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REPRESENTATION AND ENHANCEMENT OF THE EXCESS ENERGY OF ROSSI'S REACTORS VIA SANTILLI'S NEUTROIDS AND NUCLEOIDS

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Abstract

A recent, independent-party report shows that Rossi's E-Cat reactor produces an excess heat that cannot be explained via quantum mechanical or chemical processes, thus supporting the possible presence of new nuclear processes. In this paper, we recall the studies by Don Carlo Borghi on the synthesis of the neutron from the Hydrogen, and the systematic, mathematical, theoretical and experimental studies conducted by R. M. Santilli on the neutron synthesis via the covering hadronic mechanics and chemistry. We review in particular the detection of an apparent new bound state of a proton and an electron called "neutroid," which is solely predicted by hadronic mechanics with the characteristics of the neutron except spin zero, thus being different than Mills hydrino. We then recall Santilli's new series of "nucleoids" which are given by conventional nuclides when absorbing a neutroid or nucleoid, and illustrate their esoenergetic decay into stable nuclides. In this paper, we submit the hypothesis, apparently for the first time, that Rossi's E-Cat reactor converts, at least in part, Hydrogen into Santilli's neutroids by therefore avoiding the Coulomb repulsion between protons and nuclei present in current interpretation. The use of Santilli's nucleoids and their esoenergetic decay then allow a quantitative interpretation of the excess heat in Rossi's reactor. We close the paper by indicating the reasons according to which Santilli's new species of MagneHydrogen offers realistic possibilities to enhance the energy output for Rossi's as well as other Hydrogen-based nuclear transmutations.

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KEY WORDS: nuclear fusion, neutroid, nucleoids

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1. THE REPORTED EXCESS ENERGY OF ROSSI'S REACTORS

Andrea Rossi has developed reactors known under the name of E-Cat based on S. Focardi research work [1]. Rossi claims his reactor develop more output energy than fed input one. Several experts have partially tested the device, whose internal configuration and operation is undisclosed by the inventor. Recently, G. Levi et al.[2], have published a third independent long report showing some important performances of the E-Cat in terms of COP about 3.6. They had also the new opportunity of analyzing the untreated and treated reactants in terms of composition, grain size and surface properties. Their report makes evident the occurring of nuclear transmutations during the reaction, because atomic and isotopic composition variations were measured.

In particular, ^7Li (contained in the reactants as hydrogen donor metal hydride) resulted depleted, and ^{58}Ni too. The presence of ^{62}Ni and Cu resulted enhanced. According to the authors of the report, *something* occurs that probably induces ^7Li to turn into ^8Be and finally into two ^4He, with energy release, like the (although impossible) reaction :

$$p +^7 Li \rightarrow^4 He +^4 He \tag{1.1}$$

In parallel, ^{58}Ni contained in the reactants is induced by *something* to turn (step by step) into ^{59}Ni, ^{60}Ni, ^{61}Ni,^{62}N (with energy release) and unstable Cu that decays into Ni by a β^+ emission, similar to the (although impossible) reaction :

$$p +^{58} Ni \rightarrow^{59} Cu \tag{1.2}$$

with ^{59}Cu decaying back to ^{59}Ni via β^+ emission. The above hypothesis is compatible with the measured energy production and with the comparison between analyzed compositions of reactants and ashes.

2.INCOMPATIBILITY OF ROSSI'S EXCESS ENERGY WITH QUANTUM MECHANICS

As measured by the authors of the report, the involved energy densities developed during the reaction cannot be matched with the magnitude

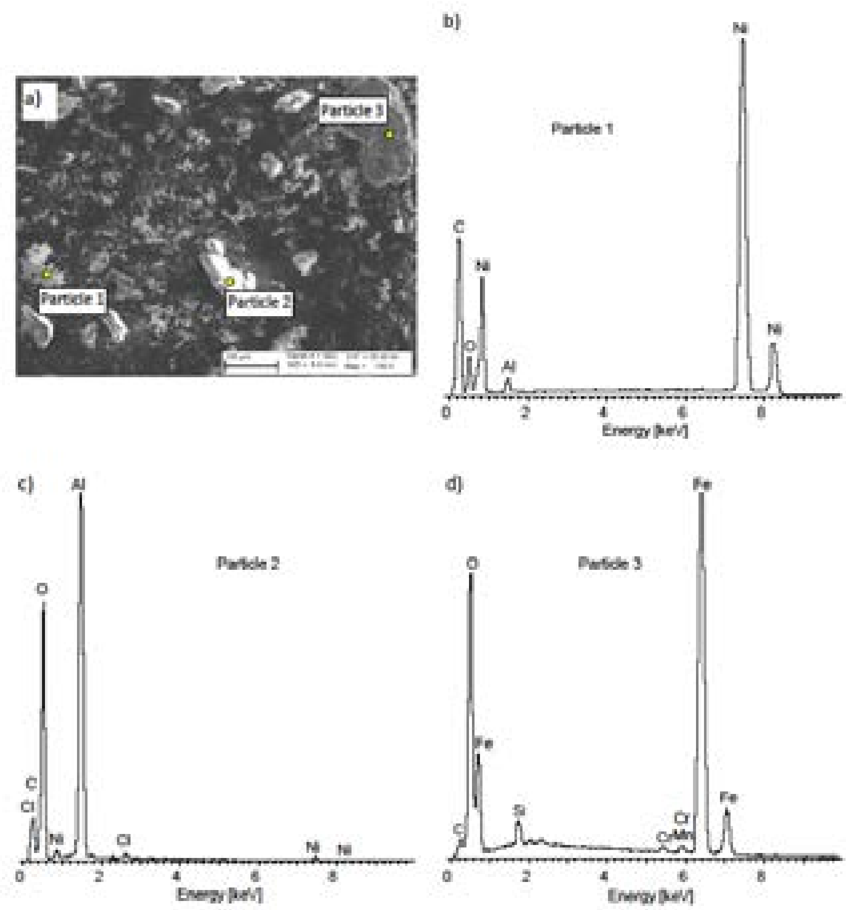

Figure 1: *Reproduction of some of the scans from Appendix 3 of Ref. [2] establishing the existence beyond scientific doubt of nuclear transmutations with excess heath in Rossi's reactor that are beyond any quantitative interpretation via quantum mechanics.*

order of chemical behaviors. So, nuclear reactions are hypothesized, specially related to the measured transmutations occurred, according to the scheme of (1.1, 1.2). On the other hand, the authors explicitly note that the recalled equations are prohibited by Quantum Mechanics, owing to:

a) E-cat reactors have no means to overcome the Coulomb repulsion between protons and Li or Ni nuclei;

b) the unavailability in the E-cat reactors of 0.782 MeV per proton for the transformation into neutrons (via β-capture), to avoid the Coulomb barrier in the experimented conditions;

c) the insufficient cross section for such an event, in the same conditions.

Therefore, basically new processes must be invoked to perform the indicated nuclear transmutations and their related positive energy output.

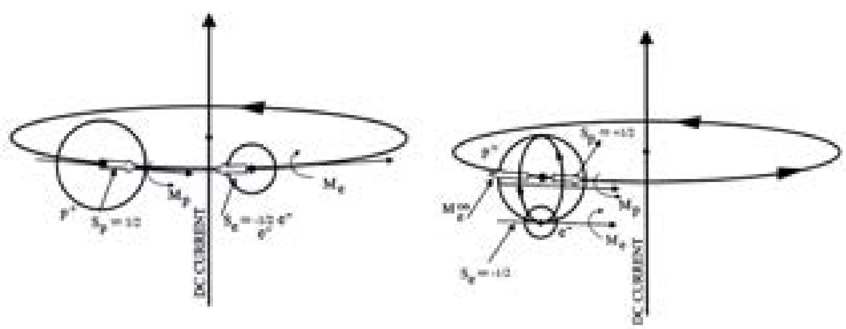

Figure 2: *Schematic view of Santilli's synthesis of the neutron from the Hydrogen atom in the core of a star. The figure in the left depicts the ionization of the Hydrogen atom via an electric arc and the proper alignment of the proton and the electron. The figure in the right illustrates the coupling of the proton and electron at short distances. Additional contributions called the "trigger" force the penetration of the electron inside the hyperdense proton according to the laws of hadronic mechanics [3-8].*

3. SANTILLI SYNTHESIS OF NEUTRONS AND NUCLIDES

The synthesis of the neutron according to Fermi's historical weak reaction

$$p^{+} + e^{-} \rightarrow n + \nu \tag{3.1}$$

is incompatible with quantum mechanics, quantum chromodynamics, special relativity and other 20th century theories because *the rest energy of the neutron is bigger than the sum of the rest energies of the proton and of the electron,* as established by the known data

$$E_p = 938.272\ MeV, \ \ E_e = 0.511\ MeV, \ \ E_n = 939.565\ MeV, \tag{3.2a}$$

$$E_n - (E_p + E_e) = 0.782\ MeV > 0, \tag{3.2b}$$

under which the Schrödinger equation does not yield physically consistent results due to the need for a "positive binding energy" resulting in a "mass excess" that are beyond any descriptive capacity of 20th century theories.

