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HADRONIC PARADIGM REASSESSED: NEUTROID AND NEUTRON SYNTHESIS FROM AN ARC OF CURRENT IN HYDROGEN GAS

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Abstract

The hadronic paradigm may be reassessed around the evidence gathered in an inexpensive and easily replicable experiment where neutrons and an intermediate spin zero state prior to the full neutron synthesis known as *neutroids* are synthesized from an arc of current in hydrogen gas. We will review the history of this experiment in its various forms, as well as offer a recounting of the history related to neutrino theory in order to then provide an alternative model which rightly fits experimental results. Once quantum theory and hadronic science admits these experimentally derived conflicts and solutions, then the new paradigm offered in *Hadronic Mechanics* and *Hadronic Chemistry* may allow for new sources of energy and the stimulated decay of nuclear waste.

Key words: Neutron, Neutroid, Hadron, Rutherford, Hydrogen

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I. INTRODUCTION AND HISTORY.

Although quantum theory is unquestionably one of mankind's greatest and most useful achievements, it must be remembered that even its most accurate inculcation as demonstrated in Quantum Electro Dynamics (QED) does not proceed from a firm causal basis, as it is renormalized [1] (p. 128). This situation admits new possibilities which might more closely approach the truth in order to create new solutions to the intransigent problems which have beset mankind. Hadronic science offers us just such a new avenue where a simple and easily replicable experiment could allow insight permitting paradigm adjustment and new solutions. Toward that end, we will first review the experimental history of the synthesis of neutrons and an intermediate spin zero state prior to the full neutron synthesis known as *neutroids* (see section so named below) from an arc of current in hydrogen gas proceeding conceptually and experimentally from Rutherford to Ernest Sternglass, Edward Trounson then Don Carlo Borghi and R. M. Santilli, after which we will articulate the overarching implications for theoretical physics.

Rutherford (1920) [2] first proposed the notion that neutrons might actually be synthesized within the furnace of stars as compressed hydrogen atoms:

$$p^+ + e^- \rightarrow n, \tag{1}$$

as Chadwick [3] experimentally confirmed in (1932):

$$p^+ + e^- \rightarrow n + \nu\ , \tag{2}$$

where ν symbolizes a neutrino, meaning "little neutral one." The neutral charge, zero mass neutrino was proposed by Wolfgang Pauli under the name of neutron [4,5,6] so as to account for how beta decay conserves energy, momentum and angular momentum, even though Pauli had such severe reservations [4] as to call his proposed solution a "desperate remedy." Later Pauli's "neutron" was renamed as the "neutrino" by Enrico Fermi [7], a name humorously suggested by Eduardo Amaldi [8,9] to avoid subsequent confusion after Chadwick's discovery [3] of the neutron proper in 1932 [7,8,9,10]. It should be remembered that, although great expense has been incurred attempting to detect neutrinos directly, no direct detection of neutrinos has ever occurred; their "existence" has been ***inferred entirely from signature effects*** involving gamma ray production from electron

positron annihilation and also gamma ray production stemming from cadmium neutron interactivity, allowing signature-specific timing differentiation between two supposedly neutrino induced gamma sources [11].

In assessing the likely plausibility of his own "desperate" solution, we read (translated) from his 1930 communication to the *Physical Institute of the Federal Institute of Technology*, Zurich [4]:

" . . . I have hit upon a desperate remedy to save the "exchange theorem" of statistics and the law of conservation of energy. . . . I admit that my remedy may seem almost improbable because one probably would have seen those neutrons [here meaning neutrinos], if they exist, for a long time. "

Also, on the Berkley Center for Theoretical Physics web site [*7a*] we find:
"Because neutrinos interact so weakly with matter, Pauli bet a case of champagne that nobody would ever detect one."

II. EXPERIMENTAL RESULTS.

The initial successful synthesis of neutroids from an arc of current in hydrogen gas and subsequent synthesis of neutrons by a process of substance-specific nuclear transmutation was performed by Earnest Sternglass in 1951 while completing his Ph.D. thesis at Cornell. He wrote to Einstein of his inexplicable results, which seemed to occur in conditions lacking sufficient energy to synthesize the neutrons his experiments had indeed somehow apparently created.

From the Rare Manuscript Collection division of Cornell University Library as represented in [12]:

Ithaca, N.Y.
August 26th, 1951
518 Dryden Rd.

Dear Professor Einstein,

You may be interested to learn that in the course of the past two months I have been able to obtain experimental evidence for the formation of neutrons from protons and electrons in a high-voltage hydrogen discharge.

The experiments were carried out with a demountable gas X-ray tube capable of dissipating 1,200 watts filled with hydrogen and surrounded by about 6 inches of paraffin on all sides. Voltages up to 35 kV and currents up to 40 mA were used and silver and indium foils were placed near the tube walls. The neutron induced beta--activities were measured with a thin-walled aluminum Geiger-Muller counter in a lead housing of about 3-4" thickness giving a background count of 15 counts per minute. The initial activities in indium and silver were found to be 6--7 counts above background, decaying with the respective mean lives of 2.4 min for Ag and 54 min. for In. Having a standard neutron source, this arrangement could be calibrated roughly so that the rate of neutron formation can be determined to be on the order of 10--20 neutrons/sec at 38 mA and 25 kV and an estimated pressure of 10^{-2} mm of mercury in the discharge.

