

# HADRONIC ENERGY

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## Abstract

The sources of energy known at this writing are of molecular, atomic or nuclear origin. As a third curiosity for scientists with young minds following the preceding two studies on antigravity and the space-time machine, in this note I submit in a language accessible to the general physics audience a conceivable new form of energy called *hadronic energy* because originating from mechanisms, this time, in the structure of individual hadrons, such as the neutron. Recall that the nuclear energy could not be predicted by Newtonian mechanics and required the advent of quantum mechanics. Intriguingly, the hadronic energy cannot even be conceived, let alone treated, via quantum mechanics, while it is predicted and quantitatively treated by the covering discipline known as *hadronic mechanics*. The generalization is requested to represent nonlocal-integral and nonpotential-nonhamiltonian interactions expected for conditions of total mutual penetration/overlapping of the charge-distributions/wavelengths of hadrons at distances  $\leq 1$  fm; it is realized via the integro-differential generalization  $\hbar$  of the basic unit of quantum mechanics, Planck's constant  $h = 1$ ; and implies a structural generalization of all mathematical aspects of quantum mechanics. It is shown that the hadronic energy, if confirmed, would be a joint direct production of electricity and heat which is without harmful radiations, of light weight and virtually inexhaustible. Additional industrial, medical or scientific applications are expected for recycling highly radioactive nuclear waste into less dangerous materials, the construction of *hadronic drills* substantially more efficient than the usual laser drills, the transmutation of erroneous nuclei in a DNA, and other applications. A conceivable yet specific realization of the hadronic energy as joint production of electricity and heat recently filed for U. S. Patent is outlined with understandable paucity of details. The note ends with the suggestion of a systematic experimental program consisting of tests all feasible with current technology and of cost which is a fraction of that of contemporary particle experiment.

U. S. PATENT PENDING

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## 1. PROPOSED HADRONIC ENERGY

The forms of energies currently known are of molecular (such as fossil oil), or of atomic (such as radiant heat), or of nuclear origin (such as nuclear power plants).

In a nontechnical language accessible to the general physics audience and as a scientific curiosity for young minds, this note presents, apparently for the first time, preliminary studies on a possible novel form of energy called **hadronic energy** because originating, this time, in the structure of individual neutrons or, more generally, in the structure of strongly interacting particles called hadrons.

A fundamental reaction of hadron physics is that isolated neutrons have a mean life of  $918 \pm 14$  sec (about 15') with *spontaneous decay* under weak interactions also called *beta decay* (see, e.g. [1])

$$n \rightarrow p^+ + \beta^- = p^+ + e^- + \bar{\nu}. \quad (1.1)$$

By assuming in first approximation that the neutron and proton are at rest (thus, ignoring the small proton recoil) and by recalling the rest energies  $E^0(n) = 939.573$  MeV,  $E^0(p) = 938.279$  MeV, the energy released in beta decay (1.1) is 1.294 MeV.

By keeping in mind that the electron has the rest energy  $E^0(e) = 0.5$  MeV and that the neutrino has an ignorable rest energy for the scope of this note,  $E^0(\nu) \approx 15$  eV, the energy available is essentially carried out by the electron according to available experimental data of the energy distribution between electrons and the antineutrino [3]. We therefore have following:

**Established property:** *Spontaneous decay (1.1) has a positive energy output with total energy of the  $\beta^-$  decay  $E(\beta^-) = 1.294$  MeV and the electron emitted with kinetic energy  $K = 0.80$  MeV in a conservative 90% statistical average.*

Also, the electron is emitted straight from the center of the neutron and without angular momentum.

The main mechanism of the proposed hadronic energy is the *stimulated decay of the neutron* via scattering with gamma photons  $\hat{\gamma}$  of a particular resonating frequency  $\hat{\omega}$  suitable to excite the electron as discussed in Sects. 2 and 3, according to the reaction

$$\hat{\gamma} + n \rightarrow p^+ + \beta^- = p^+ + e^- + \bar{\nu}, \quad (1.2)$$

where we have introduced the symbol  $\beta^-$  because its energy is different than that of the  $\beta^-$  decay in the spontaneous decay (1.1).

According to the above mechanism, the electron is excited by the particular gamma photon. As a result, its energy is entirely absorbed by the electron. We therefore have the following:

**Expected property:** By recalling that decay (1.1) occurs spontaneously with a positive-energy output, the stimulated decay (1.2) is expected to preserve such positive energy output, with the input energy  $E(\hat{\gamma})$  of the gamma photons, the output energy  $E(\beta^-) = E(\gamma) + E(\beta^-) = 1.294 \text{ MeV} + E(\hat{\gamma}) > E(\hat{\gamma})$  and with electrons emitted with kinetic energy  $K = 0.80 \text{ MeV} + E(\hat{\gamma})$  in 90% conservative statistical average.

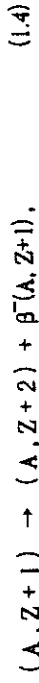
The biggest source of neutrons is evidently given by nuclei of ordinary, stable, natural elements (A, Z) with total number A of protons and neutrons (nucleons) and total number Z of protons. The practical realization of the proposed hadronic energy is therefore based on the stimulated decay of peripheral neutrons of a nuclear structure via gamma photons, again, of a particular frequency  $\hat{\omega}$  suitable to stimulate the emission of the electron. In this case, the original nucleus (A, Z) is artificially transmuted into a different nucleus (A, Z+1) in which the total number of nucleons A is evidently unchanged, but the number of protons Z is increased of one unit. We therefore have the reaction



where we have differentiated the gamma photon  $\hat{\gamma}$  from the gamma  $\gamma$  of reaction (1.2) owing to adjustments  $\hat{\omega}$  in the characteristic excitation frequency  $\hat{\omega}$  expected from the nuclear binding energy and other data.

Now, the transmutation (A, Z)  $\rightarrow$  (A, Z+1) generally releases energy (and for this reason is called *esoenergetic*). In fact, the neutron is heavier than the proton and, consequently, the atomic weight of the nucleus (A, Z) is generally bigger than that of (A, Z+1) (with exceptions illustrated in Sect. 4).

Also, when (A, Z) is a suitably selected, stable, natural element, the isotope (A, Z+1) is generally unstable with spontaneous  $\beta^-$  decay into a final stable natural element according to the reaction



where the beta decay has been indicated with the symbol  $\beta^-(A, Z+1)$  because it is spontaneous but its energy changes from nucleus to nucleus. Note that the spontaneous transmutation (A, Z+1)  $\rightarrow$  (A, Z+2) is also generally *esoenergetic*, again, because the atomic weight of the original nucleus is bigger than that of the final

nucleus.

Recall that the nuclear energy can be defined as the positive energy output which can be obtained via the stimulated disintegration of <aggregates> of nucleons (the nuclei). We therefore have the following:

**Proposed hadronic energy:** It is defined as the positive energy output which can be obtained from the artificial disintegration of individual hadrons such as the neutron, and its conceivable practical realization is composed of the following parts:

- 1) The stimulated transmutation of a suitably selected, stable, natural, element with nuclei (A, Z) into an unstable isotope with nuclei (A, Z+1) via bombardment of the original nuclei with a coherent beam of gamma photons  $\hat{\gamma}$  of a particular frequency  $\hat{\omega}$  suitable to excite the emission of electrons, with consequential spontaneous decay of the stimulated nuclei (A, Z+1) via  $\beta^-$  into a final, stable, natural element (A, Z+2);
- 2) Positive energy balance in a way fully consistent with the conservation of the total energy, essentially consisting of the artificial transmutation of one natural element (A, Z) into another stable element (A, Z+2) of smaller atomic weight, with input energy  $E(\hat{\gamma})$  and output energy  $E(\hat{\gamma}) + E(A, Z) - E(A, Z+2)$ ;
- 3) Practical utilizations of the energy released, such as:

3.A) **Direct production of electricity** because each gamma photon produces two energetic electrons leaving the original material (which therefore acquires a positive charge) and can be captured by a suitable metal shield (which therefore acquires a negative charge), thus resulting in a difference of potential much similar to that of batteries suitable to operate electric motors or other uses;

3B) **Joint direct production of heat**, because the stimulated and spontaneous electrons hitting the shield have high energies of the order of MeV's (about one thousand times bigger than the energy of the electrons hitting a television screen), thus implying the heating up of the shield itself which can be utilized via a suitable flow of water in the outside of said shield or for other practical purposes; and

3) **Other industrial, medical and scientific applications**, such as: the stimulated recycling of highly radioactive waste with very long meanlives produced by nuclear power plants into materials with lesser or no radioactivity and much reduced meanlives; the artificial transmutation of erroneous nucleus in a DNA into correct nuclei; the artificial production of rare isotopes; realization as the "hadronic drill", i.e., a machine performing drills in ordinary substances via more efficient mechanisms (as compared to laser drills) at the subnuclear

level, and other applications.