The inapplicability of quantum chromodynamics for the neutron synthesis is easily seen from the impossibility of reducing electrons to quarks in Synthesis (3.1) and for numerous other technical reasons.

The inapplicability (and certainly not the violation because not conceived for that) of special relativity for the neutron synthesis is clearly established by the impossibility of achieving a quantitative representation of synthesis (3.1) via Dirac's equations, insurmountable technical difficulties of defining the axioms of special relativity within the hyperdense medium inside the proton and and other reasons.

After joining the Department of Mathematics of Harvard University in September 1977 under DOE contract, Ruggero Maria Santilli initiated long term, comprehensive, mathematical, theoretical and experimental studies on the synthesis of the neutron from the Hydrogen atom as occurring in the core of stars.

The studies initiated with the admission of non-linear, non-local and non-Hamiltonian interactions during Rutherford's historical conception of the neutron as a "compressed hydrogen atom," which interactions can solely be represented via a *non-unitary* covering of quantum mechanics.

Therefore, in a series of seminal mathematical works. Santilli developed the axiom-preserving isotopic covering of 20th century applied

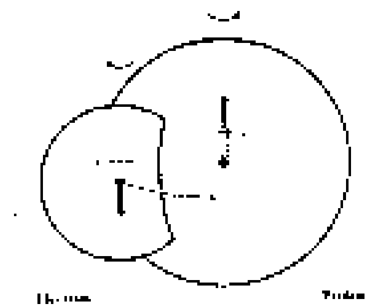

Figure 3: *A basic novelty in Santilli's synthesis of the neutron from the Hydrogen atom is the appearance of a constrained angular motion of the electron immersed within the hyperdense proton. This orbital motion eliminates the need for the emission of a neutrino; it is solely permitted by the representation of the proton as extended according to hadronic mechanics; and it did not exist during Pauli's and Fermi's time since quantum mechanics solely represents the proton as a massive point [3-8].*

mathematics, today called *Santilli IsoMathematics,* with particular reference to the isotopies of the various branches of Lie's theory, today called the *Lie-Santilli isoTheory,* as well as the isotopies of spacetime symmetries for physical media such as those in the interior of hadrons (see the Springer-Verlag monographs [3] for these initial studies).

Santilli then suggested the construction of a covering non-unitary mechanics under the name of *hadronic mechanics* and presented since the initial proposals the isotopic generalizations of Schrödinger and Heisenberg's equations today known as *Schrödinger-Santilli and Heisenberg - Santilli IsoEquations* (see also monographs [3], page 112 of Vol. II for the first historical appearance of the name of "hadronic mechanics," and see monographs [4] for subsequent comprehensive formulation).

Following these mathematical and theoretical preparatory studies, Santilli achieved the *first known, exact and time invariant representation of 'all' characteristics of the neutron in its synthesis from the Hydrogen atom in the core of stars.* the representation was achieved, firstly, via non-relativistic hadronic mechanics [5,6] and then at the level of relativistic hadronic mechanics [7,8].

The first experimental test on the laboratory synthesis of the neutron from a Hydrogen gas was attempted in the 1960s by the Italian priest-scientist Don Carlo Borghi and his associates G. Giori and A. Dall'Olio [9].

Figure 4: *The experimental set up, called Hadronic Reactor I, used by Santilli first for the synthesis of the neutron from the Hydrogen [5-15] and then for the synthesis of the Nitrogen-14 from the Deuterium-2 and Carbon-12 [21].*

Regrettably, Don Borghi and his colleagues experienced extreme oppositions against the conduction of the experiment from his Italian colleagues on grounds that the experiment would violate quantum mechanics and Einstein's special relativity, and the tests had to be done in Brazil.

Following the achievement of comprehensive mathematical and theoretical understanding of the synthesis of the neutron inside a star, Santilli conducted systematic experimental tests on the laboratory synthesis of the neutron from a Hydrogen gas [10-15] . although according to mechanisms and principles different than those used by Don Borghi and his associates.

It should be indicated that the U. S. publicly traded company *Thunder Energies Corporation* is current setting up production of a *Thermal Neutron Source* under Santilli's license (see film [15] for a view of a prototype).

We should also indicate that in the representation of the synthesis

Figure 5: *A view in the left of the team from Princeton Gamma Spectroscopy that conducted extensive verification of Santilli's synthesis of the Nitrogen from the Deuterium and Carbon, and a check in the right of the confirmation of the lack of emission of neuronic radiations and the lack of release of radioactive waste [32].*

of the neutron from a Hydrogen atom, Santilli could find nowhere any source of energy or to justify the emission of the neutrino in the r.h.s. of reaction (3.1).

Additionally, the representation of the proton as an extended hyperdense particle implies the appearance of a new angular momentum completely absent during Pauli's and Fermi's times, which is given by the orbital motion of the electron when compressed inside the hyperdense proton (Fig. 3).

This new orbital motion accounts exactly for the spin of the neutron because the total angular momentum of the electron is null when constrained within the hyperdense medium inside the proton, the spin of the neutron coincides with that of the proton, thus avoiding any need to conjecture the emission of the hypothetical neutrino in the neutron synthesis (see the original derivations [10-15], independent reviews [53] and additional references quoted therein).

Despite these advances, Santilli remained with the problem of the origin of the $0.782\ MeV$ needed for the synthesis of the neutron from data (3.1), which energy cannot be provided by the relative kinetic energy between the proton and the electron because in this case the cross section between the proton and the electron would be so extremely small to pre-

Figure 6: *A view of the Hadronic Reactor II used by Santilli for the first synthesis of the Silicon-28 from Carbon-12 and oxygen-016. [22].*

vent the synthesis.

Additionally, the missing energy of $0,782\ MeV$ cannot be provided by the star interior because at the initiation of nuclear processes, stars synthesize 10^{50} or so neutrons *per second.* In the event the missing energy originated from the star interior, stars would *lose,* rather than produce, about $10^{50}\ MeV$ per second and, as such, stars would never initiate to produce light.

In view of these aspects, Santilli conjectured the existence of the *etherino* [16] (see also the independent studies [17.53] et al.) conceived not as a new particle, but as an *longitudinal impulse* denoted with the symbol "a" (from the Latin aether) transferring the missing energy from space conceived as a universal substratum with very high energy density, essentially long old theories of continuous creation in the universe.

Therefore, due to insurmountable difficulties in accommodating the neutrino as in synthesis (3.1), Santilli proposed in Ref. [15] the alternative formulation

$$p^+ + a + e^- \to n \tag{3.3}$$

Note that Santilli could not use the antineutrino in lieu of the etherino according to reaction (3.1),

$$p^+ + \bar{\nu} + e^- \to n \tag{3.4}$$

for the evident reason that it would *violate the principle of conservation of the energy,* since reaction (3.3) "requires" $0.782\ MeV$ that cannot credibly be provided by the antineutrino due to its essentially null cross section with the proton and the electron.

Lectures [18] are recommended as an introduction to Santilli's studies in the synthesis of the neutron, with the understanding that a technical knowledge can solely be acquired by studying the original contributions.

