

By no means, do I claim that the generalization of quantum into hadronic mechanics is the only possible generalization, because a beauty of scientific inquiries is their polyhedricity. Nevertheless, the reader should be aware that hadronic mechanics has been proved to be "directly universal", that is, holding for all infinitely possible (topologically well-behaved), nonlinear, nonlocal and nonpotential-nonhamiltonian-nonunitary generalizations of quantum mechanics (universality), directly in the fixed coordinates of the experimenter (direct universality).

Any other broadening of quantum mechanics should verify the same basic criteria of quantum and hadronic mechanics, such as verify causality, probability laws, invariance, etc. To be novel, other generalized theories should then be proved to be non-equivalent to hadronic mechanics which appears to be a rather difficult (if not impossible) task.

Recall from Sect. I.1.2 that *I am solely interested in the study of new energies which are not predicted by quantum mechanics* (Definition I.1.2.1). As we shall see, a main feature of hadronic mechanics is precisely that of predicting "new energies" as per this definition, as well as permitting their quantitative treatment as per footnote I.2 (i.e., mathematical treatments predicting invariant numerical results which can be tested experimentally). These features are the central motivation of this Paper. II.

Despite the volume of research conducted to date on specific applications, studies on the applications of hadronic mechanics to new energies and fuels are still at their beginning and so much remains to be done. Any critical remark on the presentation, content or references of these papers would be gratefully appreciated.

2. ORIGINS OF THE INSUFFICIENCIES OF QUANTUM MECHANICS

The insufficiency of quantum mechanics which is fundamental for new energies is *the lack of any qualitative or quantitative description of the conditions of deep overlapping of the wavepackets of particles* (Figure 2).

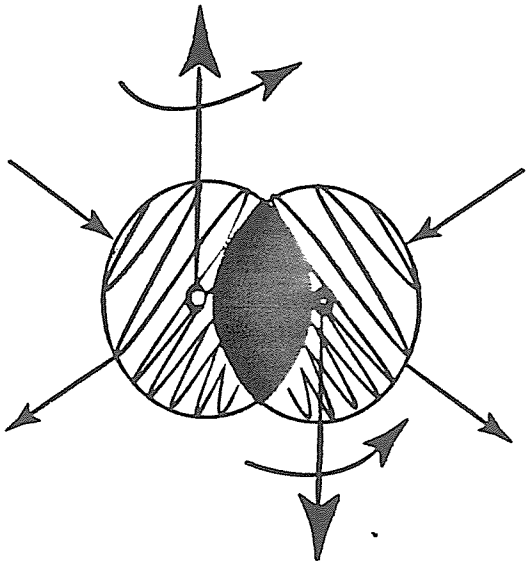

FIGURE 2: A schematic view of the central physical conditions studied in these papers, the deep overlapping of the wavepackets of particles at mutual distances of 1 fm or less, which are known to be *nonlinear* (*i.e.*, depending on powers of the wavefunctions greater than one), *nonlocal* (*i.e.*, extended over a volume which, as such, is not reducible to a finite set of isolated points), and *nonpotential* (*i.e.*, not admitting of a potential energy). Note that the *nonlocal interactions* depicted in this figure occur also (and primarily) for particles with *point-like charges*, such as the electrons. In fact, the physical conditions

here considered are due to *wave-overlappings,* and have no connection to charges. The interactions here considered are beyond any scientific treatment via quantum mechanics for various reasons. To begins, quantum mechanics lacks the conceptual foundations needed to represent the conditions depicted in this figure, because the theory can only represent action-at-a-distance interactions among point-particles. These interactions are represented with a potential in the Hamiltonian, and are realized via the known mechanism of particle exchanges. As such, the interactions over a volume of this figure should be eliminated in quantum mechanical treatments, and replaced with particles exchanges between dimensionless point-charges, as in Feyman's diagrams. On the contrary, the interactions depicted in this figure are of *contact* type, thus having *zero-range,* no potential energy, and no representation via particle exchanges. Moreover, quantum mechanics lacks the mathematical methods for the representation of the interactions here considered. The basic topology of quantum mechanics is notoriously local-differential, while consistent mathematical treatments of the conditions here considered require a *nonlocal topology.* Also, quantum mechanics can solely admits systems and interactions represented by a Hamiltonian. By contrast, the interactions of this figure should be represented with anything, *except a potential or a Hamiltonian,* as well established for resistive forces in classical mechanics. In short, the insufficiencies of quantum mechanics for a scientific treatment of the conditions of this figure are beyond *credible* doubt. The only scientifically valid issue is the selection of the appropriate *generalization* of quantum mechanics, capable of representing in a consistent and invariant way nonlinear, nonlocal, and nonpotential or non-Hamiltonian interactions. As shall be shown, new clean energies and fuels are not predicted by quantum mechanics precisely because of its lack of quantitative representation of wave-overlappings, while numerous forms of new clean energies and fuels are readily predicted and treated via an invariant broader theory representing the conditions of this figure.

In fact, these are precisely the conditions occurring in the overlapping of the wavepackets of: the two electrons in the helium; the bound state of a proton and a neutron in the deuteron; electrons in the Cooper pair; valence electrons in molecular bonds; etc.

Quantum mechanics is strictly: 1) *linear* (that is, depending on powers of the wavefunctions of the first order only); 2) *local-differential* (that is, solely valid for a finite number of isolated points); and 3) *potential* (that is, solely admitting of forces derivable from a potential V(r). The theory is consequentially: 4) *Hamiltonian* (that is, describable via the sole knowledge of the Hamiltonian operator $H = K + V = p^2/2m + V(r)$); and, therefore, 5) *unitary* when defined on a conventional Hilbert space $\mathcal{H}$ over a conventional field of complex numbers C.

By comparison, the deep overlapping of wavepackets is known to be: $\hat{1}$) *nonlinear* (because dependent on powers of the wavefunction bigger than one); $\hat{2}$) *nonlocal-integral* (because extended to the volume of overlapping which cannot be exactly reduced to a finite number of isolated points); and $\hat{3}$) *nonpotential* (because the interaction is of "contact/zero-range" type, thus prohibiting any description via an action-at-a-distance potential). Consequently, the conditions here considered are: $\hat{4}$) *non-Hamiltonian* (in the sense that they are not entirely describable with a Hamiltonian) and $\hat{5}$) *nonunitary* (namely, violating the condition of unitarity when defined on a conventional Hilbert space $\mathcal{H}$ over a conventional field C). The insufficiency of quantum mechanics for a quantitative description of wave-overlapping is then beyond scientific doubt.

3. THE "MAJESTIC" AXIOMATIC CONSISTENCY OF QUANTUM MECHANICS

It is important in these papers to separate the limitations of quantum mechanics from its axiomatic consistency. In fact, the latter is simply "majestic" (as stated in Paper I) and, therefore, the numerical predictions of the theory, when applicable, are unquestionable. The limitations are due to the fact that the basic axioms of quantum mechanics in their current realization are not valid for the entire universe, but are solely valid for conditions under which particles can be effectively approximated

as being point-like.

The "majestic" axiomatic consistency of quantum mechanics is due to the fact that its finite time evolution characterizes a *Lie group of unitary transforms* on a Hilbert space $\mathcal{H}$ with states $|\psi>$ over a field C(c,+,×) of complex numbers c with conventional addition + and multiplication × (the literature on quantum mechanics is so vast as to prevent discriminatory partial listings):

$$A(t) = U(t) \times A(0) \times U\dagger(0) = e^{iH\times t} \times A(0) \times e^{-it\times H},$$

$$|\psi(t)> = U \times |\psi(t_0)> = e^{iH\times t} \times |\psi(t_0)>,$$

$$U \times U\dagger = U\dagger \times U = I, \qquad (3.1)$$

with corresponding infinitesimal version given by the celebrated Heisenberg's and Schrödinger equations:

$$i\, dA/dt = [A, H] = A \times H - H \times A,$$

$$[r^i, p_j] \times |\psi> = \delta^i_j \times |\psi>,$$

$$H \times |\psi> = E \times |\psi>, \quad H = H^\dagger, \quad E \in R(n,+,\times),$$

$$p_k \times |\psi> = -\hbar\, \partial_k |\psi>, \qquad (3.2)$$

where: H (= $H^\dagger$) is the (Hermitean, thus observable) Hamiltonian representing the total energy); R(n,+,×) is the conventional field of real numbers n; and the product [A, B] = A×B − B×A characterizes a Lie algebra.

The "majestic" axiomatic consistency of quantum mechanics indicated in Section I-2.2 is then guaranteed by its Lie structure, which assures the invariance of the entire theory under unitary transforms. This invariance includes the preservation under the time evolution of the physical laws and numerical predictions, as illustrated by the following basic invariances under unitary transforms:

$$U\times H\times|\psi> = U\times H\times U\dagger\times U\times|\psi> = H'\times|\psi'> = E'\times|\psi>, \quad E' \equiv E,$$

$$U\times\{e^{i\,H\times t}\}\times U^\dagger = U\times\{I + iH\times t/1! + (iH\times t)2/2! + ...\}\times U^\dagger = e^{iH'\times t},$$

$$U \times (A \times B) \times U^\dagger = A' \times B', \quad K' = U\times K\times U^\dagger, \quad K = A, B$$

$$U\times[A, B]\times U^\dagger = A'\times B' - B'\times A',$$

$$U\times[r^i.\, p_j]\times|\psi> = [r'^i, p'_j]\times|\psi'> = \delta^i_j\times|\psi'>. \qquad (3.3)$$

It then follows that unitary transforms leave invariant all various special functions and transforms, thus preserving the data elaborations of the theory. This axiomatic consistency then results in *invariant basic units of space, time, energy, etc., as well as unique and invariant numerical predictions.* The same occurs for all basic spacetime symmetries of the theory, such as the celebrated Galilei's and Poincaré's symmetries. Whenever *physically* applicable, quantum mechanics then yields consistent results without internal inconsistencies.

The main line of research followed in these papers is that of assuming the axiomatic consistency of quantum mechanics as the foundations of our generalized theories, and constructing covering theories via *broader realizations* of the same axioms solely applicable for broader physical conditions.

Above all, the most fundamental requirement of our studies is that of *preserving the*

abstract Lie axioms and merely subjecting them to broader realizations valid for additional nonlinear, nonlocal and nonpotential-nonhamiltonian-nonunitary effects. As we shall see, this condition alone guarantees that the generalized theories have exactly the same axiomatic consistency of the conventional theory.

4. CATASTROPHIC INCONSISTENCY OF BROADER THEORIES BASED ON CONVENTIONAL MATHEMATICS

The next important aspect is an outline of the rather serious physical inconsistencies of generalized theories which have departed from the axiomatic structure of quantum mechanics.

Let us recall that a theory is said to be *equivalent to quantum mechanics* when it can be derived from the latter via any possible unitary transform (verifying certain conditions of topological smoothness hereon ignored for simplicity).

As a consequence, *a necessary and sufficient condition for a theory to be inequivalent to quantum mechanics is that it must be outside the class of its unitary equivalence,* that is, the new theory must be connected to quantum mechanics via a *nonunitary transform* on $\mathcal{H}$ over C:

$$U \times U^\dagger = U^\dagger \times U \neq I. \tag{4.1}$$

As such, true generalized theories must have a *nonunitary structure, e.g.,* their time evolution must verify law (4.1), rather than laws (3.1).

This is a first basic technical point for our studies of new energies. In fact, if the energy considered is predicted by a theory whose time evolution is unitary, that particular form of energy *is not new* according to Definition I.1.2.1.

I have devoted my research life to the study of this topic. An outline of the results appears to be useful for researchers in new energies, to avoid their use of structurally inconsistent theories which, as such, will not resist the test of time.

During my undergraduate studies in physics, as soon as I understood the Lie structure of quantum mechanics, Equations (3.1)-(3.3), I devoted myself to its generalization. Subsequently, as part of my Ph.D. thesis, I published in 1967 [2a] the following *parameter deformation of Lie's theory* in its finite and infinitesimal forms on $\mathcal{H}$ over C:

$$A(t) = e^{iH\times q\times t} \times A(0) \times e^{-it\times p\times H},$$

$$i\, dA / dt = (A, B) = p \times A \times H - q \times H \times A =$$

$$= m\times(A\times B - B\times A) + n\times(A\times B + B\times A) = m\times[A, B] + n\times(A, B), \tag{4.2}$$

where $p = m + n$ and $q = m - n$ are non-null parameters, and $\times$ represents the conventional associative product (*e.g.,* for matrices), $AB \equiv A\times B$, $A\times(B\times C) \equiv (A\times B)\times C$. I also published a classical counterpart of Equations (4.2) [2c], here ignored for brevity.

Following a long search in mathematical libraries, I discovered that the product (A,B) is *Lie-admissible* according to Albert [3], that is, the product is such that the attached antisymmetric product $(A, B) - (B, A) = (p+q)\times[A, B]$ is Lie. I therefore released paper [2a] for publication in a physics journal, but only after quoting all papers in Lie-admissible algebras at that time (three in total and solely existing in the pure mathematical literature). I should indicate for clarity that Albert and the other two papers treated Lie-admissibility on abstract mathematical grounds. Explicit realization (4.2) was introduced in paper [2a] for the first time.

When at Harvard University in 1978 under DOE support, I resumed full time study of the issues and published paper [2d] in 1978 indicating the insufficiency of the parameter generalization (4.2) and suggesting the following *general Lie-admissible equations* defined on conventional Hilbert spaces

over conventional fields (first proposed in [2d], Equations (4.15.34) and (4.18.11) and monograph [2f]):

$$A(t) = U \times A(0) \times U^{\dagger} = e^{iH\times Q\times t} \times A(0) \times e^{-it\times P\times H}, \quad P = Q^{\dagger},$$

$$i\, dA/dt = (A\hat{,}B) = A < B - B > A = A \times P \times H - H \times Q \times A =$$

$$= (A\times T\times B - B\times T\times A) + (A\times W\times B + B\times W\times A) = [A\hat{,}B] + \{A\hat{,}B\}, \qquad (4.3)$$

where P = T+W and Q = T−W are nowhere singular operators (or matrices).

I then introduced as a particular case the following *general Lie-isotopic equations* on $\mathcal{H}$ over C, first presented in [2d] of 1978, Equations (4.15.49) (see also monograph [2f] of 1983):

$$A(t) = U \times A(0) \times U\dagger = e^{iH\times T\times t} \times A(0) \times e^{-it\times T\times H}, \quad T = T\dagger,$$

$$i\, dA/dt = A\,\hat{\times}H - H\,\hat{\times}\,A = A\times T\times H - H\times T\times A = [\,A\hat{,}B\,], \qquad (4.4)$$

and proposed the construction of the *hadronic mechanics* [2d,2f] with fundamental Lie-isotopic equations (4.4) for closed-isolated systems for which $idH/dt = H\hat{\times}H - H\hat{\times}H \equiv 0$, and the general Lie-admissible equations (4.3) for open-nonconservative systems for which $idH/dt = H\times P\times H - H\times Q\times P \neq 0$.

It is relatively easy to prove that: 1) time evolution (4.2) is nonunitary, $U\times U^{\dagger} \neq I$; 2) the application of another nonunitary transform $R\times R^{\dagger} \neq I$ to structure (4.2) yields precisely the broader structure (4.3) by essentially transforming the parameters p and q into the operators $P = p\times(R\times R^{\dagger})^{-1}$ and $Q = q\times(R\times R^{\dagger})^{-1}$; and 3) the application of any additional nonunitary transforms $S\times S\dagger \neq I$ to structure (4.3) preserves the same structure, although with different versions of the P and Q operators. This process essentially proves the following:

> *THEOREM 4.1: General Lie-admissible laws (4.3) are "directly universal" (Section 1) for all infinitely possible (well behaved) operator generalizations of Lie's theory admitting a consistent algebra in their infinitesimal form (i.e., a product verifying the distributive and scalar laws).*

I have not been the only researcher to look for generalized theories. In fact, the lack of "final character" of structures (3.1)-(3.3) has been perceived by various researchers throughout this century. Numerous generalizations of quantum mechanics have, therefore, been attempted via the relaxation of one or the other of the main axiomatic principles of the theory.

First, numerous theories have been proposed with the *relaxation of the unitary structure of quantum mechanics*. It is important to see that *all these generalizations are particular cases of general laws (4.3),* such as:

1) Dissipative nuclear and other theories characterized by an imaginary potential [4]. These theories have nonhermitean Hamiltonian, $H = H_0 = iV \neq H^{\dagger}$ [4], and consequentially violate quantum structures (3.2). These theories are particular cases of laws (4.3) with $H = H_0\times P$, $H_0 = H_0\dagger$, $P\dagger = Q$. Their Lie-admissible reformulation is not a mere mathematical curiosity, because *dissipative nuclear models with nonhermitean Hamiltonians lose all algebras in the brackets of their time evolution (requiring a bilinear product) in favor of a triple system.* In fact, the finite time evolution assumes the evident nonunitary form $A(t) = [\exp(i\times H\times t)]\times A(0)\times[\exp(-it\times H\dagger)]$ with infinitesimal version $idA/dt = A\times H^{\dagger} - H\times A = [A, H, H^{\dagger}]$ which is no longer bilinear, as requested for any algebra. Contemporary papers on these dissipative nuclear models are incorrect when considering "protons and neutrons" as conventionally understood, trivially, because their definition (*e.g,* for the spin) mandates the presence of a consistent algebra. The Lie-admissible reformulation reconstructs a consistent algebra in the brackets of the time evolution, $[A, H, H^{\dagger}] \equiv (A\hat{,}H_0)$ as a condition to do physics..

2) Statistical theories with an external collision term C and equations of motion of the density $id\rho/dt = \rho\odot H = [\rho, H] + C$, $H = H^{\dagger}$ [5], which violate the conditions for the product $\rho\odot H$ to characterize

any algebra, as well as exponentiation law (3.1), let alone the conditions of unitarity. These theories are a particular case of the general Lie-admissible theory (4.3) with P = I and Q = 1 + (ρ×H)-1×C. Again, the Lie-admissible reformulation reconstructs a consistent algebra which would be otherwise absent.

3) The so-called "q-deformations" of the Lie product A×B - q×B×A [6], where q is a non-null scalar, which are a trivial particular case of structures (4.2).

4) The so-called "k-deformations" [7] which are a relativistic version of the q-deformations, thus also being a particular case of general structures (4.2), (4.3).

5) The so-called "star deformations" [8] with generalized associative product A*B = A×T×B, T fixed, and generalized Lie product A*B - B*A, which violate structures (3.1)-(3.3) and *coincide* with Santilli's Lie-isotopic laws (4.4) even in the symbols used.

6) Deformed creation-annihilation operators theories [9].

7) Nonunitary statistical theories [10].

8) Irreversible black holes dynamics [11] with Santilli's Lie-admissible structure (4.3).

9) Noncanonical time theories [12].

10) The so-called supersymmetric theories [13] with product (A, B) = [A, B] + {A, B} = (A×B - B×A) + (A×B + B×A), which are an evident particular case of Santilli's Lie-admissible product (4.3) with T = I and W = I.

11) The Kac-Moody superalgebras [14], which are also a particular case of Santilli's Lie-admissible product (4.3) with T = I and W a phase factor.

12) The string theories [28], which have a supersymmetric structure with consequential time evolution which is non-canonical at the classical level and nonunitary at the operator level.

13) Grand unified theories on a curved manifold (see the review in [28a]) whose time evolution is also noncanonical at the classical level and nonunitary at the operator level.

Despite their unquestionable mathematical beauty, all the above theories (beginning with my own) possess the following physical inconsistencies which have been called "catastrophic" in the literature [15,16]:

> *THEOREM 4.2: All theories possessing a nonunitary time evolution formulated on conventional Hilbert spaces* $\mathcal{H}$ *over conventional fields of complex numbers* C(c,+,×) *do not admit consistent physical applications because:*
> *1) They do not possess invariant units of time, space, energy, etc., thus lacking any physically meaningful application to experimental measurements;*
> *2) They do not conserve Hermiticity in time, thus lacking any physically meaningful observables;*
> *3) They do not possess unique and invariant numerical predictions;*
> *4) They generally violate causality and probability laws; and*
> *5) They violate the basic axioms of Einstein's special relativity.*

A comprehensive treatment is presented in memoir [16]. I here recall only the following main points.

The most fundamental drawback of the theories considered is their *lack of invariance*. This can be best illustrated with the lack of invariance of the general Lie-admissible laws (4.3), which admit as a particular case all other nonunitary theories. In fact, under nonunitary transforms U×U† ≠ I we have, *e.g.*, the lack of invariance of the Lie-admissible brackets:

$$U\times(A,\hat{B})\times U^\dagger = U\times(A<B - B>A)\times U^\dagger =$$

$$= (U\times A\times U^\dagger)\times[(U\times U^\dagger)^{-1})\times(U\times P\times U^\dagger)\times(U\times U^\dagger)^{-1}]\times(U\times B\times U^\dagger) -$$

$$- (U\times B\times U\dagger)\times[(U\times U^\dagger)^{-1})\times(U\times Q\times U^\dagger)\times(U\times U^\dagger)^{-1}]\times(U\times A\times U^\dagger) =$$

$$= A'\times P'\times B' - B'\times Q'\times A' = A'<'B' - B'>'A'.$$

$$P'=(U\times U^\dagger)^{-1})\times(U\times Q\times U^\dagger)\times(U\times U^\dagger)^{-1},\ Q'=(U\times U^\dagger)^{-1})\times(U\times Q\times U^\dagger)\times(U\times U^\dagger)^{-1}. \quad (4.5)$$

The above rules confirm the preservation of a Lie-admissible structure under the most general possible transforms, thus confirming the direct universality of laws (4.3) as per Theorem 4.1. The point is that *the formulations are not invariant because* $P' \neq P$ *and* $Q' \neq Q$.

More explicitly, the invariance of quantum mechanics follows from the fact that the associative product "×" is not changed in Equations (3.3). By comparison, the generalized products "<" and ">" of broader theories (4.3) is changed by the transformations, including the time evolution of the theory itself. The same results hold for the simpler Lie-isotopic case (4.4).

The physical implications of this lack of invariance are disastrous and can be summarized as follows. When working on a conventional Euclidean space, its basic geometric unit I = Diagonal Matrix (1, 1, 1) provides a dimensionless representation of the basic units of length in each space direction, I = Diag. (1 cm, 1 cm, 1 cm). It then follows that, by their very conception, the nonunitary time evolution of theories [2-14] *does not* preserve these basic units, $I' = U\times I\times U^\dagger \neq I$, with similar occurrences for other units. This fact prevents meaningful applications, because a necessary condition for valid measurements is the invariance of the basic units.

Similarly, it is easy to prove that the condition of Hermiticity at the initial time, $(<\phi|\times H^\dagger)\times|\psi>=<\phi|\times(H\times|\psi>)$ is violated at subsequent times for all theories with nonunitary structures when formulated on $\mathfrak{C}$ over C:

$$[<\psi|\times U^\dagger\times(U\times U^\dagger)^{-1}\times U\times H\times U^\dagger]\times U|\ \psi> =$$

$$= <\psi|\times U^\dagger\times[U\times H\times U^\dagger)\times(U\times U^\dagger)^{-1}\times U|\ \psi>] =$$

$$= (<\hat\psi\times T\times \hat H^\dagger)\times|\ \hat\psi> = <\hat\psi|\times(\hat H\times T\times|\ \hat\psi>),$$

$$|\ \hat\psi> = U\times|\ \psi>,\ \hat T = (U\times U^\dagger)^{-1} = T^\dagger,$$

$$\hat H^\dagger = T^{-1}\times\hat H\times T \neq H \quad (4.6)$$

As a result, all theories [2-14] do not admit physically meaningful observables.

Causality and probability laws are notoriously based on the unitary character of time evolution (3.1). Their violation for all theories [2-14] is then evident.

The violation of the basic axioms of Einstein's special relativity by all theories [2-14] is so evident as to require no comment.

The mathematical inconsistencies are equally catastrophic. In fact, the loss of the basic unit indicated above implies the evident loss of the field of numbers on which the theories are defined. As a result, the entire mathematical structure assumed at the initial time is no longer applicable at subsequent times, because vector and Hilbert spaces, algebras and groups, geometries and topologies, etc. are *all* defined on the initial field which is no longer applicable at subsequent time, since it has lost its basic unit.

Next, additional generalized theories were attempted via *the relaxation of the linear character of quantum mechanics.* These theories (see, *e.g.*, [17]) are essentially based on eigenvalues equations with the structure $H(t, r, p, \psi)\times\psi = E\times\psi$ (*i.e.*, H depends on the wavefunction).

Even though mathematically impeccable and possessing a seemingly unitary time evolution, these theories also possess rather serious physical drawbacks, such as: they violate the superposition principle of quantum mechanics, thus being strictly inapplicable to composite systems; they violate the fundamental Mackay imprimitivity theorem [18] which is necessary for the applicability of Galilei's or Einstein's relativities; and possess other drawbacks [19] so serious as to prevent any application to the real world.

Yet another type of broader theory is *Weinberg's theory with a nonassociative envelope*

[20]. This is a theory in which the associative enveloping product $A\times B$ of the Lie product $[A, B] = A\times B - B\times A$ is replaced with a certain *nonassociative* product $A\odot B$, $A\odot(B\odot C) \neq (A\odot B)\odot C$.

The latter theory violates Okubo's No-Quantization Theorem [21], which prohibits the use of nonassociative envelopes because of catastrophic physical consequences, such as the loss of equivalence between the Schrödinger and Heisenberg's representations (the former remains associative, while the latter becomes nonassociative, thus resulting in inequivalence, with consequential inconsistency of the entire theory).

Weinberg's theory also has additional catastrophic inconsistencies, studied in detail in [22], such as: the complete absence of any unit at all, let alone its lack of invariance (because of the lack of a nontrivial quantity E such that $E\odot A \equiv A\odot E \equiv A, \forall A$) with consequential impossibility of applying the theory to any measurement of any type; the violation of Galilei's and Einstein's relativities (because of the loss of exponentiation); and others.

Several authors also attempted *the relaxation of the local-differential character of quantum mechanics*. The attempt was done via the addition of "integral potentials" $V = \int d\tau\, \Gamma(\tau,...)$ in a Hamiltonian.

These theories are worse than all the preceding ones, because they are structurally flawed on both mathematical and physical grounds. The nonlocal extension is elaborated via the conventional mathematics of quantum mechanics. But the mathematics of the latter, beginning with its topology, is strictly local-differential, thus implying fundamental *mathematical* inconsistencies. Nonlocal interactions are, in general, of contact type for which the notion of a potential has no physical meaning, thus resulting in catastrophic *physical* inconsistencies.

The above occurrences prevent the use of nonlinear, nonlocal, and nonunitary theories for any serious study of new energies when treated with conventional mathematics.

For completeness, the following additional inconsistencies (studied in detail in memoir [16]) are listed without proof:

> *THEOREM 4.3. All classical theories with a noncanonical structure formulated on conventional metric spaces over conventional fields do not possess consistent physical applications because of the lack of invariant units, invariant time evolutions, and invariant numerical results.*

The best illustration is given by the Lie-admissible reformulation of the historical analytic equations, *Hamilton's equations with external terms* [2g,2i], which are "directly universal" for all conceivable classical equations.

My recent studies have established that the ensuing *Hamilton-Admissible Mechanics* I laboriously submitted in monograph [2i] has no known physical value.

Exactly the same fate recently emerged for the *Birkhoffian Generalization of Hamiltonian Mechanics* I laboriously submitted in monograph [2f] (published by one of the most prestigious scientific publishers, Springer-Verlag, in its most prestigious series of "Text and Monographs in Physics"). In fact, such a mechanics is a *noncanonical* image of the conventional Hamilton's equations of the contemporary literature (those with the external terms cut out). As such, they are noninvariant under their own action with consequential Theorem 4.3.

In conclusion, by the early 1980's I had indeed reached classical [2i] and operator [2f] formulations that are directly universal in their fields, with a plethora of simpler versions by various other authors. However, all these theories have no physical meaning known to me, because they are noninvariant.

5. THE NOVEL ISO-, GENO-, AND HYPER-MATHEMATICS, AND THEIR ISODUALS

The history of science establishes that *there cannot be really new scientific advancements without*

new mathematics and, in turn, there cannot be really new mathematics without new numbers.

The best example is Isaac Newton, who had to introduce the differential calculus as a necessary pre-requisite for the formulation of his famous physical laws. When digging beyond all subsequent basic advances in physics, new mathematics emerge and, when digging deeper, new numbers emerge (as is the case of quantum mechanics, which introduced for the first time the use in physics of complex numbers).

Intriguingly, the origin of the physical inconsistencies of Theorems 4.2 and 4.3 resulted precisely in Newton's differential calculus, which is local-differential, thus unsuited for broader nonlocal systems. In fact, all generalized theories of papers [2-14] were inconsistent because the basic equations are expressed via the conventional differential calculus. In order to achieve invariant equations of motion for the broader conditions under consideration, I had to generalize first the differential calculus in the form outlined below. Physics can be done only thereafter.

To illustrate how true this historical teaching is, the reader should know that *the entire current mathematical knowledge is generally inapplicable for quantitative studies of new energies,* with only a few (yet qualified) exceptions published in *Rendiconti Circolo Matematico Palermo; Algebras, Groups and Geometries; Mathematical Methods in Applied Sciences; Journal of Balkan Geometry Society; Acta Applicandae Mathematicae; (Indian) Journal of Mathematics;* and other mathematics journals.

In fact, conventional mathematics is based on conventional numbers (real, complex, quaternions, and octonions), while the new mathematics requires the use of new numbers, as will be shown. Moreover, the existing mathematics is local-differential, while we need a nonlocal mathematics to treat new energies. The very few pre-existing integral geometries are unsuited to construct covering physical theories, because they do not admit local-differential methods as a clear particular case, or are unable to separate local-differential and nonlocal-integral effects as necessary for experimental verifications.

After having identified the lack of physical applicability of pre-existing generalized theories, as a physicist I had to construct basically novel mathematical methods as a necessary condition to conduct novel physical inquiries.

While at the Department of Mathematics of Harvard University under DOE support, I proposed [2g] in 1978 the construction of a sequence of novel mathematics of increasing complexity for the description of systems of increasing methodological needs. I then continued to study the new mathematics in subsequent years (see the recent mathematical memoir [I-3e] and monograph [I-3f]). The same mathematics have been studied by various pure and applied mathematicians (see the monograph. [I-3i-I-3l] and recent papers [23] for comprehensive references), and have now reached operational maturity.

The main idea I proposed in 1978 is the generalization (also called *lifting*) of the trivial n-dimensional unit I = Diag. (1, 1, ..., 1) of conventional mathematics into a generalized n×n-dimensional matrix (or operator) $\hat{1}$ which is everywhere invertible, Hermitean and positive-definite as I, yet possesses an unrestricted functional dependence on all needed local variables, such as time t, coordinates r, velocities v, wavefunctions ψ, etc.:

$$I = \text{Diag.}\,(1, 1, ..., 1) \to \hat{1} = \hat{1}(t, r, v, \psi, ...) = 1 / \hat{T} \equiv \hat{1}^{\dagger} > 0. \tag{5.1}$$

The new mathematics then follows from the reconstruction of the entire original formalism in such a way to admit $\hat{1}$, rather than I, as the correct left and right new unit.

Since $\hat{1}$ preserves the topological characteristics of I, the liftings under consideration here were submitted under the name of *isotopies* [2e] in the Greek meaning of being "axiom-preserving." The ensuing mathematics is then called *Santilli's isomathematics.*

Its construction requires, first, the lifting of the conventional associative product A×B (= AB) among generic quantities A, B (such as numbers, matrices, operators, etc.) into the product:

$$A \hat{\times} B = A \times \hat{T} \times B\,, \tag{5.2}$$

where $\hat{T}$ is fixed for all products, under which $\hat{1} = 1/\hat{T}$ is the correct left and right unit of the new theory called the *isounit:*

$$\hat{1} \hat{\times} A = \hat{T}^{-1} \times \hat{T} \times A = A \hat{\times} \hat{1} = A \times \hat{T} \times T^{-1} \equiv A . \tag{5.3}$$

while $\hat{T}$ is called the *isotopic element.*

The product $A\hat{\times}B$ is then called *isoassociative* (or *isoproduct* for short) because it preserves the original axiom of associativity, $A\hat{\times}(B\hat{\times}C) = (A\hat{\times}B)\hat{\times}C$. We then have the following isotopic liftings:

1) Conventional real numbers, complex numbers, and quaternions n, m, etc., with trivial unit 1 and product nm = n×m are lifted into the *isoreal, isocomplex and isoquaternion numbers* [I-3h] $\hat{n} = n\times\hat{1}$, $\hat{m} = m\times\hat{1}$, etc. with isosum $\hat{n} \hat{+} \hat{m} = (n+m)\times\hat{1}$, *isoproduct* $\hat{n}\hat{\times}\hat{m} = \hat{n}\times\hat{T}\times\hat{m} = (n\times\hat{1})\times T\times(m\times\hat{1}) = (n\times m)\times\hat{1}$, *isoquotient* $\hat{n}\hat{/}\hat{m} = (\hat{n}/\hat{m})\times\hat{1}$, and other generalized operations characterizing the *isofield* $\hat{R}(\hat{n},+,\hat{\times})$;

2) The conventional differentials dr^k of the Euclidean coordinates r^k, k = 1, 2, 3 (= x, y, z), are lifted into the *isodifferential* [I-3e]:

$$\hat{d}r^k = \hat{1}^k{}_i(t, r, v, \psi, ...) \times dr^i; \tag{5.4}$$

the conventional derivatives $\partial/\partial rk$ are lifted into the *isoderivative* with related main property (see again [I-3e] for details):

$$\hat{\partial}/\hat{\partial}r^k = \hat{T}_k{}^i \times \partial/\partial r^i; \quad \hat{\partial}\, r^i \,\hat{/}\, \hat{\partial}\, r_j = \hat{\delta}^i{}_j = \delta^i{}_j \times \hat{1} ; \tag{5.5}$$

3) Corresponding compatible generalizations occur for *all* remaining aspects of conventional mathematics, including metric and Hilbert spaces, conventional and special functions and transforms, algebras, groups and geometries, topologies, etc. [I-3,23].

A salient feature of the isomathematics is that of preserving all original axioms by construction. This is an evidently important feature that assures the preservation of the original physical consistency, as we shall see in the next section.

It should be stated to prevent misrepresentations that *the preservation of the original axioms occurs only in isospaces over isofields (i.e., when referred to generalized units) and not necessarily in their projection in conventional spaces over conventional field (i.e., when referred to the conventional unit).*

As an illustration, isoderivatives isocommute on isospaces, $\hat{\partial}_i\hat{\partial}_j \equiv \hat{\partial}_j\hat{\partial}_i$, but they do not generally commute when projected on conventional spaces, $\hat{T}_i{}^m(r)\times\partial_m\hat{T}_j{}^n(r, ...)\times\partial_n \neq \hat{T}_j{}^m(r, ...)\times\partial_m\hat{T}_i{}^n(r)\times\partial_n$ evidently because of the general dependence of the isotopic element $\hat{T}$ on the local variable. A similar occurrence holds for most of the remaining properties.

A knowledge of isomathematics as given, e.g., in [I-3e] (which we cannot possibly review here for brevity) is tacitly assumed hereon for an in-depth technical understanding of these papers. The reader is warned that any appraisal of these papers via conventional mathematics (*e.g.*, under the assumption that "2 × 2 = 4") is afflicted by a number of insidious inconsistencies which generally remain undetected by nonexperts. As an illustration "2 × 2 = 12" for $\hat{1} = 3$, or the number 4 becomes *prime* for $\hat{1} = 4$.

In 1978 I also proposed the broader *genomathematics* [2e], which is characterized by the relaxation of the Hermiticity of the generalized unit. This implies the existence of *two different generalized units,* called *genounits* and related *genoproducts*, which are denoted by:

$$^{<}\hat{I} = \hat{1} / \hat{P}, \quad A < B = A \times \hat{P} \times B, \quad ^{<}\hat{I} < A \equiv A < ^{<}\hat{I} \equiv A,$$

$$\hat{I}^{>} = \hat{1} / \hat{Q}, \quad A > B = A \times \hat{Q} \times B, \quad \hat{I}^{>} > A \equiv A > \hat{I}^{>} \equiv A,$$

$$\hat{I}^{>} = (^{<}\hat{I})^{\dagger}, \tag{5.6}$$

where $\hat{P}$ and $\hat{Q}$ are again fixed for all products.

In this case we have *two* independent generalizations, one for *the ordered product to the left* $A<B = A\times\hat{P}\times B$ and related unit $<I$, and one for the *ordered product to the right* $A>B = A\times\hat{Q}\times B$ and related unit $I>$. These two products are then interconnected by Hermitean conjugation (5.6c).

This implies the existence of a *dual* lifting of the *entire* conventional mathematics of quantum mechanics, including [I-3b,I-3e]: a) *forward and backward genonumbers* $n^{>} = n\times I^{>}$, ${}^{<}n = {}^{<}I\times n$ with corresponding *genoproducts* $n^{>}>m^{>} = (nm)\times I^{>}$ and ${}^{<}n<{}^{<}m = {}^{<}I\times(nm)$; b) *forward and backward genodifferentials and genoderivatives:*

$$d^{>}r^{k} = I^{>k}{}_{i}\times dr^{i},\ {}^{<}dr^{k} = {}^{<}I^{k}{}_{i}\times dr^{i};$$

$$\partial^{>}/\partial^{>}r^{k} = Q_{k}{}^{i}\times\partial/\partial r^{i},\ {}^{<}\partial/{}^{<}\partial r^{k} = P_{k}{}^{i}\times\partial/\partial r^{i}. \tag{5.7}$$

and c) corresponding dual liftings for all remaining methods.

I submitted the above broader liftings under the name of *genotopies* [2e] from the Greek meaning of being "axiom-inducing," that is, of mapping conventional into covering axioms which admit both the conventional and isotopic realizations as particular cases. The resulting new mathematics is today called *Santilli's genomathematics.*

I also submitted more recently the still broader *hypermathematics* [I-3e], which is characterized by the relaxation of the single-valued character of the genounits. This implies two generalized, nonhermitean and multivalued units, called *hyperunits*, each with its own ordered *hyperproducts* and conjugation:

$${}^{<}I = \{ {}^{<}I_{1}, {}^{<}I_{2}, \ldots, \} = 1/P = ({}^{<}I)^{\dagger},$$

$$A<B = \{ A\times\hat{P}_{1}\times B,\ A\times\hat{P}_{2}\times B, \ldots,\}\ {}^{<}I<A \equiv A<{}^{<}I \equiv A,$$

$$I^{>} = \{ I^{>}{}_{1},\ I^{>}{}_{2}, \ldots,\ I^{>}{}_{N}\} = 1/\hat{Q},$$

$$A>B = \{ A\times\hat{Q}_{1}\times B,\ A\times\hat{Q}_{2}\times B, \ldots \},\ I^{>}>A \equiv A>I^{>} \equiv A, \tag{5.8}$$

In this case we have the *forward and backward hypernumbers* $n^{>}>m^{>} = \{ (nm)\times I^{>}{}_{1}, (nm)\times I^{>}{}_{2}, \ldots \}$, with multivalued products such as ${}^{<}n<{}^{<}m = \{{}^{<}I_{1}\times(nm), {}^{<}I_{2}\times(nm), \ldots\}$; the *forward and backward hyperdifferentials, hyperderivatives, hyperfunctions, hyperspaces, etc.* The resulting new mathematics is today called *Santilli's hypermathematics.*

Intriguingly, the simple lifting of the unit, equation (5.1), implies a chain of generalizations of the entire contemporary mathematics admitting a unit. In fact, the entire pre-existing mathematical knowledge has been restricted to the simplest possible unit I, as the reader is encouraged to verify. This occurrence also illustrates the truly fundamental character of the unit for all possible mathematical and physical theories.

The need for the above sequence of generalized mathematics is the following. Isomathematics permit a resolution of certain insufficiencies of quantum mechanics. However, being "axiom-preserving," isomathematics has its own limitations since it preserves the essential characteristics of quantum mechanics, and, therefore, can only represent systems which are *reversible in time* and verify *total conservation laws.* As such, isomathematics is adequate for the representation of *the structure of hadrons, nuclei, atoms, molecules, stars and other interior problems when considered as isolated from the rest of the universe* with linear and nonlinear, local and nonlocal, Hamiltonian and non-Hamiltonian interactions. The former are represented by a conventional Hamiltonian and the latter by the isounit. However, isomathematics is transparently insufficient to represent *irreversible* systems, such as chemical reactions.

Genomathematics resolves the latter insufficiency because it is *structurally irreversible* [2e,I-3f]. In fact, motion forward (backward) in time can be represented with forward (backward)

products A>B (A<B). Since these products are different, the theories forward and backward in time are different, and irreversibility follows. Time reversal is then ensured by conjugation (5.6c).

Genomathematics has its own limitations when facing more difficult interior problems, such as *biological structures,* whose complexity is beyond human imagination, *e.g.,* because they are multivalued [I-3f].

Hypermathematics resolves the latter insufficiency because it is as irreversible as genomathematics, yet it adds an unlimited number of representational capabilities due to its multivalued character.

It is evident that hypermathematics admits, as a particular case, genomathematics when the hyperunits are reduced to a single non-Hermitean quantity. In turn, genomathematics admits as a particular case isomathematics when the generalized unit returns to being Hermitean. Finally, isomathematics admits conventional mathematics as a trivial particular case when the isounits assume the value I.

It is important to indicate the following examples of generalized units already in these introductory lines, because they can be of guidance for the understanding of subsequent aspects:

$$\hat{1} = \text{Diag.}\,(n_1^2, n_2^2, n_3^2)\,, \tag{5.9a}$$

$$\hat{1} = \exp\{N \int dr^3\, \psi^\dagger_\uparrow(r)\, \psi_\downarrow(r)\}, \tag{5.9b}$$

$$\hat{1} = \begin{pmatrix} 1 & [\,1 - \exp\{N \int dr^3\, \psi^\dagger_\uparrow(r)\, \psi_\downarrow(r)\}\,] \\ [\,1 - \exp\{N \int dr^3\, \psi^\dagger_\uparrow(r)\, \psi_\downarrow(r)\}\,] & 1 \end{pmatrix}, \tag{5.9c}$$

As we shall see in Paper III, isounit (5.9a) is used for the characterization of extended, nonspherical (in this case ellipsoidical) and deformable shapes of protons and neutrons; isounit (5.9b) is used for the characterization of the nonlocal-nonpotential conditions of deep wave overlappings (Figure II-2); and isounit (5.9c) is used for the fit of the experimental data on Bose-Einstein correlation [I-15]..

Note that none of the features represented by isounits (5.9) can be represented via a Hamiltonian. Irrespective of all the arguments of Paper I, this feature alone is sufficient to establish the insufficiencies of quantum mechanics, trivially, because such a theory is purely Hamiltonian. Note also that all isounits (5.9) admit the trivial unit I of quantum mechanics as a particular case. The latter condition is evidently necessary for hadronic mechanics to be a *covering* of quantum mechanics.

Numerous other generalized units have been identified depending on the problem at hand and they will be considered in subsequent papers.

The reader can go to an advanced mathematics library, and select at random any mathematical presentation, including those on iso-, geno-, and hyper-mathematics. The entire pre-existing mathematics, including that outlined above in this section, is unapable to provide a consistent *classical* representation of antimatter.

As indicated in Paper I, the map from matter to antimatter must be anti-isomorphic like charge conjugation in *second* quantization. But current science possesses only *one channel of quantization, the conventional one.* The use of any conventional or generalized mathematics for the classical treatment of antimatter then implies operator images that *do not* constitute antiparticles, but merely particles with the wrong sign of the charge (because reached with the same quantization channel of particles).

In view of these and other inconsistencies, in order to achieve a consistent classical representation of antimatter, as a physicist, I had to study additionally new mathematics specifically constructed for the task.

After laborious search, I introduced in 1985 [25b] the map of an arbitrary quantity A (and

related spaces) called *isoduality* for certain technical reasons:

$$A(r, \psi, ...) \rightarrow A^d(r^d, \psi^d, ...) = - A\dagger(- r\dagger, - \psi\dagger, ...),$$

$$A\hat{\times}B = A\times\hat{T}\times B \rightarrow A\ \hat{\times}^d\ B = A\times(-\hat{T}^\dagger)\times B = - A\times\hat{T}^\dagger\times B. \tag{5.10}$$

As one can see, the main idea was essentially that of assuming, for the first time in mathematical history, *negative definite units,* and then reconstructing the entire conventional, iso-, geno- and hyper- mathematics in such a way to admit $-\hat{1}\dagger$, rather than $\hat{1}$, as the correct left and right unit. This implies isodual images of all various notions considered above, resulting in a yet novel mathematics today called *Santilli's isodual mathematics* [I-3e].

In particular, isodual mathematics possesses a *negative norm,* which implies the reversal of the sign of all physical characteristics of particles, thus providing the desired anti-isomorphic image of matter applicable at all levels, including the classical one. Moreover, isodual mathematics identifies a new channel of quantization, specifically, for antimatter. As such, isodual mathematics has resulted to be particularly suited to represent *antimatter* (see [I-3g]) beginning at the classical level and then persisting at the operator level, where it becomes equivalent to charge conjugation. These papers deal solely with *matter* and, as such, isodual mathematics shall not be considered for brevity.

6. CLASSICAL AND OPERATOR ISO-, GENO-, AND HYPER-MECHANICS, AND THEIR ISODUALS

6.1. Introduction

In 1978 I submitted [2d] a generalization of quantum mechanics under the name of *hadronic mechanics* based on general Lie-admissible equations (4.3) for open-nonconservative systems with unrestricted interactions and the simpler Lie-isotopic equations (4.4) for closed-isolated systems with non-Hamiltonian internal effects.

The new mechanics was subsequently studied by numerous mathematicians, theoreticians and experimentalists in over one thousand papers, twenty advanced monographs, and over thirty volumes of conference proceedings (see their listing in the IBR Web Site). I apologize for being unable to quote them on an individual basis because they are too numerous (see Vols. [I-3b,I-3c] for comprehensive literature up to 1995 and representative papers [24]).

The reader should be made aware that all publications on hadronic mechanics (including mine) prior to 1996 are *physically inconsistent* due to lack of full invariance, which was recently achieved in memoir [I-3d] published in *Foundations of Physics* Vol. 27 of 1997, following the prior achievement of mathematical maturity at *Rendiconti Circolo Matematico Palermo,* Suppl. Vol. 42 (1996), and maturity in generalized symmetries in memoir [23a] published in *M mathematical Methods in Applied Sciences,* Volume 19, 1996, as well as monographs [I-3j,I-3k,I-3l]. As a result of these collegial efforts, hadronic mechanics has now reached the operational maturity first presented in recent memoir [I-3d].

Today hadronic mechanics comprises various formulations for the classical and operator description of matetr, and, separately, antimatetr, as summarized in Table I. Moreover, *each* of these formulations is divided into *nonrelativistic and relativistic treatments* with *field theoretical extensions* under construction at this writing.

These formulations are used for the classical and operator treatment of: reversible systems of particles at large mutual distances in exterior conditions in vacuum with only Hamiltonian interactions (conventional mechanics); reversible systems of particles in interior conditions with Hamiltonian and non-Hamiltonian interactions (isomechanics); irreversible systems of particles in interior conditions (genomechanics); and multi-valued irreversible systems of particles as occurring

in biology (hypermechanics).

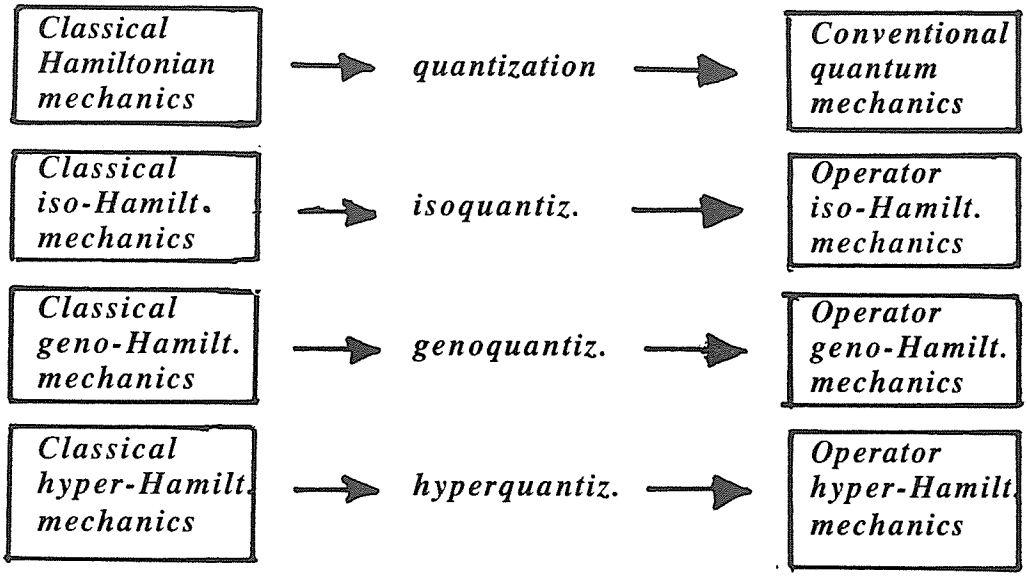

TABLE I: A schematic view of: the four basic formulations of hadronic mechanics used for the classical description of matter in conditions of increasing complexities; their operator counterparts; and their unique interconnecting maps. In addition, hadronic mechanics includes eight corresponding anti-isomorphic formulations, obtained via isodualities, for the corresponding classical and operator description of antimatter. Each of these sixteen formulations should then be divided into nonrelativistic, relativistic, and field theoretical versions, resulting in a total of forty eight distinct theories. Only classical and operator, nonrelativistic and relativistic mechanics for the description of matter are outlined in this section. Note that all these formulations are uniquely and unambiguously characterized by progressive generalizations of the unit. Such a generalization therefore assumes its proper role at the ultima and most fundamental, conceptual, topological, mathematical, theoretical, and experimental notion.

It is evident that I cannot possibly review in this paper all the above thirty-two different formulations (excluding the twelve additional quantum field theoretical extensions). In this section I shall, therefore, merely indicate the most recent references of the various aspects and outline only the basic lines important for new energies.

6.2. Nonrelativistic Classical Isomechanics

A misconception of contemporary theoretical physics is the rather widespread belief that the validity of the conventional ten, Galilean or Einsteinian, *total conservation laws* (for the conservation of the total energy, linear momentum, angular momentum, and uniform motion of the center of mass) necessarily imply conservative internal forces derivable from a potential.

This belief is dramatically disproved by the observation (and admission) of nature, such as the visual inspection of Jupiter's structure under a telescope which, when considered as isolated from the rest of the universe, does indeed verify the celebrated ten total conservation laws, yet its internal structure is dramatically nonpotential-non-Hamiltonian, as manifested by vortices with *variable angular momenta*, irreversible internal processes, entropy, etc. (Technically, Jupiter's internal equations violate the integrability conditions for the existence of a potential or a Hamiltonian, the conditions of *variational selfadjointness* studied in detail in monographs [2e,2f].)

I spent a considerable number of years to construct, first, a classical mechanics capable of

an invariant description of *closed-isolated systems verifying conventional total conservation laws, yet possessing conservative-potential, as well as nonconservative-nonpotential internal forces.* Quantization and operator versions were studied thereafter because no new operator theory can pass the test of time without a sound classical counterpart.

As recalled in Section 4, for the above purpose I first constructed the *Birkhoffian Generalization of Hamiltonian Mechanics* with a Lie-isotopic structure [2f] and then the broader *Hamilton-Admissible Mechanics* with a Lie-admissible structure [2i]. Unfortunately, both these mechanics resulted in subsequent studies to be noninvariant, thus without physical validity.

Therefore, I had to construct the *Hamilton-isotopic mechanics* which was first presented in monograph [1-3c] of 1993. However, I subsequently discovered that this latter mechanics too had no physical meaning, because it was also noninvariant.

After laborious search, I finally identified the lack of invariance in Newton's historical *ordinary differential calculus.*

It was only after the publication of memoir [1-3e] of 1996 on the isodifferential calculus that I finally reached the desired invariance, as well as mathematical and physical maturity.

The invariant formulation of the classical nonrelativistic iso-Newtonian/iso-Hamiltonian mechanics can be outlined as follows.

The fundamental notions of Hamiltonian mechanics in phase space and in CGS units are: the conventional, Euclidean *space-unit* I_r = Diag. (1 cm, 1 cm, 1 cm), *momentum unit* I_p = Diag. (1 cm/sec, 1 cm/sec, 1 cm/sec) and time unit I_t = 1 sec, geometrically expressed in the usual dimensionless forms $I_r = I_p = I$ = Dig. (1, 1, 1) and I_t = 1; the related fields $R_r = R_p = R(n, +, \times)$ and $R_t = R(t,+,\times)$; the basic Euclidean carrier space characterized by the well known Kronecker product of Euclidean spaces $E_{Tot} = E_t(t,R_t) \times E(r,\delta,R_s) \times E(p,\delta,R_s)$, where $r = \{r_k\}$, $p = \{p_k\}$, $k = 1, 2, 3$, δ = Diag. (1, 1, 1); the intervals are given by $r2 = r_i \times \delta_{ij} \times r_j \in R$, $p2 = p_i \times \delta_{ij} \times p_j \in R$, $r = r_1 - r_2$, $p = p_1 - p_2$; and the ensuing theory (action principle, Hamilton and Hamilton-Jacobi equations, classical realization of Lie's theory, Euclidean and symplectic geometries, etc.).

The fundamental notions of the *classical nonrelativistic isomechanics* are:

1) The basic isounits:

$$\textit{pace isounit } \hat{1}_r = \hat{1} = (\hat{1}^i{}_j) = \hat{T}^{-1} = (\hat{T}_i{}^j)^{-1} > 0,$$

$$\textit{momentum isounit } \hat{1}_p = \hat{T} = \hat{1}^{-1} > 0 \text{ and}$$

$$\textit{time isounit } \hat{1}_t > 0, \tag{6.2.1}$$

which can be always diagonalized into the form:

$$\hat{1}_r = \hat{1} = \text{Diag.}\ (\hat{1}_{11}, \hat{1}_{22}, \hat{1}_{33}),$$

$$\hat{1}_p = \hat{T} = \text{Diag.}\ (\hat{T}_{11}, \hat{T}_{22}, \hat{T}_{33}) \text{ and}$$

$$\hat{1}_t \text{ a real valued nowhere null function;} \tag{6.2.2}$$

2) The isofields $\hat{R}_r(\hat{n}+,\hat{\times})$ with Isounit $\hat{1}$, $\hat{R}_p(\hat{m},+,\hat{\times})$ with isounit $\hat{T}$, and $\hat{R}_t(\hat{t}+,\hat{\times})$ with isounit $\hat{1}_t$;

3) The basic carrier isospaces given by *Santilli's isoeuclidean spaces* (first introduced in [2g] of 1978):

$$\hat{E}_{Tot} = \hat{E}_t(\hat{t},\hat{R}_t) \times \hat{E}(\hat{r},\hat{\delta}_r\hat{R}_r) \times \hat{E}(\hat{p},\hat{\delta}_p,\hat{R}_p), \tag{6.2.3}$$

with *isocoordinates, isomomenta and isometrics:*

$$\hat{r} = r \times \hat{1}_r,\ \hat{p} = p \times \hat{T}\ ;\ \hat{\delta}_r = \hat{T} \times \delta,\ \hat{\delta}_p = \hat{1} \times \delta; \tag{6.2.4}$$

and the *isointervals:*

$$\hat{r}^{\hat{2}} = \hat{r}^i \hat{\times} \hat{\delta}_{ij} \hat{\times} \hat{r}^j = (r^i \times \hat{\delta}_r^{ij} \times r^j) \times \hat{1}_r \in \hat{R}_r,$$

$$\hat{p}^{\hat{2}} = \hat{p}_i \hat{\times} \hat{\delta}^{ij} \times \hat{p}_j = (p_i \times \hat{\delta}_p^{ij} \times p_j) \times \hat{1}_p \in \hat{R}_p, \qquad (6.2.5)$$

where $\hat{\delta}_p = (\hat{\delta}_p{}^{ij}) = \hat{\delta}_r^{-1} = (\delta_{rij})^{-1}$, thus confirming the indicated isounits for r and p;

4) The isofunctional analysis comprising conventional and special isofunctions and isotransforms, isodifferential calculus, etc.;

5) The Lie-Santilli isotheory, comprising the isotopies of universal enveloping associative algebras, Lie algebras, Lie groups, Lie symmetries, representation theory; etc.

By dropping the subindex r and p in the isoproducts for simplicity, the classical nonrelativistic isomechanics is characterized by [I-3e]:

A) The *Newton-Santilli isoequations,* first introduced in [I-2e], p. 31:

$$\hat{m} \hat{\times}_t \frac{\hat{d}\, \hat{v}_k}{\hat{d}\, \hat{t}} - \hat{F}_k(t, \hat{r}, \hat{v}) = \qquad (6.2.6)$$

$$= (m \times I_t) \times \hat{T}_t \times \hat{T}_t \times \frac{d\,(\hat{T}_k{}^i \times v_i)}{dt} - \hat{1}_t \times \hat{T}_k{}^i \times F^{SA}{}_i =$$

$$= \hat{T}_t \times \hat{T}_k{}^i \times \Big(m \times \frac{d\, v_i}{dt} - F^{SA}{}_i - F^{NSA}{}_i \Big) = 0, \; F^{NSA}{}_i = \hat{T}_t \times \hat{1}_i{}^s \times \frac{d\hat{T}^r{}_s}{dt}$$

where: quantities with (without) a "hat" are defined on isotopic (conventional) spaces; and SA (NSA) stands for the verification (violation) of the conditions of variational selfadjointness for the existence of a potential [2f]. As one can see, isoequations (6.2.6) embed all nonpotential forces *in the differentials,* including all nonlocal effects outside the topology of Newton's equations. The new effects are now permitted by the new Santilli-Sourlas-Tsagas nonlocal isotopology [I-3e,23b].

B) The *isoaction principle* [I-3e] (where we assume hereon for simplicity $\hat{1}_t = 1$):

$$\hat{\delta}\hat{A} = \hat{\delta} \int_{t_1}^{t_2} (\hat{p}_k \times \hat{d}\hat{r}^k - \hat{H} \times \hat{d}\hat{t}) =$$

$$= \hat{\delta} \int_{t_1}^{t_2} (p_i \times \hat{1}^i{}_j(t, r, p, ...) \times dr^j - H \times dt) = 0,$$

$$H = \tfrac{1}{2} p_k \hat{\times}_p p^k + V(t, r, p), \qquad (6.2.7)$$

C) The *Hamilton-Santilli isoequations* derivable from the above isoprinciple, first presented in [I-3e], p. 47:

$$\frac{dr^k}{dt} = \frac{\hat{\partial}\hat{H}}{\hat{\partial}\hat{p}_k} = \hat{1}^k{}_i(t, r, p) \times \frac{\partial H(t, r, p)}{\partial p_i},$$

$$\frac{dp_k}{dt} = -\frac{\hat{\partial}\hat{H}}{\hat{\partial}\hat{r}^k} = -\hat{T}_k{}^i(t, r, p) \times \frac{\partial H(t, r, p)}{\partial r^i}, \qquad (6.2.8)$$

which are directly universal for all possible isoequations (6.2.6)

D) The *Hamilton-Jacobi-Santilli isoequations:*

$$\frac{\hat{\partial}\hat{A}}{\hat{\partial} t} + \hat{H} = 0, \qquad \frac{\hat{\partial}\hat{A}}{\hat{\partial}\hat{r}^k} = \hat{p}_k, \qquad \frac{\hat{\partial}\hat{A}}{\hat{\partial}\hat{p}_k} = 0. \tag{6.2.9}$$

E) The algebraic form of the time evolution for an arbitrary quantity A(r,p) (see Equation (2.66) of [I-3e], p. 51):

$$\frac{dA}{dt} = [A, \hat{H}] = \frac{\partial A}{\partial r^k} \times \frac{\partial H}{\partial p_k} - \frac{\partial H}{\partial r^k} \times \frac{\partial A}{\partial p_k}, \tag{6.2.10}$$

whose brackets $[A,\hat{B}]$ constitute a classical realization of the *Lie-Santilli isotheory* [I-3i to I-3l], here omitted for brevity jointly with the underlying *isoeuclidean and isosymplectic geometries* (see [I-3e]).

The resulting new mechanics is now called *Santilli's classical isomechanics* (see, *e.g.*, [I-3i to I-3l] and quoted literature). Its most important feature is that of being *invariant* under the most general possible *noncanonical* transformations $U\times\omega\times U\dagger \neq \omega$, where ω is the symplectic two-form, provided that they are formulated via isomathematics (all products must be isotopic).

In fact, all transforms $U\times\omega\times U\dagger \neq \omega$ can always be identically rewritten in the isocanonical form $\hat{U}\hat{\times}\hat{\omega}\hat{\times}\hat{U}^\dagger \equiv \hat{\omega}$, where $\hat{\omega}$ is the *fundamental isosymplectic structure,* thus yielding the desired invariance. These notions require a knowledge of the isosymplectic geometry I cannot possibly review here (see memoir [I-3e] for brevity).

I finally resolved in 1996 the fundamental inconsistency of the preceding Birkhoffian mechanics [2f], Hamilton-Admissible Mechanics [2i] and Hamilton-isotopic mechanics [I-3d].

The Hamilton-Santilli isomechanics is "directly universal" for all infinitely possible (well-behaved) reversible-isolated systems of particles verifying conventional total conservation laws, yet possessing: 1) internal forces which are of linear, local and potential type represented by the Hamiltonian $\hat{H} = p\hat{\times}p/2m + \hat{V}$; plus 2) nonlinear, nonlocal and nonpotential forces represented by isounits of the form:

$$\hat{1} = \prod_{k=1,\ ...,N} \text{Diag.}\ (n_{k1}^2, n_{k2}^2, n_{k3}^2) \times \Gamma_k(t, r, p, ...), \tag{6.2.11}$$

where the diagonal term represents the shape of the individual particles, local densities along the space axes or other characteristics of the system at hand, while the Γ's represents their nonlinear, nonlocal, and nonpotential interactions. The isorepresentation occurs, by construction, directly in the frame of the observer (direct universality).

For more general shapes, the diagonal realization is lost in favor of (real-valued, symmetric and positive-definite) nondiagonal forms. Countless explicit models can be worked out according to the specific case at hand (see the quoted literature for various examples).

Despite the presence of nonpotential internal forces, the total energy is trivially conserved because $\hat{\partial}\hat{H}/\hat{\partial}\hat{t} \equiv 0$, and a similar case occurs for the other conservation laws.

Note the crucial role played by the isoderivative, first, to represent all non-Hamiltonian effects and, second, to permit the abstract identity between the conventional and isohamiltonian mechanics. In fact, at the abstract, realization-free level, all distinctions cease to exist between $\hat{\partial}/\hat{\partial}r$ and $\partial/\partial r$, etc. As a result, iso-Hamiltonian equations (6.7) coincide at the abstract level with the conventional Hamiltonian form (one could remove the "hat" and use the *same* equations of conventional mechanics under a *new interpretation* of the various symbols). We evidently have the same abstract identity of the conventional and isotopic Newton's equation.

Note that *the classical isomechanics can be characterized by a "hidden" symmetry of the Poisson brackets,* Equations (6.10), the identity $[A,\hat{B}] \equiv [A, B]$, or *a "hidden symmetry" of the basic Euclidean invariant,* first introduced in memoir [I-3d]

$$r^2 = (r^i\times\delta_{ij}\times r^j)\times I \equiv [r^i\times(n^{-2}\times\delta_{ij})\times r^j]\times(n^2\times I) = (r^i\times\delta_{ij}\times r^j)\hat{\times}\hat{I} = \hat{r^2}. \tag{6.2.12}$$

Note that the above new invariance has remained unknown since Euclid's times, because its identification required the prior discovery of *new numbers*, those with arbitrary units [I-3h].

For the construction of the classical isomechanics, I first constructed *the isotopies of Galilei's symmetry and relativity* [25], and proved the local isomorphism of the conventional and isotopic formulations. Regrettably, I cannot review these studies in this paper.

A fundamental feature of the direct universality of classical isomechanics is that the analytic representations occur in the frame of the observers. This feature is important, because of the existence of known transformations mapping non-Hamiltonian systems of our physical reality into Hamiltonian images via the use of the celebrated *Darboux's transforms* $r \to r'(r, p)$, $p \to p'(r, p)$. After regaining a Hamiltonian structure (which is possible only for analytic and local-differential systems), orthodox physicists then claim to have "recovered" Einsteinian doctrines, or that the violation in the nonhamiltonian form was only "apparent."

The point is that Darboux's transforms are highly *nonlinear*. Therefore, Darboux's transforms map the original inertial reference frame into highly noninertial ones, with consequential total collapse of Einsteinian doctrines. Moreover, transformed frames have a pure *mathematical* meaning, evidently because one cannot possibly conduct measurements in transformed coordinates, say, of the type $r' = A(r,p)\times Exp[B(r,p)]$.

The necessity of using actual variables r and p as occurring in the physical reality of the observer is necessary to avoid additional problems, this time at the operator level. In fact, under a Darboux transform you may have the *impression* of recovering quantum mechanics, although this occurs in *mathematical* coordinates $r'(r, p)$ and $p'(r, p)$ without any physical meaning.

In view of these insidious aspects in the specialized literature, *the entire analysis of these papers will be restricted to the sole use of the fixed variables r and p = m×v as occurring in the physical reality of the observer.*

In conclusion, the classical isomechanics outlined above provides an invariant description of closed-isolated systems verifying conventional conservation laws, yet having new non-Hamiltonian internal effects. As we shall see in subsequent papers, the latter *new* effects are directly relevant for the prediction, treatment, and optimization of *new* energies.

6.3. Nonrelativistic Isoquantization

Once the above classical foundations are understood, the transition to the operator isomechanics is straightforward. Recall that the naive quantization $A \to i\times\hbar\times\ln|\psi(t, r)$ maps the *conventional* canonical action A into Schrödinger's equations. The symplectic quantization is a more rigorous map of classical into quantum formulations, essentially yielding the same results.

It is evident that the conventional quantization is *inapplicable* to classical isomechanics and requires an isotopic lifting into a form applicable to the isoaction (6.6).

This quantization yields the *unique and unambiguous* map of the classical into the operator isomechanics called *isoquantization*, first studied by A. O. E. Animalu, E. B. Lin and R. M. Santilli (see [I-3c] for details and references) which, in its simplest form, is expressed via the map of Equations (6.2.9) (where we here assume $\hbar = 1$ and $\hat{1}$ independent from t and r, but dependent on p and $\hat{\psi}$; see [I-3c] for the general case):

$$\hat{A} \quad \to \quad i \times \hat{1} \times \ln | \hat{\psi}(\hat{t}, \hat{r}) >,$$

$$\partial\hat{A} / \partial\hat{t} + \hat{H} = 0 \quad \to \quad i\hat{1}\times(\partial \hat{\psi}/ \partial \hat{t}) / \hat{\psi} + \hat{H} = 0,$$

$$\partial\hat{A} / \partial\hat{r}^k - \hat{p}_k = 0 \quad \to \quad i\hat{1}\times(\partial\hat{\psi}/\partial\hat{r}^k) / \hat{\psi} - \hat{p}_k = 0,$$

$$\partial\hat{A} / \partial\hat{p}_k = 0 \quad \to \quad i\hat{1}\times(\partial\hat{\psi}/\partial\hat{p}_k / \psi) = 0. \qquad (6.3.1)$$

All other aspects of the operator mechanics can then be constructed via mere compatibility arguments. The more rigorous *isosymplectic quantization* essentially yields the same results.

6.4. Nonrelativistic Isomechanics

The fundamental equations of the isotopic branch of nonrelativistic hadronic mechanics are:

1) ***The iso-Schroedinger equations,*** first reached in a **noninvariant** form by R. Mignani, H. C. Myung and R. M. Santilli in 1981-1982 (see [I-3c] for references) and first reached in the following **invariant** form via the isodifferential calculus by Santilli in Ref. [I-3d], p. 675. Via a simple reformulation of Equations (6.3.1), they can be written:

$$i\,\hat\partial_t|\,\hat\psi> = i\,\hat T_t\times\partial_t\,|\,\hat\psi> = \hat H\,\hat\times\,|\,\hat\psi> =$$

$$= \hat H\times\hat T\times|\,\hat\psi> = \hat E\times\hat T\times|\,\hat\psi> = (E\times\hat 1)\times\hat T\times|\,\hat\psi> = E\times|\,\hat\psi>,$$

$$\hat p_k\,\hat\times\,|\,\hat\psi> = \hat p_k\times\hat T\times|\,\hat\psi> = -\,i\,\hat\partial_k|\,\hat\psi> = -\,i\,\hat T_k{}^i\times\partial_i|\,\hat\psi>, \qquad (6.4.1)$$

where: quantities with (without) a "hat" are represented on isospaces over isofields (conventional spaces over conventional fields); $\hat e$ is the isoexponentiation:

$$\hat e^X = \hat 1 + X/1\,! + X\hat\times X/2! + \ldots = [\,\exp(X\times\hat T)\,]\times\hat 1 =$$

$$= \hat 1\times[\,\exp(\hat T\times\hat A)\,]; \qquad (6.4.2)$$

$|\,\hat\psi> = |\,\hat\psi(t,\,r)>$ are *isostates* defined on an *isohilbert space* $\hat{\mathcal{H}}$ with *isoinner product:*

$$<\hat\phi\,|\times\hat T\times|\,\hat\psi>\times\hat 1 = (\int dr^3\,\hat\phi\dagger\times\hat T\times\hat\psi)\times\hat 1, \qquad (6.4.3)$$

over the isofield $\hat C$ of isocomplex numbers $\hat c = c\times\hat 1$; and *isoexpectation values* are given by:

$$<A> = \frac{<\hat\phi\,|\times\hat T\times A\times\hat T\times|\,\hat\psi>}{<\hat\phi\,|\times\hat T\times|\,\hat\psi>}. \qquad (6.4.5)$$

One should note that all iso-Schrödinger equations prior to their formulation via the isodifferential calculus in memoir [I-3d] are noninvariant and, thus, physically meaningless.

2) ***The iso-Heisenberg equations,*** first submitted by Santilli in [2d], Equations (4.4) in noninvariant form, and then formulated in their invariant form via the isodifferential calculus in memoir [I-3d], p. 675:

$$\hat A(t) = \hat U\,\hat\times\,\hat A(0)\,\hat\times\,\hat U^\dagger = \hat e^{i\hat H\times t}\,\hat\times\,\hat A(0)\,\hat\times\,\hat e^{-i\,t\times\hat H} =$$

$$= e^{i\hat H\times\hat T\times t}\times\hat A(0)\times e^{-it\times\hat T\times\hat H},$$

$$i\,\hat d\hat A/\hat dt = i\,\hat T_t\times dA/dt = [\,\hat A,\hat H\,] =$$

$$= \hat A\,\hat\times\,\hat H - \hat H\,\hat\times\,\hat A = \hat A\times\hat T\times\hat H - \hat H\times\hat T\times\hat A,$$

$$[\,r^s,\hat p_j\,]\,\hat\times\,|\,\hat\psi> = \delta^s{}_j\,\hat\times\,|\,\hat\psi> = \delta^i{}_j\times|\,\hat\psi>,$$

$$[r^i \hat{,} r^j] \hat{\times} |\hat{\psi}> = [p_i \hat{,} p_j] \hat{\times} |\hat{\psi}> = 0, \tag{6.4.6}$$

The most salient property of the above isotopic laws is that they provide a *new realization* of Lie's axioms which is *invariant* under the most general possible transformations, including the invariance under the time evolution of the theory itself, *provided* that the transformations are written in the appropriate isomathematics. This invariance was lacking for Equations (4.3), see noninvariance (4.5).

In fact, the most general possible nonlinear, nonlocal and nonunitary transforms can always be *identically* rewritten in the *isounitary form*, first introduced by R. M. Santilli in [I-3d]:

$$W \times W^\dagger = \hat{1} \neq I, \; W = \hat{W} \times \hat{T}^{1/2}, \; W \times W^\dagger \equiv \hat{W} \hat{\times} \hat{W}^\dagger = \hat{W}^\dagger \hat{\times} \hat{W} = \hat{1}. \tag{6.4.7}$$

The isotopic branch of hadronic mechanics is then invariant under the above isotransforms. This includes the invariance of the *numerical values* of the isounit, isotopic element, isoeigenvalues, etc., exactly as it occurs for quantum mechanics (Section 3):

$$\hat{1} \rightarrow \hat{1}' = \hat{W} \hat{\times} \hat{1} \hat{\times} \hat{W}^\dagger \equiv \hat{1},$$

$$\hat{A} \hat{\times} \hat{B} \rightarrow \hat{W} \hat{\times} (\hat{A} \hat{\times} \hat{B}) \hat{\times} \hat{W}\dagger = \hat{A}' \times \hat{T} \times \hat{B}' = \hat{A}' \hat{\times} \hat{B}',$$

$$\hat{W} \hat{\times} (\hat{A} \hat{\times} \hat{B} - \hat{B} \hat{\times} \hat{A}) \hat{\times} \hat{W}^\dagger = \hat{A}' \hat{\times} \hat{B}' - \hat{B}' \hat{\times} \hat{A}',$$

$$\hat{H} \hat{\times} |\hat{\psi}> = \hat{E} \hat{\times} |\hat{\psi}> \rightarrow \hat{W} \hat{\times} \hat{H} \hat{\times} |\hat{\psi}> = \hat{H} \hat{\times} |\hat{\psi}'> = \hat{E} \hat{\times} |\hat{\psi}'>, \hat{E}' \equiv \hat{E}. \tag{6.4.8}$$

In short, the isoproduct is changed under conventional transforms as in Equation (4.5), $\hat{x} \rightarrow \hat{x}' \neq \hat{x}$, thus implying noninvariance, while it is left unchanged by the isotransforms, $\hat{x} \rightarrow \hat{x}' \equiv \hat{x}$, thus yielding invariance.

The equivalence of the iso-Schrödinger and iso-Heisenberg equations can then be easily proved via isounitary transforms (see [I-3c] for details).

It is instructive for the interested reader to prove that time evolution (6.4.1) is itself an isounitary transform. The theory is, therefore, invariant under its own time evolution, as necessary for physical consistency.

The invariance of the iso-Schrödinger and isoheisenberg equations is then completed by the necessary use of the isodifferential calculus in the partial and total isoderivatives $\hat{\partial}/\hat{\partial t}$, $\hat{d}/\hat{dt}$, $\hat{\partial}/\hat{\partial r}^k$, etc., which are now invariant because their basic unit is invariant.

Note that conventional derivatives *cannot* lead to invariant dynamical equations because they are based on conventional numbers whose basic unit is no longer the unit of the theory, thus leading to a host of inconsistencies.

The above invariances, achieved for the first time in memoir [I-3d] of 1997, finally permitted consistent physical applications and verification of hadronic mechanics (outlined in Paper III) that had not been possible since the original proposal of the theory back in 1978.

A system is characterized in quantum mechanics via the sole assignment of the Hamiltonian with the tacit assumption of the simplest possible unit + 1. A system is characterized in hadronic mechanics via the assignment of the Hamiltonian for action-at-a-distance, potential interactions and the explicit form of the isounit for the additional contact non-Hamiltonian interactions.

Note that *changing the unit or the isounit implies the transition to a different system.* For this reason quantum mechanics solely allows transformations such that $U \times U\dagger = \hat{U}t \times U = I$ *with* I *fixed.* For exactly the same reason, hadronic mechanics solely allows isotransforms $\hat{U} \hat{\times} \hat{U}^\dagger = \hat{U}^\dagger \hat{\times} \hat{U} = \hat{1}$ *with* $\hat{1}$ *fixed for the system at hand.*

It is easy to prove that *all quantities that are Hermitean-observables in quantum mechanics remain so in (operator) isomechanics* because the conditions of Hermiticity and iso-Hermiticity coincide. In fact, the use of an iso-Hilbert, rather than a Hilbert space (that is, the use of the

isoproduct $H\hat{\times}|\ >$ rather than the conventional product $H\times|\ >$), implies the transition from condition (4.6) to the form, first proved by H. C. Myung and R. M. Santilli in 1981 [I-3c]:

$$\{<\hat{\psi}|\times T\times \hat{H}^{\dagger})\times\hat{T}\times|\hat{\psi}> = <\hat{\psi}|\times\hat{T}\times\{\hat{H}\times T\times|\hat{\psi}>\},$$

$$\hat{H}^{\dagger} = T\times T^{-1}\times\hat{H}\times T\times T^{-1} \equiv H^{\dagger}. \qquad (6.4.9)$$

It is also easy to prove that, under sufficient topological conditions here ignored for simplicity, *all iso-Hermitean operators admit isoreal isoeigenvalues, i.e.*, for $\hat{H}\dagger \equiv \hat{H}$ we have Equation (6.3.2) where E is an ordinary real number.

The important point is that *isomechanics preserves all conventional observables, all observables remain so under the time evolution of the theory, and all numbers predicted by the theory are unique, invariant and conventional.*

The above results are sufficient to indicate that *all features of quantum mechanics admit a unique and consistent image in isomechanics,* thus including causality, probability, etc. These additional aspects are not reviewed here for brevity (see [I-3c,I-3d]).

Next, it is important to see that *isomechanics preserves all conventional quantum laws and principles,* although derived from a broader formalism.

The preservation of Heisenberg's uncertainties can be inferred via the mere inspection of the preservation of the conventional eigenvalues δ_i^j in the fundamental (r, p)- isocommutators of Equations (6.4.5). In fact, we have the *isotopic uncertainties* (for $\hbar = 1$), first proved by R. M. Santilli [I-3d]:

$$\hat{\Delta}r\times\hat{\Delta}p \geq \tfrac{1}{2}<\hat{\psi}|\hat{\times}[r,\hat{}\ p]\hat{\times}|\hat{\psi}> = \tfrac{1}{2}\ . \qquad (6.4.10)$$

where now, by central assumption, r and p are the actual, physical coordinates and momenta of the observer beginning at the classical level (rather than deceptive mathematical algorithms without physical meaning). The preservation of Pauli's exclusion principle is established by the preservation of the spin ½ under isotopies (see [I-5c] for brevity). The same holds for all other quantum laws and principles.

The above results disprove several claims in the literature of "violation" of Heisenberg's uncertainties, *e.g.*, the claims by the so-called "squeezed states theories." In fact, *all* the latter theories admit an *identical* reformulation in terms of isoequations (6.4.5) which reconstruct the validity of the *conventional* uncertainties on iso-Hilbert spaces over isofields for closed-isolated systems (see [I-3c] for details).

By no means is the isotopic preservation of conventional principles, trivial, because it implies their validity under the most general known nonlinear, nonlocal and nonpotential interactions.

Recall that the Hamilton-Santilli isomechanics is directly universal for all possible, classical (well-behaved), closed-isolated systems with Hamiltonian and non-Hamiltonian internal forces.

It is easy to see that the operator image is also directly universal. In fact, we have the following:

> *THEOREM 6.1: The iso-Schrödinger and iso-Heisenberg equations are directly universal for all possible closed-isolated systems verifying conventional total conservation laws, yet admitting linear and nonlinear, local and nonlocal, and potential or nonpotential internal interactions.*

The verification of conventional total conservation laws follows from the antisymmetric character of the Lie-Santilli isobrackets $[A,\hat{}\ B] = A\hat{\times}B - B\hat{\times}A$ (as well as, more technically, from the preservation of conventional generators in the spacetime isosymmetries [25]). The admission of all possible non-Hamiltonian effects is established by the arbitrariness of the isounit $\hat{1}$.

The direct universality can be illustrated via the *identical* reformulation of conventional

nonlinear equations [17] $H(r, p, \psi)\times\psi \equiv H_0(r, p)\times\hat{T}(\psi, ...)\times\psi = E\times\psi$ (*i.e.*,with the embedding of all nonlinear terms in the isotopic elements). This reformulation permits the recovering of the superposition principle, as one can verify, as well as the resolution of the other inconsistencies of the conventional nonlinear theories. Similar resolutions hold for all known inconsistent theories [2-14] (see [16] for brevity).

An important property of isomechanics is that of turning any divergent quantum series into a convergent form under the sole assumption of a sufficiently small absolute value of the isotopic element, $|\hat{T}| \ll 1$. This can be seen from the following divergent canonical series which is turned into a convergent isocanonical form, first studied by R. Mignani, A. Jannussis and R. M. Santilli (see [I-3c], for a detailed presentation of the isoperturbation theory and related references):

$$A(k) = A(0) + k[A, H]/1! + ... \to \infty, \; k > 1,$$

$$A(k) = A(0) + k[A, H]/1! + ... = N < \infty, \; \hat{T} = k^{-n}. \tag{6.4.11}$$

As a consequence, any series in physics or chemistry which is divergent (such as those for strong interactions) or slowly convergent (such as the Gaussian lobe expansions in quantum chemistry), can be turned by the isotopies into a convergent or much faster convergent form, respectively, via the sole judicious selection of the isounit.

We finally note that *isomechanics is not a "new theory"* because it is based on exactly the same abstract axioms of quantum mechanics, and merely provides a "new realization" of quantum axioms and physical laws.

The above occurrence can be best seen by noting that *quantum and isomechanics coincide at the abstract, realization-free level* in which all distinctions cease to exist between I and $\hat{1}$, $A\times B$ and $A\hat{\times}B$, $\mathcal{H}$ and $\hat{\mathcal{H}}$, etc.

The ultimate abstract unity of quantum and isomechanics can be best seen as follows. The central difference between the two mechanics is given by the lifting of the basic unit $I \to \hat{1}, \hat{1} = \hat{1}^\dagger > 0$. It is then easy to see that $\hat{1}$ preserves all properties of I, first identified by R. M. Santilli in [I-3h]:

$$I > 0 \;\to\; \hat{1} > 0,$$

$$I^n = I\times I\times ... \times I \equiv I \;\to\; \hat{1}^{\hat{n}} = \hat{1}\hat{\times}\hat{1}\hat{\times} ... \hat{\times}\hat{1} \equiv \hat{1},$$

$$I / I \equiv I \;\to\; \hat{1}\hat{/}\hat{1} \equiv \hat{1},$$

$$I \times |\psi\rangle \equiv |\psi\rangle \;\to\; \hat{1}\hat{\times}|\hat{\psi}\rangle \equiv |\hat{\psi}\rangle,$$

$$i\, dI / dt = I\times H - H\times I \equiv 0 \;\to\; i\, d\hat{1} / dt = \hat{1}\hat{\times}\hat{H} - \hat{H}\hat{\times}\hat{1} \equiv 0,$$

$$\langle I\rangle = \frac{\langle\psi| \times I \times |\psi\rangle}{\langle\psi|\times|\psi\rangle} = I \to \hat{\langle\hat{1}\rangle} = \frac{\langle\hat{\psi}|\hat{\times}\hat{1}\hat{\times}|\hat{\psi}\rangle}{\langle\hat{\psi}|\hat{\times}|\hat{\psi}\rangle} = I\,. \tag{6.4.12}$$

The two units then coincide at the abstract level, by implying the abstract identity of all formulations built on them.

Note in the last expression that *the isoexpectation values of the isounit produce the conventional unit value* I. By remembering that the unit of quantum mechanics is Planck's unit $\hbar = I$, this means that isomechanics lifts Planck's *constant* $\hbar$ into a *local integro-differential operator* $\hat{\hbar} = \hat{1}$ in such a way that its isoexpectation values recover the conventional numerical value $\hbar$.

Despite the above abstract identity, the reader should be aware that quantum and isomechanics are physically inequivalent, because they are connected by a nonunitary transform and admit *different eigenvalues for the same Hamiltonian operator,* $H\times|\rangle = E\times|\rangle$, $H\times\hat{T}\times|\rangle = E'\times|\rangle$, $E' \neq E$.

Also, hadronic mechanics has provided in 1978 the first explicit and concrete realization of hidden variables λ, $H\hat{\times}|\psi\rangle = H\times\lambda\times|\rangle = E\times|\rangle$, $\lambda = \hat{T}$ (see [I-5c] for a detailed analysis).

An effective way to introduce hadronic mechanics is by noting that it is the outcome of the *novel degrees of freedom of Euclid's axioms*, Equation (6.2.12), plus the *novel degree of freedom of Hilbert's axioms* (here expressed for a matrix $\hat{1} = 1/\hat{T}$ independent from the integration variable), first introduced in [I-3d]:

$$< \phi \mid \times \mid \psi > \times I \equiv < \phi \mid \times \hat{T} \times \mid \psi > \times \hat{1} . \tag{6.4.13}$$

The above invariance assures that all physical laws valid for theories formulated on conventional spaces and fields also hold for theories formulated on broader isospaces over isofields.

The fact that the new invariance (6.4.12) has remained unknown since Hilbert's time should not be surprising because its identification required the prior discovery of *new numbers*, those with *arbitrary units*.

In conclusion, the operator isomechanics permits quantitative treatments of a *new conception of isolated bound states of particles*, those verifying conventional total conservation laws, yet admitting novel non-Hamiltonian internal effects. These systems are the unique and unambiguous operator counterpart of the corresponding generalized classical systems of Section 6.2.

The *new* operator effects will then permit in subsequent paper the prediction, treatment and optimization of *new* energies at the operator level. In this way the *new* energies as per Definition I.1.2.1 are equipped for the first time with a rigorous, diversified, interconnected, and invariant classical and operator theory.

6.5. Relativistic Isomechanics

As is well known, relativistic theories are based on the Minkowskian spacetime $M(x,\eta,R)$ with local coordinates $x = (x^\mu) = (rk, t)$, $c_0 = 1$, $\mu = 1, 2, 3, 4$, $k = 1, 2, 3$, metric $\eta = \text{Diag.}\ (1, 1, 1, -1)$, and interval $(x - y)^2 = (x-y)^\mu \times \eta_{\mu\nu} \times (x-y)^\nu$ defined on the field of real numbers $R(n,+,\times)$.

Relativistic isomechanics is based on the isotopies of the Minkowskian space, which were first introduced by the author in 1985 [25a] and in various subsequent papers [25], and are today called *Minkowski-Santilli isospaces* see [23a,I-3i to I-3j] for independent reviews. They have the structure $\hat{M} = \hat{M}(\hat{x},\hat{\eta},\hat{R})$ with: isocoordinates $\hat{x} = x \times \hat{1}$; isometric $\hat{N} = (\hat{\eta}_{\mu\nu}) \times \hat{1}$, $\hat{\eta} = (\hat{\eta}_{\mu\nu}) = \hat{T}(x, v, \psi, \partial\psi, ...) \times \eta$, where the isotopic element $\hat{T}$ is now a nowhere singular, Hermitean and positive-definite 4×4 matrix which, as such, can always be diagonalized to the form $\hat{T} = \text{Diag.}\ (\hat{T}_{11}, \hat{T}_{22}, \hat{T}_{33}, \hat{T}_{44})$.

The fundamental interval of the theory is the isoinvariant on $\hat{M}$ over the isofield $\hat{R}(\hat{n},+,\hat{\times})$ with the same isounit $\hat{1} = 1/\hat{T}$:

$$\begin{aligned}
(\hat{x} - \hat{y})^{\hat{2}} &= (x - y)^\mu \times \hat{1} \times \hat{T} \times \eta_{\mu\nu} \times \hat{1} \times \hat{T} \times (x - y)^\nu \times \hat{1} = \\
&= [\, (x - y)^\mu \times \hat{\eta}_{\mu\nu}(x, v, \psi, \partial\psi, ...) \times (x - y)^\nu \,] \times \hat{1} = \\
&= [\, (x - y)^1 \times \hat{T}_{11} \times (x - y)^1 + (x - y)^2 \times \hat{T}_{22} \times (x - y)^2 + \\
&+ (x - y)^3 \times \hat{T}_{33} \times (x - y)^3 - (x - y)^4 \times \hat{T}_{44} \times (x - y)^4 \,] \times \hat{1} \in \hat{R}.
\end{aligned} \tag{6.5.1}$$

It is easy to see that the joint lifting $\eta \to \hat{\eta} = \hat{T} \times \eta$ and $I \to \hat{1} = 1/\hat{T}$ preserves all the original geometric axioms of M. The spaces M and $\hat{M}$ are therefore locally isomorphic and the lifting $M \to \hat{M}$ is an isotopy.

The basic invariance of conventional relativistic theories is the celebrated Poincaré symmetry of interval $(x-y)^2$. The corresponding symmetry of the isospacetime was first studied in [25], and is today called *Poincaré-Santilli's isosymmetry* [I-3h;I-3l;23,24]. It consists of the most general possible isolinear, isolocal and isocanonical invariant of isoseparation (6.5.1). Its main

components are:

1) The *isorotational symmetry,* first presented in [25b] which, for the case of isorotations in the x-y axes, can be written:

$$\hat{x}' = \hat{x}\times\cos(\hat{T}_{11}^{1/2}\times\hat{T}_{22}^{1/2}\times\theta_3) - \hat{y}\times\hat{T}_{11}^{-1/2}\times\hat{T}_{22}^{1/2}\times\sin(\hat{T}_{11}^{1/2}\times\hat{T}_{22}^{1/2}\times\theta_3),$$

$$\hat{y}' = \hat{x}\times\hat{T}_{11}^{1/2}\,\hat{T}_{22}^{-1/2}\times\sin(\hat{T}_{11}^{1/2}\times\hat{T}_{22}^{1/2}\times\theta_3) + \hat{y}\times\cos(\hat{T}_{11}^{1/2}\times\hat{T}_{22}^{1/2}\times\theta_3), \qquad (6.5.2)$$

with corresponding symmetries in three dimensions [I-3c].

2) The *Lorentz-Santilli isosymmetry,* first submitted in [25a], which includes the isorotations plus the isoboosts in the $\hat{z}$-$\hat{t}$ plane:

$$\hat{x}^{3\prime}=\hat{x}^3\times\sinh(\hat{T}_{33}^{1/2}\times\hat{T}_{44}^{1/2}\times v)-\hat{x}^4\times\hat{T}_{33}^{-1/2}\times\hat{T}_{44}^{1/2}\times\cosh(\hat{T}_{33}^{1/2}\times\hat{T}_{44}^{1/2}\times v)$$

$$= \hat{\gamma}\times(\hat{x}^3 - \hat{T}_{33}^{-1/2}\times\hat{T}_{44}^{1/2}\times\hat{\beta}\times\hat{x}^4),$$

$$\hat{x}^{4\prime}= -\hat{x}^3\times\hat{T}_{33}^{1/2}\times c_0^{-1}\times\hat{T}_{44}^{-1/2}\times\sinh(\hat{T}_{33}^{1/2}\times\hat{T}_{44}^{1/2}\times v) +$$

$$+ \hat{x}^4\times\cosh(\hat{T}_{33}^{1/2}\times\hat{T}_{44}^{1/2}\times v) = \gamma\hat{x}(\hat{x}^4 - \hat{T}_{33}^{1/2}\times\hat{T}_{44}^{-1/2}\times\hat{\beta}\times\hat{x}3),$$

$$\hat{\beta} = v_k\times\hat{T}_{kk}^{1/2} / c_0\times\hat{T}_{44}^{1/2}, \quad \hat{\gamma} = (1 - \hat{\beta}^2)^{-1/2}. \qquad (6.5.3)$$

as well as the isotopies of the SU(2)-spin symmetry first presented in [25c,25d], here omitted for brevity.

3) The *isotranslations,* first presented in [25e]:

$$\hat{x}' = (\hat{e}^{i\hat{p}\times a})\hat{\times}\,\hat{x} = \hat{x} + a\times A(x, ...), \qquad \hat{p}' = (\hat{e}^{i\hat{p}\times a})\hat{\times}\,\hat{p} = \hat{p},$$

$$A_\mu = \hat{T}_{\mu\mu}1/2 + a^\alpha\times[\hat{T}_{\mu\mu}1/2,\hat{p}_\alpha]/1! + ... \qquad (6.5.4)$$

4) The *space and time isoinversions,* first presented in [25a]:

$$x' = \hat{\pi}\hat{\times}\hat{x} = (-\hat{r}, \hat{t}), \qquad \hat{x}' = \hat{\tau}\hat{\times}\hat{x} = (\hat{r}, -\hat{t}), \qquad (6.5.5)$$

5) The novel *isoscalar symmetry,* first introduced in [I-3d]:

$$\hat{\eta} = \hat{T}\times\eta \rightarrow \hat{\eta}' = \hat{T}'\times\eta, \hat{1} = 1/\hat{T} \rightarrow \hat{1}' = n\times\hat{1}, n \in R. \qquad (6.5.6)$$

The verification that the above isosymmetries do in fact leave invariant isointerval (6.5.1) is instructive. It shows that the Poincaré-Santilli isoinvariance holds for all infinitely possible, well-behaved, real-valued, nowhere singular and symmetric isometrics $\hat{\eta}$ irrespective of their explicit functional dependence, which can therefore be selected for the specific case at hand (Section II.7 and Paper III).

While the Poincaré symmetry has *ten* dimensions, the Poincaré-Santilli isosymmetry has *eleven* dimensions. As we shall see, the added *new* dimension is crucial for the prediction of *new* energies as well as for several other *new* applications.

In addition to the above isosymmetries we finally have the *spinorial covering of the Poincaré-Santilli isosymmetry* first presented in [25f] which is here omitted for brevity. The nonrelativistic image, the *Galilei-Santilli isosymmetry,* has been studied in detail in volumes [25h,25i] and its review will also be omitted for brevity.

The iso-Minkowskian spaces and symmetries and their underlying methods permit the easy construction of the isotopies of any needed, classical and operator relativistic formulations. As an example, we quote here the *second-order isorelativistic equation:*

$$(\hat{N}^{\rho\sigma} \hat{\times} \hat{p}_\rho \hat{\times} \hat{p}_\sigma + \hat{m}^2) \hat{\times} \hat{\psi} = 0 , \tag{6.5.7}$$

its linearized form called the *Dirac-Santilli isoequation:*

$$(\hat{N}^{\mu\nu} \hat{\times} \hat{\gamma}_\mu \hat{\times}^{Spin} \hat{p}_\nu - i \times \hat{m}) \hat{\times}_{orb} \hat{\psi} =$$

$$= (\hat{\eta}^{\mu\nu} \times \hat{\gamma}_\mu \times \hat{1}^{Spin} \times \hat{p}_\nu \times \hat{1}^{Orb} - i \times m) \times \hat{\psi} = 0, \tag{6.5.8}$$

where the *isogamma matrices* are defined by:

$$\{ \hat{\gamma}_\mu , \hat{\gamma}_\alpha \} = \hat{\gamma}_\mu \times \hat{1}^{spin} \times \hat{\gamma}_\alpha \times \hat{1}^{Spin} + \hat{\gamma}_\alpha \times \hat{1}^{Spin} \times \hat{\gamma}_\mu \times \hat{1}^{Spin} = 2 \times \hat{\eta}_{\mu\alpha} , \tag{6.5.9}$$

and admit the explicit realization:

$$\hat{\gamma}_\mu = (\hat{T}_{\mu\mu}^{Orb})^{1/2} \times U^{Spin} \times \gamma_\mu \times U^{\dagger\, Spin} \times \hat{1}^{spin} ,$$

$$\hat{\gamma}_k = (\hat{T}_{kk}^{Orb})^{1/2} \times \gamma_k \times \hat{1}^{Spin} = \hat{T}_{kk}^{1/2} \times \begin{pmatrix} 0 & \hat{\sigma}_k \\ \hat{\sigma}^d{}_k & 0 \end{pmatrix} \times \hat{1}^{Spin}$$

$$\gamma_4 = (\hat{T}_{44}^{Orb})^{1/2} \times \gamma_4 \times \hat{1}^{Spin} = (\hat{T}_{kk}^{Orb})^{1/2} \times \begin{pmatrix} I^{Spin}{}_{2\times 2} & 0 \\ 0 & \hat{1}^{d\ Spin}{}_{2\times 2} \end{pmatrix} \times \hat{1}^{Spin}$$

$$\hat{\sigma}_k = W \times \sigma_k \times W^\dagger , \quad \hat{\sigma}^d{}_k = - \hat{\sigma}^\dagger{}_k = - W^\dagger \times \sigma_k \times W, \tag{6.5.10}$$

with W being an arbitrary 2×2-dimensional *nonunitary* transform and "d" representing isoduality.

Equation (6.5.7) is fully symmetric for particles and antiparticles, the former defined on isospaces over isofields and the latter defined on their isodual. Equation (6.5.7) also admits as a particular case a similar fully symmetrized version of the conventional Dirac equation for $\hat{1}_{22} = I_{22}$.

Equation (6.5.7) permits, for the first time, *a description of antiparticles at the level of first quantization* (the current description only holds for the *second* quantization). This should not be surprising because isodualities permit a characterization of antimatter which begins at the *Newtonian* level, and then continues at all subsequent levels, including second quantization where it becomes equivalent to charge conjugation [1-3g].

As we shall see, the above isorelativistic equations play a fundamental role in the applications and experimental verification of hadronic mechanic, particularly those for new energies.

6.6 Geno- and Hyper-mechanics

The broader classical and operator genomechanics for open-nonconservative systems [1-3d] are characterized by the relaxation of the symmetric character of the isounit and the use of general Lie-admissible equations (4.3) [2d] with corresponding classical counterparts [2f]. The formulation of Equations (4.3) via the genomathematics of Section 5 then permits the achievement of invariance as in the isotopic case (see [1-3d] for brevity).

A most salient feature of classical genomechanics is that of providing the first known invariant formulation of the historical Lagrange's and Hamilton's equations, those *with external*

terms.

A salient aspect of operator genomechanics is that of permitting for the first time the *identification of the origin of irreversibility in the ultimate levels of nature, those of elementary particles in interior conditions,* such as an electron in the core of a star.

The broader classical and operator hypermechanics [I-3e] are characterized by the relaxation of the single-valuedness of the genounits as per the hypermathematics of Section 5.

A rather direct way of seeing the inevitability of the genotopic and hyperstructural formulations is by inspecting the fundamental novel invariants (6.2.12) for the Euclidean axioms and (6.4.12) for Hilbert's axioms. These invariances also hold for nonsymmetric as well as multivalued structures. Therefore, all properties of quantum mechanics must necessarily admit a genotopic and hyperstructural expansion as consistent as the conventional theory.

For details on the geno- and hypermechanics, I refer the interested reader to monograph [I-3e,I-3d,I-3f]. We shall use genomechanics whenever considering new energies under open-nonconservative conditions. Hypermechanics will be used only when necessary due to their complexity.

Due to widespread plagiarisms existing in the contemporary physics literature, I have copyrighted numerous publications on hadronic mechanics, and I intend to defend such copyrights in any means permitted by law. Hadronic mechanics can be used by anybody in part or in full for any scientific purpose without any prior authorization, provided that: 1) Original publications on hadronic mechanics are quoted, e.g., Refs. [I-3a] to [I-3e]; 2) The main lines of the copyrighted hadronic mechanics are outlined as a prerequisite for allegations of novelty; and 3) Paternities are identified with clarity.

7. ISO-, GENO-, HYPER-RELATIVITIES AND COSMOLOGIES

As stressed in Paper I (Section I.3), special relativity is a serious obstacle for new energies. It is an easy prediction that no quantitative scientific study on new energies is possible without an identification of the limitations of special relativity (done in Paper I) and the construction of suitable covering relativities for broader physical conditions (outlined in this section).

Special relativity was constructed by Lorentz, Poincaré, Einstein, Minkowski and others for the *invariant formulation of the speed of light in vacuum* c_0 (the literature accumulated in the field is so vast as to prevent discriminatory partial listings).

However, the contemporary notion of "universal constancy of the speed of light" is a purely philosophical (or political) abstraction because, in the physical reality, *light has a local speed* $c = c_0/n(\mu, \tau, ...)$, that is, a speed depending on the local physical conditions of density μ, temperature τ, etc., of the medium in which it propagates. This dependence is generally represented by the familiar index of refraction n, which is known since the discovery of the apparent bending of a straight stick when partially immersed in water.

More generally, incontrovertible experimental evidence establishes that light has *different speeds* $c = c_0/n < c_0$ when propagating in different media of low density such as air, water, glass, oil, or other transparent substances. It has also been experimentally established nowadays that light has speeds $c = c_0/n > c_0$ when propagating in media of extreme densities, such as those in the interior of hadrons and stars (see Section I-3.2 of [I-13]).

It is evident that a relativity which has been constructed for the speed of light in vacuum with c_0 = constant, is *inapplicable* (and not "violated") for the arbitrary local speeds of the physical reality with $c = c_0/n(\mu, \tau, ...)$ = function.

As an illustration of the impossibility to adapt physical reality to the special relativity, consider the *Cerenkov light* (the bluish light visible in the water pools of nuclear reactors) which is created by *ordinary electrons traveling faster than the speed of light* in water. If one assumes the speed of light as the maximal causal speed (as necessary for special relativity), the Cerenkov light would constitute evidence of the violation of the basic principle of causality (since ordinary physical

particles would travel faster than the maximal causal speed).

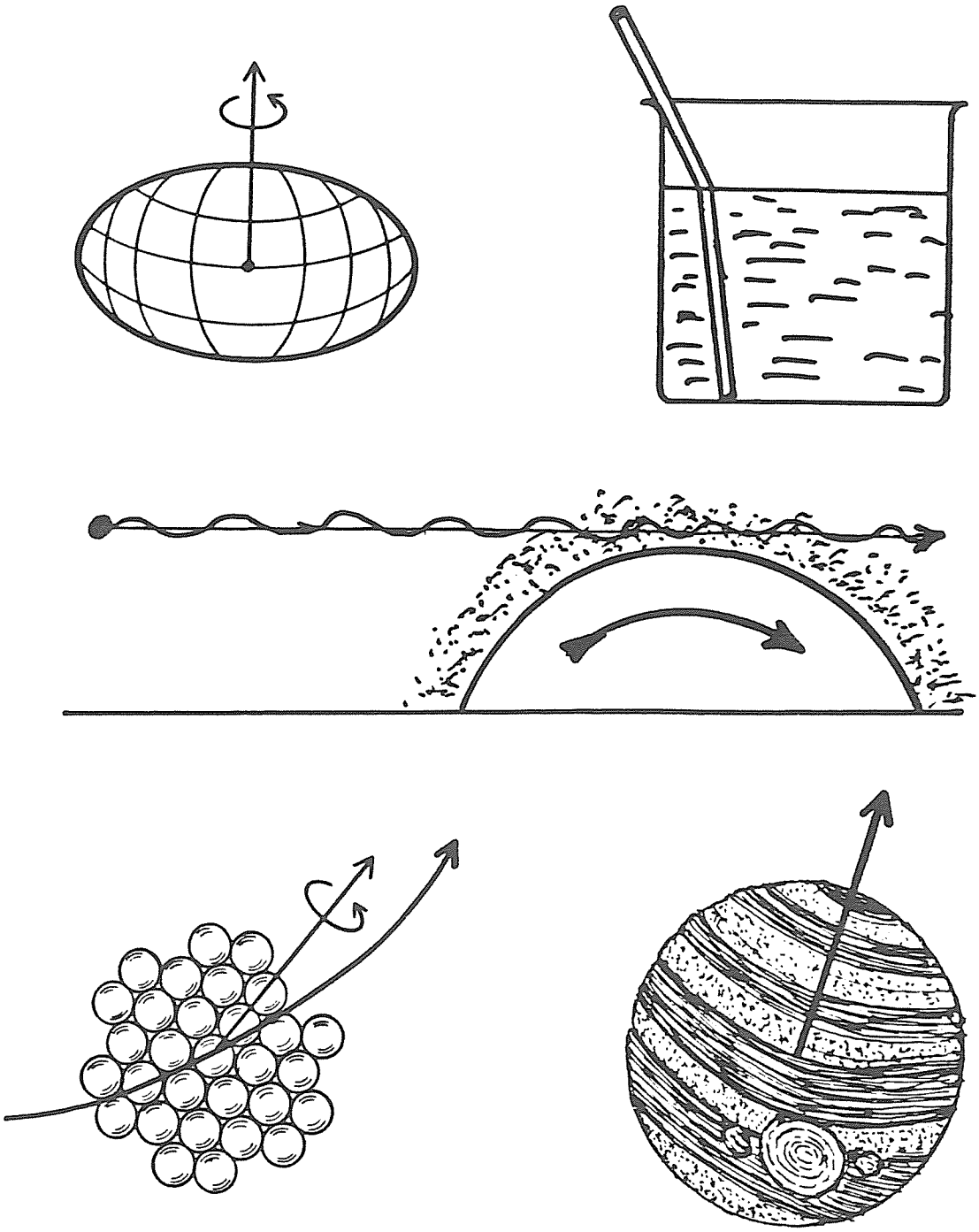

FIGURE 3: Special relativity is traditionally presented in contemporary physics as being universally valid for all possible events existing in nature. On real scientific grounds, special relativity is solely valid for the conditions of its original conception by Lorentz, Poincaré, and Einstein, namely, the description of light propagating in vacuum, point-particles moving in vacuum under sole action-at-a-distance interactions, or closed, isolated, reversible systems of particles with Keplerian nuclei (such as the planetary or

atomic structures). It is easy for the reader to see that special relativity is "inapplicable (and not "violated") for the systems depicted in this figure: 1) Special relativity cannot describe in an invariant way extended and nonspherical particles (e.g., spheroidal ellipsoids such as hadrons), because its basic rotational symmetry only leaves invariant perfect spheres; 2) Special relativity cannot represent any deformations, as expected for extended and deformable particles, because deformations are notoriously incompatible with the very axioms of the theory; 3) Special relativity cannot represent simple interior events of our everyday life, such as the refraction of light (the apparent bending of a straight stick when partially submerged in water), because the very cause of refraction (the *decrease* of the speed of light within physical media), is outside the conceptual and technical capabilities special relativity (and, as shown in the text, attempts at reconciliationm of physical reality with the theory are afflicted by serious inconsistencies); 4) Special relativity cannot represent the natural shift of light frequencies toward the red when entering within a physical medium, such as our atmosphere (e.g., the redshift at sunset), because it is caused again by the decrease of the speed of light (see Paper III for details); 5) Special relativity lacks conceptual, mathematical, and experimental means for a final description of typical interior systems of particles, those without a Keplerian nucleus, as well as with internal nonlocal and nonpotential interactions, such as the structure of hadrons, nuclei, planets, and stars. As will be shown, these insufficiencies are the very reasons for which new clean energies and fuels are not predictable or treatable by special relativity, and relativistic quantum mechanics. Therefore, the resolution of the above insufficiencies of special relativity has a truly fundamental character for any serious advance in new clean energies and fuels. Santilli's iso-, geno-, and hyper-relativities have been constructed to resolve all these insufficiencies, while admitting special relativity as a simple particular case when motion returns to be in vacuum. It should be noted that numerous generalizations of one or another aspect of special relativity have been attempted in this century. However, most of them depart from the axioms of the special relativity, thus creating the need to identify new relativity axioms, prove their consistency, and establish them experimentally, *prior* to any meaningful application of any new relativity. By comparison, iso-, geno-, and hyper-relativities have been constructed in such a way to preserve the conventional abstract axioms, and actually coincide with special relativity at the abstract, realization-free level, thus merely being *new realizations* of well established abstract axioms. This important aspect is guaranteed by the local isomorphism between the Poincaré symmetry and its iso-, geno-, and hyper-coverings. It is evident that the iso-, geno-, and hyper-liftings of special relativity for matter, and their isoduals for antimatter, do indeed achieve a dramatic broadening of the applicability of special relativity, the conventional formulation remaining fully applicable under the simpler conditions in vacuum. It should be finally noted that other generalizations of special relativity (e.g., those characterized by deformations) are afflicted by the catastrophic mathematical and physical inconsistencies indicated in Section 4, due to their lack of invariance and other problems. By comparison, iso-, geno-, and hyper-relativities are the only generalizations of special relativity known at this writing which have been proved in rigorous, refereed, technical journals to avoid said catastrophic inconsistencies, and provide an invariant description of natural events of increasing complexity.

The attempt to salvage the principle of causality by assuming the speed of light *in vacuum* as the maximal causal speed *in water*, immediately implies the violation of another pillar of special relativity, the relativistic composition law for speeds. Similar inconsistencies occur for other possible assumptions.

The above evidence establishes that special relativity is inapplicable (rather than violated) for interior dynamical problems implying propagation within physical media, contact zero-range effects and other interior conditions. The selection of the appropriate generalization is evidently open to scientific debates, but its need should not be questioned.

All research I reported so far in these papers (as well as in the subsequent papers) is preparatory for the classical and operator generalization of special relativity into *isospecial relativity defined as an invariant formulation of: extended, nonmsp(herical, and deformable*

particles such as hadrons; arbitrary speeds of light within physical media; or, more generally, arbitrary interior systems; under the condition of recovering special relativity identically whenever motion returns to be in vacuum.

The isotopies of special relativity have been studied in [25] with a comprehensive review in volumes [I-3b,I-3c]. The isotopies of Galilei's relativity have been studied in Volumes [25h,25i] and, for brevity, will not be considered here.

First, the task required the lifting of the mathematical foundations of special relativity reported in the preceding sections, plus the lifting of the Lie theory in all its branches (enveloping algebras, Lie algebras, Lie groups, Lie symmetries, representation theory, etc.).

The lifting of special relativity itself was then constructed first via the lifting of the Minkowski spacetime [25a] reviewed in Sect. 6.5, the lifting of the fundamental spacetime symmetries [25] also reviewed also in Section 6.5, and, finally, the lifting of the basic physical axioms, so as to achieve an articulated body of formulations as mutually compatible, invariant and axiomatically consistent as the conventional ones.

The main postulates of the covering isospecial relativity are specifically and solely constructed for *interior dynamical problems*, and they recover the Einsteinian postulates for exterior conditions.

The original formulation of the Minkowski spacetime by Minkowski was based on the metric for dynamics in vacuum η = Diag. (1, 1, 1, $-c_0 2$). For dynamics within physical media we should therefore consider the lifting η = Diag. (1, 1, 1, $-c_0 2$) $\rightarrow \hat{\eta}$ = Diag. (1, 1, 1, $-c_0 2/n2$). However, such isometric is not properly symmetrized in space and time, thus requiring the fully symmetrized form $\hat{\eta}$ = Diag. ($n_1 - 2$, $n_2 - 2$, $n_3 - 2$, $-c_0 2/n_4 - 2$). The latter can be reached via the application of a conventional Lorentz transform to an interval with isometric $\hat{\eta}$ = Diag. (1, 1, 1, $-c_0 2/n2$), or simply via the diagonalization of $\hat{T}$ and the assumption $\hat{T}_{\mu\mu} = n_\mu - 2$, $n_4 = n$.

