

Confirmation of the laboratory synthesis of neutrons from a hydrogen gas

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Abstract. We review theoretical studies on the synthesis of the neutron from the hydrogen atom in the core of stars; we outline tests conducted in the 1960s on the laboratory synthesis of the neutron by C. Borghi and his collaborators; we outline the confirmatory tests conducted in the 1990s by R.M. Santilli; and we present new tests apparently confirming that neutrons can be synthesized in laboratory from a hydrogen gas.

Keywords: Neutron, hydrogen, pseudoprotton

1. Introduction

1.1. Historical notes

The synthesis of the neutron from the hydrogen atom inside stars was proposed in 1920 by H. Rutherford [1] and experimentally established in 1932 by Chadwick [2], resulting in the historical synthesis



Systematic theoretical studies on the above synthesis were conducted by R.M. Santilli at the non-relativistic and relativistic levels [3–6]. The major difficulty originated from the fact that, from the known data

$$E_p = 938.272 \text{ MeV}, \quad E_e = 0.511 \text{ MeV}, \quad E_n = 939.565 \text{ MeV}, \quad (2a)$$

$$E_n - (E_p + E_e) = 0.782 \text{ MeV} > 0, \quad (2b)$$

the rest energy of the neutron is 0.782 MeV *bigger* than the sum of the rest energies of the proton and the electron, thus requiring a “positive binding energy” and resulting in a “mass excess” that are anathema for quantum mechanics, since the sole consistent bound states predicted by quantum mechanics are those characterized by “negative binding energies” that results the well known “mass defect”.

Santilli solved the problem, firstly, via the construction of a new mathematics today known as *isomathematics*, and then its use for the construction of a non-unitary covering of quantum mechanics for the invariant description of extended particles moving within physical media under the name of *hadronic*

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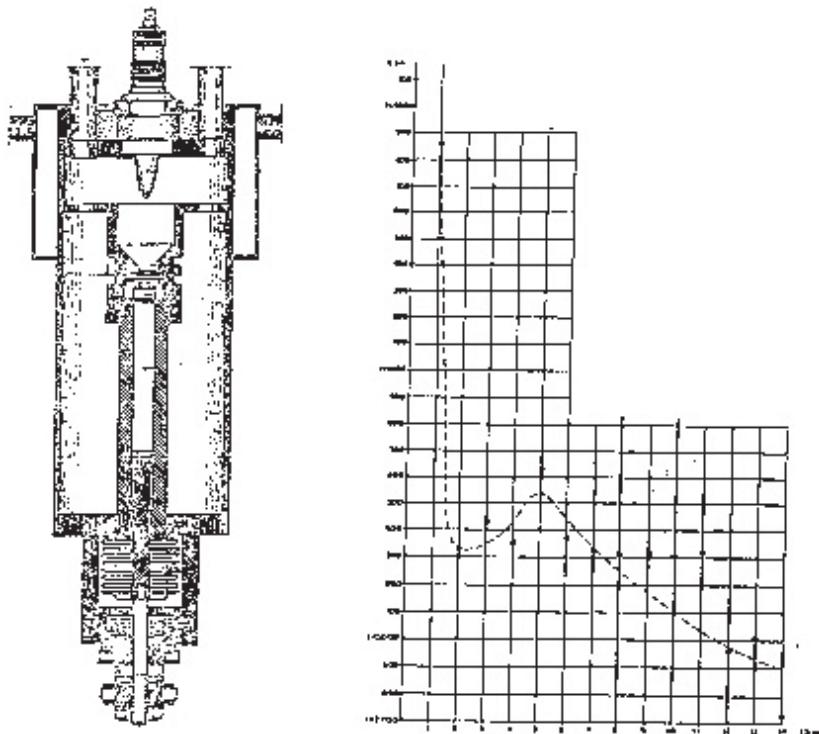


Fig. 1. A view of the klystron used by Don Borghi's in tests [8] and some of the nuclear transmutations caused by a neutron flux that could only originate from its interior.

mechanics (see Refs. [7] for a comprehensive presentation). These studies allowed the exact and time invariant representation of all characteristics of the neutron in synthesis (1) at both non-relativistic and relativistic levels [3–6].