Following, and only following the acquisition of systematic mathematical, theoretical and experimental knowledge on the most fundamental synthesis in nature, that of the neutron from a Hydrogen gas, Santilli introduced at the 1998 *Salt Lake City International Meeting on New Energies* the novel *Intermediate Controlled Nuclear Syntheses (ICNS) of two light natural and stable nuclides called hadronic Fuels into a third light, natural and stable nuclide without the emission of harmful radiations and without the release of radioactive waste* according to the reaction expressed in standard nuclear units

$$N_1(A_1,\, Z_1,\, J_1^{p_1},\, u_1) + N_2(A_2,\, Z_2,\, J_2^{p_2},\, u_2) + \mathrm{TR} \rightarrow$$

$$\rightarrow N_3(A_3,\, Z_3,\, J_3^{p_3},\, u_3) + \mathrm{Heat}, \tag{3.5}$$

under the verification of all nuclear laws, including the evident conservation laws

$$A_1 + A_2 = A_3,\; Z_1 + Z_2 = Z_3,\; J_1 + J_2 = J_3,\; p_1 + p_2 = p_3, \tag{3.6a}$$

$$U_1 + u_2 = u_3 + \Delta E,\;\; \Delta E = E_3 - (E_1 + E_2) > 0, \tag{3.6b}$$

as well as the verification of various *Hadronic Laws for Nuclear Syntheses* presented in details in Ref. [20], which we cannot possibly review here for brevity, and merely mention:

SANTILLI'S HADRONIC LAWS FOR NUCLEAR SYNTHESES [20]:

HADRONIC LAW 3.1: Nuclei have to be exposed in a systematic and controlled way as an evident prerequisite for controlled nuclear synthesis;

HADRONIC LAW 3.2: Nuclei must have the proper spin couplings, given by either the planar singlet or the axial triplet coupling see Fig. 8), also as a necessary prerequisite for meaningful nuclear syntheses;

Figure 7: *A view the Hadronic Reactor III built and used by Santilli for the synthesis of Silicon from Carbon and Oxygen [22-25]. It should be noted that Santilli has constructed five additional Hadronic Reactors that are not illustrated in this paper for brevity.*

HADRONIC LAW 3.3: The used energy must have the minimal "threshold" value for all services because insufficient (excessive) energies solely admit nuclear syntheses at random (create industrially uncontrollable instabilities).

HADRONIC LAW 3.4: Following the controlled exposure of nuclei and the controlled coupling of nuclear spins, ICNAS requires a "trigger" intended as an engineering mean pushing the exposed nuclei to be in contact with each other, at which point there is the activation of the nuclear force and, acting under conservation laws (3/6) and Hadronic Laws 3.1-3.3, the synthesis of the original nuclei into the third is unavoidable.

HADRONIC LAW 3.5: The sole Hadronic Fuels (the original light natural and stable elements) admitted for ICNS are those for which the synthesis emits no harmful radiation and releases no radioactive waste.

It should be indicated that the primary environmental character of ICNS is the lack of neutron emission because protonic and beta radiations are easily trapped by the metal casing of Santilli's *Hadronic Reactors.* In any case, it seems to be evident that, either reaction (3.5) exists, in which case no neutron emission is possible, or synthesis (3.5) does not occur, in which case the used energy is about 10^{-6} times the energy needed to smash nuclei as a condition to produce the widely expected neutrons.

Santilli then conducted systematic experimental confirmations of ICNS [20-25] following independent chemical analyses by qualified American laboratories signed by the director [26-31].

Said ICNS have been confirmed by independent contributions [32-34] also following signed report by the directors of qualified American laboratories [35-39] (see also the very instructive lecture [35] by L. Ying).

For general studies we quote Santilli's monographs [52], the independent monograph by I. Gandzha and J. V. Kadeisvili [53], and the forthcoming monograph [54] by U. Abundo, S. S. Dhondge A. Nas. where the results of this paper are being considered in more details.

It is important for the understanding of next sections to review at least some of Santilli's nuclear syntheses based on his hadronic laws and their engineering realizations illustrated in the figures.

The first ICNS suggested for study in Ref. [20], experimentally estab-

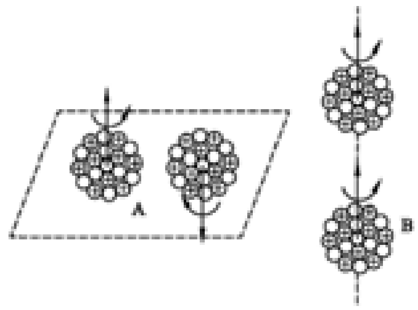

Figure 8: *A generally ignored necessary condition for the proper coupling of nuclear spins as a necessary condition to avoid fusions at random and achieve them in a controlled fashion. According to the laws for nuclear syntheses set forth by hadronic mechanics, controlled nuclear syntheses can only occur for the "planar singlet coupling" in the left or the "triplet axial coupling" in the right [20].*

lished in Ref. [21]. and independently confirmed in Ref. [32.35] is the synthesis of the Nitrogen from Deuterium and Carbon

$$H(2,1,1^+,2.0141) + C(12,6,0^+,12.0000) + TR \quad \rightarrow$$

$$\rightarrow \quad N(14,7,1+,14.0030) + \Delta E_{heat}, \tag{3.7a}$$

$$\Delta E = (E_C + E_H) - E_N = 0.0111\ u = 10.339\ MeV \approx 1.5 \times 10^{-15}\ BTU, \tag{3.7b}$$

The above synthesis was suggested in Ref. [20] as having a distinct feasibility over other syntheses currently receiving the majority of interest (such as the synthesis of the Helium) for various reasons, such as:

1) Since the Carbon isotope has null spin, the engineering realization of a controlled spin coupling is dramatically simplified, e.g., with respect to the synthesis of the Helium;

2) When occurring at threshold energies, and only in that case, the above synthesis cannot possibly release any harmful radiation, since it is impossible for various reasons to have proton, neutron or alpha radiations as a byproduct; and

3) Since all hadronic laws are verified, the realization of the Nitrogen synthesis is essentially reduced to engineering issues.

In Ref.[22], Santilli established the ICNS of the Silicon from Carbon and Oxygen according to the reaction (see confirmations [23-25]

$$O(16, 8, 0^+, 17.9991) + C(12, 6, 0^+, 12.0000) + TR \rightarrow$$

$$\rightarrow Si(28, 14, 0^+, 29.9737) + \Delta E, \tag{3.8a}$$

$$\Delta E = 0.0254\, u, \tag{4.8b}$$

The above synthesis is particularly significant for environmental profiles because *the synthesis of the Silicon from Carbon and Oxygen allows a significant enhancement of the energy output of the combustion of fossil fuels, while assuring the combustion of all combustible contaminants in the exhaust evidently due to the high temperature of the combustion,* as currently developed by *Thunder Energies Corporation.*

Note that *any increase of the energy output of fossil fuel combustion de facto implies a corresponding increase of natural reserves,* thus illustrating the industrial and environmental orientation of Santilli's decades of research in the field.

The following ICNF was suggested in Ref. [19,20]

$$H(2, 1, 1^+, 2.0141) + O(16, 8, 0^+, 15.9949) + TR \quad \rightarrow$$

$$\rightarrow \quad F(18, 9, 1+, 18.0009), \tag{3.9a}$$

$$\Delta E_1 = 0.0081\, u = 7.545\, MeV, \tag{3.9b}$$

with secondary process due to the instability of $F(18, 9, 1+, 18.0009)$

$$F(18, 9, 1+, 18.0009) + EC \quad \rightarrow \quad O(18, 8, 0^+, 17.9991) + 1.656\, MeV, \tag{3.10}$$

resulting in the following total energy output per synthesis

$$\Delta E_{tot} = 9.201\, MeV \;\approx\; 1.30 \times 10^{-15}\, BTU, \tag{3.11}$$

in which case 10^{30} syntheses *per hour,* which is a rather modest requirement for nuclear settings, would yield a rather substantial new clean energy.