The possibilities of cosmic--ray produced neutrons was eliminated by exposing the foils without turning the discharge on. Contamination of anode & cathode with materials that could give rise to neutrons was eliminated by replacing them with freshly machined parts. The possibility of a deuteron--deuteron reaction was eliminated by a calculation using famous values of the cross--section for this process leading to a factor of 10^{5}-10^{6} too small a rate of neutron formation by the slight admixture of deuterium in normal hydrogen. So far, no one in the department here has been able to suggest any nuclear reaction that could be made to account for the activity at such a low energy. During the next few weeks we intend to make measurements on the activities in a salt--mine, 2000 ft. below ground as to improve the statistics of our counts. Professor Cocconi and Professor Ieiri will setup the equipment for this experiment after which we shall feel ready to announce it possibly at the Chicago meeting.

The indicated rate of formation is consistent with a cross-section of 2.5×10^{-24} cm^2 for the case of an isolated proton capturing an electron in the process calculated by C.G. Darwin in 1913. It is not consistent with the cross--section of 10^{-42} cm^2 predicted by neutrino theory. This seams to lend strongly support to the view that the neutron is a purely electromagnetic entity composed of a proton and a highly "distorted" electron as I have outlined to you in my last letter.

I remain sincerely yours,

Ernest J. Sternglass [12] (pp. 8-9)

Although Einstein firmly advised that the results must be published even though they apparently contradicted standard theory, Sternglass refused due to the stultifying preponderance of contrary opinion and so, his results were preemptively excluded under orthodox pressure within the discipline [12,13] leaving them unpublished. Edward Trounson, a physicist working at the Naval Ordnance Laboratory repeated the experiment and again gained successful results but they too, were not published [12,13].

It will be demonstrated that Sternglass' experiments could only have synthesized *neutroids*, which were then subsequently transformed into neutrons by a process of substance-specific nuclear transmutation. (See the section entitled *Neutroids* below.)

The next to synthesize neutroids and hence neutrons via an intermediate process of substance-specific nuclear transmutation was Don Carlo Borghi. His seminal experiment involved a cylindrical metal chamber named a "klystron," containing low pressure hydrogen gas irradiated with microwaves at $10^{10}\ s^{-1}$ frequency and also using an electric arc of 500 *V* and 10 *mA* [14]. Santilli [14*a*, 15] later discovered that microwave irradiation of the gas was not necessary to create the experimental effects, although the influence of such radiation was not excluded as to its possible contributory influence. In both the experiments of Don Carlo Borghi and those of Santilli, *delayed neutron synthesis* was sometimes observed. From Santilli [14*a*,15]:

> "A first series of measurements was initiated with Klystron I on July 28, 2006, at 2 p.m. Following flushing of air, the klystron was filled up with commercial grade hydrogen at 25 psi pressure. We first used detector PM1703GN to verify that the background radiations were solely consisting of photon counts of 5 – 7 *μR/h* without any neutron count; we delivered a DC electric arc at 27 V and 30 A (namely with power much bigger than that of the arc used in Don Borghi's tests . . .), at about 0.125" gap for about 3 s; we waited for one hour until the electrodes had cooled down; and then placed detector PM1703GN against the PVC cylinder. This resulted in the detection of photons at the rate of 10 – 15 *μR/h* expected from the residual excitation of the tips of the electrodes, but no

neutron count at all.

> However, about three hours following the test, detector PM1703GN entered into sonic and vibration alarms, specifically, for neutron detections off the instrument maximum of 99 *cps* at about 5' distance from the klystron while no anomalous photon emission was measured. The detector was moved outside the laboratory and the neutron counts returned to zero. The detector was then returned to the laboratory and we were surprised to see it entering again into sonic and vibrational alarms at about 5' away from the arc chamber with the neutron count off scale without appreciable detection of photons, at which point the laboratory was evacuated for safety. After waiting for 30 m (double neutron's lifetime), we were surprised to see detector PM1703GN go off scale again in neutron counts at a distance of 10' from the experimental set up, and the laboratory was closed for the day." [14*a*,15] (Santilli, 2006 pp. 4-5, 2007 p. 715)

Neutron counts registering much higher and in these cases arising more rapidly, some necessitating the actual evacuation of the laboratory, were obtained by first increasing the arc energy to 700V and 1.2 amps via a transformer, noting closely that manual impact of the experimental device and also a triggering-implosion from oxygen admixture yielding oxygen/hydrogen combustion both dramatically increased synthesis effects. Once hydrogen pressure was stepped up to 100 psi, dangerous experimental results were assured. It appears from analysis of this first series of Santilli's experiments [14*a*, 15] that arc energies are associated with the possible delayed creation/detection of neutrons if those energies are low (by a particular mechanism to be specified), or the immediate synthesis of neutrons may be encouraged if the energies achieve some higher energetic constituency.