The first laboratory synthesis of the neutron according to reaction (1) was done in the late 1960s by the Italian priest-physicist Don Carlo Borghi and his associates at the University of Recife in Brazil [8]. In the late 1990s, R.M. Santilli conducted systematic tests that apparently confirmed the laboratory synthesis of the neutron from a hydrogen gas [9], although via principles and apparatus different than those used by Don Borghi. A general presentation is available in Vol. IV of Refs. [7]; an additional presentation with all detector scans of tests [9] are available in website [10]; an independent review is provided in Ref. [11]; and lectures on the mathematical, theoretical and experimental aspects of the neutron synthesis are available from archive [12].

1.2. *Don Borghi's laboratory synthesis of the neutron*

Don Borghi's experiment [8] was conducted via a cylindrical metallic chamber (called "klystron") filled up with a hydrogen gas at a fraction of 1 bar pressure, which gas was traversed by an electric arc with about 500 V and 10 mA, as well as by microwaves with 10^{10} s^{-1} frequency (see Fig. 1).

According to Don Borghi conception, the electric arc was intended to ionize the hydrogen gas and keep it in a partially ionized form, while its synthesis into neutrons was triggered by microwaves.

The experimentalists placed in the exterior of the klystron various materials suitable for activation when subjected to a neutron flux (such as gold, silver and other substances). Following exposures of the

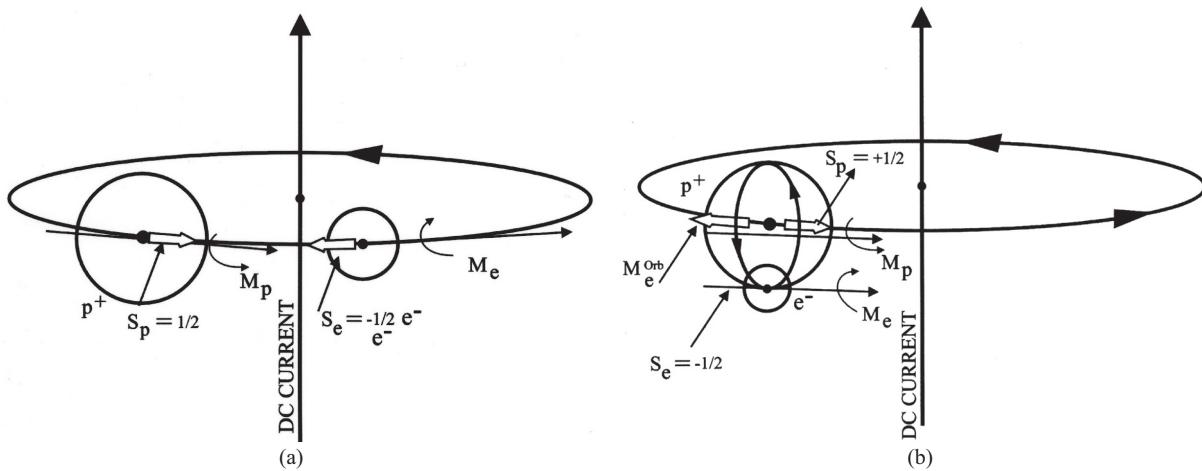


Fig. 2. A schematic view in the left of the tangential alignment of protons and electrons along the tangent to a magnetic force line (Fig. 2a), and a view in the right of the compression of the electron against the proton caused by opposing electric and magnetic polarities (Fig. 2b).

latter material to test runs of the order of days, the experimentalists reported nuclear transmutations of the external material due to an apparent neutron flux that could only originate from the interior of the klystron. Said nuclear transmutations were also confirmed by beta emissions not present in the original material.