An additional alternative for hadronic fuels recommended in Refs. [19-21] is given by a 50-50 mixture of Deuteron and Helium gases with ICNS

$$H(2, 1, 1^+, 2.0141) + He(4, 2, 0^+, 4.0026) + TR \;\rightarrow$$

Sample ID	%Na	%Al	%Si	%S	%Cl	%K	%Ca	%Ti
8.23.13.A x	0.55	0.015	0.024	0.010	0.015	0.005	0.006	0.001
8.23.13.A (-)	0.44	0.11	0.47	0.028	--	0.006	0.041	0.002
8.23.13.A (+)	0.30	0.020	0.15	0.014	--	--	0.013	--

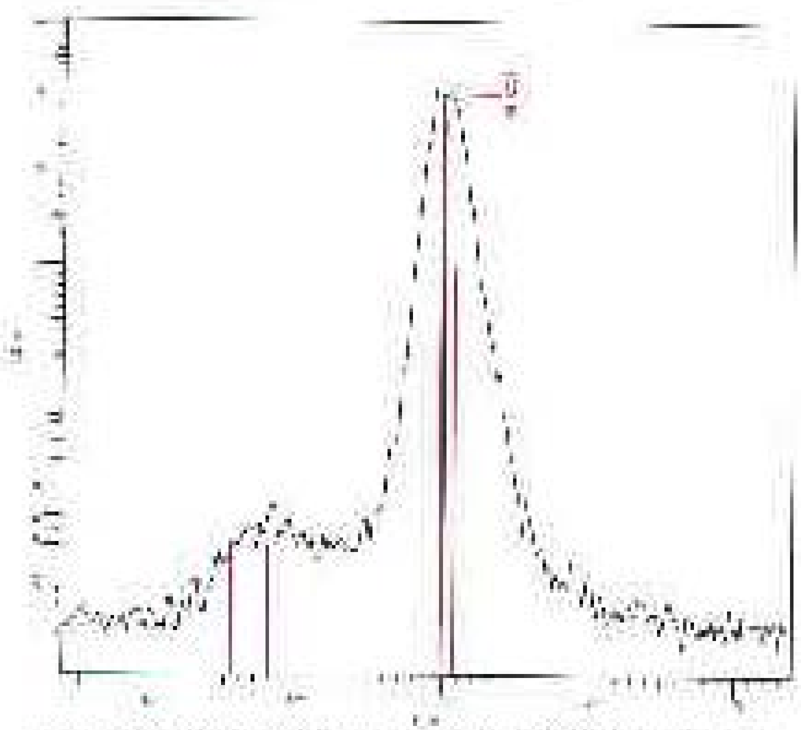

Figure 9: *Views of the main result of the report by Constellation Laboratory signed by the director [40] showing a twenty-fold increased of Silicon over background values (see Ref. [23] for details).. The engineers of Thunder Energies Corporation are currently working under Santilli's heading to enhance (but not to replace) the energy output of fossil fuels combustion in atmospheric Oxygen (www.thunder-energies.com).*

$$\rightarrow \quad Li(6, 3, 1^+, 6.0151) + \Delta E_{heat}. \qquad (3.12a)$$

$$\Delta E = 0.0016 \;\; u \approx 2.5 \times 10^{-16} \; BTU, \qquad (3.12b)$$

that verifies all hadronic laws.

Hence, one can see that a hadronic reactor with the above hadronic fuels becomes industrially relevant under the achievement of about 10^{30} ICNS per hour, that would yield the hourly production rate of about $10^9 \; BTU$.

Numerous additional ICNS can also be identified in the experimental, data accumulated by Santilli over the years, among which we merely quote from the laboratory data of refs. [22-25]

$$O(16, 8, 0^+, 15.9949) + Si(28, 14, 0^+, 29.9737) + TR \rightarrow$$

$$\rightarrow \; Ti(44, 22, 0^+ 43.9596) + \Delta E, \qquad (1.13)$$

Which is not studied by Santilli because 22-Ti-44 is unstable although with 93 years mean life.

Figure 10: *A view in the left of the small hadronic reactor with 5 kW power unit used by Santilli for the synthesis of neutroids, and a rendering in the right of the neutroid as a proton with an electron orbiting around it with partial mutual penetration in single coupling.*

Worth mentioning are also the following ICNS from Ref. [19] page 299, Eqs. (5.4.8) and Ref. [20] as the only one admitted for Hydrogen induced transmutations of the Palladium

$$H(1, 1, 1/2^+, 1.0078) + Pd(106, 46, 0^+, 105.9034 + TR \rightarrow$$

$$\to Ag(107, 47, 1/2^+, 106.9050) + Heat \quad (3.14)$$

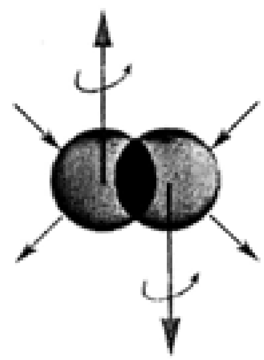

Figure 11: *In the same way as quantum mechanics cannot be exactly valid for nuclear structure, Santilli has shows that quantum chemistry cannot be exactly valid for molecular structures because the two identical valence electrons in singlet coupling must repel each other according to quantum chemistry, while the covering hadronic chemistry has indeed achieved a strongly attractive force that overcomes the Coulomb repulsion [42-44].*

Finally, an ICNS of direct relevance for Rossi's reactor [1,2] studied in details by Santilli in Refs., [19,20,21] is given by

$$H(1, 1, \frac{1^+}{2_\downarrow}, 1.0078) + Li(7, 3, \frac{3^-}{2_\uparrow}, 7.0160) + TR \to$$

$$\to 2 \times He(4, 2, 0^+, 4.0026) + \Delta E_{heat}, \quad (3.15a)$$

$$\Delta E = 2.887 \times 10^{-12} \; J, \quad (3.15b)$$

$$E_{out} = (2.88 \times 10^{-12} \; J) \times 10^{16} = 2.8 \times 10^4 J/min = 1.7 \times 10^6 J/h. \quad (3.15c)$$

One should keep in mind the opposing nuclear polarizations $Li_\uparrow$ and $H_\downarrow$ to verify the law of the conservation of the angular momentum, a feature of crucial relevance for the engineering realization of industrial relevance.

Note that the energy output (3.15c) is *industrially* significant. It is achieved by recalling that one mole of Lithium has 20^{23} nuclei, by assuming an efficiency of 10^{16} ICNS per minute, and by using energy units in Joules [21].

It should be stressed that, in the terminology of Refs. [19-21], $H(1, 1,$-$\frac{1}{2}{}^{+}_{\downarrow}, 1.0078)$ represents a *proton,* and not a Hydrogen atom, thus being equivalent to Eq. (1.1). However, the problem to be addressed for the understanding of Rossi's reactor is the use of a Hydrogen *atom,* as requested by industrial realizations., This aspect was not treated by Santilli and will be studied in Section 6.

4. SANTILLI'S SYNTHESIS OF NEUTROIDS AND NUCLEOIDS

During his systematic tests on the laboratory synthesis of the neutron from a Hydrogen gas [10-15], Santilli noted that neutrons were indeed synthesized beginning from the power of $5\ kW$ and depending on the used trigger.

In fact, by using a full hadronic reactor (see Fig. 4) with $50\ kW$ power, Santilli had to evacuate the laboratory twice because all neutron detectors entered into sonic and vibrational alarms.

At the same time, Santilli noted that, under certain conditions of low power (see the hadronic reactor of Fig. 10) and weak trigger, there was the production of "entities" that were not neutrons because they did not actuate neutron detectors. Yet, they stimulated delayed nuclear transmutations in substances away from the reactor.