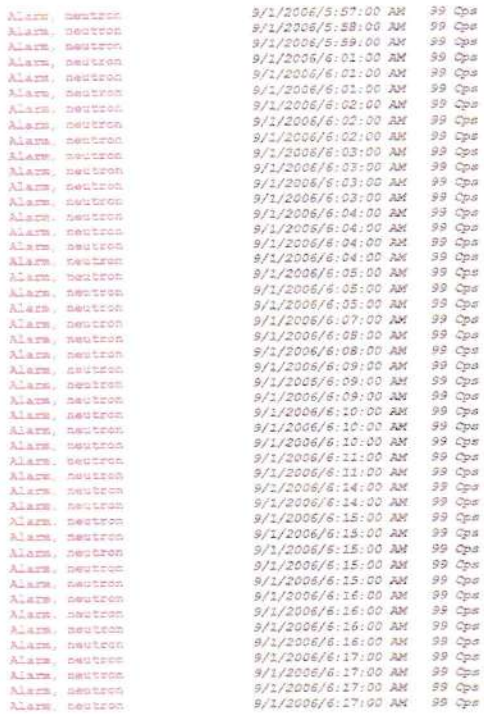

FIG. 1.
Print-out reproduction of a typical scan of detector PM1703GN indicating neutron alarms that required evacuation of the laboratory [15] (Santilli 2007). (Used with permission of Ruggero Santilli/Hadronic Journal).

Experimental apparatus used by Santilli in [14*a*,15] as represented in [16]:

FIG. 2.
[16] (Santilli, 2014) (Used with permission of Ruggero Santilli/Journal of Computational Methods in Sciences and Engineering)

The next tests discussed [16] (Santilli, 2014) were conducted using several different more advanced pieces of experimental apparatus. (See below).

FIG. 3. Second reactor constructed with schedule 40 steel used in tests with hydrogen gas at 100 psi. [16] (Santilli, 2014). (Used with permission of Ruggero Santilli/Journal of Computational Methods in Sciences and Engineering)

FIG. 4. One experimental setup, equipment from the left: SAM 940 neutron and gamma detector; a Polimaster, a Berkeley Nucleonics PalmRad; and a Ludlum neutron and gamma detector (not shown in this figure); the reactor; the specially built rapid DC pulsing power unit (patent pending) with incorporated capacitors in it; and the hydrogen bottle. [16] (Santilli, 2014). (Used with permission of Ruggero Santilli/Journal of Computational Methods in Sciences and Engineering)

In these new experiments neutrons were synthesized immediately upon the condition that the arc energy was sufficient to exclude the production of neutroids (see section below) which are indeed excluded at energies of a ~500J [16]. Santilli states in regard to the striking result concerning synthesis of thermal neutrons: ". . . a reactor comprising an essentially pure hydrogen gas at 30 psi, when exposed to a high voltage DC discharge with about 3 kVA at about 15 kV and a frequency of about 1 Hz through a 3/16" gap between 1/4" tungsten electrodes, produces thermal neutrons with less than 1 MeV." [16] (p. 412).

This is a decidedly practical result considering the usual bulky, hazardous and costly mechanisms of spallation sources and research reactors currently used in the production of thermal neutrons.

We see in this series of tests [16] the expected positive correlation between arc energy, gas pressure and neutron synthesis rates such that at 100 psi hydrogen gas pressure and arc strength of 50 kVA radiation of such potency is produced so as to necessitate the closure of the lab and preclude even the proper collection of data.

Recent tests reported privately to us by Santilli clearly state that a nonlinear relation exists between arc pressure, gas pressure and neutron production [17]. From one such correspondence:

". . . neutrons are not synthesized in appreciable numbers of CPS for arc voltage less than 3 *kV* and energy less than 3 *mJ* and that, beyond the threshold values, the number of neutron CPS increases non-linearly with the increase of the hydrogen pressure, the arc voltage and the delivered energy." [17] (p. 3).

It may be concluded that*: Only such energies as those used in the work of Santilli which exceed threshold energy values as specified can directly produce neutrons.* The mechanism of neutroid interactive substance-specific nuclear transmutation involved in delayed neutron synthesis at low arc energies will be defined shortly. In our consultations Santilli has strictly specified that a low energy continuous arc can only produce neutroids (see below), and threshold minimum energies expressed in a pulsing arc (fig. 4) are required for the most efficient direct neutron production.

Clearly, the arc energy was below threshold values in the experiments of Sternglass and Borghi to have accounted for the direct production of neutrons and so we propose, only *neutroids* would have been synthesized from the $35kV$ $30mA$ and $500V$ $10mA$ currents used, hence those *neutroids were then only subsequently transformed into neutrons*. Next, it will be demonstrated how this proposed delayed transformation occurs.

III. THEORETICAL ANALYSIS.

History:
In order to address and repair the limitations of quantum theory and relativity so as to allow new solutions to be derived, a mathematical covering of existing theory was required. The new model which has achieved this, that of Santilli's Hadronic Mechanics, is based on new mathematics called "Iso-mathematics" which has been extended to include several new methods of calculation [18,19,20,21,22,23,24].

To condense briefly from references [18,19,20,21,22,23,24]:

Isomathematics is derived through an isotopic lifting of the conventional associative product between generic quantities into an iso-product. In this way, the mathematics and differential calculus of Newton-Leibniz might be

reformulated so as to find new answers and solutions to old problems. Lie's theory has been augmented to articulate non-linear, non-local and non-Hamiltonian systems (meaning, variationally nonself-adjoint systems not representable with a Hamiltonian). Fundamental time evolution invariance was accounted for in Santilli's Iso-Differential calculus. A summary of these ideas is available here: [19,23,24]. The Schrodinger-Santilli isoequations underlying hadronic mechanics and the Heisenberg-Santilli isoequations constituting a *completion* of existing quantum theory have been created. [22] (pp. 64-65).

