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HADRONIC MECHANICS BASED NUCLEAR CONFIGURATION OF ELEMENTS OF THE PERIODIC TABLE AND SOME OF THEIR ISOTOPES

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Abstract

Keywords: Hadronic chemistry, Radioactivity, Nuclear structure, Nuclear Stability.

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1 Introduction

The subject of nuclear structure needs to be based on Santilli's hadronic mechanics [1–5] because there we have to deal with the distances well under the 1 fm, the hadronic horizon. We know from our experience and observations that neutron is unstable having half life of is 614.6 s [6] (In 1967 experiment the half life of free neutron was recorded as 10.8 min [7]) and the deuteron is stable nuclide. Coupled with it is the fact that neither the dineutron nor the diproton nuclides have been detected. Hence, one concludes that they are extremely unstable nuclides [8].

Therefore, we have attempted to analyze the stability of the elements of the periodic table, that we have presented herein, using the above mentioned facts about the primary nuclides — deuteron, neutron, dineutron and diproton, and then arriving at the corresponding nuclear configurations. Below we have presented our analysis of the nuclear configuration arrived at in terms of isodeuterons, isoneutrons and protons. But we see that there doesn't evolve a single yard stick of the stability of nuclides. But this analysis do point out that there we need to identify additional features commensurate with the observed stability and other nuclear properties such as nuclear magnetic moment, nuclear spin, charges on nuclei etc.

In Section 2 we have described the conjectural views on nuclear forces, in Section 3 we have briefly described the hadronic mechanics of neutron and deuteron structures and then in Section 4 we describe the nuclear configuration in terms of isodeuterons, isoneutrons and protons element wise of the periodic table. Of course, we have covered only the first three rows of the periodic table but our analysis is adequate in pointing out some fundamental aspects of nuclear interactions and the need of identifying them. In Section 5 we present preliminary inferences from our present analysis.

2 Conjectural View of Nuclear Forces by Earlier Workers

As stated by Glasstone [8] there must exist force of attraction between the nucleons (protons and neutrons) to account for the stability of nonradioactive elements. Thus he conjectures that in order to overcome the increasing repulsion of among the protons and maintain stability in the heaviest elements, the nuclei must contain the larger proportion of neutrons. The additional

$(n-n)$ and $(n-p^+)$ attractive forces then partly compensate for the growing proton-proton repulsion. Nevertheless, beyond a certain point say atomic number $Z = 30$, the electrostatic repulsion has increased to such an extent that the binding energy per nucleon decreases steadily with increasing mass number, A, see Figure 1.

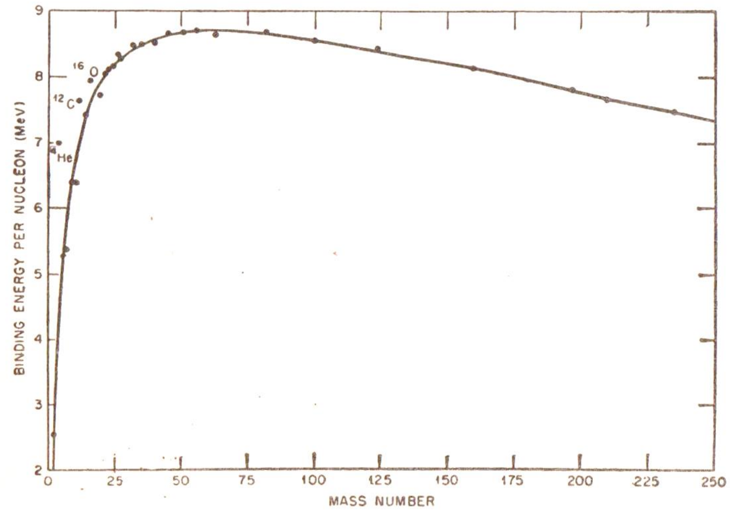

Figure 1: Binding Energy per nucleon as a function of mass number of stable nuclides.

For the semi-quantitative discussion recall the expression of nuclear binding energy, that reads as,

$$BE/\mathrm{MeV} = 931.4\,(Z \times m_{\mathrm{H}} + (A - Z) \times m_n - M) \tag{1}$$

where m_{H} and m_n are the masses on amu scale of Hydrogen and neutron respectively and M is atomic mass on amu scale of the given element. Notice that the mass of electrons has not been included separately in the above expression because it remains included in m_{H}. The standard plot of binding energies of all nuclides is shown in Figure 1.

He further asserts that the nuclear binding energy is the result of $(n-n)$, $(n-p^+)$ and (p^+-p^+) forces operating within the nucleus. The experimental data on the nuclear scattering and correspondence of binding energies of the identically same mass number elements (isobars) it was concluded that the magnitudes of $(n-n)$, $(n-p^+)$ and (p^+-p^+) forces of attraction are almost equal [8].

In view of the above assertion it was expected that the diproton and the dineutron nuclei should be stable as deuteron is a stable nucleus (which consists of one proton and one neutron). But so far neither of the two nuclei have been detected experimentally. That is, the diproton and the dineutron combinations are not stable in respective free states. This observation indicates that there doesn't exist any force of attraction in a free state between two neutrons and similarly no force of attraction operates between two protons in a free state even at 1 fm and below.