For simplicity we present the main postulates of the isospecial relativity for the simpler case with *space isotropy but spacetime anisotropy, i.e.,* for $n_1 = n_2 = n_3 = n_2 \neq n_4$ (see monograph I-3c] for all details):

ISOPOSTULATE I: The maximal causal speed is :

$$\hat{V}_{Max} = c_0 \times n_s / n_4; \tag{7.1}$$

ISOPOSTULATE II: The isorelativistic addition of speeds is:

$$V_{tot} = (u + v) / (1 + u_k \times n_k^2 \times v_k / c_0 \times n_4^2 \times c_0); \tag{7.2}$$

ISOPOSTULATE III: The isodilations of time and space are given by (where $\hat{\gamma}$ is given by Equation (6.5.3):

$$t' = \hat{\gamma} \times t, \quad r' = \hat{\gamma}^{-1} \times r; \tag{7.3}$$

ISOPOSTULATE IV: The isodoppler shift is given by (for the simpler case null aberration):

$$\hat{\omega}' = \hat{\gamma}^{-1} \times \hat{\omega}; \tag{7.4}$$

ISOPOSTULATE V: The mass-energy isoequivalence is:

$$E = m \times c^2 = m \times c_0^2 / n_4^2 . \tag{7.5}$$

A few comments are in order. First, the isospecial relativity does indeed achieve the desired invariance for arbitrary speeds of light $c = c_0/n$, $n = n_4$. For this purpose it is sufficient to use the isometric $\hat{\eta}$ = Diag. ($n_1 - 2$, $n_2 - 2$, $n_3 - 2$, $-c_0 2/n_4 - 2$) in isointerval (6.5.1). The invariance follows from the

universality of the Poincaré-Santilli isosymmetry for that isointerval, as the reader can verify.

The extension to arbitrary isorelativistic interior systems then follows by merely selecting more general isounits (see Paper III for explicit cases).

Second, it should be indicated that the isospecial relativity permits a symbiotic unification of the special and general relativity. This is permitted by the *Minkowski-Santilli isogeometry, i.e.*, the geometry of isospaces $\hat{M}$, studied in detail in monographs [I-3b,I-3c,25g].

The new geometry is a symbiotic unification of the Minkowskian and Riemannian geometries. In fact, it contains the isoimage of conventional aspects of the former (such as the light isocone), as well as all the machinery of the latter (covariant derivative, torsion, etc.).

All possible Riemannian metrics g(x) are a simple particular case of the isometric $\hat{\eta}(x, v, \psi, ...)$. More specifically, all possible Riemannian metrics admit the isotopic decomposition $g(x) = \hat{T}(x)\times\eta$, where $\hat{T}(x)$ is necessarily positive-definite and η is the conventional Minkowski metric (because of the local Minkowskian character of Riemann).

Therefore, the iso-Minkowskian geometry permits the identical reformulation of conventional gravitational equations for $g(x) \equiv \hat{\eta}(x)$, such as the Einstein-Hilbert field equations $G_{\mu\nu} = R_{\mu\nu} - \frac{1}{2}\hat{\eta}_{\mu\nu}\times R = 0$. For brevity, I refer the reader to the presentation in memoir [25g].

A dominant property of the new geometry is that of being *isoflat*, that is, flat on isospaces over isofields. This implies the abandonment of the notion of curvature (because of the inconsistencies outlined in Section I-3.3), and the reformulation of the Einstein-Hilbert field equations in a manifold with the covering notion of isoflatness.

For instance, the celebrated Schwarzschild line element is identically written in the iso-Minkowskian form $\hat{ds}^2 = \hat{dx}_1^2 + \hat{dx}_2^2 + \hat{dx}_3^2 - \hat{dx}_4^2$, namely, *by embedding the Riemannian terms in the isodifferentials of the theory which therefore becomes Minkowskian.* Flatness is then regained in isospace.

The iso-Minkowskian reformulation of gravity implies the resolution of a number of the truly serious controversies on the inconsistencies of the general relativity that have raged during this century, as outlined in Section I-3.3 (see [25g] for brevity).

The extension to interior gravitational problems is then naturally permitted via the mere assumption of isometrics with a more general functional dependence, *e.g.*, in the velocities, $\hat{\eta} = \hat{\eta}(x, v)$ which is impossible for the Riemannian geometry. In this way one can obtain the Schwarzschild's line element for interior conditions with a locally varying speed of light.

More generally, we can say that *the isospecial relativity is directly universal for all possible spacetime theories with a symmetric metric.* This includes: 1) the preceding interior and exterior relativistic and gravitational cases; 2) Galilean-type theories with isounits $\hat{1} = 1_{space}\times\hat{1}_{time}$; 3) all possible symmetric generalizations of the Minkowskian geometry; 4) the indicated geometric unification of special and general relativities; 5) the first known axiomatically consistent grand unification of electroweak and gravitational interactions permitted precisely by the preceding features [25j].

The covering character of the isospecial over the conventional relativity is evident because the former applies for manifestly broader conditions, while admitting the latter as a simple particular case for $\hat{1} = I = \text{Diag.}(1, 1, 1, 1)$.

The maximal causal speed is not, in general, the local speed of light, but rather quantity (7.1), and it is the speed of light only in vacuum. This assumption is necessary to resolve the inconsistencies of special relativity for the Cerenkov light and other interior conditions (see volume [I-3c] for details).

It is mentioned for completeness that the relaxation of the symmetric character of the isometric implies the *genospecial relativity;* the additional relaxation of the single-valued character implies the *hyperspecial relativity;* the use of *isoduality* then permits corresponding images for antimatter.

The above generalized relativities have permitted a new generation of rather intriguing cosmologies which are based for the first time on universal *symmetries* rather than covariance) and include, also for the first time, biological structures (as it should be from the very definition of

"cosmos").

As an illustration, *isocosmology* predicts: an equal amount of matter and antimatter in the universe; identically null total characteristics of time, energy, charge, etc (because antimatter under isodual representation has all physical characteristics changed in sign); a dramatic decrease of the currently believed size of the universe (from Isopostulate IV as we shall see in Paper III); no need for the missing mass (thanks to Isopostulate V as we shall also see in Paper III); and other novel features.

The *genocosmology* implies an open and irreversible universe, while the broadest possible *hypercosmology* implies that the universe has multi-warps, each of which possessing conventional spacetime, each warp being open and irreversible.

In conclusion, the biggest technical and political obstacle for scientific studies of new energies is, in my view, the generally tacit assumption of the "universal constancy of the speed of light" c_0. When the physical evidence of the locally varying character of the speed of light is identified (and admitted), basically novel energies become merely consequential. Their quantitative-scientific treatment however requires the covering of the special relativity outlined in this section.

I should recall that, even when restricted to hold in vacuum, special relativity is not immune from criticisms, and numerous alternative relativities have been constructed, among which I mention:

1) *Wilhelm's relativity* [29a], which reformulates special relativity in the much needed form admitting a universal frame at rest with the aether, and is in excellent agreement with experimental data;

2) *Bogoslowski's relativity* [29b], which generalizes the special relativity to an *anisotropic vacuum*, resulting in a theory whose predictions coincide with those of special relativity, except at the speed of light;

3) *Mocanu's relativity* [29c], which is constructed via the elegant Helmholtz calculus, and uses Hertz's original relativity conceptions; and other relativities.

All these relativities apply for particles at large mutual distances in vacuum, and, therefore, they are not applicable to new forms of energies and fuels implying short range effects. Nevertheless, the isotopic lifting of special relativity outlined in this section is easily extendable to any of alternative relativities [29], thus rendering them capable of representing nonlinear, nonlocal, and nonpotential effects at short mutual distances of particles.

Due to widespread plagiarisms existing in the contemporary physics literature, I have copyrighted numerous publications on the iso-, geno-, and hyper-relativities and their isoduals, and I intend to defend such copyrights in any means permitted by law. The new relativities can be used by anybody in part or in full for any scientific purpose without any prior authorization, provided that: 1) Original publications on the new relativities are quoted, e.g., Refs. [I-3b,I-3c,I-3f,I-3i]; 2) The quoted new relativities are outlined as a prerequisite for allegations of novelty; and 3) Paternities are identified with clarity.

8. ISO-, GENO-, AND HYPER-CONDUCTIVITY

The new theory of isosuperconductivity has been constructed by Animalu [26a], Animalu and Santilli [26b] and others. As we shall see in Paper III, the resulting covering theory permits the first direct representation of the *attraction* of two *identical electrons* in the Cooper pair in a way which is in remarkable agreement with experimental evidence. The geno- and hyper-superconductivity can be constructed via the methods outlined earlier. Superconductivity aspects of new energies will be studied via the above novel theories.

9. ISO-, GENO-, AND HYPER-CHEMISTRY.

Hadronic mechanics has recently permitted the construction by Santilli and Shillady [27] of a covering of quantum chemistry called *hadronic chemistry,* which also possesses the iso-, geno- and hyper-branches for the description of closed-isolated molecular structures, irreversible chemical reactions and biological structures, respectively. Chemical aspects of new energies will be studied via the novel hadronic chemistry.

10. SIMPLE CONSTRUCTION OF CLASSICAL AND OPERATOR GENERALIZED THEORIES.

It is important to know that the mathematical complexity of hadronic mechanics, hadronic superconductivity and hadronic chemistry is only apparent. A simple ,method for the explicit construction of isomechanics was introduced by Santilli in the original proposal [I-3a], and treated in detail in several subsequent publications, such as Refs. [I-3d,I-3e].

The method essentially consists in the use of a simple *nonunitary transform* which is assumed to characterize precisely the isounit:

$$U \times U^\dagger = \hat{1} \begin{cases} \neq I \text{ for } r \ll 10^{-13} \text{ cm} \\ = I \text{ for } r \gg 10^{-13} \text{ cm.} \end{cases} \tag{10.1}$$

The above transform must then be applied, for consistency, to the *totality* of the quantum formalism with no exception known to me, including the unit itself, numbers and their operations, vector and Hilbert spaces, Lie's theory, etc., according to the general lines:

$$\begin{aligned} I \ &\to \ U \times I \times U^\dagger \equiv \hat{1}, \\ c \ &\to \ U \times c \times U^\dagger = c \times (U \times U^\dagger) = c \times \hat{1} = \hat{c}, \\ A \times B \ &\to \ U \times (A \times B) \times U^\dagger = \\ &= (U \times A \times U^\dagger) \times (U \times U^\dagger)^{-1} \times (U \times B \times U^\dagger) = \hat{A} \times \hat{1} \times \hat{B} = \hat{A} \hat{\times} \hat{B}, \\ e^X \ &\to \ U \times e^X \times U^\dagger = (e^{X \times \hat{1}}) \times \hat{1} = \hat{e}^X, \\ H \times |\psi> \ &\to \ U \times (H \times |\psi>) = \\ &(U \times H \times U^\dagger) \times (U \times U^\dagger)^{-1} \times (U \times |\psi>) = \hat{H} \hat{\times} |\hat{\psi}>, \\ <\phi| \times |\psi> \ &\to \ U \times (<\phi| \times |\psi>) \times U^\dagger = \\ &= (<\phi| \times U^\dagger) \times (U \times U^\dagger)^{-1} \times (U \times |\psi>) \times (U \times U^\dagger) = \\ &= <\hat{\phi}| \hat{\times} |\hat{\psi}> \times \hat{1}, \text{ etc.} \end{aligned} \tag{10.2}$$

In this way, isounits, isonumbers, isospaces, isoalgebras, etc. are all easily, uniquely, and unambiguously constructed by nonunitary transform (9.1).

Classical isomechanics is similarly constructed via the systematic *noncanonical map* $U \times U^T = \hat{1}$ applied to all aspects of Hamiltonian mechanics [I-3e].

An important condition for compatibility between quantum and isomechanics expressed in Equation (7.1) and in the notion of "hadronic horizon" (Figure 1) is that $\hat{1}$ must have the conventional

value I everywhere, *except* at distances of 1 fm or less, in which I must be admitted as a particular case.

As an illustration, isounits (5.9) verify automatically the above conditions because it recovers the conventional unit whenever the overlapping of wavepackets is no longer appreciable.

Once achieved via the above simple transform, isomechanics remains invariant under any other possible *nonunitary* transform, provided that it is expressed in the isounitary form of Section 6.4, Equations (6.4.7).

A similar method for the construction of genomechanics was introduced in Ref. [3d]. It consists in the use of the *dual* nonunitary transforms:

$$U \times U^\dagger \neq I, \quad W \times W^\dagger \neq I,$$

$$U \times W^\dagger = I^>, \; W \times U^\dagger = {}^<I \quad \begin{cases} \neq I \text{ for } r \ll 10^{-13} \text{ cm} \\ = I \text{ for } r \gg 10^{-13} \text{ cm}. \end{cases} \tag{10.3}$$

which must also be applied to the totality of the original formalism. This transform yields the dual generalizations of forward and backward genonumbers, $U \times n \times W\dagger = n \times I^> = n^>$ and $W \times n \times U\dagger = {}^<I \times n = {}^<n$, the related forward and backward genoproducts $U \times (A \times B) \times W^\dagger = A' >B'$, $W \times (A \times B) \times U^\dagger = A' < B'$, etc.

The hypermechanics can be constructed via the relaxation of the single-valued character of transforms (9.5), and the use of multi-valued dual nonunmitary transforms [I-3d,I-3e].

In summary, as we shall see in the following papers, the central problem for practical applications of iso-, geno- and hyper-mechanics is the identification of nonunitary transforms (9.1) or (9.5) which permits the consistent and invariant inclusion of internal non-Hamiltonian effects missing in conventional quantum models. *This property renders applications of iso-, geno- and hyper-mechanics rather easy because they are essentially constructed via simple nonunitary transforms of conventional quantum models.*

Due to widespread plagiarisms existing in the contemporary physics literature, I have copyrighted the publications on the simple methods for the construction of hadronic mechanics outlined in this section, and I intend to defend such copyrights in any means permitted by law. The method of this section can be used by anybody for any scientific purpose without any prior authorization, provided that: 1) Original publications on said methods are quoted, e.g., Refs. [I-3a,I-3d,I-3e]; 2) Said copyrighted method is outlined as a prerequisite for allegations of novelty; and 3) Paternities are identified with clarity.

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THE PHYSICS OF NEW CLEAN ENERGIES AND FUELS ACCORDING TO HADRONIC MECHANICS, PAPER III: NEUTRON STRUCTURE AND NEW ENERGIES OF CLASS I[1]

Ruggero Maria Santilli[2]

ABSTRACT

This is the third of a series of five articles outlining systematic research on new energies at the particle, nuclear, and molecular levels, initiated by the author at Harvard University in 1978 under DOE support, and then continued by numerous scientists at various Institutions. Paper I identified the new energies studied in this series as those not predictable or treatable by quantum mechanics, and presented clear limitations of quantum mechanics in numerous fields. Paper II outlined the covering hadronic mechanics in its various branches; identified the novel mathematics needed for its invariant treatment; proved its universality; and reviewed catastrophic inconsistencies of nonunitary theories when treated with the conventional mathematics of quantum mechanics. This Paper III initiates the application of hadronic mechanics to new energies, and begins with the classification of the new energies as being of *Class I,* when of particle origin, of *Class II,* when of nuclear origin with possible contributions of Class I, and of *Class III,* when of molecular origin, with possible contributions of Classes I and II. As a necessary pre-requisite for the study of the new energies of Class I, this paper outlines the rather numerous experimental verifications of hadronic mechanics in particle physics, astrophysics, and cosmology. The paper then outlines new structure models of unstable hadrons with physical constituents emitted in the spontaneous decays with the lowest modem, which structure models are at the foundation of new energies of Class I. Particular attention is devoted to the representation, permitted by hadronic mechanics, of all characteristics of the neutron as a bound state of one proton and one electron totally immersed in its interior according to Rutherford's historical legacy, as first achieved by the author in 1990. The paper then reviews the first experimental verification of Rutherford's conception of the neutron conducted by don Borghi *et al.* =. The paper then review the hypothesis first submitted by the author in 1994 that the neutron can be stimulated to decay, thus releasing the rather large energy of 1.294 MeV per decay, and providing a representative example of new energies of Class I. The related experimental verification by Gr. Tsagas *et al.* is also outlined. This new knowledge is then applied to new means for the stimulated decay of nuclear waste via the the decay of their peripheral neutrons. The paper concludes with the identification of the physical laws and conditions under which new energies of Class I are possible, and the proposal of various new experiments.

1. CLASSIFICATION OF NEW ENERGIES

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This is the third of a series of five articles outlining systematic research on new energies at the particle, nuclear, and molecular levels, initiated by the author at Harvard University in 1978 under DOE support, and then continued by several researchers at various Institutions.

In Papers I [1a] and II [1b], I presented the necessary conceptual and theoretical foundations of new forms of energy not predicted by conventional theories (see Definition I-1.2.1, where the prefix "I" denotes the paper of this series).

In this Paper III, I initiate the experimental and industrial analysis of new clean energies under study at Toups Technology Licensing, a public company in Largo, Florida (see web site [2]), Trienergy, Inc., a company in Salt Lake City, Utah, and numerous other corpoerations in the U. S. and abroad, as well as the new clean energies presented in the *Journal of New Energy,* and various other journals, which include:

1) New clean energies originating in the structure of the neutron and other strongly interacting particles called *hadrons,* thus originating at the *subnuclear-particle level* (hadronic energy, and others studied in this paper);

2) New clean energies originating at the *nuclear level* (cold fusion, and others studied in Paper IV); and

3) New clean energies originating at the *atomic-molecular level,* including new clean fuels developed by Toups Technology Licensing, and other energies, to be studied in Paper V.

The main objective of these papers is to show that the novel *hadronic mechanics* [3] outlined in Paper II permits a numerical, consistent, and invariant treatment of *all* new energies. The main hope is that the availability of such a unifying theory will permit the increase of present efficiencies, the identification of alternative means of producing new energies, and the development of new industrial applications.

I initiated the analysis in Paper I by presenting an outline as comprehensive as possible of the insufficiencies of quantum mechanics in most branches of science, which is a *mandatory* requirement for the study of covering mechanics.

In Paper II [1b,1c], I have: 1) indicated that the insufficiencies originate from the lack of representation by quantum mechanics of the nonlinear, nonlocal, and nonpotential effects due to deep overlapping of the extended wavepackets of particles; 2) outlined "catastrophic" inconsistencies suffered by various generalized theories treated with conventional mathematics; 3) introduced new mathematics specifically constructed for the resolution of these inconsistencies; 4) presented the main axiomatic lines of *hadronic mechanics* [3], which, to my best knowledge, is the only known generalized theory capable of resolving said inconsistencies and providing an *invariant* description of nonlinear, nonlocal, and nonpotential interactions (communication to this author of other generalized theories with a rigorous mathematical proof of their consistency and invariance would be appreciated); and 5) presented elementary rules accessible to all for the explicit construction of hadronic models (without the use of generalized mathematics), which consist of simple nonunitary transforms of conventional quantum models.

I begin the analysis in this paper with the following classifications of the energies under study at Toups Technology Licensing, *Infinite Energy,* and the New Energy Research Laboratory:

DEFINITION 1.1: The new clean energies as per Definition I-1.2.1 are said to be of:
CLASS I, when they originate in the structure of the neutron or hadrons at large, thus being sub-nuclear;
CLASS II, when they originate in the structure of nuclei, with possible contributions of Class I;
CLASS III, when they originate in the structure of atoms and molecules, with possible contributions of Classes I and II.

This Paper III is devoted to a study of new clean energies of Class I via nonrelativistic and relativistic hadronic mechanics, while the study of the new energies of Classes II and III will be conducted in subsequent papers. New clean fuels will be studied in Paper V.

I should stress that the beauty of scientific inquiries is their polyhedricity. By no means is

hadronic mechanics intended to be the only possible theory for new energies, and the study of alternative theories is encouraged.

However, to separate science from fiction, alternative theories have to be proved: 1) To represent all the same data represented by hadronic mechanics; 2) To be as *consistent and invariant* as hadronic mechanics; and 3) To be *inequivalent* to the latter (which is an evident necessary condition for novelty). By keeping in mind the direct universality of hadronic mechanics, the above tasks 1), 2), and 3) appear to be rather difficult, if not impossible.

In fact, if a given theory has a linear, local and unitary time evolution, it has no relevance for these papers, because it is within the class of equivalence of quantum mechanics. If a given theory has a nonlinear, and/or nonlocal, and/or nonunitary time evolution, it is indeed of interest for these papers, although it is within the class of equivalence of hadronic mechanics.

This includes some of the most general theories conceivable at this time, such as those formulated on ordered multivalued hypernumbers with a countable infinity of geno-quaternions. In any case, the formulation of single-valued, bi-valued or multi-valued nonunitary theories via the formalism of hadronic mechanics is *necessary* to avoid the catastrophic inconsistencies outlined in Paper II, Section 4 (hereon referred as II-4).

Stated concisely, *the fundamental condition for the existence of new energies of Class I is that quantum mechanics is not exactly valid in the interior of hadrons due to their hyperdense structure, which implies novel, internal, nonlinear, nonlocal and nonpotential (thus nonhamiltonian and nonunitary) effects (Papers I and II).*

Hadronic mechanics has been built to preserve all *exterior* characteristics of hadrons (technically achieved via the preservation of the generators in the transition from Lie to Lie-Santilli isosymmetries), while admitting an invariant representation of the most general possible internal nonunitary effects (technically achieved via generalized units).

In this Paper III, I outline part of the rather vast body of experimental evidence supporting the validity within the hadronic structure of nonrelativistic and relativistic hadronic mechanics, and related isogalilean and isopoincaré symmetries.

Following this experimental background, I review: A) The exact, numerical, consistent, and invariant representation of *all* characteristics of the neutron as a bound state of one proton and one electron according to the historical legacy of Rutherford, as first achieved by Santilli in 1990 via hadronic mechanics; B) The consequential new structure model of unstable hadrons with ordinary physical constituents, and its compatibility with the SU(3) Mendeleev-type classification of hadrons; and C) Examples of new energies of Class I, and some of their expected industrial applications.

As will be shown, the existence of new clean energies of Class I crucially depends on a new structure model of unstable hadrons with constituents given by ordinary massive particles freely emitted in the spontaneous decays, generally those with the lowest mode.

In essence, if the constituents of unstable hadrons are ordinary physical particles (that is, particles which can be defined and directly detected in our spacetime), then naturally unstable hadrons (such as the neutron) can be stimulated to decay, resulting in new forms of clean energy. On the contrary, if the constituents of hadrons are the hypothetical un-physical quarks (because quarks cannot be defined and individually detected in our spacetime), then no possibly whatever exists for the contemporary theory of strong interactions to have practical applications.

Note that a structure model of unstable hadrons with conventional massive particles as physical constituents is *prohibited* by quantum mechanics, as well known, although the same model is readily admitted by hadronic mechanics (whose name was suggested precisely for that reason). This occurrence begins to illustrate the absolute necessity of a covering of quantum mechanics, for serious scientific studies of new clean energies.

As shown in Papers IV and V, essentially the same situation occurs for new clean energies of Classes II and III, whose existence crucially depends on new structure models of nuclei and molecules, respectively. The latter models too are prohibited by quantum mechanics, yet readily permitted by the covering hadronic mechanics.

2. EXPERIMENTAL VERIFICATIONS OF HADRONIC MECHANICS IN PARTICLE PHYSICS, ASTROPHYSICS, AND COSMOLOGY

2.1. Statement of Objectives

As stressed in Paper I, the most insidious obstructions for new energies are special relativity, its underlying relativistic quantum mechanics, and quark theories/quantum chromodynamics (QCD) [4].

In Paper I, I have expressed the view (opposed by some colleagues in new energies) that *special relativity is exactly valid for relativistic exterior dynamical problems* (particles moving in vacuum at large mutual distances under only long range interactions), while special relativity is *inapplicable* (and not "violated") for the much broader and more complex *relativistic interior dynamical problems* (particles at short mutual distances in conditions of deep overlapping of their wavepackets, thus experiencing long range as well as contact interactions).

The experimental verification of the validity of special relativity for exterior conditions is established on a daily basis in particle accelerators (I here refer specifically to *mathematical* treatments yielding *numbers* which are verifiable with *tests*, and exclude epistemological aspects).

In Paper I, I have also expressed the view that the SU(3)-color theory provided the final *Mendeleev-type classification of hadrons into families*, while the problem of the structure of the individual hadrons requires a new mechanics permitting the identification of hadronic constituents with ordinary massive particles, generally those produced in the spontaneous decay with the lowest mode (tunnel effect of the constituents [3a]), much along the Mendeleev classification of atoms and structure of individual atoms which required the advent of a new mechanics.

The return to ordinary physical particles as hadronic constituents then permits the new energies of Class I, as we shall see, much along the case of conventional nuclear and atomic energies.

In this section I outline the experimental evidence on the inapplicability of special relativity and relativistic quantum mechanics for *interior* problems (only), and the consequential validity of their isotopic coverings.

The latter evidence establishes the foundations of the new model of structure of the neutron and hadrons outlined in Section 3, and voids the conjecture that quarks are the physical constituents of hadrons (evidently because of the inapplicability of their dynamical foundations). Jointly, the experimental evidence presented in this section reinforces the validity of special relativity, SU(3) and QED for the *exterior* classification-type description of hadrons, thus permitting new energies as per Definitions I-1.2.1 and II-1.1 without any conflict.

2.2. Insufficiencies of Special Relativity and the Universality of its Isotopic Covering

As reviewed in detail in Paper I, the "universal constancy of the speed of light" c_0 is a political abstraction, because *in physical reality the speed of light is a local variable* c depending on position r, frequency ω, density μ, temperature τ, and other local characteristics of the medium in which it propagates, according to the known expression $c = c_0/n(r, \omega, \mu, \tau, ...)$, where n is the local index of refraction.

The validity of special relativity for propagation of light in vacuum has been recalled earlier. I assume the reader is aware of the huge inconsistencies of special relativity when misused to represent locally varying speeds c, as outlined in Section I-3.

It follows that the experimental evidence on the inapplicability of special relativity for interior conditions is provided by the mere inspection of physical evidence in our environment, such as the refraction of light (the apparent bending of a straight stick when partially immersed in water).

In fact, this evidence requires a *decrease of the speed of light* at the point of bending and below, thus establishing the *inapplicability* (and not the violation) of special relativity in water because of numerous serious inconsistencies outlined in Paper I (violation of causality because

particles can travel in water faster than light, violation of the relativistic composition of speeds, lack of invariance for locally varying speeds, etc.).

If special relativity is inapplicable for media of low density, the belief that it is exactly valid for hyperdense media as existing in the interior of hadrons or stars has *zero credibility*, as disproved by the experimental evidence presented in this section. The door is then open for basically new forms of energies.

The above scenario has mandated the construction of the covering *isospecial relativity*, with underlying *isominkowskian spaces* and *isopoincaré symmetry* in their classical and operator formulations [3], as outlined in Paper II.

Isospecial relativity is axiomatically consistent, invariant and "directly universal," *i.e.*, including all infinitely possible signature-preserving modifications of the Minkowski space (universality), directly in the frame of the observer (direct universality).

A primary purpose of this section is to identify some of the available direct experimental verifications of isospecial relativity for interior problems in hadron physics, as a prerequisite for new energies.

Another basic notion the reader should keep in mind from these introductory lines is that *special and isospecial relativities coincide at the abstract, realization-free level* by conception and construction (Section II-6). It then follows that *isospecial relativity extends the arena of applicability of special relativity from exterior conditions in vacuum, to universal interior conditions*, as we shall see in this section.

2.3. Experimental Verification with Data on the Local Speed of Light

Speeds $c<c_0$ ($n > 1$) for media of low density, such as our atmosphere, were studied by numerous authors at the turn of this century, most notably by Lorentz [5a] (see the quotation by Pauli [5b]). These studies were then ignored for the rest of this century because they are not compatible with special relativity.

In fact, various machinations were concocted to adapt physical reality to special relativity, all discredited for various inconsistencies reviewed in Paper I (*e.g.*, the old reduction to light scattering among the molecules of a medium has been discredited by the experimental evidence of superluminal speeds and other measurements).

Speeds $c>c_0$ ($n < 1$) have been considered throughout this century, first at the level of science fiction and then gradually becoming scientific reality (see, *e.g.*, the papers in [6a] and references quoted therein).

A study on speeds $c > c_0$ directly relevant for these papers is the hypothesis submitted by R. M. Santilli [6b] in 1982 that *the maximal causal speed in the interior of hadrons is generally bigger than that in vacuum*, or, more generally, that *contact interactions can accelerate ordinary masses at arbitrary speeds beyond* c_0.

The main argument of [6b] is that the maximal possible speed under *action-at-a-distance interactions* is indeed c_0, as well-known and experimentally established, *e.g.*, in particle accelerators. However, under contact effects, the maximal causal speed is arbitrary because the energy balance of the latter is dramatically different than that of the former, as classically verified, *e.g.*, in the acceleration of a balloon by the atmosphere.

Subsequently, V. de Sabbata and M. Gasperini [6c] conducted the first phenomenological verification of the above hypothesis for the interior of hadrons via the use of conventional gauge theories, by obtaining under extreme conditions maximal causal speeds up to $c = 75\, c_0$.

More recently, various astrophysical measurements [7] have established the validity of the hypothesis submitted in [6b], by detecting masses expelled in astrophysical explosions (thus under contact interactions) at speeds $c > c_0$.

Additional experimental verifications of speeds $c > c_0$ have been made [8] for photons propagating in certain wave guides (see the forthcoming review of all superluminal speeds by E.

Recami [8c]).

As is well-known, the celebrated *Minkowski space* M(x,η,R) [9a] and related *Minkowskian geometry* (see Section II-6.5 for notations) provide a *direct and invariant geometrization of the speed of light in vacuum,* where the term "direct" is referred to the representation of the speed c_0 in the metric itself (as originally written by Minkowski [9a]), η = Diag. (1, 1, 1, $-c_0^2$), and "invariant" is referred to the fact that the most general class of admissible transformations, those of the Poincaré symmetry, leave η, thus c_0, invariant.

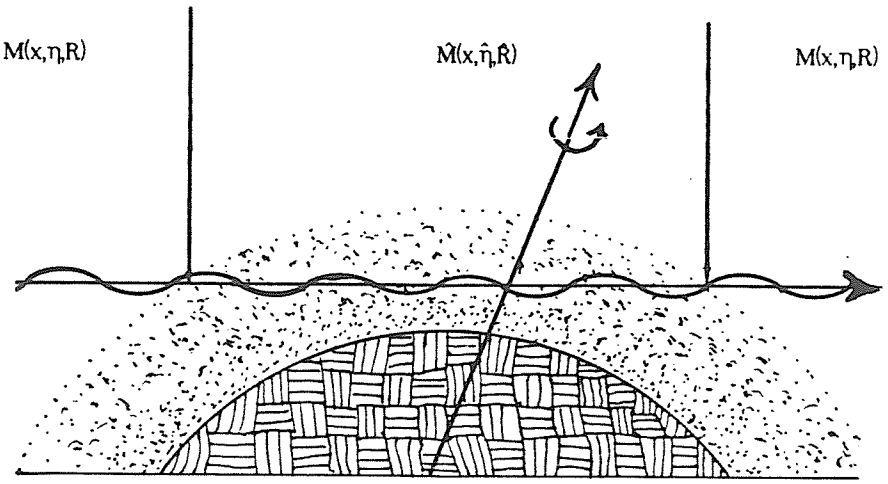


FIGURE 1: A representation of the propagation of light in our atmosphere with Santilli's iso-Minkowskian geometry [9b-9e] and the conventional geometry in empty space.

The admission of the experimental reality that, in general, the speed of light has the local value $c = c_0/n \neq c_0$, evidently creates the problem of its geometrization in a way as direct and invariant as that in vacuum.

To my best knowledge, the first direct and invariant representation of arbitrary speeds of light (or of arbitrary local causal speeds) was reached in 1983 by R. M. Santilli [9b] via the *isominkowskian spaces* $\hat{M}(\hat{x},\hat{\eta},\hat{R})$ (see also Section II-6.5 for a review and notations) which confirmed the prediction of speeds $c > c_0$ for hyperdense media submitted in the preceding paper [6b].

The *isominkowskian geometry* was subsequently studied in various works (see the latest presentation in memoir [9c]). Catastrophic mathematical and physical inconsistencies of other generalizations of the Minkowski space were treated in detail in memoir [9d].

A conceptual-nontechnical outline of these studies can be summarized as follows. Recall that all unitary transforms of relativistic quantum mechanics (*e.g.*, those of the Poincaré symmetry) are defined by the invariance $\eta \to \eta' = W\times\eta\times W^\dagger \equiv \eta$. Therefore, the map η = Diag. (1, 1, 1, $-c_0^2$) $\to \hat{\eta} = W\times\eta\times W^\dagger$ = Diag. (1, 1, 1, $-c_0^2/n^2$) is necessarily *nonunitary* (with a *noncanonical* counterpart at the classical level here ignored).

This activates *relativistic hadronic mechanics* (Section II.6.5) as the *only known invariant theory.* The invariance of the representation requires that the nonunitary transform is identified with the new basic unit of the theory (the *isounit*) and consequently, the *totality* of the original Minkowskian formulation is subjected to the same nonunitary transform with no exception known to me.

This implies the nonunitary lifting of numbers and fields, metric and Hilbert spaces, geometries and topologies, etc., via the elementary rules of Section II-9:

$$I \to U \times I \times U^\dagger = \hat{1} = \text{Diag.}\,(1,\,1,\,1,\,n^2),\quad \hat{1} = (U \times U^\dagger)^{-1}, \tag{2.1a}$$

$$n \in R(n,+,\times) \to \hat{n} = U\times n \times U^\dagger = n \times (U \times U^\dagger) = n \times \hat{1} \in \hat{R}(\hat{n},\hat{+},\hat{\times}), \tag{2.1b}$$

$$A\times B \to U\times(A\times B)\times U^\dagger = (U\times A\times U^\dagger)\times(U\times U^\dagger)^{-1}\times(U\times B\times U^\dagger = A \,\hat{\times}\, \hat{1} \times B' = A' \,\hat{\times}\, B', \tag{2.1c}$$

$$x^2 = x\times\eta\times x^\dagger \to U\times x^2\times U^\dagger = U\times(x\times\eta\times x^\dagger)\times U^\dagger =$$

$$= (Ux^\mu\times U^\dagger)\times[(U\times U^\dagger)^{-1}\times\eta_{\mu\nu}]\times(U\times x^\nu\times U^\dagger)^\dagger =$$

$$= \hat{x}^\mu \times \eta_{\mu\nu} \times \hat{x}^\nu \in \hat{R}(\hat{n},\hat{+},\hat{\times}), \tag{2.1d}$$

$$\eta = \text{Diag.}\,(1,\,1,\,1,\,-c_o^2) \to \hat{\eta} = (U\times U^\dagger)^{-1}\times\eta =$$

$$= \text{Diag.}\,(1,\,1,\,1,\,-c_o^2/n^2). \tag{2.1e}$$

The direct representation of arbitrary speeds $c = c_o/n$ is then evident. Its extreme simplicity as well as direct universality under a nonunitary transform should be noted. Once the above nonunitary theory is achieved, its invariance is established for all possible additional nonunitary transforms $W\times W^\dagger = \hat{1} \neq I$, *provided* that they are treated via *isomathematics* (Section II–5).

This essentially implies that the nonunitary transforms on M over R are identically rewritten in the form $W = \hat{W}\times\hat{T}^{1/2}$ yielding the *isounitary transform* on $\hat{M}$ over $\hat{R}$ $W\times W^\dagger \equiv \hat{W}\hat{\times}\hat{W}^\dagger = \hat{W}^\dagger\hat{\times}\hat{W} = \hat{1}$. Then, and only then, it is easy to prove the invariance of the isounit, $\hat{1} \to \hat{1}' = \hat{W}\hat{\times}\hat{1}\hat{\times}\hat{W}^\dagger \equiv \hat{1}$, of the isoproduct $A\hat{\times}B \to \hat{W}\hat{\times}(A\hat{\times}B)\times\hat{W}^\dagger = A'\hat{\times}B'$, etc.

The invariance of arbitrary speeds of light is established by the Poincaré–Santilli isosymmetry $\hat{P}(3.1)$ [10,11] for the particular isounit $\hat{1}$ here considered. The applicability of the *isospecial relativity* [3] then follows (see also Section II–6.5).

The above direct and invariant representation of arbitrary speeds of light constitutes the *first experimental verification of the isospecial relativity and relativistic hadronic mechanics.*

2.4. Experimental Verifications Via Phenomenological Calculations of Hadronic Media

Iso-Minkowskian model (2.1) is a particular case of Santilli's general isominkowskian line element [9b]:

$$U\times U^\dagger = \hat{1} = \text{Diag.}\,(b_1^{-2},\, b_2^{-2}\, b_3^{-2} - b_4^{-2}) =$$

$$= \text{Diag.}\,(n_1^2,\, n_2^2,\, n_3^2,\, n_4^2) = 1/\hat{T} > 0,\quad b_\mu^2 = n_4^{-2} > 0, \tag{2.2a}$$

$$\hat{\eta} = (U\times U^\dagger)^{-1}\times\eta = \text{Diag.}\,(b_1^2,\, b_2^2,\, b_3^2,\, -c_o^2\times b_4^2) =$$

$$= \text{Diag.}\,(1/n_1^2,\, 1/n_2^2,\, 1/n_3^2,\, -c_o^2/n_4^2), \tag{2.2b}$$

$$\hat{x}^{\hat{2}} = \hat{x}^\mu\times\hat{\eta}_{\mu\nu}\times\hat{x}^\nu = \hat{x}^1\times b_1^2\times\hat{x}^1 + \hat{x}_2\times b_2^2\times\hat{x}^2 + \hat{x}^3\times b_3^2\times\hat{x}^3 - \hat{x}^4\times b_4^2\times\hat{x}^4 =$$

$$= \hat{x}^1\times\hat{x}^1/n_1^2 + \hat{x}_2\times\hat{x}^2/n_2^2 + \hat{x}^3\times\hat{x}^3/n_3^2 - \hat{t}\times\hat{t}\times c_o^2/n_4^2, \tag{2.2c}$$

where: $n_4 = b_4^{-1} = n$ is the index of refraction representing the *density* of the medium considered as compared to the vacuum, which is assumed to have density $n_4 = b_4^{-1} = n = 1$; the n_k's emerge from the spacetime symmetrization of n_4 (or application of the Lorentz transforms to interval (2.1)); and the "hat" in the $\hat{x}$'s indicates measurements on $\hat{M}$ over $\hat{R}$, a notation omitted hereon for simplicity.

The quantities $n_\mu = b_\mu^{-1}$ are called the *characteristic functions* of the medium considered.

When a hadron is considered from the outside, the n's and b's are averaged into constants usually denoted $n_\mu{}^\circ = b_\mu{}^{\circ -1}$. As an example, the n's are functions when describing the *local* speed of light in the interior of our atmosphere. On the contrary, when inspected from the outside, the passage of light throughout our atmosphere can be described via the *average* of n_4 to the constant n°_4.

Note that isometric (2.2b) is the most general possible isometric under the assumed topological conditions of being symmetric, real-valued, and nowhere singular (see the geno- and hyper-metrics of Paper II for relaxations of these conditions).

The first experimental verification of the full isominkowskian formulation (2.2b) for the geometrization of media in the interior of hadrons has been provided by H. B. Nielsen and I. Picek [12] (of the Niels Bohr Institute in Copenhagen, Denmark), who conducted extensive phenomenological calculations via conventional gauge theories in the Higgs sector, and derived the following isometrics for the interior of pions and kaons, respectively:

$$\hat{\eta} = \text{Diag.}\,[(1 - a/3, (1 - a/3), (1-a/3), -c_0{}^2 > (1 - a)] \equiv$$

$$\equiv \text{Diag.}\,(b_1{}^2, b_2{}^2, b_3{}^2, -c_0{}^2 \times b_4{}^2) =$$

$$= \text{Diag.}\,(1/n_1{}^2, 1/n_2{}^2, 1/n_3{}^2, -c_0/n_4{}^2), \qquad (2.3a)$$

$$\text{PIONS } \pi^\pm\text{: } b^\circ_1{}^2 = b^\circ_2{}^2 = b^\circ_3{}^2 = 1 + 1.2\times 10^{-3},\ b^\circ_4{}^2 = 1 - 3.79\times 10^{-3}, \qquad (2.3b)$$

$$\text{KAONS } K^\pm\text{: } b^\circ_1{}^2 = b^\circ_2{}^2 = b^\circ_3{}^2 = 1 - 2\times 10^{-4},\ b^\circ_4{}^2 = 1 + 6.1\times 10^{-4}. \qquad (2.3c)$$

As one can see, *the phenomenological results by Nielsen and Picek [12] constitute the second experimental verification of the isospecial relativity and relativistic hadronic mechanics*, including the hypothesis [6b,9b] of speeds $c > c_0$.

In fact, for pions we have $b^\circ_4 < 1$ and speeds $c < c_0$, while for kaons we have $b^\circ_4 > 1$ and $c > c_0$. Since the density of hadrons increases with mass, speeds $c > c_0$ are expected to persist for all heavier hadrons, as confirmed by subsequent data.

Again, the simplicity and universality of the isominkowskian geometry in representing data [12] should be kept in mind.

I should indicate that *particles traveling in interior conditions faster than light in vacuum are not tachyons, but ordinary, conventional, massive particles.* In fact, the notion of tachyons must be re-defined for the considered experimental data as *particles traveling faster than the local maximal causal speed* (which *is not* that of light, as shown in Section II-6.5, since interior physical media are generally opaque to light anyhow).

2.5. Experimental Verification with the Behavior of the Meanlife of Unstable Hadrons with Speed

The hyperdense character of the medium inside hadrons has been known since the discovery of protons and neutrons. In turn, dynamics within hyperdense media lead to the historical open legacy that strong interactions have a *nonlocal* component due to deep wave-overlappings, namely, a component that violates special relativity.

In fact, strong interactions have a range of 1 fm ($= 10^{-13}$ cm) which *coincides* with the size of all hadrons, as well as with the size of the wavepackets of all particles. It then follows that, unlike electromagnetic interactions, a necessary condition to activate strong interactions is that hadrons enter into conditions of deep mutual overlappings. The nonlocality of these conditions is then consequential.

In particular, to be physical, the hadronic constituents must have wavepackets of the order of the entire hadrons. This implies that, unlike the atomic constituents, the hadronic constituents are

in condition of total mutual penetration of their wavepackets, one inside all others, thus resulting again in a nonlocal structure.

To my best knowledge, the first experimental verification of nonlocal internal effects in the structure of hadrons was studied in 1964 by D. L. Blokhintsev [13a] (of the JINR in Dubna, Russia), who suggested the *measure in a particle accelerator of the behavior of the meanlives of unstable hadrons with speed (or energy).*

In essence, Blokhintsev argued that the behavior of meanlives of unstable hadrons with the speed v (or the energy $\frac{1}{2}mv^2$) should *not* follow the prediction of special relativity:

$$\tau = \tau_0 \times (1 - v_k \times v_k / c_0 \times c_0)^{-1/2}. \tag{2.4}$$

Deviations from the above Minkowskian law would then establish dynamical effects in the interior of hadrons beyond special relativity (interior problem).

Note that such deviations are fully compatible with the exact verification of special relativity for the center-of-mass trajectory of the same particle (exterior problem).

The studies by Blokhintsev and his group in Russia were continued by L. B. Redei [13b] in Italy, D. Y. Kim [13c] in Canada, and others.

A rather unsettled feature of these studies is that they proposed different generalizations of the Minkowskian law (2.4), thus creating the problem of which law to test.

In 1983 R. M. Santilli [9b] proposed the isominkowskian spaces $\hat{M}(\hat{x},\hat{\eta},\hat{R})$ with isometric (2.2) and generalized law:

$$\tau = \tau_0 \times (1 - v_k \times b_k^2 \times v_k / c_0 \times b_4^2 \times c_0)^{-1/2} =$$

$$= \tau_0 \times [1 - (v_k \times v_k / n_k^2) / (c_0^2 / n_4^2)]^{-1/2}. \tag{2.5}$$

A. K. Aringazin [14] then proved that the above iso-Minkowskian law is *directly universal* for all possible (signature preserving) modifications of the Minkowski space (as expected from the direct universality of the isominkowski spacetime).

All generalized laws [13] can be obtained as particular cases of isolaw (2.5) via different expansions in terms of different coefficients subjected to different truncations [14]. Rather than testing a variety of seemingly different laws, the experiments can be solely conducted for isotopic law (2.5).

The first direct experimental measurement of the behavior of the meanlife of the unstable K°s with energy was conducted in 1983 by S. H. Aronson *et al.* [15a] at Fermilab suggesting *deviations* from the Minkowskian law (2.4) in the energy range from 30 Gev to 100 GeV.

Additional direct experimental measurements were conducted in 1987 by N. Grossman *et al.* [15b] also at Fermilab, showing apparent *verification* of the Minkowskian law, although in the *different* energy range from 100 to 400 GeV.

Moreover, a test of the decay law at short decay times was made by G. Alexander *et al.* at LEP [15c], in which the events $Z^\circ \to \tau^+ \tau^-$ show a *deviation* from the conventional law of the order of 1.1%.

In paper [16a] of 1992, F. Cardone (then of the First University in Rome, Italy) *et al.* proved that *Santilli's isominkowskian spaces permit an exact fit of experimental data* [15a] (see Figure 2).

In the subsequent paper [16b], F. Cardone *et al.* proved that the same isominkowskian representation *unifies* the seemingly discordant results of tests [15a] and [15b] (Figure 3).

In this way, Cardone *et al.* achieved the following numerical values of the characteristic constants for the K°s:

$$b^\circ_1{}^2 = b^\circ_2{}^2 = b^\circ_3{}^2 = 0.989080 \pm 0.0004; \tag{2.6a}$$

$$b^\circ_4{}^2 = 1.002 \pm 0007; \tag{2.6b}$$

$$\Delta b^{\circ}{}_{k}{}^{2} = 0.007, \ \Delta b^{\circ}{}_{4}{}^{2} = 0.001 . \qquad (2.6c)$$

It is evident that *the above fits constitute the third experimental verification on the validity of the isominkowskian geometry and relativistic hadronic mechanics for the characterization of media in the interior of hadrons.*

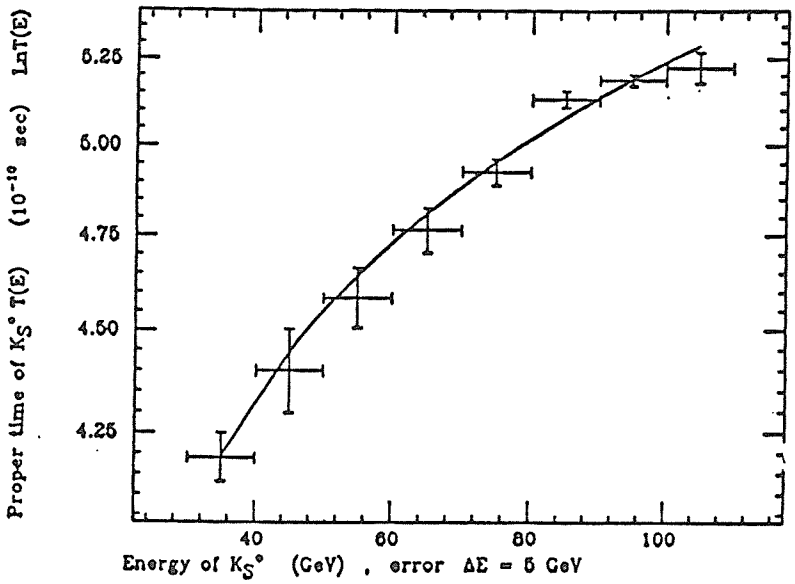


FIGURE 2: The exact fit of Santilli's iso-Minkowskian law (2.5) [9b] provided by Cardone *et al.*[16a] on the data of Fermilab experiment [15a].

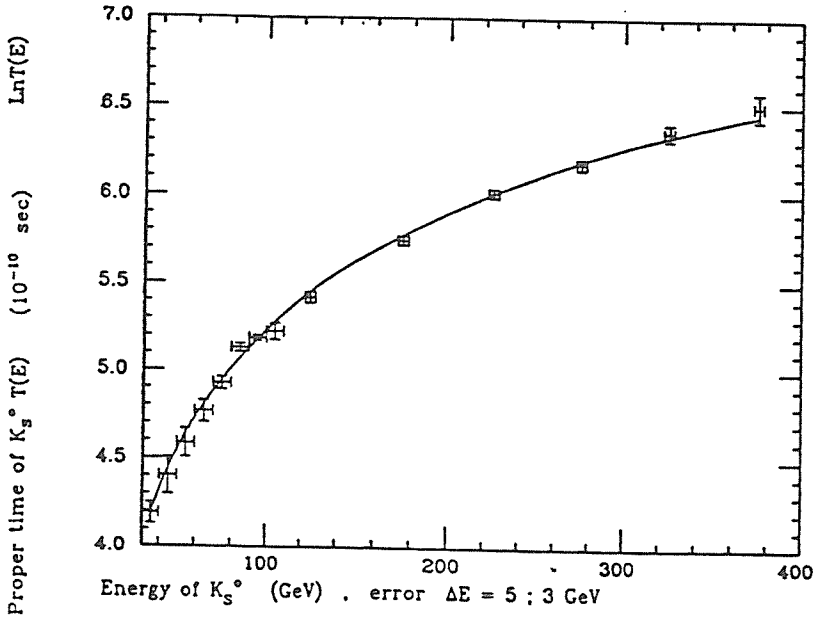


FIGURE 3: The exact fit of Santilli's iso-Minkowskian law (2.5) [9b] provided by Cardone *et al.*[16b] on the data of both Fermilab experiments [15a] and [15b].

Results (2.3) and (2.6) have the following important implications:

1) They confirm in a completely independent way that the maximal causal speeds in the interior of kaons is bigger than that in vacuum. In fact, values (2.6b) are very close to values (2.3b)

even though derived in different ways (the former via direct measurements and the latter via phenomenological calculations).

2) Results (2.3) and (2.6) confirm that the quantity $b^\circ_4 = 1/n^\circ 4$ characterizes the *density* of the hadron considered (normalized to the value $b^\circ_4 = 1/n^\circ 4 = 1$ for the vacuum), while the dependence of the characteristic functions on the speed (or energy) is essentially in the space components $b^\circ_k = 1/n^\circ_k$ (also normalized to the values $b^\circ_k = 1/n^\circ_k = 1$ for the vacuum).

3) Results (2.3) and (2.6) void the measurements by Grossman *et al.* [15b] of any conclusive value, evidently because we have experimental deviations from the Minkowskian geometry even under the assumption that tests [15b] are valid.

4) Results (2.3) and (2.6) establish that the rest energy of the constituents of hadrons *is not* given by the familiar expression $E = m \times c_0^2$, but rather by the isorenormalized Equation (II-7.5), *i.e.*:

$$E_{Hadr.\ Const.} = m \times c^2 = m \times c_0^2 \times b_4^2 = m \times c_0^2 / n^\circ_4{}^2, \tag{2.7}$$

with a value evidently *bigger* than that currently believed for all particles with mass bigegr than that of the kaon.

5) Results (2.3) and (2.6) establish that the frequency ν of photons or gluons emitted in the interior of hadrons *is not* characterized by the traditional law $E = h \times \nu$, but instead by the isorenormalized law:

$$\hat{\nu} = \nu / n^\circ_4{}^2, \tag{2.8}$$

with evident *isoredshift* (tendency toward the red due to physical media) for the π° and *isoblueshift* (tendency toward the blue) for kaons and all other hadrons.

6) Results (2.3) and (2.6) establish that light emitted in the interior of hadrons is also *isoredshifted* or *isoblueshifted*, that is, it reaches the outside at a frequency smaller or bigger than that originally emitted in the interior because of mechanisms of the isospecial relativity studied in astrophysical applications (essentially due to release or absorption of energy from the medium).

7) Results (2.3) and (2.6) establish that *in the interior of kaons and all other heavier hadrons, space becomes smaller and time flows faster than in the exterior.* In fact, the basic units of space and time following experimental fits (2.6) are given by:

$$\hat{1} = \text{Diag.}\,(\hat{1}_{space}, \hat{1}_t), \tag{2.9a}$$

$$\hat{1}_{space} = \text{Diag.}\,(1.001, 1.001, 1.001),\ \hat{1}_{time} = 0.9980. \tag{2.9b}$$

Since invariants have the structure (Sections II-6.5):

$$\text{Invariants} = (\text{Length})^2 \times (\text{Unit})^2, \tag{2.10}$$

it is evident that the increase (decrease) of a unit implies the decrease (increase) of the related length.

As an incidental note, the above features have stimulated the formulation of the so-called *geometrical propulsion*, in which objects can move following a local change of the geometry without the application of any force visible to the outside, thus permitting arbitrary speeds for an outside observer (see Vol. II of monographs [3e] for brevity). Rather remarkably, *features 1) to 7) are verified by all subsequent experiments*, as we shall see.

A few comments are now in order. I should first indicate that the measurements by Grossman *et al.* [15b] have been the subject of rather severe criticisms. To begin, the experimenters have made the *theoretical* assumption in the data elaboration of a frame in which there is no CP violation, in which case it is known that there cannot be Minkowskian anomalies, as shown by D. Y. Kim [13c] and others. Moreover, the statistics of tests [15b] are insufficient for any conclusion, whether in

favor or against orthodox doctrines. Additional flaws of tests [15b] have been identified by Yu. Arestov *et al.* [15d].

I would like also to stress that *the deviations from the Minkowskian geometry do not constitute a violation of the fundamental Lorentz symmetry and of Einstein's special relativity.* This is due to the fact that the isotopies reconstruct the Lorentz symmetry and special relativity as being *exact in isominkowskian space,* as reviewed in Section II-6.5.

This comment is recommendable because of erroneous beliefs in the literature due to lack of technical knowledge of the isospecial relativity, *e.g.,* the claim by H. B. Nielsen and I. Picek that their parameter α characterizes a "violation" of the Lorentz symmetry [12].

For instance, it is easy to see that *the maximal causal speed in isospace is* c_0 *and not* c. This is due to the fact that the lifting of the speed of light $c_0^2 \to c^2 = c_0^2/n_4^2$ occurs jointly with the *inverse* lifting of the unit $1 \to n^\circ{}_4^2$. In view of invariant (2.10), it is then evident that the maximal causal speed in isospace remains c_0. The *exact* reconstruction of *all* other features of special relativity then follows [9c].

In short, rather than violating special relativity, *the mathematical, theoretical and experimental studies presented in these papers extend the applicability of the special relativity from the vacuum to universal conditions.* A *necessary* requirement to achieve this result is the use of the isomathematics.

The reader should also be aware that the exact fits of Figures 2 and 3 were simply unavoidable, due to the direct universality of Santilli's isominkowskian geometry for the representation of all infinitely possible, signature preserving deviations from the Minkowskian form.

Finally, I would like to mention that numerous other deformations of the Minkowski spacetime exist in the literature, *e.g.,* papers [17]. Besides lacking a direct experimental verification comparable to the above ones, these models are afflicted by the catastrophic physical inconsistencies of Section II-4.

2.6. Experimental Verification Via Data on the Bose-Einstein Correlation

The fundamental assumption of hadronic mechanics is that strong interactions have a *nonlocal* component of contact, thus nonpotential type due to deep wave-overlappings which, as such, has to be represented with anything *except* the Hamiltonian (to prevent granting potential energy to interactions that have none, a rather common nonsense in the orthodox physics, because the latter can only represent reality with H).

The most fundamental experiments are, therefore, those testing directly the nonlocality of the strong interactions.

Among them, the most important tests are those on the *Bose-Einstein correlation* in which: 1) protons and antiprotons are made to collide at very big or very small energies; 2) in so doing they annihilate each other in a region called the *fireball* and then decay into a large variety of unstable particles; and 3) the latter decay in various modes whose final stages are given by correlated mesons (*i.e.,* very loosely speaking, mesons which are "in phase" despite the large mutual distances).

It is well-known in the literature that *the Bose-Einstein correlation cannot occur for purely local theories,* that is, theories dealing with a finite set of isolated point-like particles.

Lesser known, in general, (although well-known to experts in the field as I can testify) is the fact that *the notion of correlation violates the axiom of expectation values of quantum mechanics.*

For initial $|a_k>$ and final $|b_k>$ multi-states, said axiom can only yield *diagonal* expressions of the type:

$$< A > = < a_k | \times A \times | b_k > \ = \sum_k a_k \times A_{kk} \times b_k, \tag{2.11}$$

evidently because the quantity A, to be observable, must be Hermitean, thus diagonal.

On the contrary, a scientific representation of the Bose-Einstein correlation, requires *off-diagonal terms* mixing $<a_i|$ with $|b_i>$, $i \neq j$, which are evidently impossible for quantum mechanics.

In summary, the Bose-Einstein correlation is conceptually, technically, and (as we shall see shortly) experimentally outside the axioms of quantum mechanics.

Despite that, the literature in the Bose-Einstein correlations continues to claim "verification" of relativistic quantum mechanics (see, *e.g.*, review [18a] and numerous papers quoted therein). This is achieved via manipulations of the equations (also adopted in similar manipulatory cases) via: a) the introduction of all needed parameters of unknown origin; b) using these parameters to fit the experimental data; and c) then claiming verification of the theory.

As a specific example, it is easy to prove that, under the exact validity of relativistic quantum mechanics (including its crucial axiom of expectation values), the quantity measured in the experiments (called the *two-particle correlation functions*) can only have the form:

$$C_2 = N \times (1 + e^{-r^2 \times Q^2}, \tag{2.12}$$

where: r is the radius of the fireball, Q is the relative four momentum, and N is a constant restricted by severe renormalization conditions.

The point is that, as well-known, *expression (2.12) does not represent correctly the experimental data, thus confirming the insufficiency of relativistic quantum mechanics.*

To salvage their beloved theory, orthodox physicists then introduce as many unknown parameters λ_k (called *chaoticity parameters*) as needed to fit the experimental data, and modify the rigorous formula (2.12) into the manipulated form (see, *e.g.*, papers [18]):

$$C_2 = N (1 + \lambda_1 \times e^{-r_1^2 \times Q}{}_+ \lambda_2 \times e^{-r_2^2 \times Q^2} + \lambda_3 \times e^{-r_3^2 \times Q^2} + \lambda_4 \times e^{-r_4^2 \times Q}). \tag{2.13}$$

It is evident that, under these manipulations, formula (2.13) does fit the experimental data. However, the claim that in so doing quantum mechanics is verified is scientific deception. In fact, the parameters λ_k are a measure precisely of the *deviation* of the Bose-Einstein correlation from the main axioms of the theory.

The first exact and invariant representation of the Bose-Einstein correlation via unadulterated first axioms of relativistic hadronic mechanics was done in 1992 by R. M. Santilli in memoir [19a]. Due to the importance of the issue for new energies, a brief outline of the derivation appears recommendable.

First, the basic axiom of isoexpectation values, Equation (II-6.4.5), has been *conceived* for the Bose-Einstein correlation. In fact, it easily resolves the basic insufficiency of (2.11) with the broader structure:

$$< \hat{A} > = < \hat{a} | \hat{\times} A \hat{\times} | \hat{b} > = < \hat{a}_i | \times \hat{T} \times A \times \hat{T} \times | \hat{b}_j > =$$

$$= \sum_{ijm} \hat{a}_i \times \hat{T}_{im} \times A_{mm} \times \hat{T}_{mj} \times \hat{b}_j, \tag{2.14}$$

because, unlike observables, the isotopic element $\hat{T}$ can indeed be *nondiagonal*. This yields, by conception, all off-diagonal terms needed to represent the Bose-Einstein correlation from first axioms without ad hoc adulterations.

In memoir [19a] Santilli then uses isominkowskian space (2.2) characterized by the following isotopic element for the two-particle correlation function (Equation (8.10 of [19a]):

$$\hat{T} = \text{Diag.} (b^\circ_1{}^2, b^\circ_2{}^2, b^\circ_3{}^2, b^\circ_4{}^2) \times$$

$$\times \begin{pmatrix} A & B [1 - \exp\{ \int dx^4 \hat{\psi}_{b2}(x)^\dagger \times \hat{\psi}_{a1}(x)\}] \\ C[1 - \exp\{\int dx^4 \times \hat{\psi}_{a2}(x)^\dagger \times \hat{\psi}_{b1}(x)\}] & D \end{pmatrix}. \tag{2.15}$$

where: $b^\circ_k{}^2 = 1/n^\circ_k{}^2$ represent the semiaxes of the fireball normalized to 1 for the vacuum; $b^\circ_4{}^2 =$

$1/n^{\circ}_4{}^2$ represents the density of the fireball also normalized to 1 for the vacuum), and the quantities A, B, C, D are restricted by the normalization Det. $\hat{T} = 1$, so that they have no impact on the fit.

As one can see, isotopic element (2.15) does indeed represent the overlapping of the wavepackets of particles 1 and 2 (via the integrals in the exponents). Also, the representation is such that, when the overlapping is null, the isotopic element becomes diagonal, and all correlations disappear. This confirms the *necessity* (rather than the validity alone) of the axiom of isoexpectation values.

After elaborations conducted in detail in memoir [19a], the final two-particle isocorrelation function derived from first axiomatic principles of relativistic hadronic mechanics has the structure (first derived in Equation (10.8), page 122 of [19a]):

$$\hat{C}_2 = 1 + (K/3)\times\sum_{\mu}\hat{n}_{\mu\mu}\times e^{-q_t/b^{\circ}\mu}{}^2 = 1 + (K/3)\times(b^{\circ}_1{}^2\times e^{-q_t/b^{\circ}1}{}^2 + b^{\circ}_2{}^2\times e^{-q_t/b^{\circ}2}{}^{2+} + b^{\circ}_3{}^2\times e^{-q_t/b^{\circ}3}{}^2 - b^{\circ}_4{}^2\times e^{-q_t/b^{\circ}4}{}^2), \tag{2.16}$$

where q_t is the experimentally measured momentum transfer, under the isonormalization:

$$K = b^{\circ}_1{}^2 + b^{\circ}_1{}^2 + b^{\circ}_3{}^2 = 3, \tag{2.17}$$

and consequential upper and lower limits (Equation (10.26), page 127 of [19a]):

$$\hat{C}_2{}^{Max} = 1 + 1/3 + 1/3 + 1/3 = 1.67, \quad \hat{C}_2{}^{Min} = 1. \tag{2.18}$$

Representation (2.16) also predicts the upper value of $n^{\circ}_4 = 1/b^{\circ}_4$ evidently for $\hat{C}_2{}^{Max} = 1.67$ (Equation (10.27), page 127 of [19a]):

$$n^{\circ}_4{}^2 = 0.429, \quad b^{\circ}_4{}^2 = 2.33, \quad b^{\circ}_4 = 1.53, \tag{2.19}$$

thus implying again *local speeds in the interior of the fireball bigger than that of light in vacuum.*

Representation (2.16) also predicts that the fireball is a very prolate spheroidal ellipsoid with characteristic values (Equations (10.26), page 127 of [19a]):

$$n^{\circ}_1 = n^{\circ}_2 \ll n^{\circ}_3{}^2, n^{\circ}_S = (n^{\circ}_1 + n^{\circ}_2 + n^{\circ}_3)/3 > n^{\circ}_4 < 1. \tag{2.20}$$

Finally, I should stress that, being constructed via an isotopic theory, representation (2.16) preserves the *exact validity of the Poincaré symmetry under nonlocal interactions*, although expressed as the covering Poincaré-Santilli isosymmetry [11,12].

It is rewarding for me to report that *the fit of the experimental data on the Bose-Einstein correlation at high energy with the data of the UA1 experiments at CERN have confirmed the totality of the above predictions beyond my most optimistic expectations.*

The fit was conducted by F. Cardone and R. Mignani (of the University of Rome, Italy), was first referred to me in 1992 via a private communication (Figure 4), and was then published in paper [19b] of 1996. The Cardone-Mignani fit provided the following numerical values of the characteristics constants for the $p-\bar{p}$ fireball:

$$b^{\circ}_1 = 0.267 \pm 0.054, b^{\circ}_2 = 0.437 \pm 0.035, \tag{2.21a}$$

$$b^{\circ}_3 = 1.661 \pm 0.021, \ b^{\circ}_4 = 1.653 \pm -0.015. \tag{2.21b}$$

As one can see, *the fit of Figure 4 provides the fourth direct experimental verification of the isominkowskian geometry and relativistic hadronic mechanics, this time, in its most fundamental assumption, the historical legacy of the nonlocality of strong interactions.*

The fit of Figure 4 also confirms all features 1)-7) of the preceding section.

I should mention that paper [19c] identifies the new upper limit of the isocorrelation function (2.16) (not treated in [19a]):

$$C_2^{Max} = 1 + 1 + 1 + - 1 = 3, \tag{2.22}$$

thus permitting the theoretical representation of anomalous upper limits of the order of 3 detected in [18c] and other papers.

This constitutes additional, rather strong experimental support for the isominkowskian geometry and related relativistic hadronic mechanics because of the absolute impossibility for conventional quantum mechanics to reach such anomalous value.

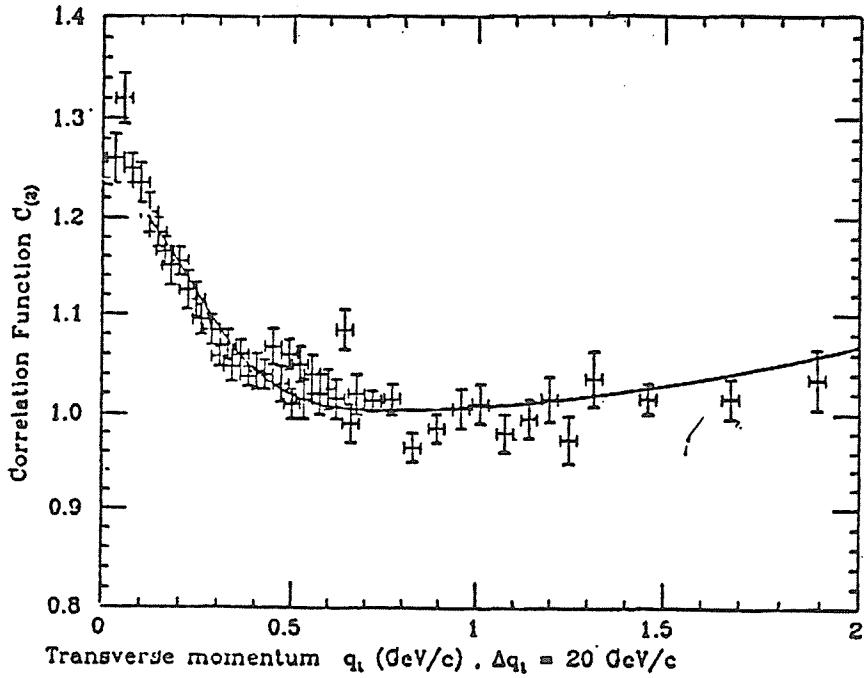


FIGURE 4: The exact fit of Santilli's two-point isocorrelation function (2.16) at high energy conducted by F. Cardone and R. Mignani (private communication of 1992 subsequently published in [19b]) via the experimental data on the Bose-Einstein correlation at high energy of the UA1 experiments at CERN.

Finally, numerical values (2.21) will soon result to be fundamental for the construction of a new structure model of neutron as a hadronic bound state of a proton and an electron.

The repetition of the study and related fit for the Bose-Einstein correlation of proton-antiproton at low energy (here omitted for brevity) confirms the above results (Figure 5).

It is evident that *the exact fit of Figure 5 provides the fifth direct experimental verification of the isominkowskian geometry and relativistic hadronic mechanics for the characterization of interior problems at large.*

In closing, I should point out that, unlike preceding papers listed in [II-22,II-24,III-16,III-25], and other papers, F. Cardone, M. Gasperini, and R. Mignani elected in papers [19b,19c] of 1996 and 1998 to abstain from quoting the preceding relativistic hadronic treatment [19a] of 1992, which was fully known to them, since Cardone and Mignani had provided its best fit in 1992 (Figure 4).

However, the main equations of [19b,19c] are *totally identical* to Equations (2.14) to (2.18) of [19a] even in the symbols, as the reader is encouraged to verify. Moreover, Cardone, Gasperini and Mignani elected to use in [19b,19c] a "deformed Minkowski space" which is *identical* to Santilli's space (2.2) even in the symbols, although without the quotation of its origination in [9b], as well-known to them as well as internationally.

To give the impression of novelty, in papers [19b,19c] Cardone, Gasperini and Mignani defined the formalism over ordinary fields, and elaborated the results via conventional functions and transform, by therefore abstaining from using the formulation of the original studies [9b,19a] via the full isomathematics (isofields, isospaces, isofunctions, etc.).

However, in so doing, *papers [19b,19c] are afflicted by the catastrophic inconsistencies of Section II-4 (lack of invariant units of measurements, absence of observables, lack of unique and invariant numerical results, violation of causality and probability laws, etc.) which are instead resolved ab initio by the prior unquoted studies [9b,19a].*

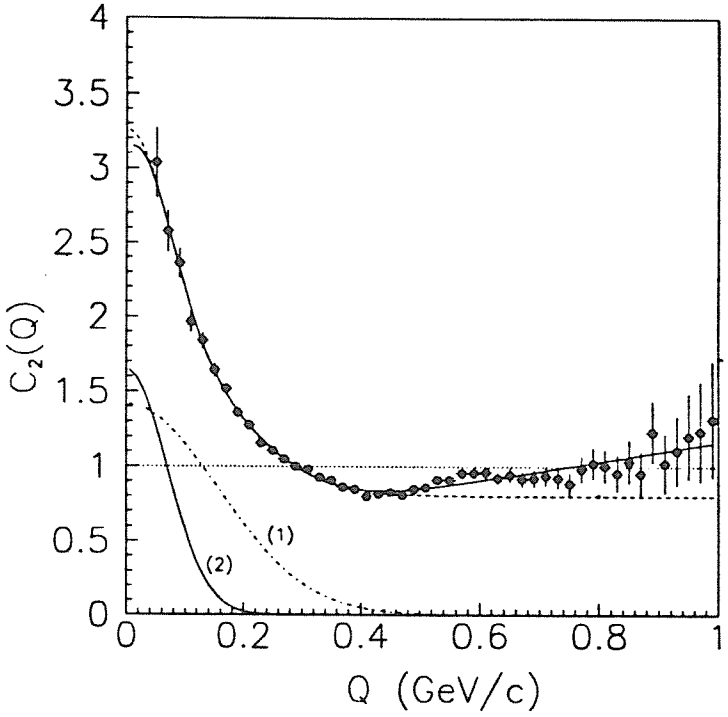


FIGURE 5: An illustration from [18c] of another exact fit of the Bose-Einstein correlation from first axiomatic principles, this time of the $p-\bar{p}$ annihilation at very low energies, which can be obtained via the exact Equation (2.16) of relativistic hadronic mechanics, rather than adulteration (2.13) of relativistic quantum mechanics.

2.7. Experimental Verifications in Gravitation and Grand Unified Theories

In Paper I, Section 3.3, I have outlined a number of serious structural inconsistencies of Einstein's conception of gravitation, which have accumulated in the literature of this century, such as:

1) The lack of invariant units of length, energy, time, etc., thus preventing any scientifically meaningful verification of the theory with experiments (because all Riemannian representations of gravity are characterized by *noncanonical time evolutions*, which do not conserve units by their very definition);

2) Prediction of gravitational attraction double the experimentally detected one (one for curvature, and one for Newtonian attraction, e.,g.,. as existing for bodies in free fall along straight radial line, in which there is no curvature);

3) Incompatibility of the general relativity with the special (because of the historical lack of a *relativistic* limit of Einstein's gravitation, all limits being Euclidean; the proved inability of gravitational total conservation laws to recover the relativistic ones; and other inconsistencies);

4) Irreconcilable incompatibility of Einstein's gravitation with electrodynamics (because the

mass of all elementary particles has a primary electromagnetic origin, which implies the existence of a large non-null energy-momentum tensor in the exterior gravitational problem in vacuum, in irreconcilable disagreement with Einstein's primary assumption that gravity in vacuum has no source, and is solely characterized by curvature);

5) Catastrophic inconsistencies in any possible operator formulation of gravity (e.g., because the time evolution is necessarily nonunitary, thus implying the catastrophic inconsistencies of Section II-4, plus a host of other major structural inconsistencies and disagreements with experimental evidence); and other flaws.

In view of these inconsistencies, Santilli [30a] proposed the novel *iso-Minkowskian formulation of gravitation*, which essentially consists of:

I) Factorization of any Riemannian metric g(x) in spacetime with coordinates $x = \{x^\mu\}$, $\mu = 1, 2, 3, 4$, into the Minkowskian metric η multiplied by a four-by-four matrix:

$$g(x) = \hat{T}_{gr}(x) \times \eta = \hat{\eta}(x), \qquad \eta = \text{Diag.}\,(1, 1, 1, -1); \tag{2.23}$$

II) The interpretation of $\hat{\eta}(x)$ as the *isometric* of an iso-Minkowskian space; and

III) The lifting of the trivial unit I = Diag. (1, 1, 1, 1) of the Minkowskian geometry in the *gravitational isounit:*

$$\hat{1}_{gr}(x) = 1 / \hat{T}_{gr}(x), \tag{2.24}$$

the construction of the resulting *iso-Minkowskian geometry* on isofields with isounit (2.24), with related machinery (Christoffel's symbols, covariant derivative, etc.) [9c], and related formulation of gravity.

Detailed studies conducted in Refs. [9,10,30], as well as by independent authors (see, e.g., Kadeisvili's monograph [12c], and references quoted therein), have indicate the apparent resolution by the above assumptions I), II), and III) of all known inconsistencies of Einstein's gravitation.

The guiding ideas has been the *elimination of curvature, as permitted by the isotopies, while preserving conventional field equations.* It is now clear that the ultimate origin of the inconsistencies of Einstein's gravitation rests in the curvature itself (in fact, curvature implies a noncanonical time evolution, doubling of the gravitational attraction, and all other inconsistencies).

The iso-Minkowskian reformulation of gravity was conceived precisely to eliminate curvature. If the metric $\hat{\eta}(x) = \hat{T}_{gr}(x) \times \eta$ is defined with respect to the conventional unit I, then it characterizes the conventional Riemannian curvature. However, if the same metric $\hat{\eta}(x) = \hat{T}_{gr}(x) \times \eta$ is defined with respect to a generalized unit is the inverse of the gravitational element $\hat{T}_{gr}(x)$, Eq. (2.24), then curvature is eliminated on geometric grounds, because the modification of η by $\hat{T}_{gr}(x)$ is entirely compensated by its inverse $\hat{1}_{gr} = 1/\hat{T}_{gr}(x)$ (a new geometric notion called *isocurvature* [9c]).

The first consequence is *the achievement of the first known theory of gravitation verifying an exact symmetry, the Poincaré-Santilli isosymmetry* [10] (rather than the verification of the current covariance). A resolution of the indicated inconsistencies then follows, e.g.:

1) The time evolution of iso-Minkowskian gravity is isocanonical, thus preserving the generalized unit (2.24) by conception and construction;

2) Since curvature is no longer the origin of gravitation, double predictions of attractions are eliminated;

3) Special and general relativities are unified, and merely differentiated by the assumed unit, thus avoiding current incompatibilities (e.g., the compatibility of total conservation laws for relativistic and gravitational treatments is established by the fact that the generators of the related symmetries are the same);

4) Since curvature does not represent gravitation, iso-Minkowskian gravity admits a source in vacuum, thus achieving compatibility with electrodynamics;

4) Iso-Minkowskian gravity admits a fully consistent operator formulation, which is given by relativistic hadronic mechanics, as presented in Paper II, and only referred to isounit (2.24).

Other advances then follow. For instance, the singularities of the isounit and of the

isotopic elements (or, equivalently, the zeros of the isotopic element and the isounit):

$$\hat{1} \to 0, \quad \hat{T} \to \infty, \quad \text{or} \quad \hat{1} \to \infty, \quad \hat{T} \to 0, \tag{2.25}$$

represent gravitational collapse. This can be easily proved by submitting Schwarzschild's metric to isotopic decomposition $g(x) = \hat{T}_{gr}(x) \times \eta$. Eqs. (2.25) then follow for the gravitational horizon and singularities, respectively.

By combining all the preceding advances, the most important application of Santilli's isospecial relativity has been the construction of the only known consistent grand unification of all interactions, called *Iso-Grand-Unification,* which includes electroweak interactions for matter and antimatter, and gravity for matter and antimatter at both the classical and operator level. The new Iso-Grand-Unification was first presented at the VIII M. Grossmann Meeting on General Relativity held in June 1977 in Jerusalem, (see the proceedings) and also published in Ref. [30b].

The above grand unification has made possible by the embedding of gravity for matter in the *unit* of unified gauge theories with its isodual image for antimatter. The resulting iso-grand-unification has far reaching implications. In fact, *all the results of these papers, including those at the particle, nuclear, and molecules levels, are a direct consequence of Iso-Grand-Unification.*

I regret the inability to present new clean energies and fuels from this ultimate, and most rigorous possible profile, because the technical level of the presentation would grossly surpass the intended audience. Nevertheless, readers of these papers can easily understand the main hypothesis of the Iso-Grand-Unification [30], namely, that *gravitation was already present in existing unified theories of electroweak interactions; it only existed where nobody looked for: in the unit.*

All new clean energies and fuels presented in these papers can be uniquely and unambiguously derived form exactly the same ultimate geometric principle: the generalization of the unit. This main assumption explains the reasons why they *cannot* be identified by conventional theories, implies the consistency and invariance of the theory, and assures the verification of all conventional laws.

2.8. Experimental Verifications in Astrophysics

It is important for researchers in new energy to know that the iso-Minkowskian geometry, isorelativistic mechanics, and isospecial relativity possess a number of additional verifications in fields other than particle physics. In this section I outline the verifications in astrophysics and cosmology, while experimental verifications in nuclear physics, superconductivity, and chemistry will be outlined in the subsequent Papers IV and V.

One of the unsolved mysteries of contemporary astrophysics is the confirmation by Sulentic [31c] in 1983 of Arp's hypothesis (see Ref. [31a] for the history and comprehensive literature) that certain quasars are physically connected to associated galaxies, even though they have dramatic differences in cosmological redshifts (Figure 6).

The Einsteinian treatment of cosmological redshift requires its interpretation via motion in vacuum away from us, resulting in the known expansion of the universe. However, the evidence that quasars and galaxies with dramatically different redshifts are physically connected, thus move with the *same* speed, evidently prevents any scientific representation via Einsteinian theories, whether in Minkowski or Riemannian spaces.

Numerous interpretations of the above anomalous occurrence have been attempted, such as Arp's suggestive hypothesis that the difference in cosmological redshift is due to *creation of matter* within the quasars [31b]. However, none of them has acquired the necessary verifications for scientific credibility.

In 1991, Santilli [3d] proposed the simplest possible explanation according to which the indicated difference in cosmological redshifts is merely due to the *slow-down of the speed of light in the huge quasar chromospheres* (which can be as large as entire galaxies), similar to the slow-

down of the speed of light in our atmosphere. As a result, *light exits said quasars chromospheres already redshifted.* A similar phenomena does not exist in the same magnitudes for a galaxy because their stars are isolated in space, and have dramatically smaller chromospheres. In this way, light from physically connected quasars and galaxies having the same expansion speed from us can reach us with a dramatically different redshifts.

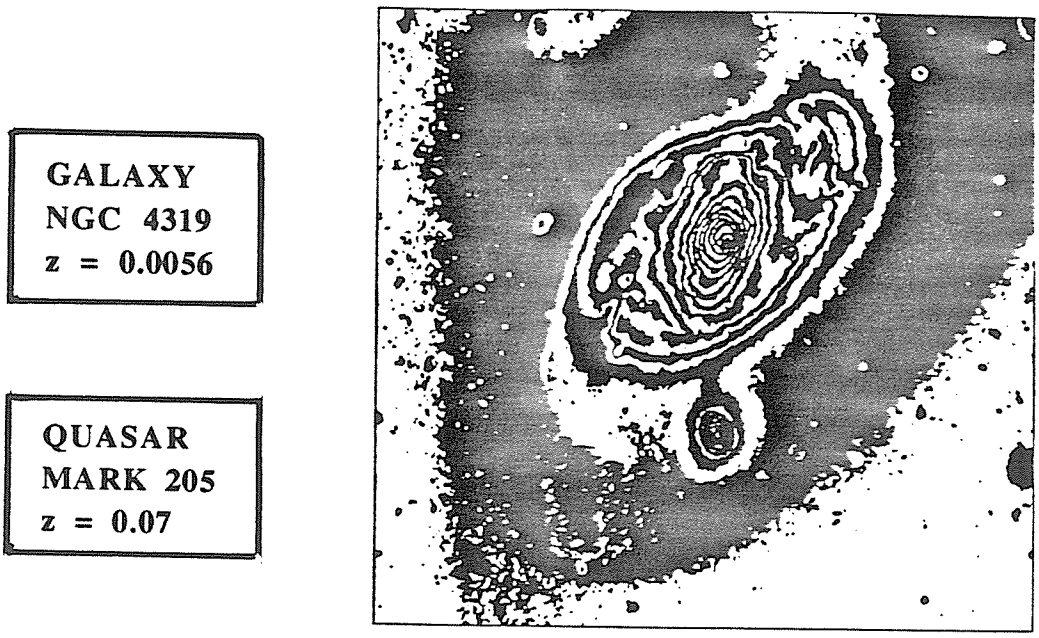


FIGURE 6: An example of clear evidence of astrophysical conditions beyond the capabilities of Einstein's special and general relativities (or, equivalently, beyond the Minkowskian and Riemannian geometries): the physical connection between the galaxy NGC 4319 and the quasar Mark 205, first predicted by Arp [31a], and experimentally verified by Sulentic in 1983 [31b] via the superposition of several gamma spectroscopic plates. Despite the above physical connection, the quasar Mark 205 has a redshift with z = 0.07, while the associated galaxy NCG 4316 has a redshift of only z = 0.0056. The interpretation of this difference requires necessary departures from the Minkowskian and Riemannian geometries because said difference would require that the quasar has at least 10^4 times the speed of the galax, under which conditions the quasar and its associated galaxies would have separated completely billions of years ago. Santilli's iso-Minkowskian geometry permits an exact-numerical representation of the indicated large difference in cosmological redshifts, while restoring the abstract Minkowskian axioms on isospaces over isofields.

The effect can be first read-off in the expansion of the Minkowskian redshift (here presented for simplicity for the case of null aberration):

$$\omega = \omega_0 \times \frac{(1 - v/c_0)}{(1-v^2/c_0^2)^{-1/2}} \approx \omega_0 \times [1 - v/c_0 + \tfrac{1}{2}(v/c_0)^2 + \dots). \qquad (2.26)$$

Since $v \ll c_0$, it evident that a *decrease* of c_0 will imply an *increase* of the redshift.

It was shown in [3d] that the above equation is insufficient to represent astrophysical evidence, *e.g.*, because chromospheres are *anisotropic and inhomogeneous*, while the geometry underlying law (2.23) is purely *isotropic and homogeneous*.

By using Isopostulate IV of isospecial relativity (Paper II, Section 7), Santilli [*loc. cit.*] suggested the following *isodoppler law for the cosmological redshift:*

$$\hat{\omega} = \omega_o \frac{1 - (v / c_o)(n_4 / n_s)\cos(a\, b_s^2)}{[1 - v^k (1/n_k)^2 v^k / c_o (1/n_4)^2 c_o]^{1/2}} \approx$$

$$\approx \omega_o [1 - \beta (n_4 / n_s) + \tfrac{1}{2} \beta^2 (n_4 / n_s)^2 + ...] \qquad (2.27)$$

which predicts an additional contribution in the redshift due to the anisotropy and inhomogeneity of quasar chromospheres.

In 1992, R. Mignani [16c] provided a verification of Santilli's Isopostulate IV and related isodoppler law by identifying the following parameters of most coupled quasars-galaxies (Table I):

$$K^\circ = \frac{b^\circ_s}{b^\circ_4} = \frac{(\Delta\omega + 1)^2 - 1}{(\Delta\omega + 1)^2 + 1} \times \frac{(\Delta\hat{\omega} + 1)^2 - 1}{(\Delta\hat{\omega} + 1)^2 + 1}, \qquad (2.28)$$

where $\Delta\omega$ represents the measured Einsteinian redshift for galaxies, and $\Delta\hat{\omega}$ represents the isotopic redshift for quasars according to law (2.24).

GAL.	ω'_1	QUASAR	B	$\hat{\omega}_2$
NGC	0.018	UB1	31.91	0.91
		BSOI	20.25	1.46
NGC 470	0.009	68	87.98	1.88
		68D	67.21	1.53
NGC 1073	0.004	BSO1	198.94	1.94
		BSO2	109.98	0.60
		RSO	176.73	1.40
NGC 3842	0.020	QSO1	14.51	0.34
		QSO2	29.75	0.95
		QSO3	41.85	2.20
NGC 4319	0.0056	MARK205	12.14	0.07
NGC 3067	0.0049	3C232	82.17	0.53

TABLE I: A summary of Mignani's data [16c] verifying Santilli's isospecial relativity for cosmological redshifts of physically connected quasars and galaxies.

It is evident that the data of Table I provide another experimental verification of the iso-Minkowskian geometry and isospecial relativity.

Yet another experimental confirmation is given by the quantitative-numerical representation [16d] of the internal red-, and blue-shift of quasars, which is permitted by the ω-dependence of the n's (se Figure 7).

These studies predict that *one component* (but not all) of the tendency toward the red of Sunlight at Sunset and Sunrise is precisely of isotopic origin. In fact, at Sunset the Earth's rotation

simulated precisely motion away from the source. This results in a *necessary* redshift in an amount which is measurable with current technology (see [3d] for brevity).

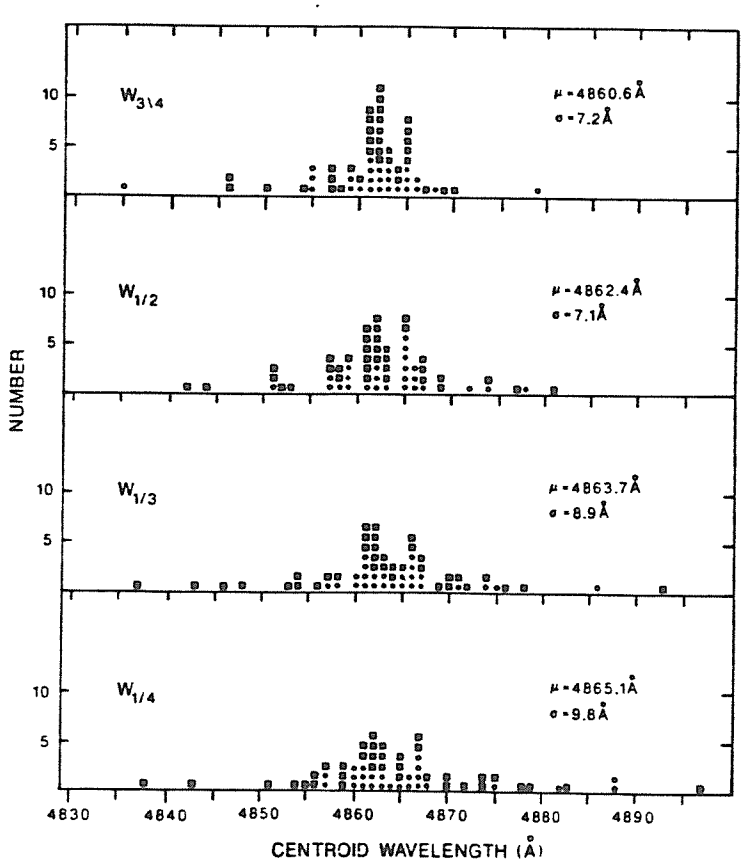


FIGURE 7: A schematic view of Sulentic's [31c] discovery of the *internal red- and blue-shift* of quasars, that is, the decrease or increase of the cosmological redshift of quasars with corresponding variations of the light frequency. The latter occurrence is a final experimental confirmation of the validity of Santilli's iso-Minkowskian geometry for quantitative representations of cosmological redshifts. In fact, the evidence establishes a dependence of the redshift with the frequency, which is precisely evidence of propagation of light within physical media. The iso-Minkowskian geometry then applies, e.g., because of its direct universality for interior conditions.

The prediction recommended for verification in Section 5 is the existence of an additional measurable component of redshift at Sunset due to the anisotropy and inhomogeneity of our atmosphere (see Figure II-3). The visibly bigger redshift at Sunset as compared to that at Sunrise is then due to the rotation of Earth, which increases the redshift at Subset, while decreasing it at Sunrise.

2.9. Experimental Verifications in Cosmology

Additional applications and experimental verifications of the isospecial relativity exist in cosmology, such as the elimination of the need for the "missing mass".

A study conducted in [16e] has revealed that the conjecture of the "missing mass" is due to

the rather simplistic belief that the density of the universe is that of the vacuum. In this case the average index of refraction of the universe is $n^\circ_4 = 1/b^\circ_4 = 1$, the average speed is c_o, and the total energy of the universe is $E_{tot} = m_{tot} \times c_o^2$, which is insufficient to represent various astrophysical data.

However, incontrovertible evidence establishes that *the average density of the universe is bigger than that of vacuum,i.e.*, $n^\circ_4 \neq 1$, evidently because of the large number of galaxies and quasars. Moreover, all experimental evidence outlined in this section establishes that the average index of refraction of the universe is *bigger than one*, $n^\circ_4 = 1/b^\circ_4 > 1$, because of the hyperdense media in the interior of stars and quasars.

Therefore, isospecial relativity computes the total energy of the universe according to Isopostulate V of Paper II, Section 7, $\hat{E}_{tot} = m_{tot} \times c^2 = m_{tot} \times c_o^2 / n^\circ_4{}^2 = m_{tot} \times c_o^2 \times b^\circ_4{}^2 > E_{tot}$. The "missing mass" is then merely due to the difference of the two values [16e]:

$$\text{"missing mass"} = m_{tot} \times (b^\circ_4{}^2 - 1). \tag{2.29}$$

Equally intriguing is the new cosmology permitted by the isospecial relativity for matter and its isodual for antimatter [16e], called *isoselfdual cosmology* (because it is invariant under isoduality), which implies:

1) The first cosmology characterized by a *universal symmetry* (rather than the current covariance), given by the tensor product of the Poincaré–Santilli isosymmetry for matter and its isodual for antimatter;

2) Equal amounts of matter and antimatter in the universe (as a limit case, which can be relaxed with various means);

3) Emission by antimatter of a new photon, called *the isodual photon*, which can be experimentally distinguished from the photon emitted by matter, thus permitting, for the first time in astrophysics and cosmology, the future resolution whether a far away galaxy or quasar is made up of matter or of antimatter;

4) Elimination of the "missing mass" and other shortcoming due to the inconsistencies of Einstein's gravity;

5) Locally variable time for matter, and, separately, for antimatter (because the isounit of time depends on the mass, thus implying that astrophysical bodies with different masses have different times in a novel way);

6) Identically null total values of time, energy, angular momentum, etc. (because the values for matter are equal and opposite to those for antimatter), thus having no discontinuity at the time of creation.

7) Elimination of the discontinuities at creation of the universe (as occurring for the big bang theory)(, thus permitting the first mathematical study of the creation itself.

For brevity, I refer the interested reader to the specialized literature for these and other verifications of the isospecial relativity in astrophysics and cosmology.

In conclusion, the experimental verifications of isospecial relativity, iso-Minkowskian geometry, and the Poincaré–Santilli isosymmetry in particle physics, astrophysics, and cosmology, are sufficiently diversified to provide all the necessary credibility for applications.

Due to widespread plagiarisms existing in the contemporary physics literature, I have copyrighted various publications in the experimental verifications of hadronic mechanics outlined in this section, and I intend to defend such copyrights in any means permitted by law.

The content of this section can be used in part or in full by anybody for any scientific purpose without any prior authorization, provided that: 1) The original publications identified in this section are quoted; 2) The main results of the quoted publications are outlined as a prerequisite for allegations of novelty; and 3) Paternities are identified with clarity.

3. THE NEW STRUCTURE MODEL OF HADRONS WITH PHYSICAL CONSTITUENTS

3.1. Statement of Objectives

During my entire research life I have always considered *physical particles* to be particles which can be rigorously defined in our *spacetime* as unitary irreducible representations of the Poincaré group.

In Paper I, therefore, I stressed that *quarks are not physical particles* because they simply cannot be defined in our spacetime, being solely definable in the mathematical unitary space of the SU(3) symmetry with no known connection to our spacetime (due to the O'Raifearthaigh theorem).

As stated in the original proposal [3a] of 1978 (and treated in detail in the subsequent works [3b-3f]), *hadronic mechanics has been conceived and built for the primary purpose of identifying the constituents of all unstable hadrons with physical particles generally given by ordinary massive particles produced free in the spontaneous decays with the lowest mode (tunnel effect of the constituents).*

The main objective [3a] is, therefore, that of achieving novel structure models for: the neutron as a hadronic bound state of one proton and one electron according to the historical legacy of Rutherford reviewed in the next subsection, in view of the only decay mode:

$$n \rightarrow p^+ + e^- + \bar{\nu}; \tag{3.1}$$

the π° meson, as a bound state of one electron and one positron, in view of its lowest decay mode:

$$\pi^\circ \rightarrow e^+ + e^-; \tag{3.2}$$

the $\pi^\pm$ mesons, as hadronic bound state of e^+, $e^\pm$, e^-, where $e^\pm$ is a joint symbol for both the electron e^- and the positron e^+, in view of decay mode:

$$\Pi^\pm \rightarrow e^+ + e^\pm + e^-; \quad \text{etc.} \tag{3.3}$$

It is at this point that an invariant generalization of quantum mechanics becomes *mandatory*. In fact, the indicated models are not even remotely possible with quantum mechanics, due to a host of inconsistencies identified later in this section.

On the contrary, the same models are fully permitted and quantitatively treatable by hadronic mechanics to yield *exact* representations of *all* characteristics of the particles considered on an *individual basis*.

By comparison, the conjecture that quarks are physical constituents of hadrons permits the representation of only *some* of said characteristics of hadrons, and only when assembled in SU(3)-*families*, rather than individually.

Note that hadrons shall be studied as isolated from the rest of the universe, thus verifying all known total conservation laws. In this context, I shall only consider the isotopic branch of hadronic mechanics, and ignore the broader geno- and hyper-branches.

In this and in the following papers, symbols such as p^+, $e^\pm$, n, π°, $\pi^\pm$, etc., are referred to *particles* as defined above (unitary irreducible representations of the Poincaré symmetry P(3.1) [4]). Symbols such as $\hat{p}^+$, $\hat{e}^\pm$, $\hat{n}$, $\hat{\pi}^\circ$, $\hat{\pi}^\pm$, etc., are referred instead to *isoparticles* defined in Section II-6.5 (isounitary irreducible representations of the Poincaré-Santilli isosymmetry $\hat{P}$(3.1)).

In particular, particles are referred to as those which can be experimentally *isolated* and *individually* detected when moving in vacuum under long-range electromagnetic interactions. Isoparticles are instead ordinary particles when in conditions of deep overlapping of wavepackets with other particles. The latter conditions cause additional nonpotential, nonhamiltonian, nonunitary effects represented precisely by the isotopy P(3.1) $\rightarrow$ $\hat{P}$(3.1) (Section II-2.6).

A main aspect of these papers (which is particularly important for new energies) is the following. Recall that *all interactions cause renormalizations of physical characteristics,* as is well established in particle physics.

The unitary interactions of conventional particles have resulted in the intrinsic characteristics of particles as tabulated, *e.g.,* by the Particle Data Group.

The important point is that *nonunitary interactions cause new renormalizations of the intrinsic characteristics of particles,* called *isorenormalizations.* The new structure models of hadrons with physical constituents are permitted precisely by these nonunitary renormalizations.

In other words, the lifting $P(3.1) \to \hat{P}(3.1)$ is far from being purely mathematical, because it alters the *intrinsic* characteristics of particles, called *mutations* [3a].

Since $\hat{P}(3.1)$ is isomorphic to $P(3.1)$, the new isorenormalizations simply cannot be dismissed without loss of credibility, and must be confronted with experimental evidence. Since the isosymmetry $\hat{P}(3.1)$ recovers $P(3.1)$ identically when particles return to move in vacuum, in the decay of hadrons, isoparticles reacquire conventional characteristics plus possible secondary effects, such as emission of photons or neutrinos.

The most fundamental aspect of this section is the understanding of the above differences between particles and isoparticles.

The ultimate physical foundation is given by the fact that the electron, when subjected in the core of a collapsing star to pressures beyond our imagination, cannot possibly be identical to the same electron when orbiting in vacuum around a nucleus. In fact, the extreme conditions here considered are expected to *mutate* all physical characteristics of the particles. When totally immersed inside a proton, the physical conditions experienced by the electrons are similar, due to the hyperdense character of the the proton. Similar occurrences hold for all particles.

The quantitative, consistent, and invariant representation of the mutation of particles in the transition from motion in vacuum to motion within hyperdense media is provided by nonrelativistic (relativistic) hadronic mechanics and related basic Galilei–Santilli (Poincaré–Santilli) isosymmetry.

The implications are such as to warrant serious studies. On scientific grounds, I am referring to the reduction permitted by hadronic mechanics of the contemporary vast zoo of particles to protons and electrons in various forms of bound states. On industrial grounds, I am referring to new clean forms of subnuclear energy and their applications, such as new means for stimulating the decay of highly radioactive nuclear waste (see Section 4).

3.2. The Forgotten Legacy of Rutherford

In 1920, E. Rutherford [20] conceived a new particle as a "compressed hydrogen atom," that is, as the electron entirely compressed inside the proton, and called it a *neutron.* In essence, Rutherford thought that, when the conventional hydrogen atom is in the core of an ordinary or collapsing star, it is "compressed" all the way to the size of the proton by the extremely high pressures existing there, thus resulting in a new neutral particle.

The *existence* of the neutron was established experimentally twelve years later by J. Chadwick [21] and it is now part of history. However, Rutherford's *conception* of the neutron as a bound state of a proton and an electron was dismissed by Heisenberg, Pauli, Schrödinger, and other founders of quantum mechanics because of numerous inconsistencies, such as: 1) The model would require a "positive binding energy" since the rest energy of the neutron (939.6 MeV) is *bigger* than the sum of the rest energies of the proton and the electron (938.8 MeV), which is anathema for quantum mechanics. 2) Both constituents have spin 1/2 and, as such, quantum mechanics prohibits them to characterize the spin 1/2 of the neutron; 3) Quantum mechanics also prohibits a representation of the magnetic moment of the neutron from those of the proton and electron; other inconsistencies also exist.

The above occurrence signaled a change of the direction of research in physics of clear historical proportions. In fact, up to that time, physics had been based on the solid foundation that

constituents of bound states have to be "physical," that is, they can be isolated and identified in laboratories.

The impossibility of representing the structure of the neutron with physical particles forced the physicists of the time to seek new structure models evidently *without* physical constituents.

In fact, Heisenberg proposed the SU(2)-isospin (see, *e.g.*, Ref. [4])which unified the proton and the neutron, although in the *mathematical* space of the unitary SU(2) symmetry.

The SU(3) symmetry for the classification of hadrons into families was then a natural extension. Equally consequential was the assumption that the (regular) *mathematical representations* of SU(3) called quarks are physical constituents of hadrons, by predicting in this way that mesons are composed of two quarks, and baryons are composed by three quarks.

Despite these developments, studies on the original Rutherford conception of the neutron have continued since its origination (for details and literature, see Volume III of [3e]).

In the 1970s I inspected several of these studies and found that they do not resolve all the historical objections by Heisenberg, Pauli and Schrödinger. More recent studies resolve some (but not all) objections, and, in addition, are afflicted by the catastrophic inconsistencies of Section II-4. This scenario suggested systematic studies via a new mechanics specifically built for that purpose.

As recalled earlier, hadronic mechanics was conceived and proposed in 1978 [3a] for a quantitative treatment of the historical open legacy of Rutherford. To indicate the feasibility of the objective, I presented the hadronic structure model $\pi^\circ = (\hat{e}^+, \hat{e}^-)_{HM}$ which, already in the first proposal of 1978, represented *all* characteristics of the π° particle (rest energy, charge, charge radius, meanlife, electric and magnetic moments, parity, and spontaneous decays).

It was not until 1990 that I achieved [22a] the nonrelativistic model $n = (p^+, \hat{e}^-)_{HM}$ via Rutherford's compression of the hydrogen atom:

$$p^+ + e^- \to n + \nu, \tag{3.4}$$

which, to my best knowledge, is capable of resolving *all* historical objections and also produce an exact and invariant representation of *all* characteristics of the neutron.

I subsequently reached the relativistic model of $n = (\hat{p}^+, \hat{e}^-)_{HM}$ in 1995 [22b]. The length of time elapsed in between the two models was due to the rather difficult problem of spin, which required the prior lifting of the SU(2) spin symmetry first reached in [22c] (see the subsequent studies [22d,22e]).

Once the total characteristics of the π° and n are represented via physical constituents, it is easy to extend the model to all remaining unstable hadrons, as we shall see.

The equation used by Heisenberg, Pauli, and Schrödinger to dismiss Rutherford's conception of the neutron is the traditional *Schrödinger equation for the hydrogen atom,* which can be written in relative coordinates (for $\hbar = 1$):

$$H \times \psi_n = [- \frac{1}{2m} \times p \times p - \frac{e^2}{r}) \phi_n (r) = E_n \times \phi_n(r), \tag{3.5a}$$

$$p_k \times \phi_n(r) = - i \partial_k \phi_n(r). \tag{3.5b}$$

I always accept the above equations as valid for the representation of the bound state of a proton and an electron *when moving in vacuum at large mutual distances* as in the hydrogen atom. However, I never accepted the same equations for the representation of the same particles when in the dramatically different conditions of moving one inside the other. As a consequence, I never accepted as valid the historical objections against Rutherford's legacy.

At any rate, the *industrial,* let alone scientific implications of Rutherford's legacy are so important to warrant serious studies, while keeping a distance from organized interests in physics.

Quantum mechanics can only represent both the proton and the electron as *point-like particles.* However, in the physical reality, both particles have extended wavepackets. Under Rutherford's short-range conditions, I simply cannot accept point-like representations of the

constituents.

I cannot equally accept quantum field theoretical extensions as sufficient to represent the extended character of particles via form factors, because the emerging shapes are known to be perfectly spherical and perfectly rigid (in order not to violate the Poincaré symmetry), while physical reality suggests the representation of hadrons as generally *extended, nonspherical, and deformable* (see the next Paper IV on nuclear physics), thus being outside any dream of representation via quantum mechanics and field theory.

Moreover, quantum mechanics only admits *action-at-a-distance interactions* derivable from a potential. These are indeed the sole possible interactions for the structure of the hydrogen atom. However, in Rutherford's conception of the neutron we have *the total immersion of the extended wavepackets of the electron within the hyperdense medium in the interior of the proton.*

Under the latter conditions there is the emergence of the additional *contact interactions* which, as such, have *zero range* and cannot possibly be represented via a Hamiltonian. As a result, quantum mechanics misses the very means for a scientific study of Rutherford's conception of the neutron.

Physicists with vested interest in current lines of research will immediately claim that "the problem does not exist" because solved by quark theories. I suggest researchers in new energies to keep a distance from these vested interests. Even ignoring the established fact that, when made up of quarks, the neutron *cannot* have gravity and is afflicted by other major inconsistencies, I cannot accept quark conjectures as being even remotely valid for Rutherford's historical case in view of the following additional reasons.

When treated with quark conjectures, the neutron cannot be considered alone, because it must be part of the *family* of baryons. However, stars at their initiation are notoriously formed by *hydrogen alone* (protons and electrons only). A scientifically credible representation of the neutron therefore requires the use of *only one baryon,* the proton, evidently because all the remaining baryons of the SU(3) multiplet do not exist as yet. Such an approach is impossible for quark conjectures, precisely because they were conceived for the *classification* of hadrons.

It is evident that Rutherford's legacy must be studied without any consideration of quark theories. Only after reaching the new structure model of hadrons we can study its compatibility with the SU(3) *classification* (but not the compatibility with quarks as physical particles).

The contemporary theory of *weak interactions* provides a good representation of the synthesis of the neutron via the known reaction (3.1). While I accept this description as valid for the *external* treatment, I cannot accept it as a *structural* description (evidently because it carries zero information on the structure of protons and neutrons).

Moreover, *according to weak interactions, the electron and the proton disappear at the time of the formation of the neutron.* This is another belief that I never did and never will accept, because the proton and the electrons are the most *stable* massive particles existing in the universe. I can certainly accept that they are altered (mutated in the language of hadronic mechanics) when subjected to major changes of their local conditions. However, I cannot accept that, since they are stable, they can be eliminated from the universe, and replaced with the *unstable* neutron.

In the exterior-statistical description, the problem of the elimination of stable particles does not surface. On the contrary, when studying the structural problem, it is easy to prove the impossibility of turning perfectly stable particles into unstable ones, thus confirming that the contemporary theory of weak interactions has zero impact on the problem here considered, the structure of the neutron.

3.3. Hadronic Two-Body Bound States (Copyrighted and Patent Pending)

We now outline the *hadronic two-body bound state,* because it is important for the new structure model of all hadrons and related new energies of Class I.

As we shall see in the subsequent papers, the same model is also at the foundation of new energies of Class II, such as the cold fusion of protons and nuclei despite their repulsive Coulomb

interactions. The same model has fundamental character also for the new energies of Class III, because it permits a deeper understanding of how two identical valence electrons can bond to each other despite their repulsive Coulomb force.

To render these papers directly applicable to new energies,, it is then recommendable we review the two-body hadronic model in minimally necessary details.

The model is characterized by a *nonunitary transform* of the quantum mechanical two-body model (3.2), under the basic assumption that the two particles are in *singlet* coupling (otherwise there is the emergence of a strong repulsive force, as we shall see) and under conditions of *deep mutual overlapping of their wavepackets at distances equal or smaller than 1 fm* (otherwise quantum mechanics applies).

By following Section II-9, the nonunitary transform is selected in such a way as to: A) characterize the basic unit of the new theory (isounit); B) represent the conditions of deep mutual overlapping of the wavepackets of the constituents necessarily in singlet coupling (from Pauli's exclusion principle); and C) become unitary at sufficiently large mutual distances, where quantum mechanics is recovered identically.

The simplest possible selection I adopt is the following:

$$U \times U^\dagger = \hat{1} = \hat{1}_o \times \exp\{[\phi_{12}(r)/\hat{\psi}_{12}] \times \int d^3r \times \hat{\psi}_{1\uparrow}(r)^\dagger \times \hat{\psi}_{2\downarrow}(r)\} = 1/\hat{T}\,, \tag{3.6}$$

where: $\hat{1}_o$ is a factor representing the shape of the bound state as in Equation (2.15), if needed (otherwise $\hat{1}_o$ is assumed equal to 1); ϕ_{12} is the conventional quantum mechanical solution; $\hat{\psi}_{12}$ is the hadronic solution; $\hat{\psi}_{1\uparrow}$ and $\hat{\psi}_{2\downarrow}$ are the hadronic wavefunctions of the constituents in singlet couplings (antiparallel spin).

As one can see, isounit (3.6) represents interactions which are *nonlinear* (because of the presence of the wavefunctions in the exponent), *nonlocal* (because of the volume integral also in the exponent), and *nonpotential* (because not represented via the Hamiltonian). Note also that, for sufficiently large mutual distances, the integral in Equation (3.6) is null, the isounit recovers the conventional value 1, and quantum mechanics is recovered identically, as discussed in detail in Paper II.

As stressed in Paper II, the achievement of a quantitative, consistent, and invariant model requires the nonunitary transform of the *totality* of the mathematical and physical notions underlying two-body quantum mechanical problems, such as the hydrogen atom.

We reach in this way isonumbers, isoeuclidean spaces, isohilbert spaces, isoschrödinger equations, etc. (see Paper II for details hereon assumed as known):

$$U \times n \times U^\dagger = n \times (U \times U^\dagger) = n \times \hat{1} = \hat{n} \in \hat{R}(\hat{n}, \hat{+}, \hat{\times}), \tag{3.7a}$$

$$U \times r^2 \times U^\dagger = U \times (r^i \times \delta_{ij} \times r^j) \times U^\dagger =$$

$$[r^i \times (U \times U^\dagger)] \times [(U \times U^\dagger)^{-1} 1) \times \delta_{ij}] \times [r^j \times (U \times U^\dagger)] = \hat{r}^i \times \hat{\delta}_{ij} \times \hat{r}^j = \hat{r}^{\hat{2}} \in \hat{E}(\hat{r}, \hat{\delta}, \hat{R}) \tag{3.7b}$$

$$U \times \langle \phi | \times | \psi \rangle \times U^\dagger = \langle \phi | \times U^\dagger \times (U \times U^\dagger)^{-1} \times U \times | \psi \rangle \times (U \times U^\dagger) =$$

$$\langle \hat{\phi} | \times \hat{T} \times | \hat{\psi} \rangle \times \hat{1} = \langle \hat{\phi} | \hat{\times} | \hat{\psi} \rangle \times \hat{1} \in \hat{C}(\hat{c}, \hat{+}, \hat{\times}), \tag{3.7c}$$

$$U \times H \times U^\dagger \times (U \times U^{\dagger\,-1} \times U \times \psi = \hat{H} \hat{\times} \hat{\psi} = \hat{E}_o \hat{\times} \hat{\psi} = E_o \times \hat{\psi}\,, \tag{3.7d}$$

$$U \times p_k \times \psi_n = U \times p_k \times U^\dagger \times (U \times U^\dagger)^{-1} \times U \times \psi_n = \hat{p}_k \hat{\times} \hat{\psi}_n = -iU\partial_k \psi_n =$$

$$= -i\hat{\partial}_k \hat{\psi}_n = -i\hat{T}_k{}^i \times \partial_i \hat{\psi}_n, \text{ etc.} \tag{3.7e}$$

The above formulation remains invariant under any additional nonunitary transform $W \times W^\dagger = \hat{1}$

$\neq$ I, *provided the invariance is treated via isomathematics.* This merely requires the identical reformulation:

$$W = \hat{W}\times\hat{T}^{1/2},\ W\times W^{\dagger} \equiv \hat{W}\hat{\times}\hat{W}^{\dagger} = \hat{W}^{\dagger}\times\hat{W} = \hat{1}\,, \tag{3.8}$$

under which we have the invariance of the isounit $\hat{1}' = \hat{W}\hat{\times}\hat{1}\hat{\times}\hat{W}^{\dagger} \equiv \hat{1}$, the invariance of the isoproduct, $\hat{W}\hat{\times}(A\hat{\times}B)\hat{\times}\hat{W}^{\dagger} = A'\hat{\times}B'$, etc.

Note that the proof of invariance is universal for all possible models and needs not be repeated for each individual model. As such, it can be ignored hereon.

Isoschrödinger's equations (3.7d) and (3.7e) can be written for the two-body case of particles of arbitrarily positive or negative charges $\pm n\times e$, n = 1, 2, 3, ...:

$$\hat{H}\hat{\times}\hat{\psi} = \frac{1}{2\hat{m}}\hat{p}\hat{\times}\hat{p}\hat{\times}\hat{\psi}_{12} \pm n\times\frac{e^2}{r}\times\hat{T}\times\hat{\psi}_{12} =$$

$$= -\frac{1}{2\hat{m}}\hat{\Delta} \pm \frac{e^2}{r}\times\left(1 - N\times\frac{\psi_{12}}{\hat{\psi}_{12}} + ...\right)\times\hat{\psi}_{12} = E\times\hat{\psi}_{12} \tag{3.9a}$$

$$\hat{p}_k\hat{\times}\hat{\psi}_{12} = -i\hat{\partial}\hat{\psi} = -i\hat{T}\times\hat{\psi}_{12} = -i\left(1 - \frac{\psi_{12}}{\hat{\psi}_{12}}\right)\partial_k\hat{\psi}_{12}, \tag{3.9b}$$

where we have used the isotopic element as the inverse of (3.6) and, for a bound state, the integral $\int d^3r\times\hat{\psi}_{1\uparrow}(r)^{\dagger}\times\hat{\psi}_{2\downarrow}(r)$ has been approximated to the constant N.