Experimentally demonstrated inconsistencies articulated in this paper regarding orthodox quantum mechanics and relativity have been addressed and new theoretical solutions which fit experimental results have been offered by way of the successful *covering* of existing theory. The resulting model includes relativistic and nonrelativistic treatment of *all characteristics* of the neutron in its synthesis from a proton and an electron using isomathematics and related isomechanics which allow the representation of the proton with its actual extended shape, as can be seen here:[14*a*,15,16,19,20,25,26,27,28,29].

Further theoretical explanation may be found below.

Applied theory:

Quantum mechanics is unable to account for these experimental results. Further explanation will follow; note initially that:

$$Ep = 938.272 \text{ MeV}, \quad Ee = 0.511 \text{ MeV}, \quad En = 939.565 \text{ MeV}, \tag{3a}$$

$$En - (Ep + Ee) = 0.782 \text{ MeV} > 0, \tag{3b}$$

indicating the rest energy of the neutron is 0.782 MeV greater than the combined rest energies of the proton and electron, demonstrating both "positive binding energy" and "mass excess" which are both *disallowed* by quantum mechanics.

The Neutroid:
Don Borghi and his scientific associates coined the name "neutroid" (symbolized

here as $\tilde{n}$). The neutroid was proposed as an intermediate particle mutation preceding synthesis of actual neutrons. Neutroids have also been experimentally created by Santilli. Santilli defines the proposed neutroid as a (spin zero) particle having the values (in standard nuclear units: A = total number of nucleons; Z = number of protons; (N = number of neutrons); J the total angular momentum; with *amu.* = mass),

$$A = 1, Z = 0, J = 0, \text{m} = 1.008amu.$$

Santilli then writes:

$$p^{+}{}_{\uparrow} + e^{-}{}_{\downarrow} \rightarrow \tilde{n}(1, 0, 0, 1.008) \tag{4}$$

where $J = 0$ avoids a spin anomaly in the synthesis [29].

In order to fully articulate the proposed formalism and mechanics of neutroid to neutron transformation within a process of substance-specific nuclear transmutation yielding experimentally demonstrated delayed neutron synthesis, we must return to the idea of the neutrino and offer a new piece of theory.

The Santilli Aetherino:

The currently accepted theory of weak interactions has been applied in a model of inverse beta decay with proposed collective electron effects in order to explain the creation of neutrons from hydrogen catalyzed through nuclear reactions on metallic hydride surfaces [12, 30]. However, the high probability of inelastic scattering in these low energy experiments has not been addressed to the satisfaction of the discipline within those explanations offered in this model [12].

A causal model and specific explanation of neutron synthesis detailing internal hadronic structure is available in Hadronic Mechanics [19], Hadronic Chemistry [31] and the theory of the Santilli Aetherino [32]. A new mathematical construct (with flexible -/+ signs) along with experimental demonstration the existence of neutroids and the synthesis of the neutron with over 340 tests will soon be published as: *Experimental confirmation of the synthesis of neutrons and neutroids from a hydrogen gas*: [33].

In standard theory neutron synthesis as here discussed requires emission of a neutrino, or absorption of an antineutrino:

$$p^{+} + e^{-} \rightarrow n + \nu, \tag{5a}$$

or

$$p^{+} + e^{-} + \bar{\nu} \rightarrow n. \tag{5b}$$

Logically, this is assertion is necessarily revealed as flawed:

1. A positive binding energy of 0.782 MeV is indicated to account for the rest energy difference between the constituent components of the neutron, the electron and the proton, and the neutron itself. However the Schrödinger equation does not admit such positive binding energies and can not account for the bound state of the electron within the hyper-dense medium of the proton.

2. Experiments plainly demonstrate a positive binding energy. However in classical anti-matter theory the antineutrino is ascribed negative energy, contrary to experimentally derived data.

3. Antineutrinos have a *null cross section* for electron and proton interactions, contrary to experimental results.

4. Paradoxical results seem to indicate neutrino scattering effects implying some "particle" mass, yet no particle is detected. Such "particle scattering" sans particle implies another solution: a longitudinal impulse moving through a substantial surrounding energy density interacting with targets: *the Aetherino* (symbolized as: "*a*") [32].

The Aetherino carries mass and charge zero, spin 1/2 and 0.78 energy according to the synthesis $p^{+} + a + e^{-} \rightarrow n$.

A. Neutron from substance-specific neutroid absorption and aetherino:

We may now directly approach the delayed synthesis of neutrons demonstrated in

low energy experiments by way of articulating the formalism used to define Aetherino/Neutroid interactivity within the context of detector and experimental substance-specific nuclear transmutation and then applying that formalism to the specific compounds actually used in the experiments and detectors [15, 29]. The basic equation is written as:

$$\tilde{n}(1,0,0,1.008)+a \rightarrow n(1,0,1/2,1.008) \tag{6}$$

The basic component interaction is given by:

$$N(Z,A,J)+\tilde{n}(0,\,1,\,0)+a(0,\,0,\,1/2) \rightarrow \tag{7}$$

where N is a nuclide. The probable transformation of the neutroid is that of a neutron given by,

$$\tilde{n}+a \rightarrow n, \tag{8}$$

that of the predicted form,

$$N(Z,A,J)+\tilde{n}(0,\,1,\,0)+a(0,\,0,\,1/2) \rightarrow N'(Z,A+1,J+1/2)\,. \tag{9}$$