Thus at least for low atomic number nuclei their stability originates only when there takes place overlap of the wave packets of two hetero-particles such as proton - electron and proton-neutron. From Santilli's work we learn that such an overlap of wave packets generates Hulthén potential [9], which is many fold stronger than the conventional electrostatic forces of attraction and repulsion.

3 Hadronic Mechanics Based Nuclear Structures of Neutron and Deuteron

Santilli has demonstrated that the neutron structure is indeed a compressed hydrogen atom [5, 9–11] in that deep penetration of wave packets of electron within the hyperdense medium of the proton takes place. That is pictorially represented in the following Figure 2,

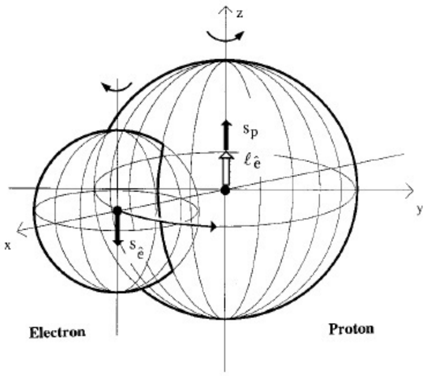

Figure 2: A conceptual view of Rutherford's compression of the electron inside the hyperdense proton in singlet coupling (necessary for stability), resulting in the constrained orbital angular momentum of the electron under which the total angular momentum of the electron is zero and the spin of the neutron coincides with that of proton.

Rutherford's conjecture that the neutron is a compressed hydrogen atom led Santilli to quantify this proposal through his hadronic mechanics developed using his isomathematics [1,2]. Thus the compression of a Hydrogen atom (HA) from quantum mechanical (QM) level to Hadronic Mechanics (HM) level has been represented by Santilli as,

$$\mathrm{HA} \equiv (p^+,\, e^-)_{\mathrm{QM}} \longrightarrow n = (\hat{p}^+_{\uparrow},\, \hat{e}^-_{\downarrow})_{\mathrm{HM}} \tag{2}$$

where subscripts QM and HM stands for the horizons of quantum mechanics and hadronic mechanics respectively, p^+ is the proton, e^- is the electron, n is the neutron, $\hat{p}^+$ is the mutated isoproton, $\hat{e}^-$ is the mutated isoelectron and, up and down arrows represent the +1/2 and -1/2 spins. From the model of Figure 2 it is evident that the dimensions of interaction between isoelectron and isoproton are of 1 fm or less.

The nuclear spin predicted by this model is 1/2 and the magnetic moment $\mu_n = -1.9123\,\mu_N$, where μ_N is the nuclear magneton. These values excellently match with the experimental values ($I = 1/2,\ \mu_n = -1.9131\,\mu_N$) [8].

At this juncture it is interesting to recall the inferences drawn by Glasstone on the observed non-zero magnetic moment of neutron. He states that — *The neutron, although an electrically neutral particle, has a fairly large negative magnetic moment, so that it would appear to be equivalent to a spinning negative charge. It was thought at one time that there was evidence for a partial separation of charges in the neutron from electron scattering experiments, but it is not certain if this conclusion is justified. As an alternative to a variable charge distribution within the neutron to account for the magnetic moment, it may be supposed that there is a current (or moving charge) distribution. Although there is no doubt of the magnetic moment of the neutron, its origin is not yet clear* [8].

However, now we can state that the first conjectural statement of Glasstone has been unequivocally confirmed by Santilli and that too quantitatively. The above referred charge separation within the neutron turns out, indeed, as a deep penetration of the electron wave packet into the hyper-dense medium of the proton as has been depicted in Figure 2.

Similarly, Santilli has demonstrated that the hadronic mechanics based deuteron structure is as shown below in Figure 3, which he writes in terms of constituent symbols as,

$$d = (p^+_{\uparrow}, \hat{e}^-_{\downarrow}, p^+_{\uparrow})_{\mathrm{HM}} \tag{3}$$