The most important characteristics of the proposed hadronic energy are:  
**I) Lack of harmful radiations.** As is well known, the nuclear energy produces large doses of harmful radiations and dangerous waste which have caused considerable societal problems. By comparison, the proposed hadronic energy produces neutrinos (which are harmless to humans and to the environment) plus electrons and secondary gamma photons which can be completely stopped with a relatively thin metal shield.

**II) Light weight.** As is equally well known, the nuclear energy can only be realized in large plants owing to the need of sizable shielding material as well as of a critical mass. By comparison, the proposed hadronic energy requires no critical mass and light shields for the absorption of electrons and gamma photons. As a result, the proposed hadronic energy can be realized via light equipment suitable to power automobiles or heat individual houses, and is expected to be even minuterizable (see Sect. 4).

**III) Virtually inexhaustible.** As we shall see in Sect. 4, the "fuel" of the proposed hadronic energy is given by ordinary stable elements in virtually endless diversity and individual availability on Earth.

The above characteristics are such to suggest scientific caution before venturing personal theoretical beliefs one way or another. After all, *the basic mechanism occurs spontaneously in nature*. A mechanism for its artificial stimulation will then be found in one way or another by the young minds indicated earlier.

A serious scientific study of the proposed hadronic energy can only be done via a comprehensive experimental program, e.g., along the lines suggested in Sect. 5.

## 2: SCIENTIFIC BACKGROUND

According to currently established views, the electron and neutrino are produced via processes due to weak interactions at the moment of decay (1.1) [1].

However, recent experiments [3] conducted by don Borghi (a late Italian priest-physicist) and his collaborators have shown the apparent possibility to fabricate the neutron in laboratory via the chemical synthesis of one proton and one electron according to the reaction



The experimenters essentially filled up a metallic chamber (called klystron) with a gas of protons and electrons at low energy and at room temperature, obtained via the electrolytic separation of the hydrogen. Since the protons and electrons are charged, they cannot escape the metallic chamber and are therefore trapped in the inside. However, since the expected results of their chemical synthesis are neutral, the neutron can indeed escape the chamber and be detected in the outside.

The experimenters therefore put in the outside of the klystron a variety of stable and fissionable materials. After a measured amount of time of the order of days or weeks, they discovered that the outside materials had experienced nuclear transmutations of the type  $(A, Z) \rightarrow (A+1, Z)$ . In the absence of any other neutron source, these outside transmutations can be solely interpreted as due to a flux of neutrons originating from inside the chamber, that is, from chemical synthesis (2.1).

It should be stressed that don Borghi's experiment [3] is in need of independent verifications submitted in Sect. 5 and currently under consideration by various laboratories. However, as explained later on, the new hadronic energy could exist even if don Borghi's experiment fails to be confirmed.

The scientific background underlying don Borghi's experiment and the proposed hadronic energy can be summarized as follows.

The English physicist E. Rutherford [4] conceived the neutron in 1920 as a compressed hydrogen atom, that is, as a hydrogen atom compressed down to the size of the proton, say, in a supernova explosion. A central condition of Rutherford's conception of the neutron is therefore the complete immersion of the electron within the hyperdense medium inside the proton. These are physical conditions evidently different than the conventional ones of current theoretical treatment and experimental detection of the electron. For this reason, the term *electron* and the symbol  $e^-$  will be referred to the ordinary electron in vacuum, while we shall use the term *Rutherford's electron* and the symbol  $\tilde{e}^-$  to denote the particle when totally immersed inside the proton.

Rutherford's hypothesis on the existence of the neutron was subsequently confirmed by J. Chadwick twelve years later [5], but his conception of the neutron as a bound state of a proton and an electron at very short distances was rejected by the scientific community because contrary to quantum mechanics on numerous grounds, such as:

- 1) the bound state would require a "positive binding energy", which is evidently prohibited by quantum mechanics, because the rest energy of the neutron  $E(n) = 939.57$  MeV is bigger than the sum of the rest energies of the proton  $E(p) = 938.28$  MeV and of the electron  $E(e) = 0.5$  MeV;
- 2) the impossibility to reach the spin  $1/2$  of the neutron via two particles each with spin  $1/2$ ;
- 3) the impossibility to represent the magnetic moment of the neutron

from those of the proton and electron; and other problematic aspects.

Quantum mechanics is certainly exact for the description of the electron in the hydrogen structure or under electromagnetic interactions at large (characterized by motion of a point particle in vacuum referred in the literature as the *exterior dynamical problem*). However, the use of the same discipline for the fundamentally different physical conditions of Rutherford's electron (characterized by motion of extended wavepackets within hyperdense hadronic media referred in the literature as the *interior dynamical problem*) leads to manifest inconsistencies, such as:

- a) <The proton is an ideal empty sphere with points in it>, as needed to apply the local/differential/action-at-a-distance structure of quantum mechanics, contrary to the experimental evidence that the proton is one of the densest media measured in laboratory until now;
- b) <The electron freely orbits inside the proton>, as necessary also to apply the local-potential structure of quantum mechanics, contrary to the evidence that the electron experiences a resistive force when moving in the hyperdense medium inside the proton;
- c) <The electron forms a tiny atom inside the proton>, evidently because the only bound states permitted by quantum mechanics are those of conventional atomic type, and other consequences.

Because of the manifest inconsistency of the above consequences, the objections raised by quantum mechanics against Rutherford's conception of the neutron do not have real scientific value, and studies on Rutherford's historical hypothesis have continued throughout this century. For instance, C. Borghi [6], E. J. Sternglass [7], P. F. Browne [8], A. O. Barut [9] and others have provided explicit structure models of the neutron in which the electron is a physical constituent, although based on conventional quantum mechanics.

Deeper studies of Rutherford's conception of the neutron require theories capable of representing:

- a) interactions which are *nonlocal-integral* over the finite volume of mutual wave-overlapping which cannot be effectively reduced to a finite set of isolated points;
- b) Interactions which are *nonlinear in the velocities and in the derivative of the wavefunction*, as typical for all resistive interactions experienced by extended objects moving within physical media; and
- c) Interactions which *admit no potential or Hamiltonian* (in addition to those of conventional potential-Hamiltonian type) because they are of contact/zero-range type, as it is the case for all resistive forces, thus preventing the conventional quantum mechanical representation via exchanges of real or virtual quanta of energy.

It is evident that nonrelativistic or relativistic quantum mechanics, being

strictly local-differential and potential-Hamiltonian, offers no realistic hopes of quantitative treatment of the above interactions in Rutherford's conception of the neutron.

The task of constructing a generalization of nonrelativistic and relativistic quantum mechanics capable of representing the above characteristics was initiated in a systematic way by this author back in 1978 when at Harvard University under DOE support via the proposal [10,11] to construct a nonlinear-nonlocal-nonhamiltonian generalization of quantum mechanics under the name of *hadronic mechanics*.

In the ensuing years, the proposal was studied by numerous researchers from various Countries in a variety of technical papers, monographs and conference proceedings. A summary of all these efforts is presented in monographs [12,13] for the classical profile and monographs [14] for the operator counterpart.

The main idea of hadronic mechanics is to represent conventional action-at-a-distance interactions via the Hamiltonian H as the sum of the kinetic energy K and the potential energy V, and to represent all zero-range nonpotential interactions via a generalization of Planck's unit  $\hbar = h/2\pi = 1$  into an integro-differential operator unit  $\hbar = \hat{h} = \hat{1}$  which is invertible and positive-definite, but otherwise possesses an arbitrary dependence on the velocities  $\dot{r}$ , accelerations  $\ddot{r}$ , derivatives of the wavefunctions  $\psi(t,r)$ , and any needed additional quantity,

$$\hbar = 1 > 0 \rightarrow \hat{h}(t, \dot{r}, \ddot{r}, \partial\psi, \partial\partial\psi, \dots) = \hat{1}(t, \dot{r}, \ddot{r}, \partial\psi, \partial\partial\psi, \dots) = \hat{1} > 0. \quad (2.2)$$

By recalling that the unit is deeply linked to the product, any generalization of the unit demands a corresponding compatible generalization of the conventional associative product AB among generic quantum mechanical quantities A, B, into the form  $A \hat{*} B = A \hat{T} B$  which admits  $\hat{1}$  as the correct left and right unit of the theory for  $\hat{1} = \hat{T}^{-1}$ ,

$$A B \rightarrow A \hat{*} B = A \hat{T} B, \quad \hat{1} = \hat{T}^{-1}, \quad (2.3a)$$

$$1 A = A 1 = A \rightarrow \hat{1} \hat{*} A = A \hat{*} \hat{1} = A, \quad \forall A, \quad (2.3b)$$

in which case  $\hat{T}$  is called the *isotopic element* and  $\hat{1}$  is called the *isounit*.