Note that tests [8] made no claim of direct detection of neutrons, and only claimed the detection of clear nuclear transmutations caused by a neutron flux (see Kadeisvili review [11] for details).

1.3. Santilli's laboratory synthesis of the neutron

Theoretical studies [3–6] suggested that microwaves are insufficient to trigger the “compression of the electron inside the proton” according to Rutherford [1]. Therefore, Santilli attempted the laboratory synthesis of the neutron from a hydrogen gas via the sole use of a sufficiently powerful DC electric arc without any use of microwaves [9].

In essence, Santilli argued that a DC electric arc with 50 A at 120 V ionizes hydrogen atoms and axially aligns the resulting protons and electrons along tangents to a local magnetic field line (Fig. 2a) with a spin coupling suitable for their bond (called *axial triplet coupling*). Under a sufficiently strong magnetic field, opposing charges and dipole moments, as well as additional features called the trigger (TR), compress the electron inside the proton (Fig. 2b), at which point the synthesis of the neutron is unavoidable [4–6]. Santilli also verified that a DC electric arc with a minimum of 5 kVA can supply 0.782 MeV missing in the neutron synthesis according to data (2) in order to verify the principle of conservation of the energy (see refs. [3–7] for details).

With reference to Fig. 3a, the first experimental set up of tests [9], called *hadronic reactors* (because conceived according to the laws of hadronic mechanics) comprised a vertical cylindrical vessel of 6" outside diameter and 15" in length built in translucent PVC containing a hydrogen gas at about 15 psi which gas is exposed to a DC electric arc powered by a 5 kVA AC-DC converter, the arc occurring through a gap of about 1/16" between 1/4" cylindrical tungsten electrodes axially aligned in the interior of the reactor.



Fig. 3. A picture in the left of the first reactor in translucent PCV used in tests [9] with the hydrogen gas at 15 psi (Fig. 3a), and a view in the right of the second reactor built with schedule 40 steel used in tests [9] with the hydrogen gas at 100 psi.

The reactor was built in translucent PVC to allow the visual verification of an actual existence of an arc in the interior of the reactor through the gap of the electrodes because of the possibility of a short under which there is full power absorption but no neutron can be synthesized.

A second reactor used in tests [9] comprised a pressure resistant, schedule 40, horizontal metal vessel of 12" outside diameter and 24" length containing hydrogen at 100 psi exposed to an internal DC electric arc powered by a 50 kVA AC-DC converter, said arc occurring through a gap of about 1/8" between 1/2" cylindrical tungsten electrodes also axially located in the interior of the reactor (Fig. 3b).

Both the first and second reactor of tests [9] included means for the external control of the internal gap between the electrodes. After flushing out the atmosphere in the interior of the reactor via a pure hydrogen gas, and after filling up the reactor with pure hydrogen at the indicated pressures, operations were initiated under short with the electrodes in contact of each other, and then the electrodes were manually separated to such a gap allowing a stable arc. This procedures was needed because the low voltage of the DC (of the order of 20 V) power source did not allow the initiation of the arc under a pre-set gap.

The radiation detectors used by Santilli consisted of [9]:

- 1) A photon-neutron detector model PM1703GN manufactured by Polimaster, Inc., in Russia, with sonic and vibration alarms as well as memory for printouts, with the photon channel activated by CsI and the neutron channel activated by LiI;
- 2) A photon-neutron detector SAM 935 manufactured by Berkeley Nucleonics, Inc., in California, with the photon channel activated by NaI and the neutron channel activated by He-3 also equipped with sonic alarm and memory for printouts of all counts;
- 3) A BF-3 activated neutron detector model 12-4 manufactured by Ludlum Measurements, Inc., New Jersey, without counts memory for printouts;
- 4) An alpha, beta, gamma and X-ray detector model 907-palmRAD manufactured by Berkeley Nucleonics, Inc.; and
- 5) Various material suitable for nuclear transmutations.