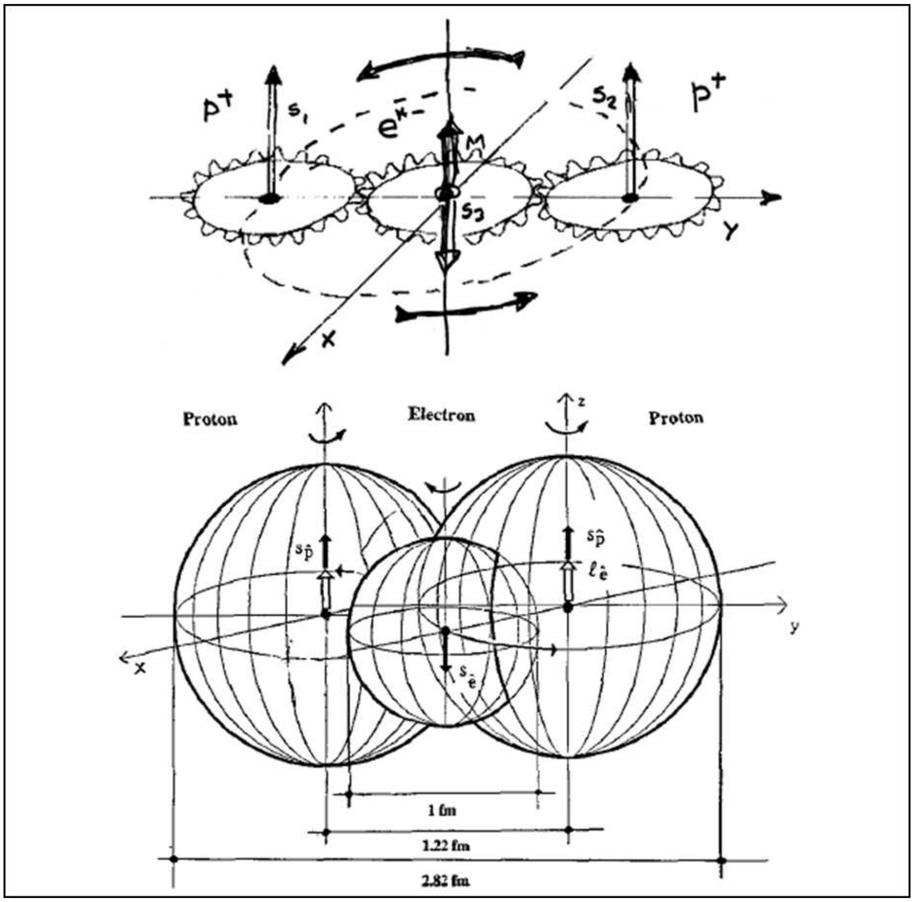

Figure 3: Represents the structure of the deuteron as a restricted three body of two un-mutated protons (due to their weight) and one mutated electron. The top view uses the very effective "gear model" to avoid the highly repulsive triplet couplings, while the bottom view is the same as the top view, the particles being represented with overlapping spheres.

The above stated and shown Santilli model of deuteron gives nuclear spin equal to 1 and nuclear magnetic moment equal to $\mu_d = 0.857\,\mu_N$. These two values also match excellently with the experimental values ($I = 1$, $\mu_d = 0.8574\,\mu_N$) [8].

We recall that the half life of the radiative β^- decay of free neutron is 614.6 s [6] (In 1967 experiment the half life of free neutron was recorded as 10.8 min [7]). Thus the neutron is unstable entity whereas the deuteron is a stable nuclide.

Therefore, we are tempted to analyze the nuclear stability of various nuclides of periodic table by incorporation of the stable representation $(p^+_\uparrow, \hat{e}^-_\downarrow, p^+_\uparrow)_{\mathrm{HM}}$ (that of a isodeuteron) and unstable representation $(\hat{p}^+_\uparrow,\, \hat{e}^-_\downarrow)_{\mathrm{HM}}$ (that of a free isoneutron). Notice that in the case of isoneutron the proton and the electron are both mutated and hence represented as the *isoproton* and *isoelectron* respectively. Whereas, in the case of isodeuteron only electron is mutated (as per the proposed model by Santilli) hence there we have a combination of two protons sandwiching between them an isoelectron. Also, Santilli has categorically stressed that half of the time the electron penetrates deep into the hyper-dense medium of one proton and for other half of the time it remains penetrated into the hyper-dense medium of the other proton. This also means that on an average 1 proton behaves as an isoproton.

In other words, we can say that as the structure $(\hat{p}^+_\uparrow, \hat{e}^-_\downarrow)_{\mathrm{HM}}$ is unstable, there is a natural tendency of the bound electron in $(p^+_\uparrow, \hat{e}^-_\downarrow, p^+_\uparrow)_{\mathrm{HM}}$ to get released from the grip of its isoproton to which it is bound at that instant of time, but no sooner it succeeds in getting released it immediately gets trapped into the hyper-dense medium of the other very closely placed proton. This is how isodeuteron enjoys its stability against radioactivity. This interpretation of nuclear stability and instability appears to be quite reasonable and hence we are presenting our analysis of nuclear stability — element by element — in this paper.

4 Hadronic Mechanics Based Nuclear Configuration of Elements of Periodic Table

For the sake of demonstration purpose we are handling the stable and a few unstable isotopes of each element up to Argon. In the Santilli representations of eqs.(2) and (3) we have shown below the net spin of the isoneutron and isodeuteron. Thus, the isoneutron gets represented as,

$$[(\hat{p}^+_\uparrow,\, \hat{e}^-_\downarrow)(\uparrow)]_{\mathrm{HM}} \equiv \hat{n}(\uparrow) \tag{4}$$

and the isodeuteron as,

$$[(p^+_\uparrow, \hat{e}^-_\downarrow, p^+_\uparrow)(\uparrow\uparrow)]_{\mathrm{HM}} \equiv \hat{d}(\uparrow\uparrow) \tag{5}$$

Notice that we have shown in eqs. (4) and (5) by (↑) the spin 1/2 and by (↑↑) the spin 1, etc. of the nuclides. Also notice that in eqs.(4) and (5) we have further shortened the notation of isoneutron and isodeuteron in the form of $\hat{n}(\uparrow)$ and $\hat{d}(\uparrow\uparrow)$ respectively.