The generalizations of the basic unit and product then require, for necessary reasons of compatibility, corresponding generalizations of the totality of the mathematical structure of quantum mechanics into that of hadronic mechanics. The ensuing methods are called *isotopic*, in the sense of being *axiom-preserving*. In fact, under the assumed conditions, there is no difference

between  $\hbar$  and  $\hbar$  at the abstract realization-free level because both are left and right positive-definite units. Similarly, there is no difference between the conventional product  $AB$  and the generalized product  $A \cdot B$  because the latter preserves the original axiom of associativity, i.e., for  $A(BC) = (AB)C$  we consequently have  $A \cdot (B \cdot C) = (A \cdot B) \cdot C$ . The same abstract identity between the conventional and generalized formulations exists at all subsequent levels.

As an illustration, the fields of real numbers  $R(n, +, \times)$  with conventional elements  $n, m, \dots$ , sum  $n + m$  and product  $n \cdot m = nm$ , must be generalized under the lifting of the unit  $1 \rightarrow \hat{1}$  into the so-called *isofields*  $R(\hat{n}, +, \cdot)$  with generalized elements  $\hat{n} = n\hat{1}$ , sum  $\hat{n} + \hat{m} = (n + m)\hat{1}$ , isomultiplication  $\hat{n} \cdot \hat{m} = \hat{n}\hat{1}\hat{m} = (nm)\hat{1}$ , and consequential generalization of all other operations such as square root, quotient, power, etc.

However, the generalization is such that at the abstract level, fields and isofield coincide (and are therefore locally isomorphic). Similar compatible generalizations admitting  $\hat{1}$  as the correct left and right units have been constructed for: vector, metric and Hilbert spaces; trigonometric and special functions; algebras, groups and symmetries; Euclidean, Minkowskian and Riemannian geometries; and other methods of quantum mechanics (see refs [14] for details).

Relativistic quantum mechanics is then exactly valid for the conventional electron  $e^-$  in exterior dynamical conditions, e.g., when moving in vacuum in the structure of the hydrogen atom. In this case space-time is characterized by the Minkowski space  $M$  with metric  $\eta = \text{diag. } (1, 1, 1, -1)$  and line element  $xx + yy + zz - tc_0^2t$ , where  $(x, y, z)$  are the space coordinates,  $t$  is time, and  $c_0$  represents the speed of light in vacuum.)

When the same electron moves within a physical medium, space-time is deformed by the medium itself for numerous reasons now experimentally established (see the review in [14]). The deformation is first due to the fact that the speed of light  $c_0$  cannot possibly remain the same within physical media, and must be modified into the familiar form  $c = c_0/n$  where  $n$  is the index of refraction. Additional reasons for the deformation are of geometric character and originate from the fact that empty space is homogeneous and isotropic, while physical media are inhomogeneous and anisotropic.

No theory on Rutherford's electron can acquire a resolatory character unless the underlying methods directly represent a locally varying speed of light, the inhomogeneity and anisotropy of the medium in which motion occurs, and other characteristics of interior problems, *beginning* at the classical level [10-13] and then persisting at the operator version [14].

Relativistic hadronic mechanics is "universal" for the representation of all infinitely possible signature-preserving deformations of the Minkowski space called *isominkowski spaces*  $\hat{M}$ . They are characterized by an infinite class of

deformations  $\hat{\eta}$  of the space-time metric  $\eta$ , which are written in the geometrically unified form  $\hat{\eta} = \hat{T}\eta$ ,  $\hat{T} > 0$ ,  $\hat{1} = \hat{T}^{-1}$ . Since the isounit  $\hat{1}$  is a positive-definite four-by-four matrix, it can always be diagonalized into the form  $\hat{1} = \text{diag. } (n_1^2, n_2^2, n_3^2, n_4^2)$ , where the quantities  $n_\mu > 0$ ,  $\mu = 1, 2, 3, 4$ , are called the *characteristic quantities* of the medium considered and have an arbitrary functional dependence. The space-time line element then becomes

$$x n_1^{-2} x + y n_2^{-2} y + z n_3^{-2} z - t c_0^2 n_4^{-2} t. \quad (2.4)$$

One can therefore see that relativistic hadronic mechanics can represent directly with the new metric  $\hat{\eta}$ , and beginning at the classical level, all desired features of interior dynamical problems, such as the locally varying speed of light  $c = c_0/n_4$ , the inhomogeneity and anisotropy of the medium considered, etc.

In particular, the generalization  $\eta \rightarrow \hat{\eta}$  implies a step-by-step generalization of the special relativity into a covering theory submitted by this author under the name of *isospecial relativity* (see [12,13] for the classical formulation and [14] for the operator version). As an example, the principle of equivalence which is at the foundation of the nuclear energy  $E = mc_0^2$  is evidently *inapplicable* (and not "violated") in interior dynamical problems here considered because the speed of light is no longer  $c_0$ . In these interior particle conditions (only) it is replaced by the so-called *principle of isoequivalence*

$$E = m c^2 = m c_0^2 / n_4^2, \quad (2.5)$$

which is at the foundations of the proposed hadronic energy.

We should mention that the alteration of the rest energy in the interior conditions here considered has been proved independently [14] as being a new form of renormalization called *isorenormalization*. In fact, all interactions produce a renormalization of the characteristics of particles. Those of Hamiltonian type produce known renormalizations [1]. Isoerenormalizations of type (2.5) are due to the *nonhamiltonian* character of the contact interactions here considered and, as such, imply an alteration of *all* intrinsic characteristics besides the rest energy, including charge, angular momentum etc.

As a final comment, note that *the relativistic quantum and hadronic mechanics, with related special and isospecial relativity, coincide at the abstract level by construction*. This can be seen from the fact that jointly with the deformation of the metric  $\eta \rightarrow \hat{\eta} = \hat{T}\eta$  there is a lifting of the unit in an amount inverse of the deformation  $1 \rightarrow \hat{1} = \hat{T}^{-1}$ , thus leaving all original structures axiomatically unchanged (for instance, the "light cone" in Minkowski space is evidently inapplicable for varying speeds of light, but it is reconstructed as exact in isominkowski space). Moreover, relativistic hadronic mechanics and the

isospacial relativity recover all conventional formulations identically, at the limit when particles exit interior conditions and return to move in vacuum, which limit is simple represented by  $\hat{1} \rightarrow I = \text{diag. } (1, 1, 1, 1)$ .

### 3: THEORETICAL INTERPRETATION OF THE PROPOSED HADRONIC ENERGY

Recall that the nuclear energy could not be predicted by Newtonian mechanics and required the advent of quantum mechanics.

It appears that essentially the same scenario occurs for the hadronic energy because it is beyond any realistic capability of prediction and treatment by quantum mechanics. On the contrary, the covering hadronic mechanics not only predicts the new energy, but identifies the specific numerical value of the characteristic excitation energy  $\hat{\omega}$  for the stimulated decay of the neutron, while providing a representation of all characteristics of the neutrons as a bound state at short distances of one proton and one electron.

Moreover, in the transition from classical to quantum mechanics most mathematical methods essentially remained the same, with the sole addition of the Hilbert spaces and related methodology. In fact, both classical and quantum mechanics used the same numbers, the same angles, the same functions, the same metric spaces, etc.

On the contrary, the *totality* of the mathematical methods must be generalized in the transition from quantum to hadronic mechanics. In fact, the understanding (let alone prediction and quantitative treatment) of the hadronic energy requires generalized numbers, generalized angles, generalized metric spaces, etc.

This is a rather insidious aspect for nonexperts in the field when first inspecting the hadronic energy. In fact, because of protracted use of quantum mechanics, they are predictably lead to inspect and appraise the hadronic energy via conventional quantum mechanical methods, thus ending up in a number of inconsistencies which generally remain undetected.

An effective way to illustrate this important point is by nothing that traditional statements such as "two multiplied by two equals four" have no meaning for hadronic mechanics, evidently because of the lack of identification of the multiplication and related unit. In fact, by assuming for isounit  $\hat{1} = 3$ , "two multiplied by two equals twelve" (because we have  $\hat{2} \cdot \hat{2} = (2 \times 2)\hat{1} = 12$ ), with the understanding that the actual multiplication of numbers becomes *integro-differential* (because the basic unit  $\hat{h} = \hat{h}\hat{1} = 1$ ,  $\hat{h} = 1$ , is integro-differential). Also, number which are ordinarily assumed to be prime are not necessarily so under the isotopy of the unit. A fully similar situation occurs for angles, functions,

spaces, etc. It is then evident that the use of the old quantum mechanical mathematics under a fundamentally novel integro-differential units leads to a host of inconsistencies.

With a clear understanding that the hadronic energy requires the rigorous application of its appropriate mathematical structures [14], let us outline here the main results.

