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CAN ANTIMATTER ASTEROIDS, STARS AND GALAXIES BE DETECTED WITH CURRENT MEANS?

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Abstract

Via the use of the isodual theory of antimatter, in this note we point out, apparently for the first time, that antimatter asteroids are not necessarily visible with light originating from a matter star, such as light from our Sun, thus constituting a threat for our planet requiring collegial inspection and resolution,

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As it is well known (see, e.g., Ref. [1]), during the 20th century, matter was treated at all levels of study, from Newtonian Mechanics to second quantization, while antimatter was solely treated at the level of second quantization, resulting in a clean scientific imbalance with rather deep implications from particle physics to cosmology some of which will be indicated in this note. The imbalance originated from the absence in special relativity of quantitative means for differentiating *neutral* matter and antimatter, as well as for other shortcomings.

Santilli (see general review [2] and original papers quoted therein) resolved the above imbalance via the construction of a new mathematics, today known as *isodual mathematics,* the related *isodual mechanics and relativity* with the resulting *isodual theory of antimatter.* The understanding of this note requires a knowledge of isodual mathematics and physics, as well as the knowledge that they constitute the isodual branch of the *hadronic mechanics* [3]. In this note we recall the truly essential aspects for minimal self sufficiency of these studies, and then focus our attention on the problem of detecting antimatter asteroid, stars and galaxies. We assume the reader is familiar with the evidence according to which Earth has been hit in the past by antimatter asteroids (see Fig. 2)

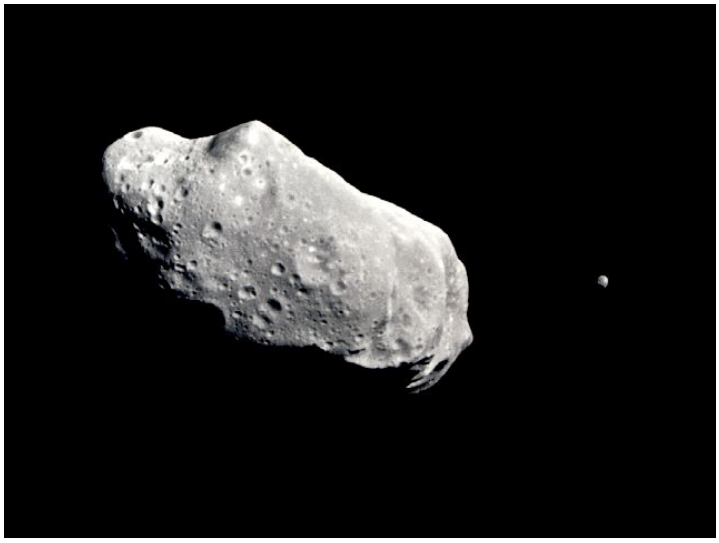

Figure 1: An illustration of the main objective of this note: can we identify antimatter asteroids with Sun light or to protect our planet we need a new technology? This ;problem will also be studies art a workshop in Italy, September 5-9,. 2011, http://www.workshops-hadronic-mechanics.org/

The main idea of the isodual theory of antimatter can be outlined as follows. Recall that the conventional *charge conjugation* is defined on a Hilbert space $\mathcal{H}$ with states $\psi(x)$ over the field of complex numbers $\mathcal{C}$ and can be characterized by expressions of the type

$$C\ \psi(x) = -\ \psi^\dagger(x), \tag{1}$$

where x is the coordinate of the representation space, such as the Minkowski spacetine.

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ntilli [2] constructed the isodual mathematics, mechanics and relativity via an anti-Hermitean conjugation, called *isoduality* and denoted with the upper index d, applied to the totality of the mathematics and physics used for matter with no known exception to avoid catastrophic inconsistencies when mixing conventional and isodual formulations. Therefore, the isodual conjugation of an arbitrary classical or operator quantity $A(x, p, ...)$ depending on coordinates x, momenta p, and any other needed variable is given by

$$A(x, p, ...)\ \rightarrow\ A^d(x^d, p^d, ...) = A(-x^\dagger, -p^\dagger, ...). \tag{2}$$

This conjugation characterizes the novel *isodual unit* $1^d = -1^\dagger$, *isodual real, complex or quaternionic numbers* $n^d = -n^\dagger$, *isodual product* $n^d \times^d m^d = n^s \times (1^d)^{-1} \times m^d$, *isodual functional analysis*, isodual differential calculus, etc. (see Ref. [2] for brevity).