4.1 Nuclear Configuration of Isotopes

The convention of expressing elements, X, depicting mass number (A) and atomic number (Z) is as under,

$$ {}^{A}_{Z}\mathrm{X} \tag{6} $$

We have followed a nuclear version of the Aufbau type principle with the requirement that the resulting nuclear configuration should correctly predict the observed nuclear spin of the isotopes of elements. We are presenting in Table 1 the so arrived at nuclear configurations and also present against each isotope the observed nuclear spin and nuclear magnetic moment. All the nuclear spins and the nuclear magnetic moments reported now onwards are taken from [12] unless otherwise other sources are cited.

Table 1: Nuclear configuration of the isotopes of elements of the periodic table up to the atomic number 18

Atomic Number, Z	**Isotopes of Elements**	**Nuclear Stability**	**Nuclear Configuration**	**Nuclear Spin**, I	**Nuclear Magnetic Moment**, μ/μ_{N}
1	${}^{1}_{1}\mathrm{H}$ (proton)	stable	$p^{+}(\uparrow)$	1/2	2.79284739
	${}^{2}_{1}\mathrm{H}$ (deuteron)	stable	$\hat{d}(\uparrow\uparrow)$	1	0.85743823
	${}^{3}_{1}\mathrm{H}$ (triton)	unstable decays with β^{-} emission to ${}^{3}_{2}\mathrm{He}$ with half life of 12.33 y	$\hat{d}(\uparrow\uparrow)$, $\hat{n}(\downarrow)$	1/2	2.97896248
2	${}^{3}_{2}\mathrm{He}$	stable	$\hat{d}(\uparrow\uparrow)$, $p^{+}(\downarrow)$	1/2	- 2.12762485
	${}^{4}_{2}\mathrm{He}$	stable	$\hat{d}(\uparrow\uparrow), \hat{d}(\downarrow\downarrow) \equiv \left[{}^{4}_{2}\mathrm{He}\right]$	0	0
3	${}^{6}_{3}\mathrm{Li}$	stable	$\left[{}^{4}_{2}\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$	1	0.8220473
	${}^{7}_{3}\mathrm{Li}$	stable	$\left[{}^{4}_{2}\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow), \hat{n}(\uparrow)$	3/2	3.2564268
	${}^{8}_{3}\mathrm{Li}$	unstable decays with	$\left[{}^{4}_{2}\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow), \hat{n}(\uparrow), \hat{n}(\uparrow)$	2	1.65356

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Table 1 – continued from previous page

Atomic Number, Z	**Isotopes of Elements**	**Nuclear Stability**	**Nuclear Configuration**	**Nuclear Spin**, I	**Nuclear Magnetic Moment**, μ/μ_{N}
		β^-, α, emission to ${}^{4}_{2}\mathrm{He}$ with half life of 840.3 ms			
4	${}^{8}_{4}\mathrm{Be}$	unstable decays with α emission with half life of 6.7×10^{-8} ns that produces 2α per nuclide of ${}^{8}_{4}\mathrm{Be}$	$\left[{}^{4}_{2}\mathrm{He}\right], \hat{d}(\uparrow\uparrow), \hat{d}(\downarrow\downarrow) \equiv 2\left[{}^{4}_{2}\mathrm{He}\right]$	0	0
	${}^{9}_{4}\mathrm{Be}$	stable	$\left[{}^{4}_{2}\mathrm{He}\right], \hat{d}(\uparrow\uparrow), \hat{d}(\uparrow\uparrow), \hat{n}(\downarrow)$	3/2	-1.1778
	${}^{10}_{04}\mathrm{Be}$	unstable decays via β^- emission to ${}^{10}_{05}\mathrm{B}$ with half life of 1.513×10^{6}y	$2\left[{}^{4}_{2}\mathrm{He}\right], \hat{n}(\uparrow), \hat{n}(\downarrow)$	0	0
	${}^{11}_{04}\mathrm{Be}$	unstable the major decay is through β^- emission to ${}^{11}_{05}\mathrm{B}$ with half life of 13.81s and 3% through	$2\left[{}^{4}_{2}\mathrm{He}\right], \hat{n}(\uparrow), \hat{n}(\uparrow), \hat{n}(\downarrow)$	1/2	Not available

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Atomic Number, Z	**Isotopes of Elements**	**Nuclear Stability**	**Nuclear Configuration**	**Nuclear Spin**, I	**Nuclear Magnetic Moment**, μ/μ_{N}
		β^-, α emission to $^{7}_{3}$Li			
5	$^{8}_{5}$B	unstable decays via β^+ emission to α particles with half life of 770 ms	$\left[^{4}_{2}\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow), p^+(\uparrow), p^+(\uparrow)$	2	1.0355
	$^{10}_{05}$B	stable	$\left[^{4}_{2}\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow), \hat{d}(\uparrow\uparrow), \hat{d}(\uparrow\uparrow)$	3	1.8006448
	$^{11}_{05}$B	stable	$2\left[^{4}_{2}\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow), \hat{n}(\uparrow)$	3/2	2.6886489
6	$^{12}_{06}$C	stable	$3\left[^{4}_{2}\mathrm{He}\right]$	0	0
	$^{13}_{06}$C	stable	$3\left[^{4}_{2}\mathrm{He}\right]$, $\hat{n}(\uparrow)$	1/2	0.7024118
	$^{14}_{06}$C	unstable decays with β^- emission to $^{14}_{07}$N with half life of 5.71×10^3y	$3\left[^{4}_{2}\mathrm{He}\right]$, $\hat{n}(\uparrow)$, $\hat{n}(\downarrow)$	0	0
7	$^{13}_{07}$N	unstable decays with β^+ emission to $^{13}_{06}$C with half life of 9.965 m	$3\left[^{4}_{2}\mathrm{He}\right]$, $p^+(\uparrow)$	1/2	0.3222
	$^{14}_{07}$N	stable	$3\left[^{4}_{2}\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$	1	0.403761
	$^{15}_{07}$N	stable	$3\left[^{4}_{2}\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\downarrow)$	1/2	- 0.28318884