From this repeated and systematic evidence, Santilli assumed that the entities were neutral and of the same size of the neutron as a condition to traverse the walls of hadronic reactors and then being absorbed by nuclei of testing materials. Consequently, the "entities" could not possibly be Mill's Hydrinos [55]

In full parallelism with Don Borghi's experiments [9], Santilli called these "entities" *neutroids* and suggested their synthesis via the reaction (see Eq. (1), Ref. [21])

$$p^{+} + e^{-} \rightarrow \tilde{n}(1,\ 0,\ 0,\ 1.008), \tag{4.1}$$

where: the value $J = 0$ is clear indication that the entities are not neu-

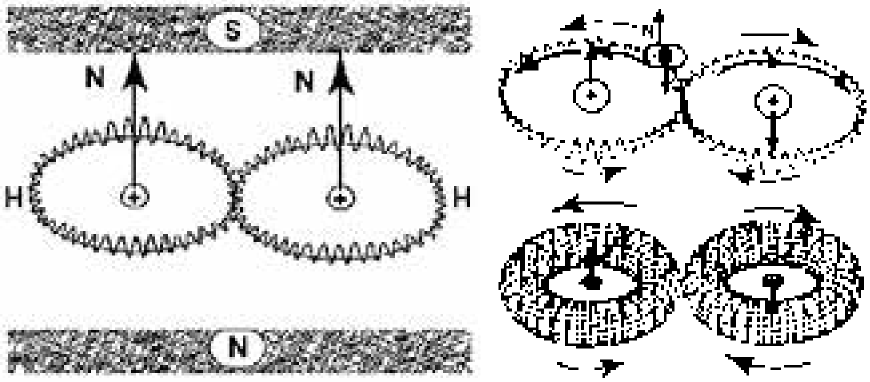

Figure 12: *In the left, we illustrate another reason establishing the impossibility for quantum chemistry to be exactly valid for molecular structures, given by the prediction from the current treatment of orbitals that all quantities are paramagnetic in dramatic disagreement with experimental evidence [42]. In the right, we illustrates how the Santilli-Shillady strong valence bond assure the diamagnetic character of the Hydrogen and water molecules [43-44].*

trons; the rest energy of the neutroids is assumed *in first approximation* as being that of the neutron in *a.m.u.*, from the known data below

$$1amu = 931.49\, MeV, m_p = 938.27\, MeV = 1.0078\, amu,$$

$$m_e = 0.511\, MeV = 0.0005\, amu, \tag{4.2a}$$

resulting in the rest energy of the neutroid

$$m_{\tilde{n}} = m_p + m_e = 1.008 amu \tag{4.3}$$

which is assumed to be that of the Hydrogen atom and *not* that of the neutron.

The understanding of this numerical value is expected to be treated in a separate paper. Hence, the value of the mass $1.008amu$ of the neutroid is merely assumed to be an upper limit.

It should be stressed to prevent misconceptions that *Santilli neutroids cannot exist under the validity of quantum mechanics since the latter theory solely admits the Hydrogen atom as historically known.*

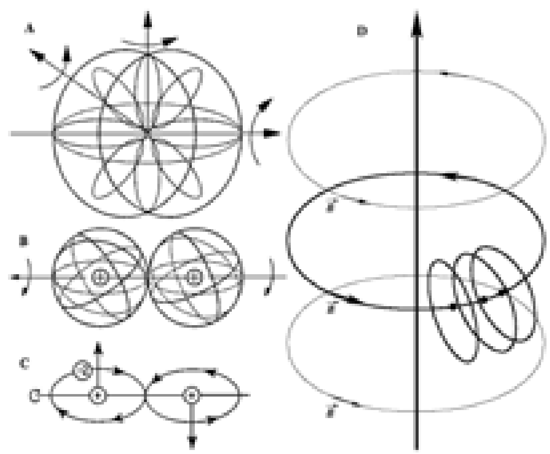

Figure 13: *An illustration from Ref. [42] of the process according to which Santilli controls the orbit (rather than orbital) of the electron in the Hydrogen atom down to the desired toroid polarization.*

In fact, Santilli showed that the neutroids were created, first of all, by the *quantum mechanical* Coulomb attraction at short distances between the proton and the electron (represented with the usual Coulomb Hamiltonian), plus a strong attraction created by a partial mutual penetration of the wavepackets of the proton and the electron in singlet coupling.

The latter attraction was proved to be much similar to that of the electron valance bond in singlet coupling which can be solely treated in a quantitative way via *hadronic mechanics* and represented with santilli isounit (see Fig. 11].

Next, Santilli assumed that the neutroids would be converted into neutrons following their absorption by ordinary nuclides. In this case, all misusing quantities are assumed to be provided by the etherino [16] according to the reaction (Eq. 9), ref. [21])

$$\tilde{n}(1,\, 0,\, 0,\, 1.008) + a \rightarrow n(1,\, 0,\, 1/2,\, 1.0015), \tag{4.4}$$

under the prohibition to use the neutrino hypothesis in order not to violate the principle of conservation of the energy as discussed in the preceding section.

Following these preliminaries, Santilli [predicted in ref. R21] (see also the general reviews [52-54]) the existence of a new class of nuclides that are generally absent in the standard *Table of Nuclides* [41] according to the following:

HYPOTHESIS 4.1 [21]: The absorption of a neutroid by tabulated nuclide generally produces new, unstable, non-tabulated nuclide called "nucleoid" according to the reaction

$$N(A,\, Z,\, J,\, M) + \tilde{n}(1,\, 0,\, 0,\, 1.008) \rightarrow \tilde{N}(A+1,\, Z,\, J,\, M+1.006). \quad (4.5)$$

It should be stressed that *once neutroids are absorbed by nuclei, there is no need that they are turned into neutrons. As a matter of fact, the instability of nucleoids is due precisely to the disintegration of neutroids when within a nuclear structure.*

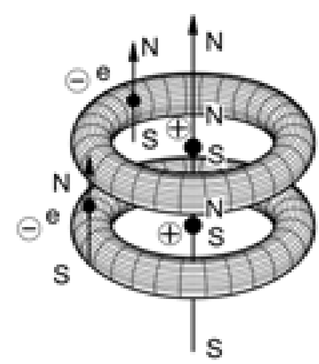

Figure 14: *In Santilli's view, an additional reason for the insufficient efficiency of various nuclear fusions at low energy is their lack of engineering realization of means for the systematic and controlled exposure of nuclei as an evident necessary prerequisite for the fusions themselves. Santilli constructed decades of research to solve this problem, including the construction of hadronic chemistry and the new chemical species of magnecules (here depicted) to achieve a controlled exposure of nuclei, as well as their proper spin alignment [42].*

The understanding of the implications of Santilli's studies to enhance the energy output of Rossi's and other reactors requires the quotation of the following nuclear reactions of Ref. [21], Eqs. (3) to [9].

Firstly, Santilli indicates the following possible nuclear reaction for one of the activated substances in Don Borghi's tests

$$\begin{aligned} &\mathrm{Au}(197,\ 79,\ 3/2,\ 196.966) + \tilde{n}(1,\ 0,\ 0,\ 1.008) + a \rightarrow \\ &\qquad \rightarrow \mathrm{Au}(198,\ 79,\ 2,\ 197.972), \end{aligned} \tag{4.6}$$

thus recovering conventional activation processes repeatedly measured in Don Borghi's experiment [9].

By comparison, the application of the above assumption to the steel casing of Don Borghi klystron would yield the less probable transmutation

$$\mathrm{Fe}(57,\ 26,\ 1/2,\ 56.935) + \tilde{n}(1,\ 0,\ 0,\ 1.008) + a \rightarrow \mathrm{Fe}'(58,\ 26,\ 1,\ 57.941), \tag{4.7}$$

Needless to say, the anomalous nuclide $\mathrm{Fe}'(58,\ 26,\ 1,\ 57.941)$ is expected to be highly unstable and to decay in a variety of possible modes, although they do not appear to provide the source of neutrons necessary to represent Don Borghi data.

This excludes that the neutrons in Don Borghi experiment were synthesized in the walls of his klystron and confirms that the neutrons were synthesized by the activating substances themselves.

Hypothesis (4.5) allows an interpretation of some of Santilli's detections, with the understanding that the anomalous behavior of the detectors, such as the delayed neutron counts, requires special studies and perhaps the existence of additional event not clearly manifested in Don Borghi's tests.