Figure 2: *A view of the devastation caused by the 1908 Tunguska explosion in Siberia that has been estimated as being the equivalent of 1,000 atomic bombs, yet it left no crater or solid residue in the ground. Consequently, the Tunguska explosion is solely representable on a quantitative-numerical way via an antimatter asteroid annihilating in our atmosphere. Other interpretations have been dismissed by calculations because essentially conceptual. For instance, the hypothesis of a comet has been disproved on various quantitative grounds, such as: absence of a necessary depression in the ground caused by the expected huge amount of water; basically insufficient energy to represent the event; inability to represent the luminescence of the entire atmosphere on Earth for days, which luminosity is solely representable via radiations typical of annihilation processes; and other reasons. There is additional evdience of antimatter asteroids hitting our planet, such as large explosions in the upper atmosphere that are known not to be caused by atomic bombs. Additionally astronauts and cosmonauts routinely see "flashes" in the upper atmosphere when in darkness that can solely be interpreted as due to the annihilation of antimatter cosmic rays.*

In particular, the reader should keep in mind that isoduality is the only known consistent procedure for the differentiation between *neutral* as well as charged matter and antimatter at all levels of treatment.

Even though charge and isodual conjugations are both anti-Hermitean, their differences are not trivial. From a physical viewpoint, charge conjugation conjugates states in a Hilbert space, but does not conjugate the local coordinates x. This implies that, for 20th century theories, antimatter exists in the same spacetime of matter. At any rate, the relegation of antimatter at the level of second quantization, e.g., via Dirac's "hole theory," leaves the Minkowski spacetime unique, thus entirely characterized by

Figure 3: *Picture recently released by FERMILAB illustrating the apparent existence of antimatter in the universe.*

the fundamental Poincaré symmetry and special relativity.

By contrast, the isodual conjugation additionally maps spacetime coordinates x into the novel *isodual coordinates* $x^d = -x^\dagger$ that are defined on the *Minkowski-Santilli isodual spacetime* $M^d(x^d, \eta^d, 1^d)$, where η is the usual Minkowski metric. Therefore, under isoduality, the *Poincaré-Santilli isodual symmetry,* and the *isodual special relativity,* antimatter is predicted to exist in a new spacetime which is distinct from, yet coexisting with our spacetime. In particular, the differences of conventional and isodual spacetimes are not trivial. e.g., because the isodual conjugation of coordinates is different than inversions [2].

It should be remembered that the Minkowski spacetime is, ultimately, a mathematical structure since our senses perceive space and time separately. Due to the full democracy between matter and antimatter, the same applies for the isodual spacetime that is here reviewed under the understanding of its mathematical character. At any rate, despite being the originator of the theory, the author has to admit its inability to "understand" the isodual theory of antimatter, in the same way as the author must admit his inability to "understand" infinite dimensional Hilbert spaces at the foundation of quantum mechanics. The author's sole interest in the isodual theory is the ability of the theory for providing a *mathematical* representation of antimatter compatible with all available experimental evidence at the classical and particle levels, as well as admitting *new* predictions [2].

The achievement of full democracy in the treatment of matter and antimatter has identified a new symmetry called *isoselfduality* [2] with rather intriguing implications. To begin, particle-antiparticle systems are evidently invariant under isoduality, as it is the case for the positronium,

$$(e^-, e^+) = [e^-, (e^-)^d] \equiv (e^-, e^+)^d. \tag{3}$$

Figure 4: *A view the Trifit Nebula, one of the numerous dark nebulas existing in the universe. They are generally interpreted as being due to dense aggregates of matter, thus being opaque to light. Recent studies have indicated the possibility that at least some of the nebulas are caused by antimatter because of their being totally opaque to matter light. In the event confirmed, the latter feature would support the entire content of this note, because it would establish our inability to see antimatter with ordinary light as well as establish the absorption without refraction of matter light originating from clear matter stars in their background.*

Additionally, the imaginary unit, the differential, the Hilbert inner product, and the spacetime line element are isoselfdual 9see Ref. [2] for technical details)

$$i \equiv i^d \tag{4a}$$

$$dx \equiv d^d x^d \tag{4b}$$

$$< \psi| \times |\psi > \times I \equiv < \psi|^d \times^d |\psi >^d \times I^d \tag{4c}$$

$$\begin{aligned} (x-y)^2 = [(x-y)^\mu \times \eta_{\mu\nu} \times (x-y)^\nu] \times I \equiv \\ \equiv [(x-y)^{\mu d} \times^d \eta^d_{\mu\nu} \times^d (x-y)^{\nu d}] \times I^d = (x-y)^{d2d} \end{aligned} \tag{4d}$$

The above invariance illustrates the mathematical meaning of the indicated coexistence of matter and antimatter in the same region of space, as well as the reason for the lack of discovery of the isodual theory until recently.