It is known from the atomic structure that the quantum wavefunction ψ_{12} behaves like $e^{-b\times r}$, where b^{-1} is the radius of the orbit, while it is known beginning from [3a] that the hadronic wavefunction $\hat{\psi}_{12}$ behaves like $[1 - \exp\{-b\times r\}]/r$. By ignoring the additional terms in the expansion, the potential in (3.9) can therefore be written:

$$\pm n\times\frac{e^2}{r}\times\left(1 - N\times\frac{\psi_{12}}{\hat{\psi}_{12}}\right) \approx \pm n\times\frac{e^2}{r} - V_0\frac{e^{-b\times r}}{1 - e^{-b\times r}}, \tag{3.10}$$

thus exhibiting the appearance of a *Hulten potential,* which is well known for the representation of *strong nuclear forces.*

But the Hulten potential behaves like the Coulomb potential at distances of the order of 1 fm, while being much stronger than the latter. We therefore have

$$\pm n\times\frac{e^2}{r}\times\left(1 - N\times\frac{\psi_{12}}{\hat{\psi}_{12}}\right) \approx -V\times\frac{e^{-b\times r}}{1 - e^{-b\times r}}, \tag{3.11}$$

where V represents the adjustment of V_0 after the absorption of the Coulomb potential. Equation (3.9) then assumes the form (first identified in Equation (5.1.10) page 834 and (5.1.14a), page 836 of [3a]):

$$\left(-\frac{\rho^2}{2m}\Delta - \frac{e^{-b\times r}}{1 - e^{-b\times r}}\right)\times\hat{\psi}_{12} = E\times\hat{\psi}_{12} \tag{3.12a}$$

$$\hat{p}_k\hat{\times}\hat{\psi}_{12} = -i\hat{\partial}\hat{\psi} = -i\,\rho\,\partial_k\hat{\psi}_{12},\ k = x, y, z\,, \tag{3.12b}$$

where: (3.12a) follows from the use of (3.12b); ρ is a constant approximating the term within brackets in (3.9b) (which approximation is permitted for stable orbits); and $\hat{m} = m/\rho^2$ is the isorenormalized reduced mass of the hadronic bound state. As one can see, the equations to be solved are reduced to ordinary differential equations without isotopic terms.

The occurrence most important for new energies is that *the hadronic two-body bound state (3.12a) exhibits a final strongly attractive force at short distances irrespective of whether the original Coulomb force was attractive or repulsive at large distances.* This occurrence is evidently due to the absorption of the Coulomb potential by the much deeper Hulten well, and the known dominance of the latter over the former at short distances.

As we shall see, the above occurrence has far reaching implications at all levels of studies and for all new energies of Classes I, II and III. To have an indication, hadronic structure model (3.12) permits quantitative-numerical studies of bound states that are simply impossible for quantum mechanics, such as: the models $\pi^\circ = (\hat{e}^+, \hat{e}^-)_{HM}$, $n = (\hat{p}^+, \hat{e}^-)_{HM}$ and other new models of hadrons; the absorption of a proton by a positively charged nucleus as occurring in cold fusion; the experimentally established *attraction* between the *identical electrons* in the Cooper pair in superconductivity; new conceptions of molecules with a strong *attraction* among the *valence electrons*; and other *new* models.

Equation (3.12a) has been studied in details and solved exactly in Section 5 of the original proposal [3a], pages 835-839. An outline is important to render these papers self-sufficient for applications to new energies.

The solution of the angular part of model (3.12) is conventional when formulated for the total angular momentum $M = r \wedge p$ with $p = \rho^{-1} \times \hat{p}$ (see later on for individual angular momenta of the constituents).

The radial part can be written:

$$[\frac{d}{dr}(\frac{d}{dr} r^2 \frac{}{}) + \frac{m}{\rho^2 \times \hbar^2}(E_0 + V \times \frac{e^{-b\times r}}{1 - e^{-b\times r}})] \times \hat{\psi}(r) = 0. \tag{3.13}$$

Under the expressions:

$$\hat{\psi}(r) = e^{-|A|^{1/2} \times b \times r} \times S(b\times r) / r, \tag{3.14a}$$

$$A = \hat{M} \times E_0 / \rho^2 \times \hbar^2 \times b^2 < 0, \; B = m \times V / \rho^2 \times \hbar^2 \times b^2 > 0, \tag{3.14b}$$

and the substitution $x = 1 - b^{-b\times r}$, Equation (3.13) becomes:

$$[x(1-x)\frac{d^2}{dx^2} - (2 \times |A|^{1/2} + 1)\frac{d}{dx} + B] S(x) = 0, \tag{3.15}$$

with boundary conditions:

$$S(0) = 1, \; \text{Lim}_{b\times r \to \infty} e^{-|A|^{1/2} \times b \times r \times S(b\times r)} = 0. \tag{3.16}$$

The solution is given by Equation (5.1.21), page 837 of [3a]:

$$\hat{\psi}(r) = {}_2F_1 = {}_2F_1((2\times\alpha + 1 + n, 1-n, 2\times\alpha + 1, e^{-b\times r}) \times e^{-\alpha \times b \times r} \times (1 - e^{-b\times r}) / r,$$

$$\alpha = (B - n^2) / 2 \times n. \tag{3.17}$$

Since $\alpha > 0$, the boundary conditions demand that:

$$B = m \times V / \rho^2 \times \hbar^2 \times b^2 > n^2, \; n = 1, 2, 3, \ldots \tag{3.18}$$

The *binding energy* then acquires the familiar spectrum of the Hulten potential:

$$| E_o | = \frac{\rho^2 \times \hbar^2 \times b^2}{4 \times m} \left(\frac{m \times V}{\rho^2 \times \hbar^2 \times b^2} \times \frac{1}{n} - n \right)^2 . \tag{3.19}$$

Note that the isorenormalization of the reduced mass $m \to \hat{m} = m/\rho$ eliminates the need for "positive binding energies," and permits bound states with total energies much bigger than the sum of the energies of the constituents. This improvement resolved the first historical objection by Heisenberg, Pauli, Schrödinger, and others against Rutherford's legacy.

To reach a numerical solution, I introduced in [3a] the following parametrization:

$$k_1 = 1 / \lambda\!\!\!^{-} \times b , \quad k_2 = m \times V / \rho^2 \times \hbar^2 \times b^2 , \tag{3.20}$$

where $\lambda\!\!\!^{-}$ is the characteristic wavelength of the constituents. After normalization, we have the expressions for the kinetic and total energies:

$$E^K = k_1 \times \hbar \times b \times c_o = \rho^2 \times \hbar^2 \times b^2 / 2 \times m , \tag{3.21a}$$

$$E^T = 2 \times E^{Kin} + E_o = 2 \times k_1 \times [1 - k_2 - 1)^2] \times \hbar \times b \times c_o , \tag{3.21b}$$

whose solution requires the consideration of a specific case (see next subsections 3.4 and 3.5).

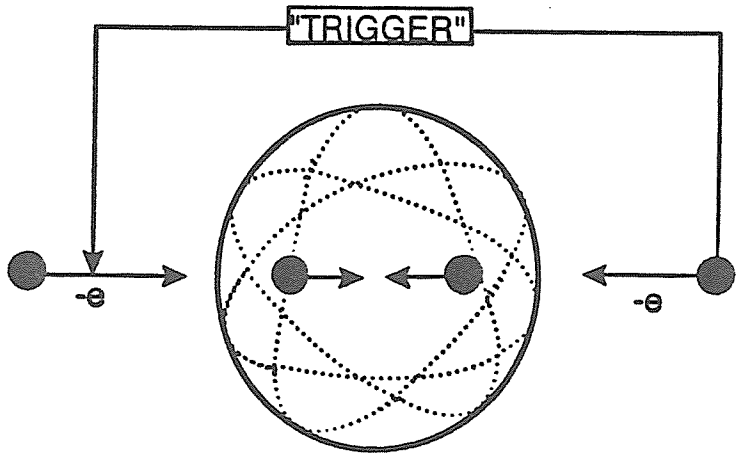


FIGURE 8: A schematic view of the *trigger*, namely, external conditions suitable to push particles with charges of the same sign to move one against the other repulsive Coulomb force until they cross the *hadronic horizon* (Figure 1 of Paper II). At that point the strongly attractive hadronic forces overcome the repulsive Coulomb force, thus permitting new bound states not predicted by quantum mechanics.

A few comments are now in order. First, *only singlet couplings (spin antiparallel) are stable, while triplet couplings (spin parallel) are highly unstable.*

This occurrence, which is unique of hadronic mechanics, was fully identified in [3a] via the so-called *gear model*. In fact, gears can notoriously be coupled only in singlet, while in triplet they

experience a strong repulsive force.

Triplet couplings are *prohibited* in hadronic mechanics also because they would imply *strong drag forces caused by the motion of wavepackets against that of others.*

When the constituents of a hadronic bound state have *opposite charges,* hadronic mechanics predicts their natural tendency to form hadronic bound states at ordinary temperature, under a number of conditions and physical laws, such as: 1) the availability of the necessary threshold energy for the conservation of the total energy; 2) the coupling must be in singlet; and other conditions.

When the constituents have *opposite charge,* a hadronic bound state is still possible, under the additional condition that the environment provides the *trigger,* that is, the constituents are forced to move one against each other Coulomb repulsion, until they pass the *hadronic horizon* (the sphere of 1 fm in radius in which hadronic mechanics applies), at which point the Hulten well dominates the repulsive Coulomb force and a bound state occurs (see Figure 8).

We have already identified the trigger that forces the identical electrons of the Cooper pair in superconductivity to create a quasi-particle state $(\hat{e}^-, \hat{e}^-)_{HM}$ as being provided by the strongly attractive Cuprate ions, in a way remarkably in agreement with experimental evidence [23a,23b].

We have also identified the trigger that forces valence electrons to create molecular bonds as being given by the positively charged nuclei [23c].

As we shall see in Paper IV, the efficiency of cold fusion and other forms of new energies of Class II can be considerably increased via the identification of: 1) the trigger, and its optimization; 2) the singlet character of the coupling and its maximization, *e.g.,* via magnetic polarizations; and 3) the threshold energy and its minimization.

Final expression (3.12) with the Hulten potential can be reached in a variety of different, yet equivalent ways depending on the case at hand. For the case of new energies of Class I, the Coulomb potential is known to be a fundamental *invariant* of quantum mechanics, but only *under unitary transform.* One can, therefore, directly apply a nonunitary transform to the Coulomb potential and transform it into the desired attractive potential irrespective of whether the original Coulomb potential was attractive or not.

A different approach was adopted in [22a] based on isoquantization (II-6.3.1) and a time dependent isounit similar to (3.6). This approach results in a logarithmic nonlinearity which, after simple elaborations, yields the same Equations (3.12).

The situation is different for new energies of Classes II and III because *the trigger is long-range, thus verifying quantum mechanics exactly.* As a result, the trigger *cannot* be subjected to nonunitary transform, and the bound states requires specific studies in Papers IV, and V of this series.

3.4. The Structure Model $\pi^\circ = (e^+, e^-)_{HM}$ (Copyrighted and Patent Pending)

The characteristics of the π° are: 1) zero spin; 2) null charge; 3) null magnetic moment; 4) rest energy of 135 MeV; 5) meanlife of (about) 10^{-16} sec; 6) charge radius of (about) 1 fm; and 7) decay with the lowest model $\pi^\circ \to e^+ + e^-$, which is here interpreted as the tunnel effect of the constituents.

The *quantum mechanical* bound state of one electron and one positron, called the *positronium,* permits the representation of characteristics 1), 2), and 3), while all the others are impossible. For instance, a representation of the rest energy is impossible for Equation (3.5) because the total rest energy of the constituents is much lower than the total energy (1 MeV $\ll$ 135 MeV), thus requiring a large *positive* binding energy under which the indicial equation of (3.5) admits no real solution (see Refs. (22) for details). Similarly, quantum mechanics cannot represent the main life, charge radius, and tunnel effect of the constituents.

The rules of the preceding subsection resolve all the above insufficiencies, resulting in the following *structure equations of the* π° *meson as the compressed positronium* $\pi^\circ = (\hat{e}^+, \hat{e}^-)_{HM}$ (first appeared in Equations (5.1.14), page 836 of [3a]):

$$\left(-\frac{\rho^2}{2m}\Delta - V\frac{e^{-b\times r}}{1-e^{-b\times r}} \right) \times \hat{\psi}_{12} = E \times \hat{\psi}_{12} \tag{3.22a}$$

$$E^{Tot}_{\pi^\circ} = 2 \times E^{Kin}_{\hat{e}} + E^{Bind} = 135\ MeV, \tag{3.22b}$$

$$\tau^{-1}_{\pi^\circ} = 4\times\pi\times\lambda\!\!\!^{-2} \left| \hat{\psi}(0) \right| \times\alpha\times E^{Kin}_{\hat{e}} / \hbar = 10^{16}\ sec^{-1}, \tag{3.22c}$$

$$b^{-1}_{\pi^\circ} = 10^{-13}\ cm, \tag{3.22d}$$

where: characteristics 1), 2), and 3) are ignored because automatically verified; (3.22a) is the nonunitary image of (3.5) with isounit (3.6) although in a local approximation obtained via power series expansions; (3.22c) is a standard nonrelativistic expression of the meanlife; $\hat{m}$ is the reduced isomass.

Equations (3.21) then yield:

$$E^{Kin}_{\hat{e}} = k_1 \times \hbar \times b \times c_o = \rho^2 \times \hbar^2 \times b^2 / 2 \times m, \tag{3.23a}$$

$$E^{Tot}_{\pi^\circ} = 2\times E^{Kin}_{\hat{e}} + E_o = 2\times k_1[1 - k_2 - 1)^2]\times\hbar\times b\times c_o, \tag{3.23b}$$

$$\tau^{-1}_{\pi^\circ} = 4 \times \pi \times b \times c_o \times (k_2 - 1)^3 / 48 \times 137^2, \tag{3.23c}$$

$$|A| = (k_2 - 1)^2 / 4, \tag{3.23d}$$

$$\hat{\psi}(0) = (k_2 - 1)^{3/2} \times b / 48^{1/2}. \tag{3.23e}$$

In this way, model (3.22) is reduced to the solution of the following algebraic equation in k_1 and k_2:

$$k_1[1 - (k_2 - 1)^2] = E^{Tot}_{\pi^\circ} / 2\times\hbar\times b\times c_o = 0.33, \tag{3.24a}$$

$$(k_2 - 1^3 / k_1 = 2.38 \times 10^{-6} / \tau_{\pi^\circ} \times b_{\pi^\circ} = 2.38 \times 10^{-3}, \tag{3.24b}$$

with numerical solutions (5.1.33b) of [3a]:

$$k_1 = 0.34, \quad k_2 = 1 + 4.27 \times 10^{-2}. \tag{3.25}$$

As one can see, *hadronic mechanics permits an exact representation of all characteristics 1) to 7) of the* π°.

Note that *one single equation of structure represents all main characteristics of the* π°, *exactly as is the case for the hydrogen atom.* By comparison, *quark models do not have one single equation of structure capable of representing all main characteristics of the* π°, and the characteristics are represented with different spectra, *e.g.*, that for mass.

Moreover, the quark model obtain the rest energy *but only when combined with those of other mesons,* as correctly expected for a model of classification, but not of structure. The representation of the meanlife of the π° becomes problematic for quark models (because it cannot be linked to those of other mesons in a spectrum).

Finally, there is complete silence in the quark literature on the representation of the all important size of the particle, its actual shape, its density, and other features.

The first important property of the π° model is *the suppression of the quantum spectrum of the positronium down to only one energy level,* 135 MeV. In fact, the Hulten spectrum (3.19) is finite to begin with, and all excited states over the value n = 1 are forbidden under the boundary

conditions of the model.

The suppression of the atomic spectrum of energy is a first necessary condition for the consistency of the model, because there are no mesons which can be interpreted as excited states of the model $\pi^\circ = (\hat{e}^+, \hat{e}^-)_{HM}$. The suppression therefore signals the abandonment of the usual *classification* in favor of the *structure* of the hadron considered.

More specifically, the model $\pi^\circ = (\hat{e}^-_\downarrow, \hat{e}^+_\uparrow)_{HM}$ does indeed admit excited states, but they recover those of the positronium identically. In fact, any excited state implies that the isoelectrons $\hat{e}^\pm$ exit the Hulten well, thus re-acquiring their conventional quantum form $e^\pm$ and related quantum spectrum of the positronium.

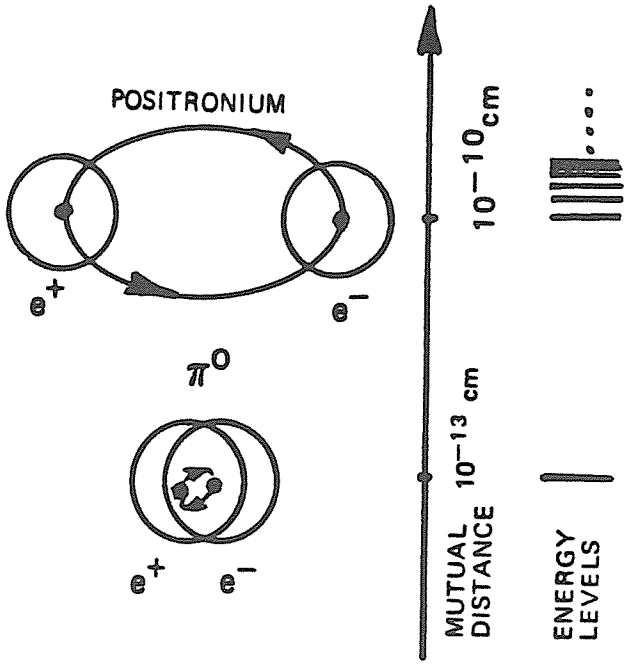


FIGURE 9: A schematic view of the complete spectrum for the bound state of one electron and one positron represented by hadronic mechanics, which includes the infinite spectrum of the positronium for the quantum case, plus one single, additional, bound state at short distancesrepresenting the π° meson.

In short, the structure $(\hat{e}^-_\downarrow, \hat{e}^+_\uparrow)_{HM}$ characterized one and only one energy level at short distance, the π°, while characterizing the infinite spectrum of the positronium at large distances (for particle standards).

The suppression of the atomic energy spectrum has the rather fundamental consequence of *mandating the increase of the number of constituents of hadrons with the increase of mass.* For instance, hadronic mechanics predicts that, in the transition from π° to $\pi^\pm$, the number of constituents increase by one unit (Subsection III-3.7).

The model permits the identification of an approximate, yet significant, numerical value of the Hulten constant V according to Equation (5.1.27) of [3a]:

$$V = k_2 \times \rho^2 \times \hbar^2 \times b^2 / \hat{m} = 2 \times k_1 \times k_2 \times \hbar \times b \times c_o \approx 2 \times E^{Kin}_{\hat{e}} \approx 135 \text{ MeV}, \qquad (3.26)$$

where the last expression is due to the fact that the binding energy is so small as to be ignorable in nonrelativistic approximation, as the reader is encouraged to verify.

An understanding of the latter aspect is crucial for an understanding of hadronic mechanics. In fact, significant values of the binding energy are expected under long-range, action-at-a-distance, potential interactions, as is well known. By comparison, contact zero-range interactions do not admit any potential energy at all, by central assumptions, thus generally yielding very small values of the binding energy, an occurrence verified in all hadronic states studied so far.

Due to widespread plagiarisms existing in the contemporary physics literature, I have copyrighted various publications on the structure model of the neutral meson outlined in this section, and I intend to defend such copyrights in any means permitted by law.

The content of this section can be used in part or in full by anybody for any scientific purpose without any prior authorization, provided that: 1) The original publications identified in this section are quoted; 2) The main results of the quoted publications are outlined as a prerequisite for allegations of novelty; and 3) Paternities are identified with clarity.

3.5. The Structure Model $n = (\hat{p}^+, \hat{e}^-)_{HM}$ (Copyrighted and Patent Pending)

The main characteristics of the neutron are: 1) rest energy 939.6 MeV; 2) meanlife 916 seconds; 3) charge radius 0.8×10^{-13} cm; 4) spin 1/2; 5) magnetic moment $-1.9\ \mu_p$; 5) null electric dipole moment; 6) space and charge parities; and 7) spontaneous decay (3.1).

The invariant nonrelativistic representation of *all* the characteristics of the neutron was first reached by R. M. Santilli in paper [22a] of 1990 via model $n = (p^+, \hat{e}^-)_{HM}$. The first relativistic extension was first achieved in 1993 while visiting the JINR in Dubna, Russia [22b], and additionally published in Ref. [22c]. 1

The conceptual and physical foundations of hadronic mechanics, as well as Santilli's structure model of the neutron were recently plagiarized *ad litteram* by E. Conte in Ref. [24c] without any quotation of the prior Refs. [22], despite Conte's full awareness of the latter since the early 1990, according to numerous documentations and and eyewitnesses. Also, Conte's plagiarism [24c] of Refs. [22] was only the representation of the rest energy and spin of the neutron, while the original Ref. [22a] had achieved the exact-numerical representation of *all* characteristics of the neutron ten years earlier. The reader should also be aware that Conte's plagiarism [24c] has no indication of its catastrophic inconsistencies identified in Section II-4 (which I communicated to Conte in detail prior to the publication of Ref. [24c]), because he abstained from using the generalized mathematics needed for the invariant elaboration of the basic equations. As a consequence, none of the numerical results copied by Conte [24c] from Refs. [22] is preserved in time, and the presentation has no known physical value.

The main assumption of Santilli's nonrelativistic representation of the neutron structure $n = (p^+, \hat{e}^-)_{HM}$ [22a] is that the proton is not considered to be mutated because it is 2,000 heavier than the electrons. The characteristics of the neutron are, therefore, recovered via the mutation of the electron only. Needless to say, this is merely a first nonrelativistic approximation. The full relativistic treatment was reached by Santilli in paper [22b] of 1996.

As we shall see, papers [22a,22b) provided a remarkable (and unexpected) verification of the experimental results of Section 3, particularly the experimental data on the Bose-Einstein correlation.

The main results of [22a] can be summarized as follows. The charge and parities of the neutrons are automatically represented by the model and will be ignored. The model represented in Eq. (3.12) is readily applicable, resulting in the following *nonrelativistic equation for the structure of the neutron as a compressed hydrogen atom* for the rest energy, meanlife, and charge radius :

$$\left(\frac{1}{\hat{m}}\hat{p}\hat{\times}\hat{p} - \frac{e^2}{r}\hat{1} - V_0\times\frac{e^{-b\times r}}{1-e^{-b\times r}}\times\hat{1} + \ldots\right)\hat{\times}\,\hat{\psi}(r) = E_0\times\hat{\psi}(r)\,, \tag{3.27a}$$

$$E^{Tot}{}_n = 2\times E^{Kin}{}_{\hat{e}} + E^{Bind} = 939.6\ \text{MeV}, \tag{3.27b}$$

$$\tau^{-1}_n = 4\times\pi\times\lambda\!\!\!^{-2}|\hat{\psi}(0)|\times\alpha\times E^{Kin}_{\hat{e}}/\hbar = 1.09\times10^{-3}\,\mathrm{sec}^{-1}, \tag{3.27c}$$

$$b^{-1}_{\pi^\circ} = 0.8\times10^{-13}\ \mathrm{cm}. \tag{3.27d}$$

The repetition of the solution as in the preceding subsection then yields the values:

$$k_1 = 2.6,\quad k_2 = 1 + 0.81\times10^{-8}, \tag{3.28}$$

which should be compared with values (3.25).

The above numerical values imply that *the kinetic energy of the electron and the binding energy of the neutron are null in first approximation.* In fact, from the low value of k_2 we have (Equation (2.44) of [3a]):

$$E^k_{\hat{e}} = k_1\times b\times c_o \approx 0, \qquad E = V\times(k_2-1)^2/4\times k_2 \approx 0. \tag{3.29}$$

This implies that *the electron is essentially at rest in the center of the proton and it is held there by contact interactions without potential energy (namely, mechanical constraints).*

The above results also imply the following isorenormalization of the rest energy of the electron:

$$E_{\hat{e}} = m_e\times c^2 = m_o\times c_o\, b^{\circ 2}_4 = 1.3\,\mathrm{MeV}. \tag{3.30}$$

A most important result of paper [22a] was, therefore, the prediction in 1990 of the following numerical value of the density of the proton (Equation (2.45), page 527 of [22a]):

$$b^\circ_4 = [(E_n - E_p)/m_e]^{1/2} = (1.3/0.5)^{1/2} = 1.65. \tag{3.31}$$

It was thene astonishing for me to see this prediction *exactly* verified in 1992 with the independent fit of the Bose-Einstein correlation, Equations (2.21b).

Recall that $b^\circ_4 = 1/n^\circ_4$ represents a geometrization of the *density* of hadronic media normalized to the value 11 for the vacuum. Value (2.21b) constitutes an experimental measurement of the density of the interior of the Bose-Einstein fireball. But its density is fully comparable to that of the proton. The remarkable occurrence is therefore the confirmation that experimental value (2.21b) permits the resolution

(As an incidental note, Equation (2.45) of [22a] contains the evident typographic error 16.5 rather than 1.65, which escaped my attention during the correction of the galleys. In fact, the value $b^\circ_4 = 16.5$ would imply the totally unacceptable rest energy of the isoelectron 544.5 MeV, while the only consistent value is given by $[(E_n - E_p)/m_e]^{1/2} = 1.65$, which yields the correct value of the neutron mass under the assumption of an electron at rest, as repeatedly stated in [22a]).

The above results establish beyond credible doubts the axiomatically consistent and invariant resolution by hadronic mechanics of the historical objections against the representation of characteristics 1), 2), and 3) of the neutron recalled at the beginning of this section.

Note that *hadronic mechanics provides again the suppression of the atomic spectrum.* In view of values (3.28), spectrum (3.19) admits one and only one solution, the neutron. Any excitation implies that the isoelectron exits the proton, thus returning to its quantum configuration. As a result, any excitation of the model implies the full recovery of the spectrum of the hydrogen atom.

This occurrence will again force the *increase of the number of constituents with mass* (see Section III-3.7).

The representation of the total spin 1/2 with two constituents of spin 1/2 was first presented in [22a] and it is conceptually elementary for Rutherford's compression of the hydrogen atom. In fact, the electron is assumed to be literally compressed inside the proton all the way to its center. Under

these conditions, it is evident that we do not have conventional angular momenta as for a particle moving in vacuum around a nucleus. On the contrary, we have angular momenta under subsidiary constrains evidently mandated by the fact that motion is within the hyperdense medium in the proton.

It is then easy to see that, as soon as the electron initiates its compression inside the proton, its *angular momentum* must coincide with the *spin* of the proton (see Figure 10). This is the configuration in which the proton (which is about 2,000 times heavier and denser than the electron) drags around the electron in its spin.

Any other configuration in which the *angular momentum* of the electron inside the proton is *different than the proton spin* would imply the highly unstable condition that the electron moves within and against the hyperdense medium inside the proton.

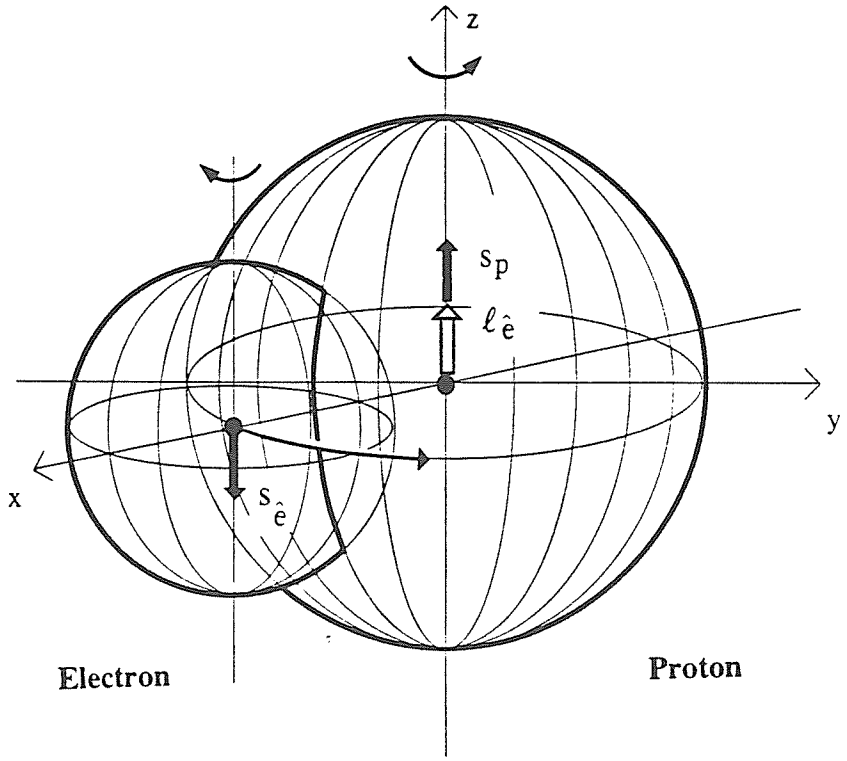


FIGURE 10: A reproduction of Figure 1, page 525 of [22a] presenting a conceptual view of the penetration of the electron within the much heavier proton. The orientation of the various momenta are important to understand the spin and magnetic moment of the neutron. As one can see, the historical inability by quantum mechanics to represent the spin of the neutron as conceived by Rutherford, is easily resolved by hadronic mechanics. At the initiation of its compression within the hyperdense structure of the much heavier proton, the electron is constrained to acquire an *angular* momentum which coincides with the proton *spin* 1/2 (otherwise the electron should mysteriously drag within the proton). A null total value of the angular momentum of the electron then follows from the spin orientations of this figure, thus achieving the first quantitative representation of the spin of the neutron according to Rutherford. Quantum mechanics strictly ;prohibits the value 1/2 for angular momenta (because of various axiomatic inconsistencies), while the same value is readily permitted by hadronic mechanics without inconsistencies, thanks to the isotopy of the Hilbert space.

At the same time, the spin of the electron must necessarily be antiparallel to that of its angular momentum, otherwise we would have again that the electron is somewhat mysteriously forced to move within and against the intrinsic rotation of the proton.

The latter occurrence was represented in [3a] with the *gear model*. In fact, as indicated earlier, gears can only couple themselves in singlet, while triplet couplings are highly repulsive.

In summary, *the isoelectron of the model* $n = (p^+, \hat{e}^-)_{HM}$ *has null total angular momentum,* J_{tot} = spin + angular momentum = 1/2 − 1/2 = 0. The representation of the spin in the model $n = (\hat{p}^+, \hat{e}^-)_{HM}$ is then equally elementary. In fact, *the spin of the neutron coincides with that of the proton.*

The above results also permit an interpretation of spontaneous decay (3.1), as well as a novel origin of the neutrino from the decay:

$$\hat{e}^- \to e^- + \nu. \tag{3.32}$$

The algebraic representation of the above conceptual derivation of the neutron's spin was also worked out for the first time by the author in paper [22a], and can be summarized as follows.

The spin of particles is characterized by the SU(2) symmetry, the spin 1/2 being the fundamental (regular), two-dimensional representation known under the name of *Pauli's matrices* σ_k with: familiar eigenvalues $\sigma_k \times \sigma_k \times | b > = 3 \times | b >$, $\sigma_3 \times | b > = \pm 1 \times | b >$; spin $J_k = \sigma_k / 2$; and well-known rules to compute the total angular moment of a composite state including angular and intrinsic momenta (the literature in this field is so vast as to discourage discriminatory partial listings).

As recalled earlier, the quantum mechanical SU(2) theory *prohibits* the achievement of a spin 1/2 from two particles each having spin 1/2. Therefore, the *only* possible solution for model $n = (p^+, \hat{e}^-)_{HM}$ is to consider a *nonunitary image* of the SU(2) symmetry. The *only* known invariant formulation of nonunitary images of SU(2) is the Lie-Santilli isosymmetry $\hat{SU}(2)$ (see Sections II-6 and papers [22b-22d]).

The nonunitary character of the theory then readily permits the needed solution. For instance, *angular* momenta with value 1/2 are prohibited in quantum mechanics (because they violate the unitarity law). On the contrary, 1/2 angular momenta are completely admitted for hadronic mechanics due to the degree of freedom of the Hilbert product, Equation (II-6.4.12).

It is easy to see that the lifting of the angular momentum yields the expressions (see [22a] for their derivation):

$$\hat{L}_k \hat{\times} \hat{L}^k \times | \hat{Y}(\theta, \phi) > = \rho \times 1 \times (\rho \times 1 + 1) \times | \hat{\psi}(\theta, \phi) >, \tag{3.33a}$$

$$\hat{L}_3 \hat{\times} | \hat{\psi}(\theta, \phi) = \rho \times m \, | \hat{\psi}(\theta, \phi) >, \tag{3.33b}$$

$$1 = 1, 2, 3, ..., \; m = 1, 1 - 1, 1 - 2, ..., -1, \rho > 0 . \tag{3.33c}$$

The selection of the value $\rho = 1/2$ of the angular momentum then permits the exact, consistent, and invariant representation of the spin of the neutron in model $n = (p^+, \hat{e}^-)_{HM}$ as coinciding with that of the proton.

Paper [22a] also provided a *second solution* for the spin of the neutron. Let us consider first the spin of the isoelectron. Its explicit formulation requires the invariant Lie-Santilli isosymmetry $\hat{SU}(2)$ characterized by (Equations (2.32), page 523 of [22a]):

$$U \times U^\dagger = \hat{1}_{Spin} = Diag. (g_{11}^2, g_{22}^2), \; \hat{\sigma}_k = U \times \sigma_k \times U^\dagger , \; \hat{J}_k = \hat{\sigma}_k / 2,$$

$$\hat{\sigma}_1 = \begin{pmatrix} 0 & g_{11} \\ g_{22} & 0 \end{pmatrix}, \hat{\sigma}_2 = \begin{pmatrix} 0 & -i g_{11} \\ i g_{22} & 0 \end{pmatrix}, \hat{\sigma}_3 = \begin{pmatrix} g_{11} & 0 \\ 0 & -g_{22} \end{pmatrix},$$

$$[\hat{J}_i, \hat{J}_k] = \hat{J}_i \hat{\times} \hat{J}_j - \hat{J}_j \hat{\times} \hat{J}_i = i \times \epsilon_{ijk} \hat{J}_k,$$

$$\hat{J}_k \hat{\times} \hat{J}_k \hat{\times} | \hat{b} > = (\Delta/2)(\Delta/2 + \hat{1}) | \hat{b} >, \hat{J}_3 = \pm(\Delta/2) \times | \hat{b} >,$$

$$\Delta = (\text{Det.} \hat{I}_{spin})^{1/2} = (g_{11} \times g_{22})^{1/2}, \; g_{kk} > 0. \tag{3.34}$$

As one can see, the main effect of the isotopy is to shift the original spin value s = 1/2 to the isorenormalized value $\hat{s}$ $\Delta/2$, $\Delta^2 = g_{11} \times g_{22}$, where the g's are, at this time, unrestricted, non-null real parameters or functions.

By assuming expression (3.33) for the angular momentum, the total angular momentum of the isoelectron when immersed inside the proton is then given by (Equation (2.34) of [22a]):

$$\hat{J}_{tot}^2 \times | \hat{Y} \times \hat{b} > = (\rho \times \hat{1} + \Delta/2)(\rho \times \hat{1} + \Delta/2 + \hat{1}) \times | \hat{Y} \times \hat{b} >, \tag{3.35a}$$

$$\hat{J}_{3\,tot} \hat{\times} | \hat{Y} \times \hat{b} > = \rho \times m \pm \Delta/2) \times | \hat{\psi} \times \hat{b} >. \tag{3.35b}$$

The constraints representing the prohibition for the electron to rotate within the hyperdense medium in the interior of the proton are represented by (Equation (2.36) of [22a]):

$$\rho = \Delta / 2, \tag{3.36}$$

for which the total angular momentum of the isoelectron is identically null, thus permitting an exact, consistent, and invariant representation of the spin of the neutron.

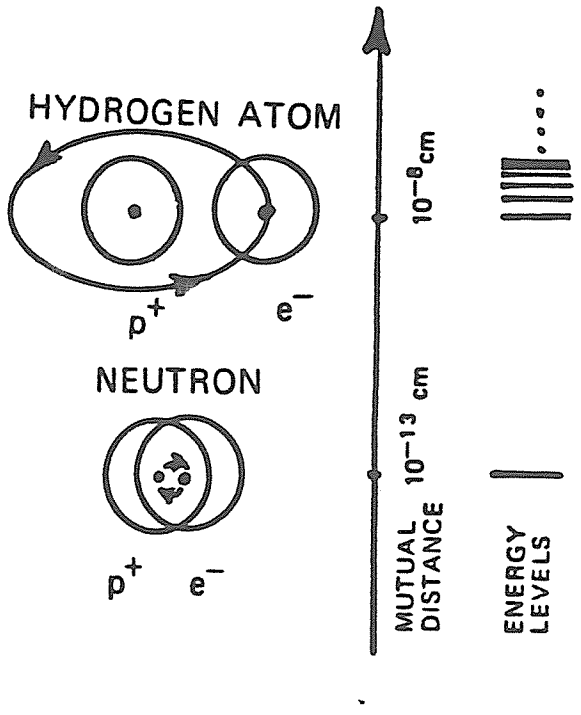


FIGURE 11: A schematic view of the complete spectrum for the bound state of one proton and one electron represented by hadronic mechanics, which includes the infinite spectrum of the hydrogen atom for the quantum case, plus one single, additional, bound state at short distances representing the neutron.

The significance of the above second solution of paper [22a] is that of permitting fluctuations

of the eigenvalues of the spin and angular momentum of the isoelectronium (which are typical for interior conditions). These fluctuations are evidently absent in the first solution.

Needless to say, we are only referring to *small mutations, ie..*, $\Theta = 1 + \epsilon$, $\epsilon \approx 0$. Also, for $\Delta = 1$ ($\epsilon = 0$), one recovers the preceding solution with hadronic angular momentum 1/2.

The reader should keep in mind that $S\hat{U}(2)$ is isomorphic to SU(2) by conception and construction (in fact, the structure constants coincide, as one can see). Such local isomorphic has far reaching implications for new energies because orthodox physicists cannot dismiss the implications of $S\hat{U}(2)$ without losing credibility.

Stated in different terms, the spin symmetry has been restricted during this century to the simplest conceivable realization of the Lie product $[J_i, J_k] = J_i \times J_j - J_j \times J_i$. The Lie-Santilli isotheory realizes the product in the less trivial form $[\hat{J}_i, \hat{J}_k] = \hat{J}_i \hat{\times} \hat{J}_j - \hat{J}_j \hat{\times} \hat{J}_i = \hat{J}_i \times \hat{T} \times \hat{J}_j - \hat{J}_j \times \hat{T} \times \hat{J}_i$, with $\hat{T} = 1/\hat{1} > 0$ and fixed. Since the latter product verifies in full the Lie axioms, there is no scientific reason whatever to restrict the theory to the simplest possible form. The broader isotopic form then becomes fully acceptable, and so is its resolution of the problem of the spin of the neutron according to the historical legacy of Rutherford.

The representation of the *anomalous magnetic moment* of the neutron was also achieved for the first time in paper [22a], and turned out to be the most exciting and unexpected *verification* of hadronic mechanics.

The study of magnetic moments requires the representation via relativistic hadronic mechanics of the full model $n = (\hat{p}^+, \hat{e}^-)_{HM}$ on isominkowskian spaces (2.2), and the *isodirac equation* (II-6.5.7). The repetition of simple elaboration used to derive magnetic and electric moments then yields the expressions (Equation (2.39), page 526 of [22a]):

$$\hat{\mu}_{\hat{e}} = \frac{b^\circ_3}{b^\circ_4} \times \mu_e, \quad \hat{m}_{\hat{e}} = \frac{b^\circ_3}{b^\circ_4} \times m_e, \tag{3.37}$$

where: the moments are assumed to be along the third axis in a spherically symmetric proton (otherwise an average of the b°_k must be used); $\hat{\mu}_{\hat{e}}$ and $\hat{m}_{\hat{e}}$ are the mutated magnetic and electric moments of the isoelectron, and μ_e and m_e are the conventional expressions for electrons in vacuum.

The following numerical values of the parameters then hold for the model under consideration (Equation (2.45) of [22a]):

$$\Delta \approx 1, \ \rho \approx 1/2, \ b = b^\circ_1 = b^\circ_2 = b^\circ_3 \approx 4 \times 10^{-2},$$

$$b^\circ_4 = 1.65, \quad b^\circ_3 / b^\circ_4 = 2.5 \times 10^{-3}, \tag{3.38}$$

under which *hadronic mechanics permits a representation also of the anomalous magnetic moment of the neutron* (Equations (2.0) and (2.41), page 526 of [22a]):

$$\mu_n = \mu_p - \mu_{\hat{e}} = = 2.7 \times \frac{e}{2 \times m_p \times c_o} - 2.5 \times 10^{-3} \times \frac{e}{2 \times m_e \times c_o} =$$

$$= 2.7 \times \frac{e}{2 \times m_p \times c_o} - 4.6 \times \frac{e}{2 \times m_p \times c_o} = -1.9 \times \mu_p. \tag{3.39}$$

Note again the remarkable appearance for the second time in the structure of the neutron of the numerical value of the density $b^\circ_4 = 1.65$ which produces an *exact* representation of the *anomalous* magnetic moment of the neutron while coinciding with the experimental value (2.21b) for the Bose-Einstein correlation.

The representation of the null electric dipole moment requires the first (and only) mutation of

the proton, thus explaining the need of the full model $n = (\hat{p}^+, \hat{e}^-)_{HM}$. In essence, we have a mutation m_p which is equal but opposite to that of m_e, thus resulting in an (approximately) null total electric dipole moment. Technical details via the isolorentz symmetry are omitted for brevity.

In conclusion, *Santilli achieved in paper [22a] the exact, consistent, and invariant representation of all characteristics of the neutron. The representation resulted to be consistent with completely independent experimental data on the Bose-Einstein correlation, the behavior of the meanlives of unstable particles with speeds, and other experiments.*

Subsequently, Santilli [22b] conducted a comprehensive study on the model $n = (\hat{p}^+, \hat{e}^-)_{HM}$ via relativistic hadronic mechanics, which confirmed in full the results already achieved at the nonrelativistic level [22a]. This study is not reviewed here for brevity.

Due to widespread plagiarisms existing in the contemporary physics literature, I have copyrighted various publications on the structure model of the neutron outlined in this section, and I intend to defend such copyrights in any means permitted by law.

The content of this section can be used in part or in full by anybody for any scientific purpose without any prior authorization, provided that: 1) The original publications identified in this section are quoted; 2) The main results of the quoted publications are outlined as a prerequisite for allegations of novelty; and 3) Paternities are identified with clarity.

3.6. Don Borghi's Verifications of the Synthesis of the Neutron from Protons and Electrons

It is rewarding to me to report that *the first experimental verification of the synthesis of the neutrons from protons and electrons was reached by C. Borghi, C. Giori and A. Dall'Olio in the 1980's via a test conducted at the CEN Laboratories in Recife, Brazil, and published only later in 1993 [24a] (in the prestigious Russian Journal of Nuclear Physics).*

This experiment is today known as *Don Borghi's experiment* from the leader of the team, the late Italian priest-physicist C. Borghi, formerly from the Department of Physics of the University of Milan, Italy, who spent his research life on the test.

Needless to say, Don Borghi's experiment is in need of independent reruns, either in its original form, or in one of several alternative possibilities discussed in Section 5. Nevertheless, Don Borghi's experiment constitutes the *first* historical verification of Rutherford's conception of the neutron, and is rather remarkable because of its simplicity.

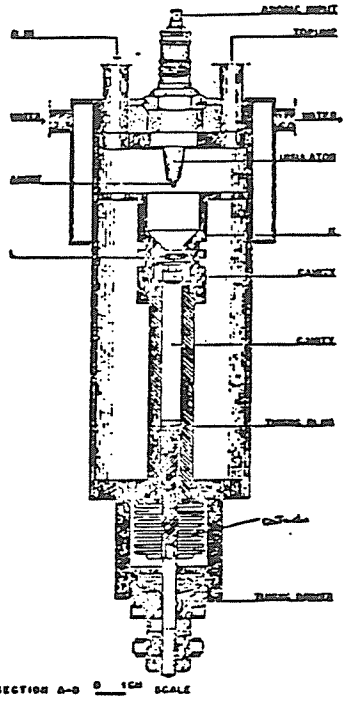
In essence, the experimenters created in the interior of a cylindrical metal chamber (called klystron) a gas of ionized hydrogen gas (free protons and electrons) originating from the electrolytical separation of the water, and kept the gas mostly ionized via an electric discharge. Since protons and electrons are charged, they could not escape from the metal chamber.

In the outside of the chamber, the experimenters put a variety of fissionable and non-fissionable material, and, after periods of time ranging from days to weeks, they detected transmutations in said exterior material, which can only be caused by a flux of neutrons. In the absence of any other source, said neutron flux can only originate from the synthesis of neutrons from protons and electrons in the interior of the klystron. Since the neutrons are neutral, once created inside the klystron, they can escape to the outside, and cause the detected nuclear transmutations.

It is evident that, if confirmed, Don Borghi's experiment establishes Rutherford's conception of the neutron, as well as its treatment via hadronic mechanics, the only one known, to the best of my knowledge, which represents *all* characteristics of the neutron in an exact, consistent, and invariant way.

An additional independent experimental test of exactly the same synthesis of neutrons from protons and electrons of Ref. [24a], although done along one of the various possible alternatives, has been recently announced by E. Conte and M. Pieralice [24b], with results that apparently confirm those by Don Borghi *et al.* [24a].





Element -	Net mass (gr)	Date -	Max net Activity (c/10^{m})
Dy (oxide)	2,580	13/02/70 06/08/70	83 107
Nb (oxide)	2,128	26/02/70 04/08/70	61 47
Er (oxide)	5,361	26/01/70 27/07/70	69 118
Sb (oxide)	2,688	18/02/70 24/07/70	51 97
In (metallic)	0,135	21/01/70	54
Ag (metallic)	2,130	12/02/70 16/06/70	51 27
Au (metallic)	0,960	23/02/70 10/07/70	10 27
Tl (metallic)	10,260	14/02/70	41

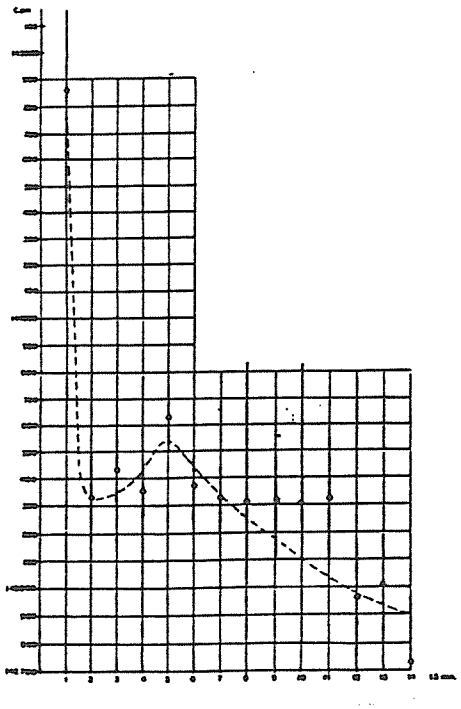


FIGURE 12: A view of: the Italian priest-physicist Don Carlo Borghi; the klystron used in the historical first experimental verification of Rutherford's conception of the neutron; and two of the tables of results published in Ref. [24a]. The last diagram shows the decay of a sample of stable Uranium due to irradiation by a neutron flux which, for the considered experimental set up, can only originate from the synthesis of the neutrons from protons and electrons at ordinary conditions.

Regrettably, Conte and Pieralice abstained from any quotation in their Ref. [24b] of the preceding historical experiment by Don Borghi *et al.* [24a], which is internationally well known, and I had personally brought to their attention years earlier in a documented and eyewitnessed way. Moreover, in subsequent comments [24d], Conte and Pieralice disclaimed the historical scientific priority of Don Borghi's test, by stating that "... these authors [C. Borghi *et al.*, Ref. [24a]] did not aim to show the synthesis of the neutron...", by therefore exiting the boundaries of science, and casting doubts on their own experimental results (see my comments [24e]).

In an unfortunate scenario of this nature, the final experimental resolution of Rutherford's legacy evidently requires additional independent experimental verifications, which should be made available for inspection to all interested researchers. Suggestions for possible specific tests are submitted in Section 5.

It is hoped that experimentalists will seriously consider the conduction of final and resolutory experimental verifications of Rutherford's conception of the neutron, because, irrespective of their nature, the implications are such to dwarf, by comparison, other preferred, yet manifestly less important tests.

As shown below, the neutron is one of the largest reservoirs of new clean energy available to mankind. The possibility of practical utilization of such energy depends in a really crucial way on the nature of the neutron constituents. If these constituents are the hypothetical quarks (which cannot be defined in our physical spacetime, and cannot be expelled free), there exist no possibility whatever to utilize the energy contained inside the neutron.

On the contrary, if Rutherford's conception of the neutron is correct, and the electron is indeed one of a physical constituent, the possibility of utilizing the new clean energy inside the neutron becomes real, and within technological reach.

The final and resolutory experimental verification that the electron is a physical constituent of the neutron would have additional theoretical and industrial implications, so fundamental to be outside our predictive capacities at this writing. On theoretical grounds, the indicated verification will require a profound revision of the current theory of strong interactions, from its current version possessing no practical applications whatever, to a form have direct and important practical applications. On industrial grounds, the experimental verification of Rutherford's legacy implies new means for recycling highly radioactive nuclear waste outlined below, as well as crucial contributions to the remaining energies of Classes II and III studied in the next papers.

3.7. Compatibility of the New Structure Model of Hadrons with the SU(3)-Color Classification

Once the problems of representing rest energy, spin, meanlife, charge radius, and magnetic moment have been solved for the π° meson and the neutron, the extension of the results to all remaining unstable hadrons is consequential.

Again, the physical constituents are generally identified with the massive particles produced in the decay with the lowest mode. We have in this way models such as:

$$\pi^\pm = (\hat{e}^-, \hat{e}^\pm, \hat{e}^+)_{HM}, \quad \eta = (\hat{\mu}^+, \hat{\mu}^-)_{HM},$$

$$K^\circ_S = (\hat{\pi}^+, \hat{\pi}^-), \quad \Lambda = (\hat{n}, \hat{\pi}^\circ)_{HM}, \text{ etc.} \tag{3.39}$$

in which the total characteristics are represented via equations of type (3.12) with different characteristic values $k_1 > 0$ and $k_2 = 1 + \epsilon \leqq 2$.

It should be indicated that, under mutations, particles generally lose their *conventional* characteristics, thus permitting numerous alternative interpretations of the *same* model which are confirmed by the spontaneous decays.

For instance, we have the equivalent models $\pi^\pm = (\hat{\pi}^\circ, \hat{e}^\pm)_{HM} = (\hat{e}^-, \hat{e}^\pm, \hat{e}^+)_{HM}$, based on the

preceding model $\pi^\circ = (\hat{e}^+, \hat{e}^-)_{HM}$ in which the isoelectron carrying the charge, $\hat{e}^\pm$, is "compressed" in the interior of the π°, resulting in the charged mesons $\pi^\pm$.

This conception also permits the representation of the spin zero of $\pi^\pm$ from three electrons each with spin 1/2 in vacuum which is fully similar to that for the neutron. In fact, $\hat{e}^\pm$ in structure $\pi^\pm = (\hat{\pi}^\circ, \hat{e}^\pm)_{HM}$ is forced to have equal and opposite values of the angular momentum and spin. The spin of the $\pi^\pm$ is then given by that of π°, in a way fully similar to the neutron.

All remaining characteristics of hadrons can be exactly represented in ways essentially similar to those for the π° and n. Their derivation is not outlined for brevity.

Note *the necessary increase of the number of the physical constituents in the transition from* π° *to* $\pi^\pm$, *or from n to* Λ, which is evidently contrary to quark conjectures (for which π° and $\pi^\pm$ or n and Λ have the same number of quark constituents).

The compatibility of the new model of hadrons with physical constituents and the established SU(3)-color classification can be outlined as follows.

In 1983, A. Kalnay [25a] first discovered the operator image of Nambu's classical mechanics for triplets which resulted in a Lie-admissible structure (Paper II). In the same year, A. Kalnay and R. M. Santilli [25b] proved that said operator image coincides precisely with hadronic mechanics. In 1995, R. Mignani first proved that the isotopic $S\hat{U}(3)$ symmetry is isomorphic to the conventional symmetry.

Based on these results, R. M. Santilli [25d,25e] constructed the *isoquark theory* (where isoquarks are fundamental representations of $S\hat{U}(3)$) which resulted having the following main features:

1) The isoquark theory preserves all original quantum numbers (including those of SU(3) color and flavor), and, therefore, cannot be experimentally distinguished from the conventional theory.

2) While the exact confinement (*identically null and rigorously proved probability of tunnel effects)* of quarks is technically impossible in real science (because it would require the necessary violation of the uncertainty principle), the exact confinement of isoquarks is elementary and merely due to the *incoherence of the interior isohilbert space with the exterior Hilbert space,* for which the transition probability for isoquarks to become free is rigorously proved to be *identically null.*

3) Perturbative series that are conventionally divergent are turned into a convergent form as in Equation (II-6.4.10) due to the fact that the absolute value of the isotopic element $\hat{T}$ is much smaller than one. As a result, the absolute value of each term $A\hat{\times}B = A\times\hat{T}\times B$ in perturbative expansions is smaller then the conventional form. Turning divergent series into convergent isoforms is then consequential.

More recently, R. M. Santilli [25f] has shown the compatibility between the new structure model of hadrons with physical constituents and the $S\hat{U}(3)$ Mendeleev-type classification of hadrons.

In essence, in this section I have shown that *the isounit changes from hadron to hadron,* evidently because of the change of mass, density, shape, and other characteristics. The octet of mesons is then characterized by *eight different isounits:*

$$\hat{1}_8(\text{mesons}) = \{\hat{1}_1(\pi^\circ), \hat{1}_2(\pi^\pm), ..., \hat{1}_8(\eta)\}, \tag{3.40}$$

with similar occurrences holding for the multiplet of baryons and all other SU(3) families.

The above occurrence establishes the emergence in the classification of hadrons of the *multi-valued hyperstructure* of Section II-6. Compatibility between the structure and classification models then follows from the multi-valued isotopies of SU(3) constructed with hyper-units of type (3.40). Since the latter are positive-definite, the isomorphism between $S\hat{U}(3)$ and SU(3) persists, thus completing the compatibility under consideration.

Note that in this process quarks lose completely and irreconcilably any possible meaning as physical particles, because they are now multi-valued hyper-representations in a purely mathematical space.

In turn, the abandonment of quark conjectures on the hadronic structure and their replacement with scientifically credible physical constituents, sets the foundations for the first time for possible novel industrial applications,

Due to widespread plagiarisms existing in the contemporary physics literature, I have

copyrighted various publications on the compatibility between the unitary model of Mendeleev-type classification of hadrons, and the new structure model of hadrons with physical constituents as outlined in this section. I intend to defend such copyrights in any means permitted by law.

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4. APPLICATION TO NEW ENERGIES OF CLASS I

4.1. The Stimulated Decay of the Neutron

We are finally equipped to treat the *new energies of Class I*, those characterized by processes in the *interior of individual hadrons* (rather than in nuclei or atoms).

To initiate the study, note that all syntheses of unstable hadrons from physical particles *require energy* (this is the reason why one could not use the terms "cold fusion"). For instance, the synthesis of the neutron from protons and electrons *requires* 0.80 MeV.

However, once created, *unstable hadrons become a large reservoir of energy*, which is evidently released in their decay.

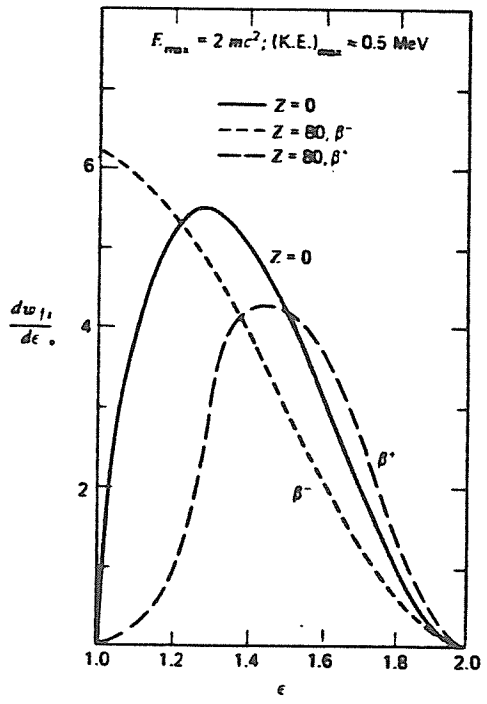

FIGURE 13: An illustration of one of the largest and cleanest energies available to manking, that contained inside the neutron, here represented via a plot of the energy distribution of the electron in spontaneous beta decays of nculei between Z = 0 and Z = 80, as available in sev eral nuclear sources. The decay of an isolated neutron $n \to p + e^- + \bar{\nu}$ releases a proton plus an energy of 0.80 MeV,of which approximately 80% is possessed in the form of kinetic energy by the expelled electron, and the remainiung energy is carried out by the antineutrino. Because of various technical reasons, considerably higher values of energies (all the way to several MeV's) are released in decays of neutrons when

members of nuclear structures. The emitted energy is clean, because of the lack of dangerous radiations (electrons are esily trapped by metal shields, while antineutrinos is notoriously harmless), and the absence of dangerous waste (the results of beta decays are generalkly given by stable elements). Therefore, the possibility of *stimulating* the beta decay in nuclei constitutes a clear example of new clean energy of Class I. adsdwer

The new energies of Class I are generated by *mechanisms capable of stimulating the decay of unstable hadrons, or using the energy in their natural decay.*

This section presents the new energy which can be derived from the neutron, as submitted by R. M. Santilli [26a] in 1994 under the name of *hadronic energy* (see the excellent review by Shannon Smith [26b]). This case is considered because neutrons have been formed in very large numbers by nature.

The reader should keep in ,mind that other forms of new energies of Class I are possible, and have additional significance as *triggers* of new energies of Class II, as we shall see in Paper IV.

Again, neutrons are the biggest reservoir of clean energy available to mankind because they are naturally unstable and decay in mode (3.1) with the emission of electron (and the innocuous neutrino) with 0.80 MeV.

To have an idea of how much energy we are referring to, the electrons emitted in the decay of the neutrons have an energy which is about 100,000 times greater than that of the electrons hitting a computer screen, which, if not properly cooled, would melt in milliseconds.

If the neutron is composed by three hypothetical quarks, there is no possibility whatever, not even remote, to use the large energy contained inside the neutron, evidently because quarks have to be confined to avoid huge inconsistencies with reality, while the utilization of the hadronic energy requires the expulsion of the constituents as free particles, exactly as is the case for ordinary nuclear and atomic energies.

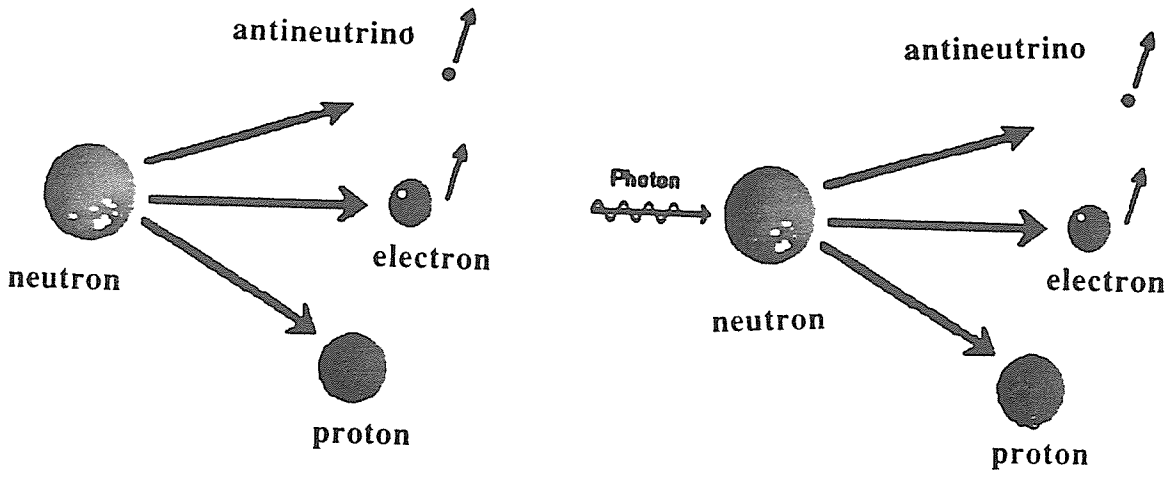

FIGURE 14: A schematic view of the *spontaneous decay of the neutron,* and the consequential possibility submitted by Santilli [26a] in 1994 of *stimulating its decay* via a photon possessing a frequency suitable to excite the internal electron, thus causing its expulsion. Note that the stimulated decay of the neutron is evident if the electron is a constituent of the particle, but the same decay is impossible if the constituents of the neutron are the hypothetical quarks.

It then follows that, if the constituents of the neutron are the physical particles p^+ and e^-, as suggested by its spontaneous decay (3.1), and as permitted by hadronic mechanics, we do have a realistic possibility of tapping the large energy in the interior of the neutron.

The main idea of proposal [26a] is the following. First, note that the neutron admits *spontaneous* decay (3.1). Second, note that the neutron does not possess the single meanlife of 15 minutes, as popularly believed, because its meanlife depends on the local conditions. For instance, the neutron meanlife is: a few seconds when member of certain unstable nuclei; 15 minutes when in vacuum; much longer in other unstable nuclei; and infinite in light natural, stable nuclei.

Since the neutron is naturally unstable, the main idea of proposal [26a] is that it *must admit means to stimulate its decay, thus permitting the control of its meanlife.* Among a variety of possibilities, proposal [26a] suggested testing the possible *stimulated decay of the neutron via the use of photons* $\hat{\gamma}$ *with the resonating frequency of 1.204 MeV, plus the additional threshold energy needed for the conservation of the energy:*

$$\hat{\gamma} + n \to p^+ + e^- + \hat{\nu}. \tag{4.1}$$

I assume the reader is now aware of the fact that the numerical value 1.294 of the resonating frequency is a direct consequence of the model $n = (p^+, \hat{e}^-)_{HM}$ of Section III–3. In particular, the value 1.294 MeV is a direct consequence of the density 1.65 of the hadronic medium inside the proton, which has been crucial to represent the rest energy and anomalous magnetic moment of the neutron, and which has been independently verified by the experiments on the Bose–Einstein correction of Section 2 of this paper.

Quantum mechanics predicts that reaction (4.1) has a very low cross section for all gamma energies, thus having no practical value. However, this is a pure "experimental belief," because the reaction has been solely studied at *very few* energies of the gamma and, from this limited information, it is *believed* that the result holds for *all* energies.

The *isoscattering theory* of hadronic mechanics (which os not reviewed here for brevity; see Chapter XII of Volume II of monographs [3e]) recovers the very low value of the cross section of reaction (4.1) for all energies *except a resonating peak at one sharp value of the gamma energy of 1.294 MeV,* in which case stimulated decay (4.1) has indeed a practical value (a smaller peak is also predicted for gammas with 0.511 MeV).

The case is similar to the discovery in the 1960s of the Λ particle at CERN. A group of physicists predicted a very flat cross section and no new particle. Other physicists looked for novelty, predicted a resonating peak, found it, and got the Nobel prize.

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4.2. Hadronic Energy (Copyrighted and Patent Pending)

A study of nuclei has revealed that, while most nuclei do not permit reaction (4.1) because of the violation of one or another conservation law, a specific class of nuclei do indeed permit said reaction, thus offering a possibility for a new form of energy I called *hadronic energy* [26a].

A representative example of admitted Stimulated Nuclear Transmutation (SNT) of Class I is given by [26a]:

$$\hat{\gamma} + {}_{42}Mo^{100} \to {}_{43}Tc^{100} + \beta^- - \text{stimulated}, \tag{4.2a}$$

$${}_{43}Tc^{100} \to {}_{44}Ru^{100} + \beta^- - \text{natural}. \tag{4.2b}$$

Note that: the initial and final isotopes, $_{42}Mo^{100}$ and $_{44}Ru^{100}$, are *light, natural, and stable elements*. The isotope $_{43}Tc^{100}$ is instead unstable, and decays in 18 seconds; one photon produces two electrons; the first electrons are predicted to have a maximum energy of 5.2 MeV, while the second electrons have tabulated energy ranging from 2.22 MeV to 3.38 MeV. Therefore, double reaction (4.2) can release a total energy of about 5.5 MeV.

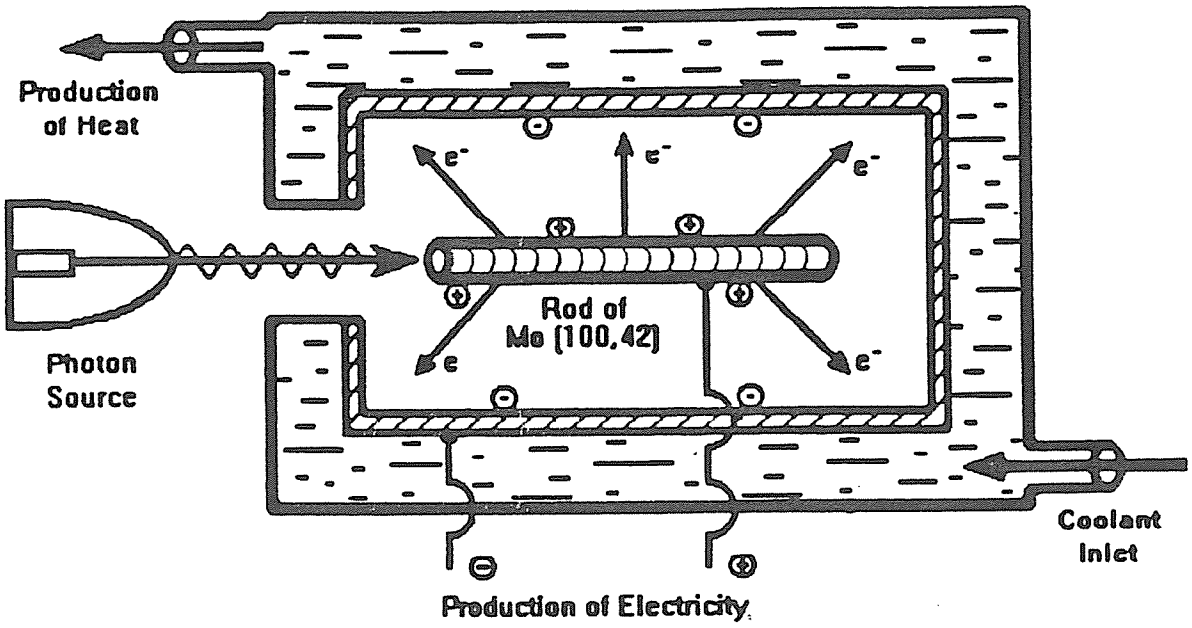

FIGURE 15: A conceptual visualization of the two forms of Santilli's hadronic energy [26a], the production of electricity and heat, via stimulated nuclear transmutations of a stick of $_{40}Mo^{100}$ caused by a coherent beam of photons with 1.294 MeV energy.

Some of the interesting aspects are: 1) hadronic energy emits no harmful radiations because the electrons can be captured with a metal screen, while the neutrinos are known to be totally harmless to humans and the environment (by comparison, nuclear energy emits very harmful radiations); 2) hadronic energy does not leave harmful waste because the energy starts from *light, natural, stable elements* and the end results are also *light, natural, and stable element* (while the conventional nuclear energy requires heavy elements and releases very dangerous waste); 3) hadronic energy consists of *two different forms of energy*, one of *electric type* originating from capturing the *charge* of the emitted electrons, and the other consisting of *heat* generated by the *kinetic energy* of the electrons (see Figure 13).

Numerous other light natural elements have the necessary pre-requisites to be "hadronic fuels". Among them, I quote from Ref. [26a]the zinc isotope (70,30), and the reactions:

$$\hat{\gamma} + {}_{30}Zn^{70} \rightarrow {}_{31}Ga^{70} + \beta^- - \text{stimulated}, \tag{4.3a}$$

$${}_{31}Ga^{70} \rightarrow {}_{32}Ge^{70} + \beta^- - \text{natural}. \tag{4.3b}$$

Note that the original isotope $_{30}Zn^{70}$ is a light, natural, and stable element. The isotope $_{31}Ga^{70}$ resulting from its stimulated transmutation is instead unstable, and decays spontaneously into the isotope $_{32}Ge^{70}$ which is also light, natural and stable, and decays in 21.6 minutes. The above double reaction released an energy of over 3 MeV which is clean, because without harmful radiations, and without dangerous waste.

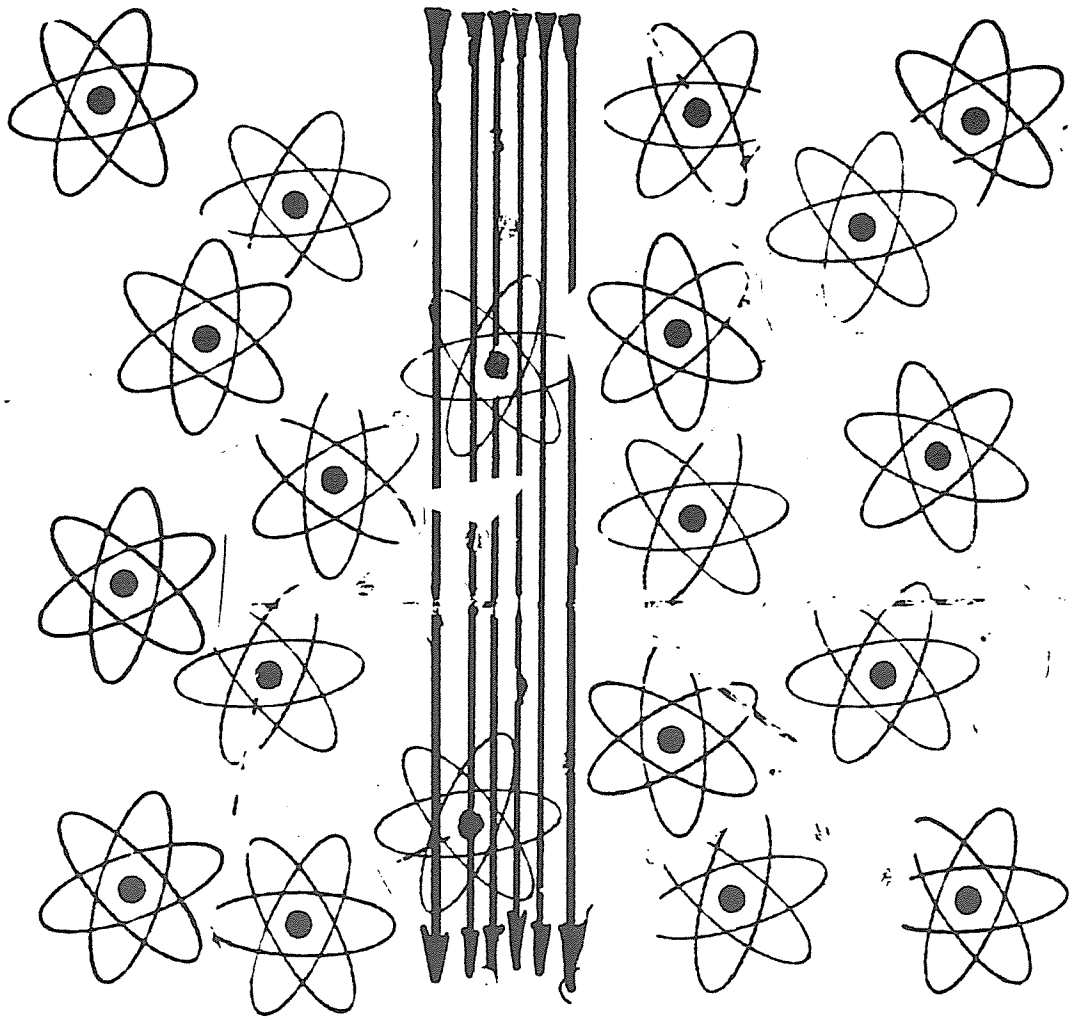

FIGURE 16: A schematic view of another expected application of the technology of new energies of Class I, the *hadronic drill* submitted by Santilli in Ref. [26a]. It essentially consists of a cylindrical beam of coherent photons with the resonating frequency needed to stimulated the decay of neutrons. The crystal structure of matter along said cylinder is expected to crumble due to the instantaneous proton excess in nuclei, resulting in a true drilling action. It should be stressed this type of application *is not* intended to produce energy, but rather to *drill* in ordinary structures, such as rocks. In fact, calculations

indicate that the amount of energy needed for the coherent photon beam is much bigger than the energy released in the stimulated neutron decays and subsequent spontaneous reactions.

Particularly intriguing is the possible use for "hadronic fuels" of the -socalled *mirror nuclei* [26a], namely, nuclei obtainable via the interchange of protons and neutrons while their total remains the same, according to:

$$\hat{\gamma} + {}_6C^{13} \rightarrow {}_7N^{13} - \text{stimulated.} \tag{4.4}$$

Note that the final element ${}_7N^{13}$ is a light,. natural, and stable. Therefore, process (4.4) is predicted without any secondary effect or radiation at all, the released energy being essentially manifested via temperature increases.

Yet another intriguing possibility is the use of stimulated decay of the neutron to synthesize rarte isotope. As an illustration from Ref. [26a], the extremely rare isotope ${}_4Be^6$ can be apparenmtly synthesized fromn the more readily available isotope ${}_3Lie^6$ and the stimulated reaction

$$\hat{\gamma} + {}_3Li^6 \rightarrow {}_4Be^6 - \text{stimulated} \tag{4.5}$$

Note that, unlike the preceding cases (4.2) and (4.4), the atomic mass of the resulting isotope, 6.019 a.m.u., is *bigger* than that of the original isotope, 6.015 a.m.u. Therefore, reaction (4.3) *requires* (ratehr than release) energy). Therefore, reactions of typer (4.3) are intended to synthesize new isotopes, and *n ot* for the production of energy.

Another intriguing application of the technology of new enegies of Class I is the "hadronic drill", also proposed in Ref. [26a]. It essentially consists of a coherent beam of photons with the resonating frequency required to stimulate the decay of neutrons. Calculations here omitted for brevity indicate that, under certain frequency, intensity, and coherence here omitted for security reasons, said photon beams creates an instantaneous excess of peripheral protons in natural elements, suchb as those contained in ordinary rocks. In turn, such proton excess in nuclei implies the instantaneous crumbling of the chrystal structure. Therefore, all matter contained in the cylindrical shape of the beam is predicted to crumble into dust, thus resulting in a true drilling action. Following that, nuclei reacquire their natural state via transmutations and/or electron capture, without expected radioactive waste (when the drilling action occurs in ordinary light elements).

Needless to say, hadronic energy requires considerable additional studies prior to any meaningfuyl appraisal. One aspect which is still unknown at this writing is balance between the energy required to produce the needed resonating photons, and the energy emitted.

Nevertheless, it is appropriate to recall the view expressed by a member of the Rockefeller family at the end of the past century, according to which fossil oil was at best expected to "fuel lamps in public streets" due to the predicted enormous costs for: drilling deep holes into the crust of the Earth; pumping the oil out into containers; transporting the oil to a refinery; refining the oil; storing the final fuel; and finally delivering it to the user. Contrary to these gloomy predictions of the past century, fossil oil resulted to be one of the most successful industrial program of this century.

I hope that this episode suggests cautions before venturing similar claims for hadronic and other new energies.

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4.3. Tsagas' Experimental Verification of Hadronic Energy

The experimental verification of stimulated nuclear transmutation (4.2) has been initiated by N. Tsagas and his group [27] (at the Nuclear Engineering Department of the University of Thrace, Xanthi, Greece), with preliminary, yet encouraging results were achieved following the publication of paper [27] (see Figure 14).

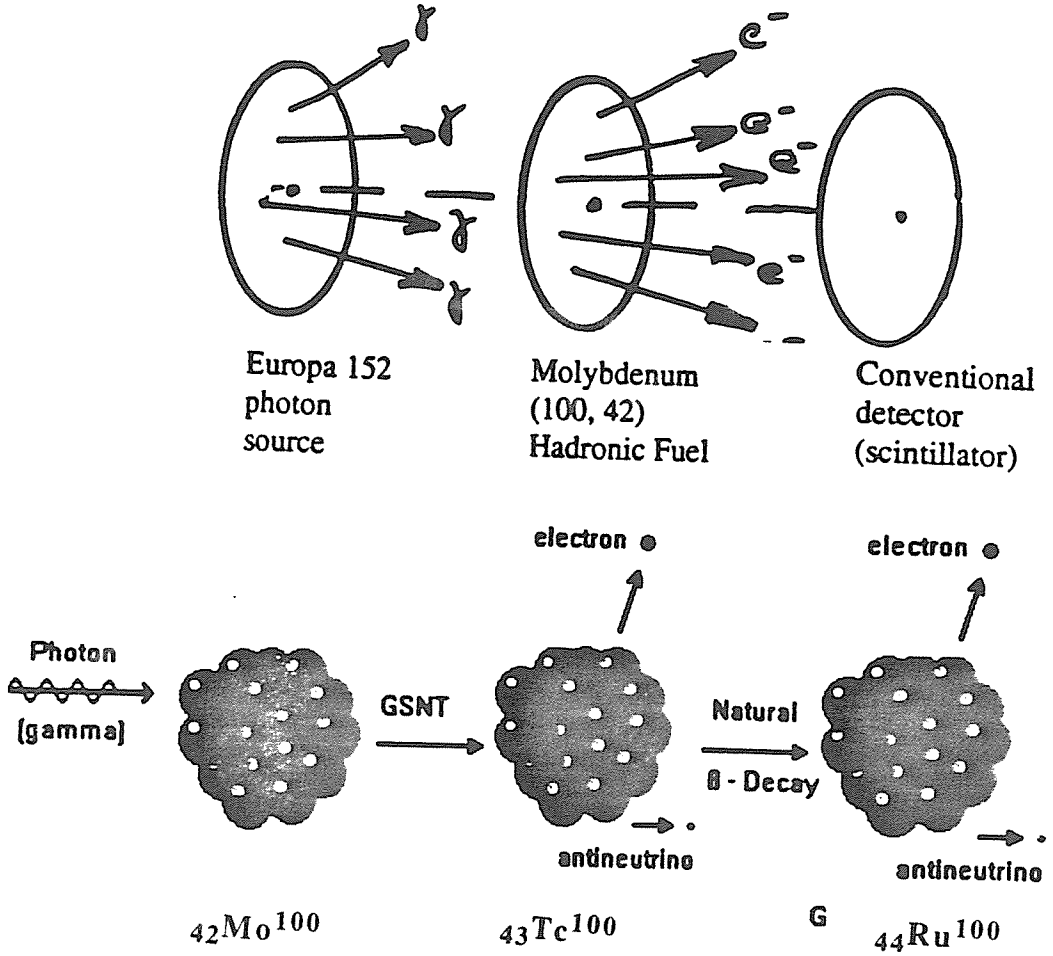

FIGURE 17: A schematic view of the ongoing Tsagas experimental verification of hadronic energy [27], illustrating: the source of photons with the needed excitation frequency of 1.94, MeV, Eu^{52}; the hadronic fuel selected for the test, $_{42}Mo^{100}$;and the scintillator. Measurements of electrons with energy sufficiently bigger than 1 MeV establish the existence of the stimulated decat of the neutron, because these electrons can only be of nuclearorigin.

The test has been conducted by: 1) using a disk of Eu^{152} as the source of photons with 1.294 MeV energy; 2) placing said disk next to a disk of natural molybdenum as target; and 3) measuring the *energy* of the electrons emitted by the Mo-disk.

Electrons originating from the Compton scattering of photons with peripheral atomic electrons can at most have 1 MeV energy [27]. Therefore, the detection of electrons with energy over 2 MeV establishes their *nuclear* origin.

Since the Eu source does not emit electrons, and the Mo-disk is stable, the only possible origin of said electrons is due to the stimulated decay of neutrons inside the Mo-disk. In fact, the first reaction (4.2a) emits electrons with minimal energy of 2.8 MeV, while the second reaction emits electrons with energy ranging from 2.22 MeV to 3.38 MeV.

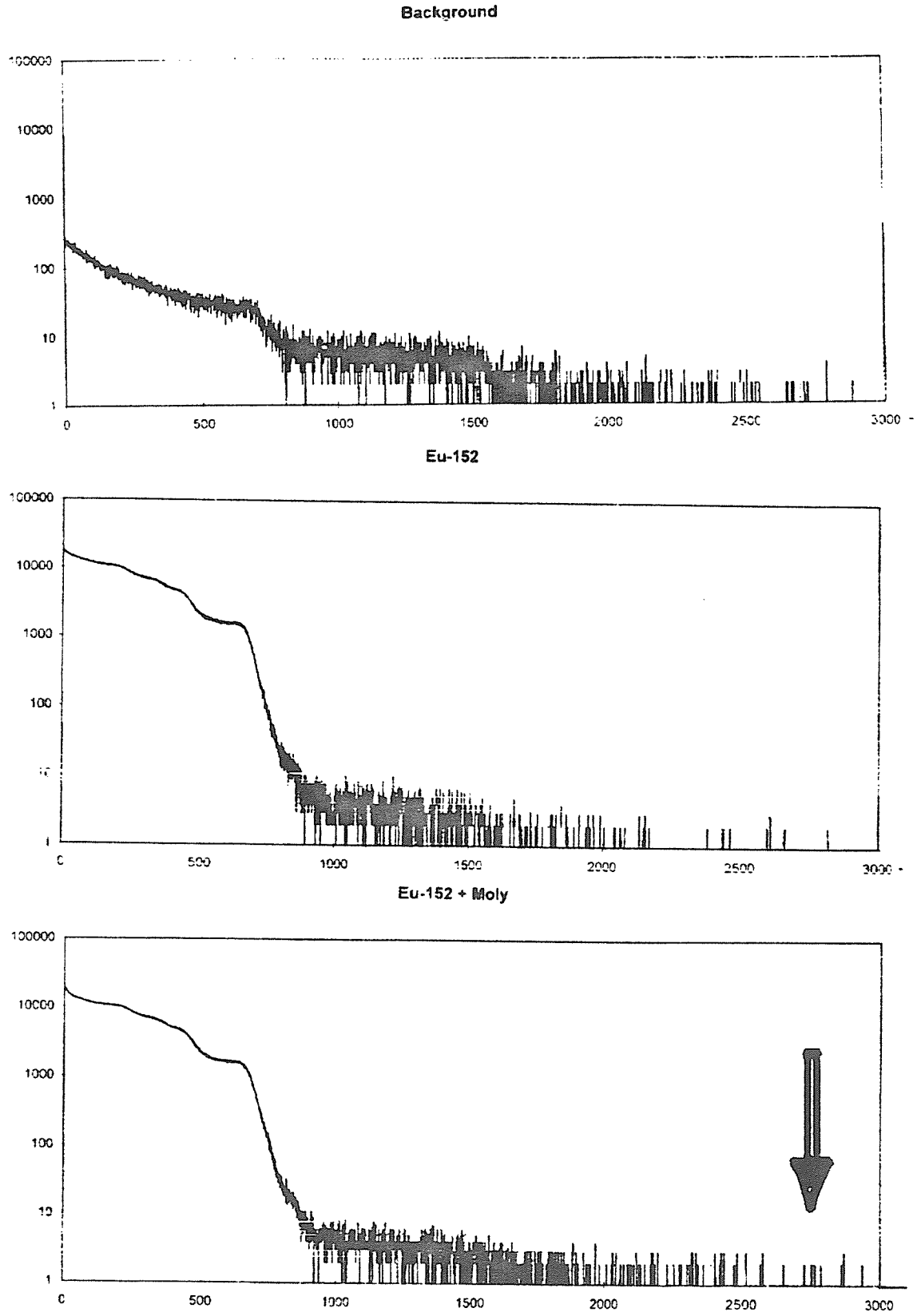

FIGURE 18: A reproduction of preliminary measurements by N. F. Tsagas and his team (private communication following [27]) on the test of Santilli's hadronic energy. The spectrum shows the detection of electrons with energies above 2 MeV which are absent in the Eu-spectrum and in the background. After elimination of any other possible sources, these electrons can only originate from the stimulated decay of the neutron in natural Molybdenum.

Tsagas's test [27] is currently limited by the fact that, while waiting for a disk of pure $_{40}Mo^{100}$, it uses ordinary Molybdenum which contains the isotope $_{40}Mo^{100}$ only to the extent of 0.6%. The statistical possibilities of reaction (4.2) are then rather limited because it is easy to prove that *none* of the other Mo-isotopes allows the stimulated decay of the neutron.

Despite the above insufficiency, the results are encouraging (see Figure 14).

4.4. Application to the Stimulated Decay of Nuclear Waste (Copyrighted and Patent Pending)

There is little doubt that the highly radioactive nuclear waste accumulating in our nuclear power plants is one of the biggest unsolved problems of contemporary society.

In the U.S. alone we have over 60,000 tons of radioactive waste currently stored at nuclear power plants. We have, therefore, surpassed the limits for safe storage in the pools of nuclear power plants. Europe has an even bigger tonnage of nuclear waste, and an unknown amount exists in other countries, all waiting for serious addressing and successful resolution of the problem. The yearly world production of about 15,000 tons of additional waste then sets the premises for a truly serious environmental problem of potentially historic proportions.

As it is well known, the "official" position by the U.S. , European and other governmental has been that of transporting the highly radioactive nuclear waste to a dumping area. This "solution" has met with predictable resistance from environmental groups and residents near the proposed dumping grounds. In fact, the transportation of the nuclear waste must occur on public streets, with evident dangers nobody can credibly deny. Assuming that local residents will permit the transit of so dangerous a material in such a large amount, additional potentially catastrophic dangers exist in the intended storage of the nuclear waste, because it cannot be credibly predicted to be viable for tens of thousands of years. This scenario has led to the current lack in the U. S. as well as abroad of a credible solution for the disposal of the highly radioactive nuclear waste.

After studying the problem for several years, it is my opinion that *contemporary scientific and industrial knowledge permits the "recycling" of highly radioactive nuclear waste, here defined as that resulting from their stimulated decay, which can reduce extremely long meanlives to hours or days.* The recycling then consists in the stimulated decay within an environment capable of absorbing the radioactive debris (*e.g.*, inside a water pool).

Moreover, *said novel recycling can be achieved via (relatively) light equipment and can be conducted by nuclear power corporations in their own plant.*

Thus, the above new recycling would *avoid the transportation and storage of the waste to an unknown and highly opposed dumping site, and eliminate the un-necessary expenditure of hundred of billions of dollars.*

Finally, *the new means for recycling nuclear waste are expected to create a new industry, that for the development, production and sale of the new equipment which is expected to be needed by nuclear power plants all over the world.*

The main ideas of the new recycling are essentially the following. The nuclei here considered are very large and naturally unstable. Thus, they must admit a number of different means to stimulate their decay. Some of them are of Class II, *e.g.*, as in patents [29a,29b] (because acting on a nucleus as a whole), such as the deformation of nuclei via the use of intense electric fields. Since the nuclei are large and naturally unstable, said deformation alone stimulates the decay of at least a percentage of the nuclei due to excessive polarized positive charges. These means will be studied in more detail in Paper IV.

The possible recycling nuclear waste via the stimulatyed decay of the neutron was proposed by R. M. Santilli [26a]. It consists of exposing the radioactive nuclear waste to an intense and coherent flux of photons with the needed resonating frequency, which can nowadays be obtained from a synchrotron of about 3 m in diameter, thus resulting in equipment that can be transported to the nuclear power plants.

Under a certain intensity and other conditions (which I cannot disclose at this writing), various peripheral neutrons of the nuclei are predicted to decay simultaneously, thus creating an instantaneous excess of protons, under which the stimulated decay is consequential.

On merely indicative grounds, consider the isotope $_{92}U^{238}$ of the waste released by nuclear power plants, which has the very long life of 4.51×10^9 years with the known harmful emission of α particles and SF. The use of the technology under consideration would imply the primary artificial transmutation [loc. cit.]

$$\hat{\gamma} + {}_{92}U^{238} \rightarrow {}_{93}Np^{238} + \hat{\beta}^-, \tag{4.6}$$

where $_{93}Np^{238}$ is also an unstable isotope, but with meanlife of 2.1 days and spontaneous beta-minus decay with 1.29 MeV.

A double stimulated transmutations yields:

$$\hat{\gamma}_1 + \hat{\gamma}_2 + {}_{92}U^{238} \rightarrow {}_{94}Pu^{238} + \hat{\beta}^-{}_1 + \hat{\beta}^-{}_2. \tag{4.7}$$

The last element $_{94}Pu^{238}$ is also an unstable isotope, which possesses the harmful emission of α particles and spontaneous fission, but has the considerable advantage of having the meanlife of only 86 days during which it can be left under suitable shields.

Possible tertiary artificial transmutations would yield $_{95}Am^{238}$ which is unstable with meanlife of 1.9 hours, spontaneous electron capture back to $_{94}Pu^{238}$ and emission of 2.3 MeV. The atomic weight of the initial element $_{92}U^{238}$ is 238.050 and that of the final element $_{94}Pu^{238}$ is the smaller value 238.049, thus establishing the compliance of the stimulated recycling of this invention with the conservation of the total energy.

The advantage of the above stimulated transmutations is then evident. A sufficiently intense bombardment of photons of the indicated excitation frequency is expected to transmute the highly radioactive element $_{92}U^{238}$ with the very long meanlife of 10^9 years into the element $_{94}Pu^{238}$ with a drastically reduced meanlife of the order of days.

Numerous additional applications, refinements and realizations of the basic principles of this inventions are possible. Some of them are contemplated for subsequent patent applications.

The reader should be aware that the above recycling requires complementary means to weaken the nuclear force via new resonating effects, as well as the complementary use of other methods such as those of patents [29a,29b].

An additional method of recycling nuclear waste related to, but different than that of Ref. [26a] is than more recently proposed by Brown [29e]. The latter method is essentially based on the well established conventional quantum mechanical merans of photodisintegration, while the former mandates the use of a covering mechanics; also, the latter method acts on a nucleus as a whol;e, while the former acts on the structure of individual neutrons. Despitre these differences, the two methods nicely complemen t each other, and should perhaps be tested jointly.

It is hoped that the U.S., European and other governments revise their current, essentially political consideration of the problem of nuclear waster, and restore its true nature, that of being a purely *scientific* issue which, as such must be resolved via *new experiments,* rather than political agreements that have no chance of being permitted by courts.

The main understand is that *the recycling of nuclear waste via its stimulated decay is strictly prohibited by quantum mechanics for the reasons reviewed in this and in the preceding papers of this series.* On the contrary, the admission that quantum mechanics is not the final theory of nature, as necessary for a credible governmental policies, does indeed permits numerous possibilities of scientific-technological resolutions of the problem of nuclear waste.

In any case, due to the dimensions of the unsolved problem of nuclear waste, the absence or protracted delay of profound revisions of current governmental policies in the issue will likely result in a condemnation of historical proportions.

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copyrighted various publications on the stimulated decay of radioacxtive nuclear waste outlined in this section, while Patent Applications are pending. I intend to defend such copyrights and Patent Pending in any means permitted by law.

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4.5. Physical Laws of New Energies of Class I (Copyrighted and Patent Pending)

The studies outlined in this Paper III can be summarized with the following physical laws for new energies of Class I, first published in [22b]:

Law I-1: Nonunitary effects produce isorenormalizations of intrinsic characteristics of particles. The intrinsic characteristics of particles are mutated by short range nonlocal and nonunitary effects due to deep overlappings of the wavepackets for distances of 1 fm or less, resulting in novel isorenormalizations characterized by the Poincaré–Santilli isosymmetry, such as the isorenormalization we have encountered in Section III-3 for the rest energy $m \times c_o^2 \rightarrow m \times c_o^2 / n^{\circ}{}_4^2$, spin $s \rightarrow \Delta \times s$, etc.

Law I-2: Only singlet hadronic bound states are stable. According to quantum mechanics, bound states at large mutual distances can occur for particles in both singlet and triplet couplings (spin antiparallel and parallel, respectively). According to hadronic mechanics, stable bound states at distances of 1 fm or less can only occur for singlet coupling. Triplet couplings are highly unstable, as illustrated by the *gear model* [3a], because they require a drag motion of one wavepacket against the other.

Law I-3: Total energies of hadronic bound states are bigger than the sum of the rest energies of the constituents. Quantum mechanical bound states can only occur when the total energy is *smaller* than the sum of the energies of the constituents (negative binding energies resulting in a mass defect). For hadronic mechanics, bound states can occur for total energies much bigger than those of the constituents, because of the isorenormalization of the rest energy of the constituents, constraints due to motion within a physical media and other effects completely absent in quantum mechanics.

Law I-4: Atomic spectra are suppressed by hadronic bound states down to only one admissible energy level. Quantum mechanical bound states admit an *infinite* number of energy levels, as it is typically the case for the hydrogen atom, the positronium, etc. By comparison, hadronic mechanical bound states admit *only one* energy level, because all excitations imply the increase of mutual distances beyond 1 fm, with consequential recovering of the infinite *quantum* spectra.

Law I-5: The sizes of hadronic bound states remains constant with the increase of the mass. Quantum mechanical bound states, such as nuclei or atoms, increase their size with mass, while the size of hadronic bound states of particles at distances of 1 fm or less (the hadrons) remains essentially the same with the increase of the mass, thus confirming their origin as due to total mutual penetration of the wavepackets.

Law I-6: Hadronic bound states occur independently of whether the Coulomb force among the constituents is attractive or repulsive. The forces described by hadronic mechanics due to deep overlapping of wavepackets are so strongly *attractive as* to create a bound state irrespective of whether the Coulomb force is attractive or repulsive.

Law I-7: New energies of Class I are produced by the stimulated decay of unstable hadrons. The synthesis of hadrons from lighter particles is endoenergetic (it *requires* energy), while their decay is highly esoenergetic (it *releases* energy) due to the generally large isorenormalizations of Law 1. The new energies of Class I are characterized by stimulated decays of

hadrons such as the neutron, via resonating and other effects which are capable of expelling one or more constituent. The new energies of Class I then consist in capturing the energy released in said decays.

It is hoped that the above physical laws may be of assistance in maximizing the efficiency of the new energies here considered. Researchers in the field are, however, warned *not* to extend blindly all the above *subnuclear* laws to the nuclear energies of Class II, because of significant differences treated in Paper IV.

Nevertheless, some of the above physical laws will persist in the transition to nuclei, most notably the *charge independence of nuclear forces,* which is *dynamically* explained for the first time by hadronic mechanics.

Lesser known is the expected significant increase in efficiency of low energy nuclear reactions and other energies of Class II by: 1) restricting the constituents to be in *singlet* coupling; 2) identifying and maximizing the trigger; and 3) identifying and minimizing the threshold energy. These and other nuclear aspects will be studied in Paper IV.

The physical laws of new energies of Class I have been published in this copyrighted publication for the first time. I intend to defend that copyright with all means permitted by law. The content of this section can be used by anybody in part or in full for any scientific purpose without any prior authorization, *provided* that: 1) This publication is quoted; 2) Its content is outlined as a prerequisite for allegations of novelty; and 3) The paternity is identified with clarity.

5. PROPOSED NEW EXPERIMENTS

I hope to have outlined in this paper the existence of experimental evidence establishing beyond credible doubt the inapplicability (and not the violation) of nonrelativistic and relativistic quantum mechanics for interior dynamical problems of particles, in addition to the conceptual arguments of Paper I and the theoretical analysis of Paper II.

Despite these advances, numerous additional experiments are warranted to gain the knowledge necessary for further basic advances in new energies of Class I, such as:

Proposed experiment 1: Measure the isoredshift of Sun light at Sunset and Sunrise. The proposal consists of: a) identifying a number of Fraunhofer lines in the Sun light at the Zenith and then follow them to the horizon; b) measuring the same lines at Sunrise and then follow them to the Zenith; and 3) comparing the two measurements (additional tests are suggested in [3d]). As indicated earlier, isospecial relativity predicts a specific numerical value of measurement a) bigger than that due to the Earth's rotation, as well as bigger than measurement b) [3d]. This test would establish the very pillar of the isospecial relativity, the anomalies due to the inhomogeneity and anisotropy of physical media (which are completely absent in special relativity). The test would also resolve on Earth the mystery of physically connected quasars and galaxies with dramatically different redshift.

Proposed experiment 2: Establish the prediction of hadronic mechanics that photons emitted from the interior of hadrons are isoblueshifted. This test can be done in a number of ways available on request, and it is a necessary complement of the preceding one.

Proposed experiment 3: Provide a final resolution of the behavior of the meanlives of unstable hadrons with speed (or energy). The proposal essentially consists in the finalization of tests [15a,15b] without equivocal theoretical assumptions in the data elaboration indicated in Section .2.5. It is unreassuring to note that, after one century of investigations, and the use of billions of dollars of public funds, the experimental finalization of deviations from Einsteinian doctrines in the interior of hadrons (as well as nuclei and media at large) has not been conducted, and Einsteinian doctrines continue to be assumed as exact in the conditions considered, despite

large evidence to the contrary. By keeping in mind that so many other, dramatically less significant experiments have been preferred by experimentalists, the above scenario leads to a *pre-meditated intent* to suppress the final veritication of deviations from Einsteinian doctrines in the interior of hadrons (see in [I-2a] the report of countless solicitations I made to Fermilab, CERN and other laboratories to conduct the test here proposed, and its documentation in [I-2b]). The final experimental confirmation of deviations from Einsteinian doctrines in the interior of hadrons, nuclei, stars, and physical media at large, constitutes the most solid foundation for new clean energies much needed by our society. The same confirmation will also stimulate a new scientific renaissance beyond the now surpassed Einsteinian doctrines, with implications and applications (such as geometric locomotion, antigravity for antimatter in the field of matter, causal spacetime machine, and others [3]) which can be only imagined at this time.

Proposed experiment 4: Verify Don Borghi's test on the synthesis of the neutron [24a]. The test can be independently verified by: 1) saturating a beryllium mass at low temperature with hydrogen, in which case the hydrogen nuclei (protons) can be considered to be essentially at rest; 2) hitting said mass with a beam of electrons with the needed threshold energy of 0.8 MeV; and 3) use magnetic fields for the opposite polarization of the spins of the protons and of the electrons (otherwise the syntheses of the neutron is not possible or it has very low efficiency). The detection of neutrons emitted by the Beryllium would provide the final confirmation of the laboratory synthesis of the neutron from protons and electrons at low temperature.

Proposed experiment 5: Verify Tsagas test on the stimulated decay of the neutron [27]. The test can be verified in a number of alternative ways, *e.g.*, via the use of the alternative stimulated transmutation $\hat{\gamma} + {}_{30}Zn^{70} \to {}_{31}Ga^{70} + \beta^-$, where ${}_{31}Ga^{70}$ is naturally unstable with spontaneous beta decay ${}_{31}Ga^{70} \to {}_{32}Ge^{70} + \beta^-$ with electrons possessing energies ranging from 0.44 MeV to 1.66 MeV. Yet another intriguing experiment is that based on the resonance enhanced reaction $\hat{\gamma} + {}_3Li^6 \to {}_4Be^6 + \beta^-$.

Proposed experiment 6: Verify the recycling of radioactive nuclear waste via the stimulated decay of their peripheral neutrons. The stimulated decay of the neutron can also be tested with radioactive nuclei, such as ${}_{92}U^{238}$ which has a meanlife of 4.51×10^9 years with an easily detectable decay into α's and other debris. Its transmutation via stimulated neutron decay would yield ${}_{93}Np^{238}$, which is also highly radioactive, yet possesses the extremely reduced meanlife to 2.1 days.

Proposed experiment 7: establish the synthesis and stimulated decay of other hadrons. Besides the neutrons, some of the best candidates are the synthesis of π° from an electron and a positron, or the synthesis of Λ from a neutron and a π°. One of the resonating frequencies of the π° is 86.5 MeV. By hitting the π° with photons of said frequency, the meson should decay into an electron a positron and a photon. A similar stimulated decay should exist for all other unstable hadrons.

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THE PHYSICS OF NEW CLEAN ENERGIES AND FUELS ACCORDING TO HADRONIC MECHANICS, PAPER IV: STRUCTURE OF NUCLEI AND NEW ENERGIES OF CLASS II[1]

Ruggero Maria Santilli[2]

ABSTRACT

This is the last of a series of five articles outlining systematic research on new energies at the particle, nuclear, and molecular levels, initiated by the author at Harvard University in 1978 under DOE support, and then continued by numerous scientists at various institutions. Paper I identified the new energies studied in this series as those not predictable or treatable by quantum mechanics, and presented clear limitations of quantum mechanics in numerous fields. Paper II outlined the various branches of the covering hadronic mechanics, the novel mathematics needed for its invariant formulation, and catastrophic inconsistencies of other noninvariant generalizations. Paper III classified the new energies into: *Class I*, when of particle origin; *Class II*, when of nuclear origin; and of *Class III*, when of molecular origin. Paper III then reviewed the experimental evidence supporting hadronic mechanics in particle physics; reviewed Santilli's structure model of the neutron as predicted by Rutherford (a bound state of the proton with the electron totally immersed in its hyperdense interior) reached in 1990; identified the physical laws of new energies as predicted by hadronic mechanics; and outlined examples of new energies of Class I, with applications to expected new means of recycling nuclear waste into stable elements by stimulating their decay. This paper is devoted to new energies of Class II, those originating at the nuclear level, and contains: a more technical identification of the rather numerous limitations of quantum mechanics in nuclear physics; evidence of the capability by hadronic mechanics of resolving said limitations, and achieving the first known exact-numerical representations of various nuclear experimental data, which are currently represented only in an approximate way; the presentation of a new structure model of nuclei permitted by the consistent treatment of Rutherford's conception of the neutron of the preceding paper; the identification of the physical laws of new energies of Class II as predicted by hadronic mechanics; and the identification of specific embodiments suggested by hadronic mechanics, either for new energies or for improving the efficiency of existing energies of nuclear type.

1. INTRODUCTION

1.1. Statement of Objectives

This is the fourth of a series of five articles outlining systematic research on new energies at the particle, nuclear, and molecular levels, initiated by the author at Harvard University in 1978 under DOE support, and then continued by several researchers at various Institutions.

Paper I [1a] presented the limitations of quantum mechanics in a way as comprehensive as

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possible, and defined the new energies to be studied in these papers as those not predicted by quantum mechanics, thus requiring the use of a covering mechanics.

Paper II [1b] outlined the foundations of a broadening of quantum mechanics known under the name of *hadronic mechanics* built over two decades by numerous mathematicians, theoreticians and experimentalists (see [2,3] and large references quoted therein) which: 1) Admits quantum mechanics as a particular case; 2) Is nonequivalent to quantum mechanics as a necessary condition for novelty (because nonunitarily related to the latter); and 3) Is as consistent and invariant as quantum mechanics. Also, Paper II contains proofs that other generalized theories are afflicted by catastrophic physical and mathematical inconsistencies.

Paper III [1c] classified new energies into: CLASS I, when of subnuclear origin; CLASS II, when of nuclear origin with possible contribution of Class I; and CLASS III, when of atomic-molecular origin with possible contributions from Classes II and I.

The same Paper III: 1) presented comprehensive experimental evidence on the *interior structural problems* of subnuclear-particle physics supporting the validity of the covering hadronic mechanics; 2) outlined my nonrelativistic studies of 1990 [4a] on the representation of the neutron as a bound state of a proton and an electron in conditions of total mutual penetration, as originally conceived by Rutherford, by referring the interested reader to papers [4b,4c] for the relativistic treatment; 3) showed that these studies have permitted the nonrelativistic and relativistic representation of the *totality* of characteristics of the neutron, including rest energy, charge radius, spin, meanlife, anomalous magnetic moments, etc.; 4) showed that such a structure model of the neutron not only is in agreement with the preceding experimental data, but can be actually derived from them (particularly for the isorenormalization of the mass); 5) identified the *physical laws of new energies of Class I;* 6) then studied a representative example of *new energies of Class I,* and outlined its preliminary experimental verification; and 7) proposed a number of additional experiments for further basic advances.

The main objective of this paper is the study of new energies of Class II. As was the case at the subnuclear level, the study requires the prior experimental verification of hadronic mechanics in nuclear physics, as well as a re-inspection of the nuclear structure via the covering mechanics.

A main objective of this paper IV is the study of the following *Stimulated Nuclear Transmutations* (SNT) as predicted by hadronic mechanics:

$$TR. + N_1(A_1, Z_1) + N_2(A_2, Z_2) \to N_3(A_3, Z_3), \tag{1.1.1a}$$

$$A_3 = A_1 + A_2, \quad Z_3 = Z_1 + Z_2, \tag{1.1.1b}$$

where TR is the *hadronic trigger* (Figure 8 of Paper III, hereon denoted III-8) to be identified in Section 3, and the nuclei are totally (or almost totally) ionized as a necessary condition to characterize energies of Class II.

SNT (1.1.1) are intentionally restricted to reactions without secondary radiations, because they are the most difficult to treat. Once SNT (1.1.1) *without* secondary radiations are theoretically and experimentally verified, their extension with the addition of secondary radiations is trivial and left to the interested reader. Also, SNT (1.1.1) *without* secondary radiations are the most significant for the environment and industry.

The above SNT will be restricted by numerous conditions, the first one being the strict verification of all conventional total conservation laws, including those for energy, linear momentum, angular momentum, etc.

The theoretical treatment of SNT (1.1.1) will be restricted to verify all established quantum laws, such as Heisenberg's uncertainty, Pauli's exclusion principle, causality, etc. This treatment implies the restriction of hadronic mechanics to its isotopic branch (Paper II), whose knowledge is hereon assumed.

As it is well known in nuclear physics [5], when possible, events (1.1.1) are generally *esoenergetic,* in the sense that they release energy in a way fully compatible with the conservation of the total energy.

The release of energy in SNT (1.1.1) is possible because the mass M_3 of the resulting nucleus N_3 is generally *smaller* than the sum of the masses of the original nuclei M_1 and M_2. The difference, called "mass defect," is then released as heat or other forms of energy,

$$\Delta M = (M_1 + M_2) - M_3 > 0. \qquad (1.1.2)$$

Also [5], mass defects are generally large (due to the high value of nuclear forces). As a result, the possible identification of only *one* SNT (1.1.1.) under the indicated consistency conditions is sufficient to warrant all possible research efforts due to their evident scientific, industrial and societal relevance.

I shall devote particular care to the identification of the physical laws and conditions under which the above SNT are possible. These laws appear to play a vital role to identify the conditions under which the efficiency of the new energies is of industrial level, where the *efficiency* of new energies of Class II is simply defined as the number of reactions (1.1.1) per mole.

More specifically, various forms of new energies of Class II already exist and, following serious research, their existence has been established beyond scientific doubt. However, their efficiency is so low that the actual macroscopic energy output is practically irrelevant, thus having little industrial value.

Other fundamental objectives of this study are the identification of the reasons for the indicated low efficiency of existing forms of new energies of Class II, as well as the identification of specific conditions and equipment capable of increasing the efficiency of the same energies to practically usable levels.

SNT (1.1.1) will also be studied under possible contributions of Class I of the type:

$$e^- + N(A, Z) \rightarrow N^*(A, Z - 1) + \text{Sec. Terms}, \qquad (1.1.3a)$$

$$\gamma + N(A, Z) \rightarrow N^*(A, Z + 1) + \text{Sec. Terms}, \qquad (1.1.3b)$$

which were studied in Paper III, and their knowledge is, therefore, assumed.

The conclusion of this study is that *the new energies of Class II are indeed real, thus warranting serious additional research by industry, academia, and government.*.

Note that that *no study of cold fusion will be conducted in this paper.* The reason is that, by assumption, this type of event must occur at ordinary temperature, thus implying the necessary use of complete, non-ionized, ordinary *atoms*, rather than naked nuclei. Therefore, certain types of cold fusions are new energies of Class III, with evident contributions of Classes II and I. As such, cold fusion will be studied in Paper V.

I believe that this point is important for cold fusion research, because numerous studies in the field are essentially restricted to *nuclear* profile, by ignoring electron clouds. Under these premises, I must agree with known reservations by orthodox academia, because electrons clouds generally *prohibit* most of the claimed reactions, evidently due to the spherical distribution of said electron clouds, and their notorious stability, which prevents nuclei to reach the needed distances of 1 fm to activate truly *nuclear* reactions.

Therefore, the setting of cold fusion reactions as part of new energies of Class III focuses the attention on the fact that one must consider the atomic-molecular structure *before* any consideration of nuclear reactions may acquire a scientific value.

The above scenario prevents me from using pre-established terminologies, such as *low temperature, or chemically assisted nuclear transmutations,* because none of them is applicable without restrictions to new energies of Class II. For instance, the achievement of a complete ionization may be reached via an electric discharge whose local temperature is about 5,000° C. As such, the nomenclature of "low temperature nuclear transmutations" is inappropriate, and the same happen for "chemically assisted nuclear transmutations" and other terms existing in the literature.

1.2. Lack of Exact Character of Quantum Mechanics in Nuclear Physics

As stressed in Paper I, despite its excellent *approximation* of nuclear phenomena, quantum mechanics has numerous basic insufficiencies which prevent a deeper understanding of nuclear physics.

Needless to say, the covering theory applicable to nuclear physics is open to scientific debates, but not its need, because physics will never achieve "final theories."

The approximate character of quantum mechanics in nuclear physics is one of the most fundamental issues addressed in these papers. The *exact* validity of quantum mechanics in nuclear physics directly and incontrovertibly implies the *lack of existence* of new energies, such as SNT (1.1.1). Therefore, new energies of Class II crucially depend on the nuclear *insufficiencies* of quantum mechanics.

The reasons for the lack of final character of quantum mechanics in nuclear physics are many. An outline was provided in Paper I, Section I-.2.3. Additional reasons for insufficiencies are the following.

1.2.1. Insufficiencies of Quantum Mechanics for the Nuclear Force

Nuclear physics has acquired the reputation as a discipline that keeps continuously increasing the number of potentials for the representation of the nuclear force. This fact is *per se* clear indication that, after about one century of research, quantum mechanics has not permitted a satisfactory understanding of nuclear forces.

As of today, we have the *Wigner, Majorana, Bartlett, Heisenberg, Serber potentials* and numerous other *central potentials,* plus numerous additional *non-central potentials,* as well as further additional *tensorial potentials,* not to forget numerous *velocity dependent potentials,* etc., etc.:

$$\text{Nuclear}_{\text{force}} = V_W + V_M + V_B + V_B + V_H + V_S +$$

$$+ V_{\text{noncentral}} + V_{\text{Tensorial}} + V_{\text{velocity dependent}} + \cdots \qquad (1.2.1)$$

It is evident that, by keeping adding potentials, a good agreement with experimental data is, sooner or later, eventually achieved. Therefore, the validity of all these potentials to represent physical reality *is not* the issue here.