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Atomic Number, Z	**Isotopes of Elements**	**Nuclear Stability**	**Nuclear Configuration**	**Nuclear Spin**, I	**Nuclear Magnetic Moment**, μ/μ_{N}
8	$^{15}_{08}$O	unstable decays with β^+ emission to $^{15}_{07}$N with half life of 2.03733 m	$3\left[^4_2\mathrm{He}\right], \hat{d}(\uparrow\uparrow), p^+(\downarrow)$	1/2	0.7189
	$^{16}_{08}$O	stable	$3\left[^4_2\mathrm{He}\right], \hat{d}(\uparrow\uparrow), \hat{d}(\downarrow\downarrow) \equiv 4\left[^4_2\mathrm{He}\right]$	0	0
	$^{17}_{08}$O	stable	$3\left[^4_2\mathrm{He}\right], \hat{d}(\uparrow\uparrow), \hat{d}(\uparrow\uparrow), \hat{n}(\uparrow)$	5/2	- 1.89379
	$^{18}_{08}$O	stable	$4\left[^4_2\mathrm{He}\right], \hat{n}(\uparrow), \hat{n}(\downarrow)$	0	0
9	$^{18}_{09}$F	unstable decays by β^+ emission to $^{18}_{08}$O with half life of 1.829517 h	$4\left[^4_2\mathrm{He}\right], \hat{d}(\uparrow\uparrow)$	1	Not available
	$^{19}_{09}$F	stable	$4\left[^4_2\mathrm{He}\right], \hat{d}(\uparrow\uparrow), \hat{n}(\downarrow)$	1/2	0.141613
	$^{20}_{09}$F	unstable decays by β^- emission to $^{20}_{10}$Ne with half life of 11.163 s	$4\left[^4_2\mathrm{He}\right], \hat{d}(\uparrow\uparrow), \hat{n}(\uparrow), \hat{n}(\uparrow)$	2	2.0935
	$^{21}_{09}$F	unstable decays by β^-	$4\left[^4_2\mathrm{He}\right], \hat{d}(\uparrow\uparrow), \hat{n}(\uparrow), \hat{n}(\uparrow), \hat{n}(\uparrow)$	5/2	Not available

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Atomic Number, Z	**Isotopes of Elements**	**Nuclear Stability**	**Nuclear Configuration**	**Nuclear Spin**, I	**Nuclear Magnetic Moment**, μ/μ_{N}
		emission to ${}^{21}_{10}$Ne with half life of 4.158 s			
10	${}^{20}_{10}$Ne	stable	$4\left[{}^{4}_{2}\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\downarrow\downarrow) \equiv 5\left[{}^{4}_{2}\mathrm{He}\right]$	0	0
	${}^{21}_{10}$Ne	stable	$4\left[{}^{4}_{2}\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\downarrow)$	3/2	- 0.661797
	${}^{22}_{10}$Ne	stable	$5\left[{}^{4}_{2}\mathrm{He}\right]$, $\hat{n}(\downarrow)$, $\hat{n}(\uparrow)$	0	0
	${}^{23}_{10}$Ne	unstable decays by β^- emission to ${}^{23}_{11}$Na with half life of 37.24 s	$4\left[{}^{4}_{2}\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\uparrow)$, $\hat{n}(\uparrow)$, $\hat{n}(\downarrow)$	5/2	-1.08
11	${}^{22}_{11}$Na	unstable decays by β^+ emission to ${}^{22}_{10}$Ne with half life of 2.60363 y	$4\left[{}^{4}_{2}\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$	3	1.746
	${}^{23}_{11}$Na	stable	$5\left[{}^{4}_{2}\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\uparrow)$	3/2	2.21752
	${}^{24}_{11}$Na	unstable decays by β^- emission to ${}^{24}_{12}$Mg with half life of 14.9589 h	$4\left[{}^{4}_{2}\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\uparrow)$, $\hat{n}(\uparrow)$	4	1.6903
	${}^{25}_{11}$Na	unstable	$5\left[{}^{4}_{2}\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\uparrow)$, $\hat{n}(\uparrow)$, $\hat{n}(\uparrow)$	5/2	3.683

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Table 1 – continued from previous page