A detailed documentation of the detections during tests [9] is available in Refs. [13] for tests with the first reactor operating with 5 kVA electric power and the hydrogen gas at 15 psi. The primary printouts

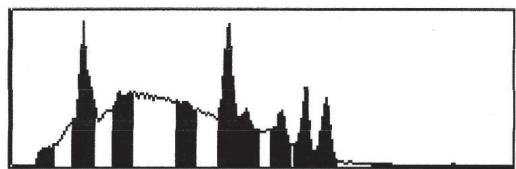


Fig. 4. A picture on the left from documentation [13b] of the continuous neutron alarms by the LiI activated polimaster during tests [9] (Fig. 4a), and the view in the right from documentation [13a] of the sole detection of photons by the He-3 activated SAM 935, suggesting the synthesis of thermal neutrons that, as such, do not have sufficient energy to activate the He-3.

of the LiI activated Polimaster during said tests are available in the website [13]. The printouts of the joint detections via the He-3 activated SAM 935 are available in website [13]. Samples of the two groups of scans are reproduced in Figs 4a and 4b, respectively.

As one can see, while the LiI activated Polimaster showed continuous sonic and vibrational alarms (that required the evacuation twice of the laboratory for safety), the He-3 activated SAM 935 only detected photons without any appreciable neutron counts. This disparity was assumed to be evidence that Santilli's reactor operating with 5 kVA power and the hydrogen gas at 15 psi solely produces *thermal neutrons* with energy expected to be less than 1 MeV.

It should be indicated that no record exists for neutron detections during tests [9] with the second reactor operating with 50 kVA and the hydrogen gas at 100 psi. This is due to the excessive violence of the radiations immediately following the activation of the arc, that required the immediate halting of the tests with the impossibility of achieving meaningful counts.

It should be finally indicated that, when run under minimal conditions of power and hydrogen density, both tests [8,9] detected an anomalous synthesis of the hydrogen into a neutral particle with essentially

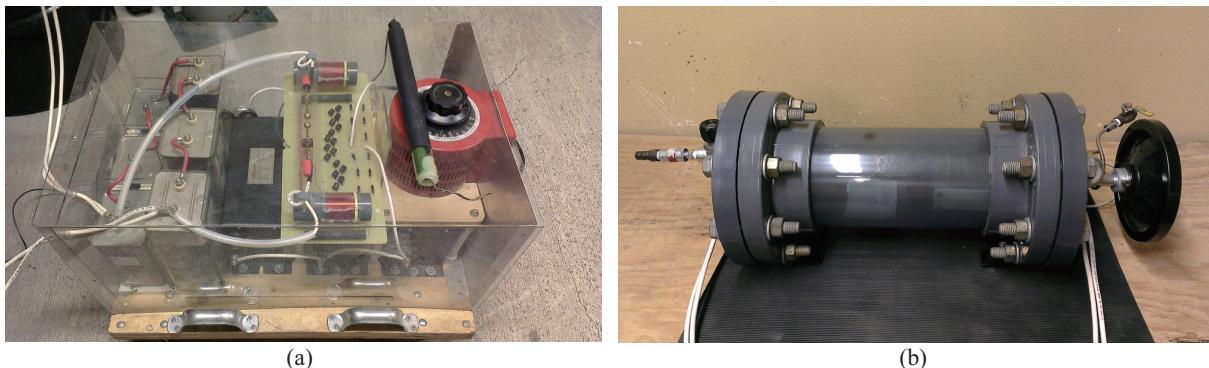


Fig. 5. A picture in the left of the high voltage DC power unit used in our tests (Fig. 5a), and a picture in the right of the hadronic reactor (Fig. 5b).

the same characteristics of the neutron except for spin 0 called *neutroids* that, in the event confirmed, would imply the existence of a new class of nuclides called *nucleoids*.

2. Confirmation of the laboratory synthesis of thermal neutrons

2.1. Experimental equipment

As indicated in Section 1.3, the experimental set up of tests [9] requires the initiation of the operation via a manual activation of an electric short between the electrodes and their separation to such a gap to have a stable arc, which initiation implies the exposure of the experimentalists to a neutron flux.