In Don Borghi's tests, gold appears to act as a neutron source through the absorption and subsequent transformation of neutroids via the calculation:

$$Au(79,197,3/2)+\tilde{n}(0,\,1,\,0)+a(0,\,0,\,1/2) \tag{10}$$

$$\rightarrow Au(79,198,2)+a(0,\,0,\,1/2)$$

$$\rightarrow Hg(80,\,198,\,0)+\beta^{-}(-1,\,0,\,1/2)+\gamma(0,\,0,\,1)$$

The silver in Sternglass' experiments absorbed neutroids to produce neutrons as given by:

$$Ag(47,\,107,\,1/2)+\tilde{n}(0,\,1,\,0)+\,a(0,\,0,\,1/2) \tag{11a}$$

$$\rightarrow Ag(47,\,108,\,1)+\,a(0,\,0,\,1/2) \rightarrow$$

$$\rightarrow Cd(48, 108, 0)[\textit{stable isotope}] + e^{-}(-1, 0, 1/2)$$

$$Ag(47, 109, 1/2) + \tilde{n}(0, 1, 0) + a(0, 0, 1/2) \qquad (11b)$$

$$\rightarrow Ag(47, 110, 1) + a(0, 0, 1/2) \rightarrow$$

$$\rightarrow Cd(48, 110, 0)[\textit{stable isotope}] + e^{-}(-1, 0, 1/2)$$

The *Li*-activated detectors in Santilli's experiment function as mediators of aetherino and neutroid interactivity yielding neutrons by:

$$Li(3, 7, 3/2) + \tilde{n}(0, 1, 0) + a(0, 0, 1/2) \qquad (12)$$

$$\rightarrow Li(3, 8, 2)$$

$$\rightarrow 2\,\mathrm{He}(2, 4, 0) + 2\,\gamma(0, 0, 1)$$

We may deduce: *the substances used for neutron detection are themselves the neutron source by way of neutroid absorption and subsequent nuclear transmutation. Li based detectors that can register thermal neutrons are best for this experimental work.* New mathematics and theory will soon be available here: [33].

IV. THE ROLE OF PHYSICAL THEORY

Physical theory explains experimental and observational results.

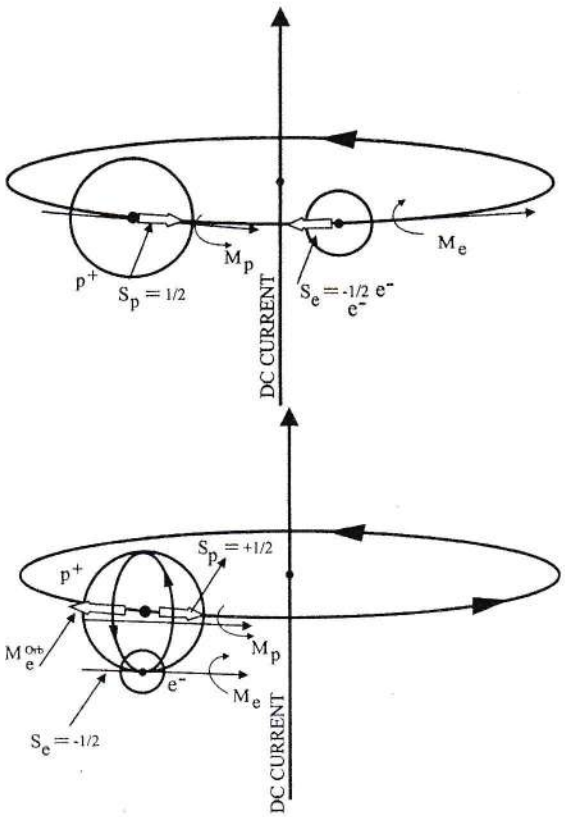

FIG. 5a. top FIG. 5b. below

A schematic view of the tangential alignment of protons and electrons along the tangent to a magnetic force line (Fig. 5a), and a view of the compression of the electron against the proton caused by opposing electric and magnetic polarities (Fig. 5b) [16] (Santilli, 2014) (Used with permission of Ruggero Santilli/Journal of Computational Methods in Sciences and Engineering).

Hadronic mechanics offers a clear causal mechanism to explain these results. The electrons and protons constituting the hydrogen gas become ionized in the arc, and by way of its tangential relation to the magnetic force lines the electron breaches the proton's hadronic horizon via opposing magnetic and electric polarities, leading to singlet coupling. The mass difference of the order of 2000 times between the heavy proton and the light electron ensure that the proton is not mutated, while the electron demonstrates constrained angular momentum orbiting

then within the proton's hadronic sphere. In this way, a stable singlet coupled particle with the proper spin is created: the neutron.

Hadronic structure is defined within Hadronic Mechanics and Chemistry as a contact type interaction characterized by full emergence of one wave-packet within the other. The dynamic tangential relations between the proton and electron ionized gas constituents mediated by DC magnetic force lines so as to breach the hadronic proton horizon and compress the electron within the proton and bind them together in singlet coupling as a neutron, offer us a specific physical mechanism to explain observed inelastic scattering probabilities:

The electron collapses into the proton from attractive Coulomb forces due to opposing charges and magnetic moments [14*a*].

Further detailed theory and mathematical explanation may be found here: [19,29,31,32].