The first insufficiency lies in the fact that, despite about one century of research, *nuclear physics has failed to achieve a solution of its most fundamental problem: the physical origin of the strong attraction among nuclear constituents (nucleons).*

All the various potentials (1.2.1) provide a mere *mathematical* representation of the attraction among nucleons, without any explanation whatever of its *physical* origin.

After all, neutrons n are neutral and protons p are positively charged. Therefore, nuclear physics is not in any position to explain how *strong attractive* forces can possibly exist for p-n, p-p and n-n systems.

As a result, quantum mechanics has left fundamentally unresolved to this day the problem of the *physical origin* of the attractive strong nuclear force.

There are additional basically unsolved problems in the current studies of nuclear forces via quantum mechanics. According to clear experimental evidence, the range of the strong interactions is of the order of 1 fm (= 10^{-13} cm), which coincides with the size of protons and neutrons. A *necessary* condition to activate nuclear forces is therefore that protons and neutrons enter into a state of partial mutual penetration and overlapping.

In fact, simple calculations based on the use of the experimental values of nucleart and

nucleon volumes establish that in a nuclear structure, nucleons are inndeed in conditions of mutual overlapping of their charge distributions, although in small amounts (as comparted to the large amounts of overlappings in the hadronic structure) [4d].

But nucleons are some of the densest objects measured by mankind in laboratory. Their mutual overlapping necessarily implies the presence of the nonlinear, nonlocal and nonpotential effects which cannot possibly be *exactly* represented via any local potential, that is, with none of the plethora of potentials (1.2.1), no matter how many are added.

The first implications of hadronic mechanics for the nuclear forces are: 1) the truncation of adding new potentials in the Hamiltonian; 2) the addition instead of nonlinear, nonlocal, and nonpotential interactions represented via the generalized unit (see Paper II); and 3) the re-inspection of the current plethora of potential forces to see whether they do indeed admit a potential energy *on clear physical (rather than mathematical) grounds*, or, in reality, some of them are of nonpotential type.

In conclusion, after about one century of research, quantum mechanics has permitted a first *approximate and purely mathematical* representation of nuclear forces without any understanding of the *physical* origin of their strongly attractive character. On the contrary, the claim that quantum mechanics has permitted the final understanding of nuclear forces is basically incorrect.

1.2.2. Insufficiencies of Quantum Mechanics for the Nuclear Structure

Numerous models of the nuclear structure have been developed through this century via quantum mechanics, including Wigner's uniform model, Fermi's gas model, the shell model, the independent particle model, the liquid drop model, and many other models [5]. The validity of these models for a *first approximation* of the nuclear structure is beyond doubt.

However, none of the existing models explains the structure of the simplest possible nucleus, the deuteron. Experimental evidence has established that the deuteron has spin 1, that it, the proton and the neutron are *believed* to be coupled in *triplets* (parallel spins). Such a coupling is against all known quantum mechanical properties, which demand that the lowest stable state between two particles with spin (the ground state) be in *singlet* (anti-parallel spins). Therefore, quantum mechanics has been unable to identify the physical reasons why the deuteron has spin 1.

In reality, a ground state with spin 1 generally constitutes evidence that the state is a *three-body* system, which is contrary to the current conception of the deuteron as a *two-body* system.

The best way to understand the unsolved nature of this problem is to conduct two desk experiments via the use of two spinning tops, the first by hitting the tops one against the other with parallel spin and the second with spin antiparallel. It is easy to see that, in the former test, the two tops are instantly pushed away from each other, thus confirming the impossibility for two spinning particles to have a stable state in triplet couplings. When the test with tops having antiparallel spin is conducted with the appropriate spins and relative center-of-mass speeds (which requires a few trials), it is easy to see visually the tendency of the two tops to attract each other, thus confirming the indicated well-known property.

Another fundamental problem which has also been left unsolved by quantum mechanic is the *stability of the deuteron*. As stated in all physics books, free neutrons *are not* stable particles, and are instead unstable with a meanlife of about 15 minutes. But then the deuteron should also be unstable with a meanlife of about 15 minutes, which is dramatically against experimental evidence, because the deuteron has *infinite* meanlife.

If all these unresolved problems exist for the structure of the simplest possible nucleus, the deuteron, one can imagine the open problems that exist for more complex nuclei.

In conclusion, the claim that quantum mechanics has permitted a first, incomplete and preliminary understanding of the nuclear structure is indeed scientifically sound and acceptable. However, the claim that quantum mechanics is the final theory for nuclear physics is uincorrect,

even when expressed by leading experts in the field.

1.2.3. Insufficiencies of Quantum Mechanics for the Representation of Nuclear Magnetic Moments

As stressed in Paper I, a theory can be considered as *exact* in a given field, when it permits an *exact* representation of *all* experimental data. This is absolutely not the case for quantum mechanics in nuclear physics. Lacking exact representations of numerous nuclear data, any claim that quantum mechanics is exactly valid in nuclear physics has insufficient experimental support. Again, the selection of the appropriate generalization is open to scientific debates, but questioning its need is outside science.

One illustration is the impossibility by quantum mechanics throughout this century to achieve an exact representation of nuclear magnetic moments, despite countless attempts. As recalled in Paper I, quantum mechanics has been unable to represent exactly the magnetic moment of the simplest possible nucleus, the deuteron, let alone those of heavy elements. After all possible corrections, quantum mechanics still misses one percent of the experimental value. Progressively increasing percentages are missed for heavier nuclei, with very large percentages being missed for large nuclei.

The impossibility for quantum mechanics to provide an exact representation of the magnetic moment of the deuteron is established by numerous aspects. First, the magnetic moment of the proton is [5]:

$$\mu_p = 2.7934\, e\times\hbar/2\times M_{co}\,, \tag{1.2.1}$$

while that of the neutron is:

$$\mu_n = -1.9135\, e\times\hbar/2\times M_p\times c_o, \tag{1.2.2}$$

where c_o is the speed of light in vacuum, M_p is the mass of the proton and $e\times\hbar/1\times M_p\times c_o$ is the unit of nuclear magnetic moments.

For the case of a proton and a neutron in triplet coupling in the ground state S (which has null angular momentum), quantum mechanics predicts that the total magnetic moment of the deuteron should be [5]:

$$\mu_d^{QM} = \mu_p + \mu_n = 0.880\, e\times\hbar/2\times M_p\times c_o\,, \tag{1.2.3}$$

while the experimental value is:

$$\mu_d^{exp} = 0.857\, e\times\hbar/2\times M_p\times c_o\,. \tag{1.2.4}$$

Therefore, the theoretical prediction of quantum mechanics for the correct representation of the deuteron in its ground state misses 2.3% of the experimental value, which is a large number for any standard, particularly when such a large percentage is referred to the simplest possible nucleus.

In view of the above large deviation, nuclear physicists have attempted to "make things fit" by assuming that the deuteron is a mixture of various states, such as the ground state S, plus the states D, and L, in which case the deviation is reduced to about 1% (see Refs. [6] and papers quoted therein).

The above assumption has no scientific validity for various reasons. First of all, *experimental value (1.2.4) has been measured for the ground state, and not for a mixture of states.*

Second, a fundamental law of quantum mechanics (for which the theory was built) is that *the transition from one energy level to another requires the emission or absorption of quanta of*

energy. The impossibility of assuming a mixture of different states for the deuteron is then proved beyond scientific doubt by the fact that *said mixture is assumed in full knowledge that there is no emission or absorption of energy between the assumed different states. Therefore, the assumption of a mixture of states of the deuteron "to make things fit" violates basic laws of of quantum mechanics.*

When faced with the above evidence, "leading" nuclear physics venture the claim that the exact solution exists at the level of quarks. This additional claim also has no scientific credibility, because "experts" know that:

1) Quarks have not been established with *direct* experiments (only their predictions have been measured) and, therefore, one cannot claim the solution of a real problem (magnetic moments) with academic imagination (quarks) as being the final solution;

2) Assuming that quarks exist as physical particles, it is known by "experts" that quark theories *cannot* permit an *exact* representation of nuclear magnetic moments, because their orbits are too small (of the order of a fraction of 10^{-13} cm), thus being unable to permit magnetic polarizations in the large percentage needed to represent physical reality;

3) No exact representation of nuclear magnetic moments via quark conjectures has been published to my knowledge (evidence to the contrary would be appreciated).

Moreover, as also stressed in Paper I, the SU(3)-color Mendeleev-type *classification* of hadrons into families has indeed a generally accepted *final* physical character, while the claim that quarks are physical particles *in our spacetime* is itself a major scientific misconception, as shown in detail in Papers I and III (quarks can only be defined in a mathematical unitary space that has no connection to our physical reality).

It is known by experts that, because of the impossibility of being defined in our spacetime, *quarks cannot have any scientifically meaningful gravitation,* and their "masses" are pure mathematical parameters in the mathematical space of SU(3) with no known connection to our spacetime. This is demonstrated beyond doubt by the impossibility to define quarks via special relativity and its fundamental Poincaré symmetry, thus preventing the introduction of masses via its second order Casimir invariant, as *necessary* for masses to exist in our spacetime.

The lack of scientifically resolutory character of quark conjectures in nuclear physics is then completed by the fact that quantum chromodynamics is a *nonlinear theory* for which no exact solution is known, while approximations can notoriously be manipulated "to make anything fit."

The final proof of the misconmception in the quantum mechanical representation of nuclear magnetic moments is the following. Assume the achievement via unknown manipulations of an exact representation of the magnetic moment of the deuteron. *What about the tritium, the lithium, the oxygen, or the beryllium, the uranium and the zirconium ?* Since the missing percentages increase dramatically with the mass of nuclei (see the Schmidt limits in Figure I-2), the impossibility for quantum mechanics to reach a scientific representation of nuclear magnetic moment is established beyond any credible doubt.

1.2.4. Insufficiencies of Quantum Mechanics for the Representation of Other Nuclear Data

The inability by quantum mechanics to represent exactly nuclear magnetic moments is far from being the only insufficiency of the theory in nuclear physics. Additional, perhaps more serious, insufficiencies exist in the representation of the electric dipole and quadruple moments, deformation of nuclei, fission, and other data.

In all these additional cases, quantum mechanics does indeed permit a valid first understanding. However, the numerical representations are grossly approximate, and deeper scrutinies reveal basic insufficiencies of the theory itself.

1.2.5. Insufficiencies of Quantum Mechanics for the Representation of Dissipative Nuclear Reactions

The most incredible additional scientific errors occur in the use of quantum mechanics for the representation of *dissipative nuclear processes* (in which the energy is not conserved by assumption, because absorbed, in part, by external terms).

The inconsistencies of the quantum mechanical treatment of dissipative nuclear processes have been indicated in Section II-4. In quantum mechanics everything must be solely represented with a Hamiltonian. Therefore, dissipative effects are represented via *imaginary potentials* and Hamiltonians of the type $H = p^2/2\times m + i\times V(r)$,

These Hamiltonians are manifestly non-Hermitean and, therefore, *non-observable*. Yet leading experts in "leading" journals in nuclear physics claim the consistency and observability of quantum descriptions of dissipative nuclear processes.

It is taught in undergraduate courses in quantum mechanics that *the time evolution for a non-Hermitean Hamiltonian is necessarily nonunitary*. In fact, the selected dissipative nuclear systems have the following finite and infinitesimal time evolutions:

$$A(t) = U\times A(0)\times U^\dagger = e^{i\times H\times t} \times A(0) \times e^{-i\times t\times H^\dagger}, \tag{1.2.5a}$$

$$i\times dA/dt = [A, H, H^\dagger] = A\times H - H^\dagger\times A\,. \tag{1.2.5b}$$

It is known that *nonunitary theories have catastrophic physical inconsistencies*, such as [9a]: 1) Lack of invariance of the basic units of space, time, energy, etc., with consequential inapplicability of the theory to real measurements; 2) Lack of preservation of Hermiticity in time with consequential lack of observables; 3) Violation of causality and probability laws; 4) Lack of uniqueness and invariance of numerical predictions; 5) Violation of the basic axioms of Einstein's special relativity; etc.

Moreover, the brackets $[A, H, H^\dagger]$ of time evolution (1.2.5b) violate the axioms of *all algebras*, let alone the Lie algebras (they violate the distributive and scalar laws). This fact implies that *the notion of protons and neutrons with spin 1/2 for dissipative processes with time evolution (1.2.5) has no known physical or mathematical meaning of any type, because of the loss of all Lie algebras, including the SU(2)-spin algebra to characterize the spin, the loss of the Lorentz algebra to characterize the particles in our spacetime, etc.*

The best possible scientific statement, at this time, is that *quantum mechanics cannot possibly be exactly valid in nuclear physics, thus establishing the need to search for a more effective covering theory.*

1.3. Primary Reasons for the Insufficiencies of Quantum Mechanics and the Selection of a Covering Theory

The primary reasons for the insufficiencies of quantum mechanics in nuclear physics are the profound physical differences between the atomic and the nuclear structure. As a result, any claim that a theory exactly valid for the former is also exactly valid for the latter is wrong.

The structure of the hydrogen atom is characterized by two particles at very large mutual distances as compared to the wavepackets of the nucleon constituents. Under these conditions, the linear, local, and potential structure of quantum mechanics is indeed valid.

By comparison, the deuteron is composed by two hadrons under conditions of mutual penetration of their wavepackets, which are *necessary* for the very activation of strong interactions.

The assumption that the conditions of mutual penetration of the constituents of the deuteron can be exactly described by the same theory for the large mutual distances of the hydrogen is scientifically inaccurate.

Quantum mechanics misses any possible mean for a quantitative representation of the latter conditions. The insufficiencies begin at the purely mathematical level and then magnify at the physical level.

On mathematical grounds, wave-overlappings require a nonlocal-extended-integral topology, while quantum mechanics has a notoriously local/point-like topology. The claim that the latter mathematics can exactly represent the former conditions is scientifically wrong. An appropriate nonlocal topology must be first constructed before any good-faith dream of representing nonlocal physical conditions can be attempted.

Similarly, wave-overlappings are of contact type, and, therefore, have zero-range by conception. As such, they can be represented with anything *except* a potential in the Hamiltonian. By comparison, quantum mechanics is of purely Hamiltonian character. Therefore, it can only represent action-at-a-distance potential forces. Any claim that the addition of further local potential in the Hamiltonian can represent the nonlocal-contact-nonpotential component of the nuclear force is scientifically wrong.

In these papers I select the *isotopic branch of hadronic mechanics*, or *isomechanics* for short [2,3], as applicable to nuclear physics for the following reasons:

1) Isomechanics is a covering of quantum mechanics, thus admitting the latter as a simple particular case. This first feature is mandatory for true novelty, as well as for the need to recover quantum mechanics at all distances sufficiently bigger than 1 fm.

2) Isomechanics verifies all conventional laws of quantum mechanics (such as Heisenberg's uncertainties, Pauli's exclusion principle, causality, probability laws, etc.), and merely provides a *broader realization* of the same laws. This second condition is mandatory to comply with experimental evidence, according to which no violation of the indicated laws has been measured to date *for the closed-isolated and reversible-conservative systems here considered* (not so for *open-nonconservative conditions under external strong interactions* [2g]). Therefore, the use of generalized theories violating one or the other of these laws for closed-isolated systems has no physical value.

3) Isomechanics has been specifically constructed to represent nonlinear, nonlocal, and nonpotential effects at mutual distances of particles (and their composites) of the order of 1 fm. The representation is permitted by the novel *isomathematics* which begins with a *nonlocal topology* for extended-nonspherical-deformable particles which features are then preserved at *all* subsequent levels, including numbers, Hilbert spaces, algebras, geometries, etc. Also, isomechanics remains to this day the *sole* mechanics representing said effects in a mathematically and physically consistent way (evidence to the contrary which begins with an appropriate nonlocal-nonpotential topology would be appreciated). Other theories *claim* to represent nonlinear, nonlocal, and nonpotential effects, but in reality they constitute an error easily identified by experts. For instance, when the underlying topology remains the conventional local topology of quantum mechanics, the claim of representing nonlocal effects has no physical value of any type *because the underlying mathematics is inconsistent, let alone the physics.*

4) Isomechanics is the *only* known theory which represents nonlinear, nonlocal, and nonpotential effects in an *invariant* way, thanks to the reconstruction of linearity, locality and potentiality on isospaces over isonumbers. These are perhaps the most important reasons for my selection of isomechanics. In fact, the lack of invariance implies the catastrophic inconsistencies mentioned earlier. Therefore, other theories which are not invariant, have no physical meaning of any type.

5) Isomechanics has been proved to be *directly universal* for closed-isolated systems, that is, capable of representing *all* possible systems of the class admitted (universality) in the fixed frame of the experimenter (direct universality). I therefore do not see the scientific need for using other theories.

Above all, the reason for the selection of isomechanics is the effectiveness for nuclear physics of its fundamental symmetry, the Poincaré-Santilli isosymmetry [7] (see also the reviews and references quoted in [3]).

Physics is a discipline that permits the reduction of events to primitive symmetries. All the insufficiencies of quantum mechanics identified in this section can be established beyond scientific doubt by the fundamental symmetry of relativistic quantum mechanics, the conventional Poincaré symmetry.

As elaborated in Section I-2.3, a computer visualization of the Poincaré symmetry shows its validity for a *Keplerian system,* namely, a system whose heaviest particle is at the center.

The evidence that *nuclei do not have nuclei* establishes beyond any conceivable doubt the *lack* of exact validity in nuclear physics of the Poincaré symmetry and, consequently, of relativistic quantum mechanics.

In fact, the admission of an arbitrary particle at the center requires an evident necessary alteration of the very structure of the Poincaré symmetry, with consequential impossibility for relativistic quantum mechanics to be exact in nuclear physics.

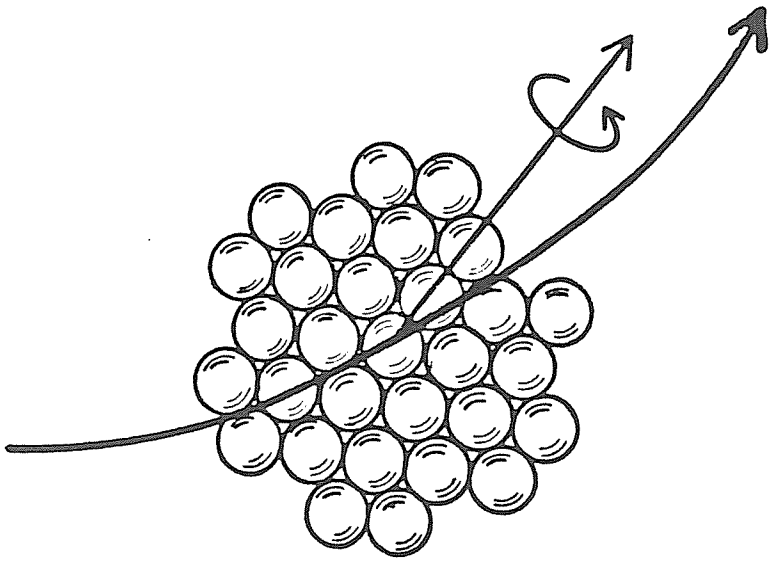

FIGURE 1: A schematic view of the central notion of this study, the representation of *nuclei without nuclei as a closed-isolated collection of extended, nonspherical, and deformable particles in conditions of (small) mutual penetration, characterized by the Poincaré-Santilli isosymmetry* [7]. This conception is the ultimate embodiment of hadronic mechanics, because it consist of a *new notion if bound state* which I introduced under the name of *closed nonhamiltonian systems*, first, at the classical level (to represent the structure of Jupiter and other interior systems), and then at the operator level, to represent the structure of hadrons, nuclei and stars (see the monographs of Ref.s [2] and papers quoted therein). These are systems verifying all total conventional conservation laws, yet have the most general possible conservative and nonconservative internal forces. As we shall see, this conception resolves all insufficiencies of quantum mechanics I know in nuclear physics, and renders the new energies of Class II a scientific and industrial reality. The reader should be aware that, by comparison, quantum mechanics can only represent nuclei as a collection of *point-particles* which, as such, are necessarily at a distance, without the heaviest constituent at the center as needed for conceptual and axiomatic consistency. The transition to quantum field theories does permit the representation of nucleons as extended, but only as perfectly spherical, and perfectly rigid spheres necessarily at a distance, thus preventing a realistic description of nuclear structures.

To my best knowledge, resulting from decades of studies of the issue, the Poincaré-Santilli isosymmetry [7] resolves in a primitive unified way *all* the problematic aspects identified above. This is due to the fact that the isosymmetry permits the representation of hadrons as extended, nonspherical, and deformable particles under linear and nonlinear, local and nonlocal, and potential as well as nonpotential interactions.

In particular, computer visualization of the Poincaré-Santilli isosymmetry establish its capability to be an exact symmetry for *nuclei without nuclei,* and with an arbitrary constituent at the center, as it is the case in physical reality.

The latter feature is reached precisely by the addition of *contact-nonpotential interactions* represented by generalized isounits, under which *nucleons are constrained to be in physical contact of each other* (Figure 1). When the isounit returns to acquire the conventional unit value, the conventional Poincaré symmetry is recovered identically, but then the constituents return at large mutual value with the Keplerian nucleus at the center.

As a final introductory comment, the reader should recall from Paper II that *the Poincaré-Santilli isosymmetry is isomorphic to the conventional symmetry, to such an extent that the two symmetries coincide at the abstract, realization-free level.*

This is due to the fact that, since the generalized units are as positive-definite as the number 1, all distinctions cease to exist between 1 and $\hat{1}$, $A\times B$ and $A\hat{\times}B$, $A\times B - B\hat{\times}A$ and $A\hat{\times}B-B\hat{\times}A$, etc. I could therefore present the entire studies of this series with exactly the same symbols and equations used in quantum mechanics, and merely submit them to *different realizations.*

Therefore, to prevent misinterpretation, I have to stress that the broader theory I use in nuclear physics *is not a new theory* when compared top quantum mechanics, but merely a *new, broader realization of the conventional abstract axioms of quantum mechanics.*

The latter feature is fundamental to understand how, despite its manifestly broader character, isomechanics verifies exactly the same physical laws of quantum mechanics, such as Heisenberg's uncertainty, Pauli's exclusion principle, causality, etc.

The latter feature also illustrates the fact that *theories deviating from the basic axioms of quantum mechanics automatically violate established physical laws for closed-isolated systems, thus having no physical value.*

Finally, the feature illustrates again the *mandatory character* for using the new isomathematics, because the sole known approach for achieving the indicated abstract unity with conventional theories.

I would like to express my apologies for my inability to review other studies, such that those by Caldirola [8a] who formulated 1941 a generalization of Schrödinger's equation which is *noncanonical in time,* the studies by Driscoll [8b], as well as those by several authors published in Proceedings [8c,8d,8e]. Independent studies more directly related to this paper can be found in Refs. [9], and their connection with hadronic mechanics is presented in Ref.s [10].

2. APPLICATIONS AND VERIFICATIONS OF HADRONIC MECHANICS IN NUCLEAR PHYSICS

2.1. Main Structural Lines

As is customary, nuclei are studied as closed-isolated, and conservative-reversible systems, generally assumed in their (stable) ground state. Therefore, in this paper I shall solely use the *isotopic branch of hadronic mechanics,* also called *isomechanics* for short [2,3] (see Section II-6 for a review).

The broader *genotopic and hyperstructural branches of hadronic mechanics* are intended for the study of open, nonconservative, irreversible, single-valued and multi-valued processes, respectively, such as nuclear or biological reactions, and will not be considered in this paper for brevity. Unless otherwise specified, the terms "hadronic mechanics" are solely referred in this paper

to its isotopic branch.

As suggested since 1978 [2b] (see [2c] for a recent presentation), the isotopic branch of hadronic mechanics can be constructed via a *nonunitary* transform of quantum mechanics. In particular, the nonunitary character should hold only at distances of the order of 1 fm = 10^{-13} cm (this is the *hadronic horizon* of Figure II-1). The transform should then recover the unitary character at larger distances, *i.e.:*

$$U \times U^\dagger = \hat{1} \begin{cases} \neq I \text{ for } r \ll 10^{-13} \text{ cm} \\ = I \text{ for } r \gg 10^{-13} \text{ cm}. \end{cases} \tag{2.1.1}$$

A simple, yet effective, 8-dimensional realization of the above assumption for the relativistic treatment of the two nucleons (the deuteron) is the *Animalu-Santilli isounit* [2g]:

$$\hat{1}_{12} = \text{Diag.}({}_1n_1^2, {}_1n_2^2, {}_1n_3^2, {}_1n_4^2) \times \text{Diag.}\,({}_2n_1^2, {}_2n_2^2, {}_2n_3^2, {}_2n_4^2) \times$$
$$\times e^{N\int dv\, {}_1\hat{\psi}^\dagger_\uparrow(r) \times {}_2\hat{\psi}_\downarrow(r)} \tag{2.1.2}$$

where: 1) ${}_kn_1^2, {}_kn_2^2, {}_kn_3^2$ represents the shape of the nucleon k = 1, 2, and characterize in this simple case the semiaxes of spheroidal ellipsoids normalized to the values for the perfect sphere and to the volume preserving conditions:

$$n_1^2 + n_2^2 + n_3^2 = 3, \tag{2.1.3a}$$

$$n_1^2 \times n_2^2 \times n_3^2 = 1, \tag{2.1.3b}$$

(more general shapes can be represented via a non-diagonal realizations); 2) ${}_kn_4^2$ is the density of the nucleon considered normalized to the value for the vacuum:

$$n_4^2 = 1; \tag{2.1.4}$$

and 3) the integral represents the overlapping of the wavepackets ${}_1\hat{\psi}^\dagger_\uparrow(r)$ and ${}_2\hat{\psi}_\downarrow(r)$ of the two nucleons in singlet coupling.

For sufficient mutual distances r ≫ 1 fm, the exponent in (2.1.1) is identically null and, therefore, the exponential is the unit, while deviations from the perfectly spherical character become ignorable, thus verifying the condition $\hat{1} = I = \text{Diag.}\,(1, 1, 1, 1)$, under which quantum mechanics is recovered identically.

As one can see, before even introducing the new dynamical equations, the basic transformation underlying hadronic mechanics permits the representation of: 1) Extended, nonspherical and deformable nucleons as they are in the physical reality (see later on); 2) The density of the medium in which the trajectories occur; and 3) The contact/zero-range interactions due to wave-overlappings represented via the generalization of the unit without any introduction of a potential or a Hamiltonian.

The reader should keep in mind the comments of Section I-2.3 illustrating the impossibility for quantum mechanics to represent nucleons as they are in the physical reality: *extended, nonspherical (e.g., oblate ellipsoids), and deformable.* In fact, quantum mechanics can merely represent nucleons as *points.* Extended features can be represented via field theory, but, as indicated in Section 1, always in terms of a perfectly spherical and perfectly rigid spheres, as *necessary* in order not to violate a pillar of the theory, the rotational symmetry. As we shall see shortly, the above insufficiency is at the foundation of the impossibility for quantum mechanics to represent total nuclear magnetic moments and other nuclear features.

Therefore, the better representational capabilities of hadronic over quantum mechanics in nuclear physics cannot be denied in good faith.

Since the size of the charge distribution and the density of protons and neutrons are numerically very similar, I can assume to a good approximation that ${}_1n_\mu = {}_2n_\mu$, $\mu = 1, 2, 3, 4$. Nonunitary transform (2.1.2) can then be well approximated to:

$$\hat{1}_{12} = \text{Diag.}\,(n_1^2, n_2^2, n_3^2, n_4^2) \times e^{N\int dv\, {}_1\hat{\psi}^\dagger_\uparrow(r) \times {}_2\hat{\psi}_\downarrow(r)}, \tag{2.1.5}$$

by keeping in mind that the total spacetime dimension of the two-particle state here considered is *eight* (as a necessary condition to represent two particles in our spacetime).

Nonunitary transform (2.1.5) is here assumed for the study of the deuteron (only). Heavier nuclei composed by 2n nucleons require the tensorial product of n structures of type (2.1.3),

$$\hat{1} = \prod_k \hat{1}_k = \prod_k \text{Diag.}\,(n_{1k}^2, n_{2k}^2, n_{3k}^2, n_{4k}^2) \times e^{N\int dv \hat{\psi}^\dagger_{\uparrow k}(r) \times \hat{\psi}_{\downarrow k}(r))}. \tag{2.1.6}$$

where $k = 2, 4, ..., 2n$, with a simple extension to 2n+1 here left to the interested reader.

As one can see, the above structure introduces *ab initio* the restriction that *nuclear correlations only hold for nucleon pairs*, as established experimentally [5]. In fact, for particles of spin 1/2, couplings in hadronic mechanics can only be in singlet, thus prohibiting the addition of a third wavefunction in the exponent.

The reader should be aware that *nucleon pair correlations is another experimental fact which is basically unresolved by quantum mechanics*, as admitted in well written treatises in the field. Yet, the same correlation is represented by hadronic mechanics even before introducing the dynamics of the theory. Therefore, the representational advantages of hadronic over quantum mechanics in nuclear physics begins to emerge.

Once the basic nonunitary transformation has been identified, the practical construction of hadronic model is truly elementary, and merely consists in the assumption of the value $\hat{1}$ as the new basic unit of the theory (the isounit), and the systematic application of the nonunitary transform to the *totality* of the formalism of quantum mechanics, beginning with numbers, and then passing to metric and Hilbert spaces, algebras and geometries, etc. (see Paper II).

As a result, any quantum mechanical nuclear model can be easily lifted to the corresponding hadronic model via the implementation of the above simple steps, plus others studied later on (such as the addition of the "trigger" needed for stimulated nuclear transmutations studied in Section 3).

The resulting hadronic models then fulfill exactly the desired need, to "complete" (along Einstein-Podolsky-Rosen [1-5a]) quantum mechanics with manifestly missing nonlinear, nonlocal, and nonpotential effects. In turn, the new energies of Class II are permitted precisely by such a "completion", as we shall see.

2.2. Reconstruction of the Exact Isospin Symmetry

As is well known [5], a central tool in nuclear physics is the historical unification of protons and neutrons into nucleons. This unification was first proposal by Heisenberg via the SU(2)-isospin symmetry in its fundamental (regular), two-dimensional representation in terms of Pauli's matrices [5]:

$$\tau_1 = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}, \qquad \tau_2 = \begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix}, \qquad \tau_3 = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}, \tag{2.2.1a}$$

$$[J_i, J_j] = J_i \times J_j - J_j \times J_i = i \times \epsilon_{ijk} J_k, \quad J_k = \tfrac{1}{2} \times \tau_k, \tag{2.2.1b}$$

$$\hat{J^2} \times |b> = (3/4) \times |b>, \quad J_3 \times |b> = \pm \tfrac{1}{2} \times |b>. \tag{2.2.1c}$$

The proton is then represented with the value +1/2 and the neutron with −1/2. Nuclear physics was subsequently constructed based, whether in a direct or indirect way, on the above unification of protons and neutrons into nucleons.

However, as is equally well known, the isospin symmetry is broken in nuclear (as well as particle) physics, because *protons and neutrons do not have the same mass* (more technically, the isospin symmetry is broken by the electroweak interactions). The lack of exact character of the SU(2)-isospin symmetry in nuclear physics has then implied, whether in a direct or indirect way, the lack of exact character of contemporary nuclear physics itself.

The first important contribution of hadronic mechanics in nuclear physics is to restore as *exact* Heisenberg's historical SU(2)-isospin symmetry.

The reconstruction was worked out for the first time by Santilli in Ref. [11a] and treated in more details in Refs. [11b,11c]. The main results can be summarized as follows.

The main idea is that the SU(2)-isospin symmetry is broken when realized via the simplest conceivable unit I = Diag. (1, 1), and Lie product [A, B] = A×B − B×A (where A×B is the conventional associative product of matrices) which are at the foundation of isospin (2.1.1).

However, when the same symmetry is realized via the lesser trivial Lie-Santilli isoproduct [2,3], the exact character of the symmetry is recovered even under electromagnetic and weak interactions.

The realization is in this case elementary. In this case we only have one quantity to be represented, the mass difference between protons and neutrons. As a result, we only need a nonunitary transform with only one free parameter, say, λ:

$$U = \text{Diag.}\,(\lambda^{-1/2}, \lambda^{1/2}),\ \hat{1} = \hat{T}^{-1} = \text{diag.}\,(\lambda^{-1}, \lambda\,). \tag{2.2.4a}$$

$$U \times [A, B] \times U^{\dagger} = [\hat{A}, \hat{B}] = \hat{A}\hat{\times}\hat{B} - \hat{B}\hat{\times}\hat{A} = \hat{A}\times\hat{T}\times\hat{B} - \hat{B}\times\hat{T}\times\hat{A}\,, \tag{2.2.2a}$$

$$\hat{K} = U\times K\times U\dagger\,,\ K = A, B. \tag{2.2.2b}$$

where $\hat{A}\hat{\times}\hat{B}$ is now isoassociative (*i.e.*, associative in isospace over isofields).

Consider now a four-component isostate acting on isohilbert space $\hat{\mathcal{H}}$ over the isocomplex field $\hat{C}$ all characterized by isounit $\hat{1}$ (see Paper II for details):

$$\hat{\psi}(x) = \begin{pmatrix} \hat{\psi}_p(x) \\ \hat{\psi}_n(x) \end{pmatrix} \tag{2.2.3}$$

with individual isostates and isonormalization:

$$|\hat{\psi}_p> = \begin{pmatrix} \lambda^{-\frac{1}{2}} \\ 0 \end{pmatrix}, \qquad |\hat{\psi}_n> = \begin{pmatrix} 0 \\ \lambda^{\frac{1}{2}} \end{pmatrix}, \tag{2.2.4a}$$

$$<\hat{\psi}_k|\times\hat{T}\times|\hat{\psi}_k> = 1,\ k = p, n. \tag{2.2.4c}$$

The $S\hat{U}(2)$-isotopic-isospin symmetry then defines the *isonucleon* as the exact unification of protons and neutrons characterized by the Pauli-Santilli isomatrices:

$$\hat{\tau}_1 = \begin{pmatrix} 0 & \lambda \\ \lambda^{-1} & 0 \end{pmatrix}, \qquad \hat{\tau}_2 = \begin{pmatrix} 0 & -i\lambda \\ i\lambda^{-1} & 0 \end{pmatrix}, \qquad \hat{\tau}_3 = \begin{pmatrix} \lambda^{-1} & 0 \\ 0 & -\lambda \end{pmatrix}, \tag{2.2.5}$$

which admit all conventional structure constants and eigenvalues of SU(2):

$$[\hat{J}_i, \hat{J}_j] = \hat{J}_i \hat{\times} \hat{J}_j - \hat{J}_j \hat{\times} \hat{J}_i = i\, \epsilon_{ijk}\, \hat{J}_k, \quad \hat{J}_k = \tfrac{1}{2} \times \hat{\tau}_k, \tag{2.2.6a}$$

$$\hat{J}^2 \hat{\times} |\hat{b}> = (3/4) \times |\hat{b}>, \hat{J}_3 \hat{\times} |\hat{b}> = \pm \tfrac{1}{2} \times |\hat{b}>. \tag{2.2.6b}$$

The latter expressions prove that the $\hat{SU}(2)$-isotopic-isospin symmetry is isomorphic to the conventional symmetry, and continues to characterize the proton and the neutron with the isospin +1/2 and −1/2, respectively, as in the conventional case.

However, the isosymmetry exhibits the "hidden variable" λ in its structure which can be used to reconstruct its exact character.

In fact, λ can always be selected in such a way that

$$m_p \times \lambda^{-1} = m_n \times \lambda, \quad \lambda^2 = m_p / m_n = 0.99862. \tag{2.2.7}$$

The mass operator can then be defined by:

$$\hat{M} = \{\tfrac{1}{2} \times \lambda \times (m_p + m_n) \times \hat{1} + \tfrac{1}{2} \times \lambda^{-1} (m_p - m_n) \times \hat{\sigma}_3\} \times \hat{1} =$$

$$= \begin{pmatrix} m_p \times \lambda^{-1} & 0 \\ 0 & m_n \times \lambda \end{pmatrix}, \tag{2.2.8}$$

and manifestly represents equal masses in isospace:

$$\hat{m} = m_p \times \lambda^{-1} = m_n \times \lambda, \tag{2.2.9}$$

thus confirming the exact reconstruction of the historical isospin symmetry [11].

The recovering of conventional masses in our physical space is readily achieved via the isoeigenvalue expression on an arbitrary isostate:

$$\hat{M} \hat{\times} |\hat{\psi}> = M \times \hat{1} \times \hat{T} \times |\psi> = M \times |\hat{\psi}> =$$

$$= \begin{pmatrix} m_p & 0 \\ 0 & m_n \end{pmatrix} \times |\hat{\psi}>, \tag{2.2.10}$$

or, equivalently, via the isoexpectation values:

$$<\hat{\psi}_p | \times \hat{T} \times \hat{M} \times \hat{T} \times | \hat{\psi}_p> = m_p, \tag{2.2.11a}$$

$$<\hat{\psi}_n | \times \hat{T} \times \hat{M} \times \hat{T} \times | \hat{\psi}_n> = m_n. \tag{2.2.11b}$$

Similarly, the charge operator can be defined by:

$$q = \tfrac{1}{2} \times e \times (\hat{1} + \hat{\sigma}_3) = \begin{pmatrix} e \times \lambda^{-1} & 0 \\ 0 & 0 \end{pmatrix}. \tag{2.2.12}$$

Thus, the $\hat{SU}(2)$ charges on isospace are isorenormalized into the expressions:

$$\hat{q}_p = e \times \lambda^{-1}, \qquad \hat{q}_n = 0. \tag{2.2.13}$$

However, the charges in our physical space are the conventional ones:

$$< \hat{\psi}_p |\hat{\times}\hat{T}\hat{\times}\hat{q}\hat{\times}\hat{T}\hat{\times}| \psi_p > = e, \tag{2.2.14a}$$

$$< \hat{\psi}_n |\hat{\times}\hat{T}\hat{\times}\hat{q}\hat{\times}\hat{T}\hat{\times}| \hat{\psi}_n > = 0 . \tag{2.2.14b}$$

The *isodual* $\hat{SU}^d(2)$-*isotopic-isospin* characterizing the antiparticles $\bar{p}$ and $\bar{n}$ will not be reviewed here for brevity (see [11]).

In conclusion, the entire theory of isospin is reconstructed by hadronic mechanics in such a way that: 1) The isospin eigenvalues remain the conventional ones, 3/4 and ±1/2, thus establishing that $\hat{SU}(2)$ is isomorphic (that is, physically equivalent) to SU(2); 2) The proton and the neutron acquire equal masses on isospace over isofield, thus establishing the exact reconstruction of the isospin symmetry, while charges are subjected to isorenormalization (2.2.13); 3) The conventional physical masses and charges of protons and neutrons are fully recovered via the projection of the theory in the ordinary space or, equivalently, via the isoeigenvalues or isoexpectation values.

The isotopic-isospin theory is clearly an application and verification of hadronic mechanics, because it is constructed via a simple nonunitary transform of the conventional theory.

The $\hat{SU}(2)$-isotopic-isospin symmetry is the first clear illustration of the capability of hadronic mechanics for turning an *approximate* quantum theory into an *exact* hadronic representation of physical reality with subtle but important implications at all remaining levels of nuclear physics.

The reader should be aware that this *is not* an isolated occurrence, because it represents a rather general capabilities of the Lie-Santilli isotheory. In fact, the property is referred to as the *isotopic reconstruction of exact space-time and internal symmetries when conventionally broken.*

For example (see [2g] for details and references, as well as Paper II), the rotational symmetry has been reconstructed as *exact* for all infinitely possible ellipsoidical *deformations* of the sphere; the Lorentz symmetry has been reconstructed as *exact* at the isotopic level for all possible signature preserving *deformations* $\hat{\eta} = \hat{T}\times\eta$ of the Minkowski metric; and the Poincaré symmetry has been reconstructed as *exact* for *nuclei without nuclei* (Figure 1).

In conclusion, in Refs. [11] (see also Refs. [2g], the first edition of 1993, and prior quoted references) I claim the first reconstruction of the exact isospin symmetry. Due to widespread plagiarisms existing in the contemporary physics literature, I have copyrighted these publications, and I intend to defend such copyrights in any means permitted by law. The reconstruction of the exact isospin symmetry can be used by anybody in part or in full for any scientific purpose without any prior authorization, *provided* that: 1) The original publications [2g,11]s are quoted; 2) The quoted references are outlined as a prerequisite for allegations of novelty; and 3) Paternities are identified with clarity.

2.3. Exact Representation of Total Nuclear Magnetic Moments

When presented as preliminary, approximate, incomplete and basically unresolved, the quantum mechanical representation of total nuclear magnetic moments is indeed scientifically acceptable.

However, the presentation of the same quantum mechanical treatment as the final formulation of total nuclear magnetic moments (as rather universally done in orthodox journals and institutions in nuclear physics world wide), has no scientific value for the reasons indicated in Section 1.2.

2.3.1. The Historical Hypothesis

The origin of the insufficiency of quantum mechanics was well identified by the founders of nuclear physics (see, e.g., (5a,5b] and references therein, as well as the quotation on page 31 of [5c]), and can be presented via the following:

HISTORICAL HYPOTHESIS 2.1: In the transition from motion in vacuum to motion within a nuclear structure, protons and neutrons experience a deformation of their charge distribution, with consequential alteration of their intrinsic magnetic moments.

The hypothesis can be easily visualized at the classical level (see Figure 2) by considering a charged and spinning sphere which, as such, possesses a magnetic moment along its axis of rotation.

Suppose that, because of sufficient external forces, the sphere is deformed into an ellipsoid while keeping the same angular momentum (pure deformation of shape). Then classical electrodynamics establishes that the deformation of shape implies a *necessary* alteration of the value of the magnetic moment, while the angular momentum remains the same.

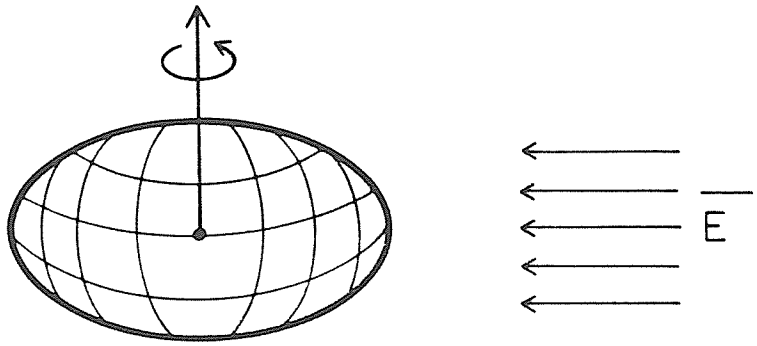

FIGURE 2: A schematic view of the historical hypothesis on the deformability of protons and neutrons under sufficient external forces with consequential alteration of their intrinsic magnetic fields.

The above classical view applies in full to protons and neutrons because they are precisely extended and spinning charge distributions with a radius of about 1 fm. Since nuclear forces are indeed "strong", it is evident that these particles can experience deformations in the transition from motion in vacuum to motion within nuclei, with consequential *necessary* alteration of their intrinsic magnetic moments called *mutation* [2a,2b].

In turn, the alteration of the *intrinsic* magnetic moments of nucleons immediately permits an *exact* numerical representation of *all* total nuclear magnetic moments, as shown in this section.

2.3.2. Incompatibility of the Historical Hypothesis with the Special Relativity

It was known up to the first half of this century, that the lack of exact representation of total nuclear magnetic moments is due to the quantum mechanical abstraction of protons and neutrons as points, which, as such, have immutable intrinsic characteristics irrespective of the interactions they experience.

It was also known that, as recalled earlier, the transition to quantum field theory *does not* permit any solution of the problem, because the latter can indeed represent protons and neutrons as extended (via the form factors), but only as perfectly spherical and perfectly rigid objects. The above scientific scene is well represented in treatises and papers in nuclear physics of the period

considered [5].

A rather drastic change in attitude occurred in the second half of this century, as one can see by comparing the quotation of hypothesis 2.2 by Blatt and Weisskopf [5c], and its complete absence with claims of final solutions via quantum mechanics by Shalitz and Feshbach [5d], as well as in generally all more recent monographs and articles in nuclear physics.

The reason for this drastic change in attitude is also well known by experts, and it is due to the fact that, after the appearance of Blatt and Weisskopf treatise [5c], it was understood that *Historical Hypothesis 2.1 is structurally incompatible with nonrelativistic and relativistic quantum mechanics, as well as with Einstein's special relativity.*

Nonrelativistically, this is due to the fact that nonspherical and deformable shapes are structurally incompatible with the very basic axioms of quantum mechanics and quantum field theory, because they violate their fundamental rotational symmetry O(3).

Relativistically, the incompatibility of Historical Hypothesis 2.1 with Einstein's special relativity is established by the fact that the geometry and symmetries underlying special relativity *prohibit* any alteration of the *intrinsic* characteristics of particles.

2.3.3. Compatibility of the Historical Hypothesis with the Isospecial Relativity.

In the following, I shall show that Historical Hypothesis 2.1 is indeed fully compatible with relativistic hadronic mechanics and its underlying isospecial relativity (Paper II), thus permitting the achievement of an exact-numerical representation of all total nuclear magnetic moments.

I want to stress from the outset that, despite its *exact* character for *all* nuclei, *the hadronic representation presented in this section remains preliminary,* and numerous, deeper representations are expected.

I first submitted a mathematical representation of the Historical Hypothesis 2.1 in 1978 (see memoir [2b], Sect. 4, Eqs. (4.20.16)). Its application to the first exact numerical representation of the magnetic moment of the deuteron and other nuclei was presented at the meeting "Deuteron 93" held at the JINR, in Dubna, Russia, in summer 1993 (see the contribution in the proceedings [12a]) The study was further developed in subsequent papers [12b,12c]. A comprehensive presentation in preparation for Vol. III of [2g].

Again, the construction of the desired exact representation is elementary and it is given by a simple nonunitary transform of the conventional treatment, as it is the case for all applications of hadronic mechanics. The nonunitary character automatically assures the addition of terms which are outside a Hamiltonian representation, thus being outside quantum mechanics. The direct universality of hadronic mechanics then assures its applicability.

The effective treatment of magnetic moments requires a relativistic approach [5]. Therefore, the applicable theory is the *isotopic branch of relativistic hadronic mechanics* [2,3], with particular reference to the Poincaré-Santilli isosymmetry [7] in its spinorial version [4c]. In fact, the latter isosymmetries automatically assures the representation of *mutations* of intrinsic characteristics, that is, deviations from conventional characteristics.

Recall that, in conventional treatment, protons and neutrons are irreducible representations of the spinorial covering of the Poincaré symmetry, usually denoted with the symbol $\mathcal{P}(3.1)$. The most rigorous study of nuclear magnetic moments is therefore given by the following:

> *HYPOTHESIS 2.2 [12]: In the transition from motion in vacuum to motion within a nuclear structure, protons and neutrons perform the transition from irreducible representations of the Poincaré symmetry to its Poincaré-Santilli covering, thus becoming isoprotons and isoneutrons.*

It is easy to prove that Hypothesis 2.2 constitutes a direct theoretical treatment of the Historical Hypothesis 2.1.

The reader should be aware that the exact isotopic isospin of the preceding section

constitutes already a realization of Hypothesis 2.2. Therefore, the exact representation of magnetic moments essentially requires the transition from the exact isospin symmetry, to the corresponding spacetime isosymmetry.

2.3.4. The Isodirac Equation.

This section presents the simplest possible treatment of Hypothesis 2.2, that based on the isotopies of the Dirac equation, which has been studied by a number of authors, although in their general form implying a mutation of spin (see [2g], Ch. 10, for details and references quoted therein).

Refs. [12a] present a new form of the isodirac equation specifically intended to represent a deformation of the magnetic moment of nucleons while preserving their spin, as necessary for a quantitative study of the historical hypothesis under the preservation of Pauli's exclusion principle and other known laws.

The study requires a *composite isounit* characterized by the tensorial product of two nonunitary transforms, one acting in the *orbital* component and the other acting on the *spin* part, resulting in the 8-dimensional total isounit:

$$(U^{Orb}\otimes U^{Spin}) \times (U^{Orb}\otimes U^{Spin})^\dagger = \hat{1}^{tot} = \hat{1}^{Orb}\otimes \hat{1}^{Spin} =$$

$$= \hat{1}^{orb-1}\otimes \hat{1}^{Spin\,-1} > 0\,. \qquad (2.3.1)$$

The simplest possible realization for protons and neutrons considered from the outside (thus implying the integration of nonlocal terms to constants) can be written:

$$\hat{1}^{Orb} = Diag.\,(n_1^2, n_2^2, n_3^2, n_4^2)\,,\ n_\mu > 0\,, \qquad (2.3.2a)$$

$$\hat{1}^{Spin} = Diag.\,(m_1^2, m_2^2, -m_1^2, -m_2^2)\,,\ n_\mu \neq 0\,, \qquad (2.2.3.2b)$$

$$U^{Spin} = \begin{pmatrix} 0 & W_{2\times2} \\ W^\dagger_{2\times2} & 0 \end{pmatrix},\ U^{\dagger Spin} = \begin{pmatrix} 0 & W^\dagger_{2\times2} \\ W^\dagger_{2\times2} & 0 \end{pmatrix}, \qquad (2.3.2c)$$

$$W_{2\times2} = \begin{pmatrix} 0 & m_1 \\ m_2 & 0 \end{pmatrix},\ W_{2\times2}{}^\dagger = \begin{pmatrix} 0 & m_2 \\ m_1 & 0 \end{pmatrix}, \qquad (2.3.2d)$$

$$\hat{1}^{Spin}{}_{2\times2} = W_{2\times2}\times W^2{}_{2\times2} = \begin{pmatrix} m_1^2 & 0 \\ 0 & m_2^2 \end{pmatrix}, \qquad (2.3.2e)$$

$$\hat{1}^{Spin}{}_{2\times2} = \begin{pmatrix} m_1^{-2} & 0 \\ 0 & m_2^{-2} \end{pmatrix}, \qquad (2.3.2f)$$

$$\hat{1}^{d\ Spin}{}_{2\times2} = -\hat{1}^{\dagger\ Spin}{}_{2\times2} = -W^\dagger{}_{2\times2}\times W_{2\times2} = \begin{pmatrix} -m_1^2 & 0 \\ 0 & -m_2^2 \end{pmatrix}, \qquad (2.3.2h)$$

$$\hat{1}^{d\ Spin}{}_{2\times2} = \begin{pmatrix} -m_1^{-2} & 0 \\ 0 & -m_2^{-2} \end{pmatrix}. \qquad (2.3.2i)$$

The simple application of the above nonunitary transform to the conventional Dirac equation

(see, e.g., [13]) then yields the *isodirac equation* [12,2g]:

$$(\hat{\eta}^{\mu\nu} \times \hat{\gamma}_\mu \hat{x}^{Spin} \hat{p}_\nu - i \times \hat{m}^2) \hat{x}^{orb} \hat{\psi} =$$
$$= (\hat{\eta}^{\mu\nu} \times \hat{\gamma}_\mu \times \hat{T}^{Spin} \times \hat{p}_\nu \times \hat{T}^{Orb} - i \times m \times m) \times \hat{\psi} = 0 , \qquad (2.3.3)$$

with *isogamma matrices* defined by:

$$\{ \hat{\gamma}_\mu, \hat{\gamma}_\alpha \} = \hat{\gamma}_\mu \times \hat{T}^{spin} \times \hat{\gamma}_\alpha \times \hat{T}^{Spin} + \hat{\gamma}_\alpha \times \hat{T}^{Spin} \times \hat{\gamma}_\mu \times \hat{T}^{Spin} = 2 \times \hat{\eta}_{\mu\alpha} , \qquad (2.3.4)$$

and explicit form:

$$\hat{\gamma}_\mu = (\hat{T}_{\mu\mu}^{Orb})^{1/2} \times U^{Spin} \times \gamma_\mu \times U^{Spin\,\dagger} \times \hat{I}^{spin} , \qquad (2.3.5a)$$

$$\hat{\gamma}_k = (\hat{T}_{kk}^{Orb})^{1/2} \times \gamma_k \times \hat{I}^{Spin} = \hat{T}_{kk}^{1/2} \times \begin{pmatrix} 0 & \hat{\sigma}_k \\ \hat{\sigma}^d{}_k & 0 \end{pmatrix} \times \hat{I}^{Spin} , \qquad (2.3.5b)$$

$$\gamma_4 = (\hat{T}_{44}^{Orb\times})^{1/2} \times \gamma_4 \times \hat{I}^{Spin} = (\hat{T}_{kk}^{Orb})^{1/2} \times \begin{pmatrix} I^{Spin}{}_{2\times2} & 0 \\ 0 & I^{d\,Spin}{}_{2\times2} \end{pmatrix} \times \hat{I}^{Spin} , \qquad (2.3.5c)$$

and *isopauli matrices*

$$\hat{\sigma}_k = W \times \sigma_k \times W^\dagger , \quad \hat{\sigma}^d{}_k = - \hat{\sigma}^\dagger{}_k = - W^\dagger \times \sigma_k \times W . \qquad (2.3.6$$

The introduction of the minimal coupling rule to represent electromagnetic interactions requires a simple extension hereon tacitly implied.

2.3.5. Conventional Values of Angular Momentum and Spin, yet Mutated Magnetic Moments.

First, it is easy to see that the orbital angular momentum via the isotopic SÔ(3) algebra is given by:

$$\hat{M}_k = \tfrac{1}{2} \epsilon_{kij} \hat{r}_i \hat{\times} \hat{p}_j , \qquad (2.3.7a)$$

$$[\hat{M}_i, \hat{M}_j] = \hat{M}_i \times T \times \hat{M}_j - \hat{M}_j \times T \times \hat{M}_i = \epsilon_{ijk} \times \hat{M}_k , \qquad (2.3.7b)$$

$$\hat{M}^2 \hat{\times} \hat{\psi} = \hat{M}_k \times \hat{T} \times \hat{M}^k \times \hat{T} \times \hat{\psi} = m \times (m + 1) \times \hat{\psi} , \qquad (2.3.7c)$$

$$\hat{M}_3 \times \hat{\psi} = \hat{M}_k \times \hat{T} \times \hat{\psi} = (\pm m) \times \hat{\psi} , \; m = 0, 1, 2, ... \qquad (2.3.7c)$$

The above properties assure that Eqs. (2.3.3) characterize *conventional* eigenvalues of the angular momentum.

Second, it is easy to see that the isotopic SÛ(2)-spin algebra characterized by the above equations has a *generalized* structure, yet *conventional* eigenvalues, as desired:

$$\hat{S}_k = \tfrac{1}{2} \epsilon_{kij} \hat{\gamma}_i \hat{\times} \hat{\gamma}_j , \qquad (2.3.8a)$$

$$[\hat{S}_i, \hat{S}_j] = \hat{S}_i \times \hat{T} \times \hat{S}_j - \hat{S}_j \times \hat{S}_i = \epsilon_{ijk} \times \hat{S}_k , \qquad (2.3.8b)$$

$$\hat{S}^2 \hat{\times} \hat{\psi} = \hat{S}_k \times \hat{T} \times \hat{S}^k \times \hat{T} \times \hat{\psi} = (3 / 4) \times \hat{\psi} , \qquad (2.3.8c)$$

$$\hat{S}_3 \times \hat{\psi} = \hat{S}_k \times \hat{T} \times \hat{\psi} = (\pm 1 / 2) \times \hat{\psi} , \qquad (2.3.8d)$$

The latter properties assure the characterization of *conventional* spin, with consequential preservation of Pauli's exclusion principle, as desired.

A simple isotopy of the conventional derivation of the magnetic moment in the conventional Dirac equation (see, e.g., [13]) yields the desired *mutation of the magnetic moment of nucleons* assumed as directed along the third axis (see [2g], Vol. II, Ch. 10, for details):

$$\hat{\mu}_N = \hat{\mu}_N(\mu_N, n_\mu^2) = \mu_N \times n_4 / n_3 , N = p, n , \qquad (2.3.9)$$

which was first proposed by Santilli in [2b]. Sect. 4, Eqs. (4.20.16), page 803, and then studied in detail in Refs. [2g,12].

In summary, *relativistic hadronic mechanics can easily represents the alteration of the intrinsic magnetic moment of nucleons due to the deformation of their charge distribution under external fields, while preserving the conventional orbital and intrinsic angular momenta.* These conditions are necessary to preserve conventional quantum laws, as indicated earlier.

2.3.6. Exact Representation of the Deuteron Magnetic Moment.

Once hadronic mechanics has permitted a consistent quantitative representation of the mutation of the intrinsic magnetic moment, Eqs. (2.3.9), as per Historical Hypothesis 2.1, the exact representation of the experimental value (1.2.2.4) of the magnetic moment of the deuteron is straightforward.

Recall experimental values $\mu_p = 2.793\ e\times\hbar/2\times M_p\times c_o$, Eq. (1.2.1), and $\mu_n = -1.9135\ e\times\hbar/2\times M_p\times c_o$, Eq. (1.2.2). Recall also that their sum for a triplet coupling yields the value $\mu_p + \mu_n = 0.880$, Eq. (1.2.3), while the experimental value is $\mu_d^{ecpx} = 0.857$, Eq. (1.2.4).

Note also that the theoretical value is 2.3% *in excess* of the experimental value. This feature essentially implies that the intrinsic magnetic moments of nucleons must *decrease* when they are members of the deuteron, i.e., $\hat{\mu}_N < \mu_N$, N = p, n. In turn, this implies that the perfect spheridicity of the nucleons in vacuum must be mutated into a *prolate* spheroidal ellipsoid when in nuclei.

As recalled in Sect. 1.2, a scientifically credible interpretation of these occurrences via quantum mechanics is impossible. The exact-numerical representation of the same occurrences via hadronic mechanics is direct and immediate.

To a very good approximation, protons and neutrons have the same size and the same mass. Therefore, we can assume that the characteristic parameters n_μ are the same for both of them (Section 2.1).

The desired exact representation is then given by the simple isotopy of Eq. (1.2.3):

$$\hat{\mu}_d^{HM} = (\mu_p + \mu_n)\times n_3/n_4 = {}_d^{Exp}\ 0.857 . \qquad (2.3.10)$$

Recall from Section III-2.6 that a good numerical value of the characteristic parameter $n_4 = 1/b_4$ for the density of proton-antiproton annihilation is $n_4 = 1/b_4 = 1/1.653 = 0.605$. However, the proton and neutron are minimally overlapping in the deuteron structure (see Section 2.5 for details), and, therefore, they can be well approximated with the value of the same parameter in vacuum:

$$n_4 = 1.000 . \qquad (2.3.11)$$

Assuming a spheroidal ellipsoidical symmetry, the numerical value of the n_k quantities is then given by:

$$n_3^2 = 1.054, \qquad n_1^2 = n_2^2 = (1 / n_3^2)^{1/2} = 0.974. \qquad (2.3.12a)$$

$$n_1^2 \times n_2^2 \times n_3^2 = 1, \tag{2.3.12b}$$

where the last condition represents the lack of compressibility of the nucleons in the deuteron conditions or, equivalently, the preservation of their volume in the transition from the vacuum, $n_K = 1$, $k = 1, 2, 3$, to strong coupling in the deuteron structure.

We also have the alternative solution:

$$n_3^2 = 1.054, \qquad n_1^2 = n_2^2 = (3 - n_3^2) / 2 = 0.973, \tag{2.3.13a}$$

$$n_1^2 + n_2^2 + n_3^2 = 3, \tag{2.3.13b}$$

where the last condition represents the normalization to the original sphere $1 + 1 + 1 = 3$, Eqs. (2.1.3).

As one can see, values (2.3.12a) and (2.3.13a) are very close to each other, thus indicating that normalizations (2.3.12b) and (2.3.13b) both hold for the deuteron.

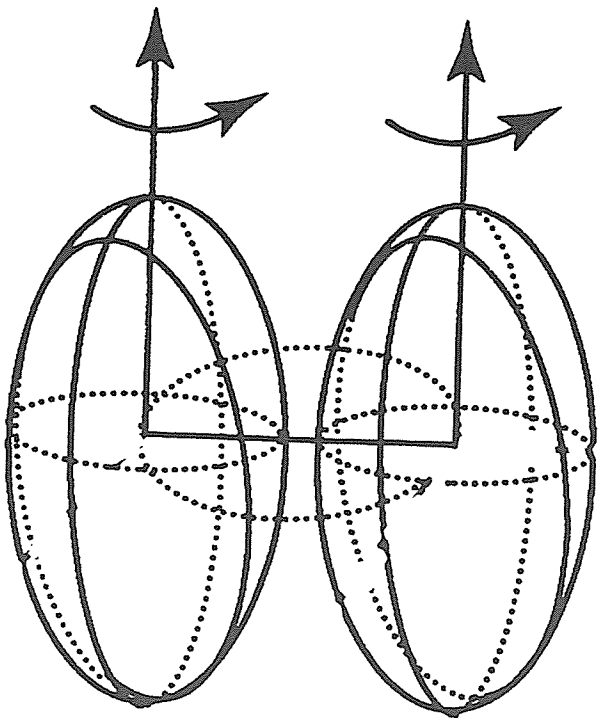

FIGURE 3: A schematic view of the small prolate deformation of the shape of the proton and the neutron when member of the deuteron, which permits the exact representation of the deuteron magnetic moment (2.3.10).

Note that Eqs. (2.3.12) or (2.3.13) establish that the ellipsoidical deformation of protons and neutrons is of *prolate* type, exactly as needed.

Note also that the mutated magnetic moments *decrease* in value, also as needed for the deuteron. Note finally that the exact representation (2.3.10) is achieved via a *small deformation* of the perfectly spherical nucleons of the order of 2.6%.

As a final comment, the reader should keep in mind that assumption (2.3.11) (the proton and the neutron move in vacuum) is valid only in first approximation, because in reality they move one within the other. The deviation from value (2.3.11) will be studied in Section 2.5.

2.3.7. Exact Representation of All Remaining Nuclear Magnetic Moments.

The deuteron model (2.3.10) is easily extendable to all remaining nuclei via a simple isotopy of the conventional quantum mechanical model for total nuclear magnetic moments [5]:

$$\hat{\mu}^{Tot} = \hat{\mu} \times \sum_k (\hat{g}_k^L \times M_{k3} + \hat{g}_k^S \times \hat{S}_{k3}), \tag{2.3.14a}$$

$$\hat{g}_n = g_n \times n_4/n_3 , \qquad \hat{g}_p = g_p \times n_4/n_3 , \tag{2.3.14b}$$

$$e \times \hbar/2 \times M_p \times c_o = 1 , \; g_n^S = -3.816 , g_p^S = 5.585 , \tag{2.2.14c}$$

$$g_n^M = 0 , \quad g_p^M = 1 , \tag{2.3.14d}$$

where the n's are the characteristic quantities varying from nucleus to nucleus, and, again, we have assumed in first approximation that the mutated shapes of protons and neutrons are the same.

The conventional quantum version of Eqs. (2.3.14) *cannot* provide a meaningful representation of nuclear magnetic moments due to the excessive deviations from the experimental values, particularly for large nuclei (see the Schmidt limits of Figure I-1).

Hadronic version (2.3.14) provides instead an exact representation of the experimental data, as the reader can easily verify, via a mere deformation of the shape of nucleons according to Historical Hypothesis 2.1.

The reader should be aware that the deformed shapes of the nucleons *cannot* possibly be the same for all nuclei, and vary from nucleus to nucleus, as evidently necessary, because different nuclei have different configurations, including different average conditions of mutual overlappings.

Moreover, average deformations are expected to be different from one nuclear shell to another, again, because of the correspondingly different configurations. Therefore, *different averages of the characteristic n-quantities are expected for different shells.*

Finally, the reader should be aware that the value of n_4 will increasingly deviate from that in vacuum with the increase of the nuclear mass, as known from Paper III and as illustrated below.

In summary, exact representations of total nuclear magnetic moments are permitted by a mere geometrical representation of the deformation of the charge distribution of nucleons, precisely along Historical Hypothesis 2.1, without any need, at the level of the first treatment, of identifying the constituents of protons and neutrons. Whatever these constituents are, they must verify exact representation (2.3.14) as a necessary condition to be physically acceptable.

I should finally stress that *I do not* claim the paternity of the main idea of this section, because it belongs to the founding fathers of nuclear physics. However, I do claim the paternity of the first consistent and invariant representation of total nuclear magnetic moments; I request the quotation, specifically, of Refs. [2b,2g,12] in subsequent works by other authors, specifically, in the field with an outline of my results whenever new advances are claimed.

2.4. Exact Representation of Rauch's 4π Interferometric Measurements

An independent, direct experimental verification of the Historical Hypothesis 2.1 (deformability of the intrinsic magnetic moments of nucleons) was conducted at the nuclear physics laboratory of the University of Grenoble, France, in the late 1970's by H. Rauch, Director of the Atominstitut, Wien, Austria, and his associates [14].

The experiment is known as the *neutron interferometric test of the 4π-spinorial symmetry of neutrons* (Figures 4 and 5). It essentially consists of a thermal (low energy) neutron beam which is first coherently split by a perfect crystal and then one or both branches are let to pass through an electromagnet gap. This result is permitted precisely by the perfect crystal due to the wide angle of

separation. The magnetic field within the gap is set to cause two complete spin-flips (4π = 720° rotation). The two beams are then coherently recombine by the perfect crystal as shown in the Figures 4 and 5.

The experimenters calibrated the magnetic field in the gap to the value 7,496 G [14], which permits exactly two spin flips *in correspondence of the conventional value of the neutron magnetic moment in vacuum*, Eq. (1.2.2).

In order to avoid stray magnetic fields at the borders of the gap (which increase the error), the experimenters filled up the electromagnet gap with Mu-metal sheets. This filling essentially provided a test of the spinorial symmetry of neutrons *under the intense fields in the vicinity of Mu-metal nuclei.*

Note that, in this case, no significant contribution is expected from strong nuclear interactions. In fact, such contributions can only occurs when the neutrons pass thru an area of 1 fm thickness around the Mu-metal nuclei, which is too small for any appreciable effect. Besides, neutrons going through that region will experience scatterings with large deviations, thus preventing their participation in the test. Therefore, the deformation of neutrons is solely expected by the passing of these particles through the intense electric and magnetic fields of said nuclei.

To confirm the above expectation, *all measurements conducted by Rauch's without Mu-metal sheets inserted within the electromagnetic gap (that is, for neutrons moving in vacuum) recovered the 4π-symmetry exactly, as expected. All apparent deviations occurred only when the experimenters inserted the Mu-metal sheets within the electromagnet gap, in which case neutrons move thru the indicated intense fields of the Mu-metal nuclei.*

In all the *latter* tests (only), Rauch and his collaborators *did not* find the expected angle of 720°, but found instead the following angle of spin-flip [14]:

$$\theta = 715.87^\circ \pm 3.8^\circ, \tag{2.4.1a}$$

$$\theta_{max} = 719.67^\circ, \quad \theta_{min} = 712.07^\circ, \tag{2.4.1b}$$

which *does not contain the exact angle 720° in their minimal and maximal values.*

Moreover, the median value were *consistently lower than 720°* in all experiments [15]. I called this occurrence the *angle slow-down effect* [15a].

It should be stressed that *experimental measurements (2.4.1) are not final because the error is too large as compared to the deviation.* To be acceptable, a deviation should be at least 1/3 of the error, which is not the case for measurements (2.4.1).

Despite this unsettled aspect, Rauch measurements (2.4.1) are indeed plausible. Perfectly rigid bodies exist in academia, but not in the physical reality. Measurements (2.4.1) then essentially express the average deformation of the neutron's charge distribution when passing thru the intense fields in the vicinity of the Mu-metal nuclei, with consequential necessary alteration of the intrinsic magnetic moment, precisely along Historical Hypothesis 2.1.

As a result, Rauch's experiments [14] constitute an indirect experimental verification of the exact representation of nuclear magnetic moments via generally small the deformations of the nucleons outlined in the preceding section.

Moreover, the consistent *decrease* of the measured angles implies that the intrinsic magnetic moment is *decreased* in its average. This fact alone is in beautiful agreement with the decrease of intrinsic magnetic moments of nucleons, as needed to represent the deuteron magnetic moment.

Therefore, the implications of Rauch's experiment are quite deep. In fact, measurements (2.4.1) imply the inapplicability (and not the violation) of the very central pillar of quantum mechanics, the rotational symmetry in its spinorial SU(2) realization [13]:

$$\psi' = R(\theta)\,\psi = e^{i\gamma_1\gamma_2\theta/2}\,\psi. \tag{2.4.2}$$

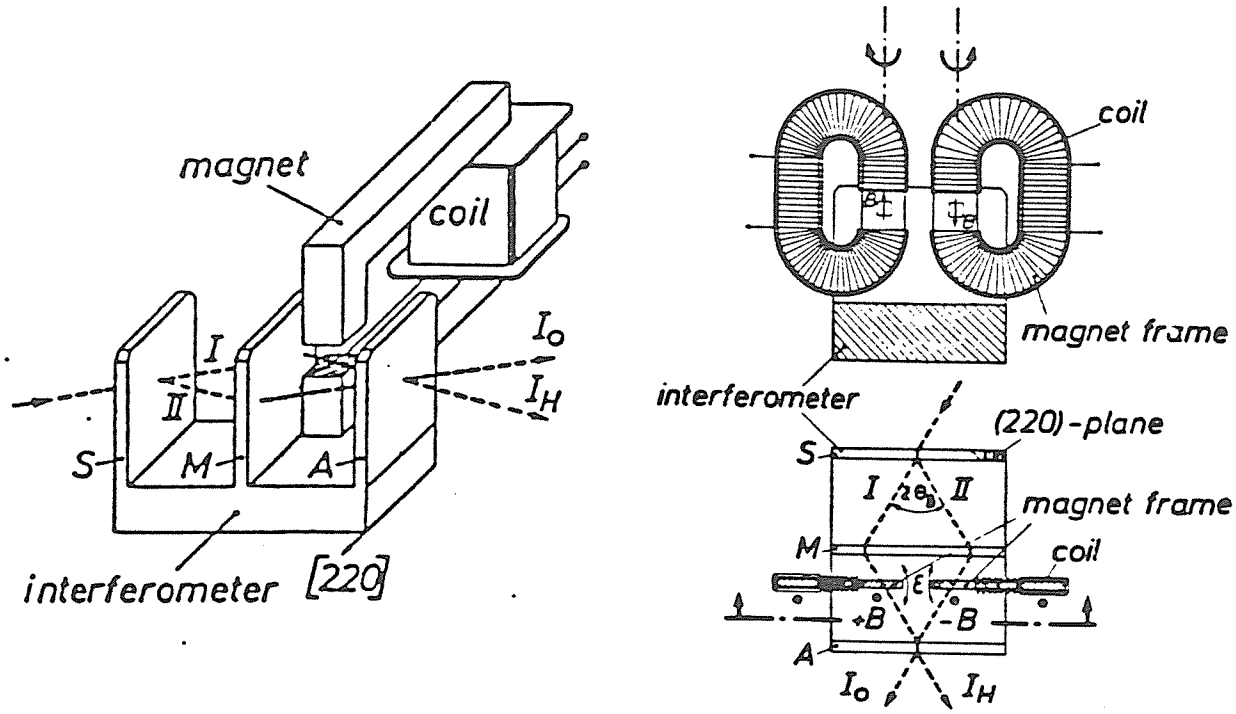

FIGURE 4: A schematic view of Rauch's interferometric measurements on the 4π-spinorial symmetry of a polarized thermal neutron beam [14]. The top view outlined the coherent splitting by the perfect crystal of the thermal neutron beam into two branches, and its coherent recombination. The bottom view outlined the electromagnetic gap, which produced the rotation of the neutron called "spin flip".

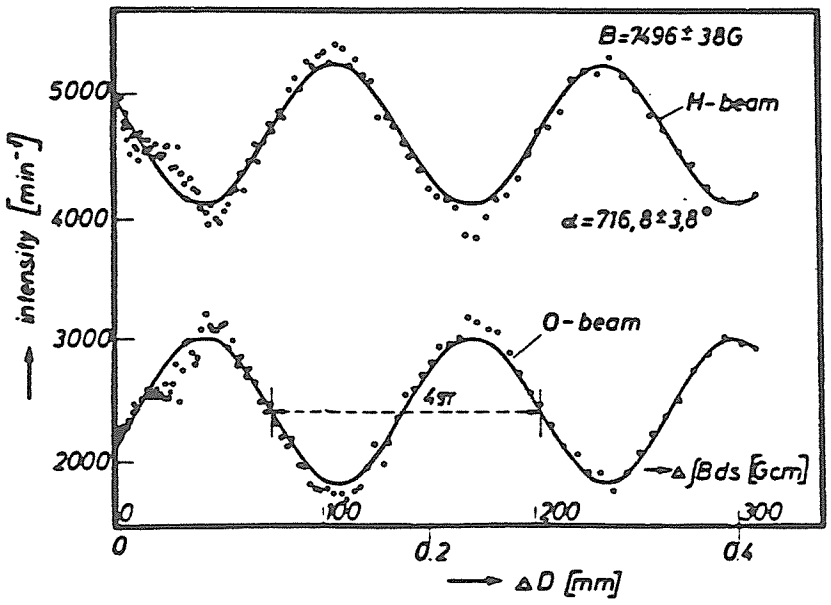

FIGURE 5: A schematic view of the plot of measurements for the intensity and the polarization modulation in tests [14]. Note that the experimental points *do not* fit well a sinusoid, which constitutes per se evidence of deviations from the conventional SU(2)-spin symmetry in favor of the covering Lie-Santilli $\hat{SU}(2)$ isosymmetry.

I presented the first exact-numerical representation of Rauch's measurements (2.4.1) at the Conference on *Differential Geometric Methods in Theoretical Physics* held at Clausthal in 1980 [15a]. The representation was reached via the first known (p, q)-deformation of SU(2)-spin (the indication of deformations, specifically, of the SU(2)-spin symmetry *prior* to 1980 would be appreciated).

The primary objective of this first representation was *strictly nonconservative,* in the sense of representing the neutron beam *under the fields of the Mu-metal nuclei considered as external.* As one recalls from Paper II, the *nonconservation* of the energy of the neutrons is a necessary condition to apply the (p, q)-deformations, because the brackets of the time evolution are not antisymmetric, thus implying the *nonconservation law* [2]:

$$i\times dH / dt = p\times H\times H - q\times H\times H = (p + q)\times H\times H \neq 0. \qquad (2.4.3)$$

The energy missed by the neutron is absorbed by the Mu-metal nuclei (or vice-versa), so that the conservation of the total energy is always verified.

Y. Ne'eman of Tel Aviv University, Israel, was present at the 1980 Clausthal Conference, and, following my presentation, acted as somewhat shocked to see the first deformation of the sacred SU(2)-spin symmetry (although he later became accustomed to them due to their current widespread study).

Apart from emotional aspects, Ne'eman objected against presentation [15a] to the effect that electromagnetic interactions preserve the SU(2)-spin symmetry. Therefore, there is no need for its violation to represent Rauch's measurements.

Ne'eman's point is obviously correct, because Rauch's setting can be treated in the center-of-mass, in which case the SU(2)-spin symmetry must be necessarily exact. In fact, I thanked Ne'eman for his comment in paper [15b].

However, I noted to Ne'eman (as well as to the audience at the 1980 Clausthal meeting, and as clearly stated in Paper [15a]) that the (p, q)-Lie-admissible deformation of SU(2) was presented, specifically, to *test the spin symmetry under external strong interactions,* an issue that remains completely open as of today, 20 years later, both theoretically and experimentally (because all tests under strong interactions are only done for the center-of-mass to this day).

My main point is that *the spin-symmetry is exact under external electromagnetic interactions, however, the validity of the same symmetry under external strong interactions is far from being certain.*

The issue is of paramount importance for nuclear physics because, translated in plain language, it identified the problem whether the individual nucleons of a nucleus must necessarily have spin 1/2, since conventional total nuclear spins are equally admitted by individually mutated values of the constituents.

Equivalently, the open issue is whether there is a new, hitherto unknown interaction within nuclei consisting of *continuous* spin exchanges between nucleons, thus resulting in deviations from the spin 1/2, while the totals spin is necessarily conventional because conserved, since the system is isolated. Since all available data are of total character, any dismissal of this hypothesis is a scientific fallacy.

In 1981 I organized an international meeting in the field which was held at the University of Massachusetts in Boston (see the proceedings [15b]), which was attended by various mathematicians experts in algebraic deformations, and various experts in neutron interferometry.

Rauch presented his best possible results (2.4.1) and stressed the plausibility of the deviations (see his paper [14e] which was part of Proceedings [15b]). He also indicated the plausibility of possible deviations from Pauli's exclusion principle in nuclear physics, precisely under *external strong conditions,* as indicated earlier.

A necessary condition for the conduction of a serious experimental test of Pauli's principle under external strong interactions is that the data are *not* elaborated, as currently done, via theories based on the validity of said principle, as it is the case for all quantum mechanical elaborations, because in this case the "experimental results" will be compatible with the basic

theoretical assumptions.

At any rate, the elaboration of the data for the experiment considered would be grossly inconsistent because external strong interactions imply nonconservation with consequential nonunitary time evolutions, while quantum mechanics can only represent conservative conditions under a unitary time evolutions.

To my best knowledge, the genotopic branch of hadronic mechanics outlined in Paper II, with time evolution $idA/dt = A<H - H>A = A\times R\times H - H\times S\times A$, $idH/dt = H\times(R - S)\times H \neq 0$, is the *only* known theory for the elaboration of the experimental data here considered which is nonconservative, nonunitary, and invariant.

At the same meeting of 1981, G. Eder [15c] of the University of Wien, Austria, studied my preceding SU(2)-deformation [15a] in great detail. Eder also studied the physical conditions of the thermal neutron beam in interaction with the intense electric and magnetic fields in the vicinity of Mu-metal nuclei, and concluded that a 1% deviation from the 4π angle of precession is indeed possible for the conditions of the tests. To my best knowledge, Eder's paper of 1981 is the second on the deformation of SU(2)-spin I am aware of.

Eder clarified the fact that external *strong* interactions had no significant or practical value for the 4π interferometric tests. This identified the need to follow Ne'eman's suggestion of keeping the SU(2)-spin symmetry exact, because we are solely dealing with electromagnetic interactions, in which case no deviations are plausible.

Since external strong interactions can be ignored, I subsequently worked out in papers [12] the *isotopies* (rather than the broader genotopies) of SU(2)-spin. In this case the conservation of the total energy H is assured by the basic axioms, in view of the antisymmetric character of the generalized brackets of the time evolution, for which (see Paper II for details):

$$i \times dH / dt = H\times\hat{I}\times H - H\times\hat{I}\times H \equiv 0 . \tag{2.4.4}$$

Moreover, the isotopic $S\hat{U}(2)$ symmetry is isomorphic to the conventional formulation, and preserves conventional quantum numbers; yet it is sufficiently broad to permit an exact representation of Rauch's data (2.4.1).

For the case of isodirac's equation (2.3.3), the conventional rotational law (2.4.2) is turned into the covering isotopic form:

$$\hat{\psi}' = \hat{R}(\theta_3) \hat{\times} \hat{\psi} = e^{i \gamma_1 \gamma_2 \hat{\theta}_3 / 2} \hat{\psi} , \tag{2.4.5a}$$

$$\hat{\theta} = \theta / n_1 n_2 , \tag{2.4.5b}$$

Moreover, as universally established without known objections, the isotopies reconstruct in isospace the exact quantum mechanical value, a condition which is evidently *necessary* for the exact reconstruction of the SU(2)-spin symmetry.

This requirement implies that the exact 720° rotation are represented precisely by the isotopic angle $\hat{\theta}$ in isospace, while θ represents the actual measured angle in physical space:

$$\hat{\theta}_3 = \theta_3 / n_1 \times n_2 \Big|_{\theta_3 = 716^\circ} = 720^\circ . \tag{2.4.6}$$

Since the neutron is a spinning particle, it is rather natural to assume that it possesses a cylindrical symmetry, i.e., $n_1 = n_2 \neq n_3$. The shape will then be a prolate (oblate) spheroidal ellipsoid if:

$$\text{Prolate spheroidal } n_3 > n_1 = n_2 , \tag{2.4.7a}$$

$$\text{oblate spheroidal } n_3 < n_1 = n_2 . \tag{2.4.7b}$$

Finally, we assume in first approximation that the ratio $\hat{\mu}/\mu$ between the mutated and conventional magnetic moment is of the order of magnitude:

$$\hat{\mu} / \mu \approx 716^\circ / 720^\circ. \tag{2.4.8}$$

where 716° is the median angle of measures (2.4.1), as a result of which:

$$n_4 / n_3 \approx = 716^\circ / 720^\circ = 0.9944 \tag{2.4.9}$$

By recalling that the neutron moves in vacuum, we have $n_4 = 1$. From the above data, the exact-numerical representation of Rauch's measurements (2.4.1) is given by:

$$n_1 = n_2 = 0.9972, \quad n_3 = 1.0056, \quad n_4 = 1.000, \tag{2.4.10}$$

which confirms the *prolate* character of the deformation, exactly as needed also for the deuteron nuclear magnetic moment.

Note that:

$$n_1^2 + n_2^2 + n_3^2 = 3.0000, \tag{2.4.11a}$$

$$n_1^2 \times n_2^2 \times n_3^2 = 1.0000, \tag{2.4.11b}$$

thus confirming the preservation of the original volume/density during the deformation, Eq. (2.1.3a, as well as the original Euclidean geometry, Eq. (2.1.3b).

In summary, the isodirac equation (2.4.3) permits a direct representation of: 1) All possible extended charge distributions of nucleons via the basic isounit $\hat{1}$ = diag. $(n_1^2, n_2^2, n_3^2, n_4^2)$, where n_4^2 geometrizes the density of the medium in which motion occurs, n_k^2, k = 1, 2, 3, represents the semiaxes, and more general shapes are represented via nondiagonal realizations; 2) All possible volume-preserving deformations of these shapes via a dependence of the isounit, e.g., on the intensity E of the external fields $n_\mu = n_\mu(E)$; and 3) The "angle slow-down effect" [15a] due to a *decrease* of the intrinsic magnetic moment is for the physical conditions considered. All these results occur by reconstructing the *exact* rotational symmetry SU(2)-spin in isospace, including the preservation of Pauli's principle.

Refs. [14] show the need for claiming an exact SU(2)-spin symmetry that: 1) The experimental data on the intensive and polarization modulation must be exactly on a sinusoid; and 2) The intensity and polarization modulation must be 90° off phase.

An inspection of the experimental plot of Ref. [15] reproduced in Figure 5 establishes that *the experimental fit of the intensity and polarization modulation do not follow a precise sinusoid.* On strict scientific grounds, this occurrence alone is sufficient to establish the breaking of the SU(2)-spin symmetry in tests [145] *even under the full recovering of the 4π angle.* The plausibility of the breaking and its incredible agreement and complementarity with the corresponding setting for nuclear magnetic moments are evident.

Regrettably, for reasons discussed in detail in Refs [II-2a,II-2b], no additional re-run has been conducted since 1978 (sic) on the fundamental test of the 4π spinorial symmetry, despite its fundamental character and numerous solicitations to neutron interferometric laboratories around the world by myself and other scientists. The sole interferometric experiments that have been permitted are those in vacuum (that is, without exposing the neutron beam to intense electric and magnetic fields in the vicinity of nuclei), in which case no deviation from quantum mechanics is possible.

It should be noted that, following major technological advances in neutron interferometry occurrence in the past 20 years, Rauch's experiment can be today conducted in a final and resolutory form, with errors which are today a fraction of those of 20 years ago. Moreover, the

experiment can be conducted nowadays for several 4π-flips, such as 50 double flips, which would imply 1/50 of the error in Eq. (2.4.1), and assure a final resolution. Despite that, the 4π-neutron interferometry test is not conducted at U.S. and foreign laboratories in the field in favor of other, transparently less important experiments.

Moreover, the final experimental confirmation of the deformability of the charge distribution of nucleons directly implies, via a simple Lorentz transformation, the expected existence of *new means of recycling highly radioactive nuclear waste via their stimulated decay.*

Despite this manifest societal importance, the 4π neutron interferometric experiment continues to be ignored at laboratories in the field, as the reader is encouraged to verify (see for detail in book [II-2a] and documented in [II-2b]).

Due to widespread plagiarisms existing in the contemporary physics literature, I have copyrighted numerous publications on the representation of the 4π interferometric test as outlined in this section, and I intend to defend such copyrights in any means permitted by law. The results of this section can be used by anybody in part or in full for any scientific purpose without any prior authorization, *provided* that: 1) The original publications are quoted; 2) The quoted publications are outlined as a prerequisite for allegations of novelty; and 3) Paternities are identified with clarity.

2.5. Hadronic Model of the Deuteron Structure

As stressed in Section 1.2, on true scientific grounds the problem of the structure of the deuteron is completely open at this writing on *all* aspects, including: stability, identification of the constituents, origin of the attractive force, spin 1, physical characteristics, etc.

2.5.1. Conceptual Foundations for Nuclei

In this section I show that *all* the above problems are solved by the following:

> *HYPOTHESIS 2.3: Nuclei are bound states of protons and electrons verifying hadronic mechanics.*

I should immediately clarify that *the above hypothesis is not new.* In fact, the very first conception of nuclei by Rutherford and his contemporaries in the 1920's has been precisely that they are composed by protons and electrons. A number of studies on the same hypothesis are conducted to this day (see the contributions in [15d].

Stars at their formation are solely composed by hydrogen, that is, by protons and electrons. For this reason, Rutherford conceived the neutron as a "compressed hydrogen atom", that is, a proton with an electron totally immersed in its interior.

Along the same lines, the most logical and plausible hypothesis of the time was that all nuclei are constituted by "compressed hydrogen atoms", thus resulting in a collection of protons and electrons at short distance.

After all, *protons and electrons are permanently stable particles.* As such, they cannot be destroyed and disappear, as per nonscientific-magic beliefs of contemporary academia.

Despite its clear plausibility and physical origin, the hypothesis that nuclei are made of protons and electrons was abandoned as soon as nuclear experimental data began to appear in the 1930's, due to a host of un-resolvable problematic aspects, such as: 1) Inability to represent nuclear spin, magnetic moments, and other data; 2) Impossibility to represent nuclear binding energies; 3) Impossibility of permanent bounds of the electron within the small nuclear regions; and others.

As a result of these difficulties, the hypothesis had to be abandoned, and the official studies were solely conducted from the 1930's on, by assuming that nuclei are composed by protons and neutrons. The perhaps *bigger* impossibilities of the latter hypothesis to explain the attractive

character of nuclear forces, nuclear stability, and other basic data (Section 1.2) were completely abandoned, resulting in scientific error, as shown in Section 1.2.

The new aspect of Hypothesis 2.3 consists of *the use of hadron is mechanics*. In fact, *the insufficiency of the conception of nuclei as bound states of protons and electrons are due to the theory used for their quantitative treatment, and certainly not to the hypothesis itself*. This is due to the clear plausibility of the hypothesis: the impossibility of eliminating in a somewhat magical way the *stable* protons and electrons, and replacing them with the *unstable* neutrons.

As we shall see, the use of hadronic mechanics permits the resolution of *all* known inconsistencies caused by quantum mechanics.

The resolution of the structure of the neutron as a hadronic bound state of one proton and one electron directly implies Hypothesis 2.3. We can say that, at a first approximation, the deuteron is composed by one proton and one neutron. However, at a deeper level of study, Hypothesis 2.3 follows, because the neutron itself is a bound state of a proton and an electron. Once the deuteron has been reduced to protons and electrons, the same reduction for all remaining nuclei is merely consequential.

I should stress that Hypothesis 2.3 *is not* intended to demolish current results, because physics is a chain of sequential approximations. Therefore, the assumption of nuclei as bound states of protons and electrons is *fully compatible, and actually complementary* to their conception as bound states of protons and neutrons.

The reader should be aware that the most effective quantitative–numerical treatment of Hypothesis 2.3 is that via the Poincaré–Santilli isosymmetry [7] and the related new notion of bound states as closed isolated non–Hamiltonian systems (Figure 1).

Such a treatment automatically guarantees: 1) Conventional total characteristics of nuclei (because the generators of the conventional and isotopic symmetries are identical), thus rendering Hypothesis 2.3. not distinguishable from current beliefs on experimental grounds; 2) The necessary mutation of the intrinsic characteristics of protons and neutrons when verifying the isosymmetry, which eliminates all inconsistencies caused by quantum mechanics; and 3) The existence of completely novel internal interactions, because they are now constituted by a superposition of action–at–a–distance potential interactions (mediated by particle exchanges), and contract nonpotential interactions which *cannot* be mediated by particles exchanges.

The more rigorous treatment of Hypothesis 2.3 via the Poincaré–Santilli isosymmetry [7,4c] will be presented in separate papers because considerably more technical than the level of this presentation.

As I hope to indicate in Section 3, Hypothesis 2.3 directly implies basically novel energies which are unthinkable via quantum mechanics. Therefore, Hypothesis 2.3. has major societal relevance.

2.5.2. Conceptual Foundations for the Deuteron.

In this section I study the structure of the deuteron according to Hypothesis 2.3, treated via the simplest possible methods of nonrelativistic hadronic mechanics. Once consistency is established at that level, the consistency at the broader relativistic, and isosymmetry levels is a mere consequence. The structure of the remaining nuclei will be discussed later.

The quantum mechanical structure of the deuteron as composed by two protons and one electron with the same characteristics as those when isolated in vacuum, is afflicted by a number of basic inconsistencies.

These inconsistencies leave no other choice than the assumption of different mechanics in the transition from the structure of the hydrogen atom to those of the neutron and deuteron, evidently in view of the profound physical differences of the two layers of nature.

In the atomic structure, protons and electrons are at very large mutual distances as compared to the size of their wavepackets, while in the deuteron structure the particles are under a necessary condition of mutual wave–overlapping with consequential nonlinear, nonlocal and

nonpotential effects. The belief that the mechanics holding for the former conditions must *necessarily* hold also for the dramatically different latter conditions is erroneous. The only open issue is the selection of the appropriate broader mechanics.

In this study, I assume the validity of hadronic mechanics for quantitative scientific studies on the structure of the deuteron, because it permitted in Paper II the only known invariant and consistent structure model of the neutron as a bound state of one proton and one electron, as well as for the various reasons outlined in Sect. 1.2.

The main mechanism is that, in the transition from motion in vacuum at large mutual distances, to motion in the condition of deep overlapping of their wavepackets, particles experience an alteration of their *intrinsic* characteristics, called *mutation* [2a,2b], or *isorenormalization* [2c].

As a result, the protons and the electrons of Hypothesis 2.3 *are not* ordinary particles as known in the literature (irreducible representations of the Poincaré group), and are instead *isoprotons* and *isoelectrons* (irreducible isorepresentations of the Poincaré–Santilli isogroup [7,4c]. In turn, the latter mutations resolve *all* problematic aspects created by the limitations of quantum mechanics for the treatment of Hypothesis 2.3.

2.5.3. Deuteron Stability.

As well known, protons and electrons are stable. Therefore, Hypothesis 2.3 resolves the problem of the stability of the deuteron in a direct, simple, and definite way.

By comparison, the current assumption that the deuteron is a bound state of a proton and a neutron leaves the problem of the stability of the deuteron fundamentally unsolved on true scientific grounds.

In fact, under a serious scrutiny, there is no credible proof whatever in the scientific literature on the reasons why, when a member of the *stable* deuteron, the *unstable* neutron is turned into a stable particle with infinite lifetime.

Recall the basic property (well known to experts in nuclear physics) that *the Poincaré symmetry prohibits such drastic changes of meanlives.* But the Poincaré symmetry is used for both conditions of the neutron, motion in vacuum with about 15 minutes meanlife, and motion in the deuteron structure with infinite lifetime. The lack of scientific credibility in claims of final understanding of the deuteron stability, is then proved beyond credible doubt.

2.5.4. Deuteron Size.

Experimental data have established that the proton has a charge radius of $R_p = 0.8\times10^{-13}$ cm = 0.8 fm, and diameter D_p = 1.6 fm, which can be well assumed as the size of its wavepacket. I shall assume for the corresponding value of the wavepacket of the electron $R_e \approx 0.5$ fm (as that providing appreciable nonlocal effects) and D_e = 1 fm. I shall then write:

$$R_p = 0.8\times10^{-13}\ \text{cm} = 0.8\ \text{fm},\ D_p = 1.6\ \text{fm}, \tag{2.5.1a}$$

$$R_e \approx 0.5\ \text{fm},\quad D_e = 1\ \text{fm}. \tag{2.5.1b}$$

Numerous values of the charge radius of the deuteron can be found in the "official" literature, such as the value R = 4.31 fm (see, *e.g.*, [5d], p. 52). However, such a value is derived via *theoretical* elaborations based on a number of physical *assumptions* based on the use of *quantum mechanics,* which are simply unacceptable for a treatment via hadronic mechanics.

After consultations with nuclear physicists, I have been unable to locate in the literature any *actual experimentally measured value* of the size of the deuteron without any theoretical manipulation (its indication would be appreciated, if available).

For these reasons, I assume the value of the charge radius of the deuteron derived by the formula $R = 1.12 \times A^{1/3}$ fm [5], which is experimentally verified for a large variety of nuclei, and yields the value for the deuteron $R_d = 1.41$ fm and $D_d = 2.82$ fm. I shall then write:

$$R = 1.12 \times A^{1/3} \text{ fm}, \; R_d = 1.41 \text{ fm}, \; D_d = 2.82 \text{ fm}. \tag{2.5.2}$$

By recalling that $D_p = 1.6$ fm, the two protons as per Hypothesis 2.3 are in conditions of mutual penetration of their hyperdense structure in the amount of 0.38 fm. In turn, these conditions imply that the electron is totally immersed within the proton structure, in full compatibility with the neutron structure [4], yielding the configuration of Figure 6

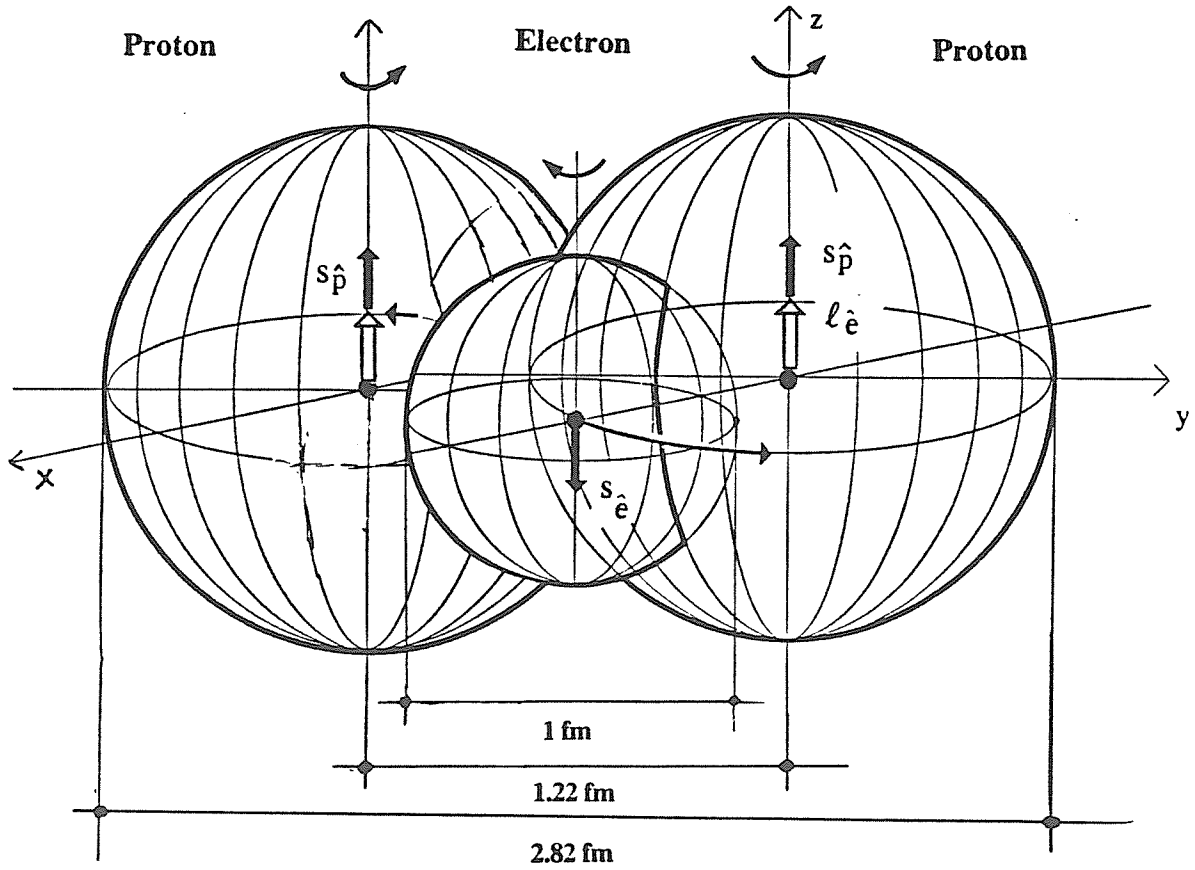

FIGURE 6: A schematic view of the deuteron according to Hypothesis 2.3 as a hadronic bound state of two isoprotons $\hat{p}$ and one isoelectron $\hat{e}$ in conditions of mutual penetration of their wavepackets, thus requiring the use of hadronic mechanics. The above view should be compared with Figure 10 of Paper III on the structure of the neutron. Needless to say, the above figure is merely schematic, because the charge distributions of the two protons is expected to be deformed into a prolate spheroidal ellipsoid, as outlined in Figure 3.

2.5.5. Deuteron Charge.

Hypothesis 2.3 trivially represents the deuteron positive charge +e. The structure of the deuterium *atom* is then represented via *quantum* (and not hadronic) mechanics (because the mutual distances

are large).

The reader should keep in mind that hadronic mechanics generally implies the mutation of *all* characteristics of particles, thus including charges which now become $\hat{e}_p = \lambda_p \times e$ and $-\hat{e}_e = -\lambda_e \times e$. The latter mutation is necessary for consistency beginning with the reconstruction of the exact isospin symmetry (Section 2.2).

However, these mutations are only *internal,* by recovering the conventional *total* charges in our spacetime, precisely as it was the case for the reconstruction of the exact isospin symmetry.

Technically, the preservation of conventional total value is established by the fact that the charge operator of the Poincaré-Santilli isosymmetry *coincides* with that of the conventional Poincaré symmetry.

2.5.6. Deuteron Spin.

As recalled in Section 1.2, quantum mechanics predicts that the most stable state between two particles with the same non-null spin must be the *singlet* coupling, for which the total spin is zero.

Therefore, the most stable state predicted by quantum mechanics between one proton and one neutron is with *spin zero.* In the physical reality, *the deuteron has spin 1.*

This discrepancy is the most powerful evidence that the deuteron is a *three-body system,* rather than a two-body system as currently taught.

At this point the use of hadronic mechanics becomes mandatory to avoid major inconsistencies. The problem is similar to that of the spin of the neutron as a bound state of a proton and an electron [4] (see Paper IIIB). Since the two constituents have spin 1/2, quantum mechanics predicts that the state should have integer total spin, while the neutron has spin 1/2. However, Santilli proved for the first time in 1990 [4a] (also reported by Conte [9f,10f] *et al.* without reference to Santilli's origination) that, when the electron is totally immersed inside the proton, the coupling must necessarily be in singlet, while the angular momentum of the electron is constrained to coincide with the spin of the proton (see Figure 1 of [4a] reproduced in Figure 10 of Paper III).

Angular momenta with *fractional* value L = 1/2, 3/2,... are anathema for quantum mechanics, that is, when one uses a conventional Hilbert spaces $\mathcal{H}$ with inner product $< | \times | >$, because integer angular momenta violate the crucial condition of unitarity, with consequential violation of causality, and other basic physical laws.

Hadronic mechanics admits instead angular momenta with the generic value $\hat{L} = \rho \times L$, where ρ is a non-null *continuously varying* scalar and L = 0, 1, 2, 3, ... without any violation of physical laws. Thisconception is permitted by the isohilbert spaces $\hat{\mathcal{H}}$ and isoinner product:

$$\hat{L} = \rho \times L, \quad L = 1, 2, 3, ..., \quad \rho \in R, \rho > 0, \tag{2.5.3a}$$

$$< | \times \hat{T} \times | > \times \hat{1} \in \hat{C}, \qquad \hat{1} = \rho^{-1}, \quad \hat{T} = \rho, \tag{2.5.3b}$$

which reconstruct unitarity, causality and all other physical laws on isospaces over isofields (a feature not properly treated, such as that by Conte [9f,10f], resulting in catastrophic inconsistencies).

Stated in different terms, violations of basic physical laws are inevitable when the angular momentum assumes values $\hat{L} = \rho \times L \neq 1, 2, 3$, L = 1, 2, 3, *under the condition of preserving the conventional unit 1,* as tacitly implied but not stated in the quantum literature.

Hadronic mechanics resolves these inconsistencies because, jointly with the mutation $L \to \hat{L} = \rho \times L$, the basic unit is subjected to the mutation $1 \to \hat{1} = \rho^{-1}$. Since ρ and ρ^{-1} cancel out, the numerical value of the angular momentum in isospace remains the integer L, thus avoiding the indicated inconsistencies.

Under these conditions, *the electron of Hypothesis 2.3 has null total angular momentum* [4], *and the total angular momentum of the deuteron can only be one, since the orbital angular momenta of the two protons is null in the S-state.*

More specifically (see Figure 6 for details), to achieve a mathematically consistent

interpretation of the spin of the deuteron, one must consider the isotopies of both the spin and angular momenta of all constituents, as done in [4a] Eqs. (2.34), reproduced in Eqs. (3.35), of Paper III.

The only novelty here is that the isotopic mutation of the spin of the two protons must all have different numerical values due to the evidently different mutual penetration. In turn, such different mutation of spin is essential to avoid problems with Pauli's principle.

In the stable configuration of the S-state (the only one here admitted), the two peripheral protons have null angular momenta. The use of Eqs. (3.35) of Paper III then implies the total angular momentum of the deuteron:

$$J_d = \Delta_{p1} / 2 + \Delta_{p2} / 2 + \Delta_e / 2 + \rho \times L_e = 1 , \qquad (2.5.4a)$$

$$\Delta_{p1} + \Delta_{p2} = 1, \quad \rho = - \Delta_e / 2 . \qquad (2.5.4b)$$

Lack of conflict with Pauli's principle is established by the fact that the two isoprotons *do not* have spin exactly equal to 1/2 and, in additional, the two mutated values *are not* equal.

Reconstruction of the total value 1 is technically assured for the reason indicated earlier that the generators of the total angular momentum of the Poincaré-Santilli and the Poincaré symmetry coincide. The mutation is caused by the *operations* on them [7,4c], but their isoeigenvalues are conventional.

Note the crucial importance for Hypothesis 2.3 that *the SU(2)-spin symmetry is broken under external strong interactions*, of course, only internally in nuclei and in a way *not* detectable in external, center-of-mass measurements (see my exchange with Yu. Ne'eman of 1980 outlined in Section 2.4).

A fully equivalent classical example is that of Jupiter which admits in its interior *vortices with varying angular momenta, yet its total angular momentum is fully conserved* (see Vol. II of monograph [2d] for a technical treatment).

The above scenario is only one of the novelties of the fundamental notion of these papers, that of closed non-Hamiltonian systems with internal conservative-potential and nonconservative-nonpotential forces (Figure 1). The former forces demand the exact validity of the SU(2)-spin symmetry at the level of *individual* nucleons, from which the validity of the same symmetry at the total level trivially follows. The latter forces mandate instead the breaking of the SU(2)-spin symmetry at the level of *individual* nucleons, while reconstructing its exact character in isospace over isofields .

2.5.7. Deuteron Force.

As stressed in Section 1.2, the assumption of the deuteron as a bound state of a proton and a neutron permits no identification whatever of the *physical origin* of the deuteron *attractive force* in sufficient *strength* to explain its structure. Quantum mechanics merely permits numerous *mathematical descriptions* of the attractive force via a plethora of forces, Eqs. (1.2.1), although none of them admits a clear *physical origin*.

In short, the studies on the structure of the neutron of this century have left, fundamentally unresolved, another basic question in the structure of the deuteron: how a proton and a neutron can possibly attract each other.

Hypothesis 2.3 permits a clear resolution of this additional insufficiency. In fact, the assumed physical constituents in the configuration of Figure 6 have *opposite charges and magnetic moments*, which, at the indicated short distances, have *very large attractive* values.

To my best knowledge, the above setting permits the first identification on record of a deuteron potential with a clear physical origin, which is simply given by the two pairs of attractions p-e and e-p due to charge and magnetic moments, less the repulsion p-p also due to charges and magnetic moments:

$$V_D = - \frac{2\times\hat{e}^2}{0.6} + \frac{\hat{e}^2}{1.2} - \frac{2\times\hat{\mu}_p\times\hat{\mu}_2}{0.6} + \frac{\hat{\mu}_p{}^2}{1.2}, \tag{2.5.5}$$

where the denominators are in fm and the symbols $\hat{e}$, $\hat{\mu}$ represent mutations with respect to the same characteristics when the particles are isolated in vacuum.

It is evident that the *attraction* far exceeds the *repulsion,* thus resulting in a bound state.

In addition, the constituents admit an *attractive force not derivable from a potential* due to the deep penetration of their wavepackets, which is the same as that of the p-e system in the structure of the neutron (Paper IIIB), and can be represented via the isounit:

$$I_{pe} = e^{N\times \int dv\, \hat{\psi}^\dagger_\uparrow p(r) \times \hat{\psi}_\downarrow e(r).} \tag{2.5.6}$$

As the reader may recall from Paper IIIB, the linear approximation of the above force implies the emergence of a Hulten potential which behaves at short distances like the Coulomb potential, by therefore "absorbing" the latter and resulting in a single, dominating, Hulten well with great simplification in calculations.

No additional nuclear force is needed besides the *potential* force due to charge and magnetic moments, Eq. (2.5.5), and the *nonpotential* force due to wave-overlappings, Eq. (2.5.6), as shown in more details below.

For instance, the mysterious "exchange forces" (in which protons and neutrons interchange themselves) are completely un-necessary. It is easy to prove that the isoelectron cannot solely be restricted within one of the two protons, because it carries a finite isoprobability of moving from the interior of one proton to that of the other proton. In turn, such a transition implies precisely the exchange of the proton and the neutron (see Figure 7).

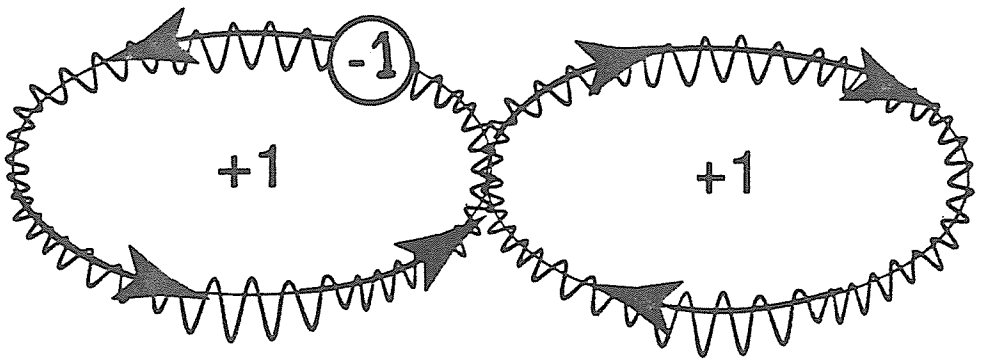

FIGURE 7: A schematic view of the representation of "exchange forces" according to Hypothesis 2.3. It is given by the the isoprobability that the electron is 50% of the time inside one proton and 50% inside the other proton. Since the two protons are mutually overlapping (Figure 6), this implies a oo-shaped orbit, with one o-branch inside one proton and the other o-branch inside the other.

In different terms, the dynamical treatment of Hypothesis 2.3 automatically implies the

exchange of the proton and the neutron, thus eliminating any need for the "exchange forces".

At any rate, the belief practiced throughout this century in nuclear physics that the exchange of a proton and a neutron implies a "force" has no physical foundation of any known type, thus being a pure academic notion. The additional assumption that such an exchange admits a "potential energy", as necessary to represent any force in quantum mechanics, has no scientific credibility of any type, because particle exchanges do not require energy, as we shown later.

Similarly, the "noncentral forces" are equally eliminated by Hypothesis 2.3 because they are a trivial particular case of the broader nonlocal forces extended over the entire volume of wave-overlappings.

A similar fate holds for all the various other mysterious forces adopted in nuclear physics during this century (Section 1.2). They all disappear from the treatment because they have no clear *physical origin*, and when the latter is known, they become inessential.

An illustration is that of velocity-dependent forces. They are known to be particular cases of contact nonlocal forces, because the latter are precisely approximated via power series in the velocities and other terms.

2.5.8. Deuteron Binding Energy.

As it is well known, the binding energy of the deuteron is [5]:

$$E_d = -\ 2.26\ \text{MeV}\ . \tag{2.5.7}$$

Hadronic mechanics permits, for the first time, the identification of the physical origin of such a numerical value, thus providing another experimental verification of the theory.

Recall from the main lines of hadronic mechanics (Paper II) that the binding energy is necessarily and solely characterized by forces derivable from a potential. In fact, the contact forces due to mutual wave-overlapping have no potential energy at all.

The binding energy of the deuteron is, therefore, solely due to the potential component of the deuteron binding force, Eq. (2.5.5). The reader is encourage to verify that for the conventional values of charges and magnetic moments, Eq. (2.5.5) has a numerical value very close to 2.26 MeV. More accurate results are reached via the isorenormalization of the charge and magnetic moments which are here ignored for simplicity (they require the full use of the Poincaré-Santilli isosymmetry).

2.5.9. Deuteron Total Energy.

Hadronic mechanics permits the exact numerical representation of the total energy of the deuteron which, as such, becomes another verification of the theory.

Recall the conversion of one atomic mass unit to MeV [5]:

$$1\ \text{amu} = 941.49432\ \text{MeV}\ . \tag{2.5.8}$$

In these units we have the known values :

$$M_p = 1.00727663 = 938.256\ \text{MeV}/c_o^2, \tag{2.5.9a}$$

$$M_e = 5.48597\times10^{-4}\ \text{amu} = 0.511\ \text{MeV}/c_o^2\ , \tag{2.5.9b}$$

(where c_o is the speed of light *in vacuum*). The mass of a nucleus with A nucleons and Z protons without the peripheral atomic electrons is characterized by [5]:

$$M_{nucl} = M_{amu} - Z\times m_e + 15.73 \times Z^{\widetilde{2/3}}\times10^{-6}\ \text{MeV}, \tag{2.5.10}$$

which yields the well-known mass of the deuteron:

$$M_d = 2.0135 \text{ amu} = 1,875.563 \text{ MeV}. \tag{2.5.11}$$

The use of relativistic hadronic mechanics and its underlying Santilli's isospecial relativity [2,3] are crucial to avoid major inconsistencies. Recall that the mass of the deuteron M_d and its binding energy E_d are measured by outside observers *in vacuum* for which the equivalence principle reads $E = m \times c_o^2$.