In order to prevent such an exposure, we selected for power unit of our tests a high voltage pulsing DC power source manufactured per our specifications by Information Unlimited, of Amherst, New Hampshire, with a maximal absorption of 5 kVA at 15 kV from a 120 V single phase electric source; said power source was equipped with a transformer with turn ratio 125:1, and a bank of six capacitors each having 4.5 kV, 30 μ F electrolytic capacitance connected in series so as to deliver a maximal discharge with 500 J at 15 kV and at a frequency of about 1 Hz. Said high voltage DC power source was additionally equipped with a rotating control wheel permitting the selection of the power from a minimum of about 1 kVA to a maximum of 5 kVA (Fig. 5a). The high voltage character of the DC discharge allowed us to preset the gap between the electrodes and operate all tests at a large distance.

As it was the case for the first reactor of tests [9], the pressure reactor of our tests was built in translucent Class 150 PVC with Class 150 PVC flanges tested to hold a hydrogen gas up to 100 psi; said reactor housed in its interior axially aligned tungsten electrodes of 1/4" diameter and 3" length, one of the two electrodes being fastened to a 3/8–16 threaded rod mechanism for the adjustment of its position with respect to the second electrode that was stationary; said adjusting mechanism being operated by an external PVC wheel which produces 1/16" gap per complete rotation; said reactor was completed by: inlet and outlet pipes to flush out the interior atmosphere with a hydrogen gas, pressure and temperature gauges, and valves for the filling up of the interior chamber with hydrogen gas at the desired pressure (Fig. 5b).

The above described reactor was connected to the high voltage pulsing power unit via 12 Ga. 40 kV stranded wire, two wires per electrode. The experimental set up was finally completed by a high pressure cylinder containing a hydrogen gas at 3,000 psi certified by the supplier to be ultra pure, and various



Fig. 6. A picture of the entire experimental set up used in our tests.

radiation detectors of which the most important one was selected as being a SAM 940 manufactured by Berkeley Nucleonics of Berkeley, California. SAM 940 was selected because it is activated not only by He-3 as it is the case of SAM 935 used in tests [8], but also of the all important LiI activation for the detection of thermal neutrons that was absent for SAM 935. A pictorial view of the entire experimental set up is provided in Fig. 6.

2.2. Operations and detections

All tests were conducted at the laboratory of Thunder Energies Corporation in Tarpon Springs, Florida. Following a certification by the manufacturer that the reactor can safely contain a gas up to 100 psi, we first flushed out the atmosphere in its interior via hydrogen from the high pressure cylinder, we took a sample of the interior gas and sent it out for chemical analyses, thus confirming that, following flushing out of the original atmosphere, the interior chamber did contain an essentially pure hydrogen gas except for small impurities caused by the PVC walls. These chemical analyses are not reported here for brevity, since no gas other than hydrogen can conceivably allow the synthesis of neutrons.

Next, we tested the experimental set up with air at 30 psi in its interior and established that we had steady discharges with frequency of about 1 Hz at about 3/16" gap of the electrodes and the power set up at 75 V over 120 V corresponding to about 3 kVA.

Following these and other preliminary tests, in the morning of August 27, 2014, we flushed out for about one minute the atmosphere in the interior of the reactor with pure hydrogen from the high pressure cylinder; we filled up the reactor with hydrogen gas at 30 psi; we pre-set the electrode gap at 3/16"; we pre-set the operating power of the high voltage DC discharge at 75 V over 100 V for maximal power output corresponding to about 3 kVA; we activated the discharge at a distance; and let the experimental set up operate for a total of thirty minutes.

Following the halting of the operation at a distance and after waiting for 15 minutes, we analyzed all detectors and ascertained that SAM 940 had detected neutrons at the rate of 1.9 CPS (see Fig. 7a), with intense gamma radiations expected for a high voltage DC discharge detected by the same SAM 940 (Fig. 7b) as well as by other detectors.