A main difference in the treatment of antimatter between 20th century Einsteinian theories and the novel isodual theories is the following. Special relativity and relativistic quantum mechanics characterize antimatter with the same *positive energy* used for matter. By contrast, the isodual theory characterizes antimatter via a *negative energy* referred to as a *negative unit,* thus being as causal as a positive energy referred to as a positive unit. Similarly, according to the isodual theory, antiparticle evolve

in a *negative time* referred to a *negative unit* of time, thus yielding an evolution as causal as that of particles evolving in a positive time referred to positive units.

It should be stressed that the joint isodual conjugation of a physical quantity and its related unit is mandatory for consistency of the theory, as well as for the very achievement of scientific democracy for the treatment of matter and antimatter. In fact, in the absence of said dual conjugation, the negative-energy solutions of Dirac's equations are unphysical, thus solely admitting as consistent the 20th century treatment of antimatter at the sole level of second quantization.

Similarly, Einsteinian theories predict that matter and antimatter emit the same light, evidently due to the indicated lack of any differentiation between neutral matter and antimatter, light having no charge as well known. By contrast, isodual theories predict that light emitted by antimatter is different than that emitted by matter in an experimentally verifiable way. In fact, matter light has a positive energy $h \times \nu$ referred to positive unit MeV, while antimatter light has a negative energy $E^d = h^d \times^d \nu^d = -E$ referred to a negative unit $MeV^d = -MeV$.

Despite the above mathematical considerations, it should be stressed to prevent major scientific misrepresentations that *the isodual theory verifies all available experimental data on antimatter at both the classical and operator levels.* In fact, the *Newton-Santilli isodual equations* for antiparticles verifies all available data for charged particles and antiparticles, while isoduality is equivalent to charge conjugation at the operator level by conception and construction, as recalled via Eqs. (1) and (2) (see Ref. [2] for details).

In addition, the isodual theory has a number of rather fundamental, experimentally verifiable prediction not tested until now. A first new prediction is that *antimatter (matter) in the gravitational field of matter (antimatter) experiences a gravitational repulsion (antigravity).* Again, this prediction can be solely formulated under isodual rules, that is, the systematic, step-by-step construction of the *isodual Riemannian geometry* and related gravitational formulation of antimatter bodies. A negative curvature tensor (representing gravitational repulsion) then occurs in the interplay between a Riemannian gravitation and its isodual [2].

An experiment to test the gravity of the positron in flight in a horizontal vacuum tube on Earth has been proposed by Santilli in 1994 based on the comprehensive prediction of antigravity by the isodual theory at all levels, from the Newton-Santilli isodual equations to the Riemann-Santilli isodual geometry (see the review in Ref. [2]). This test has been considered as being resolutory for the verification of the disproof of antigravity by experimentalists A. P. Mills [4], V. de Haan [5] and others. In fact, for a 10 m long horizontal vacuum tube and positron energy of the order of milli-eV, the displacement due to gravity of the positrons on a scientilloscope at the end of flight is visible to the naked eye whether upward or downward.

Similarly, Einsteinian theories predict that both, matter and antimatter light expe-

rience gravitational bending (attraction). By contrast, *the isodual theory predicts that antimatter (matter) light experiences gravitational repulsion from a matter (antimatter) gravitational field.* Note that the differentiation between matter and antimatter light is mandatory under isoduality which, in turn, is the only known differentiation between neutral matter and antimatter, thus including matter and antimatter light.

We are now sufficiently equipped to address a main point of this note. As it is well known, according to Einsteinian theories, matter light, such as that from our Sun, is predicted as being first absorbed by the atoms of a matter or antimatter asteroid and then being re-emitted in all directions according to the principle of refraction, thus predicting our capability of detecting antimatter asteroids with Sub light.

By contrast, the corresponding occurrence for the isodual theory of antimatter is not that simple. In fact, *when matter light hits an antimatter asteroid, it is expected to be "annihilated" in the sense of being "absorbed without re-emission."* Under the assumption that a matter photon carries energy much smaller than the rest energy of peripheral positrons, the annihilation photon-positron is evidently impossible. Nevertheless, the positive-definite energy of the photon can be "absorbed" by the negative-definite kinetic energy of the positrons, thus preventing a re-emission. A number of additional arguments suggesting an "annihilation-absorption" without re-emission is also possible, and they will be treated elsewhere, such as decreases in isodual temperature. a decrease of rotational degrees of freedom and others.