By comparison, the constituents of the deuteron move within a hyperdense physical medium for which the speed of light *cannot* be the same as that in vacuum; it is characterized by an index of refraction with value $c = c/n_4 = c_o \times b_4$; and implies the principle of isoequivalence [2,3] (Isoaxiom II-V):

$$\hat{E} = m \times c^2 = m \times c_o^2 \times b_4^2 = m \times c_o^2 / n_4^2 . \tag{2.5.12}$$

The total energy of the deuteron is therefore represented by the expression:

$$M_d = 2 \times M_p \times n_4^2 + M_e \times n_4^2 + E_d = 1,873.304 \text{ MeV}, \tag{2.5.13}$$

which implies the important value:

$$n_4^2 = 0.9980, \quad n_4 = 0.9990. \tag{2.5.14}$$

The above data imply that the *the maximal causal speed in the interior of the deuteron is :*

$$c = 1.0001 \times c_o > c_o , \tag{2.5.15}$$

thus being bigger than that in vacuum. This result is in agreement with the large body of experimental evidence outlined in Paper III.

Recall that in Section 2.3 we assumed in first approximation that the proton and the neutron move in vacuum with $n_4 = 1$. We have now learned that n_4 for the deuteron should have value (2.5.14). In turn, this requires a correction of the n_3 value (2.3.13) for the deuteron magnetic moment, although, the correction occurs at the third digit, and it is here left to the interested reader.

The iso-Schrödinger equation on the structure of the deuteron can be easily reduced to that of the neutron, Eq. (3.27) of Paper III, under the assumption that the p-e component of the p-e-p structure represents 50% of the rest energy of the deuteron, i.e., 937.782 MeV (since the electron spends 50% of its time in each proton):

$$\left(-\frac{\rho^2}{2m} \Delta - V \frac{e^{-b \times r}}{1 - e^{-b \times r}} \right) \times \hat{\psi}_{12} = E \times \hat{\psi}_{12} , \tag{2.5.16a}$$

$$E_d^{Tot} = 2 \times E^{Kin}_e + E^{Bind} = 937.782 \text{ MeV}, \tag{2.5.16b}$$

$$\tau_d^{-1} = 4 \times \pi \times \lambda^2 | \hat{\psi}(0) |^2 \times \alpha \times E^{Kin}_e / \hbar \text{ sec} = \infty , \tag{2.5.16c}$$

$$R_d = b_d^{-1} = 1.41 \times 10^{-13} \text{ cm}. \tag{2.5.16d}$$

The main differences between the above model and Eqs. (3.27) of Paper IIIB are: the different rest energy, the infinite meanlife and the bigger radius.

It is easy to see that Eq.s (2.3.6) admit a consistent solution because reducible to the algebraic expressions (see Paper IIIB, Section 3.3 for all details) :

$$\tau = 7.16\times10^{4\times k_1}/[k_2 - 1)^3\times R_d\times c_o \ = \infty, \tag{2.5.17a}$$

$$k_1[1 - (k_2 - 1)^2] = k_1 = E_d / 2\times\hbar\times R^{-1}\times c_o, \tag{2.5.17b}$$

with numerical solutions:

$$k_2 = 1, \qquad k_1 = 2.5. \tag{2.5. 18}$$

In this model the E is identically null, $E = - V\times(k_2 - 1)^2/4\times k_2 \equiv 0$, because all potential forces have been "absorbed" by the nonlocal forces.

A better description is obtained via the restricted three-body configuration of Figure 6 which, as such, does also admit an exact solution. In this case one can repeat the same procedure as that from the neutron [4] consisting of a nonunitary transform of the conventional three-body Schrödinger equation for two protons and one electron as per Figure 6 with conventional Hamiltonian H = T + V, where V is expression (2.5.5).

Such a nonunitary transform yields the *nonrelativistic hadronic equation of the deuteron*

$$[- \frac{\hbar^2}{2\times\hat{M}_{12}}\nabla^2_1 - \frac{\hbar^2}{2\times\hat{M}_{23}}\nabla^2_3 - V_{12}\times\frac{e^{-r_{12}/R_{12}}}{1 - e^{-r_{12}/R_{12}}} - V_{23}\times\frac{e^{-r_{23}/R_{23}}}{1 - e^{-r_{23}/R_{23}}})\times\psi = E_d\times\psi, \tag{2.5.19}$$

where the indices 1, 2, 3 represent the proton, the electron, and the proton, respectively, as in Figure 6, and the $\hat{M}$'s are the isorenormalized reduced masses.

The probability for the electron to be 50% of the time within one proton and 50% within the other proton is then represented by $V_{12} = V_{23}$.

Eq. (2.5.19) is exactly solvable, although such a solution is not studied here to avoid a prohibitive length.

2.5.10. Deuteron Magnetic Moment.

Hadronic mechanics permits a *second* exact representation of the magnetic moment of the deuteron, that based on Hypothesis 2.3, which is in remarkable agreement with that for the magnetic moment of the neutron of 1990 [4a] (Paper IIIB), and, therefore, constitutes an additional experimental verification of hadronic mechanics.

Recall from Section 1.2 the following experimental values of magnetic moments for isolated states in vacuum:

$$\mu_d = 0.8754\ e\hbar/2\times M_p\times c_o; \qquad \mu_p = 2.792782\ e\hbar/2M_p\times c_o; \tag{2.5.20a}$$

$$\mu_e = 1e\hbar/e\times M_e\times c_o = (M_e/M_p)\times e\hbar/e\times M_p\times c_o = 5\times10^{-4}\ e\hbar/e\times M_p c_o. \tag{2.5.20b}$$

In the stable S-state, the angular momentum is null, thus implying no angular contribution. By recalling the mutation of the maximal causal speed $c_o \to c = c_o/n_4 = 1.0001\times c_o$, and that the magnetic moment of the electron in the configuration of Figure 6 is opposite to that of the proton, the magnetic moment of the deuteron according to Hypothesis 2.3 is given by:

$$\mu_d = \hat{\mu}_{p1} + \hat{\mu}_e + \hat{\mu}_{p2} \approx 2\,\hat{\mu}_p + |\,\hat{\mu}_e\,| =$$

$$= 5.5800 + |\hat{\mu}_e| = 0.8754\ e\hbar/e\times M_p c_o, \tag{2.5.21a}$$

$$\hat{\mu}_e = 4.7046\ e\hbar/2\times M_p\times c = (4.7046/1.001)\times(M_e/M_p)\ e\hbar/2\times M_e\times c_o =$$

$$= 4.6999\times 5\times 10^{-4}\ e\hbar/2\times M_e\times c_o = 2.349\times 10^{-3}\ e\hbar/2\times M_e\times c_o. \tag{2.5.21b}$$

As one can see, the value of the mutated magnetic moment of the electron for the deuteron as re-obtained above is very close to the corresponding values for the neutron, $\hat{\mu}_e = 2.5$, Eq. (2.41) of [4a] (see Paper IIIB, Eq. (3.39)). This confirms the validity of both representations.

It is also easy to see that, in first approximation, the binding of one electron and one proton into a neutron reproduces exactly the magnetic moment of the deuteron of Section 2.3. Results (2.5.21) are, therefore, in remarkable numerical agreement with those of Section 2.3.

2.5.11. Deuteron Electric Dipole Moment and Parity.

The electric dipole moment of the deuteron is identically null according to quantum mechanics [5] Its representation via hadronic mechanics then follows because isotopies can indeed alter non-null numerical values, but cannot change the value 0.

The positive parity of the deuteron is trivially represented by hadronic mechanics via the expression

$$\text{parity} = (-1)^L, \tag{2.5.22}$$

and the restriction of the unperturbed deuteron solely to its ground state for which L = 0.

By comparison, the reader should be aware of another misrepresentation existing in the nuclear literature consisting of the fact that, on one side, one reads from experiments that the parity of the deuteron is positive (L = 0), while, on the other side, the unperturbed deuteron is assumed as a *mixture* of levels, some of which have $L \neq 0$, thus implying the impossibility of a positive parity.

In summary, in this section I have shown that nonrelativistic hadronic mechanics (in its isotopic branch) permits the exact representation of *all* the characteristics of the deuteron composed by two protons and one electrons, by resolving *all* insufficiencies due to quantum mechanics.

The hypothesis that the deuteron is a bound states of two protons and one electron is far from being new, and actually dates back to Rutherford's times in the 1920's. The scientific priority I claim is the first, consistent and invariant resolution of all historical objections against the Hypothesis 2.2 caused by quantum mechanics, which has been reached for the first time in this publication at the *Journal of New Energy*.

ue to widespread plagiarisms existing in the contemporary physics literature, I have copyrighted this publication. The content of this section can be used by anybody in part or in full for any scientific purpose without any prior authorization, *provided* that: 1) This publication is quoted; 2) Its content is outlined as a prerequisite for allegations of novelty; and 3) The paternity is identified with clarity.

2.6. Nuclear Forces

As indicated in Section 1.2, hadronic mechanics truncates the ever growing series of mathematical potentials of unknown physical origins for the representation of the nuclear force, Eq. (1.2.1), and replaces them with one and only one local, central, potential, attractive force with a clear physical

origin, Eq. (2.5.5), plus one nonlocal, noncentral, nonpotential, attractive force, Eq. (2.5.6).

It is easy to see that all existing nuclear forces are an *approximation* of the preceding hadronic force. In fact quantum nuclear forces can be all obtained from the indicated hadronic forces via different power series expansions, based on different parameters, and truncated at different terms.

In short, one of the main functions of hadronic mechanics in nuclear physics is a structural revision of the very conception of nuclear forces, as well as of its technical realization.

Of paramount importance in this process is the transition from the *sole* representation of nuclear forces to be of linear, local and potential type, the only one possible for quantum mechanics, to the representation of nuclear forces as the most general possible combination of linear and nonlinear, local and nonlocal, and potential as well as nonpotential forces, although reducible to primitive Coulomb and hulten attractions.

In short, by recalling its direct universality, hadronic mechanics permits the axiomatically consistent and invariant *most general possible* formulation of the nuclear force. This is due to the lack of any restriction on the Hamiltonian, thus permitting all conceivable potential forces, and the lack of any restriction on the isounit, thus permitting any conceivable nonpotential force. Any other possible nuclear force is a mere particular case.

2.7. Nuclear Models

As clearly stated in the original proposal [2b], one of the primary objectives for which hadronic mechanics was constructed is the identification of the constituents of the unstable neutron with physical, massive, stable particles as emitted in its spontaneous decay, the proton and the electron, an objective that was achieved in paper [4a] of 1990.

In this section I have proved that the deuteron can indeed be represented in a consistent and invariant way as the hadronic bound state of two protons and one electron.

The extension of the model to all other nuclei as per Hypothesis 2.3 is then consequential. It is not studied in this work to avoid a prohibitive length (see the forthcoming Volume III of monographs [2g]).

In conclusion, the studies outlined in this section are sufficient to confirm the insufficiencies of quantum mechanics, the capabilities of hadronic mechanics for more accurate and deeper representations of nuclear characteristics, and the existence of nuclear interactions and effects beyond any dream of scientific treatment via quantum mechanics.

We are therefore equipped to study the new energies of Class II.

3. PHYSICAL LAWS OF NEW ENERGIES OF CLASS II AS PREDICTED BY HADRONIC MECHANICS

3.1. Basic Equations for stimulated Nuclear Transmutations

This section addresses the central objectives of this paper: 1) Study the basic equations for esoenergetic stimulated nuclear transmutations (SNT) (f.1.1) characterizing new energies of Class II, with possible subnuclear contributions of Class I; 2) Identify the underlying hadronic physical laws and conditions under which these new energies are possible; and 3) Work out a few illustrative examples on how hadronic mechanics can be of assistance in bringing the efficiency of existing new energies up to industrial maturity, as well as identify high efficiency new energies of the class considered.

I should indicated from the outset that *the cold fusion does not constitute a new energy of Class II and, therefore, it will not be studied herein.*

At the same time, the new energies of Class II have no connection with the "controlled

fusion", also called the "hot fusion", via plasmas at temperatures of millions of degrees C, which has been attempted and failed during the second half of this century following the waste of many *billions* of dollars.

I can actually say that *the new energies of Class II are in between the "cold fusion" and the"hot fusion"*. In fact, complete or major ionizations of atoms can be easily achieved at the temperatures, say, of an electric arc, which are of the order of 5,000° C, thus being intermediate between the ordinary temperatures of the "cold fusion" and the millions of degrees of temperature of the "controlled fusion".

This subsection is dedicated to the fundamental equations of hadronic mechanics representing SNT (1.1.1). The remaining aspects will be considered in the remaining subsections.

Consider two, light, stable, natural elements in condition of total ionization into naked nuclei $N_1(A_1, Z_1)$ and $N_2(A_2, Z_2)$ with masses M_1 and M_2 measured in MeV/c_o^2, where c_o is the speed of light in vacuum.

This section dedicated to the stimulated nuclear transmutations (SNT) of the above two nuclei into a third under a suitable trigger (TR) to be identified in below, according to Eq. (1.1.1):

$$TR + N_1(A_1, Z_1) + N_2(A_2, Z_2) \rightarrow N_3(A_3, Z_3), \tag{3.1.1a}$$

$$A_3 = A_1 + A_2, \quad Z_3 = Z_1 + Z_2, \tag{3.1.1b}$$

where: I assume no secondary emission of particles or radiations because is the case of primary ecological and industrial interest; the trigger must be identified case by case; and the resulting nucleus N_3 is either stable or unstable, as we shall see in the applications. The extension to reactions with additional secondary emissions is trivial and will be left to the interested reader.

When treated in their center-of-mass, SNT (3.1.1) must verify *all* conventional ten Galilean or Poincaré total conservation laws (of the energy, linear and angular momentum, and uniform motion of the center of mass), as well as other nuclear features that are normally conserved in the center-of-mass system.

In particular, this conservation implies the *conservation of the total angular momentum* J^p with parity $p = (-1)^L = +$ or $-$ (positive or negative), which can be written in the absence of orbital motions of the two nuclei(hereon tacitly assumed):

$$J_1^p + J_2^p = J_3^p. \tag{3.1.2}$$

SNT (3.1.1) must also verify the *conservation of the initial total energy,* which is given by $M_1 + M_2$ measured in MeV/c_o by ignoring for simplicity a possible energy by the trigger.

In particular, the latter conservation law implies that SNT (3.1.1) is esoenergetic, thus constituting a new energy of Class II, because the mass of N_3 is (generally) smaller than the sum of the masses of N_1 and N_2, resulting in the celebrated "mass defect" [5]:

$$\Delta M = (M_1 + M_2) - M_3 > 0, \tag{3.1.3}$$

which is released as heat or other forms of energy.

The verification of other total conservation laws is trivial and will be ignored hereon.

For the limited objectives of this study, I define as *efficiency of SNT* the number of transmutations (3.1.1) per minute. Recall that: 1) SNT (3.1.1) are expected to release energy of the order of MeV per transmutation; 2) 1 MeV is equivalent to 10^{-11} joules; and 3) In a (gaseous) mole we have 20^{23} atoms. It then follows that new energies producing 1,000,000 SNT per minute have *no industrial value,* because they imply the insignificant energy of 10^{-5} joules.

A primary objective of this section is the identification of physical laws, conditions, and equipment permitting an efficiency that will release energy in macroscopically meaningful amounts.

As is well known, *SNT (3.1.1) are not predicted or permitted by quantum mechanics,* because

the original two nuclei have positive charges $+Z_1 \times e$ and $+Z_2 \times e$. These charges imply the existence of a *repulsive* mutual force $F = Z_1 \times Z_2 \times e^2/r^2$ between the original two nuclei which prevents their forming a bound state.

However, as indicated throughout these papers, the belief that quantum mechanics is the final theory of the microcosm is a scientific misconception.

The real scientific issue is that quantum mechanics is valid under the conditions for which it was constructed, those of the *atomic* structure in which the mutual distances among the constituents are so large to permit their effective approximation of as having *point-like wavepackets.*

When particles and their composites are at mutual distances of the order of their wavepackets, as it is the scientific reality of SNT (3.1.1), the *inapplicability* (and not the "violation") of quantum mechanics as an *exact* discipline is beyond scientific or otherwise *credible* doubt, because of the emergence of nonlinear, nonlocal and nonpotential effects which are beyond any dream of treatment via quantum mechanics.

The *approximate* validity of quantum mechanics for SNT (3.1.1) is also beyond scientific doubt. This fact focuses the attention on the effects that are missing, and are, therefore, responsible for the approximate character. These missing effects are precisely those permitting basically new and clean energies, as we shall see.

In short, the *sole* open scientific issue is the selection of the appropriate *generalization* of quantum mechanics capable of a more effective representation of SNT (3.1.1).

After studying the issue since my Ph. D. in physics in 1966 and following a consideration of all possible generalized theories, I solely use *isotopic branch* of hadronic mechanics [2,3] for quantitative studies of SNT (3.1.1) for the reasons identified in Section 1.3.

The isotopic branch is selected over the genotopic, hyperstructural and isodual branches, because it is the sole applicable for closed-isolated and reversible-conservative systems, such as SNT (3.1.1) when studied in their center-of-mass. Unless otherwise specified, the terms "hadronic mechanics" used in this section are specifically referred to its isotopic branch, also called *isomechanics* for short.

In regard to notation, all conventional symbols 1, $\times$, t, r, p, V, H, ψ, ..., represents known quantities of quantum mechanics. All corresponding quantities belong to hadronic mechanics will be represented with the symbols $\hat{1}$, $\hat{\times}$, $\hat{t}$, $\hat{r}$, $\hat{p}$, $\hat{V}$, $\hat{H}$, $\hat{\psi}$, ..., which are now universally adopted. In particular, the former quantities are always defined on conventional vector spaces over conventional fields of numbers, while the latter quantities are always defined over isovector isospaces defined over isofields of isonumbers.,

When quantities belonging to hadronic mechanics are written with conventional symbols, this implies that we are considered their *projection* on conventional spaces over conventional fields.

Once the above basic concepts have been identified, the construction of the hadronic equations representing SNT (3.1.1) is elementary, and can be reduced to the following three distinct phases:

QUANTUM PHASE. This is the initial phase of SNT (3.1.1) at large mutual distances under the full validity of quantum mechanics. In this case the basic equations are given by:

$$H \times \psi_{12} = \left(\frac{1}{2 \times M_1} \times p_1^2 + \frac{1}{2 \times M_2} \times p_2^2 + Z_1 \times Z_2 \times \frac{e^2}{r_{12}} \right) \psi_{12} = E \times \psi_{12}, \qquad (3.1.4a)$$

$$p_{ka} \times \psi = -i \times \hbar \times \partial_{ka} \psi, \quad k = 1, 2, 3, \quad a = 1\ 2, \qquad (3.1.4b)$$

and they transparently do not permit any bound state between the original nuclei N_1 and N_2.

HADRONIC PHASE. This is the phase in which an external trigger is applied in such a way to overcome the repulsive Coulomb force, by bringing the two nuclei at small mutual distances, thus

triggering the application of hadronic mechanics.

The basic hadronic equations can be easily constructed via the *nonunitary transform* of model (3.1.4):

$$U\times U^\dagger = \hat{1} = \hat{1}_o\times\exp([\psi_{12}/\hat{\psi}_{12}]\times\int d^3r\times\hat{\psi}_{1\uparrow}(r)^\dagger\times\hat{\psi}_{2\downarrow}(r)) = 1/\hat{T}, \tag{3.1.5}$$

where ψ is the quantum wavefunction, and the $\hat{\psi}$'s are the hadronic wavefunctions. Transform (3.1.5) is evidently nonlinear (because dependent on wavefunctions in the exponent), nonlocal (because including a volume integral) and nonpotential (because representing interactions without any potential or Hamiltonian).

In particular, the exponent of (3.1.5) is null whenever the wave-overlapping is no longer appreciable. In the latter case nonunitary transform (3.1.5) automatically recovers quantum models identically at all distances sufficiently bigger than 1 fm, as desired.

When closed-isolated system in their *stationary* ground state are considered from the outside, the volume integral can be approximated to a *constant* N. In first approximation, transform (3.1.5) is then given by:

$$\hat{1} \approx \hat{1}_o\times(1 + \psi_{12}/\hat{\psi}_{12} + \ldots \qquad \hat{T} \approx \hat{T}_o\times(1 - \psi_{12}/\hat{\psi}_{12} + \ldots). \tag{3.1.6}$$

The reader should keep in mind that the above approximation is sufficient for the *hadronic ground state* of SNT (3.1.1), but not necessarily for its excited states, which evidently require additional terms in the expansion.

To avoid the catastrophic inconsistencies indicated earlier, nonunitary transform (3.1.5) must be applied to the *totality* of the formalism of quantum mechanics, including the basic unit, the associative product $\times$, numbers, spaces, etc., which are then turned into the isounit, isoproduct, isonumbers, isospaces, etc. (see Paper II whose content is hereon tacitly assumed).

The application of said transform to model (3.1.4) yields:

$$U\times H\times\psi_{12} = (U\times H\times U^\dagger)\times(U\times U^\dagger)^{-1}\times(U\times\psi_{12}) = \hat{H}\times\hat{T}\times\hat{\psi}_{12} = \hat{H}\,\hat{\times}\,\hat{\psi}_{12} =$$

$$U\times E\times\psi_{12}=(U\times E\times U^\dagger\times(U\times U^\dagger)^{-1}\times(U\times\psi_{12})=(E\times\hat{1})\times\hat{T}\times\hat{\psi}_{12} = \hat{E}\hat{\times}\hat{\psi}_{12} = E\times\hat{\psi}_{12} \tag{3.1.7a}$$

$$U\times p_{ka}\times\psi_{12} = (U\times p_{ka}\times U^\dagger)\times(U\times U^\dagger)^{-1}\times(U\times\hat{\psi}_{12}) = -i\times U\times\partial_{ka}\psi =$$

$$= -i\times\hbar\times\hat{\partial}_{ka}\hat{\psi}_{ka} = -i\times\hbar\times\hat{1}\times\partial_{ka}\hat{\psi}_{ka},\ k = 1, 2, 3,\ a = 1, 2. \tag{3.1.7b}$$

Numerous realizations are possible for the trigger which must evidently be added to the transformed Hamiltonian $\hat{H}$ to counterbalance the repulsive Coulomb force. Simple practical examples of triggers are given by sufficiently intense electric and/or magnetic fields, or kinetic energy of one nucleus on a stationary second nucleus, which is sufficient to overcome the Coulomb repulsion, and allow the two nuclei to enter within the hadronic horizon with the minimally needed threshold energy.

The trigger I select in these introductory lines for illustrative purposes is simply given by an external electric field which opposes said Coulomb repulsion, thus having potential $-Z_1\times Z_2\times e^2/r_{12}$. We can then write:

$$TR\times\psi_{12} = -n\frac{e^2}{r_{12}}\times\psi_{12} = -n\times\frac{e^2}{r_{12}}\times\frac{\psi_{12}}{\hat{\psi}_{12}}\times\hat{\psi}_{12} =$$

$$= -n\times\frac{e^2}{r_{12}}\left(1 - 1 + \frac{\psi_{12}}{\hat{\psi}_{12}}\right)\times\hat{\psi}_{12} = -n\times\frac{e^2}{r_{12}}\times(1 - \hat{T})\times\hat{\psi}_{12},\quad n = Z_1\times Z_2. \tag{3.1.8}$$

The hadronic equations for SNT (3.1.1) are then given by the transformed equation (3.1.7) *plus* the trigger (without which the SNT remains impossible), and can be written:

$$\left(\frac{b_4^2}{2\times M_1}\times \hat{p}_1\hat{\times}\hat{p}_1\hat{\times}\hat{\psi}_{12} + \frac{b_4^2}{2\times M_2}\times \hat{p}_2\hat{\times}\hat{p}_2\hat{\times}\hat{\psi}_{12} + n\times\frac{e^2}{r_{12}}\times\hat{1}\times\psi_{12} = E\times\hat{\psi}_{12}\right. \tag{3.1.9}$$

where b_4^2 evidently represents the isorenormalization of the mass as per Isopostulate II-V of Santilli's isospecial relativity recalled earlier.

After considerable mathematical treatment to compute the isolaplacian $\hat{\Delta} = \hat{p}^k\hat{\times}\hat{p}_k = \hat{\delta}^{ij}(r, v,...)\times\hat{p}_i\hat{\times}\hat{p}_j$ on isoeuclidean spaces with generalized isometrics $\hat{\delta}$ and isodifferential calculus (see [2c,2g] for brevity), and the restriction to the radial component, Eq. (3.1.9) can be written for the stationary ground state:

$$\left(-\frac{\rho^2}{2m}\Delta + n\times\frac{e^2}{r}\times\left(1-\frac{\psi_{12}}{\hat{\psi}_{12}}+...\right)\times\hat{\psi}_{12} = E\times\hat{\psi}_{12}.\right. \tag{3.1.10a}$$

$$m = M_1\times M_2/(M_1+M_2) \tag{3.1.10b}$$

where ρ is a constant including contributions from b_4 and $\hat{\delta}$.

By recalling that at short distances [2b] ψ_{12} behaves like $\exp(-br)$ and $\hat{\psi}_{12}$ behaves like $[1-\exp(-br)]/r$, where $R = b^{-1}$ is the radius of the resulting nucleus N_3, we have the emergence of an *attractive* Hulten potential which behaves like the repulsive Coulomb potential at short distance:

$$-V_0\times\frac{e^{-b\times r}}{1-e^{-b\times r}} \approx K\frac{e^2}{r}. \tag{3.1.11}$$

But the former is much stronger than the latter. Therefore, in this hadronic phase we solely end up at short distances with an attractive Coulomb potential which has "absorbed the repulsive Coulomb potential, and we can write:

$$\pm n\times\frac{e^2}{r}\times\left(1-N\times\frac{\psi_{12}}{\hat{\psi}_{12}}\right. \approx -V\times\frac{e^{-b\times r}}{1-e^{-b\times r}}, \tag{3.1.12}$$

Eqs. (3.1.10) then assume the final hadronic form with the sole presence of the attractive hadronic potential:

$$\left(-\frac{\rho^2}{2m}\Delta - V\times\frac{e^{-b\times r}}{1-e^{-b\times r}}\right)\times\hat{\psi}_{12} = E\times\hat{\psi}_{12} \tag{3.1.13}$$

where all Coulomb contributions are absorbed in V.

Comparison between Eqs. (3.1.4) and (3.1.13) transparently shows that SBT (3.1.1), while prohibited for quantum mechanics, are fully admitted by the covering hadronic ,mechanics.

Equation (3.1.13) was proposed and solved exactly in the original proposal of 1978 to construct hadronic mechanics (see Ref. [2b], Section 5.1). For brevity, I recall here only the parametrization (5.1.24) and (5.1.26) of [2b], *i.e.*:

$$k_1 = 1/\chi\times b, \quad k_2 = m\times V/\rho^2\times\hbar^2\times b^2, \tag{3.1.14}$$

under which we have the kinetic energy (5.1.25) of [2b], *i.e.*:

$$E^{Kin} = p^2/2m = K_1 \times \hbar \times b \times c_o = \rho^2 \times \hbar^2 b^2/2 \times m\,, \tag{3.1.15}$$

the binding energy (5.1.20) of [2b], *i.e.*:

$$|E| = \frac{\rho^2 \times \hbar^2 \times b^2}{4 \times m} \left(\frac{m \times V}{\rho^2 \times \hbar^2 \times b^2} \times \frac{1}{n} - n \right)^2 = \frac{V}{4 \times m} \times \left(\frac{k_2}{n} - n \right)^2, \tag{3.1.16}$$

with boundary condition (5.1.23) of]2b], *i.e.*:

$$m \times V/\rho^2 \times \hbar^2 \times b^2 = n^2,\ k_2 = 1 + \epsilon,\ 0 \leqq \epsilon < 1\,, \tag{3.1.17}$$

and meanlife (5.1.31) of [2b], *i.e.*:

$$\tau^{-1} = 4.3 \times 10^4 \times b \times (k_2 - 1)^3. \tag{3.1.18}$$

The exact solution of SNT (3.1.1) is then turned into the solution of the *algebraic* system (5.1.32) of [2b] in the two unknown k_1 and k_2 as functions of the total energy and meanlife of the final nucleus N_3:

$$k_1 \times [1 - (k_2 - 1)^2 = E^{Tot} / 2 \times \hbar \times b \times c_o, \tag{3.1.19a}$$

$$(k_2 - 1)^3 / k_1 = 2.38 \times 10^{-6} / \tau \times b\,. \tag{3.1.19b}$$

As one can see, when the resulting nucleus N_3 is perfectly stable, k_2 is equal to 1, in which case the *hadronic* binding energy is null. In the approximation here considered, I am here solely referring to the attractive force *not* derivable from a potential which, as such, *cannot* admit any potential energy.

NUCLEAR PHASE. After achieving the necessary bond of the two nuclei N_1 and N_2, the study of the resulting nucleus N_3 can be done in a variety of ways, including the use of conventional nuclear physics [5].

In this final process all nucleons are rearranged into the appropriate configuration for the case at hand. In particular, there is the emergence of the strong nuclear force with resulting well-known *mass defect* and other known features here ignored because well known.

In summary, the quantum phase of SNT (3.1.1) essentially represents the impossibility of bonding nuclei due to their opposing Coulomb charges. The hadronic phase essentially indicates that the application of an appropriate trigger can permit the SNT, evidently under the validity of a number of physical laws identified in the next section. In particular, the hadronic phase indicates that the SNT becomes most probable at the minimal possible energy of the original nuclei (threshold energy). Finally, the nuclear case essentially indicates the final rearrangement of nucleons as needed for the final nucleus N_3, and the taking over of conventional nuclear models, *including the conventional mass defect.*

Under the assumption generally valid for these studies that the trigger has no angular momentum, SNT may be, at times, prohibited because of lack of satisfaction of the conservation law of total angular momentum, Eq. (3.1.2).

The above limitation can be at times resolved , *e.g.*, when the missing angular momentum is 1 and can be obtained via the excitation of one or both the original nuclei with a photon (which has precisely spin 1). I shall then write

$$TR + \gamma + N_1(A_1, Z_1) + N_2(A_2, Z_2) \rightarrow N_3(A_3, Z_3), \tag{3.1.20a}$$

$$A_3 = A_1 + A_2, \quad Z_3 = Z_1 + Z_2, \tag{3.1.20b}$$

$$1 + J_1 + J_2 = J_3. \tag{3.1.20c}$$

In the event this formulation is insufficient, there exist a number of other techniques capable of verifying the conservation laws of the total angular momentum, which must be studied case by case.

As indicated earlier, new energies of Class II may have contributions from processes of Class I. Some of the latter are the *Stimulated Neutron Decay* (SND) [4], caused by a photon $\hat{\gamma}$ with a suitable resonating frequency

$$\hat{\gamma} + N(A, Z) \rightarrow N'(A, Z+1) + e^- + \bar{\nu}, \tag{3.1.21}$$

and the *Stimulated Electron Capture* (SEC) [4]

$$e + N(A, Z) \rightarrow N'(A, Z-1) + \gamma + \nu, \tag{3.1.22}$$

whose theoretical feasibility and preliminary experimental verifications have been studied in detail in Paper III.

3.2. Physical Laws of New Energies of Class II (Copyrighted and Patent Pending)

The primary physical laws to be verified for the possible production of new energies of Class I were presented in Paper II. The studies outlined above in this paper permit the identification of the following primary physical laws for new energies of Class II as predicted by hAdronic mechanics:

Law II-1: SNT require a trigger forcing nuclei to enter into the hadronic horizon against the repulsive Coulomb force. Note that the consideration of this first law is generally absent in current research for new energies, thus offering a first explanation of their low efficiency, as well as of the lack of guiding principle for its improvement.

Law II-2: SNT among few-body nuclei with non-null spin only occur for singlet couplings (antiparallel spin). This additional condition is at the very foundation of all hadronic bound states. It is theoretically represented in the exponents of the fundamental nonunitary transform (3.1.5). As indicated earlier, the law can be verified by everybody via two desk experiments with two spinning tops colliding with spin parallel and antiparallel. In the former case one can see the instantaneous repulsion of the tops, while in the second case one can see the tendency to attract each other (under the proper values of linear and angular momentum, see below). This basic law was conceptually presented in the original proposal of 1978 to build hadronic mechanics [2b] via the "gear model" See Figure 8), which precisely illustrates the fact that gears can only couple in singlet. The verification of this second law is also absent in *all* new energies I have studied, because they treat nuclei whose spin have an arbitrary orientation in space. In this case only a very minute fraction of the nuclei can experience transmutations, resulting in very small efficiencies. By comparison, the implementation of this second law via magnetic polarization and other means offers realistic hopes for a substantial increase of the efficiency to industrial values. Law II-2 has been restricted to "few-body" nuclei because of the possible existence of exceptions for large nuclei. In fact, in Paper V we shall identify specific cases in which there may be the accretion by heavy nuclei of a proton or a deuteron in triplet coupling, although aligned along the same cylindrical axis. The latter possibility cannot be excluded on theoretical grounds, thus requiring an experimental resolution. Noter that Pauli's exclusion principle only applies for *the same nucleons in the samme*

energy state. As such, Pauli's exclusion principle *does not exclude* the coupling of a proton and a nucleus in triplet. In general, it appears that single couplinmgs is necessary for stability when the two couplinmg occurs in a plane with spin directions perpendicular to it, while triplet coupling of different nucleons is possible with cylindrical alignment of the spin.

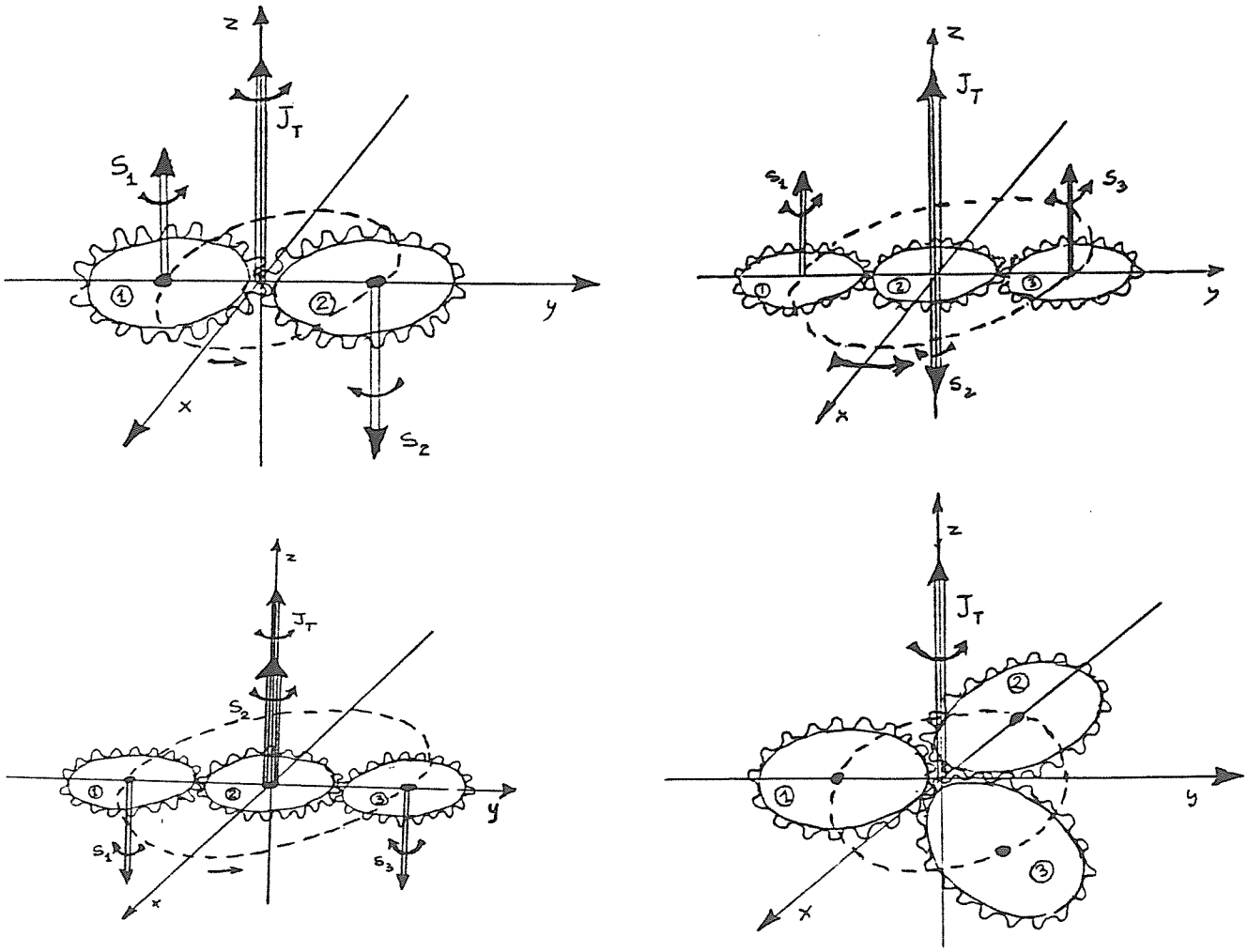

FIGURE 8: A reproduction of the figures on the "gear model" of the original proposal to build hadronic mechanics, Ref. [2b] of 1978. Despite the passing of time, this simple model understandable by all still has considerable pragmatic value for practical applications. The top model shows that the sole possibility for a stable coupling of two spinning particles or nuclei is that in singlet. The central model shows the sole possibility of stable coupling of three spinning particles or nuclei. The lower model illustrates an alternative three-body configuration which is impossible, as one can verify precisely with gears. This simple "gear model" also provides an instantaneous explanation of the experimental fact that nucleons only correlate in pairs, as it is the case for the s(pinning tops and middle configurations. Three nucleon correlations are impossible, as established by the lowest model. In the transition from gears to hadrons or nuclei, the situations remains *exactly* the same, in the sense that relative angular momenta must be "in phase" for stable couplings, exactly as it is the case or gears, while other configurations would imply the spinning of hyperdense particles *against* the spin of another particle when in mutual penetration. This results in evident major repulsive forces and consequential instabilities, precisely as it is

the case for gears.

Law II-3: The most probable SNT are those occurring at the minimal threshold energy sufficient to verify all conservation laws. In fact, at energies much higher than said threshold value we have a number of secondary effects, including possible fissions, with consequential loss of the desired objective.

Law II-4: The most probable SNT are those implying no secondary radiation. This third law implies that the two original light nuclei $N_1(A_1, Z_2)$ and $N_2(A_2, Z_2)$ cannot be arbitrarily selected, but must be selected in such a way that the resulting nucleus $N_3(A_3, Z_3)$ is also a light, natural, stable or unstable nucleus with $A_3 = A_1 + A_2$ and $Z_3 = Z_1 + Z_2$ without emission of massive radiations, such as protons, neutrons and their composites. *This third law is contrary to all popular beliefs in nuclear physics; yet it is clearly predicted by hadronic mechanics and it is the only one explaining the well established SNT of light natural elements in living organisms as well as new energies.* I should mention that the lack of emission of secondary radiations has been systematically indicated in most studies on new energies.

Law II-5: The sole possible SNT are those verifying all established total conservation laws, including the known laws regulating mass defects. This established nuclear knowledge should be compared with the corresponding Law I-3 of the new energies of Class I in which the final total energy is *bigger* than that of the original constituents, thus *requiring,* rather than releasing energy for their formation. These occurrences are due to the fact that bound states of hadrons occur under *total* mutual penetration of the constituents, with consequential very high isorenormalization of the rest energies, while nuclear bound states occur under small mutual penetration of the constituents, resulting in small isorenormalization of the energy. Then, conventional, negative binding energies dominate the energy balance. In turn, this point is essential to understand that new energies of Class I can *only* be obtained via the stimulated *decay* of unstable hadrons, while new energies of Class II can *only* be obtained from the *synthesis* of nuclei.

Additional laws and conditions are either too technical or in the process of patenting and, regrettably, cannot be disclosed at this time.

The physical laws of new energies of Class II have been published in this copyrighted publication for the first time. I intend to defend that copyright with all means permitted by law. The content of this section can be used by anybody in part or in full for any scientific purpose without any prior authorization, *provided* that: 1) This publication is quoted; 2) Its content is outlined as a prerequisite for allegations of novelty; and 3) The paternity is identified with clarity.

3.3. The Hadronic Lithium Reactor (Copyrighted and Patent Pending)

After completing the preceding studies, I have conducted an extensive inspection of the rather vast existing literature on new energies for the evident purpose of testing the validity of the preceding results.

Despite my best efforts, I soon discovered that the number of new energies of Class II attempted so far is rather limited, because of the need for physical conditions under which atoms are completely or at least mostly ionized to qualify for new energies of Class II (which *are not* those of the cold fusion).

I am available to discuss with qualified researchers specific cases of new energies of Class II, with the understanding that the basic nuclear reactions are sufficiently identified on technical grounds, whether theoretically or experimentally, or at least suspected.

One case of new energies of class II which meets the above requirement is that based on the lithium with generally reported "nuclear reaction" [16]:

$$p^+ + {}_3Li^7 \rightarrow 2 \times \alpha. \qquad (3.3.1)$$

where α is the nucleus of ${}_2He^4$.

The above reaction was first discovered by Crockroft and Walton in 1932; it was then studied in detailed theoretical and experimental grounds by Gwinn and his group at Berkeley [16a], as well as by Friedlander *et al.* at Brookhaven [16b]; and its industrial application has been studied by Taplin and his group at Crystal Energy Corporation [16c].

A typical embodyment for event (3.3.1) is the use of 20 KeV protons hitting a flame saturated with lithium in its gaseous state. Gwinn and his group have measured the emission by such an embodiment of up to 10^6 alpha particles. Others with similar, but not identical embodiments have measured less emissions, as it is the case of the Brookhaven group [16b], while others have measured bigger emissions, although not in a routinely reproducible way, as it is the case of the Crystal Energy group [16c].

Process (3.3.1) is indeed important for our society, thus warranting serious scientific and industrial attention, because it offers a realistic possibility for virtually unlimited amounts of clean and safe new energy. Since the alpha particles are charged, and have moderate energy, they can be easily stopped by a metal shield, whose acquired heat can be utilized by heat exchangers or other means.

This energy is "clean", because it emits no radiations harmful to humans and to the environment, *and* leaves no harmful waste (because the alpha particles capture electrons from the environment, by assuming their normal form of Helium).

Moreover, it is easy to see that no chain reaction or other explosive events are possible, because process (3.3.1) is instantly halted at the termination of the proton beam.

It is evident that the case here considered constitutes a new energy of Class II. In fact, protons are the ionized nuclei of the H-atoms, 20 KeV protons correspond to a hydrogen gas with over two millions degrees C, while ordinary high temperature flames cause at least a partial ionization of the lithium.

Also, event (3.3.1) has been studied independently and jointly by academia and industry, thus having sufficient credibility.

Unfortunately, the studies here reported, despite their clear significance indicated earlier, have failed to produce a practically significant source of energy, because its efficiency (as defined in Section 2.1) is excessively low. In fact, event (3.3.1) releases 18 MeV (as one can verify via the nuclear data [17]), which correspond to 2.8×10^{-12} joules. The measured number of reactions per minute then produces the power:

$$10^6 \text{ react / min} = 2.8 \times 10^6 \times 10^{-18} \text{ joules / min} = 2.8 \times 10^{-6} \text{ joules/min}, \qquad (3.3.2)$$

which is manifestly of no practical value.

I have studied event (3.3.1) in detail and a partial disclosure of my results is the following. First, I have to separate academic politics from science, as a necessary condition for new advances.

Event (3.3.1) is generally presented as a "nuclear reaction", because, when presented as such, it becomes acceptable by organized interests in nuclear physics.

In reality, event (3.3.1) is the following genuine *Stimulated Nuclear Transmutation:*

$$p^+ + {}_3Li^7 \rightarrow {}_4Be^8, \qquad (3.3.3)$$

where ${}_4Be^8$ is unstable and decays into two alpha particles in the very short lifetime of 2×10^{-16} sec (see nuclear data [17]):

$$ {}_4Be^8 \rightarrow 2 \times \alpha . \qquad (3.3.4)$$

It can be proved in various ways that the direct "nuclear reaction" (3.3.1) is impossible at 20 KeV, while for protons with energy of the order of MeV or GeV, the lithium is broken into nucleon constituent or their smaller aggregates, resulting again in the impossibility of direct reaction (3.3.1).

The reader should be aware that SNT (3.3.3) *is not* officially accepted in nuclear physics, precisely because it is a SNT. The evident reason for the opposition is that, once SNT (3.3.3) is admitted, numerous other SNT must be admitted too on mere compatibility grounds, resulting in a massive inapplicability of quantum mechanics which is officially unacceptable..

I have dedicated my life to "research" intended as the pursuit of *new* knowledge without any consideration whatever of academic politics. As such, I have been solely interested in studying the new energy here considered on its *scientific* basis (3.3.3), without any consideration of its *political* formulation (3.3.1).

The use of hadronic mechanics permits a completely different *practical realization* the new energy of Class II which can be obtained from the lithium. In particular, hadronic mechanics does not suggest esoteric-philosophical considerations, and implies instead *a new concrete equipment* based on the hadronic laws II-1 to II-5, which I have called *Hadronic Lithium Reactor.*

The main characteristics of the reactor I am in a position to disclose here are the following:

I) Realizations of the trigger (Law II-1), threshold energy (Law II-3), and prevention of secondary reactions (Law II-4). They can be realized in a variety of ways, depending on the remaining realizations of the reactor. The realization here indicated for illustrative purposes of Hadronic Laws II-1 and II-4 is the simple use of a *beam of protons with kinetic energy sufficient to overcome the repulsive Coulomb force and achieve contact with the lithium nucleus at the threshold energy requested by STN (3.3.3).* It is evident that, when the SNT is implemented in this way, no secondary reaction is conceivably possible, and Hadronic Law II-4 is automatically verified. The explicit value of the kinetic energy of the proton beam cannot be disclosed at this time. The reader should be aware that I have selected the kinetic energy as a realization of the trigger, only because it is known and readily visualized. However, numerous other realizations of the trigger are possible, and I shall disclose them at some future time.

II) Realizations of singlet coupling (Law II-2). This condition too can be realized in a number of was. The solution indicated here for illustrative purposes is permitted by the well established technology of magnetic nuclear polarization, *e.g.*, as currently applied in MRI medical equipment. According to this embodiment herin considered (see Figure 9), *the proton beam is magnetically polarized with spins oriented in a given direction, and the lithium is magnetically polarized with spins directed in the opposite direction.* Regrettably, I cannot disclose at this writing the explicit numerical values of the magnetic fields and related embodiment for obvious reasons.

III) Realizations of conservation laws (Law II-5). The conservation laws of the initial total energy, linear momentum, and uniform motion of the center-of-mass, are guaranteed in this case to such an extent of requiring no comment. The sole conservation laws requiring a study are those of the angular momentum and parity $J_{tot}{}^{P}$.

The proton has spin/parity $(1/2)^{+}$, while the lithium has spin/parity $(3/4)^{-}$. By contrast, the beryllium in its ground state has spin/parity 0^{+} [17]. Therefore, parity is automatically conserved for SNT (3.3.3). By recalling the coupling in singlet for which the spins signs are opposite to each other, one possibility for the preservation of the spin in the absence of angular momenta is that the beryllium is produced in its first excited state as:

$$\frac{1^{+}}{2} - \frac{3^{+}}{2} = 1^{+}. \qquad (3.3.5)$$

It can be shown that, under the above setting, the life of the beryllium is dramatically reduced from its conventional, already very small value of 2×10^{-16} sec. Other possibilities for the conservation of

the angular momentum cannot be disclosed at this writing.

THE HADRONIC LITHIUM REACTOR

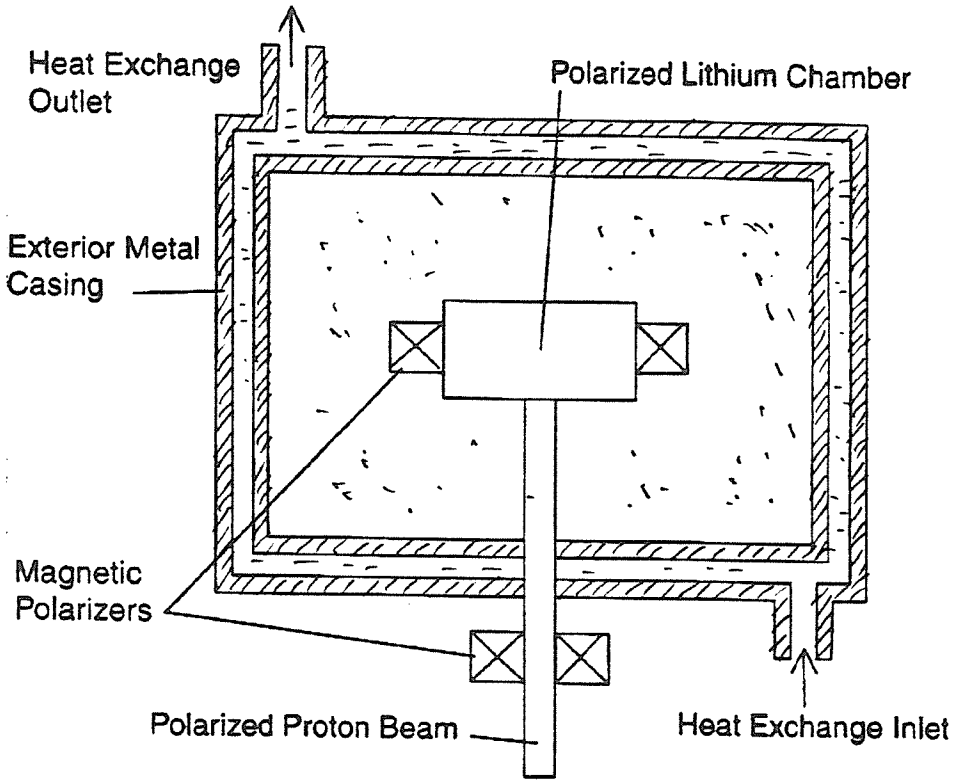

FIGURE 9: A schematic view of a representative embodiment of the *Hadronic Lithium Reactor*, the first illustration of the new energies of Class II as predicted by hadronic mechanics. The Hadronic reactor here considered consists of a magnetically polarized proton beam hitting a mass of mostly ionized lithium with opposite magnetic polarization. The polarized proton beam has minimal energy to overcome the repulsive Coulomb force, and trigger SNT (3.3.3) at threshold energy. The pair of alpha particles produced in decay (3.3.4) with 2.8×10^{-6} joules are trapped by an all encompassing outside, doubled walls, metal shield. Under the assumption of one reaction per one million nuclei of lithium, and one mole of lithium, the Hadronic Lithium Reactor is predicted to yield 1.6×10^{6} joules/min. Under such large values of energy, the metal shield instantly heats up. The resulting thermal energy can be then utilized via heat exchanges or other means using a liquid going thru the double walled external shield. The resulting new energy of Class II is clean because it does not release any harmful radiation at all (since the alpha particles can be easily contained in their entirety by a metal shield due to their charge), and does not release any harmful radioactive waste whatever (since the end products are conventional hydrogen and helium gases which can be utilized for industrial applications). Finally, the new energy here considered is safe, because the produced power is directly proportional to the intensity of the proton beam, its value can be controlled via the value of said intensity, and the produced energy can be halted in its entirety at any time by switching off the proton beam.

I have presented this case as an *illustration* of the capability by hadronic mechanics and related laws to increase the efficiency of new energies of class II, from the currently marginal values, to efficiencies of clear and practical use, thus of industrial relevance. The same criteria here used for the lithium can be applied to a variety of other new energies of Class II.

To understand the practical value of the above Hadronic Lithium Reactor, one should know that *the mere efficiency of 10^{-9} per mole (that is 1/1,000,000,000,000 SNT per mole) can produce 288 joule per minutes, which is a power already with industrial significance:*

$$(2.8\times10^{-12} \text{ joule per reaction}) \times (6 \times 10^{23} \text{ nuclei}) \times$$

$$\times 10^{-9} \text{ efficiency per mole per min}) = 1{,}628 \text{ joules/min.} \qquad (3.3.6)$$

The intriguing point is that the increase of the currently available power 2.8×10^{-6} joules/min, Eq. (3.3.2), under the appropriate technical implementation of all hadronic laws, can indeed be dramatically bigger than expectation (3.3.6). As an illustration, the rather reasonable efficiency of 1/1,000,000,000 (that is, one SNT (3.3.3) per one million nuclei of lithium) would imply:

$$(2.8\times10^{-12} \text{ joule per reaction}) \times (6 \times 10^{23} \text{ nuclei}) \times$$

$$\times 10^{-6} \text{ efficiency per mole per min}) = 1.6 \times 10^{6} \text{ joules/min,} \qquad (3.3.7)$$

which is indeed a power of direct industrial significance.

I hope this illustrate the statement of Section 1.1, to the effect that the new energies of Class II are indeed real, and they do deserve attention in science and industry.

I should stress the need for scientific caution and avoid the expectation that the proposed Hadronic Lithium Reactor can be easily built, and will instantly work. Instead, specific research and development is manifestly needed to reach final conclusion one way or another.

Evident open *technological* problems beyond the *theoretical* assistance by hadronic mechanics are: 1) The calibration of the kinetic energy of the proton to the needed threshold value, because even small deviation in excess or in defect will prevent SNT (3.3.3); 2) The achievement of a sufficient ionization of the lithium via electric discharges and/or other means, in which absence no SNT is predicted in any amount of any significance; 3) The calibration of the numerical value of the magnetic field in any selected magnetic polarizer, in which case too deviations in excess or defect will imply no SNT of any practical relevance; and other technological problems totally beyond theoretical considerations which can only be solved via systematic and comprehensive tests.

In summary, hadronic mechanics and its laws have resolve *all* objections raised by quantum mechanics; have established the *plausibility* of a new energy of Class II from the lithium as now being beyond *credible* doubts; and *partially* indicated one among many possible practical embodiments.

The aspect to be clarified is that the new lithium-based energy of Class II will not be reached overnight and will instead reach an efficiency of practical value only following systematic, comprehensive research and development.

In closing, the fundamental reaction underlying the Hadronic Lithium Reactor has been known for many decades and, therefore, it is outside any possible patenting or claim of paternity. I hereby claim paternity under the protection of the copyright, patent applications, know-how, and other laws, of the specific invention permitted by hadronic mechanics I have called the "Hadronic Lithium Reactor", and its variations. I intend to defend that invention with all means permitted by Law.

3.4. The Hadronic Helium Reactor (Copyrighted and Patent Pending)

Another example of new energies of Class II is that originating from the *stimulated nuclear transmutation at low energy of two deuterium nuclei into one helium nucleus:*

$$TR + {}_1H^2 + {}_1H^2 \rightarrow {}_2He^4 + \text{heat}, \tag{3.4.1}$$

which has been studied by numerous authors, in both the orthodox and nonorthodox literature since the 1930's. However, to my best knowledge, all prior studies I could identify were, either for the "controlled fusion" at very high temperature, or for the "cold fusion" at low temperature.

In this paper I specifically study SNT (3.4.1) under the condition that it occurs under "intermediate" temperatures of about 5,000° C between the "controlled" and the "cold" fusions for completely ionized deuterium nuclei.

In the event readers are aware of preceding contributions of SNT at the indicated intermediate temperatures, I would immensely appreciate their indication for my proper immediate quotations and corrections.

The most effective and simple way to achieve the desired complete ionization in our environment is via *the use of a direct current electric arc between ordinary electrodes within a deuterium gas.*

In fact, according to the well-established welding technology, a DC arc immersed in said deuterium gas decomposes the molecules into completely ionized deuterium atoms plus electrons, resulting in a plasma of about 5,000° C.

Hadronic mechanics and its laws for new energies of Class II permit the construction of a specific and practical embodiment for the utilization of SNT (3.4.1), which I have called the *Hadronic Helium Reactor.* Its main characteristics can be summarized as follows:

I) Realizations of trigger (Law II-1). It is easy to see that ordinary electric arcs permit one of the simplest realizations of the trigger. In fact, *the arc is one of the strongest, readily available sources of magnetic fields,* which are circularly oriented within the sectional area perpendicular to the direction of the current, and can reach in the vicinity of said current intensities up to 50 Tesla and more, evidently depending on the current (Figure 10).

It is clear that the stronger the magnetic field, the more deuterium nuclei are placed along the same magnetic line, with consequential decrease of their mutual distance. This evidently implies the existence of arc currents and other embodiments (here omitted for security reasons) for which the density of deuterium nuclei in the immediate cylindrical vicinity of the arc is such to imply mutual separations of the order of 1 fm, at which hadronic forces are triggered, thus verifying Hadronic Law II-1.

II) Realizations of singlet couplings (Law II-2). It is also evident that electric arcs are one of the best and most efficient practical means for the verification of Law II-2, on the coupling of deuterium nuclei in singlet.

As one can see in the nuclear data [17], deuterium nuclei have spin 1^+, while Helium nuclei have spin 0^+. Therefore, SNF (3.4.1) can *only* occur for deuterium nuclei coupled in singlet, exactly as predicted by Hadronic Law II-2, and I shall write:

$$1^+ - 1^+ \rightarrow 0^+. \tag{3.4.2}$$

It is evident from Figure 10 that *one* electric arc *cannot* permit the verification of the above conditions, because all nuclei are aligned in the same way, thus resulting in *triplet* couplings.

A number of embodiments can permit the needed singlet coupling. That preferred here because of its illustrative character and practical simplicity is given by *two parallel electric arcs*

with equal but opposite DC potentials and currents placed at a sufficiently small mutual distance (Figure 10).

It is evident that, in this case, the needed anti-parallel orientation of deuterium nuclei in the two arcs is indeed reached. The actual singlet coupling can be reached in a number of ways, *e.g.*, by using two opposite flows of the deuterium gas, realized in such a geometry to force the two plasmas one against the other. The resulting flow can then be discharged in a direction perpendicular to the flow in between the two arcs (Figure 11).

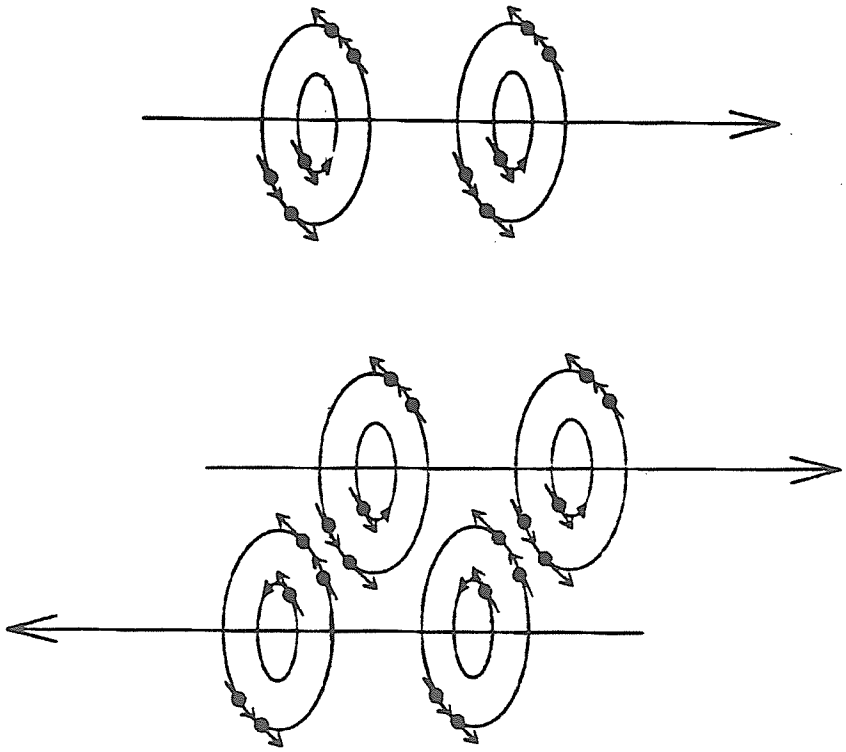

FIGURE 10: An illustration of the fact that one single DC arc (top view) aligns the deuterium nuclei all in the same direction along the magnetic force lines which are circular and perpendicular to the direction of the current. In this case we have a *triplet* alignment of the deuterium nuclei, and no SNT (3.4.1) is possible. The situation is different when two DC arcs with opposite voltage and current are placed parallel to each other and at short distance (lower view). In this case the deuterium nuclei of one arc are in *singlet* coupling with those of the other arc, thus rendering possible SNT (3.4.1) in accordance with hadronic law (II-3.

Since the arc is continuous with electrons moving at speeds not far from that of light, as soon as the arc plasma is displaced by the flow, it is immediately recreated again, thus permitting a continuous operation. A number of other embodiment are possible, such as the use of heavy water.

III) Realizations of threshold energy (Law II-3) and lack of secondary reactions. Both Hadronic Laws II-3 and II-4 are automatically verified in the considered embodiments, as one can verify. In fact, the kinetic energy of the deuterium nuclei under the considered electric arcs is minimal, thus obeying slightly above the requested threshold energy. It then follows that the same energy is insufficient to break other nuclei following constituents, thus preventing secondary reactions.

THE HADRONIC HELIUM REACTOR

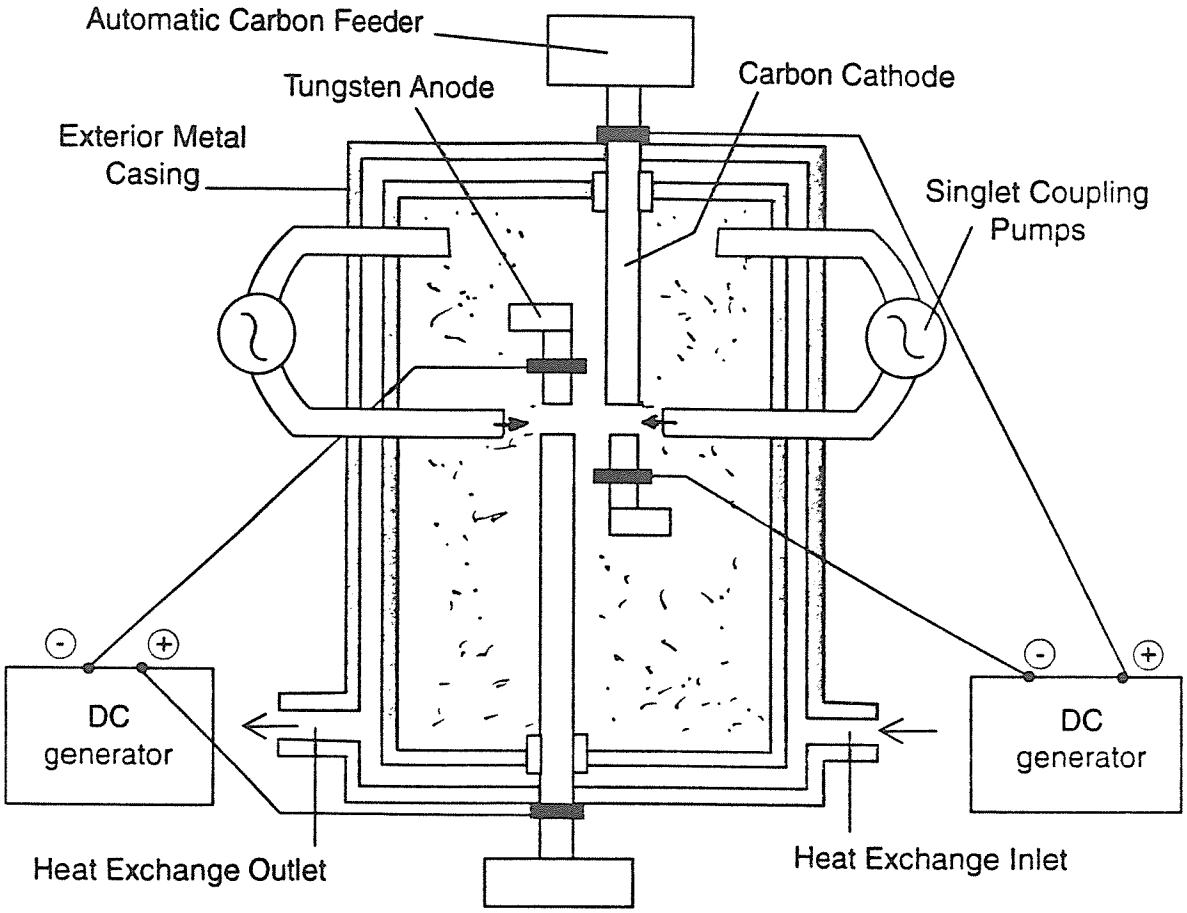

FIGURE 11: A schematic view of a representative embodiment of the *Hadronic Helium Reactor* consisting of: 1) A double walled all encompassing metal chamber whose interior is filled up with a deuterium gas; 2) Two DC electric arcs of opposite voltage and current within the deuterium gas, placed parallel to each other and at small mutual distance; 3) The selection of tungsten for anode because of long life (only when used as anode), and the selection of carbon as consuming cathode; 4) One automatic feeder per each arc which maintains the voltage at the desired optimal value, while feeding the carbon rods, as standard in the welding industry; 5) Two opposite flows of the deuterium gas directly into the arcs gaps served by two separate continuous re-circulating pumps, to force the two arc plasmas one against the other and cause SNT (3.4.1); 6) Two separate DC power units, one per each arc; and 7) A heat exchanger based on a liquid flowing in between the two walled metal casing; and various other equipment and features here omitted for security reasons. As it was the case for the Hadronic Lithium Reactor, an efficiency of one SNT (3.4.1) per billion (million) deuterium nuclei implies energies of the order of 10^3 (10^6) joules per minutes, which are indeed of practical, thus industrial relevance. The proposed Hadronic Helium Reactor has the same features of the Hadronic Lithium Reactor in regard to lack of dangerous radiations, lack of dangerous waste, and safety.

IV) Realizations of conservation laws (Law II-5). It is also easy to verify that *all* conservation laws are easily verified in the considered embodiment.

It is evident that the Hadronic Helium Reactor constitutes, if seeded within a constructive scientific and industrial environment, offers a realistic possibility for another new, clean source of energy of Class II of unlimited amounts which is clean in the sense that it does not release dangerous radiations, and does not leave radioactive waste of any kind.

To compute the energy/power of the Hadronic Helium Reactor, recall from Section 2.5 that the deuterium nucleus has the mass of 2.0141 – m_e amu + BE ≈ 1,876.122 MeV/c_o^2. Two deuterons therefore have the total mass of 3,752.245 MeV. The helium atom has the mass [17] 4.0026 amu –2×m_e – BE ≈ 4.0026 – 2×5.485X10^{-4} amu = = 3,727.377 MeV/c_o^2. The energy released by one SNF (3.4.1) is therefore given by:

$$\Delta E = 2\times M(2,\,1) - M(4,\,2) = 3{,}752.245 - 3{,}727.377 = 24.868\ \text{MeV}/c_o^2. \tag{3.4.3}$$

which is evidently released in the form of heat.

By remembering that 1 MeV = 1.6021×10^{-13} joule, the achievement of a macroscopic amount of energy is reached whenever the embodiment herein considered can provide 10^{13} SNF of type (3.4.1). By remembering that in one mole we have 6.022×10^{23} atoms, the above macroscopic amount of energy is reached under the extremely low efficiency of 1 / 10^{10} per mole:

$$(24.8\times 10^6\times 1.6\times 10^{-19}\ \text{Joule})\times(6\times 10^{23})\times$$

$$\times(10^6\ \text{reaction /min per mole}) = 2.38\times 10^6\ \text{joule/min}. \tag{3.4.4}$$

Under these so favorable conditions, the achievement of a significant, non–borderline over–unity, in which the energy output is a large multiple of the electrical energy input, is then plausible. Since the above efficiency is ultimately controlled by the the voltage and amperage of the arcs, the considered new energy of Class II is manifestly controllable.

In conclusion, as it is the case for the Hadronic Lithium Reactor, hadronic mechanics has voided all objections raised by quantum mechanics for SNT (3.4.1), has indeed established the plausibility of helium–based new energies beyond credible doubts, and has permitted the identification of a number of concrete embodiments.

However, I want to clarify that readers should not expect unlimited new energies overnight, because of the need for systematic, comprehensive and expensive technological research and developments, before any final judgment can be expressed by anybody, one way or another.

The fundamental reaction (3.4.1) underlying the Hadronic Helium Reactor is known since the 1930's. As such, it is outside any possible patenting or claim of paternity. The invention permitted by hadronic mechanics I hereby claim under the protection of the copyright, patent applications, know–how, and other laws, is that I have called the "Hadronic Helium Reactor", and its variations. I intend to defend that invention with all means permitted by Law.

3.5. The Hadronic Nitrogen Reactor (Copyrighted and Patent Pending)

It is important to know the existence of SNT which are considerably easier to achieve on technological grounds than the preceding SNT (3.3.3) and (3.4.1). As a matter of fact, another function of hadronic mechanics I want to illustrate in this section is precisely that of selecting the *easier* possible, yet sufficiently efficient new energies of Class II among a truly large variety of possibilities.

After systematic comparative studies, the SNT I have selected as easier in technical realization than the preceding two, is the *Stimulated Synthesis of the Nitrogen from ionized deuterium and carbon atoms:*

$$TR + {}_1H^2 + {}_6C^{12} \rightarrow {}_7N^{14}. \tag{3.5.1}$$

The reason for the easier technological realization is due to the fact that *the carbon nucleus* ${}_6C^{12}$ *has zero spin, thus eliminating altogether the need for equipment suitable to realize singlet couplings, as per Hadronic Law II–3.*

In fact, from nuclear data [17] we have the following conservation of the angular momentum and parity for SNT (3.5.1) (under the selection of a trigger without spin hereon tacitly implied):

$$1^+ + 0^+ = 1^+, \tag{3.5.2}$$

which is *always* verified for whatever (spinless) trigger and incident energy. The practical realization of SNT (3.5.1) is then manifestly simpler than the preceding SNT (3.3.3) and (3.4.1). The verification of Hadronic Laws II-1 to II-5 is so simple that it will not be discussed below for brevity.

My studies of SNT(3.5.1) can be outlined (in the part I can disclose here) as follows.

Several years ago, when at MIT In the mid 1970's, I was impressed by measurements of early atmospheres in our planet conducted in various laboratories, and as available in bubbles of air contained in amber and other fossils. To my recollection, these measurements indicated that the percentage of oxygen in our atmosphere was of the order of 38% ten million years ago and close to 50% 100 million years ago.

These measurements have evidently established that *the nitrogen content in our atmosphere has not been constant in time, because it has increased in large percentages through the ages.* In turn, a nitrogen increase of the order of 30% in 100 millions years cannot be credibly explained as of volcanic or asteroid origin, thus *establishing the existence in our atmosphere of events capable of synthesizing the nitrogen.*

In turn, to be meaningful and practically useful, the synthesis of nitrogen must occur in our atmosphere via *lighter* elements abundantly available in their *light, natural, and stable form.* Inspection of nuclear data reveals deuterium and carbon as the most probable ingredients for the synthesis of the nitrogen verifying the above requirements.

After leaving MIT, I conducted a study of the most probable natural event on Earth capable of synthesizing nitrogen from deuterium and carbon. The most plausible answer is: *lightning.*

In fact, lightning strokes are precisely the electric arcs of the preceding section, although lightning occurs at much higher voltage and current over much shorter period of time (of the order of nanoseconds). Nevertheless, *all* main features discussed in Section 3.4 on DC electric arcs apply also to lightning, resulting in the ionization of the atoms to bare nuclei, and their automatic compression (trigger) into small region of space sufficient to trigger hadronic forces. The latter is automatically achieved by magnetic fields associated to lightning that are locally so large to be unknown.

The plausibility of SNT (3.5.1) under these conditions is then beyond *scientific* or *credible* doubt, with the understanding that oppositiond due to lack of study of hadronic mechan ics will persist.

The energy balance of SNT (3.5.1) is intriguing. We recalled earlier that the mass of the deuterium nucleus is M_d = 1,876.122 MeV/c_o^2. The mass of the carbon nucleus is (see tables [17]) M_c = (12.000 - 6×m_e - E) amu ≈ 11,174.865 MeV/C_o^2, while the mass of the nitrogen nucleus is 13.040.137 MeV/C_o^2. Therefore, the energy released in SNS (3.5.1) is:

$$\Delta E = (M_d + M_c) - M_n = 14.850 \text{ MeV}/c_o^2. \tag{3.5.3}$$

Again, according to Hadronic Law II-4, the emission of secondary radiations would *prohibit* SNT (3.5.1). By comparison, the *lack* of secondary radiations, such as the emission of neutrons, is often used by orthodox physicists as "evidence" for the *lack* of nuclear transmutations.

The violence and rapidity of lightning are such that various other SNT are possible. It is easy to see the verification in lightning of all hadronic laws and conditions for the synthesis of the neutron (Paper III) followed by the synthesis of the deuterium (Section 2.5)

$$TR + e + {}_1H^1 + {}_1H^1 \rightarrow {}_2H^2. \tag{3.5.4}$$

The same measurements of ancient bubbles of air in amber reveal about 20% less helium 10

millions years ago and probably 50% less 100 million years ago. Since the total percentage of helium in our atmosphere is small, its volcanic and other non-nuclear origins are indeed plausible. Yet, the SNT

$$TR + {}_1H^2 + {}_1H^2 \rightarrow {}_2He^4, \tag{3.5.5}$$

appears to be possible under lightning. The study of other possible SNT in lightning is left to the interested reader.

Our studies of SNT (3.5.1) can be summarized with the following:

HYPOTHESIS 3.1: The origin of thunder in lightning is due to the instantaneously release of large amounts of energy following SNT.

THE HADRONIC NITROGEN REACTOR

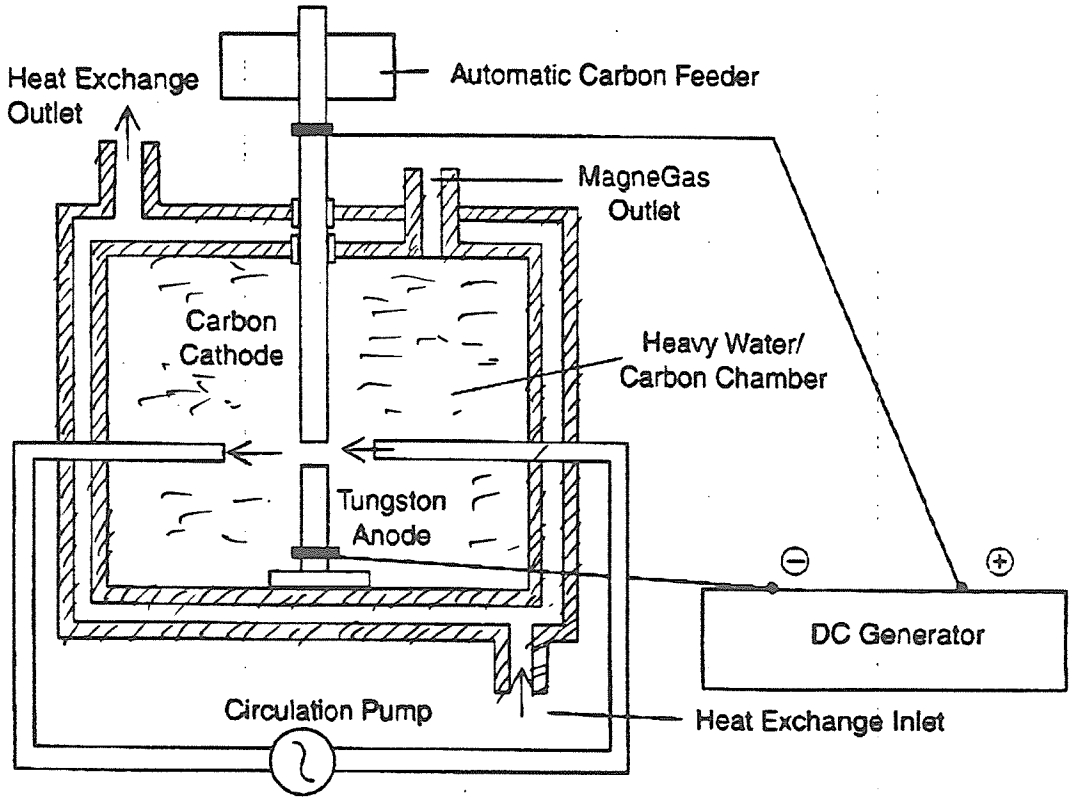

FIGURE 12: Among many different realizations of new energies of Class II originating from the study of lightning and thunder, I outline in this figure the *Hadronic Nitrogen Reactor*, essentially consisting of: 1) An all encompassing double walled metal chamber, whose interior is filled-up with heavy water saturated with carbon, *e.g.*, as available in sugar or other carbon-rich organic substances; 2) One DC electric arc occurring within said liquid, which ionizes the deuterium and carbon nuclei (as well as others), and compresses them via their intense magnetic fields, thus triggering SNT (3.5.1); 3) Electrodes composed by a long lasting tungsten anode and a consumable carbon cathode; 4) An automatic feeder of the carbon cathode which optimizes and maintains the arc voltage via a displacement of

the consumable carbon rods, as available in the welding industry; 5) A pump for the continuous flow of said liquid thru the DC arc to prevent excessive local heat and to transport the produced energy to the rest of the liquid; 6) A heat exchanger consisting of an ordinary liquid (such as water), which is made to circulate in between the two walls of the external metal chamber; 7) A DC power unit; and other equipment here omitted for security reasons. It should be indicated that the reactor also produces an excellent, clean combustible gas developed (for the case of ordinary water) at Toups Technology Licensing under the name of MagneGas^{TM} whose combustion exhausts are so clean and rich in Oxygen, to be treatable by humans and capable of sustaining life (for details on such combustible gases see [19] and Paper V). Numerous alternatives based on electric arcs, both DC and AC, are possible, as described in the pending Patent Applications and other copyrighted publications on know-how. The above Hadronic Nitrogen Reactor is fully similar to the preceding two in regard to lack of release of any harmful radiation, lack of radioactive waste, and safety. In addition, the Hadronic Nitrogen Reactor is of technological realization much simpler than the preceding two. Finally, the efficiency of the Hadronic Nitrogen Reactor is expected to be *bigger* than that of the preceding two, for the simple reason that it is based on *liquids*, thus having an atomic-nuclear concentration much bigger than the preceding two hadronic reactors.

As it is well known, the physical origin of thunder is still basically unexplained in both the orthodox and non-orthodox literature alike. We do have professional research, such as that by Graneau [18]. However, simple calculations show that the indicated possible origin does not release sufficient energy to entirely explain thunder, with the understanding that the basic processes here referred to are indeed plausible.

It is proposed that *the thunder is experimental evidence on the existence of SNT caused by lightning.* Alternatively and equivalently, *the only physical origin I know that can truly explain the large amount of energy needed to explain thunder, is that produced instantaneously by SNT.*

Elementary calculations based on hadronic [and certainly not quantum) mechanics instantly provide a *quantitative* scientific explanation of the origin of thunder via SNT. Assuming that lightning only invests one mole of atmosphere, the efficiency of one SNT per one million of atmospheric atoms is sufficient to produce an explosion equivalent to that of 50 kg of dynamite, thus *really* explaining thunder *in a numerical way* and with a *plausible physical origin.*

I should stress that it is only a human illusion to prevent the explanation of a complex physical event such as thunder via *only one phenomena*, because many different phenomena can simultaneously take place. As a result, Hypothesis 3.1, by no means, excludes those of other studies, such as [18]. In fact, the only open issue is the *respective ratio* in the energy produced for thunder, because no individual explanation can entirely exclude the others on grounds of our current knowledge.

I can therefore state that *studies of lightning and thunder constitute some of the most effective ways to study new energies of Class II, evidently because lightning strokes can be readily duplicated in our laboratory.*

Therefore, Hypothesis 3.1 suggests a considerable variety of practical realizations of new energies of Class II. The example I have selected because of its simplicity and illustrative character is proposed under the name of *Hadronic Nitrogen Reactor,* which is essentially based on one single DC electric arc within heavy water saturated with carbon, according to an embodiment outlined in Figure 12. The understanding is that numerous other embodiments are possible, as easily identifiable by any qualified mind.

The fundamental reaction (3.5.1) underlying the Hadronic Nitrogen Reactor is known since the early studies in nuclear physics. As such, it cannot be patented. The paternity I hereby claim under the protection of the copyright, patent applications, know-how, and other laws, is on the specific invention permitted by hadronic mechanics I have called the "Hadronic Nitrogen Reactor", and its variations. I am prepared to defend that invention with all means permitted by Law.

3.6. Hadronic Reactors to Synthesize Natural Elements (Copyrighted and Patent Pending)

In Section I-2.3. I have indicated that the laboratory synthesis of $_6C^{14}$ from $_7N^{14}$ is predicted by hadronic mechanics via the stimulated nuclear transmutation:

$$\text{Stimulated Electron Capture} + {}_7N^{14} \rightarrow {}_6C^{14} + \text{heat}, \tag{3.6.1}$$

of course, under the verification of all needed hadronic laws.

The studies presented in this section confirm the above statement. Recall the main argument of Section I-2.3, according to which all $_6C^{14}$ should have disappeared on Earth millions of years ago, because that particular carbon isotope is naturally unstable. The existence of $_6C^{14}$ on Earth in significant percentages and rather homogeneous distribution, such to permit the known carbon dating method (which is based precisely on $_6C^{14}$ and its spontaneous decay), are evidence of the existence in our atmosphere of a process which synthesizes the isotope (a possible volcanic origin must be excludes on grounds of distributions and other factors).

Among all possible natural processes on Earth capable of synthesizing $_6C^{14}$ from a lighter element, the most probable event is lightning. SNT (3.6.1) then follows from the abundance of nitrogen in our atmosphere.

The *Hadronic Carbon Reactor* is therefore constituted by an embodiment similar to those of the preceding sections with an internal electric arc between electrodes, in which the chamber is filled-up, this time, of nitrogen. Since the signs of the charge and magnetic moment of the electron are opposite to those of the nitrogen, the intense magnetic field of the electric arc will automatically assure singlet couplings, and other hadronic laws.

The atomic weight of $_7N^{14}$ is 14.0030740, while that of $_6C^{14}$ is 14.0032420. Therefore, SNT (3.6.1) *requires* 0.156 MeV energy for its realization, which is indeed available for electrons in lightning. But the electron has a *rest* energy of 0.511 MeV, plus kinetic energy up to 1 MeV in lightning. Therefore, SNT (3.6.1) occurs with an eccess energy which is expected to be released as heat. Contrary to initial expectations, SNT(3.6.1) *is* a possible source of thunder, jointly with the otehr SNT considered earlier.

The plausibility of SNT (3.6.1) is finally confirmed by the fact that *electron capture is a naturally occurring event. As such, there must exist mechanisms according to which the same electron capture must be stimulated. Lightning is only one of several different possibilities, the most intriguing ones occurring in living organisms.*

I should finally note that process (3.6.1) can be extend it to the general class

$$\text{Stimulated Electron Capture} + (A, Z) \rightarrow (A, Z-1) + \text{heat}, \tag{3.6.2}$$

which should also hold under the verification of all needed hadronic laws.

The fundamental reactions underlying the hadronic reactors for the synthesis of natural elements are known since the early studies in nuclear physics. As such, they cannot be patented or copyrighted. The paternity I hereby claim under the protection of the copyright, patent applications, know-how, and other laws, is on the specific invention permitted by hadronic mechanics I have called the "Hadronic Reactors to Synthesize Natural Elements", and its variations. I am prepared to defend that invention with all means permitted by Law.

3.7. Concluding Remarks

In conclusion, hadronic mechanics has indeed voided all objections raised by quantum mechanics for stimulated nuclear transmutations, thus establishing the plausibility of several new energies of Class II. Moreover, hadronic mechanics has permitted the identification of the physical laws, conditions, and geometries under which these new clean energies are possible, as well as the identification of

specific and concrete embodiment for their most efficient realization.

I want to clarify that readers should not expect instant availability of unlimited new energies, because of the need for vast research and development. After all, we should not forget that the true origin of thunder is still basically unexplained despite efforts conducted since the birth of quantitative science.

ACKNOWLEDGMENTS

I would like to express my appreciation and gratitude to Leon Toups, President of Toups Technology Licensing, Largo, Florida, for invaluable assistance and support without which this series of papers would not have been completed. Thanks are also due to Hal Fox, Editor in Chief of the *Journal of New Energy*, for the joint publication of the entire series which is important for researchers in new energies to have comprehensive view of the various aspects. I also wish to thank several colleagues for invaluable technical assistance and suggestions.

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THE PHYSICS OF NEW CLEAN ENERGIES AND FUELS ACCORDING TO HADRONIC MECHANICS, PAPER V: STRUCTURE OF MOLECULES, NEW, CLEAN, FUELS, AND NEW ENERGIES OF CLASS III[1]

Ruggero Maria Santilli[2]

ABSTRACT

This is the last of a series of five articles outlining systematic research on new energies and fuels at the particle, nuclear, and molecular levels, initiated by the author at Harvard University in 1978 under DOE support, and then continued at various Institutions. Paper I identified the new energies and fuels studied in this series as those not predictable or treatable by quantum mechanics, and presented clear limitations of quantum mechanics in numerous fields. Paper II outlined the various branches of the covering hadronic mechanics, the novel mathematics needed for its invariant formulation, and catastrophic inconsistencies of other noninvariant generalizations. Paper III classified the new energies into: *Class I*, when of particle origin; *Class II*, when of nuclear origin; and of *Class III*, when of molecular origin. Paper III then reviewed the experimental evidence supporting hadronic mechanics in particle physics; reviewed Santilli's structure model of the neutron as predicted by Rutherford (a bound state of the proton with the electron totally immersed in its hyperdense interior); identified the physical laws of new energies of Class I as predicted by hadronic mechanics; and outlined examples of new energies considered, with applications to expected new means of recycling nuclear waste into stable elements by stimulating their decay. Paper IV studied new energies of Class II, and contained: experimental verifications of hadronic mechanics in nuclear physics; a new structure model of nuclei permitted by the consistent treatment of Rutherford conception of the neutron of Paper III; the identification of the physical laws of new energies of Class II as predicted by hadronic mechanics; and specific embodiments suggested by hadronic mechanics, either for basically new energies of the class considered, or for the improvement of the efficiency of existing new energies. This final paper uses the entire preceding knowledge, plus new knowledge on molecular structure presented herein, to study the new energies of Class III, as well as new clean, environmentally acceptable fuels developed by Toups Technology Licensing, a public company of Largo, Florida. In particular, this paper contains: an outline of the rather serious environmental problems created by fossil fuels due to large carcinogenic substances in the exhaust, alarming oxygen depletion in our atmosphere, green house effect, and other problems; the rather serious insufficiencies of molecular structures as predicted by quantum chemistry; a new model of molecules permitted by hadronic mechanics, which resolves said inconsistencies, and permits the first exact-numerical representation of molecular characteristics; experimental evidence for a new chemical species called *Magnecules*,which are composed of ordinary atoms and molecules under a new strong magnetic bond originating in the plane polarization of the orbits of valence electrons; and other advances. The entire knowledge outlined in these five papers is then applied to the identification of *new, clean, over-unity combustible fuels developed by Toups Technology licensing capable of resolving the alarming environmental problems indicated earlier at a competitive cost.* The paper ends with a study of new, clean energies of Class III, their physical laws, and representative embodiments with possible efficiency sufficient for commercialization.

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1. INTRODUCTION

1.1. Statement of Objectives

This is the last of a series of five papers outlining systematic research on new energies and fuels at the particle, nuclear, and molecular levels, initiated by the author at Harvard University in 1978 under DOE support, and then continued by several researchers at various Institutions. This final paper is primarily devoted to a presentation of new, environmentally acceptable energies, fuels, and technologies developed at Toups Technology Licensing, a public company of Largo, Florida [1]. The methods and results are, however, applicable also to a variety of other new energies and fuels studied by other researchers.

Paper I [2a] identified the new energies and fuels studied in this series as those *not* predictable or treatable by quantum mechanics, and presented clear limitations of quantum mechanics in numerous fields.

Paper II [2b] outlined the various branches of the covering hadronic mechanics [3,4], the novel mathematics needed for its invariant formulation [3h], as well as catastrophic inconsistencies of other noninvariant generalized theories.

Paper III [2c] classified the new energies into: ***Class I,*** when of particle origin; ***Class II,*** when of nuclear origin with possible contributions of Class I; and of ***Class III,*** when of molecular origin with possible contributions of Classes I and II. Paper III then reviewed the experimental evidence supporting hadronic mechanics in particle physics; reviewed Santilli's structure model of the neutron as predicted by Rutherford (a bound state of the proton with the electron totally immersed in its hyperdense interior); identified the physical laws of new energies of Class I as predicted by hadronic mechanics; and outlined examples of the considered new energies with applications to expected new means of recycling nuclear waste into stable elements by stimulating their decay.

Paper IV [2d] studied new energies of Class II, and contained: experimental verifications of hadronic mechanics in nuclear physics; a new structure model of nuclei permitted by the consistent treatment of Rutherford's conception of the neutron of Paper III; the identification of the physical laws of new energies of Class II as predicted by hadronic mechanics; and descriptions of specific embodiments suggested by hadronic mechanics, either for basically new energies of the class considered, or for improving the efficiency of existing energies.

This Paper V is dedicated to the last aspect of the research, the new, clean energies of Class III: those originating at the molecular level with possible contributions of Classes I and II, as well as to new, clean fuels capable of resolving the dramatic environmental problems caused by fossil fuels.

By their very definition, any quantitative-scientific study of these new energies and fuels requires an accurate model of molecules, that is, of the ways in which atoms bonds themselves into clusters forming the various substances of our environment. Any insufficiency in the representation of molecules will imply insufficiencies in the study of new energies and fuels, with particular drawbacks expected in their efficiency.

Therefore, the first important aspect of this paper consists of the *insufficiencies of quantum chemistry for molecular structures,* as presented in Section 2.7 of Paper I (hereinafter indicated as I-2.7), and their resolution by the generalization of superconductivity, called *hadronic superconductivity,* worked out by A. O. E. Animalu and R., M. Santilli [5], and of quantum chemistry, called *hadronic chemistry,* recently achieved by R. M. Santilli and D. D. Shillady [6].

More specifically, *the belief that quantum chemistry provides final knowledge on molecular structures, implies the lack of existence of any new energy or fuel of the class considered.* On the

publication and/or preceding ones are quoted; 2) Said quoted publications are outlined as a prerequisite for allegations of novelty; and 3) Original paternities are identified with clarity. No reprints in part or in full of this publication can be made without the written authorization by the copyright owner.

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electron clouds, and their transformation from the natural state to a form permitting fusion, transmutations and other esoenergetic releases of energy. As well known, nuclear fusions at ordinary conditions are not accepted by the physics establishment. The underlying physical reasons for the rejection should not be ignored by serious researchers in new energies. On the contrary, the opposing arguments should be carefully appraised, and resolved.

A primary reason why the physics establishment rejects nuclear fusions at ordinary conditions is that *the electron clouds surrounding all nuclei naturally have a spherical and stable distribution, thus constituting a real shield against any possibility of having nuclei in the close proximity necessary for the fusion itself.* Researchers in new energy must admit that this objection is indeed valid. Note that the ionization of atoms, *e.g.,* as occurring in electrolysis, is fundamentally insufficient to resolve the objection, evidently because electrolysis merely removes the valence electrons, while all remaining electrons preserve their spherical and stable configurations, with a consequential impenetrable shield against any nuclear reaction.

The second primary objective of this paper is therefore the identification of specific technological means to control the distribution in space of atomic electron clouds into such a form permitting nuclei to reach conditions suitable for nuclear reactions. As will be shown, this objective is indeed possible because electrons orbits can be polarized via suitable external magnetic fields, that is, restricted to occur in a plane, as admitted by *conventional* quantum mechanics and electrodynamics. Therefore, a realistic possibility of controlling the atomic structure does exist, thus permitting nuclei to reach sufficiently small mutual distances under which nuclear reactions are possible.

The third primary objective of this paper is to study *the conditions under which atoms and molecules, when subjected to a suitable control of their peripheral electron could, achieve nuclear reactions.* The reader should be aware that this is the most complex physical problem I have ever addressed in my research. In fact, the problem encompasses in a direct or indirect way the totality of the existing physical knowledge, including particle physics, nuclear physics, superconductivity, chemistry, biology, etc.

Despite these shortcomings, the results of my studies presented in this paper are sufficient to establish that *new energies of Class III are indeed real, and they do deserve serious consideration by industry, academia, and governments.* The main message is that all possible problems for new energies of Class III to reach consumer and industrial maturity, can be solved once they are identified in sufficient details.

This paper also presents for the first time the achievement of a new over-unity combustible gas capable of resolving the alarming environmental problems caused by fossil fuels, developed by Toups technology Licensing [1]. As will be shown, the achievement of such a result required the entire knowledge of this series.

The new technologies needed for the production of environmentally acceptable new fuels are directly applicable to the practical realization of new, clean energies of Class III. Therefore, the problems of new energies and fuels will emerge from these papers as being deeply interconnected, and reducible to a single, unified, scientific and technological treatment.

1.2. Major Environmental Problems Addressed by Toups Technology Licensing

The content of this paper is mostly the result of research conducted at Toups Technology Licensing [1], as part of serious industrial efforts to address and resolve major environmental problems currently afflicting our society.

As well known, fuels of fossil origin are now approaching depletion. It is evident that we do not have on Earth other natural resources usable as fuels in replacement of gasoline, diesel fuel, natural gas, etc. As a result, *the first industrial reality that has been addressed by Toups Technology Licensing is that future fuels for automotive and other uses must be synthesized.*

Another main scope of this paper is to outline the most promising aspects of new fuels under

development at Toups Technology Licensing. The existence of serious environmental problems caused by fossil fuels has reached the awareness of the public. However, it is unfortunate for all of us that the major environmental problems caused by fossil fuels are still unknown to the public for various reasons.

After studying the issues for decades, the major environmental problems caused by following fuels are, in the given order of importance, the following:

MAJOR ENVIRONMENTAL PROBLEM # 1: Fossil fuel exhausts are the biggest source of cancer on Earth.

Any medical doctor who inspects the chemical analysis of the combustion exhausts of gasoline, diesel fuel, or natural gas, can testify the presence there of some of the most carcinogenic substances on Earth.

Since automotive exhausts are discharged in our environment, they are evidently inhaled by all of us. The main issue is, therefore, an estimate of how many carcinogenic substances due to fossil fuel exhausts we inhale per day in an average urban environment, as compared to carcinogenic substances we ingest from food also per day.

Official governmental estimates, in the event known are not released to the public. However, an estimate is reachable by all. It is easy to see that, while living in an average urban environment, every day we inhale carcinogenic substances due to fossil fuel exhausts which are at least 1,000 times bigger than the carcinogenic substances contained in food also ingested per day.

In case of densely populated and polluted urban areas, such as Los Algebras, New York, Tokyo, Honk Kong, etc. , the carcinogenic substances inhaled per day can be as high as 10,000 times the carcinogenic substances daily ingested in food, thus illustrating the gravity of this environmental problem, despite the silence by the newsmedia.

The above scenario establishes the following:

FIRST MAJOR DUTY BY SOCIETY, AND, SEPARATELY, BY GOVERNMENTS: Immediate initiation of systematic measurements of carcinmogenic substances in urban atmospheres, set-up standards, and release the information to the public.

FIRST REQUIREMENT FOR NEW FUELS: Their exhausts must be free of carcinogenic, lead, and other substances in amounts harmful to humans and the environment. This is the first major environmental problem seriously successfully addressed by Toups Technology Licensing, as will be shown in Section 3.

MAJOR ENVIRONMENTAL PROBLEM # 2: The burning of fossil fuels is causing an alarming depletion of oxygen in our atmosphere.

As well known, *gasoline, diesel fuel, natural gas, and similar fuels require oxygen to burn, which oxygen is removed from our atmosphere.* The major environmental issue is, therefore, whether plants can today replenish the oxygen used by internal combustion engines, and keep constant the percentage of oxygen in our planet.

It is evident that *the answer to the above distressing question is in the negative.* Today, there exist an estimated number of about *half a billion automobiles, one million trucks, and one hundred thousand planes used daily, while rain and other forests are being dramatically reduced. In a scenario of this type, the depletion of oxygen in our atmosphere is simply beyond any scientific or otherwise credible doubt.*

The main issues is, again, an estimate of the amount of yearly depletion of oxygen in our planet. The official oxygen percentage in our atmosphere in the middle of this century (see, *e.g.*, the *early* versions of the Encyclopedia Britannia or chemistry books of the same period) is:

Oxygen percentage in our atmosphere at sea level in the 1950's :

$$20.946\,\% \pm 002\,\% \qquad (1.2.1)$$

Oxygen meters can be purchased by anybody anywhere. I therefore recommend interested

readers to do what I did, get an oxygen meter and measure the oxygen percentage in your area by yourself. In the facilities of Toups Technology Licensing, which are located at sea level in an environmentally preferred area (because in between the Gulf of Mexico and the Atlantic Ocean), I have repeatedly measured 20.8 % of oxygen in our atmosphere, which corresponds to *the depletion in our atmosphere of 4.8 % of oxygen* (0.1 % of 20.946 %). Bigger percentages of oxygen depletion are expected in environmental less friendly areas, such as the central part of the U. S. A., or in densely populated areas at sea level, where (unverified) oxygen depletions up to 10% have been reported.

Unfortunately for all of us, the problem of oxygen depletion is more serious than that outlined above. Oxygen has a molecular weight much bigger than that of the largest constituent of our atmosphere, nitrogen. Therefore, the next unreassuring reality is that *the percentage of oxygen depletion increases with the increase of the elevation.*

According to numerical estimates (which I could not verify due to lack of the necessary resources), if a certain area has an oxygen depletion of 5% at sea level, the corresponding oxygen depletion of a 10,000 feet high mountain near-by is expected to be at least double in value.

An indicative idea of the amount of oxygen currently depleted per day by fossil fuels is also important. Engineers at Toups Technology Licensing under my eyewitnessing have measured the amount of oxygen depleted per minute by a 10 HP two-cycle Tecumseh engine. The depletion was computed via the difference between accurate measurements of oxygen intake used for the combustion, and oxygen released in the exhausts. The result was a depletion of 1.5 cf of oxygen per minute by the 10 HP two-cycle engine [1b].

By assuming the continuous use per day of 100 million cars with 100 HP each, 50,000 trucks with 300 HP each, and 10,000 planes of 1,000 HP each, we reach the following approximate:

Estimate of oxygen depletion due to fossil fuels combustion per day:

$$\text{about } 4 \times 10^9 \text{ cf of oxygen / day .} \qquad (1.2.2)$$

In the event that my personal measurements of oxygen depletion are just an isolated aberration due to insufficient resources and a local use of oxygen (a possibility that I must admit to be real), the depletion of oxygen in our atmosphere remains real due to the amount of daily depletion.

SECOND MAJOR DUTY BY SOCIETY, AND, SEPARATELY, BY GOVERNMENTS: Immediate initiation of systematic monitoring of oxygen depletion in various parts of the world at different elevations, set-up of standards, and release the information to the public.

SECOND MAJOR REQUEST FOR NEW FUELS: Have a positive oxygen balance, that is, the amount of oxygen released in the exhausts should be bigger than that used for combustion. This is the second major environmental problem successfully addressed by Toups Technology Licensing, as we shall see in Section 3..

MAJOR ENVIRONMENTAL PROBLEM # 3: Green house effect due to carbon dioxide in fossil fuels exhausts.

This is the main environmental problem perceived by the public until now, while, in reality, the carcinogenic substances in the exhausts, and the oxygen depletion, are problems comparatively bigger than the green house effect based on the number of deaths per year (see below).

Despite that, the latter environmental problem has potentially devastating climactic consequences, which are well known, and, therefore, there is no need to review them here. I merely recall that, according to official statistics, there have been three hundred deaths due to tornados in the U. S. A. in the first three months of 1998, namely, in a period of the year in which tornado activity should be less.

At the current rate of accretion of carbon dioxide (see below), computer extrapolations predict 1,000 deaths in the U.S.A. during the first three months of the year 2,010. Bigger numbers of deaths are predicted for carcinogenic substances, and oxygen depletion, and this illustrates the

reason for the selected priorities.

If the above gloomy scenario does indeed occur, it will be too late. From that moment on, the numbers of deaths and the related catastrophic climatic events will increase exponentially to a point of literal devastation of our planet.

As well known, circles generally associated with or depending on funding from the oil industry, have dismissed climactic changes due to the green house effect, by mentioning natural cycles in our planet. Others have gone so far to say that the increase of CO_2 is beneficial to our planet, because it provides "increased food for plants". I want to keep a distance from these circles, because just running the risk of these devastating climactic changes is irresponsible due to their irreversibility once established.

On scientific grounds there is very little room for political manipulations, because the issue , again, purely numerical. We can safely assume that, through the ages, our planet had reached a balance by the end of the past century in keeping constant the average percentage of CO_2 in our atmosphere. It is known that gasoline has about 12% CO_2 in the combustion exhausts (see the independent measurements reported in [1b]). This percentage permits the following estimate of the amount of CO_2 daily produced by the combustion exhausts of continuously running 100,000 cars with 100 HP each, 50,000 trucks with 300 HP, and 10,000 airplanes with 1,000 HP,

Estimate of carbon dioxide production by fossil fuel combustion:

$$2.1 \times 10^9 \text{ cf of } CO_2 \text{ production / day;} \qquad (1.2.3)$$

At the same time, green forests are being depleted in out planet. Under these conditions, an increase of carbon dioxide in our atmosphere should be expected.

At any rate, I recommend readers to do what I do. Trust nobody and do the measurements by yourself. The official percentage of carbon dioxide in our atmosphere at sea level in the middle of this century was (see, again, the *early* versions of the Encyclopedia Britannia, or early books in chemistry)

Percentage of CO_2 in our atmosphere at sea level in the 1950's :

$$0.033\ \% \text{ of } CO_2 \pm 0.01\ \% \qquad (1.2.3)$$

Meters of carbon dioxide can be purchased by anybody anywhere. I therefore recommend readers to obtain one of them, and conduct measurements of CO_2 content in various locations. Readers can therefore see on their own unreassuring increases of CO_2 in our planet.

As it was the case for the oxygen depletion, in the event individual measurements od excess carbon dioxide are just local occurrences that cancel out in a global planetary scale, the size of daily production (1.2.3) establishes that the increase of carbon dioxide in our atmosphere is beyond scientific or credible doubt.

THIRD MAJOR DUTY BY SOCIETY, AND, SEPARATELY, BY GOVERNMENTS: Immediate initiation of systematic monitoring of percentage of carbon dioxide in various parts of the world, set-up standards, and release the information to the public.

THIRD MAJOR REQUEST FOR NEW FUELS: Have carbon dioxide percentages in the combustion exhausts dramatically reduced over those of gasoline, and down to a level which can be substantially eliminated by passing the exhausts through CO_2 absorbing chemical treatments. This is the third major environmental problem successfully addressed by Toups Technology Licensing [1], as shown in Section 3.

In summary, ***Toups Technology Licensing has initiated, apparently for the first time in the industry, systematic studies on the possible industrial production of new combustible gases which: 1) Have no appreciable carcinogenic substances in the***

combustion exhausts; 2) Are sufficiently rich in oxygen to release more oxygen than that used for the combustion; and 3) Emit carbon dioxide in percentages sufficiently low to be mostly eliminated via chemical means. It is a pleasure for me to report that, thanks to the vision by Mr. Leon Toups, Toups Technology Licensing has indeed established the technological feasibility of the verification of the above requirements, as will be shown in the rest of this paper.

Moreover, Toups Technology Licensing has jointly addressed the problem of the production of new, clean combustible gases at a sufficiently low price to permit their acceptance by the consumer. If these new combustible gases cost, let us say, ten times the cost of gasoline, they will not be purchased by consumers, no matter how serious environmental problems are.

I am further pleased to report in this paper that Toups Technology Licensing has identified new technologies for the production of the indicated new clean combustible gases at competitive prices. The technologies are essentially based on recycling liquid and solid wastes, in which the combustible gases are obtained as by-products. In this case,the income for recycling said wastes is sufficient to support all primary costs, thus having new, clean, combustible gases produced at reasonable costs.

Note that liquid wastes, such as sewage from municipalities and towns, are essentially unlimited, thus establishing the availability of new combustible gases that can be obtained via their recycling. Moreover, readers should note the joint addressing and solution by Toups Technology Licensing of *two* environmental problems, the recycling of liquid and solid wastes that are filling up our lands in an ever increasing amounts, and the need for environmentally acceptable fuels.

Yet another issue addressed by Toups Technology Licensing is that, no matter how serious the environmental problems are, it is entirely unrealistic to assume the instantaneous elimionation of half a billion cars, one million trucks, one hundred thousand planes, and other uses of fossil fuels in operation today in the world. The automotive industry, and, more generally, the industry based on piston engines is here to stay for the foreseeable future. Admittedly, the search for completely new, clean means of locomotions (such as automobiles powered by fuel cells) are commendable, and warranting support. However, the current main environmental issue remains the handling of the existing very large number of internal combustion engines.

I am additionally pleased to report in this paper that the new clean combustible gases identified by Toups Technology Licensing can be used by any internal combustion engine as currently available, except for minor external modifications.

Yet another problem addressed at Toups Technology licensing is the safety of the selected fuels. As well known, gasoline is one of the most dangerous fuels available on Earth, since it spills during accidents, and explodes.

I am further pleased to report that the new, environmentally acceptable gases are much safer to use than gasoline, because: their tanks are much stronger than the (rather thin) gasoline tanks; in the event they are punctured by a catastrophic accident, said gases disperse in atmosphere without spilling; and, in the event they catch fire, they burn without exploding.

Another aspect that required protracted investigations and testing was the search of a new, clean combustible gas which can be efficiently produced. ***I am finally please to report in this publication for the first time scientific evidence that the new, clean, combustible gases developed at Toups Technology Licensing are over-unity in a significant amount, as will be shown in Section 3.12.***

The prerequisites for the achievement of the above results have been:

1) Conduction of systematic scientific studies of new clean fuels and energies at all levels, including particle, nuclear, and molecular levels. As an illustration, readers will see that the novel means of storing energy in the new combustible gases originate at the *particle* level. At any rate, problems associated with the identification and production of new clean fuels and energies are so great, to thwart any effort conducted at the molecular level only, no matter how

qualified the researcher.

*2) **Abandonment of quantum mechanics, superconductivity, and chemistry and use instead their covering hadronic formulations.*** Following all the evidence presented in these papers on the limitations of established doctrines, there should be no doubt that *quantum mechanics, superconductivity, and chemistry prevent serious studies on new fuels and energies.* In any case, I have no interest whatever to study "new" problems with "old" doctrines.

*3) **Construction of new structure models of hadrons, nuclei, and molecules, as outlined in Papers III, IV and V, respectively.*** Recall from Paper III that the current structure models of protons and neutrons (that based on quark conjectures) *prevent*, let alone offer, any possibility for new forms of particle energies, while such possibilities are permitted by the new structure models of unstable hadron with physical constituents freely emitted in the spontaneous decays. In Paper IV we have found a fully similar situation at the nuclear level, because current nuclear physics *prejects* any "new" energy of nuclear type, while these energies are permitted by a return to the original conception of nuclei, that based on protons and electrons verifying a mechanics specifically built for that task. In this paper I shall show that a fully similar situation occurs at the molecular level. Besides being afflicted by incredible insufficiencies, or sheer inconsistencies (see next section), current models of molecular structures *prohibit* really "new" fuels or energy of molecular origin. However, more effective models of molecular structure outlined in this paper permit new fuels and energies.

I want to express my appreciation to Mr. Leon Toups for having permitted at his company the pursuit of basically new scientific inquiries, which pursuit would have been essentially impossible in contemporary academia, as documented by by own experience [I-2a,I-2b].

1.3. Insufficiencies of Quantum Chemistry

As well known to chemists, although not indicated in Ph. D. courses or in the technical literature, despite outstanding achievements of clear historical proportions during this century, *quantum chemistry* [9,10] is still afflicted by numerous, fundamental, unsolved problems, insufficiencies, or sheer inconsistencies, which were preliminarily outlined in Section I-2.7, and were treated in technical detail in Refs. [6], such as:

*1) **Lack of a sufficiently strong molecular bonding force.*** The forces currently assumed in molecular bonds (the exchange, van der Waals, and other forces [9]) were conceived for *nuclear* structures, in which field they are known to be weak. This is the historical reason that demanded the additional introduction in nuclear physics of strong forces. In addition, the classical average of currently assumed, bonding forces implies an identically null bonding force between different atoms (see Figure I-7). Thus, the current description of molecular structures according to quantum chemistry misses the equivalent of the strong force in nuclear structures.

*2) **Impossibility to explain why the hydrogen, water, and other molecules have only two hydrogen atoms.*** The currently used bonding forces of nuclear type were conceived for an *arbitrary number of constituents*, as an evident necessary condition to have meaning for nuclei. Any graduate student in physics or chemistry can, therefore, prove that, under the current models of molecular, the hydrogen molecule can be H_3 or H_8, or H_{27}, and the water molecule can be H_3O, $H_{12}O$, $H_{27}O$, etc. (Figure I-8).

*3) **Lack of accurate representation of molecular binding energies without manipulation of basic principles.*** As well known, a historical amount of about 2% of the experimental values of molecular binding energies is still missing in quantum chemical

representations, e.g., in self-consistent treatments [9,10].

*4) **More accurate representations of molecular characteristics imply violation of basic quantum laws.*** More accurate representations of molecular binding energies have been recently achieved, but they require structural modification of the Coulomb law with Gaussian and other factors called "screenings" [9,10]. However, Gaussian screened Coulomb forces do not allow the existence of the hydrogen atom, imply necessary instabilities of all electron orbits, and prohibit the use of the very notion of "quantum of energy" , because quanta are emitted or absorbed only between stable orbits, as well known. A similar occurrence holds for variational methods which, besides admitting an unlimited number of free parameters of completely unknown physical or chemical origin (thus being of purely *mathematical* character), can be proved by graduate students to violate the very conditions to preserve a "quantum", *e.g.*, because variational solutions *cannot* be solutions of genuinely quantum Schrödinger equations (otherwise the latter would have permitted exact solutions).