See
[14*a*,15,16] for further examples of neutron and neutroid syntheses under various experimental conditions and constraints.

Possible implications for quantum theory

The parsimonious interpretation of the empirically derived internal neutron structure is that of an electron bound within a proton. If this is so, axiomatic adjustments to the current Hadronic and Quantum paradigms are logically indicated:

1. The Schrödinger equation fails to produce correct physical solutions in the case of the experimentally indicated 0.782 MeV *positive binding energy* over the rest energies of the proton and electron which is required to synthesize neutrons.

2. Quantum mechanics forbids the synthesis of the spin 1/2 neutron from the bound state of the spin 1/2 proton and spin 1/2 electron.

3. The electron being bound into the proton for the 15 *m* life of an isolated

neutron is not permitted in quantum mechanics.

4. The magnetic moments of the proton and electron are insufficient to account for the magnetic moment of the neutron according to quantum theory.

5. The uncertainty principle does not allow the electron to be bound permanently within the proton in stable nuclei such as the deuteron.

6. The interpretation of internal neutron structure which is most parsimonious, is that of an electron bound within a proton, not that of quarks. A simpler neutron structure has been articulated. The undetectable free quark is no longer required.

7. The model of Hadronic Mechanics and Chemistry implies new hadronic fuels, possible stimulated nuclear decay and rapid safe elimination of radioactive nuclear waste (see below) [31].

8. The neutron can be re-conceptualized as the hadronic bound state of the hydrogen atom with the electron orbiting within a proton (see figure 6 below). Ergo: the ordinary energy levels of the hydrogen atom may be rightly conceptualized as the excited states of the neutron.

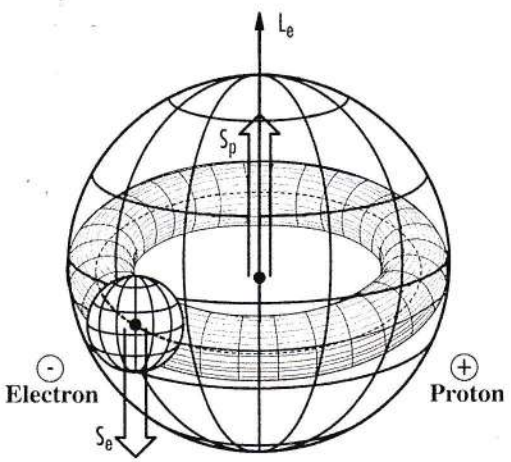

FIG. 6. Image of the hydrogen atom's electron orbiting within the proton forming a neutron in

singlet coupling. The neutron is the hadronic bound state of the hydrogen atom. Used with Permission of Ruggero Santilli.

V. PRACTICAL BENEFITS OF PARADIGM SHIFT

Should physics choose to adjust the paradigm to fit the experimental results afforded by this simple experiment rather than suppress those results, the potential benefits to mankind and the sciences are extensive in their scope.

An alternative method for disposal of high-level radioactive waste.

An alternative method for disposing of high-level radioactive waste has been proposed by Santilli. It is a form of neutralisation but does not use the conventional methods currently being researched. Indeed, classical formulations of quantum chemistry and nuclear models do not even permit the practical method proposed. This new method arises from a number of discrepancies between the theoretical and measured values using the current formulation of quantum mechanics. Conventionally, the probability for beta-decay of a neutron into a proton, electron and neutrino is very low for radioactive elements on a nuclear timescale; for stable isotopes, the lifetime of neutrons is effectively infinite. Hadronic mechanics predicts that such a reaction may be stimulated within the nuclei of radioactive materials.

In essence, a radioactive nucleus is in an excited energy state and is attempting to return to its ground state energy. Under normal circumstances, this is achieved by spontaneous fission or radioactive emission; the time taken to decay being dependent on how much excess energy the nucleus has. This can vary between

10^{-31} seconds and millions of years. An excited nucleus can return to its ground state through emission of a photon (gamma emission), an electron (beta emission), or by spontaneous fission, where alpha emission is assumed to be a form of fission. The latter two processes cause a change in the nature of the parent nucleus, altering its nuclear properties. The energy value of the excited state determines the method by which the nucleus returns to its ground state. If the decay process involves the emission of a beta particle, it may be extrapolated that

a neutron will have to decay to achieve this.

From the theoretical calculations, it is hypothesised that this decay can be stimulated by bombarding the nucleus with so-called 'resonant' photons with an energy of 1.294 Mev [31]. Under normal circumstances the probability of this interaction is extremely low. However, Santilli claims that there is a large resonance peak in the reaction cross-section (that is, the probability of the said interaction occurring) for incident photons with an energy of 1.294 Mev. [1]

If this interaction is found to be true, its application for the disposal of radioactive waste is profound. Photons with the correct resonance energy can be produced easily within a piece of equipment of small volume, such that the neutraliser could be built on the same site as the parent reactor itself. Effectively, it would allow all radioactive waste to be fissioned until all the isotopes form stable nuclei. However, a point to note is that, taking a typical sample of waste, the resultant treated material would not be radioactively dangerous but chemically could be a totally unknown concoction of elements and compounds, which may well contain high levels of toxins. Another point to note is that stimulated fission would release a considerable amount of heat energy from the fuel, and so some sort of effective coolant would be required. However, since this heat energy could be used to produce even more power, there seems no reason in principle to suppose that what might be termed a secondary 'waste reactor' could not be built.