In conclusion, *by keeping in mind that we are dealing with the safety of our planet setting up our utmost responsibility as scientist, the speculative view submitted in this note for collegial resolution is that we do not possess at this writing conclusive and incontrovertible evidence establishing beyond reasonable doubt the possibility of detecting antimatter asteroids with Sun light.*

Along similar lines, Einsteinian theories predict that matter and antimatter stars or galaxies emit the same light, thus being equally detectable with conventional telescopes. This also implies that, according to Einsteinian theories, antimatter stars and galaxies do not exist due to the indicated lack of experimentally verifiable differences with matter stars and galaxies. By contrast, isodual theories predict that light emitted by far away antimatter stars or galaxies is annihilated-absorbed in the lenses of our telescopes or even in the pupils of our eye, thus requiring new means for their detection.

Another speculative view submitted in this note, also for collegial studies, is that, *in view of the complete absence in Einstein special and general relativity of a quantitative distinction between neutral matter and antimatter, we have no conclusive scientific knowledge at this writing on the antimatter component of the universe, to such an extent that, as a limiting case, we cannot even exclude an isoselfdual universe *(a universe with* 50% *matter and* 50% *antimatter).*

In the hope of initiating the *experimental* resolution of the above open issues, we

recall that Dirac was forced to voice the "hole theory" for the consistent representation of antiparticles due to the non-physical character of negative energy solutions of his equation. This caused a clear imbalance in the treatment of particles and antiparticles with rather subtle implications for the scattering theory indicated below.

By noting that the isodual theory represents antiparticles at all levels, thus including quantum mechanics, a reinterpretation of the Dirac equation has been then unavoidable for the achievement of a full democracy of treatment for the electron and the positron. Consider the conventional Dirac equation

$$[\gamma^\mu \times (p_\mu - e \times A_\mu/c) + i \times m] \times \Psi(x) = 0, \tag{5a}$$

$$\gamma_k = \begin{pmatrix} 0 & -\sigma_k \\ \sigma_k & 0 \end{pmatrix}, \ \ \gamma^4 = i \times \begin{pmatrix} I_{2\times 2} & 0, \\ 0 & -I_{2\times 2} \end{pmatrix}, \tag{5b}$$

$$\{\gamma_\mu, \tilde{\gamma}_\nu\} \ = \ 2\times\eta_{\mu\nu}, \ \ \Psi = i \times \begin{pmatrix} \Phi \\ -\Phi^\dagger \end{pmatrix} \tag{5c}$$

Santilli [2] first noted that there exists no *irreducible* four-dimensional representation of the SU(2) symmetry for spin 1/2, and there exists no *reducible* four-dimensional representation of SU(2) with the structure of Dirac's gamma matrices. The sole known algebraically consistent meaning of the gamma matrices is that they characterize an *irreducible* representation for spin 1/2 of the Kronecker product $SU(2) \times SU(2)^d$. In the author's view, this is perhaps the strongest evidence in support of the isodual theory of antimatter.

Consequently, *Dirac equation directly represents an electron-positron system without any need for the hole theory* as expressed by the following re-interpretation verifying the crucial symmetry under isoselfduality (see Ref. [2] for details)

$$[\tilde{\gamma}^\mu \times (p_\mu - e \times A_\mu/c) + i \times m] \times \tilde{\Psi}(x) = 0, \tag{7a}$$

$$\tilde{\gamma}_k = \begin{pmatrix} 0 & \sigma_k^d \\ \sigma_k & 0 \end{pmatrix}, \ \ \tilde{\gamma}^4 = i \begin{pmatrix} I_{2\times 2} & 0, \\ 0 & I^d_{2\times 2} \end{pmatrix}, \tag{7b}$$

$$\{\tilde{\gamma}_\mu, \tilde{\gamma}_\nu\} = 2^d \times^d \eta^d_{\mu\nu}, \ \ \tilde{\Psi} = -\tilde{\gamma}_4 \times \Psi = i \times \begin{pmatrix} \Phi \\ \Phi^d \end{pmatrix} \tag{7c}$$

Since Feynman's diagrams for electrons and positrons are centrally dependent on Dirac's equation, it is evident that the above reformulation of the latter equation requires a necessary reinspection of the former. To begin, the annihilation process in Feynman's diagrams

$$e^- + e^+ \ \rightarrow \ 2\ \gamma, \tag{8}$$

violates a number of isodual laws, such as: the l.h.s. is isoselfdual but the r.h.s is not; the annihilation process is assumed to occur via the exchange of a particle (an electron or a photon), thus being itself not isoselfdual; etc.