The resolution of all nonrelativistic quantum mechanical objections for the chemical synthesis of the neutron from a proton and an electron, including binding energy, spin and magnetic moments, was reached by this author in 1990 [15]. The relativistic extension of the results, including the finalization of the essential laws underlying the chemical synthesis of unstable hadrons at large, was reached by this author in 1993 [16]. The crucial problem of the spin was first resolved by P. A. M. Dirac (without his knowledge) in two of his last and little known papers [17]. The study then received rigorous treatments via the isotopies of the fundamental Galilean and Poincaré symmetries (see the general ref.s [12-14]).

Consider the chemical synthesis  $p^+ + e^- \rightarrow n + \nu$  and represent the ensuing state  $n = (p^+, \hat{e}^-)_{HM}$  where the proton, being two thousands time heavier than the electron, is unperturbed in first approximation, the ordinary electron  $e^-$  is deformed into Rutherford's electron  $\hat{e}^-$ , and HM represents hadronic mechanics.

The quantum inconsistency due to the need of "positive binding energies" is resolved by the alteration of space-time within physical media due to the local variation of the speed of light, the inhomogeneity and anisotropy of the medium in which motion occurs and other reasons. In fact, isoequivalence principle (2.5) implies the change of the rest energy of the ordinary electron  $e^-$  in exterior conditions in vacuum into the rest energy of Rutherford's electron  $\hat{e}^-$  in interior conditions

$$E^0(e^-) = mc_0^2 = 0.5 \text{ MeV} \rightarrow E^0(\hat{e}^-) = mc^2 = mc_0^2/n_4^2 = 0.5/n_4^2 \text{ MeV} . \quad (3.1)$$

Independent experimental data from the so-called Bose-Einstein correlation of the UA1 experiment at CERN on the heavy bosons (see [18] for theoretical studies and [19] for experimental data) have permitted the identification of the numerical value  $n_4 = 0.605 \pm 0.015$  for the geometrization of media whose density is of the order of that of the proton. These results imply the numerical value

$$E^0(\hat{e}^-) = 1.36 \text{ MeV} , \quad (3.2)$$

which restores a negative although small binding energy  $E = -0.072 \text{ MeV}$  in the

state  $n = (p^+, \hat{e}^-)_{HM}$ .

It should be noted that numerical value (3.2) has been derived from indirect experimental data on proton-antiproton annihilation at high energies and, as such, could be superseded by more refined values obtained from experimental measures directly on the nucleons.

Also, the existence of a (negative) binding energy is a necessary condition for a bound state in *quantum* mechanics, but not in *hadronic* mechanics. This is due to the fact that the former admits only action-at-a-distance interactions with a potential energy. On the contrary, the latter admit contact/zero-range interactions for which the notion of potential energy has no mathematical or physical meaning (as a technical case, hadronic mechanics produces a confinement of quarks with identically null probability to be produced free in the absence of any potential barrier, and via the mere incoherence of the internal-isotopic and external-conventional Hilbert spaces [14]).

The resolution of the crucial problem of the total angular momentum 1/2 of the neutron from two particles originally of spin 1/2 each, is so simple for hadronic mechanics to appear trivial. A schematic view of the initiation of the penetration of Rutherford's electron inside the proton is presented in Figure 1. The total angular momentum of the composite system is given by the sum of the spin of the proton ( $s_p$ ) with the unperturbed known value  $s = 1/2$ , plus the unknown spin ( $s_e$ ) and orbital angular momentum ( $l_e$ ) of Rutherford's electron  $\hat{e}^-$  according to the rule

$$S_n = s_p + l_e - s_e \quad (3.3)$$

One first note the necessity that the coupling proton-electron be in singlet (with antiparallel spin). In fact, the coupling in triplets (with parallel spin) implies evident high instabilities for mutual distances smaller than the charge diameter of the proton ( $1 \text{ fm} = 10^{-13} \text{ cm}$ ) because the electron would spin inside and against the spin of the proton, thus resulting in instantaneous expulsion due to drag forces.

The main conceptual point for the total angular momentum of the structure  $n = (p^+, \hat{e}^-)_{HM}$  is that, also for stability requirements, the *orbital angular momentum of Rutherford's electron is constrained to coincide with the spin of the proton*. By recalling that the proton is a hyperdense medium 2,000 heavier than the electron, the former necessarily carries the latter in its intrinsic angular motion. In different terms, the configuration in which  $l_e \neq s_p$  would again imply evident drag forces and consequential expulsion of the electron.

Now, the *orbital angular momentum with value 1/2 is prohibited by quantum mechanics* (i.e., it is prohibited via the use of conventional numbers, angles, measures, integrals, etc.). However, its treatment via hadronic mechanics

(i.e., via generalized numbers, angles, measures, integrals, etc.) is fully consistent.

### A SCHEMATIC VIEW OF RUTHERFORD'S COMPRESSION OF THE HYDROGEN ATOM INTO THE NEUTRON

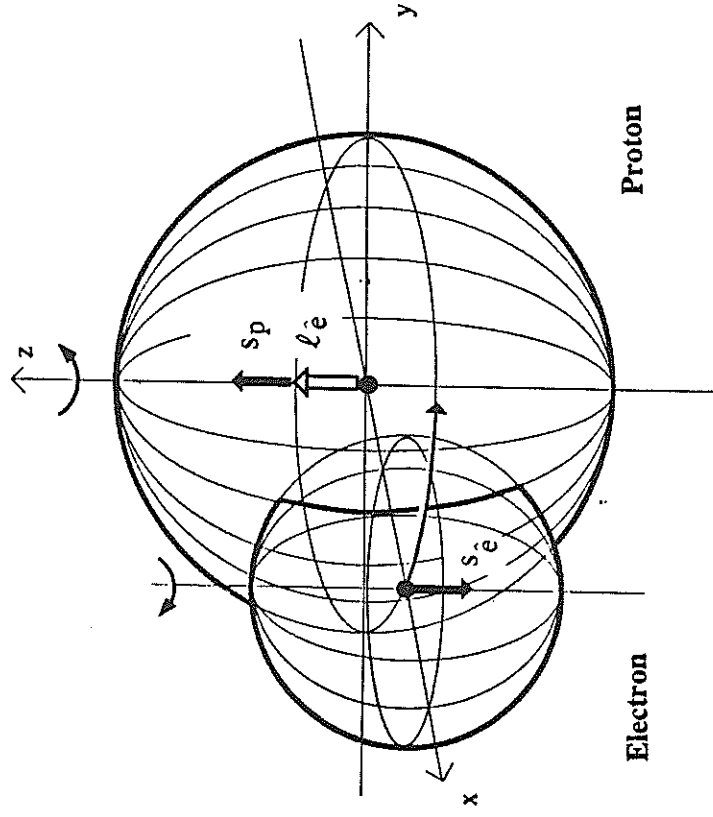


FIGURE 1: A reproduction of Fig. 1, ref. [15], p. 525, showing the initiation of Rutherford's compression of the electron inside the proton. Note the necessity for stability that the spins  $s_p$  and  $s_e$  are coupled in singlet (this occurrence was illustrated in the original proposal [10] via the coupling of gears). Note also that the orbital angular momentum of the electron is constrained to coincide with the spin of the proton (this occurrence was alternatively reached in ref. [15] as the limit of the conventional *angular* momentum for the *null* value of the radius, i.e., for the final point of the compression of the electron all the way to the center of the proton). This configuration uniquely yields the correct spin and magnetic moments of the neutron [14-16]. The mathematics of hadronic mechanics merely provides a correct representation of these simple physical occurrences.

To begin, a conventional angle  $\phi$  in the Euclidean space  $(x, y)$  is generalized under isotopy into the *isolang*  $\hat{\phi} = \phi/n_1 n_2$  where  $n_1$  and  $n_2$  are the

characteristic quantities of the medium for the x and y axis (Sect. 2). Then, the conventional integer eigenvalues of the angular momentum  $M_{QM} = 0, 1, 2, 3$ , are generalized under isotopies into the expression

$$M_{QM} \rightarrow M_{HM} = M_{QM} / n_1 n_2 \quad (3.4)$$

The values  $n_1 = n_2 = \sqrt{2} = 1.414$  then permit a consistent representation of the orbital angular momentum with value 1/2 (on technical grounds, the consistency is established by: a) the proof that the irreducible representation of the isotopic  $SO(2)$  symmetry are characterized by  $M_{QM}/(n_1 n_2)$ ; b) the fact that the  $SO(2)$  invariant measure is no longer  $d\phi$  but  $d\phi = d\phi/n_1 n_2$ ; the preservation of the full Hermiticity of the angular momentum operator for the value 1/2, certainly not in the Hilbert space of quantum mechanics, but in the appropriate isohilbert space of hadronic mechanics; etc. See [14] for details).