To continue quantitative scientific studies of the proposed new method for the disposal of nuclear waste essentially requires a few basic experiments to be

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1. It is also feasible, though not stated, that the simple existence of an excited nucleus makes it open to interaction with resonant photons, regardless of the means of decay ultimately used to return to its ground state energy. Once a neutron is converted into a proton plus reaction products, a number of possibilities could occur. Firstly, the new nucleus could be a stable isotope, in which case further interactions with the resonant photons would be unlikely and the waste would have been effectively neutralized. Secondly, the new isotope could form a new neutron deficient nucleus and one of the following could then occur: the nucleus undergoes spontaneous fission, forming two new nuclei and possibly a number of neutrons, which could interact with other fissile elements in the fuel and generate excess heat; the neutron deficient nucleus could form a new excited energy state which can simply be categorized as another target radioactive nucleus for the resonant photons.

performed. All should be of reasonable cost and are certainly realisable with present-day technology. It seems sensible to perform these experiments to decide whether or not the claims are valid. If they are, the rewards would be tremendous; if not, little would have been lost.

A. Hadronic fuels:

From the very beginning, one of the main driving forces behind Ruggero Santilli's hadronic science has been an urgent desire to help find new clean forms of energy for the benefit of all. To this end, hadronic mechanics has been developed and it is found that all energies predicted are suitable for the clean production of electricity and so may be used in the production of fuels acceptable in a so-called green economy. These new energies are found to be of three types; one at each of the particle, nuclear and molecular levels. These are all discussed in detail in the book on hadronic chemistry [31], although that volume does really concentrate on molecular aspects. However, the vitally important point to remember at all times is that the new proposed hadronic mechanics agrees with conventional theories everywhere except at short distances of the order of 10^{-13}cm. It is also important to remember that, at these short distances, many effects are non-potential ones and so may not be examined via the use of a Hamiltonian. These new effects are extremely short range and exhibit a number of unusual features:

(i) the non-hamiltonian interactions due to the deep mutual overlapping of the particle wavepackets in singlet coupling are attractive and are so attractive as to overcome repulsive Coulomb interactions,

(ii) they occur without any binding energy,

(iii)these new interactions imply a mutation of the intrinsic characteristics of particles, characterised by irreducible representations of the Poincaré-Santilli isosymmetry. e.g. a deformation of the charge distribution of protons and neutrons is representable by hadronic mechanics and allows an exact representation of nuclear magnetic moments.

The attractive nature of these new interactions combined with their lack of energy exchange and the possible alteration of the intrinsic character of particles allow for truly new clean energies. It remains to consider briefly these three types of new energy as alluded to earlier;

(1) Firstly consider that occurring at the elementary particle level.

It seems that the neutron harbours a huge reservoir of clean energy which could be.
made available to mankind. It is a naturally unstable particle with spontaneous decay

$$n \rightarrow p^+ + e^- + \bar{\nu}, \tag{13}$$

which releases electrons with huge kinetic energies up to 0.8MeV. Here, and later, the traditional notation incorporating the symbols for anti-neutrino and neutrino are used.

The capture of these electrons via a conducting screen provides a dual source of energy called hadronic energy. The first source is due to the creation of an electric potential difference, while the second is due to the creation of a large quantity of heat. This source is clean because no dangerous radiation is emitted and there is no harmful waste.

As is explained in detail in the book on Hadronic Chemistry [31], this so-called hadronic energy is based on three predictions:

(a) A peripheral neutron belonging to a group of light, natural, stable elements *N(A, Z)*, called hadronic fuels, may be stimulated to decay via a flux of photons γ with a resonating frequency of 1.294MeV,

$$\gamma + n \rightarrow p^+ + e^- + \bar{\nu}; \tag{14}$$

(b) The resulting nuclei *N(A, Z+1)* are naturally unstable with spontaneous beta decay

$$\gamma + N(A,Z) \rightarrow N(A,Z+1) + e_1^- + \bar{\nu}_1 \rightarrow N(A,Z+2) + e_2^- + \bar{\nu}_1 + \bar{\nu}_2; \tag{15}$$

(c) The final nuclei *N(A, Z+2)* of the class of hadronic fuels are light, natural, stable elements and so, there is no deposit of harmful waste material.

Examples of these so-called hadronic fuels are $Z_n(70, 30)$ and $M_0(100, 42)$. It should be noted also that the energy of the original resonating photon is not lost but remains available in the final usable energy. Also, for each resonating photon

there are two electrons and related kinetic energy produced. Again, in essence, the suggested process transforms the original nuclei into nuclei having smaller mass while producing large amounts of energy - large enough in fact to ensure a positive energy output after allowing for that needed to produce the original resonating photons. Obviously, hadronic energy is highly acceptable environmentally and it would seem that the suggested process readily delivers large amounts of usable energy. However, the entire theoretical discussion lies outside the realms of traditional theoretical physics, indicating a process which is impossible for traditional quantum mechanics. As will be noted again later, it does appear that this is what provides the most vociferous denunciation of this mentioned theory and the implied benefits for mankind if, in fact, the idea works. It does seem, though, to be a process worth evaluating independently both theoretically and experimentally since it could prove extremely beneficial for mankind if it works as expected.

(2) New Clean Energies occurring at the Nuclear Level.