Atomic Number, Z	**Isotopes of Elements**	**Nuclear Stability**	**Nuclear Configuration**	**Nuclear Spin**, I	**Nuclear Magnetic Moment**, μ/μ_N
		decays by β^- emission to ${}^{25}_{12}\mathrm{Mg}$ with half life of 0.985 m			
12	${}^{24}_{12}\mathrm{Mg}$	stable	$6\left[{}^{4}_{2}\mathrm{He}\right]$	0	0
	${}^{25}_{12}\mathrm{Mg}$	stable	$5\left[{}^{4}_{2}\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\uparrow)$	5/2	- 0.85545
	${}^{26}_{12}\mathrm{Mg}$	stable	$6\left[{}^{4}_{2}\mathrm{He}\right]$, $\hat{n}(\uparrow)$, $\hat{n}(\downarrow)$	0	0
	${}^{27}_{12}\mathrm{Mg}$	unstable decays by β^- emission to ${}^{27}_{13}\mathrm{Al}$ with half life of 9.4583 m	$6\left[{}^{4}_{2}\mathrm{He}\right]$, $\hat{n}(\uparrow)$, $\hat{n}(\downarrow)$, $\hat{n}(\uparrow)$,	1/2	Not available
13	${}^{25}_{13}\mathrm{Al}$	unstable decays by β^+ emission to ${}^{25}_{12}\mathrm{Mg}$ with half life of 7.183 s	$5\left[{}^{4}_{2}\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $p^+(\uparrow)$	5/2	3.6455
	${}^{26}_{13}\mathrm{Al}$	unstable decays by β^+ emission to ${}^{26}_{12}\mathrm{Mg}$ with half life of 7.166×10^5 y	$4\left[{}^{4}_{2}\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$ $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$	5	Not available
	${}^{27}_{13}\mathrm{Al}$	stable	$5\left[{}^{4}_{2}\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\downarrow)$	5/2	3.6415069

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Atomic Number, Z	**Isotopes of Elements**	**Nuclear Stability**	**Nuclear Configuration**	**Nuclear Spin**, I	**Nuclear Magnetic Moment**, μ/μ_{N}
	$^{28}_{13}$Al	unstable decays by β^- emission to $^{28}_{14}$Si with half life of 2.24133 m	$5\left[^4_2\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\uparrow)$, $\hat{n}(\downarrow)$	3	3.242
14	$^{26}_{14}$Si	unstable decays by β^+ emission to $^{26}_{13}$Al with half life of 2.234 s	$6\left[^4_2\mathrm{He}\right]$, $p^+(\uparrow)$, $p^+(\downarrow)$	0	0
	$^{27}_{14}$Si	unstable decays by β^+ emission to $^{27}_{13}$Al with half life of 4.16 s	$5\left[^4_2\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $p^+(\downarrow)$	5/2	0.8554
	$^{28}_{14}$Si	stable	$7\left[^4_2\mathrm{He}\right]$	0	0
	$^{29}_{14}$Si	stable	$7\left[^4_2\mathrm{He}\right]$, $\hat{n}(\uparrow)$	1/2	- 0.55529
	$^{30}_{14}$Si	stable	$7\left[^4_2\mathrm{He}\right]$, $\hat{n}(\uparrow)$, $\hat{n}(\downarrow)$	0	0
	$^{29}_{15}$P	unstable decays by β^+ emission to $^{29}_{14}$Si with half life of 4.142 s	$7\left[^4_2\mathrm{He}\right]$, $p^+(\uparrow)$	1/2	1.2349
	$^{30}_{15}$P	unstable decays by β^+	$7\left[^4_2\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$	1	not available

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Atomic Number, Z	**Isotopes of Elements**	**Nuclear Stability**	**Nuclear Configuration**	**Nuclear Spin**, I	**Nuclear Magnetic Moment**, μ/μ_{N}
		emission to $^{30}_{14}$Si with half life of 2.4983 m			
15	$^{31}_{15}$P	stable	$7\left[^{4}_{2}\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\downarrow)$	1/2	1.1316
	$^{32}_{15}$P	unstable decays by β^{-} emission to $^{32}_{16}$S with half life of 2.4983 m	$7\left[^{4}_{2}\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\uparrow)$, $\hat{n}(\downarrow)$	1	- 0.2524
16	$^{32}_{16}$S	stable	$8\left[^{4}_{2}\mathrm{He}\right]$	0	0
	$^{33}_{16}$S	stable	$7\left[^{4}_{2}\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\downarrow)$	3/2	0.6438212
	$^{34}_{16}$S	stable	$8\left[^{4}_{2}\mathrm{He}\right]$, $\hat{n}(\uparrow)$, $\hat{n}(\downarrow)$	0	0
	$^{35}_{16}$S	unstable decays by β^{-} emission to $^{35}_{17}$Cl with half life of 87.512 d	$8\left[^{4}_{2}\mathrm{He}\right]$, $\hat{n}(\uparrow)$, $\hat{n}(\uparrow)$, $\hat{n}(\uparrow)$	3/2	uncertain
	$^{36}_{16}$S	stable	$8\left[^{4}_{2}\mathrm{He}\right]$, $\hat{n}(\uparrow)$, $\hat{n}(\downarrow)$, $\hat{n}(\uparrow)$, $\hat{n}(\downarrow)$	0	0
	$^{34}_{17}$Cl	unstable decays by β^{+} emission to $^{34}_{16}$S with half life of 1.5264 s	$8\left[^{4}_{2}\mathrm{He}\right]$, $\hat{n}(\downarrow)$, $p^{+}(\uparrow)$	0	0