The admission of the value 1/2 of the orbital angular momentum then permits the exact representation of the total spin of the neutron in the chemical synthesis  $n = (p^+, e^-)_{HM}$ . In fact (see Figure 1), the spin of the neutron coincides with the spin of the proton, because Rutherford's electron  $e^-$  has null total value of the angular momentum. The interested reader can find in ref. [16] a full treatment of the latter occurrence via an isotopy of Dirac's equation, that is, a nonlinear-integral but axiom-preserving generalization of Dirac's equation for the electron in the hydrogen atom into an equation for the electron in the structure of the neutron in which the latter has a null total value of the spin.

It should be mentioned that the null value of the total angular momentum of Rutherford's electron can be obtained via completely different means, e.g., via the isorenormalization of the conventional quantum value due to the nonhamiltonian character of the underlying interactions.

Rather intriguingly, the latter result on the spin was first reached by Dirac in his generalization of his own equation [17] which, as one can see, remains four-dimensional yet admits the null value of the total angular momentum in the ground state. Also, "Dirac's generalization of Dirac's equation" emerges as possessing an essential isotopic structure, and actually constitutes one of the most intriguing structures of relativistic hadronic mechanics because, unlike the case studied in [16], it is characterized by a nonsingular isometric  $\hat{\eta} = T\eta$ , yet its related space-time is contracted to two dimensions [14].

The deformations experienced by the electron in the transition from motion in vacuum to motion within the hyperdense medium inside the proton imply a predictable alteration of its intrinsic magnetic moment. This permits the achievement of an exact, numerical representation of the anomalous magnetic moment of the neutron whose review is omitted here for brevity (see [14,16]). The representation of the remaining characteristics of meanlife, charge, charge

radius, space and charge parity, etc., then follows along similar lines.

In summary, relativistic hadronic mechanics permits the numerical representation of the totality of the characteristics of the neutron as a generalized bound state of one proton and one electron in the chemical synthesis  $n = (p^+, e^-)_{HM}$  via only one single quantity, the following generalized unit

$$1 = \text{diag.} (1.414, 1.414, 1.414, 1.653) \quad (3.5)$$

Note that the neutrino  $\nu$  is not a physical constituent of the neutron because it is emitted in the chemical synthesis  $p^+ + e^- \rightarrow n + \nu$ . Intriguingly, Rutherford's electron emerges as the apparent physical origin of neutrinos in nature. In fact, when excited, Rutherford's electron exits the medium inside the proton, returns to move in vacuum by therefore re-acquiring conventional quantum characteristics. Total conservation laws then require the decay  $e^- \rightarrow e^- + \bar{\nu}$ .

This completes our outline of the numerical representation via hadronic mechanics of Rutherford's conception of the neutron [4] and its experimental verification via don Borghi's experiment [3].

We now pass to the prediction of relativistic hadronic mechanics of the characteristic excitation frequency  $\hat{\omega}$  requested for the stimulated decay of the neutron. Note in the latter respect that, according to hadronic mechanics, Rutherford's electron is a physical constituent of the neutron with rest energy  $E^0(e^-) = 1.36$  MeV.

This implies that the characteristic frequency of the conventional electron  $\omega^0 = 1.236 \times 10^{20}$  Hz (given by  $0.5$  MeV/h) is now lifted to the value  $\hat{\omega}^0 = 3.288 \times 10^{20}$  Hz (given by  $1.36$  MeV/h). We therefore have the following

**Proposition:** *Relativistic hadronic mechanics predicts that the characteristic frequency  $\hat{\omega}$  needed to stimulate the decay of the neutron via the excitation and consequential expulsion of Rutherford's electron  $e^-$  is given by an integer multiple or a submultiple of  $3.288 \times 10^{20}$  Hz adjusted for corrections due to the binding energy of said electron, and we shall write*

$$\hat{\omega} = (3.129 \times n) \times 10^{20} \text{ Hz} \quad \text{or} \quad \hat{\omega} = (3.129 / n) \times 10^{20} \text{ Hz}, \quad n = 1, 2, \dots \quad (3.6)$$

In short, the mechanism at the foundation of the hadronic energy is the conventional resonance effect. In fact, when Rutherford's electron is hit by a frequency which is a multiple or a submultiple of its own characteristic frequency, it becomes excited. But the first excited energy level requires a radius bigger than the charge radius of the neutron. Thus, when excited Rutherford's



electron leaves the neutrons to reacquire the conventional atomic characteristics via the decay  $\hat{e}^- \rightarrow e^- + \bar{\nu}$ .

In summary, hadronic mechanics predicts only one, single, additional bound state of the protons and electron at distances smaller or equal to 1 fm, the neutron  $n = (p^+, \hat{e}^-)_{HM}$ , because, when excited, the state reproduces the infinite energy levels of the hydrogen atom  $(p^+, e^-)_{QM}$ .

This is a rather general property for the chemical synthesis of other hadrons called *spectrum suppressing*, which illustrates the rather profound structural differences with quantum mechanics and its infinite spectra of energy levels.

Besides value (3.6), two additional characteristic excitation frequencies  $\hat{\omega}$  deserve a consideration. The second is evidently given by an integer multiple of submultiple of the characteristic frequency of the ordinary electron

$$\hat{\omega} = (1.236 \times n) \times 10^{20} \text{ Hz or } \hat{\omega} = (1.236 / n) \times 10^{20} \text{ Hz, } n = 1, 2, \dots \quad (3.7)$$

In fact, in case don Borghis experiment fails to be verified, there still remains the possibility of realizing the stimulated decay of the neutron by exciting the ordinary electron.

The third possible excitation frequency is evidently given by an integer multiple or submultiple of the characteristic frequency of Rutherford's electron *without* the adjustment due to the binding energy, which, for the value  $n_4 = 0.605$ , is given by

$$\hat{\omega} = (3.288 \times n) \times 10^{20} \text{ Hz or } \hat{\omega} = (3.288 / n) \times 10^{20} \text{ Hz, } n = 1, 2, \dots \quad (3.8)$$

However, as pointed out earlier, the value  $n_4$  has only an *indirect* character because it was derived from the geometrization of the region of annihilation of proton-antiproton [18,19]. Therefore, future measures on the direct geometrization of the proton may yield a numerical value of  $n_4$  smaller than 0.605, with corresponding value of the characteristic frequency bigger than  $3.288 \times 10^{20}$  Hz and consequential higher (absolute) value of the binding energy, the threshold value being  $n_4 \approx 0.395$ .

When passing to neutrons as members of nuclei, additional corrections are expected in the characteristic excitation frequency from the nuclear binding energy which corrections would vary from nucleus to nucleus.

In summary, the final value of the characteristic excitation frequency for the stimulated decay of the neutron must be established via special experiments for each individual element selected in the realization of the hadronic energy ( Sect. 5).

Note that the chemical synthesis of the proton from one neutron and

one positron according to the reaction



is not possible for (both quantum and) hadronic mechanics because of various reasons, although expression (3.9) is possible as an ordinary weak process. In different terms, the proton *cannot* be conceived as a *hadronic bound state* of one neutron and one positron, although the *scattering* of a positron on a neutron can indeed produce one proton and one antineutrino.

This is due to various reasons, e.g., the fact that the chemical synthesis of particles requires the total initial rest energy to be *lower* than the rest energy of the bound state to activate the isorenormalization of the original rest energy, while for reaction (3.9)  $E(n) + E(e^+) > E(p^+)$  (see ref.s [14,16] for details). Also, a positron penetrating within the neutron would annihilate itself with Rutherford's electron, thus preventing any possibility of representing the stability of the proton.

The above occurrence is important to understand that, *if one of the gammas with the particular frequency (3.6) hits a proton, rather than a neutron, it will produce no artificial disintegration with consequential beta-plus decay.* In different terms, the neutron is naturally unstable when isolated, thus permitting studies on its possible artificial disintegration. On the contrary, the proton is fully stable with consequential impossibility of its artificial disintegration conceivable with current knowledge. The importance of these natural properties for the practical realization of the proposed hadronic energy is self-evident.

As a final comment, note that *the chemical synthesis of particles has no direct connection with the cold fusion* on various grounds. The former deals with *elementary particles*, while the latter deals with *atoms and molecules*. Also, the former *requires* energy, while the latter is studied to *release* energy.

Nevertheless, the indirect connections are numerous and intriguing indeed. For instance, the cold fusion of light nuclei without release of neutrons, which does not appear to be compatible with quantum mechanics, can be readily interpreted via hadronic mechanics. Also, the production of heat associated to the cold fusion can be readily explained by hadronic mechanics via the covering isorotational symmetry  $SO(3)$  which represents under a rigorous invariance law *oscillating nuclei* resulting from the cold fusion of lighter nuclei. These and other connections with the cold fusion are contemplated for study in a separate paper.

#### 4: PROBLEMS RAISED BY QUARK THEORIES

As is well known, the contemporary theory of electromagnetic interactions has produced practical applications beyond the best expectations of its originators, such as computers or interplanetary communications.