As mentioned already, one of the biggest obstacles facing these new proposals is the firmly established position of quantum mechanics within scientific circles. Orthodox quantum mechanics simply doesn't allow for some of these developments; for example, it doesn't even allow the possibility of low energy stimulated nuclear transmutations but, even if such processes are admitted, it is claimed such are accompanied by the emission of harmful neutrons. Experimental verification of stimulated nuclear transmutations at low energy without the emission of neutrons would indicate direct support for this new theory which, in a very real sense, simply extends, or covers, existing quantum mechanical theory to include physical situations not addressed by that existing theory. However, in the present context, the crucial point is that the new theory predicts a totally new model for the structure of nuclei. In this new model, hadronic mechanics, they are reduced to being composed of electrons and protons but recovering the conventional structure in terms of protons and neutrons in first approximation. These new models are, as mentioned previously, a consequence of neutron model as a hadronic bound state of a proton and an electron as originally conceived by Rutherford. It follows that the new clean energies of classes 1 and 2 are very deeply interconnected, to the extent that experimental evidence of one is experimental evidence of the other.

Three types of new clean energies emerge in this class but possibly the first is the most obvious:

(a) This first source reignites thoughts about electron capture; that is, the spontaneous capture of electrons by certain nuclei under normal conditions on Earth. In truth, such electron capture implies the synthesis of neutrons from protons and electrons, leading to low energy transmutations of the form

$$N(A,Z) + e^- \rightarrow N(A,Z-1) + \nu. \tag{16}$$

This reaction is spontaneous but hadronic mechanics has indicated how such transmutations may be stimulated with a release of energy:

$$N(A,Z) + e^- + TR \rightarrow N(A,Z-1) + \text{heat}, \tag{17}$$

(b) A second group of energies of this second type may be identified by noting that the Earth's core is still so hot, after billions of years, that it must possess an internal source of heat which could well be due to nuclear transmutations such as envisaged above. It appears that observations, conformed by hadronic mechanics, indicate that such nuclear transmutations may well be reproducible here on Earth.

(c) A third group utilises the fact that, millions of years ago, the earth's atmosphere might have been composed of only 40% nitrogen. It is thought that the ensuing doubling of nitrogen content might well be due to nitrogen being synthesized in the atmosphere from other natural elements via a low energy nuclear process without the emission of harmful radiation. This is a process permitted by hadronic mechanics but not by conventional quantum mechanics.

It seems quite possible that the trigger required to provoke this process is simply lightning. Also, the most plausible candidates as the natural elements to be in these processes are carbon and deuterium which occurs in small amounts in ordinary water. The stimulated synthesis of nitrogen predicted by hadronic mechanics would then follow

$$TR + {}_1H^2 + {}_6C^{12} \rightarrow {}_7N^{14} + \text{heat}, \tag{18}$$

where the trigger in this case is lightning together with related events such as extreme magnetic fields. The low rate of such synthesis may be attributed to the low concentration of heavy water in our atmosphere. It should be noted that the energy output associated is impressive, [31]

As an interesting aside, it might be noted that the instantaneous availability of these large quantities of energy in this process provides an obvious explanation for thunder.

(3) New Clean Energies occurring at the Molecular Level.

In this class, the idea is to tap the energy within molecules; for example, via the transition from given molecules to structures at lower energy with practical use being made of the energy difference. These transitions would be utilised in hadronic reactors of molecular type, also called PlasmaArcFlow reactors, which are, incidentally, already in industrial production. More details of this category are readily available. [31]

It should be realised that the hadronic reactors of each of the three types considered are based on the same principle – that of stimulating the decay of considered bound states via resonating effects acting on the nonpotential component of binding forces. This constitutes a totally different approach as compared with conventional approaches utilising traditional quantum mechanics. The main physical principles behind each of the three classes discussed are identical. Hence, the experimental verification of one class gives immediate support for the existence of the other two classes. It is to be hoped that independent attempts at verification will be forthcoming soon because, if these classes do exist – and the present existence of operating PlasmaArcFlow reactors would appear to suggest that such attempted verification would be successful – the World's energy problems could be a thing of the past.

VI. CONCLUSION

The purpose of physical scientific theory is to explain physical systems as revealed in observation and experimental results. Theory must not refute facts but instead be able to account for them. Many experiments using various designs have now synthesized neutroids and neutrons from an arc of current in hydrogen gas, [12,14,14*a*,15,16,17] revealing the neutron in its internal hadronic structure

as being that far more more parsimonious interpretation of an electron within a proton as first proposed by Rutherford, not that of quarks [32]. We propose that contact type interactions of full wave-packet penetration at distances of 10^{-13} cm or less characterize hadronic structure as is the case with the neutron, which is defined and properly described in the model of Hadronic Mechanics and Chemistry [20, 31]. Direct neutron production from an arc of current in hydrogen gas requires a minimum arc voltage of 3 *kV* and energy of 3 *mJ*, or only neutroids will be produced which may potentially by way of substance-specific absorption and subsequent nuclear transmutation within particular materials then become neutrons. These specifics of hadronic and neutron structure as well as neutroid to neutron transformations are fully defined within the theoretical context of Hadronic Mechanics and Chemistry [20,31] permitting new approaches to the production of energy, and the clean up of nuclear waste. *Within the province of this one simple experiment and its variants, the hadronic paradigm itself may be reassessed.*

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