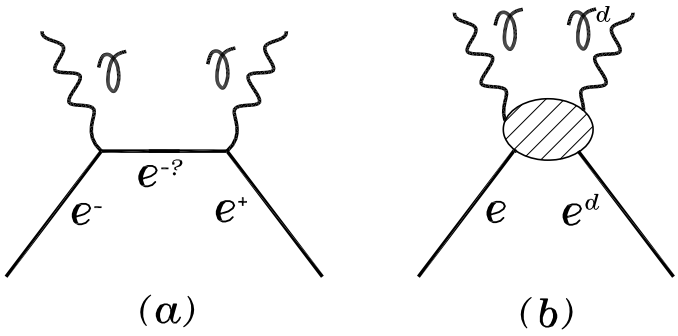

Figure 5: *A view of the electron-positron annihilation according to Dirac-Feynman theories (l.h.s) and the same annihilation as predicted by Santilli's isodual theories (r.h.s). Note the verification for the latter of all isodual laws, as well as the absence of the isoselfduality violating exchange of the former, since annihilation requires actual physical contact of particles antiparticles and cannot be triggered by particle exchanges at a distance.*

By contract, the isodual theory of antimatter represents the electron-positron annihilation with the form

$$e + e^d \equiv (e + e^d)^d \ \rightarrow \ \gamma + \gamma^d \equiv (\gamma + \gamma^d)^d, \quad e = e^-, \quad e^d = e^+, \tag{9}$$

that provides an evident resolution of all ambiguities and asymmetries of annihilation (8). Moreover, in the latter case, there is no exchange of particles, since annihilation is predicted to occur under actual physical contact or mutual penetration of the wavepackets of particles and antiparticles (see Fig. 5).

The insidious character of the lack of full democracy in the treatment of matter and antimatter is illustrated by comparing reactions (8) and (9). Reaction (8) is rather universally treated in first quantization, resulting in clear inconsistencies since, at that level, the electron and the photons can indeed be fully treated, yet the positron has negative energy in first quantization, thus prohibiting such a treatment for the sole consistent treatment in second quantization. By comparison, Reaction (9) can be consistently treated at the level of first quantization, its treatment at the level of second quantization being under study by V. de Haan (private communication).

Needless to say, there exists a very large number of experiments in electron-positron annihilation and the emitted two gammas. It is then rather natural to expect that such experimental evdience dismisses reformulation (9). A deep inspection, however, soon reveals that available experiments have provided no consideration

whatsoever on the possible differences between the two emitted photons, trivially, because no such difference was provided by the used data elaboration.

In this note, we have presented speculative comments on rather fundamental issues, such as a reinterpretation of Dirac's equation, a reinspection of Feynman's diagrams when dealing with antiparticles, and pointed out the open problem of the detection of antimatter asteroids, stars and galaxies. Clearly, these issues require an experimental resolution. With the understanding that the author is not an experimentalist, specific proposal of experiments are solicited and the following possible experiment is recommended for study. Consider a detector (such as a scintillator, a photomultiplier, et cl.) producing a signal for each energy increasing event (when hit by a photon) while producing no signal when hit by possible energy decreasing event (when hit by the isodual photon). The suggested experiment then essentially deals in the production of a known large number of electron-positron annihilation under such a condition that the produced photons are all absorbed by the detector. In the event the number of detected photons is that predicted by reaction (8), the isodual theory is in question, and antimatter asteroids, as well as stars and galaxies, can be detected with standard means as used for matter. However, in the event the number of detected photons is half that predicted by reaction (8), thus being in agreement with reaction (9), the isodual theory of antimatter is confirmed, the detection of antimatter asteroids, stars and galaxies requires the development of a basically new technologies, and we do have indeed a serious problem for the safety of out planet that has to be collegially addressed.

Acknowledgment

The content of this note is the output of long and solitary consideration by the author expressed in ref. [2]. The main point of this note was then first discussed during the recent *Third International Conference on the Lie-Admissible Treatment of Irreversible Processes* held at the University of Kathmandu, Nepal, from January 5 to 9, 2011. The author would like to thank all participants for invaluable comments. Additionally, very special thanks are due to Victor de Haan, Paul Krail, Alex Animalu and other colleagues for very penetrating and important comments that have been invaluable for the improvement of the presentation. Further very special thanks are also due to Christian Corda, the Editor of the proceedings, for an impeccable editorial control.

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