By contrast, the contemporary theory of strong interactions, the *quark theory*, has produced no practical application of any nature, nor any possible application is in the horizon, not even remote. As a matter of fact, rather than assisting in quantitative studies of the proposed hadronic energy, quark theories constitute its biggest obstacle.

The reasons for this unusual occurrence were identified in the original proposal to build hadronic mechanics [10]. They are of primary *conceptual* rather than technical character.

To begin, the ultimate origin of the molecular, atomic and nuclear forms of energies is the capability to produce the constituents free. By contrast, the contemporary theory of strong interactions is centered on hadronic constituents, the quarks, which cannot be produced free. No practical application of any nature is then in the horizon.

The historical origin of this shift from physical constituents which are isolated in laboratory to hypothetical constituents which are perennially confined inside hadrons, lies precisely in the quantum mechanical objections against Rutherford's conception of the neutron, although it does not appear to have been sufficiently investigated by historians until now. In fact, those objections first lead to the representation of the proton and neutron via mathematical unitary spaces and related SU(2) symmetry which, in turn, lead to the SU(3) symmetry and related quark theory.

Hadronic mechanics was proposed and built for a return *ad originem*, that is, to permit the hadronic constituents to be produced free as a pre-requisite for possible practical applications. In the preceding section we have outlined how this is quantitatively possible for the neutron. In refs [14,16] one can see the following

##### **New structure model of hadrons permitted by hadronic mechanics:**

*All unstable hadrons can be constructed via the chemical synthesis of suitably selected, massive lighter hadrons which are produced free generally in the spontaneous decays with the lowest mode which therefore represents a tunnel effect of the constituents.*

For instance, we have for neutral hadrons the "compressed positronium"  $\pi^0 = (\bar{e}^+, e^+)$ , the "compressed pionium"  $\kappa_S^0 = (\bar{\pi}^-, \pi^+)$ , the "compressed hydrogen atom"  $n = (p^+, e^-)$ , etc., and then  $\Lambda = (\bar{n}, \pi^0)$ , etc., while charged hadrons are

built accordingly, e.g.,  $\pi^\pm = (\bar{u}^+, e^\pm)$ ,  $\bar{u}^+$ , etc. In each case we have only one admissible energy level. In each case hadronic mechanics represents the totality of the intrinsic characteristics of the hadron considered via one, single structural equation with constituents which can be produced free [14]. Specific practical applications are then consequential.

In short, hadronic mechanics permits the reduction of all hadrons to electrons and protons, their antiparticles and their bound states at distances  $\leq 1$  fm, with photons and neutrinos being produced in the spontaneous decays.

The inability to produce the constituents free is only the beginning of the incompatibility between the proposed hadronic energy and quark theory. As an example, the prediction of the hadronic energy requires a mechanics which is structurally nonlocal-integral and nonpotential-nonhamiltonian, while quark theories are notoriously local-differential and potential-Hamiltonian.

But there is more. The chemical synthesis of the neutron (as well as all other chemical syntheses) is studied as *one, single, individual structure in our space-time only*, without any internal unitary spaces, as it is clear from the review in the preceding sections. *This implies the inability to even define a quark*. By contrast, quark theories can only study a *family of hadrons at the time*. The conceptual difficulty lies in the fact that, on rigorous grounds, the quark structure of the neutron alone has no meaning, because it requires (or otherwise implies) the joint structure of the remaining hadrons of the same multiplet.

The origin of this occurrence is rather deep. The knowledge of molecules, atoms and nuclei required *two different models, one for the classification into families and a different model for the structure of each individual element of a given family*. For instance, the Mendeleev Table provided the final resolution of the *classification* of atoms into families, but resulted to be totally unable to provide the *joint structure* of a given atom in a given family. Exactly the same occurrence emerged for the nuclei.

As stressed in the original proposal; [10], quark theories are at variance with this historical teaching because they are rather universally considered to provide a *joint classification of hadrons into families as well as the structure of each individual element of a given family*. Now, the majestic successes of quark theories in the predicting of so many new particles with great precision establishes beyond scientific doubts that *the quark theory has indeed provided the final Mendeleev classification of hadrons into families*.

The only scientifically open issue is whether the quark theory also provides the *joint final structure* of each individual element of a given family. In fact, the mechanics underlying the quark theory, the local-potential quantum mechanics, is certainly exact for the classification of hadron owing to the effectiveness in this case of their point-like approximation.

In the transition to the problem of structure the scenario is different. In fact, all massive particles have wavepackets of the order of 1 fm (there exist no "point-like wavepackets") which is of the same order of magnitude of the charge distribution of all hadrons. Hadrons therefore result to be constituted by wavepackets--wavelengths in condition of total mutual penetration and overlapping, with consequential nonlocal--nonpotential interactions recalled earlier. It is unlike that a local--potential theory will resist the test of time for these latter conditions.

Intriguingly, the isotopies appear to resolve the above impasse, by permitting a compatibility between the proposed hadronic energy and quark theories. The basic requirement is that *quarks must be considered as composite of more elementary particles obeying hadronic mechanics*. As a matter of fact, the latter approach appears to resolve some of the vexing problems of quark theories, such as: the achievement of fractional charges (which are extraneous to the conventional Lorentz symmetry but rather natural for the covering isorentz symmetry); the achievement of a strict confinement of quarks with an identically null probability of free quarks mentioned in Sect. 2 (achieved via the incoherence of the internal--isotopic and the external--conventional Hilbert spaces without any need for potential barriers reminiscent of the so-called "asymptotic freedom," although at low energies); the need to reach convergent perturbative expansions for strong interactions (which is simply achieved by hadronic mechanics with isotopic element  $|T| < 1$ ). For these and related aspects we refer the interested reader to [14].

One basic point should remain clear: if the chemical synthesis of the neutron according to experiments [3] is confirmed, the proton and the electron become the fundamental physical constituents of the neutron which permit physical applications. Quarks as aggregate of physical and virtual hadronic particles will then merely assume an intermediary role between structure and classification.

#### 4: PRACTICAL REALIZATION OF THE HADRONIC ENERGY

Let us recall from the preceding sections that the basic mechanism of the proposed hadronic energy is the stimulated decay of the neutron  $\hat{\gamma} + n \rightarrow p^+ + e^- + \bar{\nu}$  via a gamma photon  $\hat{\gamma}$  with a characteristic excitation frequency  $\hat{\omega}$  given by Eq. (3.6), with possible alternatives (3.7) and (3.8) to be resolved via experiments. Such stimulated decay preserves the positive energy balance of the spontaneous decay, by releasing electrons with kinetic energy  $K(e^-) = 0.8 \text{ MeV} + E(\hat{\gamma})$  in a conservative 90% statistical estimate.

Consider the nuclei  $(A, Z)$  of an ordinary stable element, which are

invested by a coherent beam of gammas  $\hat{\gamma}'$  with the characteristic excitation frequency  $\hat{\omega}'$  adjusted for the nuclear binding energy and other specific characteristic of the nucleus considered. Suppose that one peripheral neutron of such nucleus is hit by one such gamma  $\hat{\gamma}'$ : This event then causes the excitation of Rutherford's electron in its structure, its expulsion from the neutron structure and its subsequent exiting of the atomic structure owing to its high kinetic energy.

A first practical realization of the hadronic energy is therefore based on the reaction  $\hat{\gamma}' + (A, Z) \rightarrow (A, Z+1) + \beta^-$  hereon called *primary stimulated transmutation*, in which the total number of nucleons  $A$  remains evidently unchanged, while there is the stimulated decay of one individual neutron into a proton with  $\beta^-$  emission and consequential increase the total number of protons  $Z$  of one unit.

The above transmutation is evidently subject to all conventional conservation laws. First, the conservation of the total energy yields the expression  $E(\hat{\gamma}') + E(A, Z) = E(A, Z+1) + E(\beta^-)$ . It should be noted that, since protons are lighter than neutrons, an increase of protons under the same value of  $A$  generally implies a decrease of the energy (or of the atomic weight),  $E(A, Z) > E(A, Z+1)$  and the transmutation is *esoenergetic* (see later on for numerical examples). The stimulated transmutation here considered does therefore verify the conservation of the total energy. In certain particular cases of very light nuclei we may have  $E(A, Z) < E(A, Z+1)$  in which case the transmutation is *endoenergetic*. The conservation of the total energy is then achieved via gammas  $\hat{\gamma}'$  with sufficiently high energy (see also below for numerical illustrations). Also,  $E(\hat{\gamma})$  is subjected to the evident lower bound  $E(\hat{\gamma}) \geq |E(A, Z+1) - E(A, Z)|$  where we have used the absolute value to accommodate both esoenergetic and endoenergetic cases. The conservation of the total angular momentum introduces additional restrictions on the presence or absence of angular momentum in the emitted  $\beta^-$  which are ignored for brevity.