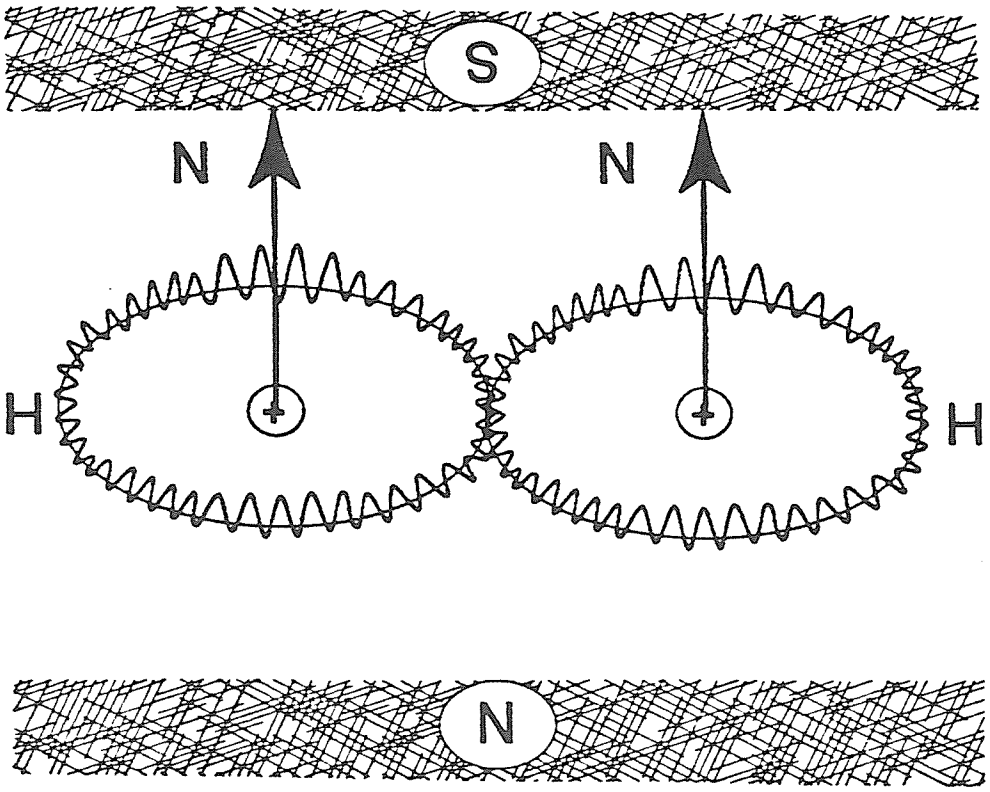


FIGURE 1.1 A schematic view of the prediction by quantum chemistry [9] that *all molecules are ferromagnetic*, here expressed for the case of the hydrogen molecule H_2 = H-H considered at absolute zero degree temperature and in the absence of any motion. The prediction is an un-avoidable consequence of the current conception of molecular structures, in which the bond is due to exchange and other forces of *nuclear* type, under which each atom preserves its individuality. The most rigorous discipline of this century, quantum electrodynamics, then establishes that, under an external magnetic field South-North, the orbits of all valence electrons must acquire a plane polarization such to offer the opposite polarity North-South, resulting in a total net magnetic polarity $H_{\uparrow}$-$H_{\uparrow}$ which is in dramatic disagreement with experimental evidence. The only way I known to resolve the above inconsistency is the introduction of a much stronger correlation among the two electrons, which, however, is outside quantum mechanics and chemistry, but fully permitted by their hadronic coverings, as will be shown.

*5) **Impossibility to conduct meaningful thermochemical studies.*** The 2% currently missing in the binding energy implies an error of about 950 Kcak/mole, while an ordinary chemical reaction implies about 20 Kcakl/mole. Therefore, quantum chemistry implies thermochemical calculations in which *the error can be 50 times bigger than the energy considered.*

*6) **Excessive times in computer calculations.*** Computer calculations in chemistry are known to require up to months of continuous running time, despite the use of the most modern possible computers. This is a clear indication of the insufficiency of the *theory*, rather than of the computer, as proved in Refs. [6]

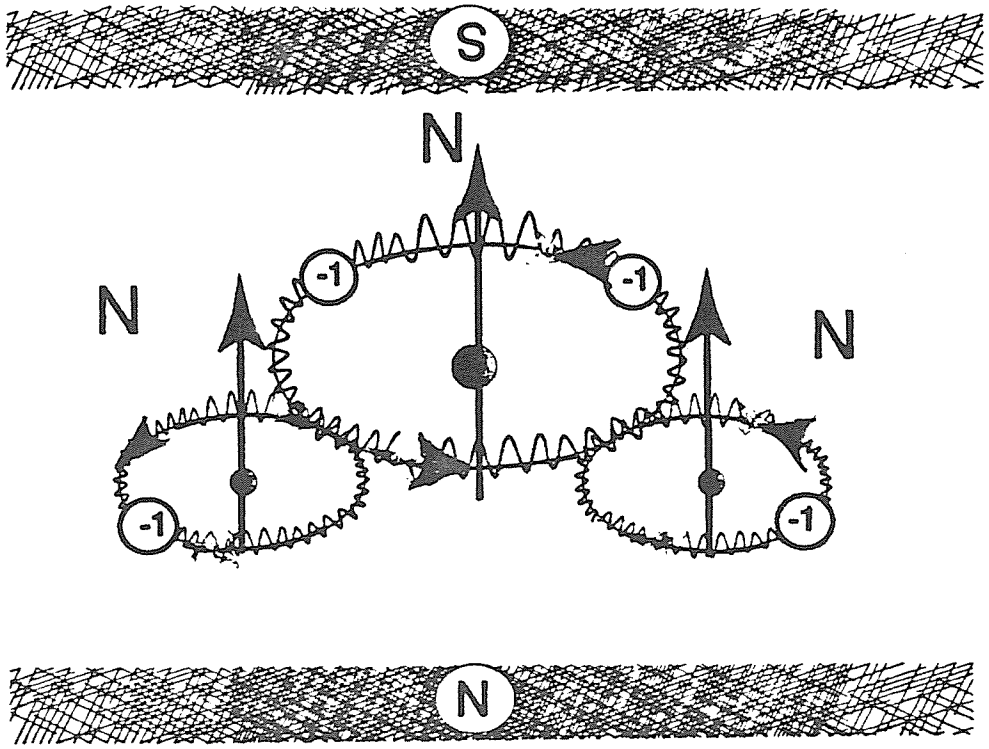


FIGURE 1.2: A schematic view of the behavior of the valence electrons of the conventional model of the water molecule $H_2O = H-O-H$ [9] considered at 0 K under an external magnetic field South-North. As it in the case for the hydrogen molecule, quantum electrodynamics requires that, under the currently assumed independence of the atoms, and weak correlations between valence electrons, each atom must assume a polarization North-South opposite to that of the external field, resulting in the total net magnetic polarity of the water molecule $H_{\uparrow}-O_{\uparrow\uparrow}-H_{\uparrow}$ which is of full ferromagnetic type. This prediction is in dramatic disagreement with experimental evidence, since water is diamagnetic, as well known [9]. After studying this inconsistency for years, the only resolution I know is the conception of a basically new model of the water molecule as achieved by hadronic mechanics and chemistry [6].

*7) **Dramatic disagreement between the correlations used in current orbital theories and the experimental evidence.*** Current orbital theories use an arbitrary number of electrons in their correlation [9,10], while experimental evidence establishes that correlation only occurs for *electron pairs.* This evidence establishes an additional insufficiency of the theory, as shown in Refs. [6].

*8) **Lack of accurate representations of molecular electric and magnetic moments.***

In fact, current representations sometimes wrong even in the sign [9], let alone the value.

9) Prediction by quantum chemistry that all molecules are ferromagnetic (Figures 1.1, 1.2), which is in dramatic disagreement with experimental evidence.

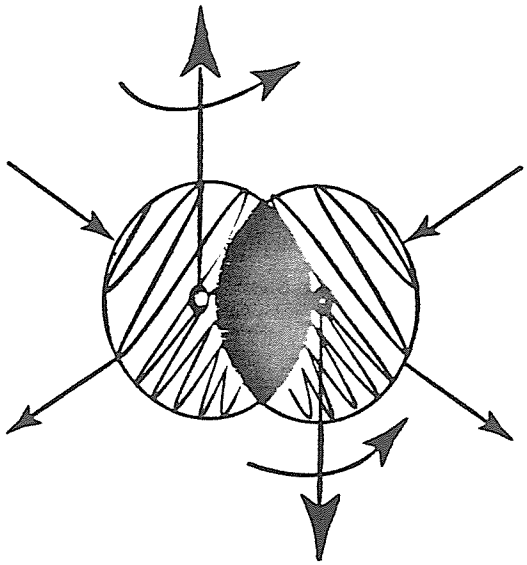


FIGURE 1.3: A schematic view of the physical conditions at the foundation of the new model of molecular structures introduced by Santilli and Shillady via hadronic chemistry [6], the deep overlapping of the *extended wavepackets* of the valence electrons with *point-like charges*. These conditions are known to be nonlinear, nonlocal, and nonpotential, thus non-Hamiltonian, and nonunitary (see Sect. 2.1 for these explicit forms), thus resulting to be outside any realistic hope of scientific treatment via quantum mechanics, superconductivity, and chemistry. The need for more adequate theories then emerges quite forcefully.

It is evident that, under so many fundamental insufficiencies and sheer inconsistencies, studies of "new" fuels and energies based on quantum chemistry has have extreme difficulties in achieving practical values.

1.4. Hadronic Mechanics, Hadronic Superconductivity, Hadronic Chemistry, and the New Model of Electron Bonding

It is evident that the origin of the insufficiencies and sheer inconsistencies of quantum chemistry outlined above *are not* due to the theory itself, but rather to the underlying theory, *quantum mechanics*. It is today known [2-8] that the indicated problems are due to the absence of a meaningful representation by quantum mechanics of the conditions of deep overlappings of the extended wavepackets of electrons, precisely as occurring in the bonding of valence electrons.

The insufficiencies and sheer inconsistencies of quantum chemistry for the molecular structure establish that *the discipline which is exactly valid for the structure of the hydrogen atom, quantum mechanics, cannot possibly be exact for the bonding of two hydrogen atoms into the hydrogen molecule (Figure 1.4), thus confirming the need for a more adequate theory.*

Thanks to the achievement of maturity of hadronic mechanics, A. O. E. Animalu and R. M. Santilli [3a,5a,5b] constructed *hadronic superconductivity*, which can also be divided into *iso-*,

geno-, and hyper-superconductivity, depending on whether one studies superconducting conditions in closed-conservative-reversible conditions, open-nonconservative-irreversible setting, and with irreversible-multi-valued structure, respectively. In particular, isosuperconductivity achieved the first quantitative representation of the *attraction* between the identical electrons of the Cooper pair, in a way remarkably in agreement with experimental data (see Section 2).

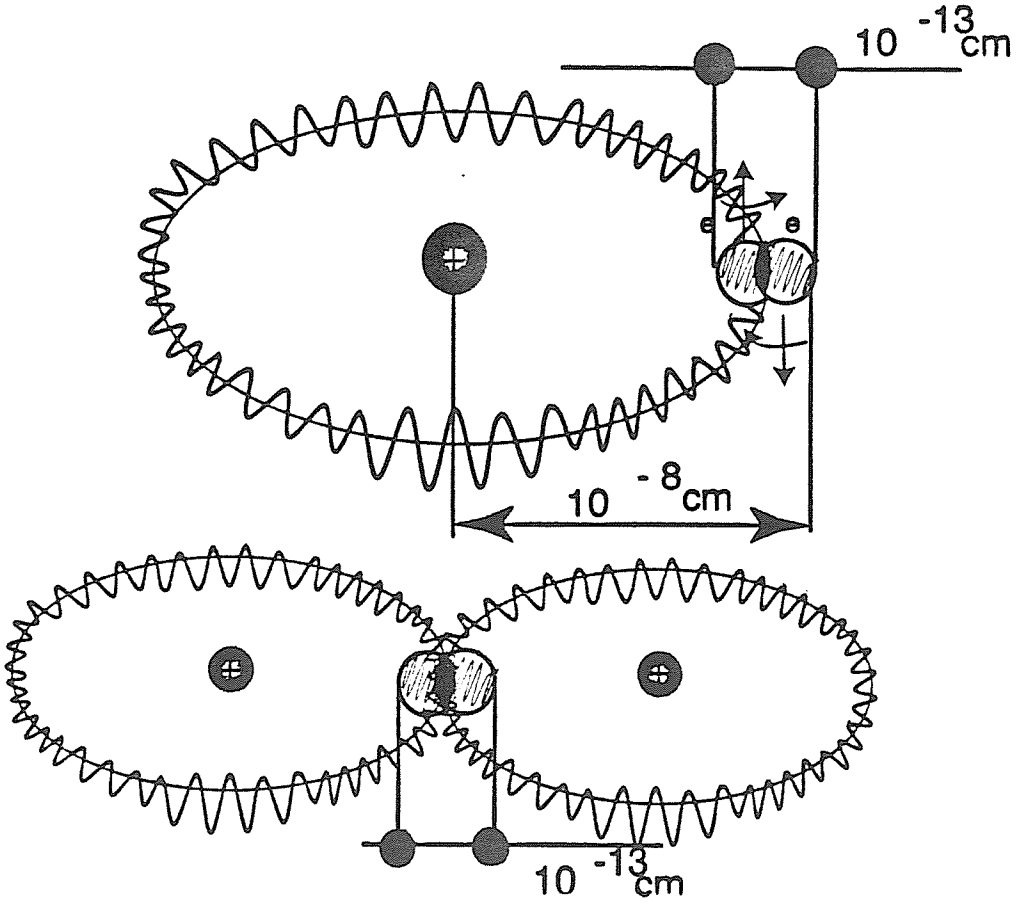


FIGURE 1.4: A schematic view of the reason why quantum mechanics is *exactly valid* for the structure of *one hydrogen atom,* but only *approximately valid* for the two atoms of the *hydrogen molecule.* In the former case (top view) we have a very large mutual distance between the electron and the nucleus, which permits an effective approximation of the electron's *wavepacket* as being *point-like.* In turn, this implies the exact applicability of the linear, local and potential axioms of quantum mechanics. In the case of the hydrogen molecule (bottom view) these conditions are no longer valid, because we now have the *deep overlapping of the wavepackets of the valence electrons at distances of 1 fm or less.* Under these conditions, a point-like approximation of the *wavepacket* of the electrons is no longer valid. It then follows that quantum mechanics and chemistry *cannot* be exactly valid for molecular structures. Hadronic mechanics and chemistry have been constructed [2-7] precisely for the quantitative invariant description of nonlinear, nonlocal, and nonpotential conditions of deep wave-overlappings of valence electrons (and other particles), as needed for the study of new fuels and energies of Class III.

As a result of the experimental verification of isosuperconductivity in its new bonding of electrons, R. M. Santilli and D. D. Shillady [6] have constructed a generalization-covering of quantum chemistry under the name of *hadronic chemistry,* which is also based on the novel iso-, geno- and hyper-mathematics. Therefore, hadronic chemistry contains three corresponding

branches also called *iso-, geno-, and hyper-chemistry,* which are used for a more accurate representation of conservative-reversible molecular structures, irreversible chemical reactions, and multi-valued biological systems, respectively.

Since this paper is devoted to molecular structures, which are notorious conservative and invariant under time reversal, I shall solely use *isochemistry.* Unless otherwise specified, the terms "hadronic chemistry" are referred in this paper to its isotopic branch.

In essence, isochemistry has permitted the construction of a new model of molecular structure, technically known under the name of ***isochemical model of molecular bonds.*** Its main feature is the assumption that *pairs of valence electrons from two different atoms couple themselves in a singlet quasi-particle state at short distances (of 1 fm or less as in Figure 1.3) called* ***isoelectronium,*** *which orbits around both nuclei in an oo-shaped orbit similar to that of planets in certain binary stars, as well as similar to the orbit of the electron in the hadronic structure model of the deuteron of Paper IV,* Figure 1.5.

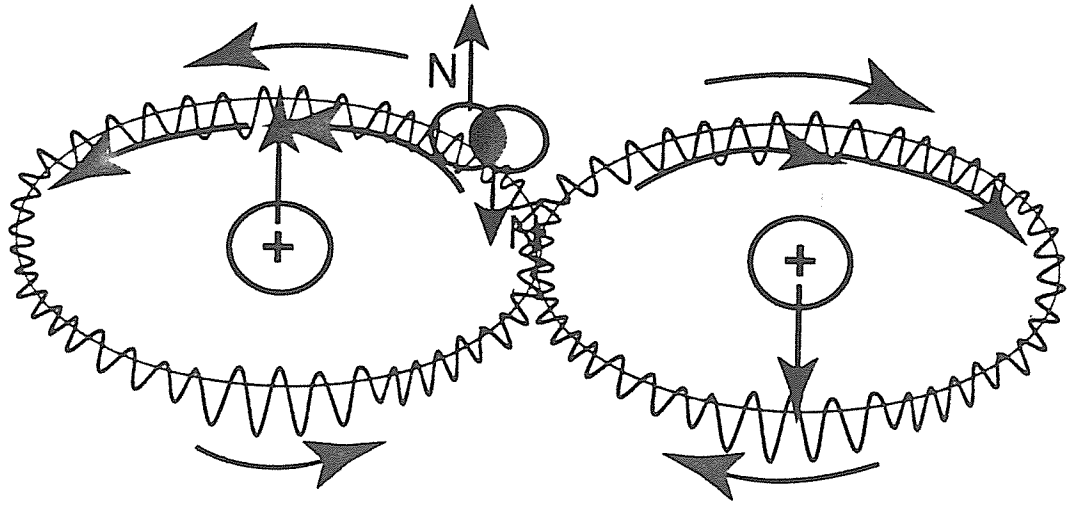


FIGURE 1.5. A schematic view of *Santilli-Shillady [6a] new isochemical model of molecular structure with a mostly stable isoelectronium,* here depicted for the case of the hydrogen molecule at absolute zero degree temperature and in the absence of rotations or other collective motions.The main assumption is that the two valence electrons, one per each atom, correlate themselves into a bonded singlet state (antiparallel spin) at distances of 1 fm or less, called isoelectronium, which describes a oo-shaped orbit around the respective two nuclei much similar to the orbit of a planet in certain binary star systems. The isoelectronium is then responsible for the *attractive force* between the two atoms. The *binding energy* is instead characterized by the oo-shaped orbit of the isoelectronium around the two nuclei conceptually represented in this figure via a standing wave for a particle of null spin and magnetic moment, mass $2m_e$, and charge $-2e$. Note that when rotations at ordinary temperatures are admitted, the model recovers the conventional space distribution of the hydrogen molecule, as experimentally established. The model also holds for generic dimers HO, HC, etc. The model is here depicted in terms *orbits* of the valence electrons (rather than of *quantum orbitals,* or *density distributions*), because orbits are the sole permitting rigorous calculations of stability. As a specific example, the law that the perimeter of the orbit must be an integer multiple of the wavelength of the particle (which is quite important for practical applications to new fuels and energies, *e.g.,* the study of the connection with Mills Blacklight [12]) has sense solely for *orbits as used in physics,* while the same stability calculations become meaningless for *orbitals*

or density distributions as used in chemistry. I should stress that the selection orbits does not exclude the description in terms of orbitals or density distributions, as familiar in the existing chemical literature. The main point here is to avoid the aprioristic selection of only one description, as rather universally done in contemporary chemistry.

It should be stressed that the above conception of molecules is strictly *prohibited* by quantum mechanics, because the forces dominating at large distance in this case are the *repulsive* Coulomb force between the valence electrons (see Section. 2.1 for the magnetic contribution at short distance). However, as we shall see in the next section, under a sufficient *trigger* (Papers III and IV), identical electrons in singlet coupling can be forced to move against their repulsive Coulomb force up to the penetration of the *hadronic horizon* (see also Papers III and IV), in which case the new, strongly attractive hadronic forces overcome the repulsive Coulomb forces, resulting in a stable bond.

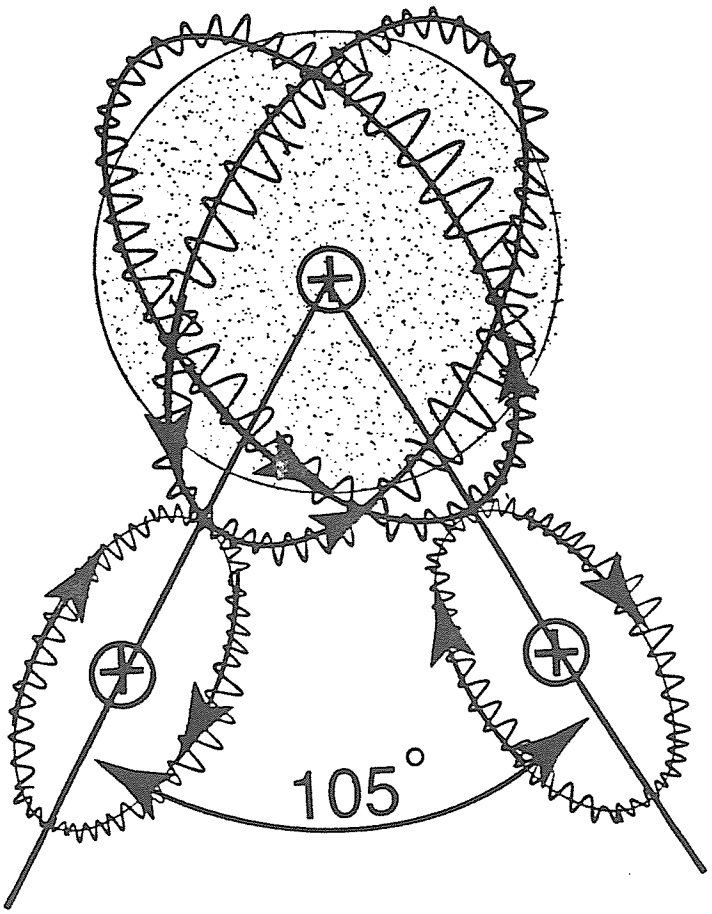


FIGURE 1.6: A schematic view of the *isochemical model of the water molecule,* first proposed in Ref. [5a] with two isoelectronia, one per each HO dimer, here presented at absolute zero degree temperature and in the absence of any rotational or other motions. As one can see, a visual inspection of the new model resolves some of the fundamental open problems of the current conception of the water molecule, such as the lack of a sufficiently strong bonding force, the inability to explain why the water molecule has only

two hydrogen atoms, and only one oxygen. Note again that when rotations at ordinary temperature are admitted, the model recovers the conventional "Mickey Mouse" shape of the water molecule [8]]. The model is also depicted in terms of *orbits* of the valence electrons as used in physics, rather than in terms of the *orbitals* used in chemistry, because the former is requested for a number of specific calculations that are impossible in the latter case. This selection does not exclude the description in terms of density distributions, as familiar in the existing chemical literature, provided that the latter is *in addition to that in terms of orbits.*

The main characteristics of the isoelectronium studied in great technical details in Refs. [6] can be summarized as follows:

$$\text{Charge: 0; spin 0; magnetic moment 0; rest energy 1.02 MeV;} \qquad (1.4)$$
$$\text{Radius } r_c = b^{-1} = 6.8432329 \times 10^{-11} \text{ cm} = 0.015424288 \text{ bohrs}.$$

A feature of the isoelectronium of particular significance for new energies (e.g., the use of charge clusters [11]) is that *the isoelectronium has an essentially null intrinsic magnetic moment* (in first nonrelativistic approximation, with non-null quadruple and higher moments). As we shall see, this feature is particular important, because electrons bonded into a magnetically neutral state are more controllable, and can perform tasks that would be extremely difficult to perform for the individual electrons. In this way, the reader can begin to have a hint of the importance of the new model of molecular structure for new fuels and energies.

The above new conception of molecular structure has permitted the resolution in Refs. [6] of all insufficiencies and inconsistencies of quantum chemistry outlined above. In fact:

1') Isochemistry introduces for the first time a new strong, attractive force between two valence electrons suitable to represent the strength of molecular bonds, In different terms, the new hadronic force between valence electrons is the equivalent, missing in quantum chemistry, of the strong force in nuclear structures.

2') Isochemistry explains for the first time why the hydrogen, water and other molecules have only two hydrogen atoms. Once two valence electrons are bonded into the singlet isoelectronium, they become a Boson and, as such, reject the bonding of any additional electron (which is a Fermion).

3') Isochemistry has permitted the first representation of molecular binding energies which is accurate to the seventh digit.

4') The above accurate representations occur under the exact validity of the basic axioms of isochemistry without ad hoc adulterations.

5') Since the representation of binding energies is accurate to the seventh digit, isochemistry permits, for the first time, accurate thermochemical calculations.

6') Isochemistry reduces computer usage at least 1,000 times. This is achieves via power series that converge much faster than those of quantum chemistry.

7') Isochemistry allows correlations solely among pairs of electrons at all levels of study.

8') Isochemistry has provided representations of electric and magnetic moments also accurate to several digits (and having the correct sign).

9') Isochemistry has resolved the inconsistent prediction by quantum chemistry that all molecules are ferromagnetic (Figures 1.8 and 1.9).

It should be indicated that Refs. [6] provided a quantitative study of both possibilities that the isoelectronium is *stable* or *unstable,* by leaving the resolution of these alternatives to the future

availability of additional theoretical and experimental evidence.

In particular, the *full stability* of the isoelectronium was reached under the *exact validity* of the axioms of isochemistry, which yields an attractive Hulten potential representing the strong bond between two valence electrons in the isoelectronium (see next section). By comparison, the case of *partial stability* of the isoelectronium was reached under an *approximation* of these basic principles, which yields an attractive, yet weaker force responsible for the isoelectronium (rather than the much stronger Hulten force). Partial stability is then a mere consequence of the weaker attractive force.

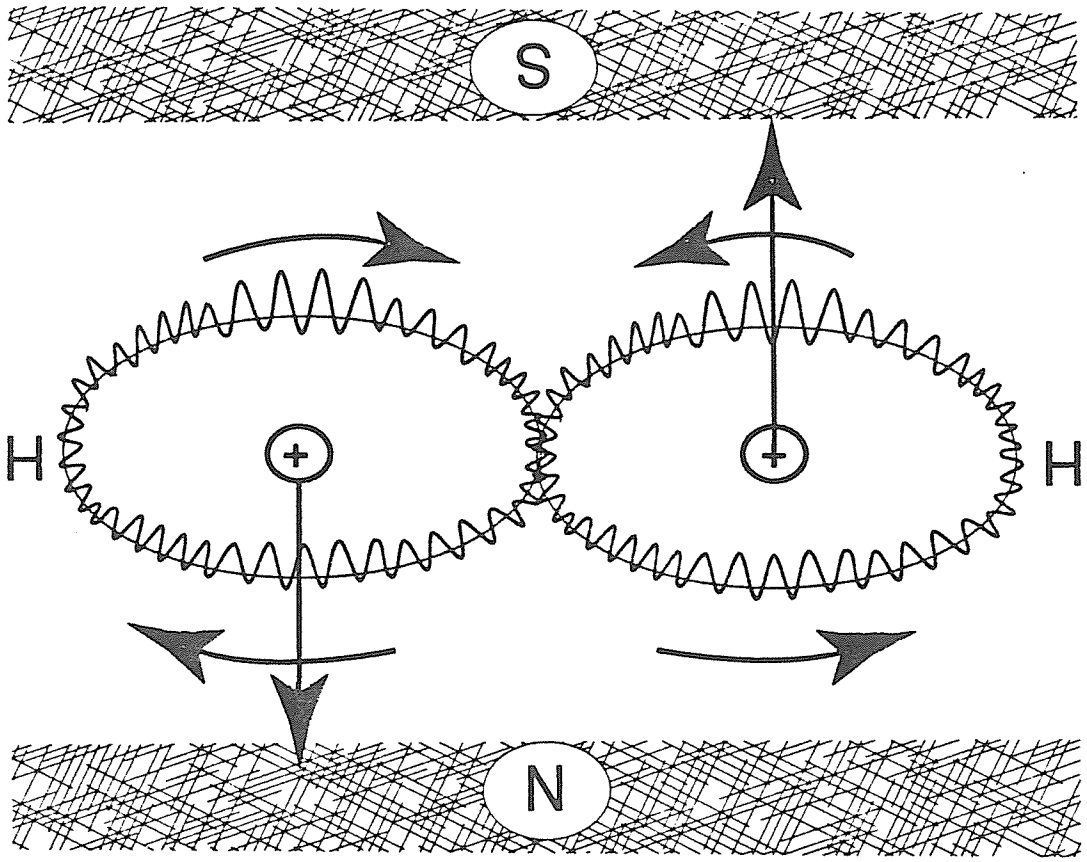


FIGURE 1.7: A schematic view of the resolution of the inconsistency of Figure 1.1 permitted by the novel isochemical model of molecular bonds [7], here illustrated for the case of the simplest possible hydrogen molecule at 0 K and in the absence of any motion. In the conventional quantum model the valence electrons preserve their individuality, thus implying the mandatory prediction of a total net magnetic polarity under an external magnetic field. For isochemistry the two valence electrons are no longer independent, but are bonded into the isoelectronium, which describes an oo-shaped orbits around the two nuclei with opposite rotational motion in the two o-branches. The impossibility of a total net magnetic polarity is then evident, and so is the resolution of the inconsistency of Figure 1.1. Note the necessity for the stability of the isoelectronium for the resolution of the inconsistency of admitting an arbitrary number of hydrogen atoms in the hydrogen and water molecules. Note finally the necessity for the oo-shaped orbit of the isoelectronium to resolve the inconsistency of the ferromagnetic character of all molecules, thanks to the opposite rotation in the two o-branches. In fact, other orbits, such as an elliptic orbit around the two nuclei, besides having insufficiencies for the stability of the molecule, would preserve in its entirety the inconsistency of the ferromagnetic prediction of quantum chemistry.

The new evidence presented in Ref. [7] favors the case of a *mostly stable isoelectronium*,

because it is necessary to resolve the inconsistency of Figures 1.1 and 1.2. In fact, if the bonding of valence electrons is only *partially stable*, this implies that all molecules should have a well-defined magnetic polarizability, whose value depends on the time percentage of said instability.

Suppose that the isoelectronium represents only the tendency of the valence electrons to couple themselves, as in Sect. 8 of Ref. II [6a], and suppose that their bonding only occurs for 10% of the time, thus having unpaired valence electrons for 90% of the time as in conventional quantum chemistry.

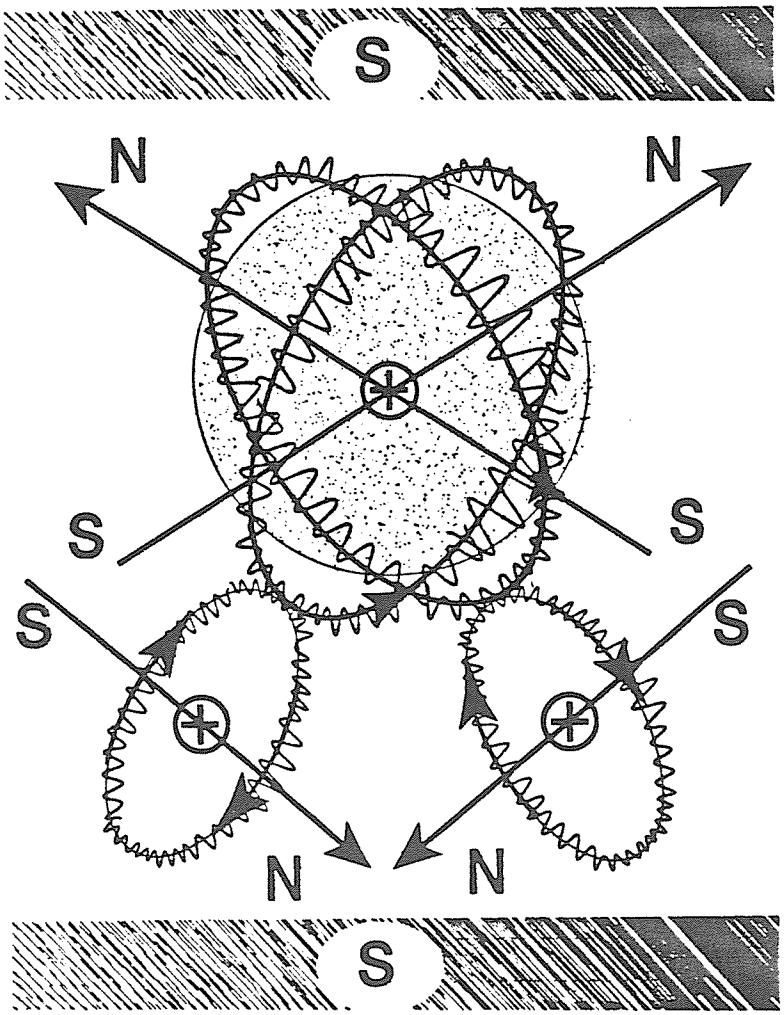


FIGURE 1.8: A schematic view, again at absolute zero degree temperature and in the absence of motion, of the resolution of the inconsistency of quantum chemistry of Figure 1.2, namely, the impossibility for the isochemical model of the water molecule to acquire a net magnetic polarity under an external magnetic field, first presented in Ref. [7]. Note that the resolution outlined in this figure is that for the worse possible configuration of the isochemical model, that with the same external polarity South-South. The resolutions of this figure and that of the preceding figure are at the foundation of the new chemical species introduced in Ref. [7].

It is evident that, under the latter assumptions, *all molecules must acquire a net magnetic polarity under an external magnetic field, thus being ferromagnetic,* although with smaller

numerical values as compared to the conventional model of molecular bonds.

The only way known to this author to resolve such a dramatic disagreement between the theory and the experimental data on the behavior of molecules under external magnetic fields, is the assumption of a mostly stable isoelectronium.

Due to the importance of the topic, interested scholars are encouraged to present alternative models with a proof of the impossibility for molecules to acquire a net magnetic polarity under a mostly unstable isoelectronium and/or correlations of valence electrons.

I should stress that the isoelectronium *cannot* be 100% stable and *small instabilities* must be assumed. This is due to the fact that isochemistry coincides with quantum chemistry at distances sufficiently bigger than 1 fm [5]. In particular, isochemistry preserves exchange, van der Waals and other forces of current use. In turn, the latter forces imply a small instability of the isoelectronium. The same small instability can be reached under relativistic and field theoretical treatments.

Throughout this analysis I shall therefore assume that *in the first nonrelativistic approximation of this paper, the isoelectronium is a stable singlet state with characteristics (1.4.1),* while small instabilities should be treated in future relativistic or field theoretical studies.

In this paper I cannot possibly review hadronic chemistry to avoid a prohibitive length. The reader should be aware that a technical understanding of the applications to new fuels and energies requires a technical knowledge of hadronic chemistry at least as presented in Refs. [6c,6d,6e].

Finally, in reading this paper, chemists should keep in mind that I am a theoretical physicist. Therefore, the terminology is that of physics rather than chemistry, although I have made an effort in trying to identify both terminologies whenever needed.

It should be kept in mind that the *foundations* of the new hadronic chemistry, of the new model of molecular structure outlined above, and of the new chemical species outlined in the next section are *purely physical,* thus rendering appropriate the use of physics terms. Chemistry and related terminology are expected to be appropriate in the study of the *chemical behavior* of the new hadronic structures, and other chemical aspects.

1.5. The New Chemical Species of Magnecules

The way according to which atoms can combine to form the various substances of our sensory perception, was scientifically established in the first of the last century, thanks to the work by Avogadro (1811), Canizzaro (1858), and several others [9], following the achievement of scientific measurements of atomic and molecular weights. These studies produced the contemporary notion of *molecules* and of its underlying *valence.*

Until 1997, molecules remained the *sole* known way according to which atoms can combine to form ordinary substances. The notion of valence has also remained the dominant mechanism for the bonding of atoms, although, with the passing of the decades, it was specialized into covalence, ionic valence, metallic valence, and others [8].

In 1998 R. M. Santilli [7a] discovered a basically new means for atoms and molecules to bond themselves into clusters that are stable at ordinary conditions, which he called *magnecules,* to denote the *magnetic* nature of their bonding force, and to distinguish them from molecules, which remain referred to the bonding of valance type.

Thanks to an invaluable backing by Toups Technology Licensing, the notion of magnecules received, also in 1998, numerous experimental verifications at independent analytic laboratories, which are outlined in Section 2. In this process, a new technology was established for the creation of magnecules which is today known as the *TTL technology of magnetically polarized gases,* reviewed in Section 3 (see Figure 1.9 for a preliminary view).

As will be shown, the new notion of magnecules and the technology for their production have a crucial relevance for new clean energies of Class III, as well as for new environmentally

acceptable fuels. To render this series self-sufficient, it is useful to review the main lines of reasoning.

In essence, the sole force fields in the atomic structure studied by chemists prior to Refs. [7] have been the *electric field of the individual peripheral electrons*, and the *intrinsic magnetic field of nuclei and electrons*. It was proved a century ago that these fields can only produce valence bonds, thus explaining the reason why the notion of molecules was the only one admitted for about two centuries.

Santilli's [7a] main discovery has been the identification of a *a new force field in the atomic structure*, which is generally stronger than the preceding ones, thus permitting a new chemical species.

Since the inception of atomic physics, electrons of an atomic structure have been assumed to have a spherical distribution around nuclei, as recalled earlier, which is indeed the case under ordinary conditions, as experimentally verified.

However, electrons are charged particles, and all charges rotating in a plane orbit create a magnetic field in the direction perpendicular to the orbital plane, generally assumed with the North polarity in the semi-space seeing a counter-clockwise rotation. Moreover, it is known that the distribution in space of electron orbits can be controlled via the use of magnetic fields.

Santilli's [loc. cit.] main hypothesis is that ***the spherical distribution at least of the valence electrons in the natural state of atoms can be controlled via suitable magnetic fields, and polarized in a plane, thus resulting in a basically novel magnetic field that does not exist in the natural state of the atoms (due to said space distribution of the orbits).***

Moreover, ***Santilli [loc. cit.] computed the magnetic field created by the polarized orbiting electron of the hydrogen atom and showed that its numerical value is 658.50 times bigger than that of the nucleus (the proton), while the magnetic moment of the polarized isoelectronium orbit in the hydrogen molecule is 1,316.33 times bigger than the intrinsic magnetic moment of the nucleus. Such a high value of the field was expected from the fact that the orbital speed of electrons approaches the speed of light, thus resulting in very strong magnetic fields.***

The calculations are elementary. By using rationalized units, the magnetic moment M of a polarized orbit of the isoelectronium with characteristics (1.4.1) is given by the general quantum mechanical law:

$$M_{isoel.} = \frac{q}{2\,m} L\,\mu\,, \tag{1.5.1}$$

where L is the angular momentum, μ is the rationalized unit of the magnetic moment, $q = -2e$, and $m = 2m_e$. By plotting the various numerical values for the ground state of the isoelectronium in the hydrogen atom, one obtains:

$$M_{isoel.} = 1{,}859590\,\mu\,. \tag{1.5.2}$$

By recalling that in the assumed units the proton has the magnetic moment 1. 4107 μ, we have the ratio (see Eq. (2.9), Ref. [sss], p. 813):

$$\frac{M_{Isoel.}}{M_{Proton}} = \frac{1{,}856.9590}{1.4107} = 1{,}316.3387\,. \tag{1.5.3}$$

An accurate independent verification of the above calculation was conducted in a Russia-Kazakhstan collaboration by M. G. Kucherenko and A. K. Aringazin [8a], who contained via various

different methods the numerical value (see Eq. (10), Ref. [8a], p. 900):

$$\frac{M_{Isoel.}}{M_{Proton}} = 1{,}315\,, \qquad (1.5.4)$$

thus confirming Santilli's most fundamental point, the existence of a field in the atomic structure which is numerically much bigger than other electric and magnetic fields.

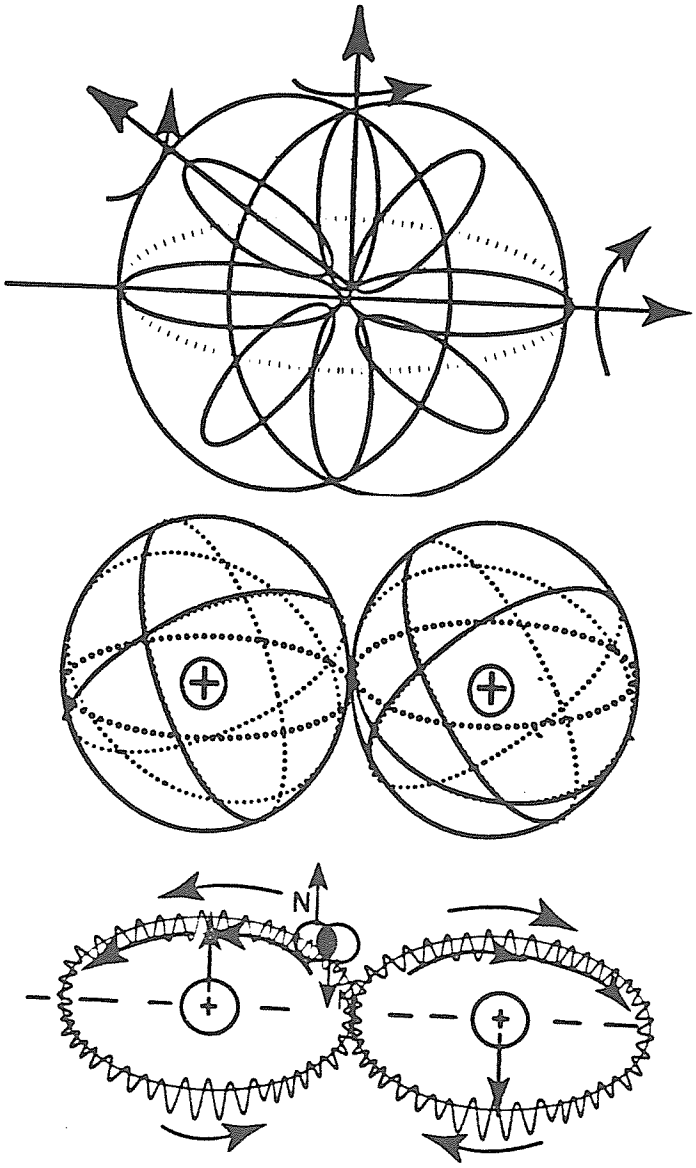


FIGURE 1.9: A schematic view of the basic lines of the *TTL technology of magnetically polarized gases* (Patent Pending) [1], the polarization in a plane of the orbits of valence electrons (cyclotron resonance orbits), here illustrated for the case of the hydrogen molecule. As it is well known, in its natural gas state at ordinary conditions of pressure and temperature, the hydrogen molecule is a sphere whose radius is equal to the diameter of a hydrogen atom (Case A). A main assumption of Ref. [7a] is the existence of a technology based on external magnetic fields which eliminates the rotational motions, by reaching first the configuration of Case B, and then that of Case C, in which the orbit of the isoelectronium is polarized in a plane. The emergence of two well defined magnetic moments is then evident. Note that I assume no new feature of the atomic structure, and merely use the manifestation of a feature which is intrinsic in the atomic structure itself.

Other possible origin for the bond of the new chemical species must be eliminatyed [7] via known arguments. For instance, the intrinsic magnetic moments of nuclei cannot possibly originate a molecular bond, first of all, because other fields are too weak, and, second, because they are too far from each other on atomic scale. Similarly, the *electric polarization* of atoms (*i.e.*, their deformation in such a way to offer the dominance of one charge in one side, and the other charge in the opposite side) cannot form a *stable* molecular bond, because of the known instability of the electric polarization itself.

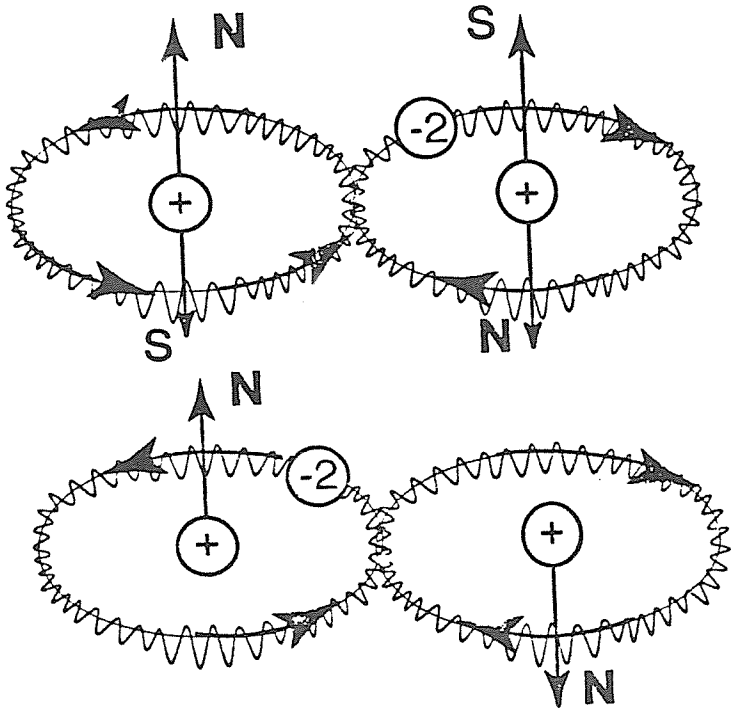


FIGURE 1.10: A schematic view of *Santilli's elementary hydrogen magnecule*, $(H\uparrow - H\downarrow)\times(H\uparrow - H\downarrow)$, first submitted in Ref. [7a], here assumed to be formed at absolute zero degree temperature, and in the absence of all collective motions. Note that the hydrogen molecule has no infrared signature. Thus, the magnecule of this figure is predicted to have no infrared signature at all. This elementary magnecule is therefore an exception to the general rule according to which all molecules have an infrared signature. By comparison, all magnecules have no infrared signature (because their bond is not of valence type), although they exhibit the infrared signature of the constituent molecules. For instance, magnecule (1.5.9) has no overall infrared signature, although it does admit the infrared signature of its C–O constituent.

Note finally that magnecules do not require the "creation" of a new force field, but only the "manifestation" of a field which already exist within all atoms, and is not manifest due to the spherical distribution of the electrons.

By denoting the conventional valence bond with the symbol " – " and the new magnetic bond with "× ", examples of *elementary magnecules* in gases and liquids are respectively given by (see next section for details and measurements):

$$\{H - H\}\times\{H - H\}, \{O - O\}\times\{O - C - O\}, \text{etc.}, \tag{1.5.5a}$$

$$\{C_{15} - H_{20} - O \times \{C_{15} - H_{20} - O\}, \text{ etc.}; \tag{1.5.5b}$$

examples of large magnecules with the same constituent (called *magneplexes* [7a]) in gases and liquids are respectively given by:

$$\{H-H\}\times\{H-H\}\times\{H-H\}\times\ldots\ , \text{etc.}, \tag{1.5.6a}$$

$$\{H-O-H\}\times\{H-O-H\}\times\ldots, \text{etc.}, \tag{1.5.6b}$$

and examples of large magnecules with different constituents (called *magneclusters*) are given by:

$$\{H-H\}\times\{C-O\}\times\{O\}\times\{O-C-O\}\times\{C\}\times\ldots, \text{etc.}, \tag{1.5.7a}$$

$$\{C_{13}-H_{18}-O\}\times\{C_{14}-H_{12}-O_3\}\times\{C_{15}-H_{20}-O\}\times\ldots, \text{etc.}, \tag{1.5.7b}$$

By denoting with the arrow $\uparrow$ the magnetic polarity North-South and with the arrow $\downarrow$ the polarity South-North, a main assumption of Ref. [7a] is that the hydrogen molecule H-H can be polarized into such a form that the orbit of the isoelectronium is in a plane with resulting structure $H_\uparrow$-$H_\downarrow$ (Figure 1.5). Under this assumption, the elementary hydrogen magnecule has the structure (see Figure 1.10)

$$\{H_\uparrow^a-H_\downarrow^b\}\times\{H_\uparrow^c-H_\downarrow^d\}, \tag{1.5.8}$$

where: a, b, c, d, are symbols denoting different atoms; the polarized hydrogen atom $H_\uparrow^a$ is bonded magnetically to the polarized atom $H_\uparrow^b$ with the South magnetic pole of atom a is bonded to the North pole of atom b; and the North polarity of atom c is bonded to the south polarity of atom d. This results in a strong bond due to the (approximately) flat nature of the atoms, the corresponding mutual distance being very small and the magnetic force being consequently being large. Once formed, magnecule (1.5.8) admits rotations, vibrations, and all conventional motions due to temperature, as in ordinary molecule.

Note that magnecule (1.5.8) has a molecular weight very closed, but not identical to, that of the helium. Thus, magnecules (1.5.8) and the helium can be distinguished by sufficiently sensitive Gas Chromatographic Mass Spectrographic equipment (GC-MS). Moreover, the hydrogen has no infrared (IR) signature, and, therefore, magnecule (1.5.8) has no IR signature, while the helium has a well defined IR signature. Therefore, a *mandatory* condition to separate "experimental beliefs" from real "experimental measurements" is that the GC-MS is equipped with InfraRed Detectors (IRD). In fact, the use of an insufficiently density GC-MS which is not equipped with IRD may result in the "experimental belief" that structure (1.5.8) is helium.

Because of the above reasons, magnecule (1.5.8) may have been detected several times in mass spectrometric measurements, but believed to be helium. This case suggests that spectrometric studies of the new species should *not* be conducted unless the mass spectrometer (MS) is equipped with an infrared detector for gases or ultraviolet detector for liquids.

Note also that *nuclear* magnetic fields can provide an *attractive* contribution to the magnecule bond, due to the proximity to each other in structure (1.5.8), of course, under the *same* orientation of said nuclear magnetic moments, which implies *opposite*, thus attractive, interlocking polarities.

A structure similar to (1.5.8) then holds for the remaining magnecules. For examples, another elementary gas magnecule is characterized by the polarizations (see, again, next section for details):

$$\{H_\uparrow-H_\downarrow\}\times\{C_\uparrow-O_\downarrow\}; \tag{1.5.9}$$

and a generic gas magnecluster has the structure (see Figure 1.11):

$$\{H_\uparrow-H_\downarrow\}\times H_\uparrow\times\{C_\uparrow-O_\downarrow\}\times O_{\uparrow\uparrow}\times\{H_\uparrow-O_\downarrow-H\}\times\{H_\uparrow-C_\downarrow-A-B-C\ldots\}\times\ldots \tag{1.5.10}$$

where A, B, C, are generic atoms in a conventional molecular chain, and the atoms without an indicated magnetic polarity may indeed be polarized but are not necessarily bonded because of said geometric distribution in space.

Note *the presence in magnecules (1.5.10) of individual atoms without valence coupling, which has been experimentally verified (see next section), and is admitted particularly when said individual atoms are trapped inside large magnecules.*

In summary, some of the main features of magnecules are the following [7]:

1) Molecules have a well defined molecular weight, while magnecules have an undefined molecular weight, depending on the atoms and molecules locally available with the needed magnetic polarizations;

2) Molecules show in mass spectroscopy as peaks which can be fully identified by the computer via its search in the memory banks of existing molecules, while magnecules show under mass spectroscopy as peaks which often remains "unidentified";

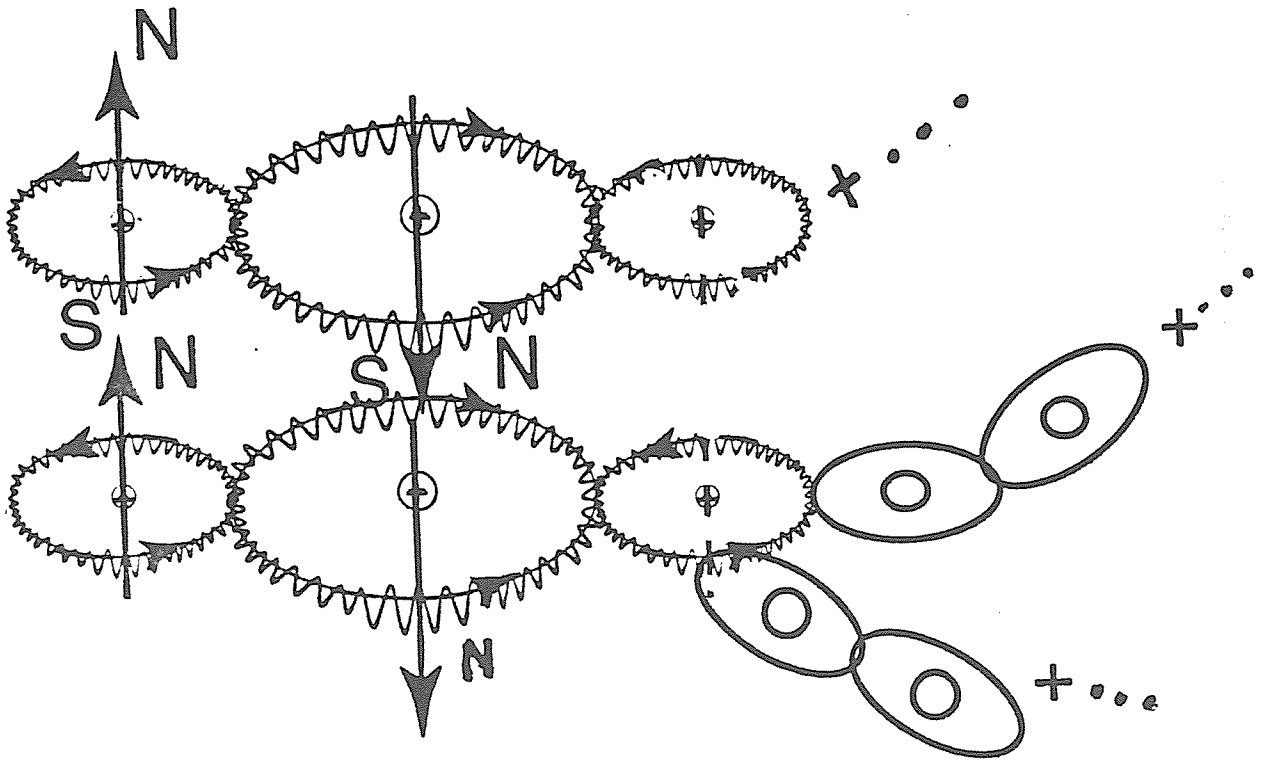


FIGURE 1.11: A schematic view of a generic magnecule (a magnecluster according to Definition 2.1) with constituent molecules in which only two dimers are magnetically bonded, while the remaining atoms of the molecules are not bonded due to their space geometry or other reasons.

3) All molecules have a well-defined, infrared (ultraviolet) signature for gases (liquids) which is characteristic of the valence bond, while magnecules have no infrared (or ultraviolet) signature at all, the only signature being those of the *conventional molecular constituents* of the magnecule considered;

4) Substances made up of given molecules have known physical and chemical characteristics (such as viscosity, adhesion, specific density, molecular weight, etc.), while the creation of magnecules in the same substance with the same molecular constituents generally alters all physical

and chemical characteristics;

5) Molecules preserve their characteristics with the increase of the temperature to values initiating their ionization or the creation of plasma, while magnecules cease to exist at a temperature which is characteristic of all magnetic phenomena, and which is generally different for different magnecules, called the *magnecule Curie point.*\

In view of the above occurrence, ***the sole scientific experimental measurements which should be conducted on magnecules are, in the case of gases, those with Gas Chromatographic, Mass Spectrographic equipped with Infrared Detectors (GS-MS/IRD), and, in the case of liquid, those with liquid, those with Liquid Chromatographic, Mass Spectrographic equipped with Ultraviolet Detectors (LC-MS/UVD). Lacking the IRD or the UVD, no measurements on magnecule should be considered as scientific, or otherwise final.***

2. EXPERIMENTAL VERIFICATION OF HADRONIC MECHANICS IN SUPERCONDUCTIVITY AND CHEMISTRY

2.1. Conceptual Foundations of Electron Bonding and Clustering

Since no appreciable contribution can be made by the atomic nuclei due to the large mutual distances, the fundamental phenomenon permitting the existence of substances is the *bonding of peripheral valence electrons.* Note the use of the term "bonding", rather than the term "correlation" of current use in chemistry [9], because the former term represents the strength of the actual bond in molecular structure as it exists in nature, while the latter term has been shown to imply substances that would crumble into atoms under minimal disturbance.

The capability of electrons to bond to each other despite their repulsive Coulomb force has been experimentally established in a variety of fields, such as:

1) Photodisintegration experiments have established that the two electrons of the helium atom in their ground state *do not* orbit as separate entities, but are actually bonded to each other, because expelled in such a state under photodisintegration [13], although the percentage of time spent in the bonded state is unknown.

2) Molecular structures are created by the bonding of valence electrons to each other.

3) Superconductivity is based on the Cooper pair [14], which is also a bonding of two electrons so strong, that the pair has been detected to tunnel together through a potential barrier.

4) The capability of electrons to aggregate themselves into clusters has also been experimentally established, and it is an important phenomenon for new energies [11].

5) The visual observation of ball lightning finally establishes the capability of electrons to aggregate themselves in very large numbers into small regions of spaces.

Hadronic mechanics, superconductivity, and chemistry have been built to provide the first known quantitative representation of the above diversified experimental evidence, identify the background physical laws, and use the acquired knowledge for specific applications to new energies and fuels.

In fact, the first hadronic bonding of charged particles was submitted in Section 5 of the original proposal [3a]. The bonding was then extended to the Cooper pair in Refs. [5], and applied to the valence bond in Refs. [6]. In this section we provide, first, a conceptual outline of these results, and their their quantitative theoretical representation. Experimental verifications are reviewed in the subsequent sections.

The first physical law governing the bonding of electrons is *Pauli's exclusion principle,* according to which particles with spin 1/2 are admitted in the same energy state if and only if the coupling is in singlet (antiparallel spin).

I have found considerable personal inspiration in an empirical verification of this principle via

the "gear model" of Ref. [3a] reproduced in Figure IV-8 (which I conducted with gears and shafts from a lego set). This is a test everybody can repeat by trowing against each other two spinning tops, the first case with spin parallel and the second throwing with spin antiparallel. It is easy to see that, when with parallel spin, the two gears instantly repel each other at contact. This experiment confirms the impossibility for spinning particles to bond to each other with parallel spin (evidently because it would require gear teeth moving against each other). On the contrary, if the two spinning gears hit each other with spin antiparallel at the correct spin rotation, one can visually see their tendency to attract each other.

The first consequence of Pauli's exclusion principle is that *electrons can initiate their bond to each other only in pairs*, a property that is also experimentally verified in chemistry [9,10]. In fact, it is easy to see with the empirical "gear model" that *three spinning gears cannot be bonded together* (see, again, Figure IV-8).

Once two electrons are bonded to each other in singlet, their physical and chemical characteristics change dramatically. In fact, electrons are Fermions with spin 1/2, charge -e, magnetic moment μ, and mass m_e. Once coupled in singlet, they change into a Boson with spin zero, charge -2e, null magnetic moment, and mass (approximately) $2m_e$. It then follows, again, that *it is not possible to bond a third electron to two bonded electrons at large distances* (for the particle world), evidently because of different statistical species (one is a Fermion and the other is a Boson). In fact, no particle with charge -3e has been detected in nature.

The first prediction of hadronic mechanics is therefore that *the accretion of electrons into clusters can only occur in pairs.* In fact, different pairs of electrons can indeed bond to each other by following the same laws of the initial bonding. As a matter of fact, *the bonding of two pairs of coupled electrons is easier than the initial coupling of two electrons*, evidently because the bonded electrons pairs have no spin and no magnetic moment, thus admitting a number of coupled configurations much greater than the single possibility for coupling two electrons.

As we shall see, once the accretion of electrons has initiated in coupled pairs, upon reaching a certain threshold, individual electrons are indeed permitted within the medium of electron pairs, because of the phenomenon of *mutation*, proposed in the original Ref. [3a], and outlined in Paper III for the structure of the neutron and the mesons.

In nontechnical terms, in the transition from motion in vacuum to motion within any particle medium (thus including the medium within electron clusters), the electrons experience a mutation defined as an *alteration of its intrinsic characteristics.* The mutation most important for the study of electron clusters is that of the *total* angular momentum, which can become null, precisely as it occurs for the structure of the neutron or of the charged pions studied in Paper III.

Once the total spin is mutated, the restriction to sole coupling by pairs, as imposed by Pauli's exclusion principle, ceases to be applicable. At that point, the accretion of electrons in clusters can proceed all the way to ball lightning, which include up to 10^{20} electrons within a few cubic centimeters.

A primary scope of hadronic mechanics, hadronic superconductivity, and hadronic chemistry outlined below is to formulate the first known consistent, and invariant representation of the above sequence of electron bonding, that is, a mathematical representation of the bonding, capable of predicting numbers, which can be verified with experiments.

The most rigorous formulation of the theory of electron bonding is provided by the central method of relativistic hadronic mechanics, its fundamental spacetime symmetry known as the *Poincaré-Santilli isosymmetry* [15]. The rigorous definition of "particles" in quantum mechanics is that via the unitary irreducible representations of the Poincaré symmetry. But quantum mechanics, and related Poincaré symmetry, are unable to represent the bonding of electrons, as shown before. The only known, consistent and invariant representation is that via the Poincaré-Santilli isosymmetry.

The Poincaré-Santilli isosymmetry is particularly suited for the indicated objectives, because it holds at distances of the order of 1 fm, provides a direct representation of the new bonding forces as needed to overcome the repulsive Coulomb force, and characterizes mutated particles precisely as needed for electron accretions by clusters.

To avoid confusion, the mutated states characterized by the Poincaré–Santilli isosymmetry are called *isoparticles*. The mutated electrons characterized by the same isosymmetry are called *isoelectrons*. Two electrons bonded in singlet coupling at short distances are then called *isoelectronium* to indicate that they are characterized by the Poincaré–Santilli isosymmetry.

Regrettably, the theory of electron bonding via the Poincaré–Santilli isosymmetry cannot be presented in this section, because advanced on technical grounds as compared to the limited technical level of this presentation. I shall, therefore, limit myself to the presentation of the underlying nonrelativistic hadronic treatment, since the latter is amply sufficient for experimental verifications. More advanced relativistic treatments then follows via mere compatibility arguments.

The rules for the construction of the theory are known since Paper II, and they consist in submitting the conventional quantum mechanical theory of electron pairs to a *nonunitary transform*, and then adding the *trigger* (Papers III, and IV), namely, the external field forcing the electron to move toward each other against the repulsive Coulomb force.

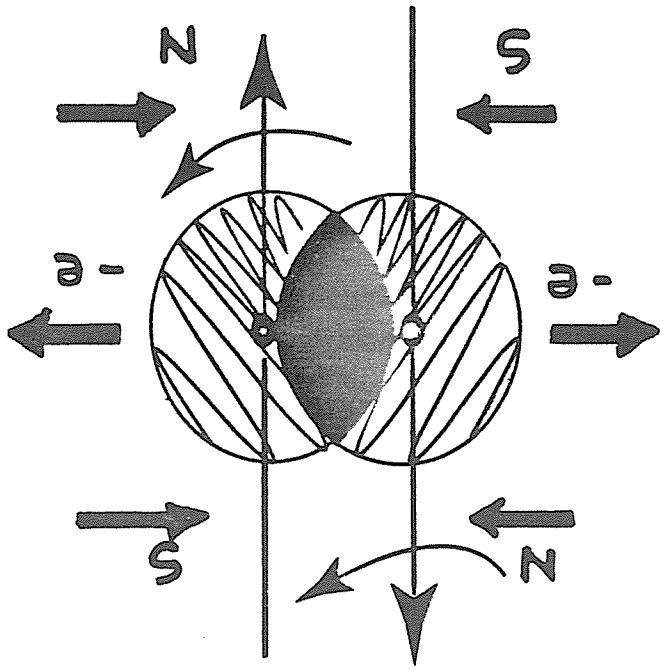


FIGURE 2.1. A schematic view of the mechanism at the foundation of the singlet bonding of an electron pair, the double magnetic attraction which overcomes the electric repulsion at sufficiently short distances. At the same time, these potential forces tend to diverge with the decrease of the mutual distance r, to become singularities at r = 0, in which case no meaningful numerical description is possible. Hadronic mechanics has been constructed to achieve a quantitative representation of the above mechanics predicting *finite* numbers *without* the singularities necessary in any quantum mechanical description.

It was discovered in Ref. [5a] that the trigger for the Cooper pair is provided by the *attraction* exercised on the electron by the *Cuprate nuclei*. It was then proved in Refs. [7] that the trigger for the bonding of valence electrons in molecules is constituted by the atomic nuclei. In fact, nuclei are *positively charged*, thus providing a natural *attraction* of the *negatively charged* electrons. When the electrons are free from orbital constraints, the above configuration implies attractions due to nuclei much stronger than the Coulomb repulsion (because nuclei have a multiple of the electron

charge), thus permitting motion of electrons against the Coulomb repulsion and the penetration in the hadronic horizon.

The physical origin of the hadronic attraction between identical electrons also deserves a few comments, because important for applications to new energies and fuels. As well known, the electron has a negative charge -e, *as well as* a intrinsic magnetic moment μ. When coupled in singlet, we do have the *repulsive Coulomb force,* but we also have the *double attractive magnetic attractions,* because the two magnetic polarities are inversed in singlet coupling, resulting in the two separate attractions North-South and South-North (Figure 2.1).

When the two electron approach themselves at very close distances, electric and magnetic forces tend to diverge, and actually reach infinite values at r = 0 (because the forces depend on $1/r^2$). Under such divergent values, no scientific treatment is possible. This occurrence is another limitation of quantum mechanics at small distance, because there exist no infinities in the physical reality.

Hadronic mechanics and the Poincaré-Santilli isosymmetry have been constructed to resolve the indicated singularities, and permit a scientific treatment in the sense indicated earlier.

Nevertheless, researchers in new energies and fuels should always keep in mind the physical mechanism represented by mathematical formulations. *The hadronic treatment of electron bonding is essentially a mathematical formulation without infinities of the fact that the double magnetic attractions between pairs of electrons in singlet coupling overcome the Coulomb repulsion at sufficiently short distances.*

2.2. Basic Equations for Electron Bonding and Clustering

We are now equipped to outline the nonrelativistic hadronic representation of electron bonding, as originally proposed in Ref. [3a], and then in Refs. [5,6]. Consider the nonrelativistic quantum mechanical equation of two ordinary electrons in singlet coupling:

$$H \times \psi(r) = \left(\frac{1}{m} p \times p + \frac{e^2}{r}\right) \times \psi(r) = E \times \psi(r) . \qquad (2.2.1)$$

where: m is the reduced mass; $\times$ is the conventional associative product of matrices; $\uparrow$ and $\downarrow$ represent the spin orientation

To transforms this quantum state into the hadronic isoelectronium, we need first to submit Eq. (2.2.1) to a nonunitary transform:

$$U \times U^\dagger = \hat{1} = 1 / \hat{T} \neq I , \quad \hat{T} = (U \times U^\dagger)^{-1}, \qquad (2.2.2a)$$

$$U \times H \times \psi(r) = (U \times H \times U^\dagger) \times (U \times U^\dagger)^{-1} \times U \times \psi(r) = \hat{H} \times \hat{T} \times \hat{\psi}(r) = \qquad (2.1.2b)$$

$$= \left(\frac{1}{m} \hat{p} \times \hat{T} \times \hat{p} + \frac{e^2}{r}\right) \times \hat{T} \times \hat{\psi}(r) = E_o \times \hat{\psi}(r) , \qquad (2.1.2c)$$

$$U \times p_k \times \psi(r) = \hat{p} \hat{\times} \hat{\psi}(r) = -i \times \hat{T} \times \hat{\nabla} \hat{\psi}(r) , \qquad (2.1.2d)$$

$$\hat{H} = U \times H \times U^\dagger , \quad \hat{\psi} = U \times \psi , \qquad (2.2.2e).$$

Eq. (2.2.2c) still represents *repulsion.* To achieve attraction we have to add the *trigger.* For the case of electron bonding in molecules, the trigger is caused by nuclei [5,6]. Therefore, we must add to Eq. (2.2.2c) the force exercised on electrons by nuclei. However, these forces are long range and, therefore, they verify conventional *quantum* equations. Assuming a nucleus with generic

charge +ze we reach in this way, the *iso-Schrödinger equations for the isoelectronium* is given by:

$$(\frac{1}{m}\hat{p}_k \times \hat{T} \times \hat{p}^k \times \hat{T} + \frac{e^2}{r} \times \hat{T} - \frac{ze^2}{r}\frac{\psi(r)}{\hat{\psi}(r)}) \times \hat{\psi}(r) = E \times \hat{\psi}(r) , \tag{2.2.3a}$$

$$U \times p_k \times \psi(r) = \hat{p} \hat{\times} \hat{\psi}(r) = -i \times \hat{T} \times \nabla \hat{\psi}(r) , \tag{2.2.3b}$$

The angular component of model (2.2.3) is conventional and it is hereon ignored (see [3c] for details). For the radial component $r = |\mathbf{r}|$, we assume the isounit [3,5,6]:

$$U \times U^\dagger = \hat{1} = e^{N \times \psi / \hat{\psi}} \approx 1 + N \times \psi/\hat{\psi}, \qquad N = \int dr^3 \hat{\psi}^\dagger(r)_{1\downarrow} \times \hat{\psi}(r)_{2\uparrow} . \tag{2.124a}$$

$$\hat{T} \approx 1 - N \times \psi / \hat{\psi} . \tag{2.2.4b}$$

where the volume integral $N = \int dr^3 \hat{\psi}^\dagger(r)_{1\downarrow} \times \hat{\psi}(r)_{2\uparrow}$. can be assumed to be constant for a stable bond.

Note that the explicit form of ψ is of Coulomb type, thus behaving like $A \times \exp(-b \times r)$ [9], with A approximately constant at distances near the hadronic horizon of radius $r_c = 1/b$, while $\hat{\psi}$ behaves like $B \times (1 - \exp(-b \times r)/r$ [3a], with B being also approximately constant under the same range. We then have:

$$\hat{T} \approx 1 - V^{Hulten} \times r = 1 - V_o \frac{e^{-b \times r}}{(1 - e^{-b \times r}) / r} . \tag{2.2.5}$$

Therefore, we can write:

$$\frac{e^2}{r} \times \hat{T} + \frac{ze^2}{r}\frac{\psi(r)}{\hat{\psi}(r)} = \frac{e^2}{r} + V_o \frac{e^{-b \times r}}{1 - e^{-b \times r}} . \tag{2.2.6}$$

But the Hulten potential behaves at small distances as the Coulomb one:

$$V^{Hulten}_{r \approx 1/b} \approx \frac{V_o}{b} \times \frac{1}{r} . \tag{2.2.7}$$

As a result, inside the hadronic horizon we can ignore the repulsive Coulomb force altogether and write:

$$\frac{e^2}{r} \times \hat{T} + \frac{ze^2}{r}\frac{\psi(r)}{\hat{\psi}(r)} \approx + V \frac{e^{-b \times r}}{1 - e^{-b \times r}} \tag{2.2.8}$$

$$V = e^2 [1 + (z + 1) A / B \times b] , \tag{2.2.8b}$$

by, therefore, resulting in the desired overall *attractive* force among the identical electrons inside the hadronic horizon, as desired. Note the crucial role played by the trigger for this result.

Model (2.2.3) can now be written [3a] (see also Paper I):

$$(\frac{1}{m}\hat{p}_k \times \hat{T} \times \hat{p}^k \times \hat{T} + V \frac{e^{-b \times r}}{1 - e^{-b \times r}}) \times \hat{\psi}(r) = E \times \hat{\psi}(r) , \tag{2.2.9a}$$

$$m \qquad\qquad 1 - e^{\quad}$$

$$\hat{p} \hat{\times} \hat{\psi}(r) = -i \times \hat{T} \times \nabla \hat{\psi}(r), \tag{2.2.9b}$$

$$\tau = \hbar / 4 \times \pi \times \lambda^2 |\hat{\psi}(0)| \times \alpha \times E^{Kin}_{e} \tag{2.2.9c}$$

$$R = 1 / b = \text{charge radius}, \tag{2.2.9d}$$

where we have added a nonrelativistic expression for the meanlife

The summation in the iso-Laplacian is computed in iso-Euclidean space:

$$\hat{p}_k \times \hat{T} \times \hat{p}^k \times \hat{T} \times \hat{\psi} = \delta(r, p, ...)^{ij} \times \hat{p}_i \times \hat{T} \times \hat{p}_j \times \hat{T} \times \hat{\psi} \tag{2.2.10}$$

After substitution of the isolinear momentum, Eq. (2.2.3b), and averaging the isoeuclidean contribution via a constant ρ (which is again admitted because the state considered is stable), we reach the radial equation now familiar from Papers III and IV:

$$[\frac{1}{r^2}(\frac{d}{dr} r^2 \frac{d}{dr}) + \frac{m}{\rho^2 \times \hbar^2}(E_o + V \times \frac{e^{-b \times r}}{1 - e^{-b \times r}})] \times \hat{\psi}(r) = E_o \times \hat{\psi}(r), \tag{2.2.11}$$

whose exact solution and related boundary conditions were first studied in detail in Ref. [3a], Section 5, and remain fully applicable to the isoelectronium.

The resulting spectrum is the typical one of the Hulten well:

$$|E_o| = \frac{\rho^2 \times \hbar^2 \times b^2}{4 \times \hat{m}} (\frac{\hat{m} \times V}{\rho^2 \times \hbar^2 \times b^2} \times \frac{1}{n} - n)^2, \tag{2.2.12}$$

A numerical solution can be reached by introducing the parametrization as in Ref. [3a], Sect. 5:

$$k_1 = 1 / \lambda \times b, \quad k_2 = m \times V / \rho^2 \times \hbar^2 \times b^2, \tag{2.2.13}$$

and by assuming that V is of the order of magnitude of the total energy of the isoelectrons at rest as in the preceding models of Papers III and IV:

$$V \approx 2 \times \hbar \times \omega \approx 2 \times 0.5 \text{ MeV} = 1 \text{ MeV}, \tag{2.2.14}$$

We note again that, from the boundary conditions [3a], k_2 must be bigger than but close to 1, while $m \times V / \rho^2 \times \hbar^2 \times b^2 = 1$, and $\rho \approx 1$. It is important to see that, at this nonrelativistic approximation, *the binding energy of the isoelectronium is not only unique, but it is also close to zero.* In fact, since $k_2 \approx 1$, we have:

$$|E_o| = \frac{\rho^2 \times \hbar^2 \times b^2}{4 \times m} (\frac{m \times V}{\rho^2 \times \hbar^2 \times b^2} - 1)^2 = \frac{V}{4 \times k_2} \times (k_2 - 1)^2 \approx 0. \tag{2.2.15}$$

The notion of *a bound state with only one allowed energy level,* called "hadronic suppression of the atomic spectrum" ([3a] and Paper III) is foreign to quantum mechanics and chemistry, although it is of great importance for new energies and fuels. The occurrence is due to the fact that any excitation of the state, whether the π^o, the Cooper pair, or the valence bond, causes the constituents to exit the hadronic horizon, by therefore re-acquiring the typical atomic spectrum.

Therefore, all electron bound states at short distance are predicted to have only *one* stable hadronic state, plus the conventional, discrete or continuous quantum spectra at distances bigger than 1 fm.

The additional notion of *a bound state with null binding energy* is also foreign to quantum mechanics and chemistry, although it is another peculiar characteristic of hadronic mechanics and isochemistry with important consequences for new energies and fuels. This additional occurrence is due to the fact that *the hadronic interactions admit no potential energy by central assumption*, as typical for ordinary contact-resistive forces of our macroscopic Newtonian reality. As such, again in first nonrelativistic approximation, hadronic bound states of electrons do not admit appreciable binding energy.

It should be indicated that, at a deeper level of study, a binding energy does indeed occur because of the presence of *forces derivable from a potential* discussed earlier. However, the latter contributions are of second order (see the case of the neutron structure in Paper III). As such, they can again be ignored in first approximation.

Another important general feature of hadronic bonding of electron pairs is the stability of the resulting state. Since $k_2 \approx 1$ from boundary conditions [3a], the *meanlife of the isoelectronium tends to infinity* which can be written from Eq. (2.2.9d) [3a]:

$$\tau = \hbar / 4 \times \pi \times \lambda^2 \, | \hat{\psi}(0) | \times \alpha \times E^{Kin}_{e} = 7.16 \times 10^4 \times \frac{k_1}{(k_2 - 1)^3 \times b \times c_o} \rightarrow \infty . \qquad (2.2.16)$$

It should be stressed that the above result is only valid in first nonrelativistic approximation, because, as recalled in Section 1.4, the isoelectronium *cannot* be a perfectly stable state when studied at deeper relativistic levels, due to exchanges, and other effects. Also, explicit studies have established that the meanlife of the isoelectronium depends on the mutual distances as well as from local conditions.

Another important property resulting from the small value of the hadronic horizon is that *the isoelectronium is sufficiently small in size to be treated as a single quasi-particle*. This property permits rather important simplifications in superconductivity, molecular structures, and clustering, with significant applications to new energies and fuels.

The main physical idea of isounit (2.1.4) is the *representation of the overlapping of the wavepackets of the two electrons under the condition of recovering conventional quantum chemistry identically whenever such overlapping is no longer appreciable*. For sufficiently large relative distances, the volume integral of isounit (2.1.4) is null, the exponential reduces to 1, the nonunitary transform becomes unitary, and quantum chemistry is recovered identically.

It is also important to see that, under transform (2.2.4), model (2.1.1) is implemented with interactions which are: *nonlinear*, due to the factor $\psi/\hat{\psi}$ in the exponent; *nonlocal*, because of the volume integral in Eq. (2.2.4); and *nonpotential* , because not representable via a Hamiltonian. Note the fundamental novelty which uniquely characterizes hadronic mechanics, whereby, even though a Hamiltonian does not exist, *the generalization of the unit does represent bona-fide interactions*.

We finally note that the explicit form of the isotopic element $\hat{T}$, Eq. (2.2.4b), emerges in a rather natural way as being *smaller than one* in absolute value, $| \hat{T} | \ll 1$. This property is particularly important for calculations and practical applications, because it implies *a large increase of the convergence of perturbative series, as well as the capability to turn conventionally divergent series into isotopically convergent forms* (Paper II). This is the property which has permitted isochemistry to decrease computer usage by at least a factor of 1,000 [6]. This isotopic elimination of conventional divergences is also the mathematical mechanism that eliminates the divergencies inherent in the electric and magnetic forces acting between electron pairs at short distances.

We are now equipped to confront the above hadronic theory of electron bonding with experimental evidence.

2.3. Experimental Verifications in Superconductivity.

As well known [14], quantum mechanics has attempted the representation of the attraction between the electrons of the Cooper pair in superconductivity by conjecturing the existence of a new particle called "phonon" which interact with the electrons, thus creating a new force. Even though of undeniable value, the assumption has been the subject of severe criticisms. By their very definition (and from the Greek meaning), phonons demand a medium for their existence, as it is the case for ordinary sonic waves. Since the atomic and molecular structures are in vacuum, the medium necessary for the hypothesis of the phonon to acquire reality is simply lacking.

Moreover, the bonding of electrons in the Cooper pair is *a phenomenon purely belonging to the particle world.* Another major drawback of the phonon conjecture is that *phonons cannot exist at the particle levels,* as it can be proved by classifying the representations of the Poincaré symmetry. At any rate, *no phonon has been detected as an isolated physical entity to date, as it has been the case for electrons, photons, and other physically established particles.*

Irrespective of these serious problematic aspects, the conjecture of phonon exchanges has long exhausted predictive capacities, resulting in the current stagnation of the efforts to increase the temperature in superconductivity. In the final analysis, attempts trying to explain an unknown structure by conjecturing a hypothetical particle that cannot be experimentally established in laboratory, do not survive the test of time.

The above problematic aspects have been resolved by A. O. E. Animalu [5a] who has constructed the image of superconductivity under hadronic mechanics, today called *Animalu's isosuperconductivity,* which is in remarkable agreement with experimental data, and possesses intriguing predictive capacities.

The model herein considered for the Cooper pair can be symbolically written:

$$CP = (\hat{e}^-_{\uparrow}, \hat{e}^-_{\downarrow})_{HM}, \tag{2.3.1}$$

where $\hat{e}^-$ represents the isoelectron of the preceding section, was originally proposed by Santilli [3a] for the structure of the π° ([3a] and Paper III). Subsequently, Animalu [5a] identified its applicability to the the Cooper pair. Animalu and Santilli [5b] presented further advances at the 1995 Sanibel Meeting, St. Augustine, Florida, which are outlined below. The model is today called in the literature the *Animalu–Santilli isomodel of the Cooper pair.*

The background theory for electron bonding in the Cooper pair is that of Section 2.1, which was applied in Refs. [5a] to experimental data of various substances. By denoting the Debye temperature θ_D (in absolute Kelvin degrees), the Fermi energy level ϵ_F (in electron Volts), and the critical temperature T_c (also in K), for the case of the cuprate $YBa_2Cu_3O_{6-\chi}$ the model yields the numerical values [loc. cit.]

$$k_1 = 1.3\, z^{-1/2} \times 10^{-4}, \qquad k_2 = 1.0\, z^{1/2} > 1, \tag{2.3.2a}$$

$$E^{Tot.}{}_{CP} = 2\, k_1 [\, 1 - (k_2 - 1)^2 / 4\,] \hbar c_o / R \approx k_2\, T_c / \theta_D, \tag{2.3.2b}$$

$$r_c = 1 / b \approx 10^{-8}\, cm, \tag{2.3.2c}$$

where the effective valence $z = 2(7 - \chi)/3$ varies from a minimum of $z = 4.66$ for $YBa_2Cu_3O_{6.96}$ ($T_c = 91^\circ$ K) to a maximum of $z = 4.33$ for $YBa_2Cu_3O_{6.5}$ ($T_c = 20^\circ$K). The the general expression predicted by hadronic mechanics for $YBa_2Cu_3O_{6-\chi}$ is given by (Eq. (5.15), p. 373, ref. [5a])

$$T_C = 367.3 \times z \times e^{-13.6\,/\,z}, \tag{2.3.3}$$

which results to be in remarkable agreement with experimental data (Figure 2.2).

Note that solutions (2.2.2) also reduce the admitted spectrum down to only one level, that of

the Cooper pair. Excited states are admitted, but they imply large distances R for which nonlinear, nonlocal, and nonhamiltonian interactions are ignorable. This implies that all excited states are fully quantum mechanical, thus recovering ordinarily free electrons.

Note also the *upper* dimension of the isoelectroniun in the Cooper pair, $r_c = 1/b \approx 10^{-8}$ cm [5a], which should be compared with the upper dimension for the valence bond, $r_c = 1/b \approx 10^{-11}$ cm, Eq. (1.4.1) [6a], and the size of the π° particle $r_c = 1/b \approx 10^{-13}$ cm [3a]. These numbers indicate the apparent existence of *three different levels of bonding charged particles resulting in states with different characteristics.* In fact, the Cooper pair is structurally different than the valence pair.

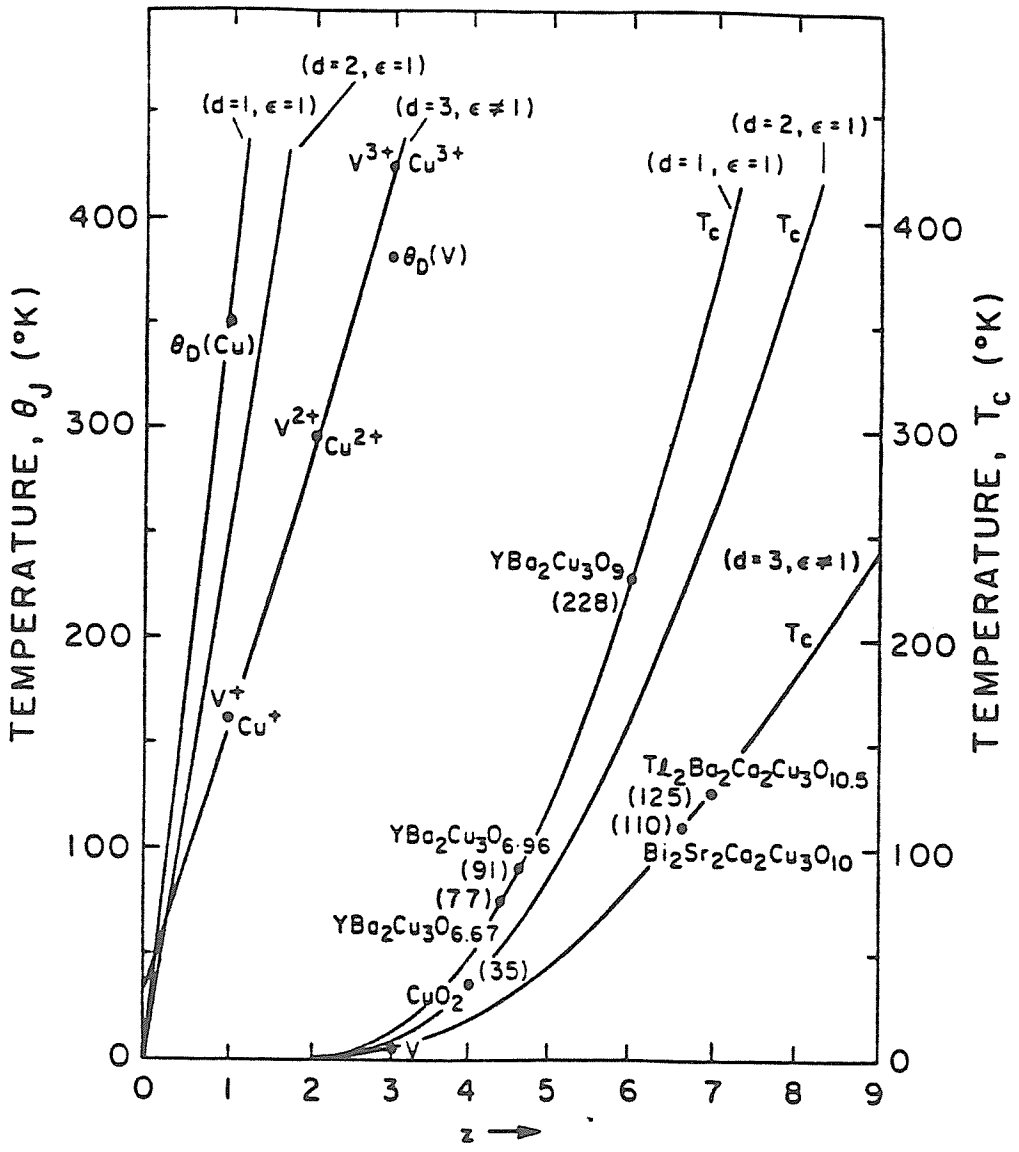


FIGURE 2.2: A reproduction of Fig. 10 of ref. [5a] illustrating the remarkable agreement between the predicted dependence of T_c from the effective valence z of ions (continuous curve) and the experimental values on the "jellium temperature" for various compounds (solid dots).

It should be indicated that the hadronic model of the Cooper pair sees its true formulation at

the *relativistic level* studied in detail by Animalu [5a], because the latter provides a *geometrization* of the Cooper pair, better possibilities for novel predictions, and the best possible experiments tests. These profiles will not be reviewed for brevity [loc. cit.].

Regrettably, I am not at liberty to disclose new practical application rendered possible by the Animalu-Santilli isosuperconductivity in details (and their disclosure would render the length of these papers prohibitive in any case). I can however indicate that new applications see their origin in the unity of experimental evidence and theoretical representation between superconductivity and valence bonds.

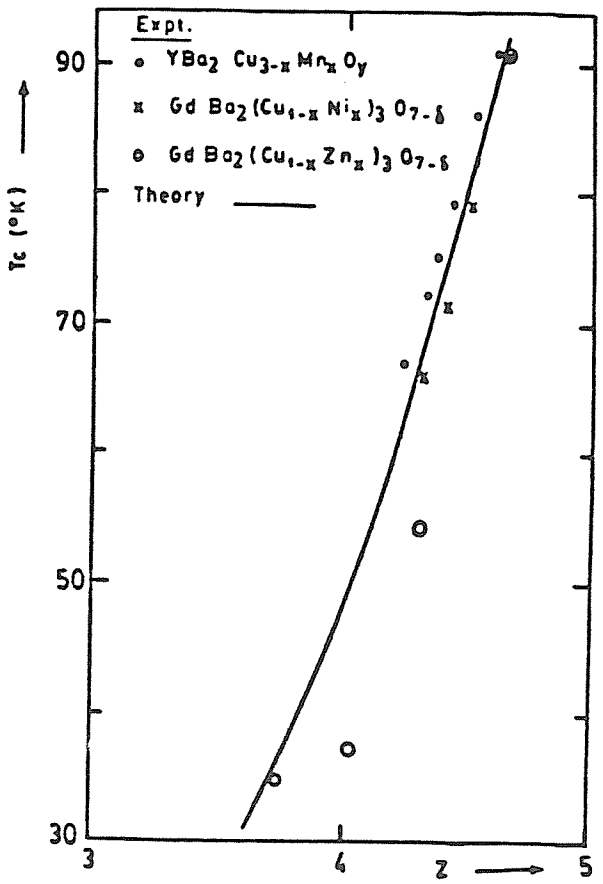


FIGURE 2.3: A reproduction of Fig. 5, p. 380 of ref. [5b] showing the agreement between the prediction of Eq. (2.2.2) for the doped 1:2:3 cuprates and the experimental data.

The main problem underlying advances in superconductivity is *the origin of the Cooper pairs*. It is evident that such a knowledge permits the production of Cooper Pairs in numbers bigger than those achieved so far. In turn, such increased production evidently implies the much needed increase of the conductivity, with consequential increase of its operational temperature.

The answer to the above question can be easily identified by any attentive reader. In fact, *the most plausible origin of the Cooper pair is in bonded electron pairs existing in the atomic-molecular structure.*

Therefore, basic advances in superconductivity can be made via the selection of an appropriate conductor which, in its natural or mutated state, can release pairs of bonded electrons

without any breaking of valence bonds (because the latter would require the energy needed for molecular dissociations). Most conductors *do not* possess such a property in their natural state. However, this *does not* means that they can be mutated into a superconducting state via an appropriate new technology. A hint on the mutations here referred to can be found in the example of control of orbital electrons of Section 3, and related experimental verifications.

The first contribution of the Animalu-Santilli isosuperconductivity in the field is therefore the identification of conductors admitting mutations suitable to enhance the production of Cooper pairs. The second contribution is the identification of the technology needed for their expected practical realization of the mutations. The third and final contribution is the prediction of specific and concrete embodiments for actual tests. The rest is no longer basic research, and belongs to industrial development.

It should be indicated that a problem of this nature encompasses the totality of the knowledge *outlined* in these papers at the particle, nuclear, and molecular levels (which exceeds 10,000 pages of research published in technical journals and monographs), all knowledge structurally beyond quantum mechanics.

Table 1. $YBa_2Cu_{3-x}Mn_xO_y$
(After N.L. Saini *et al.*, Int. J. Mod. Phys. B6, 3515 (1992)

x	y	z	T_c (theory)	T_c (expt.)
0.00	6.92	4.613	88.9	91
0.03	6.88	4.541	83.5	86.6
0.09	6.87	4.447	76.7	79.0
0.15	6.91	4.387	72.6	75.0
0.21	6.92	4.312	67.6	72.0
0.30	6.95	4.212	61.3	67.0

Note: T_c (theory) $= 367.3z\exp(-13.6/z)$, where the effect of replacing Cu_3 by $Cu_{3-x}Mn_x$ is obtained by replacing 3 by $(3-x)+2x=3+x$, which lowers the effective valence (z) on Cu^{2+} ions to $z=2y/(3+x)$.

Table 2. $GdBa_2(Cu_{1-x}Ni_x)_3O_{7-\delta}$
(After, Chin Lin *et al.*, Phys. Rev. B42, 2554 (1990))

x	$y = 7-\delta$	z	T_c (theory)	T_c (expt.)
0.000	6.96	4.640	91.0	91
0.025	6.96	4.527	82.4	79
0.050	6.96	4.419	74.8	71
0.075	6.96	4.316	67.9	65

Note: T_c(theory) $= 367.3z\exp(-13.6/z)$, $z = 2y/3(1+x)$ as discussed in Table 1.

Table 3. $GdBa_2(Cu_{1-x}Zn_x)_3O_{7-\delta}$
(After, Chin Lin *et al.*, Phys. Rev. B42, 2554 (1990))

x	$y = 7-\delta$	z	T_c (theory)	T_c (expt.)
0.000	6.96	4.640	91.0	91
0.025	6.96	4.309	67.4	54
0.050	6.96	4.009	49.0	37
0.075	6.96	3.737	36.1	35

FIGURE 2.4. .A reproduction of the tables of p. 379, ref. [5a] illustrating the numerical agreement between the predictions of isosuperconductivity with experimental data from other profiles.

The connection between the hadronic model and the conventional theory of the Cooper pair [14] is intriguing, because it shows the *compatibility* of the two theories. As studied in Ref. [5a], the constant in the Hulten potential has precisely the dimension of energy, and can therefore be interpreted as:

$$V = \hbar\omega, \qquad \omega = \text{phonon frequency.} \tag{2.3.4}$$

Also, Eq. (2.3.2b) can be rewritten:

$$E_{Tot} = 2\epsilon_F - E \approx 2k_1k_2\hbar c_o/R(e^{1/NV} - 1), \tag{2.3.5}$$

where NV is the (dimensionless) electron-phonon coupling constant. The main results of our Animalu-Santilli model can be, therefore, fully *reinterpreted* in terms of the electron-phonon interactions of current literature [14]. This is expected, because the latter model too represents *currently available* data, although without meaningful predictions for new advances.

However, the above numerical equivalence of the two models does not imply that the phonon exists as a physical particle. In fact, V is the depth of the Hulten potential well, which, as such, *cannot be* a particle. Moreover, the non-particle "entity" with frequency ω *cannot* be exchanged, because such a frequency originates from *nonpotential interactions represented via a generalization of the unit, rather, than the Hamiltonian, as necessary for the particle to be physical.*

This confirms the main point of the entire investigation considered in this section, namely, that superconductivity, beginning with the structure of the Cooper pair, is dramatically beyond the rather limited representational capabilities of quantum mechanics.

2.4. Experimental Verifications in the Hydrogen Molecule

Following the initiation of studies in the early part of this century by Lewis [10a], Langumir [10b], Norn and Hoppenheiomer [10c], and other, efforts to find a way to calculate the last 2% of the electronic energy of molecules were initiated by Hylleraas [10d] in the 1930s. Boys *et al.* [10e] derived a form of configuration interaction which offered exact variational solutions, but this proved to be very slowly convergent, and only applicable to small molecules. Moller-Plesset perturbation developed by Pople *et. al.* [10f] is popular today, but studies up to eighth order have been shown not to converge after huge expense in computer time. Linked-cluster diagrams by Shavitt *et al.* [10g] and Bartlett *et. al.* [10h], multiconfiguration-self-consistent-field (MCSCF) calculations by Schaefer *et. al.* [9d], and Goldstone-Bruekner-Feynman diagrammatic perturbation by Kelly [10j] have all been shown to require very large computer resources, are limited to small molecules and sometimes fail to give even negative binding energies as shown by Goddard for Cr_2.

Other efforts to reach the missing 2 % are based on Gaussian screenings of the Coulomb law which, as recalled in Section 1.4., imply departures from the basic laws of quantum mechanics, besides being particular forms of bona-fine isochemistry.

As a result of all these efforts over this entire century (see also the remaining quotations in [10]), quantum chemistry has left fundamentally open the problem of the exact representation of molecular binding energies, and other molecular characteristics, in a way compatible with its basic axioms, without manipulations which have been proved to imply the existing from, the boundaries of the theory.

Moreover, quantum chemistry has numerous, additional, basic problems and sheer inconsistencies outlined in Section 1.4.

Santilli and Shillady [6] have shown that the hadronic image of quantum chemistry, hadronic chemistry, provides *a representation of molecular binding energy and other characteristics which is exact to the seventh digit,* and resolves all open problems and inconsistencies. By recalling that the basic mechanism underlying molecular structures, the bonding of valence electrons, occurs at the particle level, these results have provided additional experimental verifications of hadronic mechanics at both the particle and molecular levels.

As recalled in Sections 1.4 and 2.1, the main assumption for molecular bonds according to hadronic chemistry is that two electrons from two different atoms bond themselves in singlet quasi-stable, quasi-particle state at short distances, called the isoelectronium, here indicated:

$$VP = (\hat{e}^-, \hat{e}^-)_{HP}, \tag{2.4.1}$$

where VP stands for "valence pair". The new attractive hadronic force between the electrons represents the the *valence bond*, while the *binding energy* of the molecule is characterized by the orbital motion of the isoelectronium in the oo-shaped orbit around the nuclei (Figure 1.5).

The theory for model (2.3.1) is that given in Section 2.1. Plotting the experimental data for the hydrogen, Ref. [6a] achieved the numerical solution of Eqs. (2.1.3), (2.2.13):

$$k_1 = V / 2 \times k_2 \times b \times c_o = 0.19, \; k_2 = 1, \tag{2.4.2}$$

which confirm all the essential characteristics of the hadronic bound state of Section 2.1, namely, only one hadronic energy level, null binding energy, and full stability.

Ref. [6a] then provides an accurate calculation for the the radius of the isoelectronium, which is:

$$r_c = b^{-1} \approx (\hbar^2 / m \times V)^{1/2} = (\hbar / m \times \omega_o)^{1/2} =$$

$$= (1.054 \times 10^{-27} \text{ erg sec} / 1.82 \times 10^{-27} \text{ gr} \times 1.236 \times 10^{20} \text{ Hz})^{1/2} =$$

$$= 6{,}8432329 \times 10^{-11} \text{ cm} = 0.015424288 \text{ bohrs} = 0.006843 \text{ A}, \tag{2.4.3}$$

The following should be noted: 1) the above value is only an *upper boundary* in the center-of-mass frame of the isoelectronium, i.e., it is the largest possible value admitted by the theory; 2) the value has been computed under the approximation of identically null relative kinetic energy of the isoelectrons with individual total energy equal to their rest energy; and 3) the value *decreases* with the addition of the relative kinetic energy of the isoelectrons, because this implies the increase of m in the denominator of Eq.s (2.4.15).

The actual radius of the isoelectronium is also expected to vary with the trigger, that is, with the nuclear charges, as confirmed by the calculations presented in the next section. This result illustrates again the upper boundary character of value (2.4.3). In fact, the theory cannot exclude that *the isoelectronium has a point charge, namely, the two electron are superimposed at zero distance with antiparallel spins.*

Note finally that the values of k_1 and k_2 for the hydrogen are very close to the corresponding values for the π° (Paper III) and the Cooper pair (preceding section).

Ref. [6a] has then achieved, for the first time, *an exactly solvable model of the hydrogen molecule.* Note that this is simply *impossible* for quantum chemistry, because of the assumed independence of the two valence electrons, thus renders the hydrogen molecule a *four-body system*, which does not admit an exact solution.

On the contrary, *the assumption of the bonding of the two valence electrons into the isoelectronium renders the hydrogen molecule a three-body system, which does admit exact solutions for the restricted case in the Born Oppenheimer approximation [10c] in which the two nuclei are assumed at rest.*

The *general Santilli-Shillady isochemical model of the hydrogen molecule* is a simple extension of the theory of Section 2.1, or, equivalently, a simple implementation of the conventional model of H_2 [9], plus the missing hadronic force between the pair of valence electrons, and can be written in conventionally used symbols (see [6a] for details in the derivation):

$$\left(-\frac{\hbar^2}{2\times\mu_1}\nabla_1^2 - \frac{\hbar^2}{2\times\mu_2}\nabla_2^2 - V \times \frac{e^{-r_{12}\times b}}{1 - e^{-r_{12}\times b}} - \right.$$

$$-\frac{e^2}{r_{1a}}-\frac{e^2}{r_{2a}}-\frac{e^2}{r_{1b}}-\frac{e^2}{r_{2b}}+\frac{e^2}{R})\times|\hat{\psi}>=E\times|\hat{\psi}>, \qquad (2.4.4)$$

The exactly solvable model iindicated above is the preceding model in which the two nuclei are assumed at rest. The model is essentially similar to the conventional model of the H_2^+ ion [9] (except that the molecule is now neutral and the orbiting particle has double the mass and the charge of the electron in H_2^+), and can be written:

$$(-\frac{\hbar^2}{2\mu_1}\nabla_1^2-\frac{\hbar^2}{2\mu_2}\nabla_2^2-V\times\frac{e^{-r_{12}b}}{1-e^{-r_{12}b}}-\frac{2e^2}{r_a}-\frac{2e^2}{r_b}+\frac{e^2}{R})\times|\hat{\psi}>=E\times|\hat{\psi}>. \qquad (2.4.5)$$

It is rewarding for me to report that *two independent experimental verifications of the above model have been achieved to date, each one representing characteristics of the hydrogen molecule accurate to the seventh digit:* the first verifications has been conducted by Santilli and Shillady [6a] in a Gaussian approximation of the Hulten potential, and the use of conventional methods in contemporary chemistry; and the second verification has been reached by Kucherenko and Aringazin [7b] via the exact solution of model (2.3.5).

Santilli-Shillady solution of model (2.4.5) can be outlined as follows (see Ref. [6a] for all original quotations). By approximating the Hulten potential with the Coulomb one, model [2.3.5] is characterized by the following equation expressed in atomic units (au) {9}:

$$H\times\Psi=(-\nabla^2/4-2/r_a-2/r_b+1/R)\times\Psi, \qquad [(2.4.6)$$

where the differences from the corresponding equation for the H_2^+ ion are the replacement of the reduced mass m = 2 with m = 4, and the increase of the electric charge from e = 1 to e = 2.

The standard method for solving the above equation is the following. The variational calculation is set-up in matrix algebra in a non-orthogonal basis set which has been normalized to 1. The metric of this non-orthogonal system of equations (S) is used to set up the orthogonal eigenvalue problem and the eigenvalues are sorted to find the lowest value. H, C, and S are Hermitean matrices; E is a diagonal matrix with the energy eigenvalues

$$HC=ESC;\ \text{define}\ C=S^{-1/2}C',\ \text{then}\ HS^{-1/2}C'=ES^{-1/2}C', \qquad (2.4.6a)$$

$$(S^{-1/2}HS^{+1/2}C')=H'C'=E(S^{-1/2}SS^{-1/2})C'=EC', \qquad (2.4.6b)$$

where the last equation is obtained by multiplying the first equation from the left by $S^{-1/2}$ and use the unitary property that $S^{-1/2}=S^{+1/2}$ to form an orthogonal eigenvalue problem. Finally we solve for C' by diagonalizing H' and obtain $C=S^{-1/2}C'$.

To better approximate the model (2.3.5), the Coulomb potential is "screened" with a Gaussian. The basis is formed from contracted basis sets (Ï) which are fixed linear combinations of Gaussian spheres fitted to real shapes of spherical harmonic functions. The eigenvector column in C gives the basis coefficients of the molecular orbitals [9d]:

$$\Psi_i=\sum c_{i,j}\ (j:\Psi_j=\sum a_{j,k}\Psi_k;\quad \chi=(2\alpha/\pi)^{3/4}\exp[-(\alpha-A)^2]=/a,A) \qquad (2.4.7)$$

The problem of how to form a sharp cusp on a 1s orbital is solved to a practical extent by using up to six Gaussians. The least-energy 1s orbital from Pople's group were used in Ref. [5c]. In this problem the s-, p-, d- and f-orbitals are polarization functions that merely serve to evaluate the effect of other angular components on the 1s orbitals which are the main terms of the 1s-sigma bond in H_2.

Gaussian orbitals can easily be scaled to screened nuclear charge values by multiplying the

gaussian exponents by the square of the scaling factor (in effect, shrinking the space of the H-atom model) followed by renormalization of the linear combination of Gaussians. In Ref. [6a] the scaling constant of the 1s orbitals was optimized to 1.191 and the 2-, 3- and 4-shell orbitals optimized as scaled shells rather than optimizing each orbital individually.

As the orbitals were optimized using parabolic fitting to three energy values as a function of the scaling value, it became apparent that the bond length of the three-body model is much shorter than the usual value of 1.4011 bohr (0.74143 angstroms). Thus, the bond length was re-optimized after optimization of the scaling for each principle shell. The scaling constants and the orbital contractions are given in Appendix A of Ref. [6c], along with the bond length of 0.2592 angstroms at an energy of -7.61509174 Hartrees (-207.2051232 eV), where the achievement of an exact representation of the binding energy is studied in details.

Although a large basis set of 1s, 2s, 2p, 3s, 3p, 3d, 4s, 4p, and 4f orbitals was used in Ref. [6a], this variational energy is probably higher than the exact solution of the type used by Bates, Ledsham and Stewart. However, the energy of the 6-Gaussian least-energy 1s function is -0.499946 Hartrees for the H atom so the energy quoted here should be within 0.001 hartrees of the exact solution.

Model (2.3.5) is then solved via the usual Hartree-Fock-Roothaan self-consistent-field method [9]. Note that reducing the values of the Coulomb integrals lowers the energy by reducing the electron-electron repulsion, while reducing the exchange terms will raise the energy. Ref. [5c] reached in this way the expressions

$$FC = ESC;\ F_{i,j} = H_{i,j} + \sum \sum P_{k,l}\ [(i,j/k,l) - 1/2(i,k/j,l)]\ , \tag{2.4.8a}$$

$$(i,j/k,l) = \iint \chi_i(1)\,\chi_j(1) / (1/r_{12}) / \chi_k(2)\chi_l(2) d\tau_1 d\tau_2\ , \tag{2.4.8b}$$

$$P_{i,j} = 2 \sum_n c_{n,i}\, c_{n,j}\ (\text{sum n only over occupied orbitals})\ . \tag{2.4.8c}$$

Ref. [6a] then assumed that until matrix elements of a two-electron interaction for singlet-pairs can be found for the hulten potential, a Gaussian-screened-coulomb potential can be used to describe the real-space form of the hadronic attraction. This form has the important property that it can be merged with the general case of the four-center coulomb or exchange integral derived by Shavitt using the famous Gaussian transform technique:

$$(1/r_{12}) = (1/\pi)^{1/2} \int s^{-1/2} \exp[-s(r_{12})^2)\ ds\ , \tag{2.4.9a}$$

$$[1 + ((p+q)/pq)s)] = 1/(1-t^2). \tag{2.4.9b}$$

Note that the above transform already has a pole at the lower limit where s=0. This pole was removed at the last step by a change in variable, given as Eqs. (2.4.9b). It is important to note that the formula is completely general in orientation of four Gaussian sphere lobe-orbitals as well as the distance between two electrons. As modified for description of correlation of two electrons, such a general formula can describe angular correlation as well as distance interaction. Thus, matrix elements of a screened Coulomb interaction were subtracted from the usual Coulomb repulsion to reach the real space form of the hadronic attraction of two electrons.

Ref. [6a] added the Gaussian screening as $\{\exp[-(r^2)]\}/r$ so that the special properties of Gaussians could be used, especially the properties that the product of two Gaussians form another Gaussian times a re-centering factor, and that polar coordinates readily separate into factorable x, y and z components. The two-electron, four-center matrix elements of the Gaussian-screened Coulomb potential as shown below is characterized by:

$$Y(r) = \{1 - 2 \exp[-(\alpha\, r^2)]\} / r. \tag{2.4.10}$$

Intriguingly, the Gaussian transform variable s can be simply shifted by the α value of the

screened Gaussian exponent and carried through the original derivation until the last step when integration over s is required. At this point the usual Coulombic interaction resorts to a well known auxiliary function F_0 which has been studied by Shillady and others. Since both $s^{1/2}$ and $(s+\alpha)^{1/2}$ occur in the denominator of the screened Coulomb form, two poles occur in the integral. A change of variable absorbs the term:

$$1+ [(p+q)/pq] (s+\alpha) = 1/(1-t^2), \tag{2.4.11}$$

while the pole due to $(s+\alpha)^{-1/2}$ shifts the other pole at $s^{-1/2}$ to the lower limit of the integral. A smooth spike is evident at the lower limit of the numerical integration using a 70 point Simpson's Rule Integration (two ranges are used with 20 points more closely spaced near the pole and 50 points for the remaining range).

The above work was carried out in Ref. [6a] using 64 bit double precision arithmetic which provides 14 significant figures. A simple offset δ of 1.0×10^{-15} has provided useful results with this simple offset to avoid numerical overflow. While this pole is a problem in need of a continuous function to integrate, numerical integration seems to handle this well to 14 significant figures, particularly, since the routines used for the Coulombic integrals are known to be accurate only to 12 significant figures.

The area under the pole-spike is estimated as a narrow triangle upon a rectangle 1.0×10^{-15} wide with the height of the triangle set at 1.79940×10^{13} times the height of the point set 1.0×10^{-15} into the range of integration (the first Simpson point), where the height is given in 0.5 d.

The code for this screened Coulomb integral is presently slower that the corresponding function used for the Coulombic integrals due to the 70 point Simpson integration, but the integrand is nearly flat after the spike at s=0.0, so that portion of the integrand can be evaluated more rapidly with fewer points. The resulting general equations are given by:

$$(aA(1),bB(1) \mid \exp[-\alpha(r_{12})^2] / r_{12} \mid cC(2),dD(2)) = \tag{2.4.12a}$$

$$\left(\frac{2\pi^{5/2}}{pq\sqrt{(p+q)}} \right) e^{-[ab/(a+b)]\overline{AB}^2 - [cd/(c+d)]\overline{CD}^2} \times$$

$$\int_{\rho}^{1} e^{-[pq/(p+q)]\overline{PQ}^2 t^2} \left(\frac{[pq/(p+q)]t^2}{[pq/[p+q]]t^2 + \alpha(t^2+1)} \right)^{1/2} dt \tag{2.4.12b}$$

$$\rho = \delta + \sqrt{(p+q)\alpha} / [pq + (p+q)\alpha, \quad p = (a+b), \quad q = c+d, \quad \delta = 1.0\times10^{-15}, \tag{2.4.12c}$$

$$\text{pole} = (1.79940 \times 10^{13}) e^{-[pq/(p+q)]\overline{PQ}^2 \rho^2 6} \tag{2.4.12s}$$

The new integral was incorporated into the same routine used to evaluate the usual Hartree-Fock-Roothaan SCF scheme. The restricted isochemical model of the H_2 molecule was treated using the same fixed-nuclei method with a bond distance of 1.4011 bohrs. A simple basis set of just one least-energy 6G-1s orbital centered on each H-nucleus was used to test the new program SASLOBE (Santilli-Animalu-Shillady-Lobe), set to handle up to 512 contracted orbitals.

It must be stated that the energies given are now parametricly dependent on the Gaussian screening constant since $E = E(\alpha)$. The energy is variationally bound to be above the true energy in a narrow range around the optimum value. It is extremely important to note that the energy is lowered using the new attractive hadronic term, but the optimum value is difficult to locate and a variational collapse occurs when r_c is extended or reduced away from a shallow minimum in the energy.

TABLE I: Summary of results for the Hydrogen molecule.