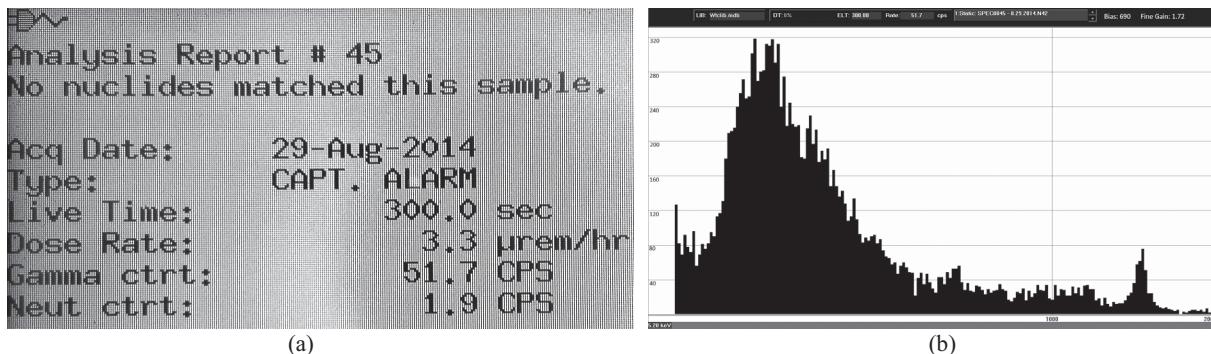


Fig. 7. Views of the radiation detections by SAM 940 over a recorded five minutes run, including in the left the detection of neutrons with 1.9 CPS (Fig. 7a), and in the right the intense gamma radiations (Fig. 7b).

The tests were repeated under the same conditions in the afternoon of August 27, 2014, as well as in subsequent days by confirming the detection of neutrons at the rate of 1.9 CPS, plus the intense electromagnetic radiations that are inherent for all high voltage DC discharges. Additional tests were conducted under different conditions so as to produce a desired rate of neutron CPS. These additional tests will be reported at some future time due to a patent application currently in process.

Following the consultation of nuclear physics experts in neutron detection, our main conclusion is a confirmation of tests [8] according to which 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. A film of the above described operation is available in Ref. [14].

The synthesis of thermal neutrons was first identified in tests [8] from the fact that there was often a waiting period prior to the detection of neutrons outside the reactor. Additionally, theoretical studies [3–6.9] confirm the sole synthesis of thermal neutron with less than 1 MeV. This is due to the fact that the electric discharge illustrated in Fig. 2 does not accelerate charged particles away from the arc, and actually converge them toward its symmetry axis. Therefore, the kinetic energy of the synthesized neutron is predicted as being primarily due to scattering with protons in the plasma surrounding the arc.

The tests reported above were repeated a number of times with the same experimental set up described above, by placing SAM 940 inside a metal box in order to shield it from Electro-Magnetic Interferences (EMI). Needless to say, possible EMI contributions in the detected neutron CPS are not excluded, and their quantitative study is planned for detailed future tests.

Additional tests worth indicating were done with the sensor of SAM 940 placed in the plane perpendicular to the electric discharge at about 10" distance from the latter, resulting in the detection of 9.27 neutron CPS and 241 gamma CPS.

By comparison, the detection of 1.9 neutron CPS reported in Fig. 7 was done with the sensor of SAM 940 placed at about 45 degrees from the plane perpendicular to the electric discharge. This confirmed the theoretical prediction that the maximal neutron flux occurs along the plane perpendicular to the electric discharge and then decreases with deviations from such a plane according to a bell-shaped curve.

In our various tests, we also conducted preliminary measurements of the energy of the neutrons, resulting in the detection of a maximal energy of about 1.6 MeV under maximal power input, thus confirming the production of neutrons with less than 1 MeV via the simple reduction of the power input.