It is evidently possible that two neutrons of the same nucleus are simultaneously hit by two gammas photons resulting in the reaction  $\hat{\gamma}'_1 + \hat{\gamma}'_2 + (A, Z) \rightarrow (A, Z+2) + \beta^-_1 + \beta^-_2$  called *secondary stimulated transmutation*. Its probability is evidently smaller than that of the primary transmutation, yet finite. The *tertiary stimulated transmutation* is defined accordingly.

The above artificial transmutations generally imply a number of *secondary spontaneous transmutations* because, in general (see below for specific examples), starting from stable natural nuclei  $(A, Z)$ , the new nuclei  $(A, Z+1)$  and  $(A, Z+2)$  are unstable isotopes. Their nuclear decays are given by the known processes [1]: *beta-minus decay*  $(A, Z) \rightarrow (A, Z+1) + \beta^-$ ; *beta-plus decay*  $(A, Z) \rightarrow (A, Z-1) + \beta^+$ ; *electron capture*  $(A, Z) + e^- \rightarrow (A, Z-1) + \gamma$  usually denoted EC; *isomeric transition* usually denoted IT; plus decays via the emission of  $n, p, \alpha$  particles or spontaneous fissions (SF) which are unwanted for the proposed

energy because harmful to humans and to the environment. Similar spontaneous decays may occur for the nucleus  $(A, Z+2)$  of the secondary stimulated or spontaneous transmutation.

Note that *the stimulated transmutations do not follow conventional nuclear knowledge in beta decay*. In fact, the latter deals with *spontaneous* decays while the former deals with *stimulated* decays, thus resulting in different energies. Also, conventional beta decays admit an effective local-potential treatment via quantum mechanics, while the stimulated transmutations require a nonlocal-integral and nonpotential-nonhamiltonian treatment via the covering hadronic mechanics for their very formulation, let alone quantitative study. On the contrary, the spontaneous decays of the nuclei  $(A, Z+1)$  and  $(A, Z+2)$  must follow established experimental and theoretical knowledge in nuclear physics, including the Fermi and Gamow-Teller rules, those of allowed and unallowed, or favored and unfavored transitions, etc., as available in the existing literature in the field (see, e.g., the ref. [20] whose nuclear data are assumed hereon).

It is easy to see that the stimulated transmutations preserve the positive energy output of the stimulated transmutation of the neutron into the proton. By assuming the original nuclei  $(A, Z)$  and the transmuted nuclei  $(A, Z+1)$  at rest (thus ignoring again the small nuclear recoil), the input energy of the primary transmutation is  $E(\tilde{\gamma}) = \hbar\omega = \hbar\omega^n$  or  $\hbar\omega^{\circ}/n$  while the output energy is the kinetic energy of the released electrons  $K(e^-) = E(A, Z) - E(A, Z+1)$ , with a statistical 90% confidence. Such energy  $K(e^-)$  is positive because the energy difference  $E(A, Z) - E(A, Z+1)$  is generally positive for light elements (see locally quoted data). The energy balance of the secondary and tertiary stimulated processes follows similar rules.

**Selection of the basic element:** *It can be made via the conditions:*

- 1) *The basic element  $(A, Z)$  should be a stable natural element;*
- 2) *No harmful radiation (those involving n, p,  $\alpha$ , SF, etc.) should originate in any of the possible primary or secondary transmutations and spontaneous decays;*
- 3) *The first transmuted nucleus  $(A, Z+1)$  can be an unstable isotope with any combination of beta, EC and IT decays only;*
- 4) *A preferred but not necessarily unique selection is that for which the first transmuted nucleus  $(A, Z+1)$  admits beta-minus decay into  $(A, Z+2)$  which is a stable natural element;*
- 5) *All processes must verify conventional total conservation laws.*

Stimulated transmutations of nuclei have a number of practical applications. Without claim of completeness, we list the following:

**4-1) Direct source of electricity.** *The stimulated disintegration  $\tilde{\gamma} + (A, Z) \rightarrow (A, Z+1) + \beta^-$  is a direct conversion of gammas into electrons which is enhanced by beta-minus decays of the unstable isotopes  $(A, Z+1)$  for the above selection of the basic element and by the secondary stimulated beta-minus decays. Thus, the first practical use of the proposed hadronic energy is the direct production of electricity.*

An equipment for the practical production of hadronic energy is illustrated in Figures 2 and 3. It can be realized in various weights and shapes. That indicated in the figures for merely illustrative purposes has a weight of the order of 50 kilograms and a cylindrical shape with diameter of the order of one meter and width of the order of seven centimeters. Bigger, smaller or miniaturized sizes are evidently possible, depending on the desired output of energy. The equipment is shown in the figures to be in vertical position supported by a stand (32). The understanding is that the functioning of the equipment is independent from its orientation, and arbitrary orientations are possible depending on the desired use. Possible handles for moving the equipment are also not shown for simplicity. To minimize weight, the exterior cylindrical casing (26) has been depicted in the figures to be plastic and thickness suitable to absorb stray electrons and photons originating in the interior of the machine. Such plastics are commercially available nowadays from various manufacturers. The understanding is that an internally insulated metal casing of a few millimeters in thickness can be equally used.

The realization of the equipment begins with a source (11,12) of coherent gamma photons, hereon called *gamma source*, with the numerical value  $\hat{\omega}'$  of the characteristic frequency identified above suitable to excite electrons. Said source is nowadays available on a commercial basis from various manufacturers in the USA, Russia, Japan, Germany and other Countries. Such gamma sources generally have various shapes resulting in a tube along which axis the gammas photons are emitted with varying sectional area and they are usually completed by a shield to absorb stray photons not aligned with said axis. The source of gamma photons has been generically indicated in Figures 2 and 3 with a sphere (12) and the shield (11) has been indicated to be plastic because of weight advantages. The gamma photons and their direction of flight are represented with arrows in Figure 3. The configuration indicated in the figures is that in which the gamma source is on top of the equipment with the gamma photons emitted in a downward vertical direction. The understanding is that the gamma source could be equally placed in any other radial configuration. Also, only one gamma source (11,12) is shown in the figure for simplicity with the understanding that several gamma sources can be used in radial position on the same equipment.

The gamma photons emitted by the source (11,12) hit a *basic element* (13) preferably selected along the criterion given before to be a stable, natural, light

metal (A, Z). Specific selections are provided below.

The basic element (13) can be formed in a variety of shapes. That selected in the figures is cylindrical with the diameter of about 80 centimeters, a width of about 5 centimeters and a depth of about three centimeters. Said cylinder is housed over a hub on a shaft (14) made of ordinary inexpensive conductors resulting in a single basic metal assembly. The shaft (14) is housed on the main exterior casing (26) of the equipment with ball bearings (27) and a retaining ring (28) on one side. Such assembly is made to rotate via an ordinary low power motor (29) to minimize the exposure of the same nuclei of the basic metal (13) to the gamma source (12), by therefore minimizing secondary and tertiary stimulated transmutations. Such reduction is proportional to the inverse of the rotational speed of the basic element assembly. A rotation of the order of 1,000 revolutions per minute is sufficient for the single gamma source (12) of the figures, with the understanding that more than one gamma source and higher energies require higher revolutions per minute.

The result of the gamma photons of the particular frequency  $\omega'$  hitting the basic element (13) is the primary stimulated transmutation of its nuclei (A, Z) into (A, Z+1) with release of electrons via beta-minus decay, one electron per each gamma photon produced by the source (12), less an efficiency factor due to the thickness of the basic element (13), the pressure of the air (15) inside the equipment, and other factors. A well built machine with low pressure of the air (15) or vacuum and a sufficient thickness of the basic element (13) implies a high efficiency in the use of the gamma photons of the order of 90% or more. The spontaneous decays of the artificially transmuted element (A, Z+1) into the stable natural element (A, Z+2) also release electrons via spontaneous beta-decays. Thus, each gamma photon produces two electrons for the basic element (13) as per selection above. Additional electrons are released by the secondary artificial transmutation of (A, Z) into (A, Z+2).

All electrons produced have high kinetic energy. For the configuration of Figure 3A, the basic element (13) is assumed to be polarized in such a way to emit electrons predominantly in the radial outward direction. In this case the metal shield (16) can be formed in the shape of a cylinder in the outside of the basic metal (13). Said shield (16) is equipped in its interior surface with a metallic sponge (17) or other means facilitating the capture of the electrons and it is separated by an insulating gap (15) from the basic element (15) which can be air, a perfect gas or vacuum. The thickness of the gap (15) is inversely proportional to the pressure of the insulating gas. As an illustration, the selection of air at ordinary temperature would require a gap (15) of the order of 2 centimeter. Figure 3B shows another possible configuration for unpolarized basic metal (13) emitting electrons in all directions. In this latter case, the metal shield (16) wraps around the basic element (13) by continuing on each side of the basic element and

then on each interior side all the way to the supporting hub as shown in the figure. In this latter configuration the metal shield (16) continues to have a metal sponge (17) in its interior surface to facilitate trapping of incoming electrons.