Species Basis Screening	H2	H2(#)	H2
1s	1.191	6.103	1.191
2s	0.50	24.35	0.50
2p	0.50	24.35	2.36
3s	0.34	16.23	*
3p	0.34	16.23	*
3d	0.34	-16.2(+)	*
4sp	0.25	12.18	*
4f	0.25	12.18	*
Variational Energy(au)	*	-7.61509174	*
SCF Energy(au)	-1.12822497	*	-1.13291228
CI Energy(au)	-1.14231305	*	*
CINO Energy(au)	-1.14241312	*	*
SAS Energy(au)	*	*	-1.174444
Exact Energy(au)[30]	-1.174474	*	-1.174474
Bond Length(bohr)	1.4011	0.2592	1.4011
Electronium Radius(bohr)	*	*	0.01124995

(+) the negative 3d scaling indicates five equivalent 3-sphere scaled to 16.20 rather than "canonical" 3d shapes.
(#) three-body Hamiltonian (5.1)

Table II Isoelectronium Results for Selected Molecules

	H2	H2O	HF
SCF-Energy(DH)	-1.132800$	-76.051524	-100.057186
Hartree Fock*			-100.07185*
Iso-Energy	-1.174441@	-76.398229@	-100.459500@
Horizon Rc(A)	0.00671	0.00038	0.00030
QMC Energy+*	-1.17447	-76.430020+	-100.44296*
Exact non-rel.	-1.174474&		-100.4595*
% Correlation	99.9#	91.6#	103.8
SCF-Dipole(D)	0.0	1.996828	1.946698
Iso-Dipole(D)	0.0	1.847437	1.841378
Exp. Dipole	0.0	1.85^	1.82^
Times(min:sec)	0:15.49	10:08.31	6:28.48

Notes:
(HD+) Dunning-Huzinaga (10S/6P), [6,2,1,1,1/4,1,1] + H2P1 + 3D1[32]
($) LEAO-6G1S + optimized GLO-2S and GLO-2P
(#) Relative to the basis set used here, not quite HF-limit.
(@) Iso-Energy calibrated to give exact energy for HF
(*) Hartree Fock and QMC energies from Luchow and Anderson[33]
(+) QMC energies from Hammond, Lester and Reynolds[30]
(&) First 7 sig. fig. from Kolos and Wolniewicz[34]
(^) Data from Chemical Rubber Handbook, 61st ed., p. E60.
Horizon Radius in Angstroms
Run Times on an O2 Silicon Graphics workstation (100 MFLOPS max.)

In order to minimize the number of parameters in the model to only one (the Coulomb-screening constant) two equations were imposed on the Gaussian-screened Coulomb function. First, the function was required to be equal to zero at some radial cutoff value r_c which is assumed to be the

inverse of the b-variable of Section 2.1:

$$b = 1/r_c = A \exp[-\alpha(r_c^2)] / r_c, \qquad A = \exp[+\alpha(r_c^2)]. \tag{2.4.13}$$

Second, this radial cutoff value was used as sigma of the inverted Gaussian (radius at half-height):

$$A \exp\{-[\ln(2)/r_c^2]\, r_c^2\} = A/2, \qquad \alpha = \ln(2)/r_c^2, \quad A = 2. \tag{2.4.14}$$

The upper boundary of the radius of the isoelectronium has been estimated in Ref. {6a} to be about $6{,}8432329 \times 10^{-11}$ cm = 0.015424288 Bohrs. This radius does lower the Hartree-Fock-Roothaan energy noticeably for H_2, and further optimization of the pole-spike produced an SCF energy of -1.17446875 Hartrees with a cutoff radius of 0.0118447 bohrs or 1.18447x10-10 cm using the minimum 1s basis. In conclusion, the fitted value of $b = 1/r_c$ is reasonably close to the estimate value for the H_2-molecule. The minimum basis was later extended to 6G-1S, 1G-2S, 1G-2P for pole calibration.

The results of the analysis are shown in Tables I and II, where one can see the representation of binding energy, electric and magnetic moments, and other characteristics of the hydrogen molecule represented with an accuracy up to the seventh digit.

Moreover, SASLOBE calculations on a 300 MFLOPS Silicon Graphics computer achieved the exact results in a few seconds, while conventional inaccurate calculations requires hours. Therefore it is clear that isochemistry calculations are, conservatively, at least 1,000 times faster than conventional calculations.

Model (2.3.5) was solved exactly by Kucherenko and Aringazin [7b] via very elegant and modern mathematical methods, by obtaining the numerical results for the binding energy and the internuclear distance R:

$$E = -7.617041 \text{ au}, \tag{2.4.15a}$$

$$R = 0.258399 \text{ au}, \tag{2.4.15b}$$

which confirm to several digits the SASLOBE results by Santilli and Shillady [6a].

Note that the exact solution occurs at an internuclear distance R smaller than that predicted by quantum chemistry (which is essentially the radius of the H-molecule). Value (2.4.15a) is also smaller than that predicted by the approximate solution of the isochemical model. This is an indication that the oo-orbit of the isoelectronium around the two nuclei, while preserving the conventional diameter of the hydrogen molecule, in reality decreases the internuclear distance, resulting in a "rosette-type" trajectory.

Regrettably, I cannot review the method used by Kucherenko and Aringazin to avoid a prohibitive length.

2.5. Experimental Verification in the Water Molecule

Water is the most important element on planet Earth. Therefore, water has been studied more than any other element [9,10]. Despite that, quantum chemistry has been unable to achieve an understanding of basic aspects of water, such as why the water molecule admits only two hydrogen atoms, and the same liquid state of water is fundamentally unknown.

Moreover, quantum chemistry is unable to explain the existence of different types of water with different physical and chemical characteristics, yet the same molecular structure, because all of them have the same H_2O structure in a "Michey Mouse" configuration, that in which the two O-H dimer form approximately 105° [9e].

Finally, quantum chemistry has been unable to reach an accurate representation of the binding energy of the water molecule; the representation of the electric and magnetic moments is

wrong even in the sign [9e]; and the theory predicts that water is ferromagnetic (Section 1.4), in dramatic disagreement with experimental evidence.

Due to the above insufficiencies and inconsistencies, Santilli and Shillady introduced in Ref. [6b] a fundamentally new *isochemical model of the water molecule* in which the four valence electrons, two per each pair of atoms, bond themselves into singlet quasi-stable states at short distance, the isoelectronia (Figure 1.6). The water molecule can then be reduced to two intersecting H-O dimers with a common O-atom.

The only known orbits yielding a stable water molecule are those in which each isoelectronium describes a oo-shaped orbit around the respective two nuclei of the H- and O-atoms. The isoelectronia are then responsible for the *bonding force* between the atoms. The *binding energy* is instead characterized by the oo-shaped orbits of the isoelectronia around the respective two nuclei.

Note that, in the absence of molecular motions, the orbits of the two isoelectronia are perpendicular to the H-O-H plane, thus confirming a known characteristic of the water molecule regarding distribution of valence electrons [9e]. Conventional exchange, van der Waals and other forces remain admitted by the model, by, therefore, implying at least a small instability of the isoelectronia.

The above isochemical model of the water molecule has the following implications:

1) It introduces a strong bonding force, which is absent in the conventional quantum chemical model;

2) It permits an immediate representation of the reason why water has only two hydrogen atoms. The Oxygen has only two electrons available for valence bonds. Once each of them is bonded to a corresponding electron of the hydrogen into the isoelectronium, there is no other possibility for bonding additional electrons. On the contrary, under the sole admission of exchange, van der Waals and other forces of nuclear type, it is evident that an arbitrary number of the hydrogen atoms can be bonded to the oxygen.

3) A simple observation of Figure 1.6 reveals the existence of a large variety of possible different configurations, whose study has been initiated in Refs. [7], all admitting the molecular structure H_2O, yet having different physical and chemical characteristics, in agreement with experimental evidence, while it is impossible to represent such a variety for the conventional model, as recalled earlier.

4) Santilli-Shillady isochemical model of the water molecule represents the binding energy, electric and magnetic moments in a way accurate to several digits.

5) The model is based, for the first time, on an *exactly solvable equation.* This is due to the fact that the water molecule is reducible to two intersecting H-O dimers with a common O-atom. In turn, each H-O dimer admits a restricted three-body, Born-Oppenheimer approximation [10c] essentially characterized by stationary nuclei in which the nucleus of the oxygen is assumed to be screened by its electron cloud less one valence electron. Such a model is extendable to *molecular chains,* which admit for the first time exact solutions [6b,6c,6e].

The isochemical equation of the H-O dimer is essentially that of the hydrogen in the preceding section, adjusted to the new data, and can be written:

$$\left(-\frac{\hbar^2}{2\times\mu_1}\hat{\Gamma}\times\nabla_1\times\hat{\Gamma}\times\nabla_2-\frac{\hbar^2}{2\times\mu_2}\hat{\Gamma}\times\nabla_2\times\hat{\Gamma}\times\nabla_2+\frac{e^2}{r_{12}}\times\hat{\Gamma}-\right.$$

$$\left.-\frac{e^2}{r_{1a}}-\frac{e^2}{r_{2a}}-\frac{e^2}{r_{1b}}-\frac{e^2}{r_{2b}}+\frac{e^2}{R}\right)\times|\hat{\psi}>=E|\hat{\psi}>. \qquad (2.5.1)$$

By recalling that the Hulten potential behaves at small distances like the Coulomb one, the above equation becomes:

$$\left(-\frac{\hbar^2}{2\times\mu_1}\nabla_1^2-\frac{\hbar^2}{2\times\mu_2}\nabla_2^2-V\times\frac{e^{-r_{12}}}{1-e^{-r_{12}\times b}}-\right.$$
$$\left.-\frac{e^2}{r_{1a}}-\frac{e^2}{r_{2a}}-\frac{e^2}{r_{1b}}-\frac{e^2}{r_{2b}}+\frac{e^2}{R}\right)\times|\hat{\psi}>=E\times|\hat{\psi}>. \qquad (2.5.2)$$

The model can be reduced to a *restricted three body problem* similar to that possible for the conventional H_2^+ ion [9], resulting in the equation:

$$\left(-\frac{\hbar^2}{2\mu_1}\nabla_1^2-\frac{\hbar^2}{2\mu_2}\nabla_2^2-V\times\frac{e^{-r_{12}\,b}}{1-e^{-r_{12}\,b}}-\frac{2e^2}{r_a}-\frac{2e^2}{r_b}+\frac{e^2}{R}\right)\times|\hat{\psi}>=E\times|\hat{\psi}>. \qquad (2.5.3)$$

Electron screenings in quantum chemistry can be represented via a Gaussian screening of the Coulomb law of the type [9d]:

$$\frac{+e}{r}\;\rightarrow\;\frac{+e(1\pm e^{-\alpha r^2})}{r}, \qquad (2.5.4)$$

where β is a positive parameters to be determined from experimental data, the sign − applies for the screened O-nucleus as seen from an *electron* (because of the *repulsion* caused by the electron clouds of the Oxygen), while the sign + applies for the screened O-nucleus as seen from the H-*nucleus* (because of the *attraction* this time caused by said electron clouds).

The screening of the various electrons in the oxygen and other corrections are needed in the "sensing" of the O-nucleus by the isoelectronium as well as by the H-nucleus, yielding in this way the *Santilli-Shillady exactly solvable isochemical model of the H-O dimer* [6a]:

$$\left(-\frac{\hbar^2}{2\mu_1}\nabla_1^2-\frac{\hbar^2}{2\mu_2}\nabla_2^2-V\times\frac{e^{-r_{12}\,b}}{1-e^{-r_{12}\,b}}-\right.$$
$$\left.-\frac{2e^2}{r_a}-\frac{2e^2(1-e^{-\alpha r_b}}{r_b}+\frac{e^2(1+e^{-\alpha R}}{R}\right)\times|\hat{\psi}>=E\times|\hat{\psi}>, \qquad (2.5.5)$$

where α is a positive parameter and E is half of the binding energy of the water molecule.

Under the latter approximation, the model permits, for the first time, the achievement of an *exact solution for the structure of the water molecule*. However, such a solution exists only for the case of the *fully stable isoelectronium*. In fact, for the unstable isoelectronium the model becomes a *many-body structure* which, as such, admits no exact solution.

The model is extendable with simple adjustment to an exact solution of other dimers involving the Hydrogen, such as H-C. In addition, the model permits the identification of electric and magnetic polarizations which are not predictable with quantum chemistry.

Ref. [6b] solved Eq. (2.4.5) via a Gaussian approximation of the Hulten potential essentially similar to that for the hydrogen outlined in the preceding section. Note that such an approximation implies an evident weakening of the Hulten attraction among the two isoelectrons of the isoelectronium. In turn, this weakening implies the instability of the isoelectronium itself, thus providing a model which is somewhat intermediate between the full isochemical model and the conventional quantum mechanical model of the water.

Despite this approximate character, the results of Ref. [6b] are significant because they show

the capability by isochemistry to achieve an essentially exact representation of the binding energy, electric and magnetic moments and other characteristics of the water molecule. Moreover, any potential can be exactly reproduced by a sufficient number of Gaussians, including the Hulten potential. Therefore, the exact representations reached in Ref. [5b] for only one Gaussian can be expected to persist for the full isochemical model.

It should be stressed that *Gaussian and other screenings of the conventional Coulomb law, even though familiar in quantum chemistry, are now known to violate basic laws of quantum mechanics, e.g.,* because they can only be reached via a *nonunitary transform* of the Coulomb law. As a result, contrary to popular beliefs, all quantum chemical models based on Gaussian screenings of the Coulomb law are, in reality, particular cases of the isochemistry.

Table I: Isoelectronium Results for Selected Molecules

	OH^+	OH^-	H_2O	HF
SCF-Energy(DH)	-74.860377	-75.396624	-76.058000	-100.060379
Hartree Fock*				-100.07185*
Iso-Energy	-75.056678	-75.554299	-76.388340	-100.448029
Horizon Rc(A)	0.00038	0.00038	0.00038	0.00030
QMC Energy+*			-76.430020^+	-100.44296*
Exact non-rel.				-100.4595
Iso-Dipole(D)	5.552581	8.638473	1.847437	1.8413778
Exp. Dipole			1.84 [2]	1.82

Notes [6]:
(HD^+) Dunning-Huzinaga (10S/6P), [6,2,1,1,1/4,1,1]+H2S1+H2P1+3D1.
Iso-Energy calibrated to give maximum correlation for HF.
(*) Hartree Fock and QMC energies from Luchow and Anderson.
(+) QMC energies from Hammond, Lester and Reynolds.

Model (2.4.5) was solved in Ref. [6b] via the HFR-SCF calculation after an additional 3d orbital was optimized for the O atom and (2S,2p) orbitals were added for the H atoms. The exponent for the O3d orbitals was optimized to three significant figures and the (O3d,H2s,H2p) exponents were 2.498, 0.500, and 1.000. These polarization orbitals were added to the Dunning-Huzinaga (10s6p) basis with the H1s orbitals scaled to 1.2 which produced a lower energy than that of a 6-31G basis using the GAMESS program.

The bond length of $O-H^+$ was optimized using GAMESS at the 6-31G basis level and found to be 1.0062 angstroms. The same bond length was used for $O-H^-$ since the anion calculation using the usual HFR-SCF process was not feasible, and in any case the bond length is only slightly longer than that in water. The horizon cutoff value of 0.00038 angstroms optimized for H_2O was also used for OH^+ and OH^-. The spike in the numerical integral routine was optimized by fitting the R_c cut-off value so as to obtain as near as possible the non-relativistic energy of the HF molecule as determined from Quantum Monte Carlo calculations (21). The dipole moments for the ions are not very useful since ion dipoles are origin dependent, but they were calculated using the center-of-mass as the origin. The results are summarized in the Table I which confirms the achievement, for the first time, of a very accurate representation of all main water characteristics.

Another important confirmation is that, as it happened for the hydrogen molecule of the preceding section, *the value of the radius of the isoelectronium, Eq. (1.4.1) computed via dynamical equations in Refs. [6a,6b] has been numerically confirmed by independent SASLOBE calculations for the water.*

More specifically, the radius of the isoelectronium was left undefined in the computer SASLOBE calculations, and the value derived by them coincides to the seventh digit with value (1.4.1).

This unexpected result confirms the most fundamental assumption of isochemistry, the bonding of a pair of valence electrons into the isoelectronium.

3. NEW COMBUSTIBLE GASES RESOLVING THE ALARMING ENVIRONMENTAL PROBLEMS CAUSED BY FOSSIL FUELS DEVELOPED AT TOUPS TECHNOLOGY LICENSING

3.1. Creation of Magnecules in Gases

Recall from Section 1.5 that *magnecules* are a new chemical species composed by ordinary atoms and molecules under a new *magnetic* bond originating in the plane polarization (cyclotron resonance orbit) of the orbits of, at least, the valence electrons.

During my studies on hadronic mechanics, I predicted the formation of magnecules in gases and liquids exposed to intense magnetic fields. In fact, these fields are expected to produce precisely the polarization needed for a strong magnetic bond. I therefore searched for specific cases in which these conditions are met.

It was easy to see that one of the strongest, readily available sources of magnetic fields in gases is *an electric arc*. Therefore, I predicted that magnecules exist in gases and liquids exposed to an electric arc. In this section I shall outline separately the experimental evidence for magnecules in gases and liquids, and solids.

Gases exposed to strong electric currents or electric arcs known to me are the following:

A) The gas patented by I. Eldridge in 1898 [16a];

B) The gas patented by W. A. Dammann and D. Wallman also in 1995 [16b];

C) The gas patented by W. J. Richardson, jr., in 1995 [16c] called AquaFuel^{TM};

D) The so-called Brown gas [17a] ;

E) The SkyGas [17b].

An electric arc in a water base liquid decomposes the various compounds by forming a plasma at about 5,000 C of mostly ionized atoms of hydrogen, oxygen, carbon and other elements, which combine in a variety of ways, forming nonexplosive combustible gases with clean emission exhausts. The new gases cool down in the surrounding liquid, and bubble to the surface where they are collected with various means.

The main hypothesis I formulated in early 1998 is that, at the time of their formation under an electric arc, gases H_2, CO, CO_2, O_2, etc. *do not* have a conventional structure because the orbits of (at least) their valence electrons are mostly polarized in a plane due to the very intense magnetic field surrounding the electric arc (of 10 Tesla or more). In turn, such a polarization implies the creation of the strong magnetic moments of Section 1.5, resulting in new magnetic bonds constituting the magnecules.

While conducting these studies, I had the opportunity of visiting in early 1998 Toups Technology Licensing [1a]. In this way I had the opportunity of seeing the production of AquaFuel^{TM}, a new, safe, clean, combustible gas under development by TTL [1b], which is produced quite simply via an electric arc between carbon rods within ordinary tap water.

It was evident that the electric arc decomposes the carbon rod, and creates a high temperature plasma of mostly ionized atoms of hydrogen, oxygen and carbon. In view of their affinity, carbon combines with virtually all available oxygen, thus resulting in a nonexplosive combustible gas, essentially composed by magnetically polarized molecules H_2, CO, CO_2, O_2, and their magnetic bonds. The resulting gas has some of the cleanest exhausts available in the fuel industry, capable of solving at least some of the environmental problems discussed in Section 1.2.

Immediately following my visual inspection of AquaFuel, I indicated to the management of

Toups Technology Licensing my hypothesis that the chemical structure of AquaFuel is anomalous, that is, *not representable with quantum chemistry*. This hypothesis was fully supported by Mr. *W*. Richardson, jr., because of his several years of unsuccessful and frustrating attempts in trying to understand AquaFuel via conventional chemical analyses, and related quantum chemistry.

Several conventional mass spectrometric analyses on AquaFuel had been conducted by 1998, which, after adjustments due to possible air contamination (indicated by nitrogen content) and averaging over various methods of production, suggested the following [1b]:

Conventional chemical composition of AquaFuel:

H_2	48 %	
CO	41 %	
CO_2	10 %	(3.1.1)
O_2	0.2 %	
Misc. struct. in ppm	0.8 %.	

However, the above chemical analysis was in dramatic disagreement with a variety of experimental evidence on AquaFuel, which I reported in detail in Web Site [1b]. For instance, the heaviest molecule present in AquaFuel in macroscopic percentage is CO_2 with a molecular weight of 44 amu. However, ,GC-MS measurements showed the presence of macroscopic peaks all the way to 1,000 amu, which evidently had no known explanation via quantum chemistry.

Another aspect of AquaFuel that could not possibly be studied in a scientific way via quantum chemistry is its energy content. During the tests at TTL in early 1998, most impressive for me was the *anomalous energy content of AquaFuel*. According to quantum chemistry, AquaFuel should have an energy content of about 167 BTU/cf. In fact, hydrogen has about 300 BTU/cf. Since AquaFuel contains approximately 50% of hydrogen, thus setting the contribution of 150 BTU/cf; CO_2 is non-combustible; while CO has a low BTU content, thus resulting in the indicated low value of energy content indicated by quantum chemistry following the conventional analysis (3.1.1).

By comparison, tests conducted by a local company specializing in cutting gases demonstrated to me that AquaFuel cuts a steel bar 3/8 " × 1" thick as fast and efficiently as acetylene, which has 2,300 BTU/cf. This discrepancy mandated the use of hadronic chemistry.

Numerous other discrepancies existed between the predictions of quantum chemistry and the experimental evidence of AquaFuel, such as anomalous passage of hydrogen through surfaces, anomalous deflation of balloons, anomalous attraction of floating balloons by metal beams, and other behavior dramatically beyond the prediction of quantum chemistry.

Therefore, I conjectured that AquaFuel is indeed composed by the gases according to conventional molecular analysis (3.1.1), but said molecular constituents are magnetically polarized due to the high magnetic field of the electric arc that produces these molecules, thus resulting in a *new* chemical structure with generic magnecules

$$\{H_\uparrow - H_\downarrow\} \times \{H_\uparrow - H_\downarrow\}, \quad \{C_\uparrow - O_\downarrow\} \times \{C_\uparrow - O_\downarrow\}, \quad \{O_\uparrow - O_\downarrow\} \times \{O_\uparrow - O_\downarrow\}, \text{ etc.}, \tag{3.1.2a}$$

$$\{H_\uparrow - H_\downarrow\} \times \{H_\uparrow - H_\downarrow\} \times \{H_\uparrow - H_\downarrow\} \times \ldots, \{C_\uparrow - O_\downarrow\} \times \{C_\uparrow - O_\downarrow\} \times \{C_\uparrow - O_\downarrow\} \times \ldots, \text{ etc.} \tag{3.1.2b}$$

$$\{H_\uparrow - H_\downarrow\} \times \{C_\uparrow - O_\downarrow\} \times H_\uparrow \times \{O_\uparrow - C_{\downarrow\uparrow} - O_\downarrow\} \times O_{\uparrow\uparrow} \times \{O_\uparrow - O_\downarrow\} \times C_{\uparrow\uparrow} \times \ldots, \text{ etc.}, \tag{3.1.2c}$$

where one should note the expected presence of individual polarized *atoms*, besides polarized *molecules*.

I recommended to TTL the conduction on AquaFuel of comprehensive scientific measurements, such as those via suitably supervised Gas Chromatographic Mass Spectrometers equipped with InfraRed Detectors(GC-MS/IRD); energy content; octanes; permeability; specific weight; etc. All these measurements were expected to be anomalous, thus providing the foundations of a possible ***new technology of magnetically polarized gases*** of evident industrial

relevance.

Mr. ***Leon Toups*** and all other TTL officers and members provided all possible financial, technical, and logistic assistance for the conduction of the proposed scientific measurements, which proved to be invaluable for the achievement of the results reported in Ref,. [7a], and outlined in this section.

One should note the *corporate* origin of the above support for the search of *basic* scientific knowledge, that is, which acquires particular significance when considering the virtual impossibility of seeking its pursuit in the contemporary academic community [I-2a,I-2b].

In this section I report the experimental verifications on the existence of magnecules in AquaFuel achieved thanks to TTL support., and presented in Ref. [7]. Additional experimental verifications are under way at this writing and they will be reported in future papers.

3.2. Definition of Magnecules and their Anomalies (Copyrighted and Patent Pending)

The content of Section 1.5 can be summarized with the following:

DEFINITION 1.5.1 [6a]: ***Magnecules*** *constitute new chemical species in gases, liquids or solids which is composed by conventional neutral atoms and molecules under a new magnetic bond due to the plane polarization of the orbits of (at least) the valence electrons, which species are stable at ordinary conditions of temperature and pressure, and which species is characterized by the following properties:*

I) The new species has variable molecular weight, depending on the number of atoms and molecules possessing the needed magnetic polarization, which molecular weight can be a large multiple of the conventional molecular weight for the same atomic constituents;

II) The new species are identified in mass spectrometry by new peaks which result to be "unknown" in the computer search among all known conventional molecular structures;

III) The new peaks identified in the mass spectrometry have no infrared (for gases) or ultraviolet (for liquids) signature at all, as a necessary condition not to have a valence bond, the sole infrared or ultraviolet signatures being those of the conventional atoms or molecules constituting the new species;

IV) The new species have anomalous physical and chemical characteristics, including anomalous infrared or ultraviolet signatures, anomalous penetrations thru other substances, anomalous adhesion to other substances, anomalous viscosity, etc.;

V) The new chemical species, their peaks, and all its anomalous features disappear at a sufficiently high temperature (the Curie point of the new species) evidently varying from substance to substance.

Magnecules are called: ***elementary*** *when composed by only two molecules;* ***magneplexes*** *when entirely composed by several identical molecules; and* ***magneclusters*** *when composed by molecules of different type.*

The experimental verification of magnecules requires the detection of a number of anomalies which can be summarized as follows:

Anomaly 3.2.1: Appearance of unexpected heavy MS peaks.

Gas magnecules are generally heavier than the heaviest molecule in a given gas. Peaks in the GC-MS are therefore expected in macroscopic percentages with molecular weights bigger than the heaviest molecule. These heavy composites should not provide MS peaks according to quantum

chemistry, thus constituting an anomaly. By ignoring heavy compounds in parts per million (ppm), AquaFuel should have no large peak in the GC-MS with more than the CO_2 molecular weight of 44 a.m.u. The existence of heavier large peaks would establish this first anomaly.

Anomaly 3.2.2: "Unknown" character of the unexpected heavy peaks.

To provide the initial premises for magnecules, the peaks of Anomaly 3.2.1 should result in "unknown" in the search by the GC-MS computer in its memory banks of conventional molecules, usually including about 150,000 molecules.

Anomaly 3.2.3: Lack of IR signature of the "unknown" peaks.

Another necessary condition to have magnecules is that the "unknown" peaks of Anomaly 3.2.1 should have no infrared signature at all. According to established evidence, all gases with a valence bond must have a well defined infrared signature (with a few exceptions of spherically symmetric molecules, such as H_2). In the event the peaks of Anomaly 3.1.1 do have such a signature, they can be constituted by new yet conventional molecules not identified before. The only infrared signatures of any given gas magnecule should be those of the *conventional* molecules and atoms constituting the cluster itself. As an illustration, the only admissible infrared signatures of magnecule $(O_\uparrow - O_\downarrow) \times (C_\uparrow - O_\downarrow)$ are those of the conventional molecules O-O and C-O.

Anomaly 3.2.4: Mutation of conventional IR signatures.

The infrared signatures of the molecules constituting a magnecules are expected to be *mutated*, in the sense that the shape of their peaks is not the established one. This is another anomaly of magnecules expected from the polarization of the orbits of the valence electrons. In fact, this polarization implies space distributions of the orbitals different than the conventional ones, thus resulting in a deformation of the shape of the IR peaks. Moreover, the same polarizations are expected to create additional strong bonds within a *conventional* molecule, which are expected to appear as new IR peaks. Still in turn, such an *internal mutations of conventional molecules* have far reaching scientific and technological implications, as will be shown.

Anomaly 3.2.5: Mutation of magnecules.

While molecules preserve their structure at conventional temperatures and pressures, this is not the case for magnecules, which are expected to *mutate* in time, that is, to change the shape of the MS peaks due to change in their constituents. Since we are referring to gases whose constituents notoriously collide, magnecules can break-down during collisions into parts which can then recombine with other magnecules to form new clusters. Alternatively, magnecules are expected to experience accretion (or emission) of polarized conventional atoms or molecules without necessarily breaking down into parts. It follows that the peaks of Anomaly 3.2.1 are not expected to remain the same over a sufficient period of time for the same gas under the same conditions.

Anomaly 3.2.6: Mutated physical characteristics.

Magnetically polarized gases are expected to have mutated physical characteristics because the very notion of polarization of the orbits implies a *smaller* average molecular volume. Mutations of other physical characteristics are then consequential.

Anomaly 3.2.7: Anomalous adhesion.

Magnetically polarized gases are expected to have anomalous adhesion to walls of disparate nature as compared to the same unpolarized gas. This is due to the well known property that magnetism can be propagated by induction, according to which a magnetically polarized molecule with a sufficiently intense magnetic moment can induce a corresponding polarization of valence (and/or other) electrons in the atoms or molecules constituting the walls surface. Once such a polarization is created by induction, magnecules can have rather strong magnetic bonds to said walls.

Anomaly 3.2.8: Increased penetration through substances.

Magnetically polarized gases are expected to have anomalous absorption or penetration through other substances. This is first due to the reduction of the average molecular volume with inherent increase of permeability, as compared to the same unpolarized gas. The second reason is the magnetic induction of the preceding anomaly.

Anomaly 3.2.9: Increased energy release.

Magnetically polarized gases are expected to have thermochemical reactions with macroscopic increases of energy releases, as compared to the same reactions among unpolarized gases, an expected anomaly which, alone, has large scientific and industrial significance.

All the above anomalies are expected to disappear at a sufficient high temperature, evidently varying from gas to gas (Curie point), while the anomalies are expected to be enhanced at lower temperature and survive liquefaction.

3.3. Necessary Conditions for the Detection of Magnecules (Copyrighted and Patent Pending)

The experimental detection of magnecules is difficult due to the fact that conventional analytic equipment and methods have been developed for *conventional* properties. As such, these instruments are generally ineffective for the measurement of the *anomalous* properties of magnecules.

For instance, Anomalies 3.2.1 through 3.2.6 should be established by GC-MS. However, most GC-MS machines are not suitable to detect magnecules because they usually operate at temperatures generally higher than the Curie point of the magnecule to be detected. In this case, the measuring equipment itself destroys the very features to be measured. The few GC-MS that are suitable for the tests should be operated in a way significantly different than the conventional one, again, to prevent destroying the very features to be measured.

Additional difficulties are created by the rather universal tendency in analytic laboratories to throw a conventional interpretation at any peak in the GC-MS, without considering any IR verification at all. When dealing with magnecules, such convenmtioinal "explanations" are vacuous and of generally of non-scientific nature, because the conventional molecular interpretation of peaks in the GC-MS are completely disproved by the lack of IR signatures (as recalled earlier, with very few exceptions for *low* a.m.u. which do not apply to large magnecules in the 500 a.m.u range, clear IR signatures are a *necessary* condition to have a conventional valence bond).

The above tendency of throwing conventional molecular interpretations of any GC-MS peak is so widespread, that GC-MS equipment are not generally equipped with an IRD, as it is usual in analytic laboratories. In view of the above occurrences, to prevent a waste of time without real science, researchers are strongly recommended to *prevent, prohibit, or otherwise avoid any measurement of magnecules with GC-MS equipment without IRD.*

Additional difficulties are of human nature, and due to the fact that analysts with long and outstanding experience in conventional analytic procedures, are generally reluctant to change their methods, thus preventing the measurement of *new* characteristics.

The necessary conditions for scientific measurements of gas magnecules with gas chromatographic, mass spectroscopic equipment are the following:

Condition 3.3.1: GC-MS should permit measurements of peaks at ordinary temperature (say, 10 C - 30 C), and the feeding lines should be cryogenically cooled. GC-MS are routinely operated at temperatures of the order of 150 C to 250 C, for which no magnecule is expected to exist. To put it explicitly, the conventional operation of GC-MS destroys the very clusters to be detected, and this identifies a first reason for the lack of detection of magnecules until now.

Condition 3.3.2: GC-MS must be equipped with IRD. In the absence of IRD, no measurement should be considered to be scientific or final (because of the lack of 50% of the necessary information for a serious conclusion). Since the great majority of GC-MS are not equipped with IRD, this provides an additional reason why the magnecules have not been detected in until now. In reality, numerous magnecules have been indeed detected in academic laboratories, but were

misinterpreted as esoteric molecules precisely because of the lack of IRD.

Condition 3.3.3: GC-MS/IRD should be equipped with feeding lines of at least 0.5 mm ID. GC-MS are usually operated with feeding lines with the smallest possible ID, at times of the order of 0.1 mm. This additional unusual requirement is due to Anomaly 3.2.7, *i.e.*, the enhanced adhesion of magnecules to the metallic walls of the feeding line, which become clogged-up to the point of preventing the passage of the most interesting magnecules, the big magneclusters with molecular weight in the 1,000's a.m.u. This is another condition analysts with extended practice on *conventional* gases can only accept after being exposed to the evidence.

Condition 3.3.4: GC-MS should be set to detect peaks at molecular weights where the analyst usually expects none. This condition identifies another reason why magnecules have simply not been looked for until now. As an illustration, the most interesting molecular weights for AquaFuel are those *bigger* than their heaviest conventional molecule, *i.e.*, bigger than 44 a.m.u. It goes without saying that smaller molecular weights are also important once the analyst *seeks an anomaly,* rather than a conventional result.

Condition 3.3.5: The ramp time should be the longest admitted by the GC-MS/IRD and of at least 25 minutes. In general, for the evident reason to reduce costs, the ramp time is set at the smallest possible operational value, which is perfectly acceptable for conventional gases, but substantially inappropriate for the anomalies we have to detect. As will be shown, for the case of magnetically polarized gases *a small ramp time implies the clustering of all magnecules into one single peak.* The analyst then looks at each individual constituent of such a unique large peak, evidently finds fully conventional molecules, thus reaching the "experimental belief" that the peak represents conventional molecules. For a sufficiently large ramp time, the magnecules are instead represented by well separated, large individual peaks. In this case the analyst is forced to identify these peaks individually. Then, and only then, the *computer* (rather than the analyst) will establish that the MS peaks are "unknown", and confirm the "unknown" character in the absence of IR signature. The latter then establishes the magnecule because it establishes the lack of valence bond for the peak considered. The analysis of Ref. [7] outlined in Section 1.5 then establishes that the magnetic origin of the bond creating the peak is the most important scientific aspect.

Numerous other conditions exist for GC-MS/IRD to be effective in the detection and identification of magnecules. They are of more technical nature and will be indicated whenever needed.

Besides the problems in identifying an appropriate GC-MS/IRD, I experienced additional difficulties in the identification of other instruments capable of providing effective measurements of the other Anomalies 7-3.-9, again, because the available instruments have been designed for the measurement of *conventional* rather than anomalous features.

As an illustration, by far the most difficult measurement of gases with magnecules has been the achievement of credible scientific values of energy content in British Thermal Units (BTU) per cubic foot (cf). By comparison, the measurement of the BTU/cf of gases with a conventional chemical structure is so elementary nowadays to be computerized following GC-MS data.

Significantly, *all* methods currently available to measure the BTU/CF failed to provide results of any credibility for gases with magnecules. This is the case of computerized computation of BTU/cf from GC-MS results) and some conventional calorimeters did not even allow AquaFuel to burn, let alone to make a measurement (this is the case of the computerized calorimeters for methane whose air intake is too big for the combustion of AquaFuel and its required adjustment outside the range of the computer program.

Equal difficulties were encountered via the use of EPA analytic techniques, evidently because they are not designed to detect anomalies.

The conditions for scientific measurements of magnecules in liquid are the same as those for gas magnecules, except for the use of Liquid Chromatography Mass Spectrometers (LC-MS) equipped with UltraViolet Detector (UVD).

3.4. Spectroscopic Evidence of Magnecules in Gases. (Copyrighted and Patent Pending)

After a laborious search in the U.S.A., I located a GC-MS equipped with IRD suitable to measure magnecules at the ***McClellan Air Force Base*** in North Highland, near Sacramento, California. Thanks to the invaluable assistance and backing by TTL, I was authorized to conduct GC-MS/IRD measurement on AquaFuel at that facility.

Following the prior arrival of a bottle of AquaFuel, on June 19, 1998, I visited the analytic laboratory of *NATIONAL TECHNICAL SYSTEMS* (NTS) located at said McClellan Air Force Base. The measurements on AquaFuel were conducted by analysts ***Louis A. Dee,*** Branch Manager, and ***Norman Wade*** who operated an HP GC model 5890, an HP MS model 5972, and an HP IRD model 5965. Upon inspection on arrival, the instrument met all conditions 3.3.1 to 3.3.5. Then, and only then, I authorized the measurements.

Thanks to a professional cooperation by the NTS analysts, the equipment was set at all the unusual conditions indicated in Section 3.3. In particular, the equipment was set for the analytic method VOC IRMS.M utilizing an HP Ultra 2 column 25 m long with a 0.32 mm ID and a film thickness of 0.52 μm. I also requested to conduct the analysis from 40 a.m.u. to the instrument limit of 500 a.m.u. This condition was necessary to avoid the CO peak of AquaFuel at 28 a.m.u. which is so large to dwarf all other peaks.

Moreover, NTS analysts were fully cooperative in implementing unconventional settings of the instrument. In fact, the GC-MS/IRD was set at the lowest possible temperature of 10 C; the biggest possible feeding line with an ID of .5 mm was installed; the feeding line itself was cryogenically cooled; the equipment was set at the longest possible ramp time of 26 minutes; and a linear flow velocity of 50 cm/sec was selected. A number of other technical requirements are available in the complete documentation of the measurements reproduced in App. A of monograph [7b].

The analysts first secured a documentation of the background of the instrument prior to any injection of AquaFuel in view of Anomaly 3.2.7, which is evidently expected to alter the background due to anomalous residues of AquaFuel in the instrument after the completion of the tests.

Following a final control that *all* requested conditions were in place, NTS analysts ***Louis A. Dee*** and ***Norman Wade*** injected AquaFuel into the HP GC-MS/IRD and initiated the tests. The results constitute the first direct experimental evidence on the existence of magnecules in gases.

After waiting for the 26 minutes of the ramp time, ***sixteen heavy anomalous peaks appeared in the MS screen, thus providing direct experimental verification of Anomaly 3.2.1*** (Figure 3.1).

AquaFuel contains from 7% to 10% of CO_2 as per various chemical analyses conducted at high temperature, after adjustment due to air contamination [1b]. The spectrum of Figure 3.1 is from 40 a.m.u. to 500 a.m.u. Comparative inspection of the various peaks and their size establishes that they represent macroscopic percentages of compounds in AquaFuel which, according to quantum chemistry, should not exist, thus providing experimental evidence for Anomaly 3.1.1 beyond scientific doubt.

I should report that, at the appearance of the peaks of Figure 3.1.1, analyst ***Norman Wade*** stated "I have not seen something like these peaks in twenty five years of analyses".

The analysts then passed to the identification of the individual peaks of Figure 3.1. As illustrated in Figure 3.2 (see the complete documentation of Ref. [7b] for more data), ***all sixteen MS peaks of Figure 3.1 resulted to be "unknown", following the computer search in the memory banks of the McClellan Air Force Base comprising about 140,000 molecules, thus providing direct experimental verification of Anomaly 3.2.2.***

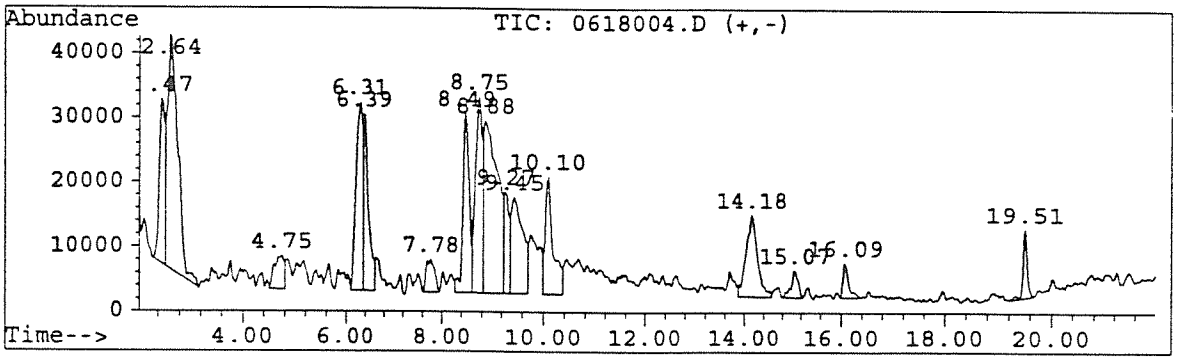
Note that there is no identifiable CO_2 peak in the MS spectrum of Figure 3.1. This absence is, per se, highly anomalous, because the CO_2 peak is well identifiable in conventional GC-MS measurements of the same gas at high temperature, Eq. (3.1.1). In fact, the absence of the CO_2 peak in

the MS is evidence that it is hidden in the remaining peaks of the spectrum.

After completing and documenting the MS data, the analysts passed to measurements at the IRD. To their surprise, ***none of the sixteen peaks of Figure 3.1 had any infrared signature at all, thus providing direct experimental verification of Anomaly 3.2.3*** (Figure 3.3). The IR scan for the MS peaks of Figure 3.1 only shows a peak belonging to CO_2, namely, to one of the *components* of the peaks of Figure 3.1. The IR signature of the other components do not appear in Figure 3.3 because they are behind the left margin of the scan. .

The analysts then established (Figure 3.4) that ***the IR peak of CO_2 is itself anomalous (mutated), thus providing experimental evidence for Anomaly 3.2.4.***

```
Information from Data File:
File       : C:\HPCHEM\1\DATA\0618004.D
Operator   : NAW
Acquired   : 18 Jun 98   3:01 pm using AcqMethod VOC_IRMS
Sample Name: TOUP'S TECH
Misc Info  : 1ML LOOP; 10C @ ULTRA COLUMN
Vial Number: 1
CurrentMeth: C:\HPCHEM\1\METHODS\DEFAULT.M
```



Retention Time	Area	Area %	Ratio %
Total Ion Chromatogram			
2.474	1753306	5.386	32.724
2.644	5091514	15.641	95.030
4.754	641528	1.971	11.974
6.307	2737749	8.411	51.098
6.390	2211258	6.793	41.272
7.782	592472	1.820	11.058
8.490	2357396	7.242	43.999
8.754	2784829	8.555	51.977
8.882	5357812	16.460	100.000
9.265	1123809	3.452	20.975
9.448	2421234	7.438	45.191
10.098	1946292	5.979	36.326
14.177	2129791	6.543	39.751
15.073	435208	1.337	8.123
16.085	389822	1.198	7.276
19.509	577433	1.774	10.777

FIGURE 3.1: A reproduction of the MS peaks providing the ***first experimental evidence on the existence of magnecules*** identified on June 19, 1998, by analysts ***Louis A. Dee*** and ***Norman Wade*** of the branch of *NATIONAL TECHNICAL SYSTEMS* (NTS) located at the

MCCLELLAN AIR FORCE BASE in North Highland, near Sacramento, California, under support from *TOUPS TECHNOLOGY LICENSING* (TTL) of Largo, Florida. The scan is restricted from 40 a.m.u to 500 a.m.u. The peaks refer to the combustible gas *AquaFuel*^{TM} [15c] under development by TTL, for molecular weights ranging from 40 a.m.u. to 500 a.m.u. AquaFuel is a *light* gas with only CO_2 as the heaviest molecule in macroscopic percentage with a molecular weight over 40 a.m.u. [1b]. Therefore, *only* the CO_2 peak should have appeared in the scan with any macroscopic size. On the contrary, the CO_2 peal is not identifiable at all in the scan; *all* sixteen peaks should not be present according to quantum chemistry; and the scan therefore provides the first direct experimental confirmation of Anomaly 3.2.1.

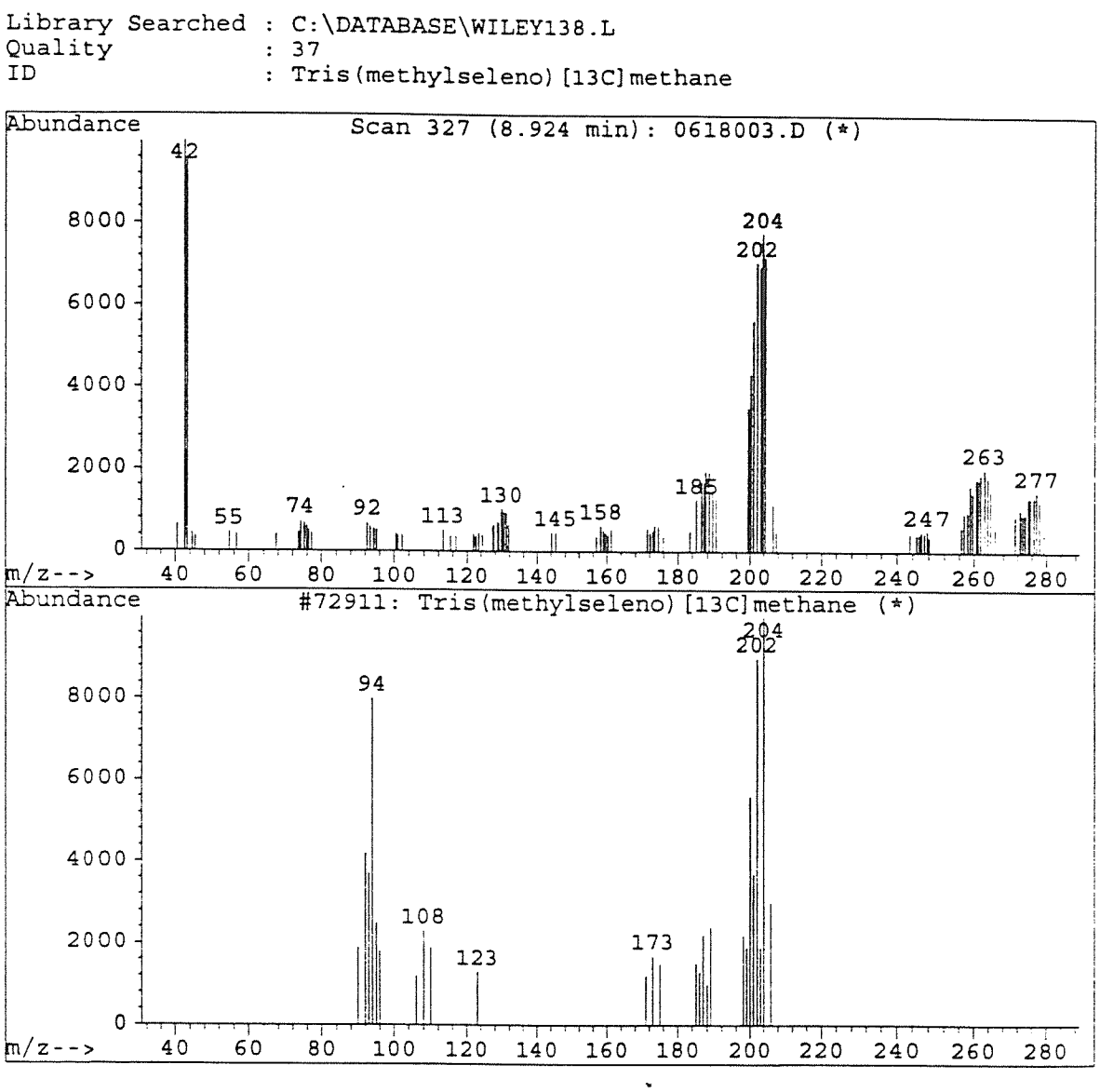


FIGURE 3.2: ***The first experimental evidence at NTS that the peaks of Figure 3.1 are "unknown"***. The peak at the top is that at 8.924 minutes and that at the bottom shows the lack of its identification by the computer search. Note that the best fit identified by the computer does not match the peak considered. Moreover, the identified substance (methylseleno) cannot possibly exist in AquaFuel because of the impossible presence of the necessary elements. Exactly the same situation holds for all remaining fifteen peaks of Figure 3.1 (see the complete documentation in Ref. [7b]), which remained "unknown", thus providing the first direct experimental verification of Anomaly 3.2.2.

```
File       : C:\HPCHEM\1\DATA\0618003.D
Operator   : NAW
Acquired   : 18 Jun 98   2:01 pm using AcqMethod VOC_IRMS
Instrument :   5972A
Sample Name: TOUP'S TECH SAMPLE
Misc Info  : 1ML LOOP; 10C START; ULTRA COLUMN
Vial Number: 1
```

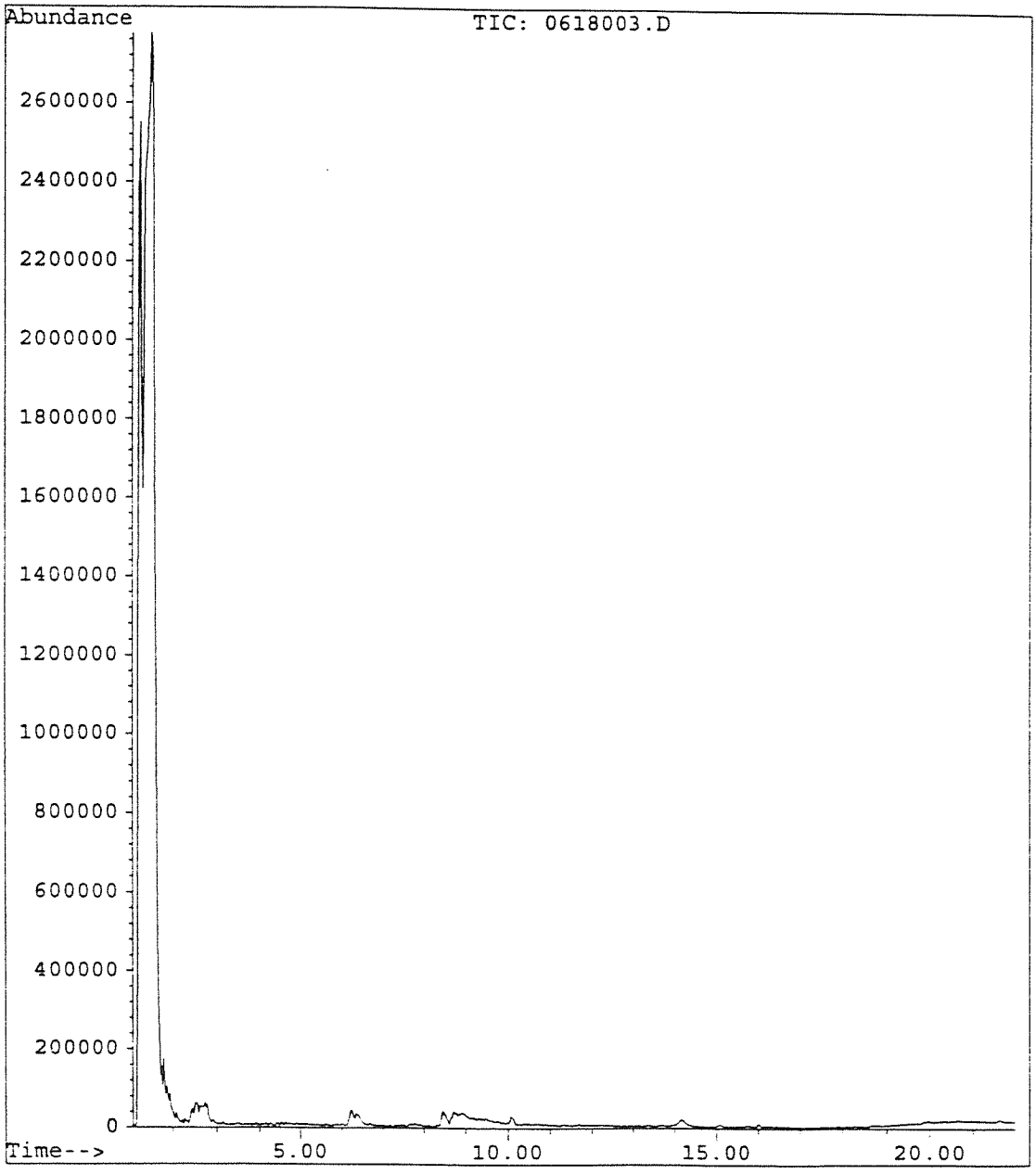
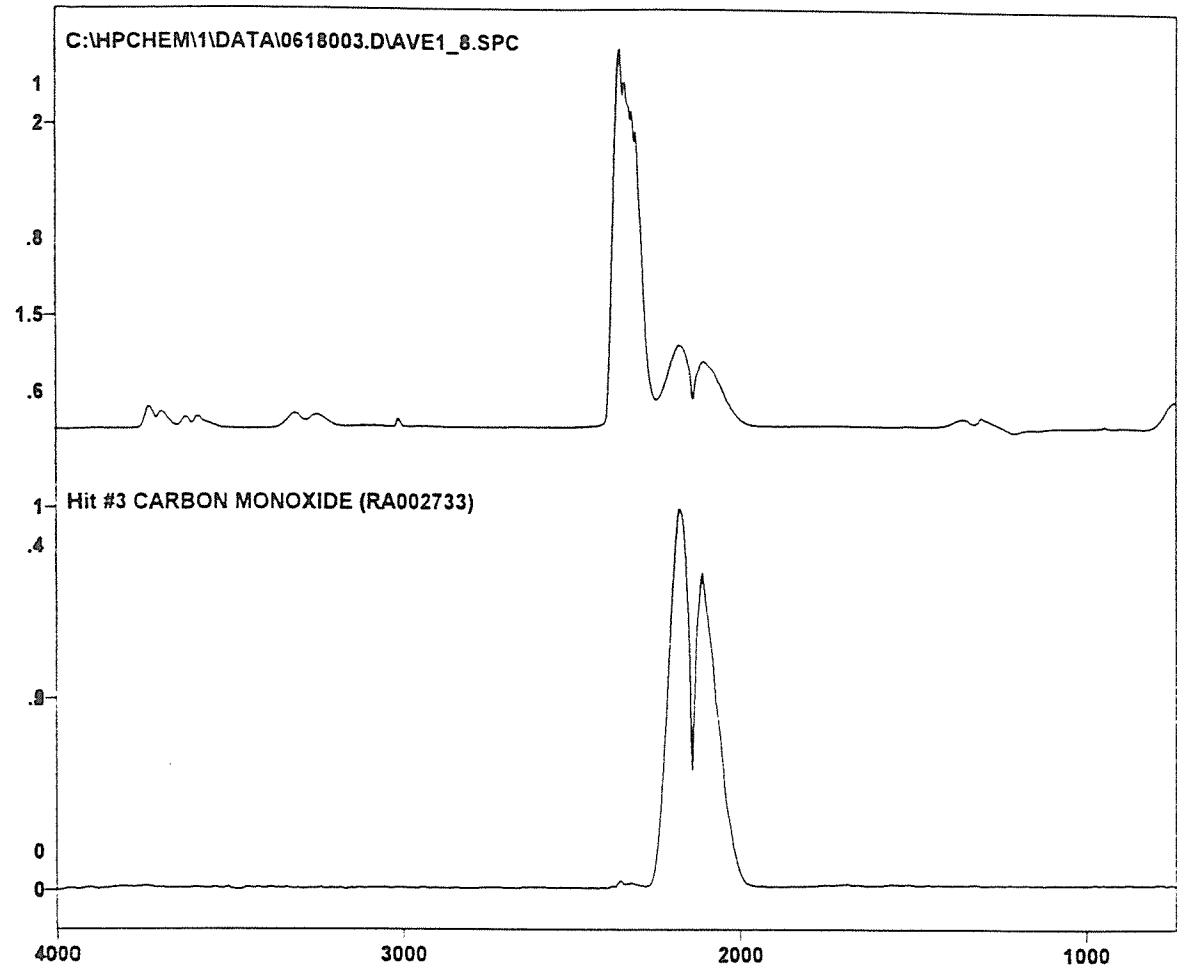


FIGURE 3.3: ***The first experimental evidence at NTS on the lack of IR signature of molecules.*** The evidence establishes the existence of large peaks in the MS which have no IR signature at all. This provided the first direct experimental verification of Anomaly 3.2.3. The only IR signatures which are possible in AquaFuel are those for the *constituents* of the peaks of Figure 3.1 which are ordinary gases such as O_2, CO, and CO_2. In the above figure only the IR signature of CO_2 appears because the scan was from 40 a.m.u. to 500 a.m.u. and, as such, could not include the IR signatures for O_2 and CO (H_2 has no IR signature).



Hit List

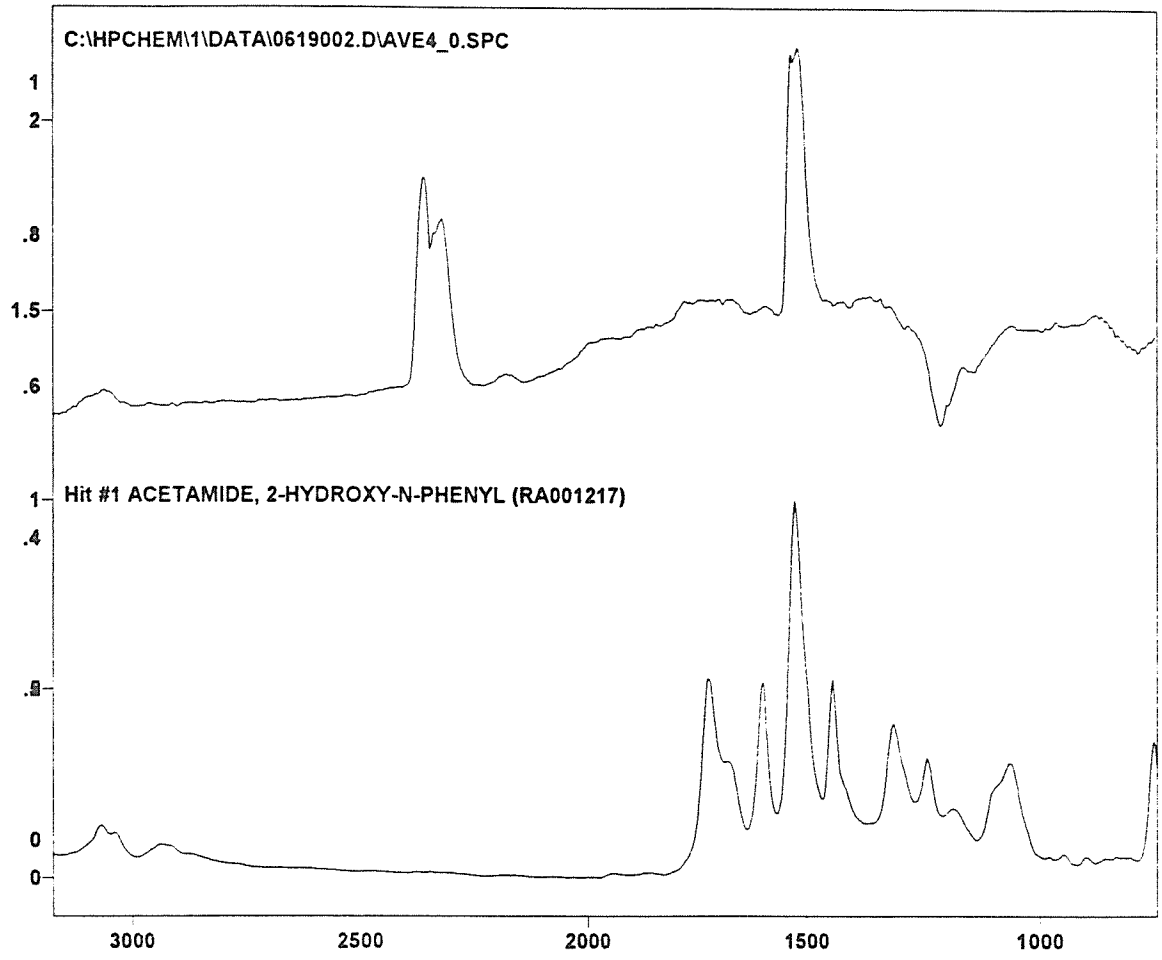
Wavenumber (cm-1)

Library	Hit Quality	Number	SPC Identification
EPA_REVA.LIB#2733	1.1855	3	CARBON MONOXIDE
EPA_REVA.LIB#2460	1.2135	4	OCTADECANE-D38
EPA_REVA.LIB#2647	1.2235	5	CYCLODODECANE-D24
EPA_REVA.LIB#201	1.2699	6	ISOTHIOCYANIC ACID, PHENYL ESTER
EPA_REVA.LIB#1408	1.2801	7	ISOTHIOCYANIC ACID, ALLYL ESTER
EPA_REVA.LIB#2260	1.291	8	ISOTHIOCYANIC ACID, P-FLUOROPHENYL E
EPA_REVA.LIB#1909	1.2953	9	THIOCYANIC ACID, METHYL ESTER
EPA_REVA.LIB#2593	1.3552	10	FORM-D-AMIDE, N,N-DI/METHYL-D6/-

FIGURE 3.4: ***The first experimental evidence at NTS on the mutation of the IR signature of magnetically polarized conventional molecules,*** here referring to the CO_2 (top) compared to the result of the computer search (bottom). This provides the first direct experimental verification of Anomaly 3.2.4, namely, that *conventional* molecules composing AquaFuel have a deformed space distribution of their electrons, as necessary to have a polarization of their orbits. In turn, such deformations imply a necessary mutation of the IR signature. Note that the known, double-lobe PQR peak of CO_2 persists in the detected peak with the correct energy, and only with decreased intensity. Jointly, there is the appearance of *two new peaks* which is evidence of *new internal bonds within the conventional CO_2 molecule*. This evidently implies an increased energy content, thus establishing experimental foundations for a new technology of magnetically polarized gases with enhanced energy content. ***Note that the computer interprets the IR signature as belonging to CO, which is erroneous since CO is out of the selected range of detection. The signature is instead that of CO_2 as confirmed in subsequent tests (see Figure 3.8).***

Search Method for C:\HPCHEM\1\DATA\0619002.D\AVE4_0.IDS
Sample Name = AVE4_0.SPC
Search Date = 06-19-1998 11:07 AM
Mask Used = None

Text Search = None
Peak Search = Forward
Full Spectrum Search = Euclidian Distance
Custom Search = None



Hit List

Wavenumber (cm-1)

Library	Hit Quality	Number	SPC Identification
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EPA_REVA.LIB#2196	.77047	2	ETHER, BENZYL 4-NITRO-M-TOLYL
EPA_REVA.LIB#1833	.78069	3	ACETANILIDE, 2-CHLORO-4'-NITRO
EPA_REVA.LIB#2946	.7943	4	QUINALDINE, 8-NITRO
EPA_REVA.LIB#2246	.79546	5	P-LACTOTOLUIDIDE
EPA_REVA.LIB#2874	.81055	6	ACETIC ACID, /2,4-DICHLOROPHENOXY/-
EPA_REVA.LIB#2208	.82026	7	THIAZOLE, 2-AMINO-4-METHYL
EPA_REVA.LIB#1253	.82986	8	ANTHRACENE, 9-METHYL
EPA_REVA.LIB#2232	.83935	9	M-CRESOL, 4-NITRO
EPA_REVA.LIB#1900	.84047	10	BIPHENYL, 2,2PR-DINITRO

FIGURE 3.5: A reproduction of the lack of identification in the computer search of small peaks in the IR scan. The best possible match offered by the computer (lower peak) does not even partially recover the detected IR peak (top). At any rate, the suggested substance (Acetamide) cannot possibly exist in AquaFuel, because of the lack of the necessary elements. All other smaller IR peaks remained equally unknown.

This result is particularly important inasmuch as it provides ***experimental evidence for a mutation of the structure of conventional molecules with the presence of additional strong internal binding forces, also expected to be of magnetic type, which is expected to imply an increased energy content.***

To appraise the implication of this aspect alone, one should consider the fact that it provides ***experimental evidence on the polarization of the orbits of internal non-valence electrons***, evidently because valence electrons cannot provide any additional molecular bond for both conventional and hadronic chemistry.

The analysts also inspected small peaks in the IR scan, and they all resulted to be "unknown", as shown in Figure 3.5, thus completing the experimental evidence of the anomalous IR behavior.

Following the measurements, I received the following signed report dated June 23, 1998 (see the original in App. I of Ref. [7b]):

"Dear Dr. Santilli,

Thank you for the opportunity to provide analytic data on AquaFuel™. Attached are all GC-MS and concomitant GC-IR data that we obtained for the unfiltered sample.

... Our blank runs obtained before and after the analyses show no high mass spectra, thus proving that the high molecular weight species found were actually in the AquaFuel™ sample.

.... Search results using a library of 138,000 chemical compounds, did not indicate any matches with this high molecular weight species found in AquaFuel™.

Based on the limitations of our equipment and our inability to find a library match, the identification of this mysterious AquaFuel™ ingredient is an unknown."

National Technical Systems
Louis A. Dee
Branch Manager"

The measurements on the same sample of AquaFuel tested at NTS were repeated on July 25, 1998, by analyst ***Kevin Lothridge*** via a GC-MS/IRD located at the *PINELLAS COUNTY FORENSIC LABORATORY* (PCFL) of Largo, Florida, under TTL support (for complete documentation see App. II of Ref. [7b]).

The equipment consisted of an HP GC model 5890 Series II, an HP MS model 5970 and an HP IRD model 5965B. Even though similar to the equipment used at NTS, the PCFL equipment was significantly different inasmuch as the temperature had to be increased from 10 C to 55 C and the ramp time reduced from 26 minutes to 1 minute. The latter reduction implied the cramping of all peaks of Figure 3.1 into one single large peak, a feature confirmed by all subsequent GC-MS tests with short ramp time.

Despite these differences, the test at PCFL confirmed *all* Anomalies 3.2.1 to 3.2.4 first detected at NTS. In addition, the tests provided the first experimental evidence of additional anomalies.

Following my request, analyst ***Kevin Lothridge*** conducted *two* MS tests of the *same* AquaFuel sample at *different times* about 30 minutes apart. As one can see in Figure 3.9, ***the test at PCFL provided the first experimental evidence of Anomaly 3.2.5, the mutation in time of magnecules.*** In fact, the peak of Figure 3.9 is macroscopically different than that of Figure 3.6.

This difference provided evidence that, when colliding, magnecules can break down into ordinary molecules, atoms, and fragments of magneclusters, which then recombine with other molecules, atoms, and/or magnecules to form new unknown peaks. Equivalently, the experimental evidence establishes the expectation that mutation of magnecules can simply occur via the accretion of release of another polarized atoms or molecule without breaking down.

As one can see in Figure 3.10, the tests conducted by analyst ***Kevin Lothridge*** also provided ***the first experimental evidence that the background following the end of the measurements resulted to be significantly similar to the MS scan, thus providing a***

direct experimental verification of Anomaly 3.2.7 on the anomalous adhesion of magnecules.

The original background prior to the measurements with AquaFuel was re-obtained only after flushing the instrument with an inert gas at about 250 C. Such flushing heated the interior walls and parts of the instrument, thus breaking down all magnecules, terminating their anomalous adhesion and re-establishing their conventional molecular structure.

A third independent verification was conducted on July 29, 1998, by analyst ***David Fries*** at the *CENTER FOR OCEAN TECHNOLOGY* of the *UNIVERSITY OF SOUTH FLORIDA* (USF) in St. Petersburg, under TTL support. The test were done via the use of a GC-MS Barian 2000 in which the GGC had been removed and replaced by a modified Paul's Trap which turned the instrument into a Ion Trap Mass Spectrometer (IT-MS).

Since the equipment belongs to an academic laboratory, it was not equipped with an IRD. This is unfortunate for scientific knowledge, because Paul's Trap is based on a locally strong magnetic field, which is expected to polarize all conventional molecules (although in an amount evidently less than the extreme magnetic fields of an electric arc).

In fact, the background of the instrument prior to the initiation of measurements showed various peaks which were tentatively identified as conventional molecules. The presence of an IRD would have evidently permitted the separation of science from personal beliefs.

Only the additional presence and use of an IRD would have permitted the scientific identification of the peaks, because of the sole existence of two possibilities: the IR signatures of the peaks in the background are those of the believed conventional molecules; or said peaks have no IR signature at all, in which case they cannot be conventional molecules.

As one can see in the following figure 3.11-3.21 (see Appendix III of Ref. [7b] for the complete documentation), despite the lack of IRD, the measurements provided a third independent verification of *all* preceding experimental evidence on the existence of magnecules.

Moreover, ***the USF measurements established the existence in the AquaFuel magnecules of individual hydrogen atoms, due to the accretion or loss by various peaks of only one hydrogen atom due to variations of only one a.m.u.*** This result was expected because of the known high sensitivity of Paul's Trap. The presence in the AquaFuel magnecules of other individual atoms (such as C or O) is implies in the preceding NTS and PCFL measurements, although it is best established for the case of the hydrogen.

In view of the above occurrence, inspection of the various MS scans indicates ***the absence in magnecules of systematic numerical periodicities,*** e.g., their systematic increase with periodicity two (sole accretion of H_2 molecules), or thirty-eight (sole accretion of CO molecules).

Experimental evidence on the disappearance of all unknown peaks at sufficiently high temperatures was established for the first time by Dr. ***N. Palibroda*** and Dr. ***P. Glueck*** at the *INSTITUTE FOR ISOTOPIC AND MOLECULAR TECHNOLOGIES* (IIMT) of Cluj-Napoka, Romania, also under TTL support, via a GC-MS MAT 311.

When operated at 150 C, the *same* sample of AquaFuel tested at NTS, PCFL, and USF showed no unknown species at all, and only ordinary light gases with ppm of more complex composites of H, O and C. This result provided additional support on magnecules as being made-up of ordinary molecules and atoms under a new bond of magnetic origin.

Additional experimental confirmation of the above GC-MS/IRD results have been conducted and are reported in monograph [7b].

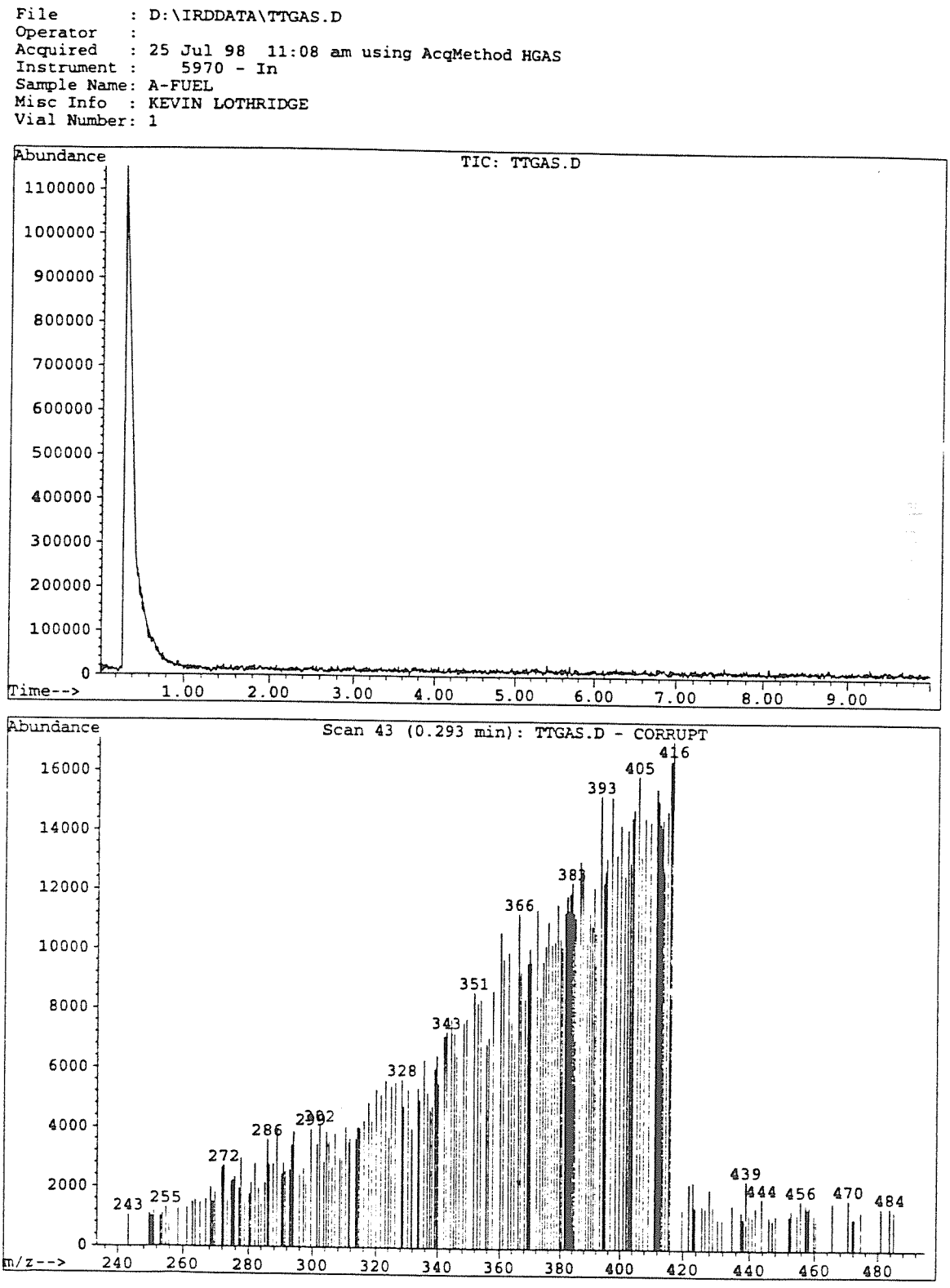


FIGURE 3.6. A view of the IRD scan (top) and MS spectrum (below) of AquaFuel conducted by analyst ***Kevin Lothridge*** on July 25, 1998, via a HP GC-MS/IRD located at the *PINELLAS COUNTY FORENSIC LABORATORY* (PCFL) of Largo, Florida, under support from *TOUPS TECHNOLOGY*

LICENCING (TTL) also of Largo, Florida. The scan is also restricted to the range 40 a.m.u to 500 a.m.u. As one can see, the scan confirms the anomalous peaks of Figure 3.1 obtained at NTS which are clustered into the single peak (bottom view) due to the short ramp time of 1 minute (as compared to 26 minutes of the NTS scan). The scan also confirms the results of Figure 3.3 obtained by NTS on the lack of IR signature (top view).

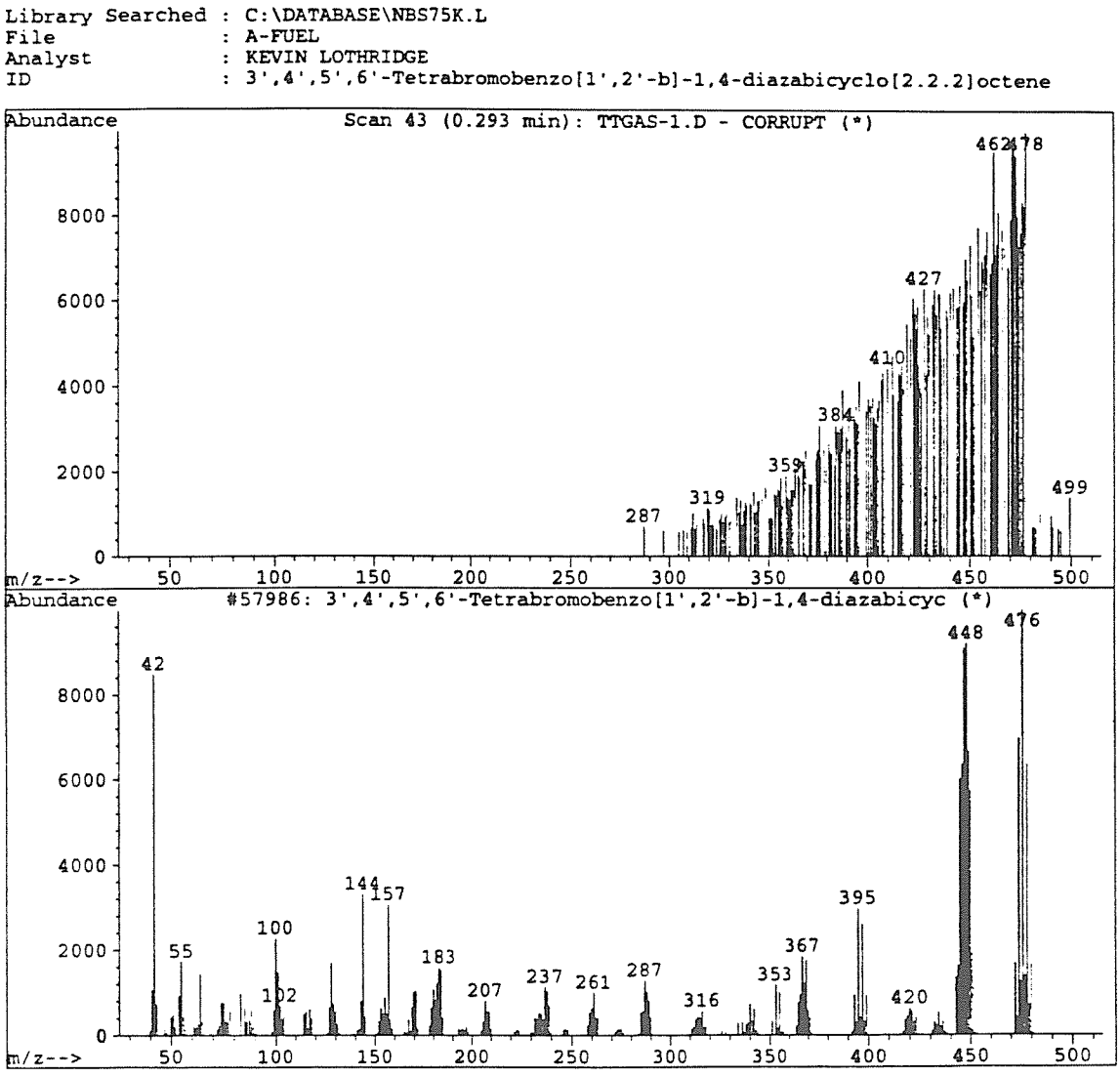
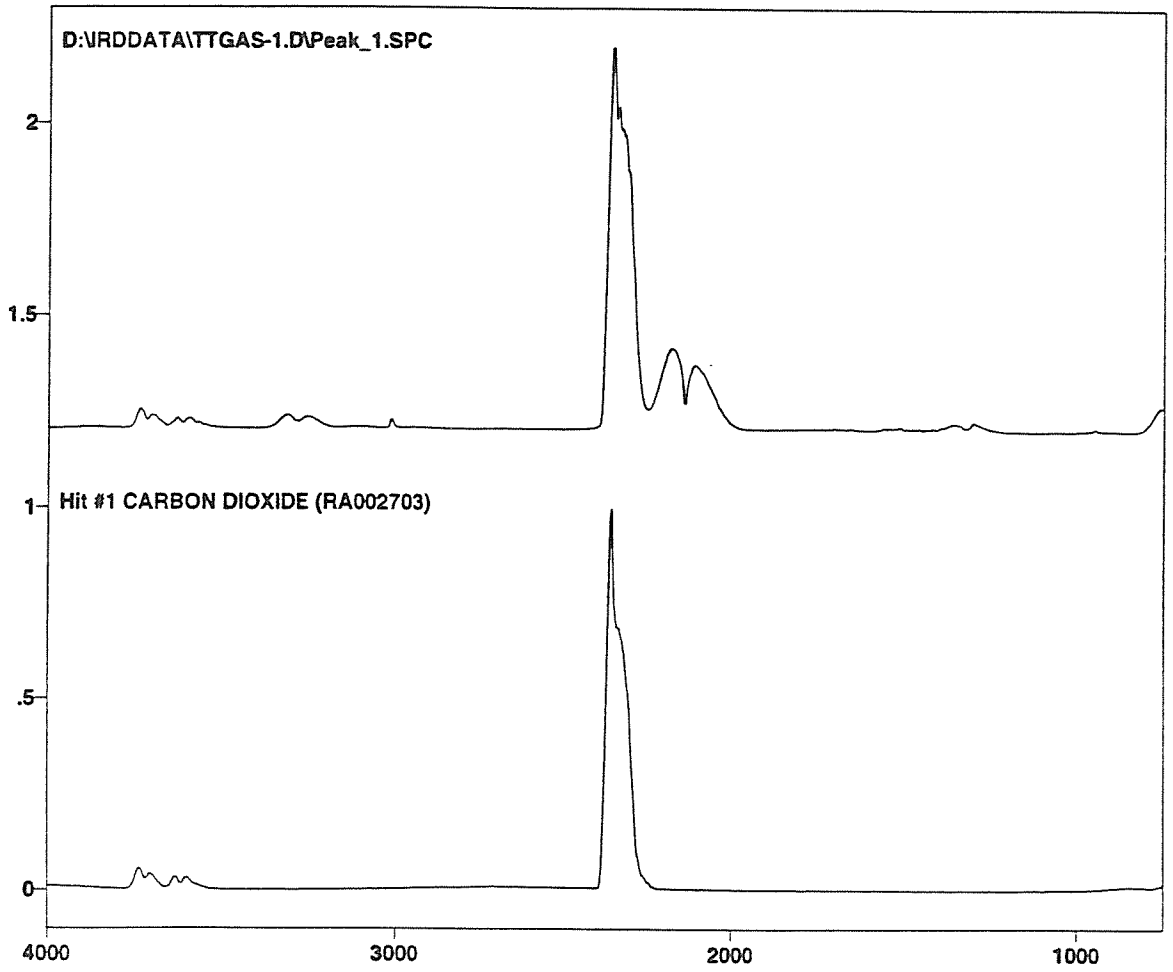


FIGURE 3.7: A confirmation at the PCFL of the NTS result of Figure 3.2, the lack of identification by the computer search of the peaks in the MS (see App. II of Ref. [7b] for the complete documentation). Again, the substance selected by the computer as the best match (bottom) does not even approach the detected peak (top), besides being impossible for AquaFuel because of the lack of needed elements.

Search Method for D:\IRDDATA\TTGAS-1.D\Peak_1.IDS
Sample Name = Peak_1.SPC
Search Date = 7/25/98 11:51 AM
Mask Used = None

Text Search = None
Peak Search = Forward
Full Spectrum Search = Euclidian Distance
Custom Search = None



Hit List

Wavenumber (cm-1)

Library	Hit Quality	Number	SPC Identification
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C:\DATABASE\IRD\EPA_R(	1.1872	2	CARBON MONOXIDE
C:\DATABASE\IRD\EPA_R(	1.1941	3	CARBODIIMIDE, BIS/2,6-DIETHYLPHENYL/
C:\DATABASE\IRD\EPA_R(	1.2188	4	OCTADECANE-D38
C:\DATABASE\IRD\EPA_R(	1.2264	5	CYCLODODECANE-D24

FIGURE 3.8: The independent confirmation at the PCFL of the NTS finding of Figure 3.4 regarding the mutated IR signature of the CO_2 in AquaFuel. Note the identical shapes of the mutated IR peak in the top of the above figure, and that in Figure 3.4 obtained via a different instrument. Note also the appearance again of two new peaks in the IR signature of CO_2, which indicate the presence of *new bonds* not present in the *conventional* molecule. The only interpretation known at this writing is that the intense magnetic field cause polarization of the orbits of internal non-valence electrons, which create internal new bonds of magnetic type. This evidence confirms ***the capability of the new technology of magnetically polarized gases of storing anomalous amounts of energy within molecules and magnecules.***

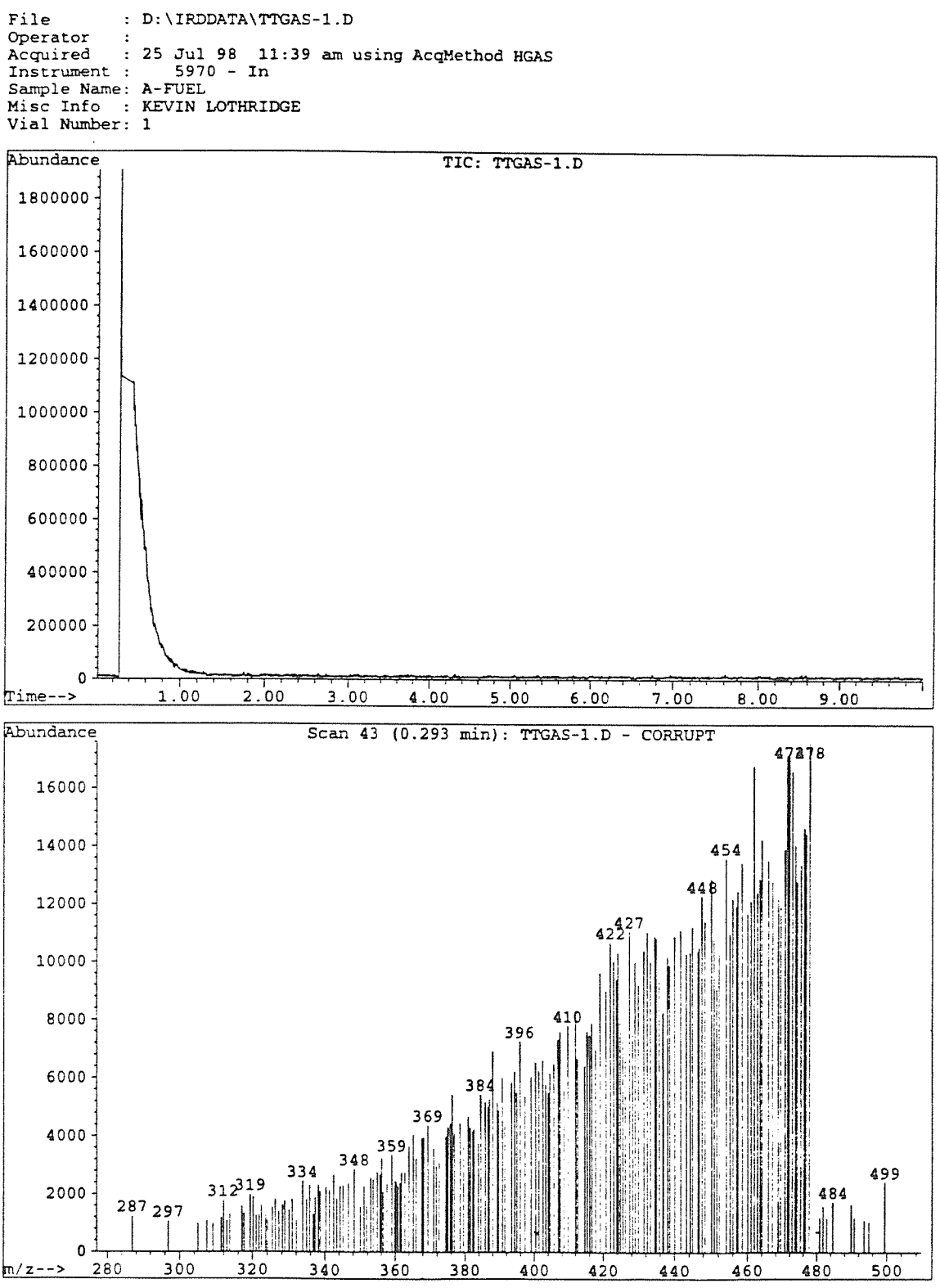


FIGURE 3.9: The first direct experimental verification of Anomaly 3.2.5 obtained by analyst ***Kevin Lothridge*** at the PCFL on July 25, 1998, on the mutation in time of the magnecules constituting AquaFuel. The MS peak of this figure is macroscopically different than that of Figure 3.6, despite the fact that they refer to the *same gas* (without even removing the bottle from the feeding line), only scanned 30 minutes apart.

```
File       : D:\IRDDATA\AIRBLANK.D
Operator   :
Acquired   : 25 Jul 98  10:55 am using AcqMethod HGAS
Instrument :    5970 - In
Sample Name: BLANK
Misc Info  : KEVIN LOTHRIDGE
Vial Number: 99
```

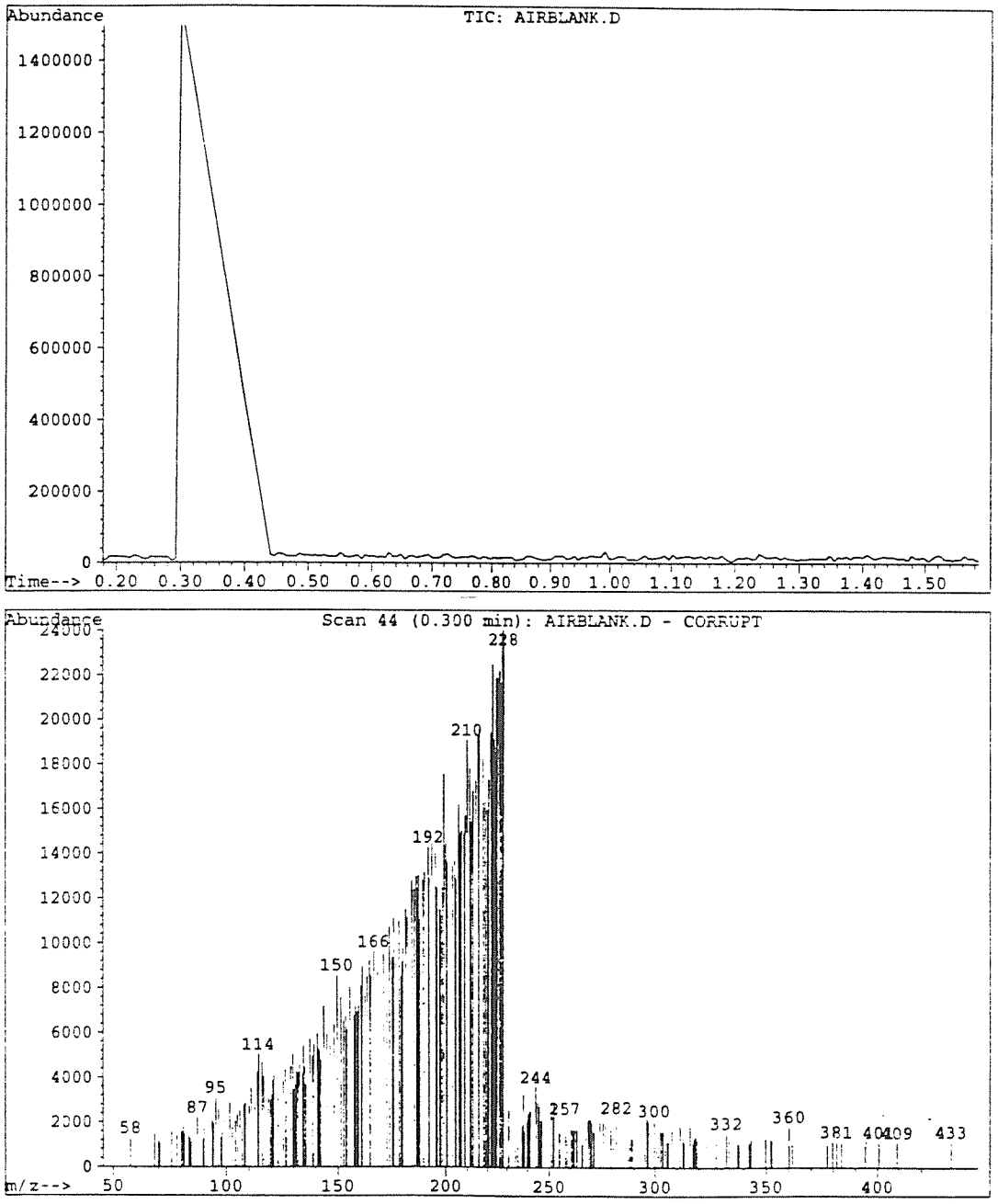


FIGURE 3.10: The first direct experimental verification obtained at PCFL of Anomaly 3.2.7, the anomalous adhesion of magnecules. The figure reproduces the background of the instrument upon completion of the measurements and removal of AquaFuel. Nevertheless, the background results to be very similar to the MS scan during the tests, thus establishing that part of the gas had remained in the interior of the instrument. This behavior can only be explained via the induced magnetic polarization of the atoms and molecules in the walls and parts of the instrument, with consequential increased adhesion via magnetic bonds. It should be noted that this anomalous adhesion has been confirmed by all subsequent tests for both the gaseous and liquid states. The removal of magnecules in the instrument after tests is easily done by flushing it with an inert gas at high temperature.

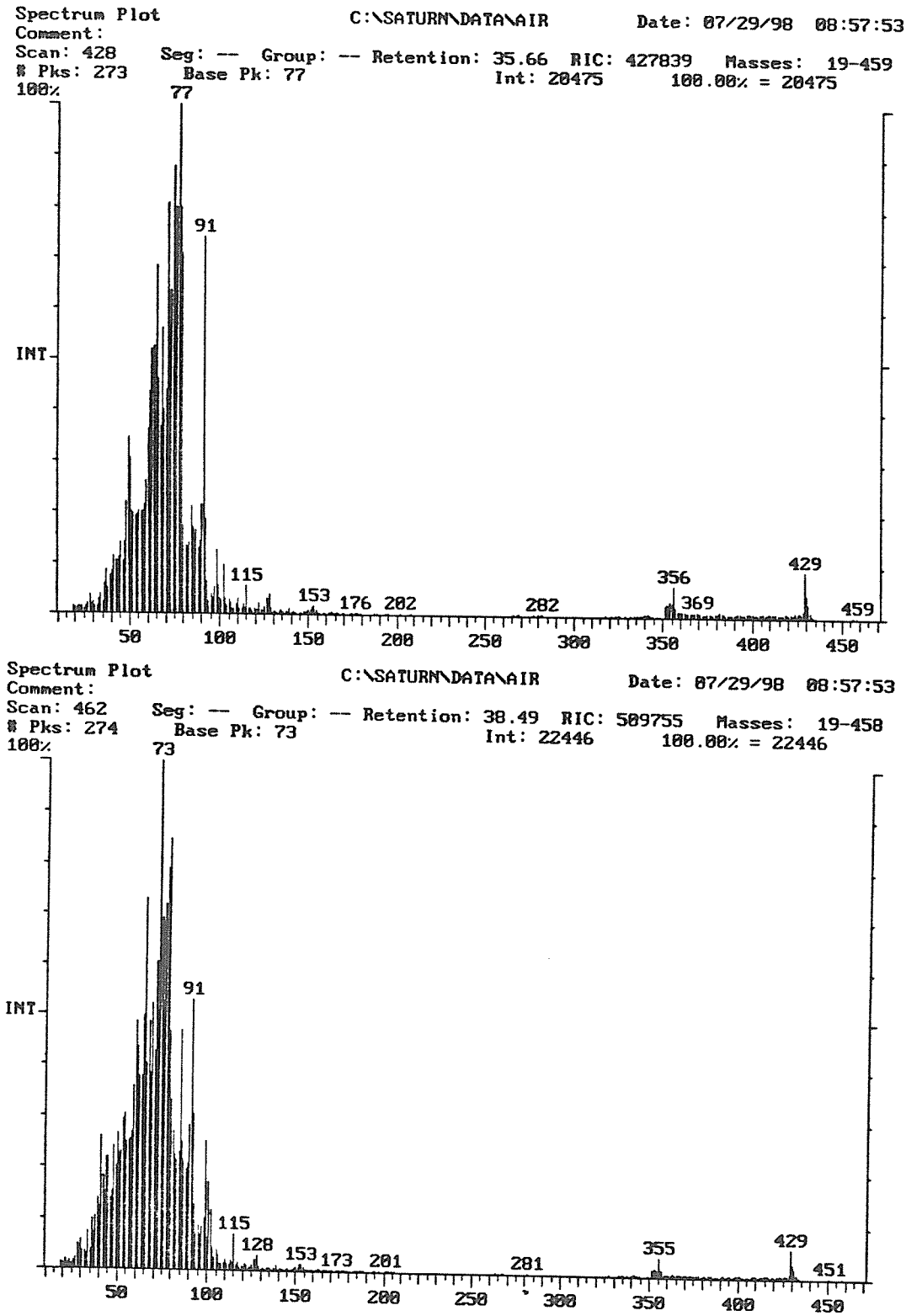


FIGURE 3.11: Scans 428 and 462 of the tests conducted on AquaFuel on July 29, 1998, by analyst *David Fries* at the *CENTER FOR OCEAN TECHNOLOGIES* of the *UNIVERSITY OF SOUTH FLORIDA* (USF) in St. Petersburg, under support by *TOUPS TECHNOLOGY LICENSING* (TTL) of Largo, Florida. Note the mutation of the largest peak from 77 a.m.u. to 73 a.m.u, which can only be interpreted as due to the loss of two hydrogen molecules, which could therefore be bonded into the elementary hydrogen magnecule. Note also the loss of one unit of the peaks at 282 a.m.u and 356 a.m.u which are evidence of the presence of one individual hydrogen atom, as confirmed by other tests.

3.5. Origin of Anomalous Energy Content (Copyrighted and Patent Pending)

As indicated earlier, a most significant aspect of AquaFuel is its anomalous energy content. According to quantum chemistry and analysis (3.1.1), AquaFuel should contain about 167 BTU/cf, while in reality AquaFuel cuts steel bars as fast and efficiently as Acetylene, which has 2,300 BTU/cf. Empirical and yet inconclusive means for measuring the BTU content of AquaFuel (reported in Ref. [1b]) have established that AquaFuel has a *minimum* of 380 BTU/cf, that is, at least 2.27 the value predicted by quantum chemistry. Higher values of BTU content are expected with the development of the technology needed for the utilization of all the internal energy (see below).

It is evident that this is an anomaly of particular industrial relevance, because, once its mechanism is understood, it can be applied to other combustible gases, thus increasing their energy content, and evidently decreasing environmental drawbacks. The evidence is also scientifically very intriguing.

The primary origins of the anomalous increase of energy content of AquaFuel currently known are the following:

1) New internal bonds in ordinary molecules. Recall that peaks in the IR scan essentially represent internal molecular bonds. The IR scan of Figures 3.4 and 3.8 are particularly important because they *establish the existence in the C–O molecule of two new internal bonds characterized by the two new peaks.* It is evident that these bonds *cannot* be of valence type, since that bond is already represented by the large IR peak of the same figures. The only possible explanation of the above experimental evidence is therefore that *the two new internal bonds are of magnetic type.* In turn, the only possible explanation is that the intense magnetic fields of the electric arc polarize in a plane the orbits of valence electrons, as established by the magnetic bonding of different molecules, and also polarize the orbits of internal, non–valence electrons, thus *creating new magnetic bonds within the structure of conventional molecules themselves, in addition to magnetic bonds between molecules.* Calculations show that these new, internal, magnetic, molecular bonds can store a virtually unlimited amount of energy, thus providing the first explanation of the anomalous energy content of AquaFuel.

2) Bigger efficiency in chemical reactions. All energies released by chemical reactions in gases, such as the basic reactions

$$H_2 + O_2 / 2 \rightarrow H_2O + 57 \text{ Kcal / mol}, \qquad (3.5.1)$$

have been measured until now for *gas molecules in their conventional spherical shape due to rotations.* According to hadronic chemistry, it is easy to see that, before the above reaction can take place, the orbits of the valence electrons of the hydrogen and oxygen must be polarized in a plane, so as to permit their bonding into the isoelectronium. It is evident that *magnetically polarized gas molecules admit chemical reactions with an efficiency bigger than that of conventional molecules,* because the atoms to be bonded already have the necessary polarization. It then follows that the basic reaction (3.5.1)for magnetically polarized gases releases more energy than the same reaction for conventional gases, thus providing a second explanation for the anomalous energy content of AquaFuel. Needless to say, the same enhancement of energy release for magnetically polarized gases applies also for all other esoenergetic chemical reactions.

3) Molecular attractions. Ordinary gas molecules have no mutual attractions, again, due to their rotations, while *magnetically polarized molecules can instead attract each other, thus implying an additional increase in the efficiency of reactions (3.5.1), as well as others.*Note that a 2.27 increase of energy release implies the increase of energy released by reaction (3.5.1) from 57 Kcal/mole to 129 Kcal/mole.

In summary, *the dramatic increase of energy release by magnetically polarized gases, more than double that of the same unpolarized gases, is the most convincing evidence I have encountered to date on the insufficiencies of quantum chemistry in its most important topic, the molecular structure.*

The anomalous energy content outlined in this section also clarifies the extreme difficulties I have encountered in the measure of the energy content of AquaFuel. The anomalies establish that *all existing calorimeters are not suited for the measurement of energy release under the above anomalies.*

As a specific example, measures of BTU content based on ordinary burning methods will indeed measure the energy associated to *conventional chemical reactions,* but they cannot measure the *internal anomalous energy in molecules,* because ordinary low burning is insufficient for that task. In this case, the unmeasured energy is merely expelled in the exhaust.

The above occurrence has been established at TTL via comparative measurements in using AquaFuel as a fuel for a four cylinder engine with conventional coils delivering sparks at 15,000 V, and the same with race coils delivering sparks at 45,000 V. The latter have indicated an increased energy release of the *same* gas under the *same* conditions of at least 25 %.

In view of the implications of the above anomalies, the continuation of accurate scientific measurements on magnetically polarized gases is trongly needed, because they are crucial for any serious industrial development on new technologies. As an example, a much needed measurement is that on reaction (3.5.1) via the use of magnetically polarized hydrogen and oxygen gases, *e.g.*, as obtainable from AquaFuel or MagneGas via ordinary separation methods.

3.6. Creation of Magnecules in Liquids (Copyrighted and Patent Pending)

The way in which I first created magnecules in liquids is the following. In early 1998 I obtained a number of samples of fragrance oils thanks to the courtesy of the multinational giant in the fragrance industry, *GIVAUDAN ROURE CORPORATION* (GR) with headquarters in Teaneck, New Jersey. The samples were obtained also via the collaboration of *MILLENNIUM CORPORATION* (MC) of Orlando, Florida.

I then placed about 50 cc of various samples of perfectly transparent fragrance oils in individual glass containers and immersed in said oils one polarity of an alnico permanent magnet with 12,000 G and dimension 1/2" × 1" × 2" supplied by *BUNTING MAGNETIC CORPORATION* of Newton, Kansas.

Starting with perfectly clear oils of known viscosity, I observed after a few days a visible darkening of the oils, jointly with a visible increase of the viscosity. The changes evidently varied from oil to oil. Both the darkening and the viscosity increased progressively in subsequent days, to reach in certain cases a dark brown color completely opaque to light. The viscosity increased to such an extent that the oil lost all its fluidity.

Following the darkening, in certain samples, there was the creation of floating objects which grew in time to such a size to be visible to the naked eye.

I should stress that the above visible effects are of pure magnetic origin because of the lack of any other contribution, *e.g.*, the complete absence of any additives. After the immersion of the permanent magnets, all samples were left open and undisturbed at ordinary room conditions.

The above tests established beyond scientific doubt that the alteration of the characteristics of the oil was of sole magnetic origin, thus excluding all other possible sources.

My main hypothesis on the reason for the darkness of the oils is that their molecules acquire a magnetic polarization in the orbits of at least some of their electrons (cyclotron resonance orbits), by therefore bonding to each other as it occurs for gases.

I should indicate that the immersion of one polarity of a permanent magnet in fragrance oils

is, evidently, the most rudimentary possible way to create magnecules. A number of more sophisticated magnetic polarization techniques are now available with rather complex geometries, which I am not at liberty of disclosing at this time.

3.7. Photographic Evidence of Magnecules in Liquids (Copyrighted and Patent Pending)

The above alteration of the structure of fragrance oils is easily confirmed by photographs taken with microscopic with minimal magnification, as illustrated in the pictures of Figures 3.12 and 3.13.

The pictures of Figures 3.12 refer to the GR fragrance oil received under the code "ING258AIN, Text 2" subjected to the rudimentary magnetic polarization indicated in the preceding section under the respective magnification 10X and 100X.

As one can see, these photographs establish that, under the indicated magnetic treatment, the oil has acquired a structure of the type of "brick layering" which is visible under only 10X magnification (top of Figs. 3.12), which is per se highly anomalous for a liquid that was originally fully transparent. The magnecules are *not* constituted by the individual "bricks" shown in the 100X magnification (bottom of the figures), but rather by the dark substance which interlock said "bricks".

Inspection of the various photograph shows a variety of sizes of magnecules, thus establishing their lack of unique characteristics for any given oil. This evidently confirms the *lack* of a valence bond (evidently because the latter would imply a fixed maximal size). The photographs also show the magnecules capability for accretion, that is, the capability of increasing their size via the addition of further oil molecules.

The photographs in Figures 3.13 are for the same magnifications 10X and 100X, but refer to different GR fragrance oils, "Mixture 2" magnetically treated to such a point to complete loss of transparency and fluidity.

As one can see, the latter picture provides incontrovertible confirmation that, following exposure to a 12,000 G magnetic field, fragrance oil molecule bond together into rather large clusters estimated to be well in excess of 10,000 a.m.u., thus confirming Anomaly 3.2.1 for liquids.

Other photographic documentations of various magnecules in liquids are available confirming the above findings (see monograph [7b]).

The dramatic difference in the structure of Figures 3.12 and 3.13 indicates that the ,magnetic polarization of liquids evidently varies with the composition.

3.8. Spectroscopic Evidence of Magnecules in Liquids (Copyrighted and Patent Pending)

The first experimental evidence on magneclusters in liquids was established on May 5, 1998, by analysts ***Brian Wallace*** and ***Mia Burnett*** at *TEKMAR-DOHRMANN CORPORATION* (TDC) in Cincinnati, Ohio, operating a Tekmar 7000 HT Static Headspacer Autosampler equipped with a Flame Ionization Detector (FID).

The tests were repeated on May 8 and 11, 1998, by confirming the preceding results. The tests were done with the assistance of Millennium Corporation of Orlando, Florida.

The measurements were done on: Sample 1, pure (magnetically untreated) GR "Fragrance Oil 2"; Sample 2, magnetically untreated tap water; and Sample 3, a magnetically treated mixture of the two.

It should be noted that the Tekmar equipment lacks the computer search as well as the UV scan. Also, recall that magnecules in a *light gas* can have molecular weight all the way to 1,000 a.m.u. and more, as established in AquaFuel.

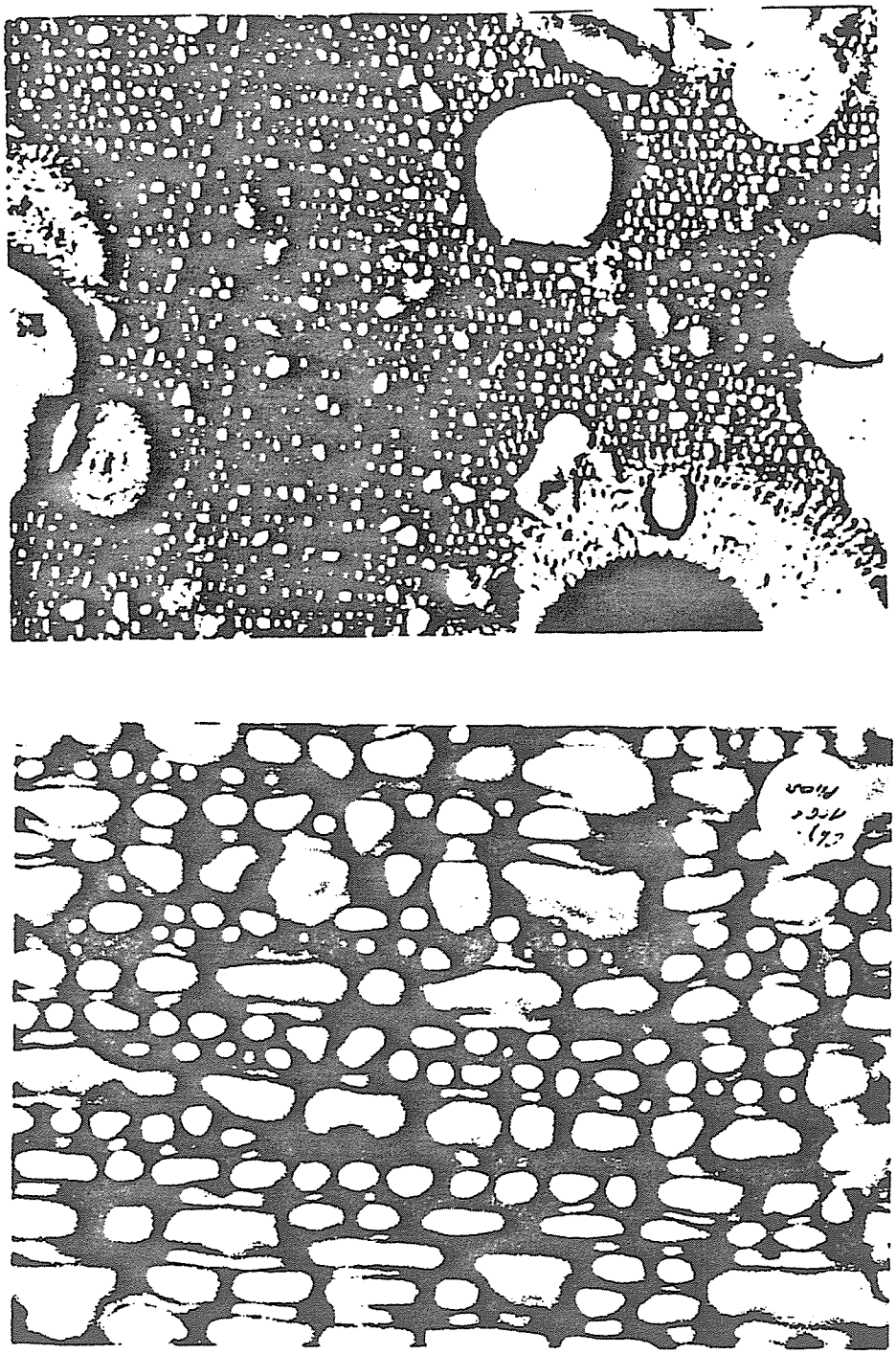


FIGURE 3.12: ***First photographic evidence of magnecules in liquids*** obtained at the Givaudan-Roure Research Laboratory in Dubendorf, Switzerland, on in the GR fragrance oil "1NG258IN Test 2" under magnifications 10X and 100X.

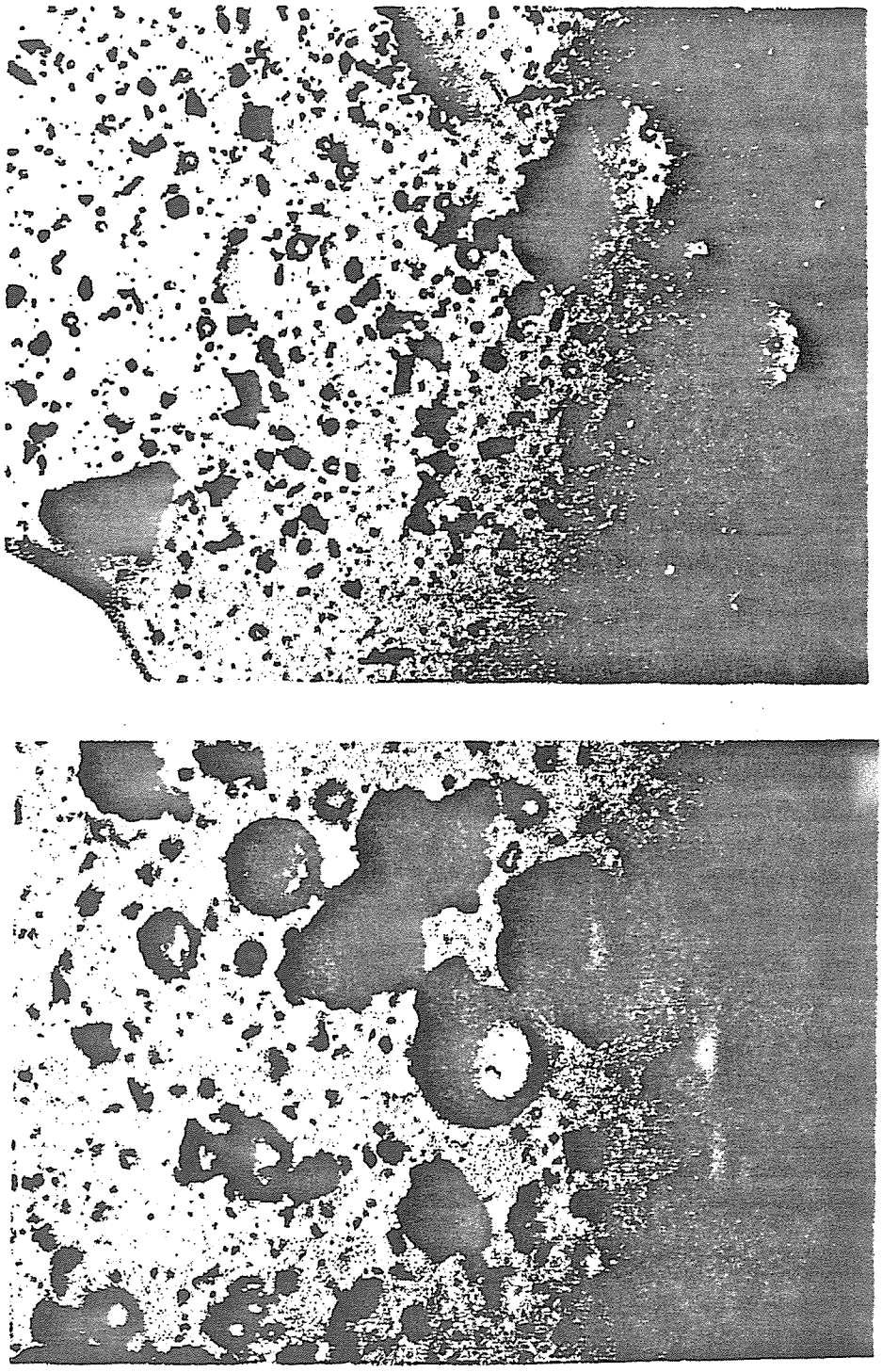


FIGURE 3.13: Confirmation of magnecules in GR fragrance oil "Mixture 2" under 10X and 100X obtained at the University of South Florida in St. Petersburg. Note the difference in sizes of the magnecules and their difference with those of Figure 3.12.