It should be indicated that we detected no neutroids during the tests and no detection was expected due to the operating feature of the tests, with particular references to discharges of the order of 500 J that are substantially beyond the limits for its possible synthesis.

Numerous additional tests are under way for reporting in a subsequent paper, including: moderations and other means for the measurement of the energy of the synthesized neutrons; the construction of hadronic reactors with higher voltage DC discharges, higher frequency, and higher power; the construction of completely automatic and remote controlled hadronic reactors powered by constant AC-DC converters with power from 5 kVA to 100 kVA for the continuous production of thermal neutrons at the desired CPS; and other tests.

2.3. Proposed tests of the Santilli pseudoproton

In the preceding paper [15] (see Appendix A), R. M. Santilli suggested the possible existence of a new particle, called the *pseudoproton* and denoted \bar{p}^- , with spin 1/2, negative charge, essentially the same charge radius and rest energy of the proton, and a mean life (when isolated) of the order of that of the neutron (15 minutes). This new particle is predicted via the repetition of synthesis (1), namely, via the “compression” of a second electron, this time, inside the neutron according to the sequential reactions



where one should note the lack of need for the emission of a neutrino in agreement with Refs. [3–6].

The relativistic and non-relativistic hadronic mechanics for the derivation of the pseudoproton are essentially the same as those of the neutron worked out in Refs. [3–6]. The mass of the pseudoproton is predicted as being of the order of that of the proton (rather than being bigger than that of the neutron) due to the very high Coulomb interactions between two electrons and one proton at distances less than 10^{-13} cm.

It is recommendable to indicate that the experimental set up for the synthesis of the neutron from a hydrogen gas appears to be suited for an experimental resolution as to whether Santilli’s pseudoproton exists or not. This is due to the fact that the neutron synthesized by the DC arc are not expelled at high energy and, therefore, are predicted to remain within the plasma surrounding the DC arc for a time sufficient to allow a second synthesis according to reaction (3). Needless to say, in the event produced, pseudoprotons cannot be detected outside the reactor due to their charge.

Consequently, the resolution as to whether the synthesis of the neutron also synthesizes Santilli’s pseudoprotons requires the construction of a sufficiently large, specially designed, hadronic reactor containing in its interior all necessary testing equipment for:

- 1) The separation of positively and negatively charged particles expectedly via positively and negatively charged plates with sufficiently strong charge;
- 2) The separation of electrons from the predicted pseudoprotons via their expected large mass difference expected to be possible via mass spectrometers; and
- 3) The elimination from all counts of detection caused by hydrogen atoms in one of its forms expected to be possible via the use of mass spectrometers solely for heavy, negatively charged particles with curved trajectories.

The conduction of the experiment here proposed is recommendable irrespective of its outcome to resolve experimentally the issue raised in Appendix A of Ref. [15], namely, whether the claimed antiprotons currently produced at CERN and elsewhere are true antiparticles or they are pseudoprotons, as expected from the very means of their synthesis (high energy protons hitting a matter target, thus colliding first with atomic electrons). The experiment here proposed is also recommendable because of its very moderate cost particularly when compared to the extreme costs sustained to date in the search of new particles via high energy accelerators.

3. Concluding remarks

The main significance of our tests is that they confirm the validity of hadronic mechanics for the synthesis of the neutron with evident implications for the structure of nuclei at large [7]. we have identified for the first time means for producing thermal neutrons via a reactor of modest size and cost for various scientific, industrial and military applications anywhere and whenever desired, as well as the capability of discontinuing their production via the mere switching of the electric power (International patenting under process by Thunder Energies Corporation). We believe that this capability is significant particularly in view of the rather large, expensive and dangerous means of producing thermal neutrons, essentially those via nuclear reactors.

Due to the low cost of the experimental set up and the evident implications for all of nuclear physics, it is hoped that experimentalists in the field will indeed repeat Santilli synthesis of the neutron for independent verifications.

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