To initiate the study, the 2007 paper [21] considers the possible reaction

$$H(1,\ 1,\ 1/2,\ 1.008) + \tilde{n}(1,\ 0,\ 0,\ 1.008) + a \rightarrow H(2,\ 1,\ 1,\ 2.014), \tag{4.8}$$

namely, we have the prediction that the coupling of a neutroid to a proton plus an adequate trigger, creates the ordinary Deuteron.

Next, Santilli considers the polycarbonate of Klystron I wall containing about 75% Carbon, for which we have

$$C(12,\ 6,\ 0,\ 12.000) + \tilde{n}(1,\ 0,\ 0,\ 1.008) + a \rightarrow C'(13,\ 6,\ 1/2,\ 13.006) \rightarrow$$

$$\rightarrow C\,(13,\ 6,\ 1/2,\ 13.003) + \gamma, \tag{4.9}$$

thus excluding the Carbon of the polycarbonate being a source of the detected neutrons. Said polycarbonate contains about 18.88% Oxygen for which we have the reaction yielding an unknown nucleoid

$$O(16,\ 8,\ 0,\ 16.000) + \tilde{n}(1,\ 0,\ 0,\ 1.008) + a \rightarrow \tilde{\mathrm{A}}(17,\ 8,\ 1/2,\ 17.006), \tag{4.10}$$

because the known nuclide is $O(17,\ 8,\ 5/2,\ 16.999)$. The latter reaction too is not expected to provide the neutron counts detected by Santilli. In conclusion, it does not appear that the detected neutrons are synthesized in the interior of the Klystron I or by its walls.

An additional important transmutation of Ref. [21] is given by

$$He(3,\ 2,\ 1/2,\ 3.016) + \tilde{n}(1,\ 0,\ 0,\ 1.008) + a \rightarrow$$

$$\rightarrow He'(4,\ 2,\ 1,\ 4.023) + \mathrm{EC} \rightarrow\ He\,(4,\ 2,\ 0,\ 4.002) + \gamma, \tag{4.11}$$

in which EC stands for electron capture and, as one can see, the detection of the neutroids is anomalous if any.

Next, for the case of B-activated detectors we have the reactions

$$B(10,\ 5,\ 3,\ 10.012) + \tilde{n}(1,\ 0,\ 0,\ 1.008) + a \rightarrow B'(11,\ 5,\ 5/2,\ 11.018) \rightarrow$$

$$\rightarrow C(11,\ 6,\ 3/2,\ 11.011) + e^- + \gamma, \tag{4.12}$$

that do not appear to behave normally under a flux of neutroids.

Finally, we review Santilli's ICNS of direct relevance for Rossi's and other reactors studied in Ref. [21]

$$Li(7,\ 3,\ 3/2,\ 7.016) + \tilde{n}(1,\ 0,\ 0,\ 1.008) + a \rightarrow Li(8,\ 3,\ 2,\ 8.022) \rightarrow$$

$$\rightarrow Be(8,\ 4,\ 0,\ 8.005) + e^- \rightarrow 2\alpha, \tag{4.13}$$

and the alternative formulation

$$Li(7,\ 3,\ 3/2,\ 7.016) + \tilde{n}(1,\ 0,\ 0,\ 1.008) \rightarrow$$

$$\rightarrow \tilde{Li}(8,\ 3,\ 3/2,\ 8.022) + e^- \rightarrow Li(8,\ 3,\ 2,\ 8.022) \rightarrow$$

$$\rightarrow Be(8,\ 4,\ 0,\ 8.005) \rightarrow 2\alpha, \qquad (5/13)$$

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Gas	Molecular Weight (g/mol or amu/molecule)
MagneGas™ [Feed]	15.60
MagneHydrogen™ [Product]	15.06
Ordinary Hydrogen [for comparis	2.016

SPECTRALAB

6349 82nd Avenue North
Pinellas Park, Florida 33781
Phone: (727) 545-2297 • Fax (727) 547-8024

Component	Gas
Hydrogen	99.2
Carbon monoxide	None detected
Carbon dioxide	None detected
Methane	0.78
Ethane	None detected
Ethene (ethylene)	None detected
Ethyne (acetylene)	None detected

Figure 15: *A reproduction of the main results of tests signed by laboratory directors showing Santilli's production of a species of Hydrogen that he called MagneHydrogen (with chemical symbol MH)which is 99.8% pure Hydrogen, yet its specific weight is about seven times that of Hydrogen [48-51]. In the author's view, Santilli's MagneHydrogen offers realistic possibilities of enhancing the energy output of nuclear transmutations based on the Hydrogen.*

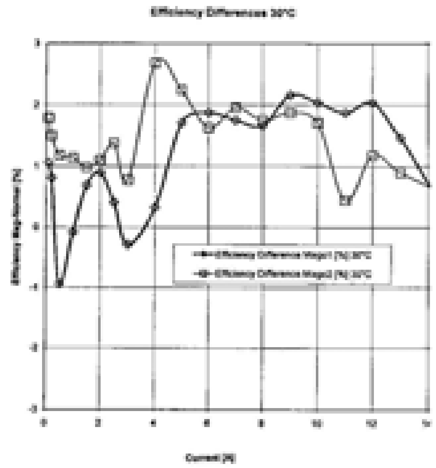

Figure 16: *A reproduction of data from Ref. [45] showing the clear increase of the efficiency of a fuel cell when using Santilli MagneHydrogen with minimal increase of specific weight and conventional Oxygen.*

Again, Santilli used the above transmutations for a quantitative interpretation of the delayed activation of the Lithium in neutron detectors exposed to the test on the synthesis of the neutron at low energy.

The relevance of the above transmutations for Rossi's and other reactors will be studied in Section 6.

5. SANTILLI NEW CHEMICAL SPECIES OF MAGNECULES AND THEIR IMPLICATIONS FOR NUCLEAR SYNTHESES.

Santilli has stated repeatedly that, without a systematic control of the exposure of nuclei and of the proper coupling of nuclear spins he had no interest in inspecting low energy nuclear fusions because they can only exist at random, thus having no industrial value.

Hence, Santilli devoted decades to the achievement of industrial mean for the achievement of hadronic Laws 3.1 and 3.2. For this, he first achieved the covering of quantum chemistry under the name of *hadronic chemistry*

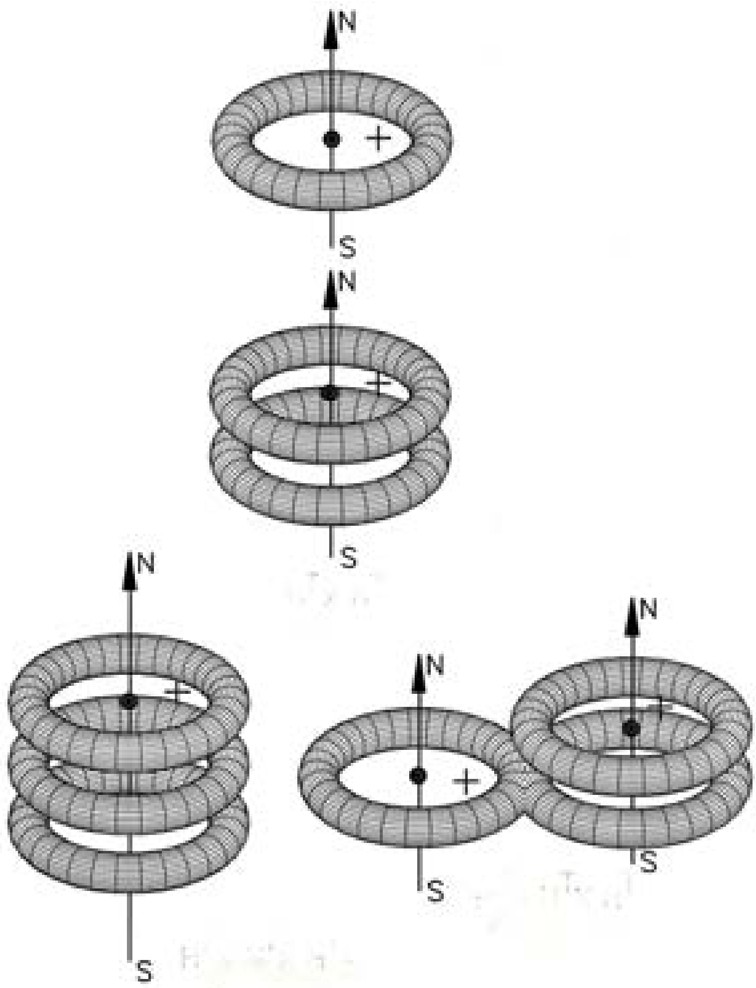

Figure 17: *An artist rendering of the structure of Santilli magnecules in MagneHydrogen as a combination of Hydrogen atoms and molecule under the magnecular bond.*

with a comprehensive presentation available in Refs. [42].