It then follows that magnecules in *liquids* can have much bigger molecular weight all the way to 10,000 amu and more, thus requiring instruments cryogenically operated and kept at room temperature, equipped with extra large feeding lines, and capable to scan all the way to very high molecular weights. The latter features were absent in the considered Tekmar instrument.

Despite that, *the results of the Tekmar tests provided the first direct spectroscopic experimental evidence of the existence of magnecules in liquids, including the first direct experimental evidence of water magneplexes* as per Definition 3.2.1. In particular, these test established that magnecules in liquids have all the same anomalies of the magnecules in gases. A comprehensive presentation of the results is provided in monograph [7b].

Additional comprehensive tests via a very modern equipment for Liquid Chromatographic Mass Spectroscopy (LC-MS) with UltraViolet Detector (UVD) were conducted on the GR fragrance oil "ING258IN Test 2" of Figures 3.12 on December 1, 1998, by Prof. ***Kenneth G. Furton,*** Chairman, and Prof. ***Piero R. Gardinali, Laboratory Director,*** *DEPARTMENT OF CHEMISTRY* of *FLORIDA INTERNATIONAL UNIVERSITY* (FIU), Miami, Florida. The tests were then repeated on December 17 and 18 by confirming the preceding results.

The tests were conducted under a number of technical characterizations specifically selected to detect magnecules, among which I indicate:

1) Total Ion Chromatogram (TIC) collected under the positive ion atmospheric pressure electrospray ionization (ESI+) mode;

2) Integrated TIC with retention times and areas for the most abundant peaks;

3) Raw mass spectra for all peaks identified in item 2;

4) HPLC chromatograms collected at fixed wavelength of 254 cm; and

5) UV-visible spectra form the HPLC diode array detector from 230- to 700 mm.

The tests were conducted on the following samples:

I) Sample GR331, the magnetically untreated, fully transparent GR fragrance oil "ING258IN Test 2";

II) Sample GR332, magnetically treated "ING258IN Test 2" with 10 % DiproPylene Glycol (DPG);

III) Sample GR332S, bottom layer of the preceding sample;

IV) Sample GR335, magnetically treated mixture 4 % GR fragrance oil "ING258IN Test 2", 0.4 % DPG and 95 % tap water; and

V) Sample GR335O, visible dark clusters in the preceding sample.

To avoid a prohibitive length of this presentation, in the following I only reproduce representative print-out of the comprehensive and detailed documentation obtained at FIU (which is available in its entirety as Appendix V of Ref. [7b]).

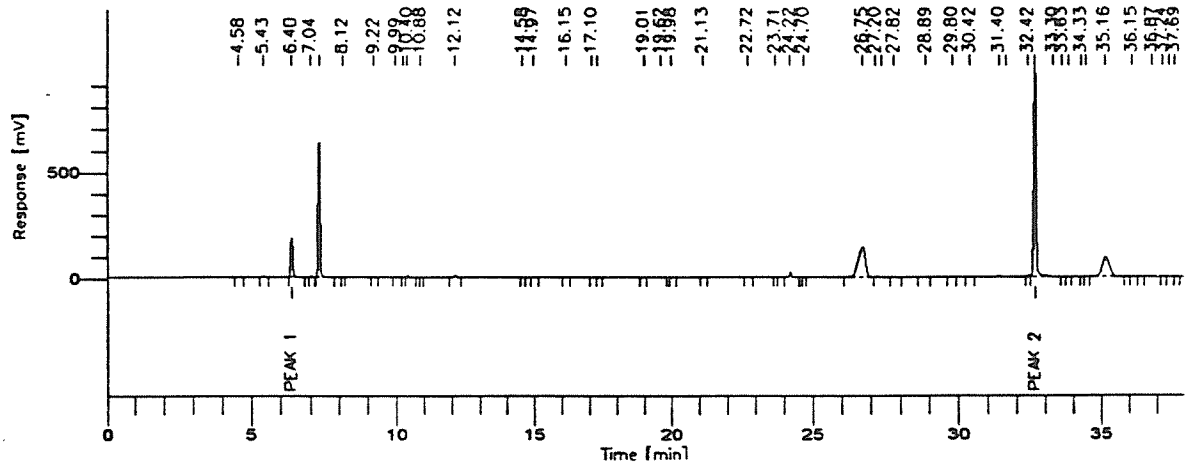
Inspection of the print-outs (as well as the comprehensive documentation) shows that ***the tests conducted at FIU on GR fragrance oil "ING258IN Test 2" provide conclusive experimental evidence on the existence of magnecules in liquids.***

3.9. Experimental Verification of Mutated Physical Characteristics (Copyrighted and Patent Pending)

In addition to the preceding *chemical* alterations, the existence of magnecules in liquids implies necessary alterations, called mutations, of *physical* characteristics, such as increase of the specific density and viscosity. This is due to the fact that magnetic bonds among ordinary molecules imply an evident reduction of intermolecular distances, thus resulting in more molecules per unit volume, as compared to the magnetically untreated liquid. The increase in viscosity is then consequential.

The reader should be aware that I am not referring to esoteric changes in minute amounts, but rather to large macroscopic alterations often visible to the naked eye, which are at times such to alter completely the visible characteristics of the original state, as it was the case for the complete loss of transparency and fluidity in the magnetically treated oils of Figures 3.12 and 3.13.

```
Software Version: 4.0<4J28>
Date: 5/8/98  12:21 PM
Sample Name   : Mixture bottom H2O layer 500ul
Data File     : C:\TC4\HP210\MY08004.RAW   Date: 5/8/98  11:32 AM
Sequence File: C:\TC4\HP210\MY08.SEQ   Cycle: 4   Channel : B
Instrument    : 772_-_2   Rack/Vial: 0/0   Operator: mb
Sample Amount     : 1.0000                 Dilution Factor  : 1.00
```



DEFAULT REPORT

Peak #	Component Name	Time [min]	Area [µV·s]	Area [%]
1		4.583	3494.00	0.03
2		5.431	16223.50	0.12
3	peak 1	6.404	792172.00	5.94
4		7.039	16982.00	0.13
5		7.325	2550078.00	19.12
6		8.124	630.00	0.00
7		9.220	415.00	0.00
8		9.985	627.00	0.00
9		10.230	309.00	0.00
10		10.398	30885.50	0.23
11		10.877	298.50	0.00
12		12.123	39988.00	0.30
13		14.575	241.00	0.00
14		14.967	986.50	0.01
15		16.152	365.00	0.00
16		17.103	2121.00	0.02
17		17.308	924.00	0.01
18		19.011	267.50	0.00
19		19.619	4481.50	0.03
20		19.981	428.00	0.00
21		21.133	2269.00	0.02
22		22.716	613.00	0.00
23		23.709	214.00	0.00
24		24.220	81808.50	0.61
25		24.704	168.50	0.00
26		26.751	2431379.65	18.23
27		27.197	8519.35	0.06
28		27.396	589.00	0.00
29		27.819	405.00	0.00
30		28.890	2294.00	0.02
31		29.804	752.00	0.01
32		30.417	607.50	0.00
33		31.395	21039.50	0.16
34		31.648	1279.00	0.01
35		32.420	30869.65	0.23
36	peak 2	32.650	5704719.54	42.77
37		33.298	22792.00	0.17
38		33.629	4363.61	0.03
39		33.849	2192.20	0.02
40		34.329	146.22	0.00
41		34.476	841.46	0.01
42		35.160	1547684.32	11.60
43		36.148	1621.00	0.01
44		36.868	2830.75	0.02
45		37.244	577.25	0.00
46		37.506	3180.55	0.02
47		37.691	1038.45	0.01

FIGURE 3.14: The ***first spectroscopic experimental evidence of magnecules in magnetically treated fragrance oils,*** achieved on May 5, 1998, by analysts ***Brian Wallace*** and ***Mia Burnett*** at *TEKMAR-DOHRMANN CORPORATION* (TDC) in Cincinnati, Ohio, by operating a Tekmar 7000 HT Static Headspacer Autosampler equipped with a Flame Ionization Detector (FID).. The magnecule is characterized by the large "unknown" peak at 25.763 min for 64.24 %. Peak 1 and 2 are two of the peaks detected for the magnetically untreated oil ≅in addition to other out of range). The other peaks are the first experimental evidence of magnecules in liquids.

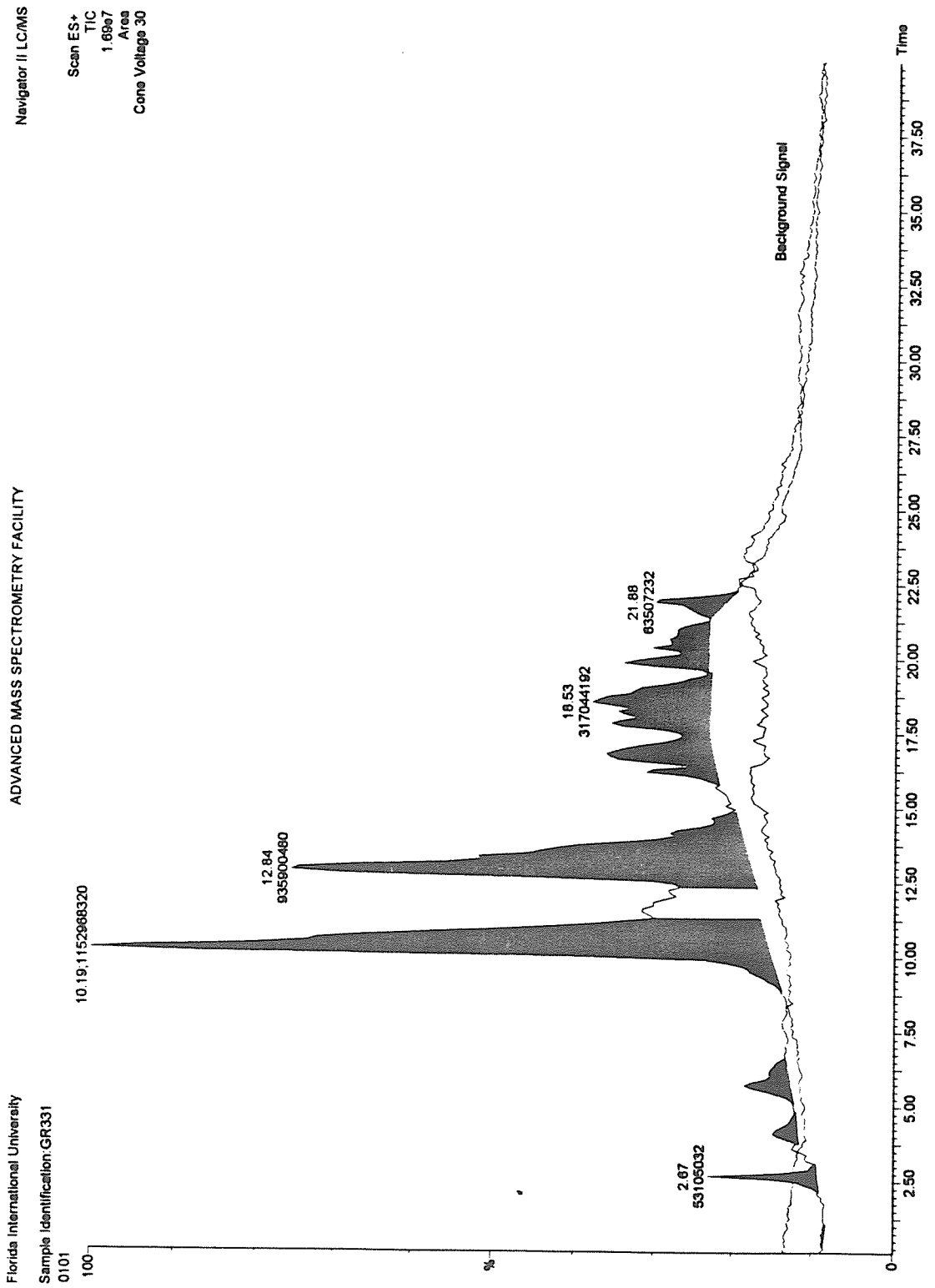


FIGURE 3.15: Scan on the untreated GR oil "ING258IN Test 2" of Figure 3.12 conducted at modern LC-MS/IRD at Florida International University done on December 1, 1998.

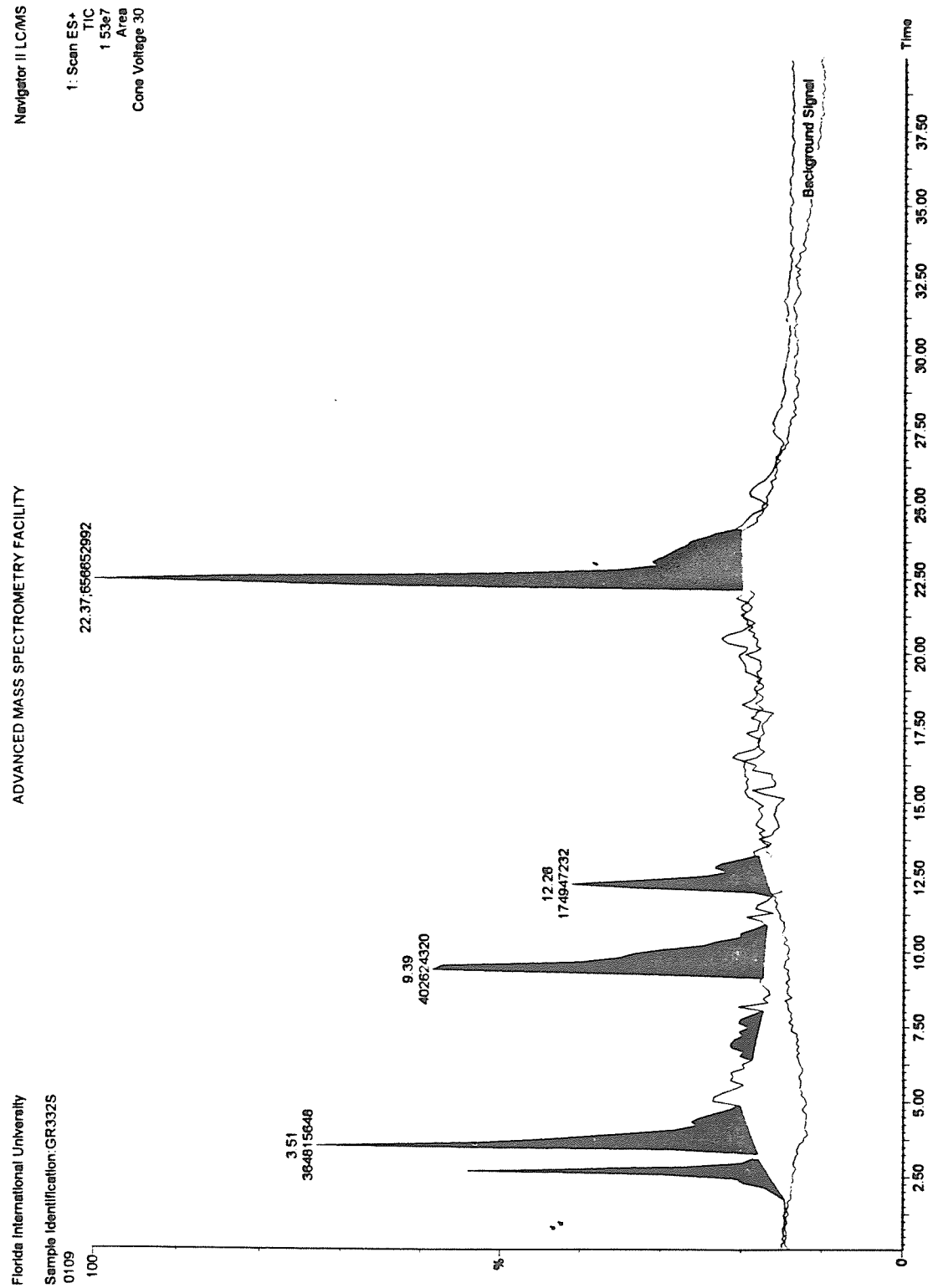


FIGURE 3.16. One of the several scans at FIU of the same oil of the magnetically treated oil of the preceding scan. The *decrease* of the peak of the untreated oil and the appearance of large new peaks constitute independent confirmation of magnecules in liquids.

At a deeper level, it appears that the mutation of physical characteristics are due to various contributions, such as :

1) The elimination under a suitable magnetic field of (at least some of the) rotational motions of the molecules which, per se, implies a decrease of their average volume, with consequential increase of the specific density;

2) The polarization of the orbits of the valence electrons which imply an additional decrease of the average molecular volume, and consequential increase of the specific density, viscosity, and other characteristics;

3) The magnetic bond among different molecules, which implies additional contributions to the indicated mutations.

In this section I report direct experimental evidence on measurements of specific density, viscosity and other characteristics which confirms the above predictions.

In all samples I used ordinary tap water and a number of GR fragrance oils. All samples here considered were prepared by conventionally mixing tap water and one fragrant oil, and then submitting that mixture to rather weak permanent magnets of 200 G (much weaker than those used for Pictures 3.12 and 3.13) via an equipment protected by Patent Applications I am not at liberty to disclose at this time. All samples resulted to be very stable without any measurable change over a period of about one year, and survive freezing ,(see next section).

In early 1998 I prepared various samples along the above procedure numbered from 1 to 25. The measurements of the specific density were conducted on March 9, 1998 by analyst Dr. ***A. Sibille*** at the *SGS U.S. TESTING COMPANY, INC.* (USTC) of Fairfield, New Jersey under assistance by Millennium Corporation (MC) of largo, Florida. The results of the tests are presented in Figures 3.17 and 3.18.

Sample 1 is ordinary untreated tap water. Sample 2 is ordinary tap water magnetically treated for about 5 minutes. Samples 3 and 4 were tap water treated with other magnetic equipment. Sample 5 was ordinary untreated GR fragrance oil received under the code of "APC Fragrance". Sample 6 was a mixture of fragrance oil 5 with tap water magnetically treated for about 5 minutes. Mixtures 7 and 8 were the same mixture 5 although treated with other equipment.

Magnetically treated fragrance 17 was a GR oil received under the code "Air Freshener 1". Mixture 19 was Fragrance 17 with tap water 16 magnetically treated for 5 minutes. Note that all measurements of the following figure were done to an accuracy of the fourth digit. Therefore, numerical results up to the third digit can be considered accurate.

In the transition from Sample 1 [untreated water] to Sample 2 [magnetically treated water] there is an increase of the specific density in the macroscopic amount of 0.86 % thus confirming the indicated magnetic mutation of water.

In turn, the increase in density clearly supports the existence of magneplexes in magnetically treated water, as detected earlier.

As well known, fragrance oils are (generally) *lighter* than water, i.e., the specific density of the untreated fragrance in Sample 5 is *smaller* than that of the untreated water in Sample 1. According to quantum chemistry, the specific density of any mixture of the above two liquids, whether solution, suspension or dispersion, must be *in between* the lighter and heavier specific densities.

On the contrary, as one can see in the following figure, ***the specific density of the magnetically treated mixture of GR "APC fragrance 1" with tap water, Sample 6, resulted to be bigger than that of the densest liquid, the water. This measurement constitutes additional, rather strong, direct experimental verification of the magnetic mutation of physical characteristics in liquids.***

The reader should be made aware that the above anomaly (a mixture of two liquids whose specific density is bigger than that of the heaviest of the two) *cannot* be explained via conventional quantum chemical knowledge. The presentation of scientifically credible opposing views is here solicited.

On the contrary, the anomaly is theoretically predicted and quantitatively treatable by the covering hadronic chemistry via the creation of magnecules [7].

A remarkable point is that the ***magnetic mutations of density are macroscopically large.*** In fact, they were called by an analyst "UPS–type anomalies", meaning that the shipment via UPS of a given volume of a magnetically treated liquid requires an increase of the shipping cost due to the macroscopic increase of the weight.

A further prediction of magnetically polarized liquids is the increase of its viscosity . This is evidently due to the arbitrary size of an individual magnecule, as well as the tendency of the same to bond near–by molecules, resulting in accretions, not to mention the anomalous adhesion to the walls of the container, which has been systematically detected for all magnetically polarized liquids.

As indicated earlier, in certain cases the increase of viscosity is so large to be first visible to the naked eye, and, when the treatment is sufficiently protracted, the increase of viscosity is such to lose the customary liquid mobility.

Ordinary engine oils are particularly suited for magnetic treatment because their increase in viscosity is so dramatic to be rapidly visible to the naked eye jointly with a visible, also dramatic change in visual appearance (color, texture, opacity, etc.).

The measurements on viscosity are reported in Figure 3.18. They were done on March 9, 1998 by analyst **J. R. Tyminski** at *SGS U.S. TESTING COMPANY, INC.* of Fairfield, New Jersey, under assistance by *MILLENNIUM CORPORATION.* The selected engine oil was an ordinarily available 30–40 Castrol Motor Oil subjected to magnetic treatments via two different equipment called of Type A and B. All treatments were done at ordinary conditions in the outsider of the oil container without any additive or change of conditions of any type.

As one can see in Figure 3.18, ***measurement 2 shows a dramatic increase of the viscosity in the magnetically treated oil of 44.5 % as compared to the viscosity of the untreated oil, while measurement 3 shows an increase in viscosity of 51.2%.***

The above experimental results evidently provide additional support for the the existence of magnecules.

The tests on viscosity also provide evidence of the anomalous adhesion of liquids with magnecules ,which is establishes in this case by a dramatic, macroscopic increase of adhesion of the oil to the walls of the glass container visible by the naked eye.

The same macroscopic anomaly is confirmed at the microscopic level. During the measurement of viscosity there was such an anomalous adhesion of the magnetically treated oils to the walls of the instrument that could not be removed via routine cleaning with acetone and required the use of strong acids.

This anomalous adhesion is further experimental evidence on the existence of magnecules, because of their predicted capability to induce the polarization of the orbits of the valence electrons of the atoms in the walls of the container, thus resulting in anomalous adhesion via magnetic bonds due to induction.

It is evident that the magnetic mutations of density and viscosity implies the expected mutation of *all* other physical characteristics of the liquid considered. Measurements along these lines are solicited (see next section).

The existence of mutation of *physical* characteristics then implies the mutation of *chemical* features. At this moment I can indicate the visual evidence reported by the analysts of USTC according to whom the reaction of magnetically treated oils with acetone is dramatically different than that with untreated oil, beginning with a visual mutation in color, texture and other appearances. I am not at liberty at this moment to report additional evidence of chemical anomalies.

More importantly, the reader should be aware that ***chemical reactions of magnetically polarized liquids are predicted to experience a mutation of their thermodynamical behavior, resulting in certain case in an increase of calories per mole.***

Systematic studies on chemical mutations are under way and they will be reported at some future time.

REPORT OF TEST

SGS U.S. Testing Company Inc.
291 Fairfield Avenue
Fairfield, NJ 07004-3833
Tel: 973-575-5252
Fax: 973-244-1694

Report Number: 103947
Date: 03/09/98
Page: 1 of 1

Millennium Results

Density of	g/mL	% Change Density vs Ordinary Water
Sample #1	0.9805	0
Sample #2	0.9889	+0.86
Sample #3	0.9804	0
Sample #4	0.9853	+0.49
Fragrant #5	0.9720	NA
Mixture #6	0.9967	+1.65
Mixture #7	0.9982	+1.80
Mixture #8	0.9902	0.99
Treated Water #16	0.9893	0.89
Frag Treated # 17	0.9453	NA
Mixture #18	0.9902	0.99
Mixture #19	0.9929	1.26

Samples were transferred to a separatory funnel. The layers were allowed to separate. The water layer was withdrawn into a funnel with Whatman #4 filter paper. The filtrate was transferred to a preweighed 10 mL volumetric flask. The sample was weighed to 0.0001 grams and the density calculated.

When the samples were pure substances, they were transferred directly to preweighed 10 mL volumetric flasks.

Calculations:

Weight flash with sample - weight flask ÷ volume of flask = g/ mL

Arlyn Sibille, Ph.D.

FIGURE 3.17: USTC measurements of specific density on magnetically treated liquids.

REPORT OF TEST

SGS U.S. Testing Company Inc.
291 Fairfield Avenue
Fairfield, NJ 07004-3833
Tel: 973-575-5252
Fax: 973-244-1694

Report Number: 103947
Date: 03/09/98
Page: 1 of 1

SUBJECT: Three (3) samples received on 02/09/98 and identified by the client as:.

PURPOSE: Determine the density and viscosity of the three samples.

TEST DATE: 02/25/98

PROCEDURE: Three 10 milliliter volumetrtic flasks were pre-weighed. One of the samples was transferred to each of the volumetric flasks with a pipet. The samples were weighed again. The density of each sample was calculated.

The three oil samples were measured for viscosity using a Kinematic viscometer (ASTM D-445).

RESULTS:

Sample Identification	Density, g/mL)	Viscosity (cps)	Increase Viscosity, %
1) Motor Oil, "as is"	0.8682	199.8	0
2) Motor Oil, Treatment Type A	0.8714	288.7	44.5
3) Motor Oil, Treatment Type B	0.8689	302.0	51.2

SIGNED FOR THE COMPANY BY:

James R. Tyminski
Laboratory Supervisor

Arlyn Sibille, Ph.D.
Laboratory Director

/mo

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FIGURE 3.18: USTC measurements of viscosity on magnetically treated liquids.

3.10. Evidence of magnecules in solids (Copyrighted and Patent Pending)

In the preceding sections I have presented theoretical and experimental evidence of the existence of magnecules in gases and liquids.

The direct experimental evidence on the existence of magnecules in solids available at this writing is so simple to appear naive.

It is given by the evidence that ***all liquids with magnecules systematically preserve the new species when frozen, as established by the recovering of anomalous features when returning to the liquid state, as well as the preservation at the solid state of opacity and other features.***

Also, magnecules can be directly verified under microscopic observation to persist at the solid state.

Needless to say, the above simplest possible evidence in solids is only the beginning of various possibilities. I merely mention here in depth study on the true chemical composition of *solids created under intense magnetic fields*, such as fullerenes [5] and other composites.

The latter study is under way and I shall report the results in some future paper.

3.11. Industrial Applications of the New TTL Technology of Magnetically-Polarized Substances (Copyrighted and Patent Pending)

It is evident that ***all the anomalies in liquids identified in this section have novel industrial applications in a variety of fields, including, but not limited to, the fragrance industry, automotive industry, paint industry, adhesive industry, medicine, etc. These applications are under patent pending and other industrial protections.***

Evidently I am not at liberty to disclose these applications in the necessary details at this time. I can nevertheless present below illustrative lines (all under patent pending) that any scientist can easy derive from the indicated anomalies.

New applications to automotive industry, such as: the new combustible gases described in the next section; improved energy content, octanes, and other features of conventional fuels; the use in a gear box of a lubricant subjected to an appropriate magnetic treatment implies the presence of sufficient lubrication at start-ups after lack of use. When conventional lubricants are used, non-immersed gears are virtually dry after a few hours of lack of use; the enhancement of energy content and octanes; and others.

New application to paint industry, such as: the use of the increased penetration of magnetically treated liquids within porous surface to produce more efficient and longer lasting paints; or the use of magnetically treated marine paints for hulls of metal ships, which is expected to last longer than conventional paints. In fact, the magnetically treated paints induce a polarization of the atoms in the metal walls, thus resulting in an anomalous adhesion which is typical of liquids with magnecules.

New applications to medicine, such as lotions subjected to the magnetic treatment herein considered, which are expected to penetrate the human skin much deeper than the same untreated lotions; or the study of conceivable new forms of local delivery of medications thru the skin (e.g., the deep local penetration of antibiotics in wounds), by therefore avoiding its current delivery to the entire body.

New appolication to gas liquefactions. In conventional conditions, gas molecules have

no mutual attractiuons are are kept apart by their temperature, thus implying the notorious high costs in liqyuefaction. The magnetic polarization described in this section is applicable to all gases. It then follows that, in the liquefaction of magnetically polarized gases, molecules *attract* each other, and clusters into large aggregates of the order of 1,000 a.m.u. and more. These conditions arte expected to imply a significant reduction in the cost of liquefaction.

New applications to fuel cells. As well known, current practical applications of fuel cells are limited because their efficiency is low. An enhancement of their efficiency is evidently expected in the use of magnetically polarized gases for fuel cells, for various reasons, such as: increased energy content; anomalous penetrationm thrgh membranes due to decreased molecualr size; attraction due to magnetic induction; and other aspects.

The above (and other) novel applications warrant additional scientific and industrial research and development on magnecules in liquids.

3.12. The New, Over-Unity, TTL MagneGas™ Resolving the Alarming Environmental Problems Caused by Fossil Fuel (Copyright, TradeMark, and Patent Pending)

As reviewed in Section 1.2, the alarming environmental problems caused by the current, large scale combustion of fossil fuels are: excessive carcinogenic substances in the exhausts; alarming oxygen depletion in the atmosphere; and excessive release of carbon dioxide, with consequential, potentially devastating "green house" effect.

Therefore, the main prerequisites for environmentally acceptable new fuels are:

1) No appreciable carcinogenic substances in the combustion exhausts;

2) Positive oxygen balance, in the sense that the amount of oxygen released in the exhausts must be bigger than the oxygen intake used for combustion;

3) Content of carbon dioxide in the combustion exhausts down to minimal levels suitable for their elimination via known chemical means.

There is little doubt that the new combustible gases patented by Eldridge [15a], Damman and Wallman [15b], Richardson [15c], and others, have provided a partial resolution of the alarming environmental problems, besides setting invaluable foundations for in the continuous advancement of new technologies.

In fact, said gases did eliminate carcinogenic substances in the combustion exhausts, as established by numerous independent laboratory analysis [1b,1c].

However, the combustible gases of Refs. [15a,15b,15c] do not have a positive oxygen balance, and their emission of carbon dioxide is environmentally unacceptable.

More particularly, analytic measurements of combustion exhausts of AquaFuel conducted by Briggs and Stratton and other laboratories have indicated the presence in the combustion exhausts of 7.1 % of Oxygen. This percentage is dramatically better than the corresponding oxygen content of gasoline exhausts (0.5 %) [1b]. However, 7.1 % of oxygen exhaust is *smaller* than the oxygen intake for AquaFuel combustion, thus resulting in an environmentally unacceptable *negative* oxygen balance.

The same tests conducted by Briggs and Stratton and other laboratories have shown the emission by AquaFuel of 14 % CO_2 in the exhausts which is *bigger* than the average 12 % CO_2 content in the gasoline exhausts, thus being environmentally unacceptable.

In view of the above measurements, in mid-1998 I initiated systematic search of a *new process* for the production of a new combustible gas verifying all environmentally acceptable conditions 1), 2), and 3) above.

As expected, due to the complexity of the problem, and the severity of the needed results, ***the search for said new combustible gas required the totality of the scientific knowledge outlined in these papers, including the particle, nuclear, and molecular levels, with no exception.*** This is the first illustration of the reason for my insistence in

considering the particle, nuclear, and molecular aspects for any serious research and development of new fuels. As will be shown shortly, exactly the same situation occurs for new energies of Class III.

In this section I can outline only the main aspects of the research conducted at Toups Technology Licensing, to avoid a prohibitive length, as well as for security reasons.

Consider first an underwater electric arc between carbon rods. Recall the related process in which the arc decomposes the carbon rods and the water, by creating a plasma at about 5,000 C of mostly ionized atoms of hydrogen, oxygen and carbon. The latter recombine in various ways, cool down in the surrounding water, and bubble to the surface for collection, resulting in a combustible gas essentially having conventional chemical structure (3.1.1).

The achievement of characteristics 1), 2), and 3) required the following in-depth scientific studies at the particle, nuclear, and molecular levels:

STUDIES # 1: On physical and chemical processes occurring in the plasma around underwater arcs. These studies established that *carbon dioxide is produced in the plasma surrounding the arc as an oxydation of carbon monoxide.* Due to their affinity, Carbon and oxygen first combine in the arc plasma to form C-O. Subsequently, CO is oxidized to form CO_2. A requirement of the new process was therefore its capability to prevent that the CO originally formed in the plasma is oxidized into CO_2. This was necessary, because: the oxydation $CO \rightarrow CO_2$ removes oxygen from the combustible gas; CO_2 is not a combustible gas, by therefore acting as a dampening in the combustion, with consequential reduction of energy content; and, last but not least, all the CO_2 contained in the gas is released in the combustion exhausts with the additional CO_2 produced by the combustion itself, resulting in this way in unacceptable percentages of CO_2 in the exhausts.

STUDIES # 2: Efficiency in the production of a combustible gas via underwater arcs. Additional, separate studies established that *the poor efficiency of underwater arcs in the production of combustible gases is due to the "burning" in the arc plasma of hydrogen and oxygen which is stimulated by the arc itself.* In other words, the large glow of an underwater arc, as compared to the same arc in air, is due to the fact that the arc first separates the water into H and O atoms, and then the same arc triggers their recombination back into water, with evident large loss of efficiency. For instance, it is estimated that, out of 100 % H and O gases produced by the arc in separating the water, only 70 % are lost to H and O burning back into H_2O, and only 30 % are produced for practical use. Another condition for the desired new process is that minimizing the burning of H and O as a necessary condition to improve the efficiency.

STUDIES # 3: Liquids capable of producing environmentally acceptable combustible gases. As predicted, conventional liquids turned out to be insufficient to achieve the needed results, particularly the conditions for a positive oxygen balance, and low CO_2 content. In fact, these conditions essentially require the selection of a liquid which: 1) Reduces dramatically the the 40 % - 50 % percentage of hydrogen content as occurring for water as a condition to increase energy content; 2) Has a sufficient content of carbon and oxygen to product the combustible CO in percentage bigger than H; and 3) The liquid should be able to release sufficient oxygen during combustion to have a positive oxygen balance.

After laborious research, the solution reached at Toups Technology Licensing on the above requirements is based on: a special liquid with magnecules, called **MagneLiquid**^{TM}, and denoted TTL-X-1 whose composition I am not at liberty to disclose here; a new process via an electric arc between permanent, non-carbon-based electrodes, called **Magnearcflowam**, which avoids the increases the oxygen and decreases the carbon dioxide; a *new* combustible gas with a *new* chemical structure called **MagneGas**^{TM}, produced by the above embodiment (see Figure 3.19).

Measurements on the combustion exhausts of MagneGas has established: the reduction of carcinogenic substances by at least one tenth and a general reduction of hydrocarbons by at least one third; up to 14 % of oxygen in the exhausts, namely, exhausts which can sustain life, with a

positive oxygen balance of about 5%; and the reduction of carbon dioxide, from 14 % of gases [15a,15b,15c] down to 2% to 3%, namely, a percentage which permit the removal of CO_2 via chemical means, e.g., its passage through CO_2-absorbing sponges before the emission of the exhausts in the environment.

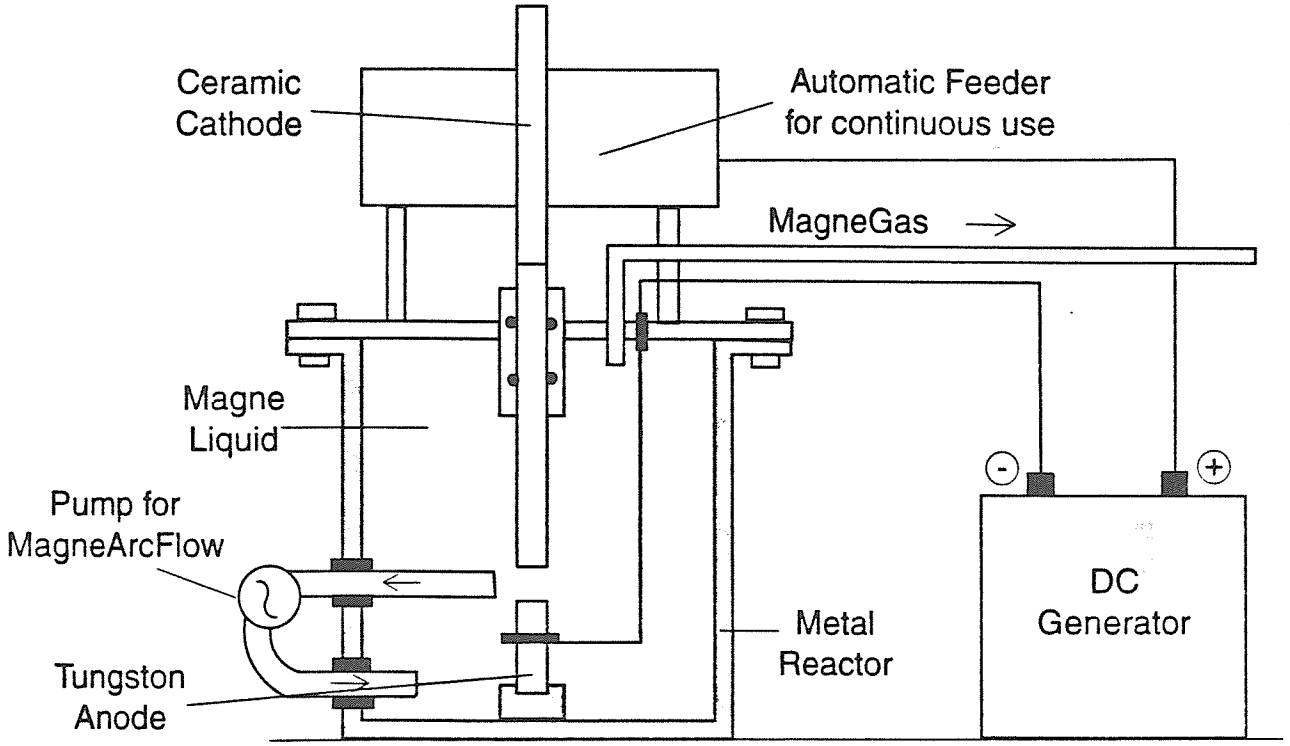

FIGURE 3.19. A schematic view of the embodiment developed at Toups Technology Licensing for the production of a combustible gas than resolves the alarming environmental problems caused by fossil fuels as outlined in Section 1.2. The embodiment essentially consists of a metal vessel filled up by a special MagneLiquid^{TM} composed by diverse liquids magnetically bonded together into magnecules. A DC electric arc occurs between non-carbon-based electrodes immersed within said MagneLiquid, via a new plasma displacement process called MagneArcFlow^{TM}. The resulting combustible gas, called MagneGas^{TM}, is also magnetically polarized into magnecules, and verifies all the chemical and physical anomalies indicated in this section. Measurements of the combustion exhausts of Magnegas have established its reduction by at least one tenth of carcinogenic substances, a positive oxygen balance, and percentage of carbon dioxide down to levels controllable via their transition through CO_2-absorbing chemical sponges prior to their release into the atmosphere. Since the liquid and the process for the production of combustible gases are not unique, it is easy to predict the future transition, from the current sole use of fossil fuels, to a *variety* of environmentally acceptable combustible gases.

Yet another problem addressed at Toups Technology Licensing is cost competitiveness, because consumers would not purchase new clean fuels of excessively more expensive than gasoline, no matter how environmentally friendly they are.

I am pleased to report that, according to preliminary measurements currently under finalization indicate, under proper industrial development, a realistic possibility that ***MagneGas can be cost competitive with gasoline.*** In fact, by using as DC generator a Miller Summit Arc 1,000 delivering an arc with 37 V DC and 1,000 A, various measurements I have personally seen, have

established that MagneGas can be produced with a consumption of electric energy in the range of 135 W/cf which correspond to about $ 0.01/cf for current electric cost of $ 0.08/Kw, at a production rate of 12 sec/cf = 300 cf/h.

Additional preliminary measurements, currently under finalization, have established that a 100 HP automobile consumes approximately 10 cf/min = 600 cf/h. At the rate of 50 mph, this yields a direct electric cost of $ 7.2/h, or $ 0.14/mile.

Evidently, the above cost is not competitive over current gasoline cost, particularly when including all conventional indirect costs. However, a clear cost competitiveness of MagneGas with respect to gasoline emerges when the process is used to *recycle liquid wastes, such as town sewage, or any fossil fuel waste.* In this case there is an *income* due to the recycling of the waste which offset the direct electric cost, resulting in a realistic possibility of achieving price competitiveness, again, under proper industrial development.

Numerous efficiency measurements have established that, in its current version, MagneGas is over-unity in the amount of 1.69. Systematic measurements have been conducted by TTL engineers **Ken Lindfors, A. Karpay, D. McKinnon,** and by TTL technicians **D. Palmer, J. Wilcox, D. Crossan,** and others. First, calibrated cumulative wattmeters have established that the production of 1 cf of MagneGas requires 140 watts of electricity (from the panel), which correspond to 495 BTU. Repeated tests of BTU content of MagneGas in comparison to naturtal gas have been conducted using identical tanks, the same initial and final pressures, the same flow, and heating up the same volume of water in the same pot at the same initial temperature. These tests have established that MagneGas has about 80% energy content of natural gas, thus having 840 BTU/cf. The ratio of 840 BTU for MagneGas and 495 BTU electricity yields the indicated over-unity of 1.69. Technicians at TTL are available for the reproduction of the above tests to any interested person.

As stressed in Section I-1, the above over-unity is fully compatible with the principle of conservation of the energy. In fact, the ratio between the total energy out and the total energy in is always smaller than one due to losses. The total energy out is MagneGas, *plus* heat, light, and other energies dissipated in its production. The total energy in is given by electricity, *plus* the large amount of energy contained in MagneLiquid. Therefore, the TTL new process for the production of MagneGas essentially taps the large energy contained in the MagneLiquid.

In view of the above occurrence, the questionm of the increase of the over-unity to values over 2 is only a matter of selecting the proper cheap additive for MagneLiquid. The over-unity can be indepednently increased by improving the efficiency of the process for the production of the gas. These tests are under way, and they will be reported at some future time. adsdwer

In closing, I would like to dispel a few misconceptions I have detected even within technicians in the field, perhaps due to the extended usage of gasoline and lack of familiarity with new combustible gases.

. First, I would like to recall that all fuels are dangerous, thus requiring to be handled with care. A first misconception I have experienced speaking with technicians, is that gasoline is safer than combustible gases. In reality, as indicated in Section 1.2, gasoline is, by far, the most dangerous fuels, because it spills and explodes. By comparison, combustible gases do not spill, their tanks are must stronger than the thin gasoline tanks, when punctured disperse in the atmosphere, and when ignited they burn without exploding.

Another misconception is that combustible fuels containing CO are dangerous, without any consideration of the fact that chemicals contained in gasoline are more poisonous than CO, as demonstrated by test in which a laboratory mouse dies within the hour after ingesting gasoline. In reality, all fuels are toxic by their need to be combustible. The environmental important problem is not their toxicity, but rather the lack of toxicity in the combustion exhausts.

Other misconceptions are the expectation that combustible gases do not permit automobiles to cover sufficient distances between refueling, or that piston engines do not work properly with combustible gases. On the contrary, a tank of liquefied combustible gas with essentially the same weight as that of gasoline permits essentially the same autonomy than that of a comparable tank of gasoline. Moreover, it is known that gasoline engines converted to combustible gases last much

longer than using gasoline, due to various factors, such as much bigger number of octanes (for the case of magnetically polarized gases [1b]), thus running much smoother than with gasoline, and the running temperature is much lower than that with gasoline.

In short, experimental evidence establishes that, besides resolving the alarming environmental problems indicated earlier, environmentally acceptable combustible fuels such as MagneGas are safer to operate than gasoline, and imply a longer life of piston engines.

4. NEW CLEAN ENERGIES OF CLASS III

4.1. Introduction

We are now equipped to study the new energies of Class III, those occurring at the atomic-molecular level, with contributions from Classes II (nuclear level), and I (particle level), thus requiring the entire conceptual, theoretical, and experimental knowledge outlined in these papers, plus the knowledge in the quoted literature for more advanced research.

It follows that new energies of Class III constitute some of the most complex problems facing contemporary science. As such, they are more difficult to realize in an industrially acceptable way than new energies of Class II, therefore, requiring research well into the next century. On such a time scale, this study will appear as introductory.

The use of quantum mechanics for new energies has only produced endless controversies, while the use of hadronic mechanics permits the identification of the conditions under which new energies of Class III are possible. Once these conditions are known, researchers in new energies can address the problems, with consequential expected improvement of the efficiencies up to the level needed for commercialization.

In this section, I study the application of hadronic mechanics to the most difficult possible new energies of Class III, those admitting stimulated transmutations *without the emission of radiations*, as studied in Section IV-3 for the nuclear case. The reasons are the same as those of Section IV-3, namely, this restricted class of transmutations is the most environmentally significant, because they are clean. Moreover, these reactions automatically imply that of more general transmutations with secondary radiations, whose study will be left to the interested reader.

While Section IV-3 dealt with *StimulAted Nuclear Transmutations* (SNT), in this section I shall study *Stimulated Atomic Transmutations* (SAT). As we shall see, SAT will soon emerge as including the so-called *cold fusion*. The name of SAT will be at times used when there is need to stress that, in addition to nuclear transmutations, we also have to take into account electron clouds.

I shall therefore study reactions similar to those of Eqs. (IV-3.1.1), but now referred to *atoms*, here denoted with the letter M (the letter A being referred to the atomic number), rather than naked nuclei generally denoted with the letter N:

$$TR + M_1(A_1, Z_1) + M_2(A_2, Z_2) \rightarrow M_3(A_3, Z_3), \tag{4.1.1a}$$

$$A_3 = A_1 + A_2, \quad Z_3 = Z_1 + Z_2, \tag{4.1.1b}$$

where TR is the familiar trigger.

Needless to say, the emission of radiations can be *associated* with the above SAT, as it is typically the case of the emission of neutrons for reactions involving deuterons. However, these neutrons are the result of the *collision* of deuterium nuclei, and their consequential fission. As such, *the emission of neutron is a secondary effect, which should not be confused with the primary SAT (4.1.1).* As a mater of fact, the emission of neutrons is an indication of the *inefficiency* of the primary reaction, e.g., because due to the use of energies much higher than the threshold energy needed for the reaction considered.

After identifying the hadronic physical laws for SAT (4.1.1), in the remaining sections I shall inspect a few representative cases of new energies of Class III for the primary purpose of illustrating the role of hadronic mechanics, including: appraising whether the new energy considered is admitted by by hadronic mechanics and related laws; identification of the conditions under which said laws are verified; submission of specific proposals for the realization of said conditions and related geometries in the most efficient possible way.

Note that a number of new energies have been *de facto* studied in Paper IV, although in their realization in terms of naked nuclei. Also, the important case of electron clusters [11] has been studied in detail in Section 3. Rather than providing additional studies of the electron clusters per se, in this section I shall point out some of their possible novel applications.

I would like to apologize to the many researchers in new energies I cannot quote in this preliminary study, and encourage them to bring their case to my attention for appropriate immediate corrective measures in the subsequent presentation.

I should also stress that, by no means, the few selected cases of new energies of Class III can be studied in detail in this section, since such a study would render the length of this paper prohibitive.

Finally, in the event I have unintentionally reproduced previously published ideas without the proper quotation of paternity, I would appreciate to be informed with copy of the related papers for the immediate implementation of corrective measures.

4.2. Physical Laws of New Energies of Class III (Copyrighted and Patent Pending)

The primary physical laws of the SAT (4.1.1) as predicted by hadronic mechanics are the following:

Law III-1: Peripheral electron clouds in atoms must be changed, from their naturally spherical space distributions prohibiting nuclei to approach each other, to polarized distributions, or ionizations permitting nuclei to approach each other at the small mutual distances needed for SAT. The technology of magnetic polarization of peripheral electron clouds outlined in Section 3 is one of the possibilities available at ordinary temperatures and pressures. Additional mechanical means, *e.g.*, due to friction, are also conceivable, and deserve attention. In the absence of effective means for orbit control, ionization should also be considered. Finally, the new energies of Class III occurring in biology should be investigated in detail, because such may permit additional technological solutions.

Law III-2: Once electron clouds are modified as per Law III-1, SAT require an external trigger forcing nuclei to approach each other down to the distance of the hadronic horizon against their repulsive Coulomb force. An effective trigger is given by conventional or electrochemical compressions. Another trigger is the plane polarization of the orbits of peripheral electrons because their magnetic dipole moment are over 1,000 times stronger than their nuclear counterpart, thus being suitable to trigger nuclei into the hadronic horizon. Numerous other triggers are possible, and they all deserve detailed study.

Law III-3: Light nuclei with spin must enter the hadronic horizon in singlet coupling, while peripheral electrons must also couple in singlet, so as not to violate Pauli's principle. This is essentially the same as Law II-2 (for new energies of Class II). Arbitrary nuclei with spin zero have no restrictions for coupling, thus being preferable over those with spin, because they require easier technological solutions. A similar need evidently exists for the peripheral electrons. The dual requirement for nuclei and electrons illustrates that new energies of Class III are evidently more difficult in practical realizations than those of Class II. I should finally mention that the case for heavy nuclei is unknown at this time, because of theoretical and

experimentally unsettled, possible mechanisms that could permit coupling also in triplet, as discussed in specific cases later on.

Law III-4: SAT must verify all conventional total conservation laws. This law implies that, after verifying the preceding laws, only a restricted number of atoms will verify SAT (4.1.1), those permitting the conservation of the angular momentum/parity, energy, etc.

Law III-5: Energies used for SAT must be as close to the threshold energies as possible. This requirement is needed to minimize secondary emissions due to nuclear collisions and disintegrations. As an illustration, suppose that the conservation of energy requires 0.1 MeV for the fusion of a given nucleus hitting another stationary nuclei. Suppose that the incident nuclear beam has, instead, 1 MeV energy, namely, ten times the threshold energy. It is evident that, in this case, the most dominant process is nuclear scattering and disintegration (when allowed), thus resulting in *nuclear reactions without any suitable SAT.*

I should stress that the above laws are expected to be incomplete. Additional laws are expected to be identified with the advancement of the theoretical and experimental knowledge. The indication of possible additional laws would be gratefully appreciated.

The physical laws of new energies of Class III have been published in this copyrighted publication for the first time. I intend to defend that copyright with all means permitted by law. The content of this section can be used by anybody in part or in full for any scientific purpose without any prior authorization, *provided* that: 1) This publication is quoted; 2) Its content is outlined as a prerequisite for allegations of novelty; and 3) The paternity is identified with clarity.

4.3. Application of Hadronic Mechanics to the Electromagnetically Pinched Deuterium Energy (Copyrighted and Patent Pending)

As well known, anomalous energies due to nuclear transmutations have been identified long before Pons and Fleishmann. To my knowledge, the first identification of new energies of Class III is that in *living organisms,* such as the experimental evidence achieved in the past century that living organisms synthesize new elements (see the case mentioned in Section I–2.8 of the measurements of essentially the same calcium in chickens fed with a calcium rich and calcium free diet, thus identifying the apparent synthesis of calcium by living organisms, evidently when needed).

The study of the new energies of biological character is of such a complexity to escape human imagination. In fact, its serious condition requires the *most general formulation of hadronic mechanics, that in terms of multi–valued hyperstructures defined over hyperfields with a generally infinite countable set of elements, as needed, e.g., to begin an understanding of the DNA code* (Paper II). A treatment of this nature is dramatically beyond the limited scope of these papers.

The next significant anomalous energy I know of, is that from an electromagnetically pinched deuterium gas achieved in the 1950's by Baker *et al.* [18] (see also the excellent studies by the Graneau's [19]). Apparently, experiments [18] constitute the first, serious scientific evidence of fusion processes in physical (non–biological) settings.

Unfortunately, the results of Refs. [18] were subjected to a manifestly nonscientific/political treatment in the literature of the time, Rather then seeking a theory representing the experimental evidence, remarkable efforts were made in Refs. [18] in attempting the adaptation of the physical reality to the theory dominating at that time, quantum mechanics. In fact, the researchers looked for all possible reasons which would *deny* the occurrence of nuclear fusion and related energy.

I am pleased to report that ***hadronic mechanics supports the production of new energy of Class III from electromagnetically pinched deuterium gas, and provides specific suggestions for the improvement of its efficiency.***

An aspect of primary attention in Refs. [18] was the emission of neutrons, because (as it is the case for the lithium energy of Paper IV) *neutrons permit the interpretation of the event as a mere*

nuclear reaction, rather than fusion, the first being compatible with academic interests in quantum mechanics, the second being incompatible with the same interests. Hadronic mechanics permits exactly the opposite attitude: focus the primary attention on the fusion, and interpret the neutrons as an indication of the insufficient efficiency in its realization.

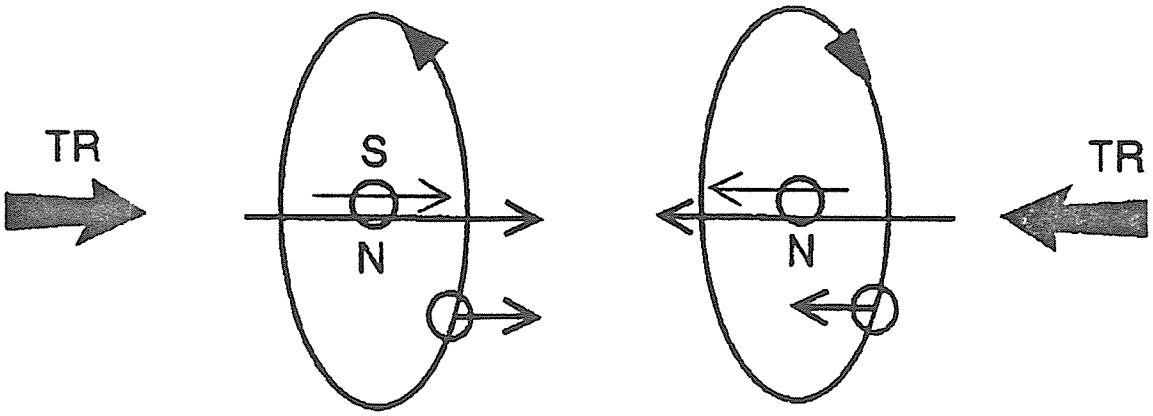

FIGURE 4.1: A schematic view of the geometry reded for two deuterium atoms to fuse into the helium. Recall from Nuclear Data [20] that the deuterium has spin/parity 1^+, while the helium has spin/parity 0^+. Therefore, the conservation of the angular momentum requires that the two nuclei be coupled in singlet (antiparallel spins), as shown in the figure (see also Section IV-3.8). Jointly, the electrons must also be coupled in singlet to avoid violating Pauli's principle (Law III-2). This requires that the two deuterium atoms must be pushed one against the other by external triggers (see next figure) in such a way to have opposite polarizations. It follows from this geometry that the nuclei can indeed fuse into the helium by verifying all remaining laws (particularly Law III-5 on the threshold energy). However, the original deuterium atoms are generally ionized, because the orbiting electrons reach each other with *opposite speeds,* due to the opposite plane polarizations. The resulting helium is then also produced in a fully ionized form. However, this type of "self-ionization" is irrelevant for the new energy here considered, because it originated from the *nuclear,* rather than electron processes.

The primary reaction is the same as that of Eq. (IC-3.4.1), i.e.:

$$TR + {}_1H^2 + {}_1H^2 \rightarrow {}_2He^4 + \text{heat}. \qquad (5.3.1)$$

The only difference is that in this section we are considering complete atoms, rather than naked nuclei as in Paper IV. It is evident that the above fusion *cannot* produce neutrons. Therefore, it is equally evident that *neutrons are produced from the disintegration of neutrons due to collisions with sufficient energies, that is, because of a violation of Hadronic Law III-5 (use of energies much in excess of the threshold energy).*

One of the primary requirements for new energies to be environmentally acceptable is that they must be clean. While Baker *et al.* [18] were all devoted to maximize neutrons so as to avoid a violation of quantum mechanics, all the efforts should instead be devoted toward the opposite goal, eliminate the neutronic radiation as a condition for the new energy here considered to be environmentally acceptable.

Hadronic mechanics provides its first contribution precisely along the latter lines. Simple calculations (here omitted for brevity) show that the implementation of Law III-5 *prevents* the

emission of neutrons, trivially, because that particular energy is *below* the energy needed for the disintegration of the deuteron.

HADRONIC ELECTROMAGNETICALLY PINCHED DEUTERIUM REACTOR

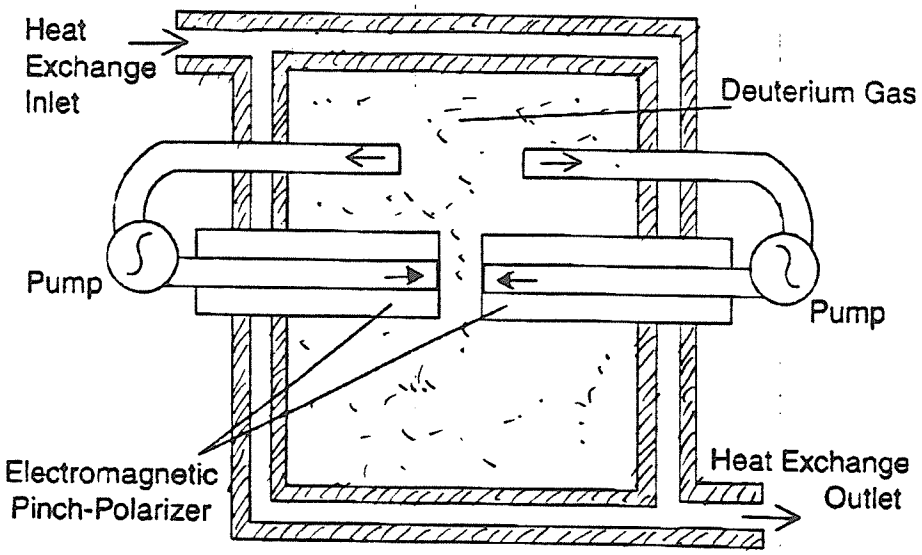

FIGURE 4.2. A schematic *and partial* view of the *Hadronic Electromagnetically Pinched Deuteron Reactor* as suggested by Hadronic Laws III-1 to III-5. It consists of two different electromagnetically pinched deuteron gases as per Refs. [18], which are calibrated to have half of the minimal threshold energy for SAT (4.3.1), and opposite polarizations in the plane perpendicular to the symmetry axis of the electromagnetic field. The two gases are then allowed to flow one against the other along the geometry of Figure 4.1. Residual deuterium gas is pumped again into the electromagnetic pinchers-polarizers to have a continuous cycle. No neutron emission is possible when the minimal threshold enemy is below the disintegration energy for the deuteron. Note that in this simple configuration the trigger is merely constituted by the pressure of one gas against the other. The energy produced is utilized via heat exchangers or other means.

Next, hadronic mechanics allows quantitative studies of the conditions under which deuterium *atoms* can be fused into the helium, thus releasing the considerable amount of energy per nuclear reaction computed in Eq. (II-3.4.3), i.e.:

$$\Delta E = 2\times M(2, 1) - M(4, 2) =$$

$$= 3{,}752.245 - 3{,}727.377 = 24.868 \text{ MeV}/c_0^2. \qquad (5.3.2)$$

The case is evidently similar, although more complex than the *Hadronic Helium Reactor* of Section IV-3.4, because it implies the additional presence of the peripheral atomic electrons. However, it is easy to see that, even though initiated as a process of Class III, the electromagnetically pinched deuterium energy ultimately ends up as a new energy of Class II, in which nuclei are completely ionized.

This occurrence is due to the general loss of the peripheral electrons due to the geometry required for two deuterium atoms to fuse into the helium (Figure 4.1). However, such a ionization is irrelevant, and actually beneficial for the production of energy, evidently because the latter

originates from the *nuclear* fusion, rather than the fusion of the peripheral electrons. At any rate, after formation, naked helium nuclei immediately capture electrons from the environment, by recovering in this way their conventional atomic form.

As a result, *the plausibility of the electromagnetically pinched deuterium energy is established by measurements [18], as well as by the Hadronic Helium Reactor, and its underlying evidence reviewed in Section IV–3.4.*

Hadronic mechanics also suggests specific embodiments to attempt an improvement of the efficiency of the energy here considered. The suggested features are similar to that of the Hadronic Helium Reactor of Sect. II–3.4, and consists in *the production of two different electromagnetically pinched deuteron gases with opposite polarizations, each one with half of the minimal threshold energy, and then their release one against the other along the geometry of Figure 4.1.* Evidently, only a very small part of the deuterium gas will produce helium (otherwise we would have the so-called "China-syndrome"),. The remaining deuterium gas can be reused for a continuous cycle, as in Figure 4.2.

Remember that 1 MeV = 1.6021×10^{-13} joule. The achievement of a macroscopic amount of energy is reached whenever the embodiment of Figure 4.2 provides 10^{13} SAT (IV–4.3.1). By remembering that in one mole we have Avogadro's number 6.022×10^{23} atoms, the extremely low efficiency of $1/10^{10}$ reactions per mole, yields in the energy release:

$$(24.8 \times 10^{6} \times 1.6 \times 10^{-19} \text{ Joule}) \times (6 \times 10^{23}) \times$$

$$\times (10^{6} \text{ reaction /min per mole}) = 2.38 \times 10^{6} \text{ joule/min} . \qquad (4.3.3)$$

In conclusion, hadronic mechanics establishes that the first recorded production of fusion energy at ordinary temperature outside biological transmutations is real, Refs [18]. It should be stressed that the *existence* of the new energy was established by measurements [18] themselves. Hadronic mechanics merely provides specific and concrete suggestions for the improvement of its *efficiency.*

4.4. Application of Hadronic Mechanics to Cold Fusion (Copyrighted and Patent Pending)

I am pleased to report that ***hadronic mechanics supports, in full, Pons and Fleishmann electrolytic cells [20], and numerous additional forms of new energies of Class III, popularly known as "cold fusion" (see representative papers [21,22]), identifies the conditions, laws, and geometries under which said energies are possible, thus permitting specific suggestions for the possible improvement of their efficiency.***

Electrolytic means for the realization of cold fusion constitute one of the most interesting research topics of contemporary science, because it includes virtually all scientific branches. As such, the topic should be of interest to all scientists.

Individuals who have proclaimed in the past and continue to proclaim dismissals of cold fusion without conducting serious theoretical and experimental research, can be easily unmasked, because they are generally connected, in a direct or indirect way, to organized interests in existing doctrines, and, in particular, to the continuation of research in the so-called "hot fusion". The point is that cold fusion is today supported by a large volume of experimental evidence, which, even though evidently preliminary, is nevertheless impressive. By contrast, after half a century of research, and investments in the range of hundreds of billions of dollars, a practically significant realization of the hot fusion has been proved to be impossible beyond *credible* doubt.

By keeping in mind that cold fusion research (including these studies) has been conducted to date mainly with *private* funds, while the hot fusion research has been and continues to be entirely supported by *public* funds, any individual who dismisses or jeopardizes serious scientific research

on cold fusion, while supporting the abuse of public funds for the hot fusion, is unethical.

As far as I am concerned, I always believed in the existence of cold fusion in our environment, because I based my judgment in the observation and *admission* of physical evidence, and not on the aprioristic assumption of theories with known limitations. Experimental evidence visible by our naked eyes establishes the existence of *electron bonding (Cooper pair), and then electron clustering all the way to ball lighting.* This evidence establishes the capability by electrons to bond themselves against their Coulomb repulsive force, as well as the capability of accretion by electron clusters of additional electrons.

Physical laws are notoriously independent form the sign of the charge. Therefore, *the evidence on the accretion of electrons by ball lightning is actual evidence on the corresponding capability by nuclei of the accretion of nucleons, which is precisely cold fusion.*

The impossibility by classical Hamiltonian mechanics, quantum mechanics, and quantum electrodynamics to provide a quantitative-numerical representation of the electron bonding and accretion by electron clusters, is then clear evidence that the same theories *cannot* provide a scientific representation of cold fusion. Therefore, said theories cannot possibly be used as a *credible* argument for the lack of existence of cold fusion.

Moreover, my guiding principle has been the clear evidence that biological structures do indeed synthesize elements, thus establishing the existence of cold fusion at the essence of life. To see this aspect, one should meditate a moment on: the incredible variety of isotopes needed for a correct DNA; the statistically minute probability that all of these isotopes are available at the appropriate location and time for the DNA production; and the incredible number of *correct and complete* DNA produced by living organisms, while *the absence of only one isotope would imply biological anomalies.*

If biological structures can synthesize new isotopes via processes well beyond our comprehension at this time, the existence of the relatively simpler cold fusion in our physical environment then follows.

The primary drawback of cold fusion at the time of its announcement in 1989, and in the following years, is *the lack of a quantitative theoretical explanation of the underlying processes.* Since quantum mechanics prohibits nuclear fusions at ordinary conditions on Earth, dismissals were a mere consequence. A primary objective of hadronic mechanics is precisely that of providing a universal and unified treatment of all "new" energies of Class III, namely, those not possible for conventional doctrines (Definition I-1.2.1).

The research conducted in cold fusion to date is so vast, and the literature accumulated in the field is so numerous, to discourage even a partial outline. Therefore, for brevity, I assume the topic and related references to be known. The number of theoretical interpretations of cold fusion have also been numerous. However, *none* of them has achieved a resolutory character for the following reasons.

Theoretical models of cold fusion possessing a *unitary* time evolution are within the class of equivalence of quantum mechanics. As such, they *cannot* be accepted by the establishment as truly explaining cold fusion, for the various technical reasons reviewed in Papers I-V. A number of other attempted interpretations of cold fusion have indeed introduced effects outside quantum mechanics, but used the conventional theory for their elaboration, thus resulting in evident inconsistencies. Additional theoretical models which exit the class of equivalence of quantum mechanics may be afflicted by one or more catastrophic inconsistencies outlined in Section II-4.

The polyhedric character of physics should be kept in mind. Therefore, approaches different from hadronic mechanics are encouraged, *provided* that they are scientific (*i.e.*, avoid the catastrophic inconsistencies of Section II-4), and are proved via rigorous procedures to be outside the direct universality of hadronic mechanics, as an evident necessary condition for credible allegations of novelty.

I should also mention the existence of research either directly related to cold fusion, or applicable to cold fusion, which constitute independent realizations of *part* of hadronic mechanics. A representative example is the research by G. Preparata (see, e.g., [23]) based on *anisotropy,* which is an evident particular case of the isotopies, because the latter constitute the most general possible

anisotropic, and inhomogeneous formulations (see, e.g., the geometrical treatment [24a] from which all other aspects uniquely follow). Unfortunately, all attempts made by myself as well as by my associates (with letters, papers, and books) to discuss with Preparata the need for the additional inhomogeneity, have remained without any answer. The relationship between Preparata's anisotropic studies and the broader anisotropic and inhomogeneous treatment by hadronic mechanics has, therefore, remained un-addressed.

As a representative example, let us consider electrolytic means to saturate palladium with ionized hydrogen and deuterium, usually denoted Pd/H and Pd/D systems, respectively. The results of this section are easily extendable to other cases of cold fusion [21,22].

To avoid missing aspects that may be crucial for the enhancement of the efficiency, it is essential to conduct a *systematic* study of *all* aspects pertaining to cold fusion. This essentially requires systematic studies on the: I) Identification of the applicable discipline; II) All possible events at the particle, nuclear, and atomic levels underlying cold fusion; III) Selection of which of the above events verifies the basic laws of the selected discipline; IV) Identification of of the geometry of acceptable events; and V) Most efficient possible technological realization of the said conditions, laws, and geometries. The following comments are a preliminary, and partial outline of the above iterim.

I) IDENTIFICATION OF THE APPLICABLE DISCIPLINE. At its initiation, cold fusion "had" to be studied via the theories available at that time, classical mechanics, quantum mechanics, and quantum electrodynamics. Today, the study of cold fusion via the same disciplines is generally of - nonscientific nature, because it is known that these disciplines lack the very effects at the foundations of cold fusion. The selection of the broader theories evidently constitutes a serious scientific topic. However, the denial of the need for cold fusion of covering theories is nonscientific. After all, the very foundation of science is the admission of evidence.

I am pleased to report that the Pd/H and Pd/D systems constitute some of the strongest evidence favoring the use of isomechanics (Paper II) at all levels. A generally accepted feature of the systems considered is that they should be first treated at the *classical* level, in view of the large number of particles compressed in the palladium lattice, which consists about 10^8 protons and 10^9 electrons compressed in a relatively small region of space.

Conventional Hamiltonian mechanics (from which quantum mechanics and electrodynamics uniquely follow via quantization) are absolutely insufficient for the description of the systems considered, because they are purely potential-Hamiltonian, namely, they only admit action-at-a-distance forces among point particles. In reality, the systems considered have additional contact-zero range forces among extended particles which are beyond any dream of representation via a Hamiltonian. rather than adapting physical reality to preferred theories, a serious scientific study of cold fusion then requires the search for a theory capable of treating the indicated physical reality.

At this first and most fundamental point, I suggest researchers in cold fusion to follow the founders of analytic mechanics, Lagrange, Hamilton, and Jacobi, rather than miopic contemporary followers. In fact, said founders presented their historical equations, not in the form available in contemporary literature, but in the form with *external terms*, e.g.:

$$\frac{dr^k}{dt} = \frac{\partial H(r, p)}{\partial p_k}, \quad H = p^2/2m + V(r,p), \tag{4.4.1a}$$

$$\frac{d p_k}{dt} = -\frac{\partial H(r, p)}{\partial r^k} + F_k(t, r, p, ...) \tag{4.4.1a}$$

$$\frac{dA}{dt} = [A, H]^* = \frac{\partial A}{\partial r^k} \times \frac{\partial H}{\partial p_k} - \frac{\partial H}{\partial r^k} \times \frac{\partial A}{\partial p_k} + \frac{\partial A}{\partial r^k} \times F_k \tag{4.4.1c}$$

where H represent all action-at-a-distance interactions and F_k represent all characteristics (e..g, the nonspherical and deformable shapes of particles), and interactions (e.,g., nonlocal and nonpotential resistive forces) outside the representational capability of a Hamiltonian.

Since the "truncated" Hamilton equations of the contemporary literature, those *without* external terms, represent a rather small part of physical reality (essentially planetary and atomic systems *only*), I dedicated myself to the study of the original analytic equations (4.4.1), on which I have written nine monographs [25] for the treatment of the various aspects, such as: integrability conditions for the existence of a Hamiltonian (the so-called *conditions of variational selfadjointness*);for closed-isolated nonhamiltonian reversible systems [25a]; open-nonconservative irreversible systems [25b]; classical relativity profiles [25d]; operator profiles [25e]; multi-valued treatments [25f]; etc. The aspects important for cold fusion can be outlined as follows.

Despite their historical character, Eqs. (4.4.1) are unacceptable for quantitative studies,. whether in cold fusion or not, because of numerous shortcomings, such as: the violation by the brackets of the time evolution, Eqs. (4.4.1c), of the right distributive and scalar law, thus preventing the use of *any* consistent algebra, let alone Lie algebras; the impossibility of deriving Eqs. (4.4.1) from a universal variational principle, with consequential impossibility of optimization; Eqs. (4.4.1) admit nonlocal resistive effects among extended particles, while the underlying topology and mathematics remain local, thus having insidious mathematical insufficiencies; etc. [25]. Therefore, Eqs. (4.4.1) must be rewritten in a form resolving these insufficiencies.

In their initial and final stages, all effects studied in cold fusion constitute closed, isolated, conservative, and reversible systems, with particular reference to the verification of total conservation laws. This result *mandates* the reformulation of Eqs. (4.3.1) in such a way to admit an *antisymmetric* algebra in the brackets of the time evolution (otherwise $dH/dt \neq 0$).

In turn, the above conditions *mandated* (because of the lack of any known alternative) the first reformulation of Eqs. (4.4.1) and related mechanics into the form I called for historical reasons *Birkhoffian Mechanics* (see Vol. II of Refs. [25a]). In their simplest possible form, the basic analytic equations can be written:

$$\frac{dr^k}{dt} = \frac{\partial H(r, p)}{\partial p_k}, \quad H = p^2/2m + V(r,p), \tag{4.4.2a}$$

$$\frac{d p_k}{dt} = - B_k^{\ i}(t, r, p) \times \frac{\partial H(r, p)}{\partial r^k} \qquad B = \text{Diag}\,[F /(\partial H/\partial r)\,] \tag{4.4.2b}$$

$$\frac{dA}{dt} = [A, H]^* = \frac{\partial A}{\partial r^K} \times \frac{\partial H}{\partial p_k} - \frac{\partial H}{\partial r^i} \times B_i^{\ j} \times \frac{\partial A}{\partial p_k}, \tag{4.4.2c}$$

As one can see, the above equations are *identical* to Eqs. (4.4.1), and merely transform the *additive* external forces F into the *multiplicative* B-terms. The results are brackets $[A,B]^*$ verifying the right and left distributive and scalar laws (as necessary for any quantitative theory), although said brackets are not antisymmetric, thus requiring a full "symmetrization" of the B-terms in the two equations, as studied in details in Ref. [25a].

Despite the achievement in Refs. [25a] of a consistent algebra characterized by an antisymmetric brackets, I clearly stated in my recent papers [26] that my own Birkhoffian generalization of Hamiltonian mechanics (published in 1983 with one of the most prestigious publishers in its most prestigious series, Vol. II of Ref. [25a]) is afflicted by *catastrophic physical inconsistencies,* because time evolution (4.4.2) is *noncanonical, thus fundamentally noninvariant.* This literally means that any number predicted by a theory based on Eqs. (4.4.2) (or, equivalently,

their symmetrized version) is not conserved in time. Therefore, the theory presented in my second monograph with Springer-Verlag, Refs. [25a], has no known physical meaning or value.

As outlined in Section II-4, the resolution of these catastrophic inconsistencies *mandated* (again, because of the lack of any alternative) the construction of the new isomathematics, with particular reference to the isodifferential calculus. These efforts resulted in the following consistent and invariant analytic equations, first submitted in memoir [3e] (here written in the simplified form without isotime isoderivatives):

$$U \times U^t = \hat{1} = 1 / \hat{T} = \hat{T}^t \neq I , \tag{4.4.3a}$$

$$\frac{dr^k}{dt} = \frac{\hat{\partial} H(r, p)}{\hat{\partial} p_k} = \hat{T}^k_i(r, p) \times \frac{\partial H(r, p)}{\partial p_j} \tag{4.4.3b}$$

$$\frac{d p_k}{dt} = - \frac{\hat{\partial} H(r, p)}{\hat{\partial} r^k} = \hat{T}^k_i(r, p) \times \frac{\partial H(r, p)}{\partial r^i} , \tag{4.4.3c}$$

$$\frac{dA}{dt} = [A, \hat{H}] = \frac{\partial A}{\partial r^k} \times \frac{\partial H}{\partial p_k} - \frac{\partial H}{\partial r^k} \times \frac{\partial A}{\partial p_k} , \tag{4.4.3d}$$

$$\frac{\partial \hat{A}}{\partial t} + H = 0 , \qquad \frac{\hat{\partial} \hat{A}}{\hat{\partial} r^k} = - p_k , \qquad \frac{\hat{\partial} \hat{A}}{\hat{\partial} p_k} = 0 , \tag{4.4.3e}$$

$$\delta \hat{A} = \delta \int_{t_1}^{t_2} (p_k \hat{d} r^k - H \times dt) = 0 , \tag{4.4.3f}$$

resulting in what is today called the *Hamilton-Santilli isomechanics.*

In essence, the isomechanics is constructed via a step-by-step application of the most general possible (well behaved) nonlinear, nonlocal and nonpotential canonical transforms (4.4.3a) to the *totality* of the formalism and mathematics of Hamiltonian mechanics (as necessary to avoid the catastrophic inconsistencies), thus yielding the isounit (4.4.3a), isoanalytic equations (4.4.3b) and (4.4.3c); the Lie-Santilli isobrackets (4.4.3d), which are only deceptively *appearing* as being the conventional Poisson brackets (because the summation is on generalized spaces with generalized metric, thus *violating* the Lie axioms when improperly treated); the Hamilton-Jacobi-Santilli isoequations (4.4.3e); and the derivation of the mechanics from the isovariational principle (4.4.3f). The resulting isomechanics is *directly universal,* that is, capable of representing all infinitely possible local and nonlocal, potential and nonpotential systems (universality), in the frame of the observer (direct universality).

The application to Eqs. (4.4.3e) of the Animalu-Santilli isoquantization [25e]:

$$\hbar \rightarrow \hat{1}(r, p) , \tag{4.4.4a}$$

$$\hat{A} \rightarrow - i \times \hat{1}(r, p) \ln \hat{\psi} , \tag{4.4.4b}$$

uniquely and unambiguously yields the fundamental iso-Schrödinger and iso-Hamilton equations of hadronic mechanics:

$$i \times \partial_t \hat{\psi}(t, r) = H \hat{\times} \hat{\psi}(t, r) = H \times \hat{T}(r, p) \times \hat{\psi}(t, r) = E \times \hat{\psi}(t, r) , \tag{4.4.5a}$$

$$i \, dA / dt = [A, \hat{H}] = A \hat{\times} H - H \hat{\times} A = A \times \hat{T} \times H - H \times \hat{T} \times A , \tag{4.4.5b}$$

$$p_k \hat{\times} \hat{\psi}(t, r) = p_k \times \hat{T}(r, p) \times \hat{\psi} = - i \hat{T}_k^{i}(r, p) \partial_k \hat{\psi}(t, r), \qquad (4.4.5c)$$

which are here assumed at the foundation of all our operator studies on cold fusion.

Equivalently, Eqs. (4.4.5) can be uniquely and unambiguously derived via the application of the most general possible, nonlinear, nonlocal and *nonunitary* tranform to the *totality* of the formalism and mathematics of quantum mechanics, with *no* exception (again, to avoid catastrophic physical inconsistencies). The resulting hadronic mechanics is then directly universal for the representation of all closed, isolated, and reversible systems in the frame of the observer (irreversible and multivalued systems requires the broader geno-, and hyper-branches of hadronic mechanics). As one can see, the resulting theory is *anisotropic and inhomogeneous* beginning from the isounit $\hat{1}$) as a necessary condition to avoid said catastrophic inconsistencies. Anisotropy and inhomogeneity are also necessary conditions to represent physical reality of protons distributions within the Pd/H system.

As now familiar, hadronic mechanics is solely applicable under conditions of appreciable wave-overlapping at mutual distances of 1 fm. Moreover, the mechanics is restricted by the condition $\hat{1}_{r > 1 \text{ fm}} = I$ of recovering quantum mechanics identically at all distances bigger than 10^{-13} cm; the mechanics verifies all conventional quantum laws (Pauli's exclusion principle, Heisenberg's uncertainties, causality, etc.). Also, hadronic mechanics coincides at the abstract realization-free level with quantum mechanics, and, therefore, *it is not* a "new theory", but merely a "new realization" of conventional abstract quantum axioms. Last, but not least, hadronic mechanics reduces all new nonunitary effects outside quantum mechanics, including cold fusion, to a concrete and explicit realization of "hidden variables", because the isoeigenvalue equations $\hat{H} \hat{\times} \hat{\psi} = \hat{H} \times \lambda \times \hat{\psi}$, $\lambda = \hat{T}$ *coincide* with the conventional equations $H \times \psi = E \times \psi$ at the abstract level (because $| \hat{T} | > 0$), thus being "hidden" in the quantum axioms.

Most importantly, as studied in Papers III, IV, and V, hadronic, short range, contact nonhamiltonian interactions due to overlappings of wavepackets, when represented with the isounit $\hat{1}$ (or, equivalently, the isotopic element $\hat{T}$), do indeed permit stimulated nuclear transmutations, in general, and cold fusion, in particular, because they are so attractive to overcome repulsive Coulomb forces. In this way, the effects underlying cold fusion are essentially reduced to the historical teaching by Einstein, Podolsky, and Rosen on the "lack of completion" of quantum mechanics, which is "isotopically completed" by hadronic mechanics, that is, (from the Greek ισοστοποσ], completed in a way which preserves conventional basic axioms and physically law.

The conclusion of decades of studies is that *the classical and operator isotopic branch of hadronic mechanics are the only known, consistent, invariant ,and universal theories with a unique and unambiguous interconnecting map, for the quantitative and numerical representation of all possible linear and nonlinear, local and nonlocal, potential and nonpotential, unitary and nonunitary effects expected in the cold fusion.*

II) SYSTEMATIC IDENTIFICATION OF ALL POSSIBLE PROCESSES. Following the availability of a consistent and effective theory, the next step is a systematic study of all possible processes underlying cold fusion, that is, all possible basic transmutations.

Allow me to lament considerable difficulties I have experienced in studying the contemporary literature on this basic issue, due to the general absence of specific, fully identified nuclear transmutations (with very few exceptions), in which absence I am essentially unable to conduct any quantitative study. This is a rather widespread insufficiency I suggest to be resolved for future research, because generic studies on anomalous energy emissions without the precisely identified of at least the suspected basic reactions, prevents any realistic improvement of the energy emission.

Let us identify first the systems under study. They are given by electrodes composed of *natural palladium* saturated with 10^8 hydrogen nuclei (Pd/H) or, separately, with 10^9 deuterons (Pd/D). Let us recall that the palladium is one of the most interesting natural elements, particularly in regard to cold fusion, because it is constituted by following *six, different, stable, isotopes* [26]:

Pd(102, 46), 0.96 % ; Pd(104, 46), 10.97 %; Pd(105, 46), 22.23 %; (4.4.6a)

Pd(106, 46), 27.33 %; Pd)108, 46), 26.71 %; Pd(110, 46), 11.81 % . ((4.4.6b)

This richness is also the first visible reasons for limited energy emission in the absence of precisely identified nuclear processes, evidently because only *one* of the indicated isotopes is expected to be allowed, all remaining isotopes implying a *dampening* of the reactions, as we shall see shortly.

The next task is the identification of all stimulated nuclear transmutations that are possible in the above setting of natural Pd saturated with protons or deuterons.

II-A) STIMULATED NUCLEAR TRANS,MUTATIONS IN THE PALLADIUM. Hadronic mechanics predicts the following reactions between *stable* elements *without* secondary radiations based on particles available within the palladium:

$$TR + N(A, Z) + e^- \rightarrow N'(A, Z-1), \quad (4.4.7a)$$

$$TR + N(A, Z) + {}_1H^1 \rightarrow N'(A+1, Z+1), \quad (4.4.7b)$$

$$TR + N(A, Z) + {}_1H^2 \rightarrow N'(A+2, Z+1), \quad (4.4.7c)$$

where: TR is the trigger; transmutation (4.4.7a) is predicted from the synthesis of the neutron according to Rutherford studies in Paper III; transmutations (4.4.7b) and (4.4,7c) are predicted from the nuclear studies of Paper IV (here assumed as known); and transmutation $N(A, Z) + \gamma \rightarrow N'(A, Z+1)$ studied in Paper III is excluded, because of the lack of photons within the palladium with the necessary excitation energy of 1.294 MeV.

A simple inspection of nuclear data [20] restricts all various possibilities (4.4.7) to the following transmutations:

$$TR + Pd(105, 46) + {}_1H^2 \rightarrow Ag(107, 47), 51.82\ \%, \quad (5.4.7a)$$

$$TR + Pd(106, 46) + {}_1H^1 \rightarrow Ag(107, 47), 51.82\ \%, \quad (5.4.8b)$$

$$TR + Pd(108, 46) + {}_1H^1 \rightarrow Ag(109, 47), 48.18\ \% ; \%. \quad (5.4.8c)$$

where the isotopic percentages are those in natural silver.

Needless to say, the above cases are merely representatives, because a virtually endless number of possibilities excise for energy generating event I cannot review here, such as the cold fusion into unstable or metastable elements.

II-B) COLD FUSION OF THE HELIUM. The next event that has to be considered is evidently the cold fusion of helium in the Pd/D systems reported in numerous experiments, with basic reaction:

$$TR + {}_1H^2 + {}_1H^2 \rightarrow {}_2He^4, \quad (4.4.9)$$

which has already been the subject of a number of interpretations by hadronic mechanics in Papers III, IV and V.

II-D) NUCLEON CLUSTERS. The theory of electron clustering developed by Shoulders, Jin, Fox, and others [11] is evidently independent from the sign of the charge. As such, it can be applied to the study of *clusters of protons, or of protons and neutrons* (nucleons).

The latter study appears recommendable because of the very high concentration of protons and deuterons in the Pd/H and Pd/D systems. In turn, such a study can be important for the improvement of the efficiency of cold fusion up to a level of industrial applications.

III) VERIFICATION OF HADRONIC LAWS. After a systematic identification of events that are rendered possible by hadronic mechanics, the next necessary task is the verification of which of them verifies all hadronic laws.

It is easy to see that the validity of event (4.4.7a) is *unknown* at this writing. This is due to the fact that the conservation law of the angular moment is *apparently* verified by reaction (5.4.7a) via the values of spin from Nuclear Data [26]:

$$TR + Pd(105, 46) + {}_1H^2 \rightarrow Ag(107, 47) : \frac{5^+}{2} + 1^+ \rightarrow \frac{7^+}{2} . \qquad (5.4.10)$$

However, the above data require that *the palladium and the deuteron* are *coupled in triplet* (spin parallel), *which is in violation of Hadronic Law II-2* (requiring coupling in singlet). It is indeed possible that reaction (4.4.10) is one of possible *exceptions* to Law II-2, as indicated in Paper IV. In fact, the increase of the size of the nucleus may permit accretion of nucleons via new effects not possible for few-body nuclei.

One possibility is the *axial accretion of nucleons by nuclei,* that is, their accretion along the direction of spin, which would necessarily require parallel spin. By comparison, singlet couplings studied until now are based on the *side accretion,* that is, the fusion of nucleons in the same symmetry *plane* with antiparallel spins.

It is evident that the issue whether reaction (4.4.10) is possible can only be solved *experimentally.*

With the exception of parity (requiring a separate study), cold fusions (4.4.7b) and (4.4.7c) are *simpler* than (4.4.7a), because the considered palladium nuclei have zero spin, thus avoiding the theoretical and technological problems of verifying Hadronic Law II-2 for nuclei with spin. In fact, we have the following conservation laws of the angular momentum:

$$TR + Pd(106, 46) + {}_1H^1 \rightarrow Ag(107, 47) : \quad 0 + 1/2 \rightarrow 1/2 , \qquad (4.4.11a)$$

$$TR + Pd(108, 46) + {}_1H^1 \rightarrow Ag(109, 47) : \quad 0 + 1/2 \rightarrow 1/2 , \qquad (4.4.11b)$$

As studied in Section IV-3.8, cold fusion (4.4.9) verifies all Hadronic Laws II-1 to II-5, e.g.:

$$TR + {}_1H^2 + {}_1H^2 \rightarrow {}_2He^4 : 1^+ - 1^+ \rightarrow 0^+ , \qquad (4.4.12)$$

In conclusion, the major nuclear transmutations expected in the palladium based cold fusion are fully admitted by hadronic laws.

IV) IDENTIFICATION OF THE GEOMETRY OF NUCLEAR PROCESSES. The geometry of processes (4.4.11) predicted by hadronic mechanic is so simple to appear trivial, and it is essentially given by triggering via external means protons to reach distances from the palladium nuclei smaller than 1 fm, after which their accretion by the palladium nuclei and resulting cold fusion is unavoidable. Most promisingly, this accretion can occur from any direction in space, evidently because Pd(106, 46) and Pd(108, 46) have zero spin.

By comparison, if allowed, cold fusion (4.4.9) requires a special geometry, the polarization in a fixed direction in space of all palladium nuclei, and all protons compressed in its lattice.

The geometry for the cold fusion of the helium, Eq. (4.4.12), is more complex than the preceding geometries, because it requires antiparallel coupling as per Figure 4.1, thus requiring opposite polarization of the nuclei to be fused.

V) SUGGESTIONS FOR POSSIBLE INCREASES OF ENERGY RELEASES. As stressed throughout these papers, hadronic mechanics has been constructed, not for esoteric academic objectives, but rather for concrete and novel industrial applications. The content of these papers can, therefore, be used for the suggestion of specific and concrete means for the possible increase of the

efficiency of cold fusion.

Regrettably, I am not at liberty to disclose excessive details at this time for obvious security reasons, and also because the problem requires systematic and protracted theoretical and experimental research well beyond these introductory lines. However, a few comments may be of assistance for other researchers in the field.

FIRST HADRONIC COLD FUSION REACTION

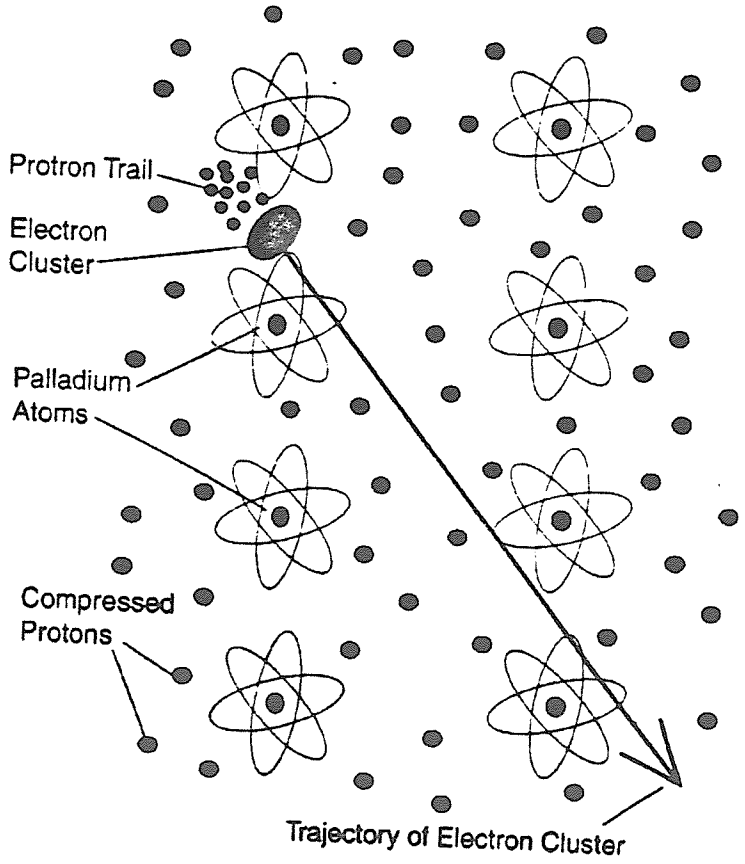

FIGURE 4.3. A schematic *and partial* view of the first cold fusion reactor suggested by hadronic mechanics to attempt the increase of energy released by Pd/H systems. It is based on selecting the simplest possible stimulated nuclear transmutations, Eqs. (4.4.11), and maximizing their trigger, that is, the electrochemical compression of protons within the palladiums lattice. The latter objective is suggested for realization via local disruption of the peripheral electron clouds of the palladium as permitted by the injection of electron clusters [11]. In fact, the latter imply an evident local increase of the density due to the collapse of the atomic structure of the palladium, as well as a local increase of the proton density, due to the fact that electrons clusters are negatively charged, thus dragging protons in their trajectories, and contributing in this way to electrochemical compression of protons. Preliminary calculations (not reported here for security reasons) indicate a realistic possibility that the efficiency of conventional Pd/H cells can be multiplied, evidently depending on the numbers of electron clusters locally injected in the palladium electrode, and various other technological aspects. The enhancement of the efficiency also requires the sole use of palladium isotopes Pd(106, 46) and Pd(108, 46), since they are the

sole isotopes admitting cold fusions (4.4.11). The additional presence of other isotopes will *decrease* the efficiency, evidently because the other four isotopes of the palladium would act as a *dampening* of reactions (4.4.11). This point is important to illustrate that the generic use of natural palladium electrodes, without the use of only specific isotopes for specific tasks, is a significant reason for the insufficient efficiency of current cold fusions cells. In turn, these aspects confirms the need for comprehensive investigations prior to the selection of specific embodiments.

The increase of the efficiency of cold fusion can be studied via *the identification of the most efficient practical realization of the geometry and trigger needed for the basic reactions.*

Consider the case of the "simpler" cold fusions (4.4.11)which have no geometry requirements. The best realization of the trigger of these reactions is that already used by researchers in the field, namely, *various electrochemical means for the compression of protons within the palladium lattice.*

In essence, experimental evidence suggests that electrochemical compression of protons within the palladium lattice forces a number of protons to reach distances from the palladium nuclei sufficient for their accretion. However, such approach has been insufficient until now to reach the efficiency needed for large industrial applications.

By proceeding along these rather rigid research lines, the next logical issue is the identification of the reason why such electrochemical pressure cannot be increased up to the desired values. The most probable answer is the old enemy of cold fusion, the peripheral electron clouds surrounding the palladium nuclei which cause evident obstructions against nuclear reactions.

The immediately next question is therefore the identification of means that could disrupt the palladium electron clouds, to such an extent to admit, at least locally, a significant increase of the electrochemical compression of protons.

A first answer *is the local injection within the palladium electrode of suitable electron clusters.* In fact, these clusters are known to disrupt conventional, atomic clouds, while having the evident capability of attracting protons due to their large negative charges, thus contributing to the electrochemical compression of protons within the palladium structure (see Figure 4.3). This type of realization of cold fusion does not appear to have been studied until now (indications to the contrary would be gratefully appreciated).

If allowed, the geometry of cold fusion (4.4.10) requires *a strong magnetic polarization of the palladium electrode and its deuteron content,* which has not been used so far, to my knowledge (indications to the contrary would also be gratefully appreciated). The best trigger remains the electrochemical compression. However, the use in this case of local injections of electron clusters generally disrupts the polarization needed for the reaction. The other alternative is the use of the new technology of magnetic polarization studied in Section 3 (see Figure 4.4).

Finally, to my knowledge at this writing, the synthesis of the helium within the palladium lattice is the most difficult nuclear transmutation encountered during all these studies. This is due to the need that the two deuterons must have opposite spin. In turn, this geometry requires *individual opposite polarizations of deuteron while under electrochemical compressions,* which is indeed a difficult technological task.

Therefore, the limited energy production due to cold fusion of helium, as well as difficulties in the reproduction of results, are due to the fact that reaction (4.4.9) todays occurs *at random, that is, for deuterium with an arbitrary orientation of their spin.* It is evident that only a minute number of deuteron have the polarization needed for the production of helium, thus explaining the low energy yield. Difficulties in the reproduction of the results are due to the very high dependence of these random conditions of otherwise irrelevant aspects, such as small differences in temperature, different chemical composition of the electrolyte, difference in the isotopic composition of the palladium electrode, and others.

Quite pragmatically, hadronic mechanics suggests the prior investment of human and financial resources for the improvement of the simplest possible reactions, Eqs. (4.3.11), followed by improvements of reactors based on reaction (4.10). The improvement of the efficiency for reaction

(4.3.12) is suggested to be addressed only following the achievement of industrial maturity in the preceding simpler reactors.

The application of hadronic mechanics, hadronic superconductivity, and hadronic chemistry to other forms of cold fusion can be done by following the same iterim, that is, systematic study of *all* aspects *prior* to the selection of specific embodiments, and then *maximization* in the technological realization of the needed geometries.

In this process one should remember the topic of study of Paper IV, consists of new forms of energies *intermediate between cold and hot fusion, yet fully realizable in our Earthly environment.* I am referring to new energies requiring local temperatures of several thousands degrees (as achievable in electric arcs), which, as such, are neither "cold", nor "hot" (the latter referring to the extreme conditions existing in the Sun).

SECOND AND THIRD HADRONIC COLD FUSION REACTORS

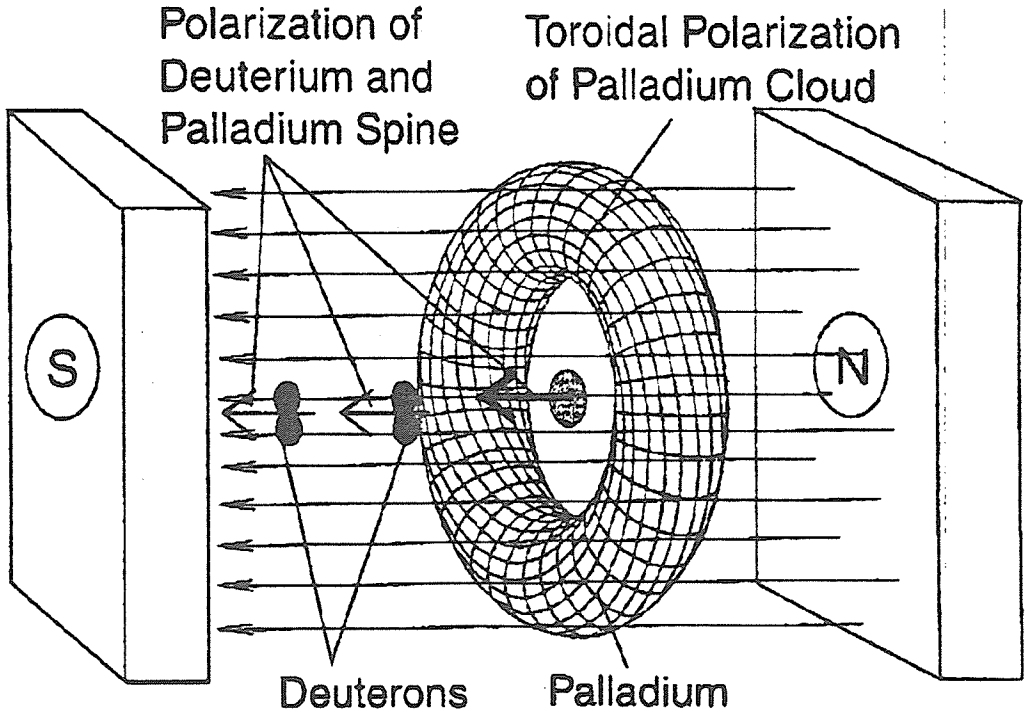

FIGURE 4.4. A schematic *and partial* view of a second conceivable cold fusion reactor as suggested by hadronic mechanics. In this case, the system is Pd/D; it is based on reaction (4.4.9); and requires the geometry and trigger discussed in the text. The reactor is essentially constituted by a conventional cold fusion Pd/D electrolytic cell, in which *the deuteron saturated palladium electrode is subjected to a sufficiently strong magnetic field* (whose numerical value, geometry, and realization I am not at liberty to disclose at this time). The main features of this suggested embodiment are the following: 1) The magnetic field implies a polarization of the orbits of the peripheral electrons in the palladium; 2) The achievement of at least a toroidal displace distribution with an opening along the magnetic axis, eliminates the biggest enemy of cold fusion, the peripheral electron clouds, by exposing nuclei to be reached by nucleons under suitable triggers without disrupting obstructions; 3) Said toroidal space distributions of electron clouds implies the increase of the density due to the decrease of the average atomic size and the increase of the specific weight, as per experimental measurements of Figures 3.17 and 3.18.; 4) The magnetic field

polarizes the spin/magnetic moment of the deuterons under compression, thus decreasing random effects, and increasing their concentration, all the way to the possible creation of the *nucleon clusters* indicated in the test; 5) The magnetic field finally polarizes the palladium nuclei and the deuteron along the same axial symmetry needed for the triplet coupling of reaction (4.4.9). In this way, the axial triplet conditions (which are *purely random* in current Pd/D cells) are identified, technically realized with a suitable magnetic field, and maximized. Needless to say, this *Second Hadronic Cold Fusion Reactor* should be solely realized with the palladium isotope Pd(105, 46), because all other five isotopes, as available in the natural state of the palladium, act as a major *dampening* of the efficiency. As indicated earlier, it is unknown whether reaction (4.4.9) is allowed. Therefore, the reactor proposed in this figure would have invaluable character for the resolution of whether Hadronic Laws II-2, and III-3 admit exceptions for large nuclei or not. The latter can be resolved experimentally via the indicated sole use of the pure isotope Pd(105, 46), and the possible, subsequent, spectrographic detection of Ag(107, 47), which can only have origin (4.4.9) under these conditions. The *Third Hadronic Cold Fusion Reactor* is that of Figure 4.3 with the additional control of peripheral electron cloud in the palladium to at least toroidal space distributions. In addition to the advantages of this figure, the use of suitable, strong, magnetic field guides electron clusters along pre-determined trajectories, thus providing an additional element of increase of the efficiency and energy release. Hadronic mechanics,. hadronic superconductivity and hadronic chemistry also provide a number of additional specific, suggestions for the increase of energy release which will be discussed at some future time.

The reference is here important because technological solutions of difficult problems are never unique, and generally require the combination of various different technologies and approaches. When fusions are not realizable at ordinary temperature and pressure, they may be realizable under conditions other than "cold", yet still far from the proved impossibility of the "hot" fusion.

We reach in this way the possible existence of *a large number of possible nuclear transmutations on Earth*, in a variety of different environments, including solid, liquid, and gas states, at a variety of different temperature and pressures.

It is an easy prediction that, once proved via systematic research based on theories of proved applicability, consistency, and rigor, stimulated nuclear transmutations will change a number of current scientific views. As an illustration, the large amount of heat existing in the interior of our planet (to such an extent to keep it at the liquid state over ages) cannot be explained via the orthodox assumption that, billions of years following the creation of Earth, that heat is still the primordial one. Simple calculations show that such an internal heat should have been dissipated in space hundreds of millions of years ago. The orthodox interpretation of internal planetary heat is, therefore, farfetched, because not scientific or credible.

The only interpretation of the internal planetary heat I know to be *scientific*, because providing a quantitative representation of evidence, is the old expectation that *planetary internal heat is due to stimulated nuclear transmutations*. In turn, this view explains recent geological measurements according to which *the Earth is growing in size* (while it should be shrinking according to the orthodox view).

In these papers, I have recommended in depth studies of stimulated nuclear transmutations already existing on Earth, such as those triggered by lighting (the only one providing a quantitative interpretation of thunder, as shown in Paper IV), or those triggered in living organisms (the only one explaining phenomena such as the so-called human self-combustion, repeatedly certified by police in formal proceedings). I suggest here additional serious studies of stimulated nuclear transmutation sin the interior of planets. With its interior ferromagnetic core, locally high magnetic fields precisely as needed for spin polarizations, and high compression, Earth appears to be the best possible model of a hadronic reactor with excellent possibilities of being duplicated in laboratory.

electrons into the isoelectronium is due to contact interactions which have no potential energy. Equivalently, we can say that the potential energy due to the repulsive Coulomb forces of the two electrons in single coupling is essentially annulled by the energy due to the double magnetic attraction of the two polarities, as in Figure 3.1. Therefore, in first nonrelativistic approximation, one can ignore energy considerations pertaining to the bonding of two electrons into the isoelectronium.

Therefore, *the bonding of one electron to the orbiting electron of the hydrogen or of the deuterium atoms constitutes sources of new energies of Class III.*

A few comments are now in order. States (4.5.1)-(4.5.4) are impossible for quantum mechanics because of the impossibility to represent the bonding of identical electron into a state that behaves like a single point-like charged particles. In fact, quantum mechanics would predict that the two electrons are "correlated", namely, have a coupling substantially insufficient to permit the to orbit around the proton. This illustrates the *necessity* of hadronic mechanics, and establishes the *new* character of the energy as per Definition I-1.2.1. The fact that Mills blacklight is a new energy is of Class III is evident from the fact that it *requires* the full atomic structure.

After having clarified these aspects, note that *states (4.5.1) to (4.5.4) are purely quantum mechanical,* evidently because hadronic mechanics recovers quantum mechanics identically at all distances sufficiently bigger than 1 fm, thus including orbital distances.

It is remarkable that Mills [loc. Cit.] obtained essentially the same results with a theory structurally different than hadronic and quantum mechanics, thus illustrating the polyhedric character of physics.

The issue of primary importance for industrial developments is the increase of the efficiency in the production of Mills blacklight. This issue requires the prior *experimental* determination as to whether the orbiting particle is one single electron, or the isoelectronium. Such determination implies dramatically different means for improving the efficiency. If the orbiting particle has charge -e, then only Mills theory can provide the necessary guidelines for the improvement of the efficiency. On the contrary, if the orbiting particle has charge -2e, then only hadronic mechanics should be used to improve the efficiency.

In the second eventuality, hadronic mechanics does indeed provide specific and concrete requirements for the improvement of the efficiency. These aspects cannot be discussed in details here for evident security reasons. Nevertheless, it is important for readers to see the implementation of the scope of these papers: ***to provide researchers in new energies with concrete suggestions to improve the efficiency.***

The objective is to maximize the conditions under which a conventional hydrogen atom can be turned into the "isoelectronium-hydrino". The increase of the energy released is then just consequential. The serious scientific addressing of this practical task requires first the identification of the applicable physical laws, and then the identification of the best means for their efficient realizations.

The hadronic physical laws of the isoelectronium have been studied in Sects. 3.1 and 3.2. Hadronic mechanics provides the additional laws for bonding an electron to that orbiting around a proton or a deuteron, which include: the elimination of the spherical distribution of the orbiting electron (Law III-1), as permitted, e.g., by the plane polarization of the orbiting electron via external magnetic fields; the injection of electrons with polarized spin/magnetic moment opposite to that of the orbiting electron, so as to permit the coupling (Law III-3); the use of the minimal threshold energy; and other requirements.

All these requirements appear feasible with current technology. It is therefore a pleasure for me to confirm Mills result that blacklight is indeed a realistic source of new energies of Class III deserving serious industrial attention and further development.

5. CONCLUDING REMARKS

In these five papers I have outlined the laborious scientific journey over more than two decades conducted by several mathematicians, theoreticians, and experimentalists on the construction of *hadronic mechanics*, which include:

1) Identification of clear limitations of classical and quantum mechanics, because of their sole capability to represent a finite set of isolated point-like particles with local, action-at-a-distance forces derivable from a potential.

2) Need for broader formulations representing extended, nonspherical and deformable particles with linear and nonlinear, local and nonlocal, as well as potential and nonpotential interactions, as existing at the classical level in motions of extended bodies within resistive media, and at the particle, nuclear, and molecular levels in deep mutual overlapping of the wavepackets of particles.

3) Catastrophic physical inconsistencies for all classical and operator generalized theories representing nonlinear, nonlocal, or nonpotential interactions while using the mathematics of conventional classical and quantum mechanics.

4) Construction of the new iso-, geno-, and hyper-mathematics, for the invariant representation of closed-reversible systems, open-irreversible reactions; multi-valued biological structures, respectively, and their isodual for antimatter.

5) Construction of numerous, sequential, generalizations of classical mechanics, until the achievement of formulations (the classical iso-, geno-, and hyper-mechanics for matter, and their isoduals for antimatter) which avoid the indicated catastrophic inconsistencies and permit a universal description of possible, well behaved systems of our macroscopic reality.

6) Identification of unique and unambiguous maps for the construction of the operator images of said classical formulations (the iso-, geno-, and hyper-quantization for matter and their isoduals for antimatter).

7) Construction of the various branches of hadronic mechanics (the operator iso-, geno-, and hyper-mechanics for matter, and their isoduals for antimatter); their extension to hadronic superconductivity and hadronic chemistry; construction of the methods for their elaboration (iso-, geno-, and hyper-functional analysis, Lie theory, etc.); and identification of simple means usable by nonexperts for the practical construction of specific hadronic model via the use of nonunitary transforms.

8) Proof that the emerging classical and operator theories are not new theories, but only "new realizations" of the abstract axioms of classical and quantum mechanics as permitted by the new mathematics, thus implying the verification of conventional physical laws (Pauli's exclusion principle, Heisenberg's uncertainty, causality, etc.), as well as concrete and explicit realizations of "hidden variables" and Einstein, Podolsky and Rosen historical argument on the "lack of completion of quantum mechanics".

9) Experimental verification of the new mechanics in particle physics, nuclear physics, superconductivity, chemistry, biology, astrophysics, and cosmology.

After having achieved scientific credibility with the above iterim, and only after that, in these papers I have applied the isomechanics to "new, clean, energies, and fuels", that is, energies and fuels which are "new" in the sense of not being predicted and quantitatively treatable via conventional classical and quantum mechanics, and are "clean" in the sense of being environmentally acceptable.

The results of these decades of efforts have been rewarding, because hadronic mechanics: I) confirms in full the existence of new clean energies at the particle, nuclear, and atomic-molecular levels, including a full confirmation of cold fusion; II) provides the first rigorous, consistent, and invariant theory for quantitative treatments of new energies; III) identifies the physical laws, conditions, and geometries under which said new energies are possible; IV) suggests concrete and specific embodiments for the most efficient possible realization of said laws, conditions, and geometries; and V) identifies hitherto unknown new energies at the particle, nuclear, and molecular

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August 1999

Biographical notes of

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Santilli was born and educated in Italy were he received his Ph.D. in theoretical physics from the University of Turin in 1966. He then emigrated to the U.S.A. and was in the faculty of: the University of Miami in Florida, Boston University, the Massachusetts Institute of Technology, and Harvard University. During these academic positions, Santilli taught all undergraduate, graduate and postgraduate courses in physics, and conducted research under the support of the U. S. Air Force, NASA, and the Department of Energy. In 1983 Santilli accepted the position of Professor of Theoretical Physics and President of the Institute for Basic Research, then located within the compound of Harvard University, more recently moved to Palm Harbor, Florida, and became a U.S. Citizen in 1985. Santilli is the author of fifteen research monographs and over 200 articles published in physics journals the world, and the editor of over 50 volumes of conference proceedings. Santilli is the founder and Editor in Chief of three technical journals, and editor of numerous other journals in mathematics and physics. Santilli has been the organizer of twenty international meetings in advanced mathematics and physics, five held at Harvard University and the other in the USA, Europe, Russia and China. He is the author of a number of mathematical and physical advances which nowadays carry his name, such as: the Hamilton-Santilli mechanics, the Lie-Santilli theory, the Heisenberg-Santilli equations, the Santilli isosymmetries, and others. Santilli has received numerous honors, including the Gold Medals for Science from the Province of Campobasso, Italy, and from the University of Orleans, France; he has also been nominated by the Estonian Academy of Sciences among the most illustrious applied mathematicians of all times, jointly with Hamilton, Weyerstrass, Lie, etc.; and has been Nominated by various senior scholars for the Nobel Prize in physics since 1985.