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Atomic Number, Z	**Isotopes of Elements**	**Nuclear Stability**	**Nuclear Configuration**	**Nuclear Spin**, I	**Nuclear Magnetic Moment**, μ/μ_{N}
17	${}^{35}_{17}\mathrm{Cl}$	stable	$8\left[{}^{4}_{2}\mathrm{He}\right], \hat{d}(\uparrow\uparrow), \hat{n}(\uparrow)$	3/2	0.8218743
	${}^{36}_{17}\mathrm{Cl}$	unstable decays 98% by β^{-} emission to ${}^{36}_{18}\mathrm{Ar}$ with half life of 3.01×10^{5} y	$8\left[{}^{4}_{2}\mathrm{He}\right], \hat{d}(\uparrow\uparrow), \hat{n}(\uparrow), \hat{n}(\uparrow)$	2	1.28547
	${}^{37}_{17}\mathrm{Cl}$	stable	$8\left[{}^{4}_{2}\mathrm{He}\right], \hat{d}(\uparrow\uparrow), \hat{n}(\uparrow), \hat{n}(\downarrow), \hat{n}(\uparrow)$	3/2	0.6841236
	${}^{38}_{17}\mathrm{Cl}$	unstable decays by β^{-} emission to ${}^{38}_{18}\mathrm{Ar}$ with half life of 37.233 m	$8\left[{}^{4}_{2}\mathrm{He}\right], \hat{d}(\uparrow\uparrow), \hat{n}(\uparrow), \hat{n}(\uparrow), \hat{n}(\uparrow), \hat{n}(\downarrow)$	2	2.05
18	${}^{35}_{18}\mathrm{Ar}$	unstable decays by β^{+} emission to ${}^{35}_{17}\mathrm{Cl}$ with half life of 1.775 s	$8\left[{}^{4}_{2}\mathrm{He}\right], \hat{d}(\uparrow\uparrow), p^{+}(\uparrow)$	3/2	0.633
	${}^{36}_{18}\mathrm{Ar}$	stable	$9\left[{}^{4}_{2}\mathrm{He}\right]$	0	0
	${}^{37}_{18}\mathrm{Ar}$	unstable decays by β^{+} emission to ${}^{37}_{17}\mathrm{Cl}$ with half life of 35.035 d	$8\left[{}^{4}_{2}\mathrm{He}\right], \hat{d}(\uparrow\uparrow), \hat{d}(\uparrow\uparrow), \hat{n}(\downarrow)$	3/2	1.145
	${}^{38}_{18}\mathrm{Ar}$	stable	$9\left[{}^{4}_{2}\mathrm{He}\right], \hat{n}(\uparrow), \hat{n}(\downarrow)$	0	0

Continued on next page

Table 1 – continued from previous page

Atomic Number, Z	**Isotopes of Elements**	**Nuclear Stability**	**Nuclear Configuration**	**Nuclear Spin**, I	**Nuclear Magnetic Moment**, μ/μ_{N}
	${}^{39}_{18}\mathrm{Ar}$	unstable decays by β^- emission to ${}^{39}_{19}\mathrm{K}$ with half life of 269.2 y	$8\left[{}^{4}_{2}\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\uparrow)$, $\hat{n}(\uparrow)$, $\hat{n}(\uparrow)$	7/2	- 1.3
	${}^{40}_{18}\mathrm{Ar}$	stable	$9\left[{}^{4}_{2}\mathrm{He}\right]$, $\hat{n}(\uparrow)$, $\hat{n}(\downarrow)$, $\hat{n}(\uparrow)$, $\hat{n}(\downarrow)$	0	0

5 Some Observations

First we present our discussion on the nuclear configurations of hydrogen and its two isotopes, deuteron and triton. Then we will present our observations on nuclear configurations of other elements and isotopes, and corresponding nuclear stability and instability, in two tables.

5.1 Isotopes of Hydrogen

Let us first analyze the isotopes of hydrogen, the first element of the periodic table.

Thus, ${}^{1}_{1}\mathrm{H}$, in fact, is the fundamental particle proton, hence it is a stable particle. Its magnetic moment is $\mu = 2.79284739\,\mu_N$.

5.1.1 Deuterium

Hydrogen of mass number 2 is conventionally termed as deuterium. It gets represented as ${}^{2}_{1}\mathrm{H}$ whose nucleus is termed as deuteron. We represent this system in Santilli notation as,

$${}^{2}_{1}\mathrm{H}:\ n = 1,\ p^+ = 1\} \Rightarrow [(p^+_\uparrow, \hat{e}^-_\downarrow, p^+_\uparrow)(\uparrow\uparrow)]_{\mathrm{HM}},\ \ \text{stable},\ \ I = 1 \qquad (7)$$

where I is the nuclear spin. How the nuclear spin of value 1 originates can be easily understood from Figure 3. Its magnetic moment is $\mu = 0.85743823\,\mu_N$ and as stated in preceding section Santilli obtained this value on assigning appropriate value of $\mu_{\hat{e},\,\mathrm{orbital}}\,(= -1842.696\,\mu_N)$ [5, 10, 11].