Subsequently, in collaboration with D. Shillady Professor of Chemistry at Virginia Commonwealth University, Santilli achieved the first know quantitative representation of the *attraction* in valence, today known as *Santilli-Shillady strong valence coupling.* This is the first known representation of the singlet coupling of two identical electrons via a hadronic *equation* (rather than nomenclatures) that produces strong attractive non-Hamiltonian forces capable to overcoming the Coulomb repulsion between the two identical electron, and such an attractive force permits the first known numerically exact and time invariant representation of the experimental data of the Hydrogen and water molecules from first axiom,as without the often-adulterations to adapt a preferred theories to reality [43,44].

Following, and only following a deeper understanding of *molecules,* Santilli proposed the new chemical species of *magnecules* consisting of individual atoms (such as H, C, O, etc.), dimer (such as CH, CO, etc.) and ordinary molecules 9such as H2 = H-H, H2O = H-O-H, etc.) under a new bond created by opposing polarities the toroidal polarization of the orbitals of at least some of the peripheral electrons [42] (see Refs. [49-51] for some of the independent experimental verifications).

Santilli created a new U. S. publicly traded company for the *industrial* development of fuels with a magnecular structure *Magnegas Corporation* with stock symbol MNGA (www.magnegas.com), that in his capacity as Chief Scientist and Chairman of Board of Directors, he brought all the way to have the stock at NASDAQ, after which he left the company because of the achievement of his goals, to dedicate himself entirely to nuclear syntheses without harmful radiations or waste.

Among a large literature in this new field alone, it is important for serious studies in controlled fusions to known the engineering means that Santilli used for the exposure of the nuclei, essentially given DC electric discharge that are described in Ref. [42] in the part Santilli is authorized to disclose to the public.

We merely mention here the systematic experimental verifications of the new species of Santilli's magnecules, with particular reference to the new species of MagneHydrogen with chemical symbol MH which is given by a collection of Hydrogen atoms and molecules with toroidal polarization of their orbits (rather than orbitals), so that they can be stacked, depending on the engineering procedure, all the way to achieve a multiple of the specific weight of conventional Hydrogen.

It should be noted that Santilli's magnecular bond is indeed stable at ordinary temperatures, but it is *weaker than the valence bond* by central conception for various reasons, firstly, to allow a full combustion and, secondly, to allow the absorption of individual Hydrogen atoms by ordinary substances.

In view of these rather unusual features, non-experts in the field should be aware that *any and all theoretical and experimental treatment of molecules have been proved to be completely inapplicable to the new species of magnecules,* if not dramatically misleading [42-51].

6. INTERPRETATION OF THE EXCESS ENERGY OF ROSSI'S REACTORS VIA SANTILLI'S NEUTROIDS AND NUCLEOIDS.

In this paper, we point out, apparently for the first time, that Santilli's neutroids and nucleoids can achieve a quantitative representation of transmutation (1.1), (1.2) in Rossi's reactor according to the reaction studied in Ref. [19-21] (see also Eqs. (3.15 a,b) of Section 3 and (3.13),(3.14) of Section 4)

$$\begin{aligned}
&\mathcal{H}(\mathbf{1},\ \mathbf{1},\ \mathbf{1/2},\ \mathbf{1.008}) + \mathbf{Li}(\mathbf{7},\ \mathbf{3},\ \mathbf{3/2},\ \mathbf{7.016}) + \mathbf{TR} \rightarrow \\
&\rightarrow \mathbf{Li}(\mathbf{7},\ \mathbf{3},\ \mathbf{3/2},\ \mathbf{7.016}) + \tilde{\mathbf{n}}(\mathbf{1},\ \mathbf{0},\ \mathbf{0},\ \mathbf{1.008}) \rightarrow \\
&\rightarrow \tilde{\mathbf{Li}}(\mathbf{8},\ \mathbf{3},\ \mathbf{3/2}, \mathbf{8.0225}) \rightarrow \\
&\rightarrow \tilde{\mathbf{Be}}(\mathbf{8},\ \mathbf{4},\ \mathbf{2}_{\uparrow},\ \mathbf{8.0225}) + \beta^{-}_{\downarrow} \rightarrow \\
&\rightarrow \mathbf{2He}(\mathbf{4},\ \mathbf{0},\ \mathbf{1},\ \mathbf{4.0026}) + \mathbf{\Delta E}
\end{aligned} \tag{6.1}$$

where TR represents the mechanisms in Rossi's reactor that trigger the transmutation.

An important aspect is that the symbol $H(1,\ 1,\ 1/2,\ 1.008)$ used in the preceding sections represents the *proton* in accordance with the notations of the Table of Nuclides [41]. By contrast, the symbol $\mathcal{H}(1,\ 1,\ 1/2,\ 1.008)$ used in Eqs. (6.1) represents the *Hydrogen atom.* Hence, Eqs. (6.1) is one of the first cases known to the author in which *atoms* enter into a *nuclear* reaction.

The last step in reactions (6.1) releases a large amount of energy, as we can easily see assuming $1\ Amu = 931.49\ MeV$ and accounting for the mass-defect between the two ^4He nuclei and ^8Li one, by therefore obtaining the value

$$\Delta E \approx 16.1\ MeV \tag{6.2}$$

in agreement with Eqs. (3.15a), (3,15b) that however refer to the entire process from Hydrogen and Lithium to Helium. Owing to the energy of a neutroid, as a spin zero bound state of a proton and an electron, certainly ranges between the proton and neutron ones (although its exact determination is out of the intent of this paper), we conservatively assume to detract $0.782\ MeV$, leading to a global reaction release

$$\Delta E >\approx 15.3\ MeV\ per\ ^7Li\ nucleus \tag{6.3}$$

To verify the internal coherence of the hypothesis (6.1), let us control the spins of both members of the reaction. As it can be seen , the null spin contribution of the neutroid correctly permits to reach the 2 spin of ^8Li by a $\beta-$ antiparallel spin emission.

It should be indicated that the inner configuration of Rossi's E-Cat reactor is unknown, together with inner wiring and electric feeding waveform. Consequently, we may only assume the presence of the magnetic field or other means necessary to trigger the transition from the Hydrogen atom to Santilli's neutroid. Needless to say, a considerable additional theoretical and experimental work is needed to achieve a final resolution of the origin of Rossi's excess energy, as well as, perhaps more importantly, its enhancement (see next section).

Similarly, the trigger used by Santilli to achieve Intermediate Controlled Nuclear Syntheses as well as to synthesize neutroid and nucleoids is equally undisclosed and controlled by the U. S. publicly traded company Thunder Energies Corporation. Additional corporate secrets exist for the formation of Santilli magnecules in a form usable for transmutations of type (6.1). Therefore, until these corporate secrets are released, academia is expected to have difficulties in even formulating serious independent studies, let alone conducting them.