### SCHEMATIC OUTSIDE VIEW OF A POSSIBLE REALIZATION OF THE PROPOSED HADRONIC ENERGY

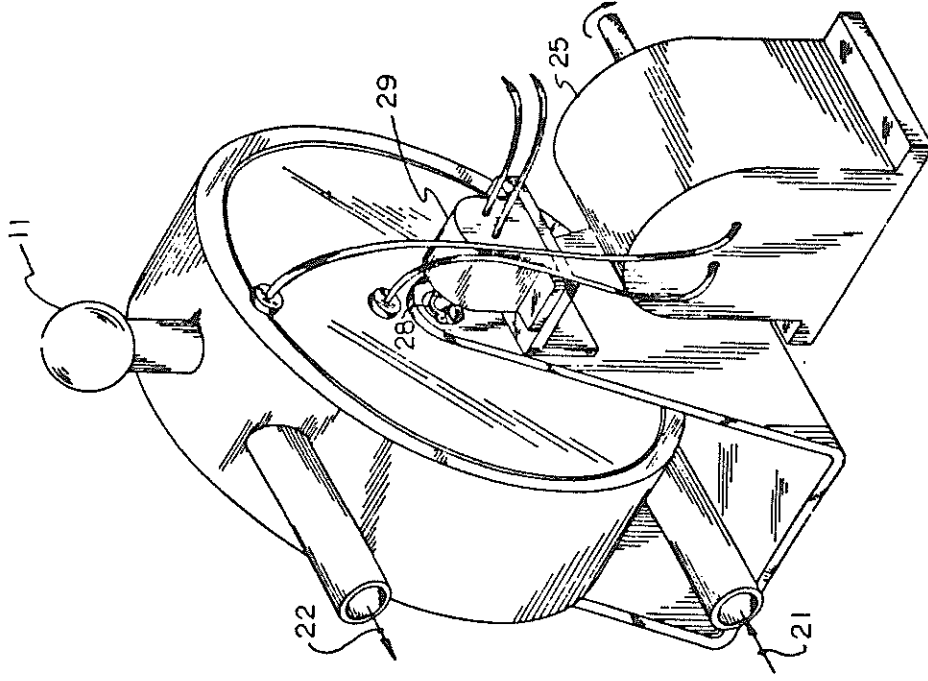


FIGURE 2. A schematic outside view of a conceivable realization of the proposed hadronic energy as a dual production of electricity operating motor (25) and how water with inlet (21) and outlet (22).

### SCHEMATIC VERTICAL SECTIONAL VIEW OF THE PROPOSED REALIZATION OF THE HADRONIC ENERGY

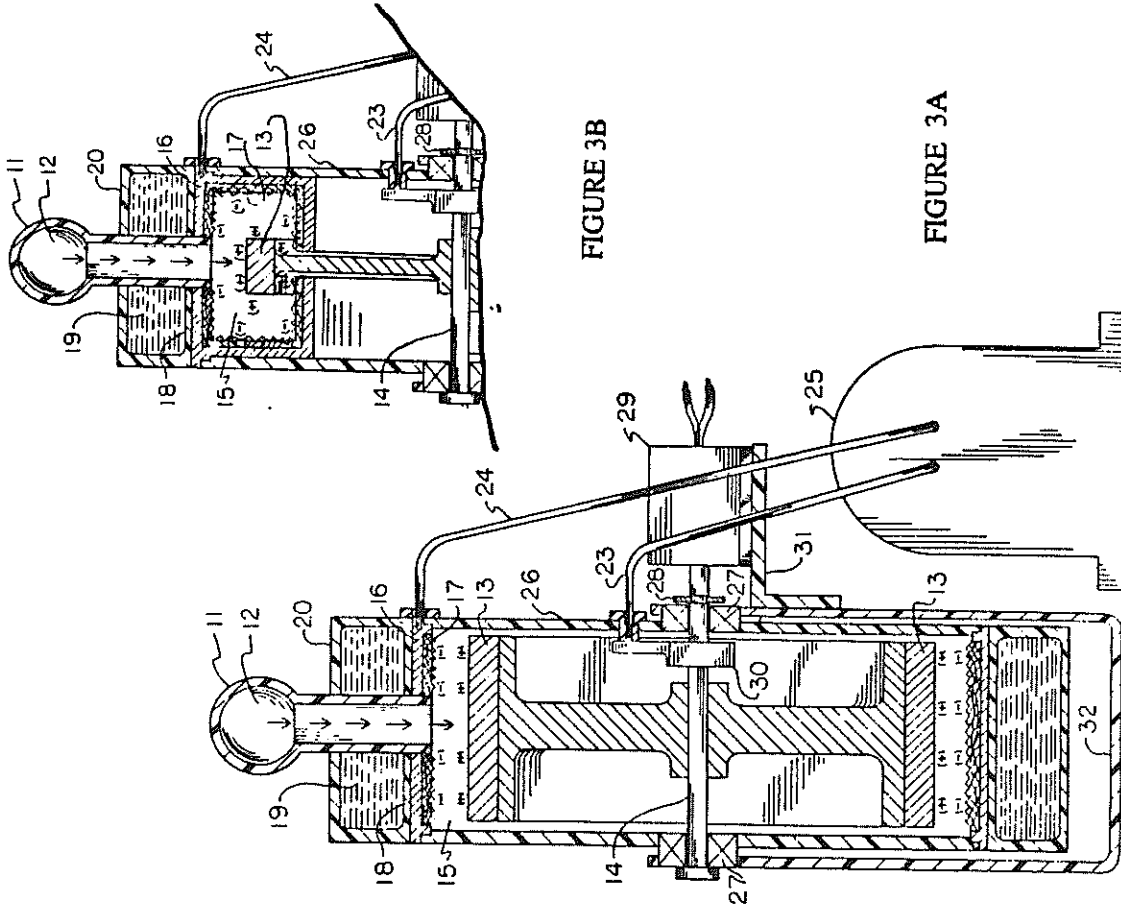


FIGURE 3: A schematic sectional vertical view of the diagram of Figure 2 showing the gamma source (11), the beam of coherent gammas (12) hitting the basic element (13) which acquires a positive charge (+) via stimulated transmutation and emission of  $\beta^-$  whose

electrons hit the shield (16) which therefore acquires negative charge (-) and heat. Figures 3A and 3B give two among endless possible configurations of the basic metal (13) and metal shield (16) to maximize the use of the energy produced in the artificial transmutations. The order of magnitude of the cylinder shown in the figure is 100 x 80 cm with projected weight of the order of 50 km.

After being hit by the electrons emitted by the basic element (13), the metal shield (16) evidently acquires a negative charge (-) while the basic metal (13) assumes a positive charge (+). Their potential difference can therefore be used for the desired practical application. That shown in the figure is the production of a continuous electric current in a wire (24) which originates from the metal shield (16), operates an ordinary electric motor (25) or other electrical equipment in a way similar to that of a battery, and returns to the basic metal assembly via wire (23) on conducting brushes (30) operating on the metal shaft (14). Starting with the originally neutral configuration of the basic metal (13), the equipment permits the regaining of the neutral configuration after the use of the hadronic energy.

The sectional area of the beam of gamma photons is important for the construction of the equipment because it sets its overall thickness. Also, such sectional area should be as large as permitted by current technology, evidently to maximize the area of the basic element (13) invested by the gamma photons. The thickness of seven inches indicated earlier is based on an equipment with air at ordinary pressure for internal insulation, a primary cylindrical beam of gamma photons with 5 millimeters in diameter and an effective sectional area including stray gamma photons of one centimeter in radius. The width of the basic element (13) in the configuration of Figure 3A is assumed to be given by such maximal diameter of two centimeters, plus about one centimeter of additional basic element per each side plus an insulating gap of about 50 millimeters on each side, plus the outside casing. The extra width of the basic element (13) over the effective sectional area of the gamma beam in the configuration of Figure 3A with said polarized basic element (13) is used to absorb possible electrons emitted in directions other than the radial outward one. In the configuration of Figure 3B with wrap-around metal shield (16) over a nonpolarized basic element (13), the width of the basic element (13) can be the same as that of the effective sectional area of the beam of gamma photons, although the overall width of the equipment essentially remains the same when air at ordinary pressure is used for internal insulator owing to the need of the air gap on each side. The configuration of Figure 3B can however be used to minimize the source of hadronic energy. In fact, for an effective sectional area of the gamma beam of the order of a square millimeter or less and internal vacuum (15) for insulation, the width of the basic element (13) can be reduced to a few millimeters or less. The overall width of the equipment is then of the order of millimeters or less. The diameter of the equipment can then be reduced proportionately.