As a final comment, we would note that mechanism (6.1) may explain the well known astrophysics problem of $Cosmological\ ^7Li\ Depletion$ [56], a problem also recalled in Ref. [2]. In a way similar to reaction (6.1), the ^{58}Ni can experience the interaction with a neutroid according to:

$$
\begin{gathered}
{}^{1}H + trigger \rightarrow \tilde{n} \\
\tilde{n} +^{58} Ni + space\ contribution \rightarrow^{59} Ni \rightarrow^{59} Cu + \beta - +Energy \\
\\
with\ {}^{59}Cu\ decaying\ back\ to\ {}^{59}Ni\ via\ \beta + emission,\ and\ the\ chain: \\
\\
\tilde{n} +^{59} Ni \rightarrow 60Ni...and\ so\ on,\ until\ {}^{62}Ni\ is\ reached.
\end{gathered}
\tag{6.4}
$$

with the energy release according to Ref. [2],

$$\triangle \mathbf{E} \approx \mathbf{3.4\ MeV\ per\ Ni\ nucleus\ per\ step}. \tag{6.5}$$

Then, it is well known that neutrons are synthesized from Hydrogen atoms in the *interior* of stars. However, in the *external* chromosphere of a star, the physical conditions appear more suitable for the synthesis of Santilli neutroids, rather than neutrons, particularly in the regions affected by flares whose electric and magnetic fields are known to have such intensity to meet Santilli's requirements.

Once synthesized, neutroids are expected to be easily trapped by nuclei due to their neutral and spin zero characters, thus rendering plausible astrophysical reactions of type (6.4) with stimulated decay into ordinary nuclei in which the proton is maintained by nuclei and the electron is released via a β^- emission.

Consequently, it appears that Santilli's neutroids and nucleoids complemented with hypothesis (6.1) can also provide a quantitative explanation of the Cosmological ^{7}Li Depletion [56], in a way parallel to Santilli's experimental verification on Earth of the IsoRedShift (redshift of light passing through a cold gas without relative motion), with the consequential lack of expansion of the universe and related conjectures [57].

7. CONCLUDING REMARKS

It is time to admit, as a *prerequisite* for basic advances in new clean energies, that quantum mechanics cannot be exactly valid for nuclear structures or processes and that among all possible generalizations providing

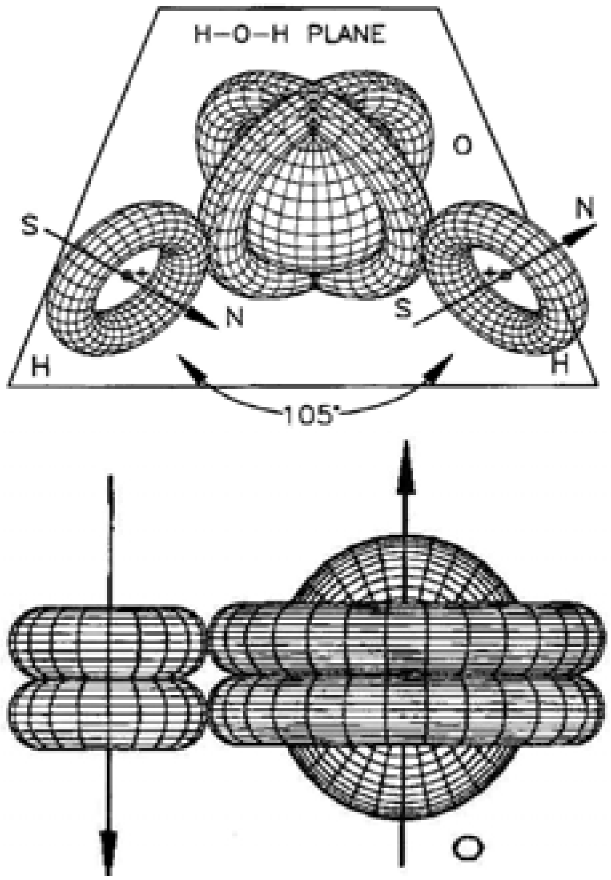

Figure 18: *A suggestive conversion from Ref. [47] of liquid water (top)into a gaseous and combustible form Santilli calls HHO (bottom). The conversion is achieved via engineering means to remove the* 105^0 *in between the two* $O - H$ *dimers, in which case the l.h.s. form is turned into the r.h.s. one with chemical structure* $(H \times H) - O$*, where* $-$ *denotes valence bond and* $\times$ *denotes magnecular bond. The new species* $(H \times H) - O$ *is clearly gaseous, because of the lack of the covalence bonds for the liquid state, besides the fact that the Hydrogen is much lighter than the Oxygen molecule. Also, the structure* $(H \times H) - O$ *is unstable, thus decaying into a stochiometric mixture of Santilli MagneHydrogen* $H \times H$ *and Oxygen* $O - O$ *that instantly melts bricks without any need for oxygen, thus confirming the special feature of Santilli Magnehydrogen.*

a deeper understanding of nuclear physics, Santilli's hadronic mechanics is the most axiomatically mature and experimentally verified to date, besides being universal for the invariant treatment of extended particles at short mutual distances with linear and non-linear, local and nonlocal and Hamiltonian as well as non-hamiltonian interactions.

Once, and only once, the inapplicability of quantum mechanics for the excess energy of Rossi's reactor is admitted, then the door is open for its quantitative representation as well as the initiation of the laborious process of increasing its energy output.

In this paper, we have presented a rudimentary outline of the rather vast mathematical, theoretical and experimental studies by R. M. Santilli in nuclear physics and have shown, apparently for the first time, that Santilli's nuclear physics does permit indeed a quantitative interpretation of the excess energy of Rossi's reactor as originating from the absorption of a Santilli neutroid by Lithium or other nuclides and their conversion into Santilli unstable nucleoids with esoenergetic spontaneous decays to stable nuclides.

Once this quantitative interpretation is independently confirmed, and following the disclosure of corporate secrets indicated in the preceding section, hadronic physics and chemistry offer realistic possibilities of enhancing the energy output of Rossi's (as well as other) reactors, as it is the case for the use in Hydrogen based reactors of Santilli MagneHydrogen, since the latter has been conceived for the conversion of a magnetically polarized (individual) Hydrogen atom to a nucleoid in a way much easier than the conversion of a conventional Hydrogen atom, besides having a specific weight which is a multiple that of Hydrogen.

In the final analysis, Santilli's hadronic reactors with excess energy output definitely superior to any other currently available nuclear process (Fig. 9) are currently under *industrial* development to enhance (but not to replace) the environmental quality and energy production of fossil fuel combustion. This establishes that hadronic mathematics, physics and chemistry [52] have proved their capability to provide specific laws and guidelines for the actual engineering realization of the needed solutions, that researchers in the field can only ignore at their own disadvantage.

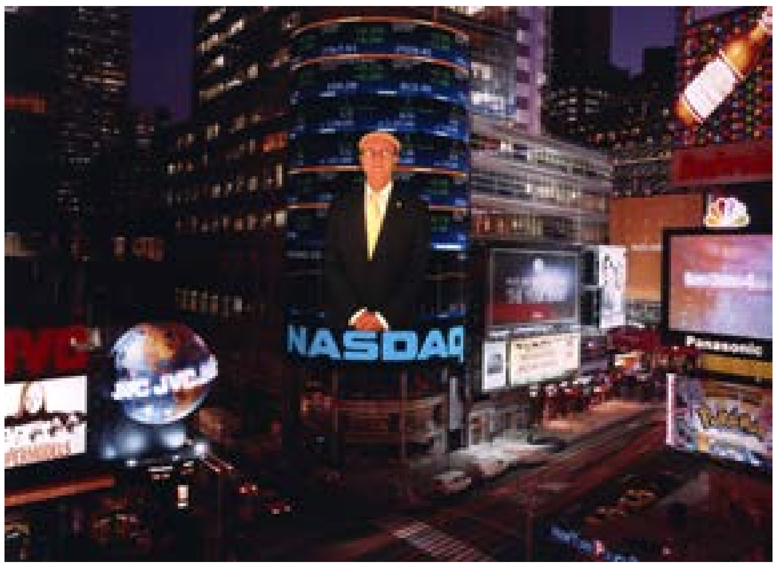

Figure 19: *Santilli has received several honors for his advances in mathematics, physics and chemistry (see the CV http://www.world-lecture-series.org/santilli-cv). However, the recognition particularly dear to Santilli is the above picture some ten stories tall in Time Square, New York, by the NASDAQ Stock Exchange in recognition of his pioneering research in chemistry that lead to the discovery of the new species of magnecules and the new fuels with magnecular structure produced and sold world wide by the U.S. publicly traded company Magnegas Corporation with stock symbol MNGA.*

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