5.1.2 Tritium

The hydrogen of mass number 3 is conventionally termed as tritium, ${}^{3}_{1}\mathrm{H}$. Its magnetic moment is $\mu_t/\mu_p = 1.0666399151 \Rightarrow \mu_t = 2.97896248\,\mu_N$ [13]. It is radioactive with half life 12.33 years. In Santilli notation we write it as,

$$\begin{aligned} &{}^{3}_{1}\mathrm{H}:\ n = 2,\ p^+ = 1\} \Rightarrow \\ &\qquad [(p^+_\uparrow, \hat{e}^-_\downarrow, p^+_\uparrow)(\uparrow\uparrow);\ (\hat{p}^+_\uparrow, \hat{e}^-_\downarrow)(\downarrow)]_{\mathrm{HM}},\ \text{unstable}\ I = 1/2 \qquad (8) \end{aligned}$$

Notice that the Tritium nuclei gets represented as the combination of a isodeuteron and a isoneutron with their spins opposite. It seems that because of this spin pairing the instability of isoneutron within the tritium nucleus decreases tremendously, which is reflected by the half life getting increased to 12.33 years compared to about 10 min that of the free isoneutron.

It disintegrates via β^- decay to ${}^3_2$He. That is, in essence the nuclear isoneutron gets converted to nuclear proton, that we have represented below,

$$[(p^+_\uparrow, \hat{e}^-_\downarrow, p^+_\uparrow)(\uparrow\uparrow);\ (\hat{p}^+_\uparrow, \hat{e}^-_\downarrow)(\downarrow)]_{\rm HM} \xrightarrow{\beta^-} [(p^+_\uparrow, \hat{e}^-_\downarrow, p^+_\uparrow)(\uparrow\uparrow);\ (\hat{p}^+)(\downarrow)]_{\rm HM} \qquad (9)$$

Thus the β^- decay of tritium gets very well explained by above nuclear configuration. Notice that the experimental spin of ${}^3_2$He is 1/2, hence in the Santilli notation the spin of the proton constituting its nucleus is opposite to that of isodeuteron that we have shown on the right hand side of eq.(9). Thus the stability of ${}^3_2$He seems to lie in the fact that the spin of proton is opposite to that of isodeuteron and also both of them are individually stable species.

In order to explain the experimental value of magnetic moment $\mu_t = 2.97896248\,\mu_N$ in terms of the structure of eq.(8) we find that the difference in magnetic moments of deuteron and tritium is $2.12152425\,\mu_N$. The magnetic moments of neutron (- 1.91304313 μ_N [13]) and deuteron (0.85743823 μ_N) would also be paired like their spins in tritium and hence the expected magnetic moment of the latter should be 2.77048136 μ_N. But this value falls short by $0.20848112\,\mu_N$ compared to the experimental value, which indeed is a substantial difference.

But then this difference can be taken as a pointer to recognize that either there gets induced an additional angular motion or both the existing angular motions get influenced cooperatively. Moreover, we need to consider that the isodeuteron and isoneutron of tritium are positioned in some specific configuration.

On the other hand since tritium is an unstable nuclide perhaps we need to describe its nuclear configuration using Santilli genomathematics. If this is so then instead of isoneutron one must treat it as genoneutron because it disintegrates into a proton and an electron spontaneously.

In the following Subsections we have presented our observations on the nuclear configurations of Table 1 and their nuclear stability in tabular form.

5.2 The Nuclides Composed Only of the Spin Paired Isodeuterons

We find from Table 1 that all nuclides composed only of the spin paired isodeuterons are stable except ${}^{8}_{4}$Be. Our observations are presented in the following Table 2. Notice that though all nuclides of Table 2 can be said to be composed of 1, 2, 3, 4, 5, 6, 7, 8 and 9 α-particles respectively but none of them emit α-particle except the second one. This then implies that in the case of stable nuclides from ${}^{12}_{6}$C and onwards of Table 2 the α-particles are strongly bound. However, we need to explain the nature of the said strong nuclear bonding and then explain why such a strong bonding is not there in the case of ${}^{8}_{4}$Be.

Table 2: Nuclides composed of all spin paired isodeuterons.

S. No.	Nuclide	Nuclear Configuration	Nuclear Stability/Instability
1.	${}^{4}_{2}$He	$\hat{d}(\uparrow\uparrow), \hat{d}(\downarrow\downarrow) \equiv \left[{}^{4}_{2}\text{He}\right]$	stable Itself is an α-particle
2.	${}^{8}_{4}$Be	$\left[{}^{4}_{2}\text{He}\right], \hat{d}(\uparrow\uparrow), \hat{d}(\downarrow\downarrow) \equiv 2\left[{}^{4}_{2}\text{He}\right]$	unstable disintegrates to α-particles
3.	${}^{12}_{06}$C	$3\left[{}^{4}_{2}\text{He}\right]$	stable
4.	${}^{16}_{08}$O	$4\left[{}^{4}_{2}\text{He}\right]$	stable
5.	${}^{20}_{10}$Ne	$5\left[{}^{4}_{2}\text{He}\right]$	stable
6.	${}^{24}_{12}$Mg	$6\left[{}^{4}_{2}\text{He}\right]$	stable
7.	${}^{28}_{14}$Si	$7\left[{}^{4}_{2}\text{He}\right]$	stable
8.	${}^{32}_{16}$S	$8\left[{}^{4}_{2}\text{He}\right]$	stable
9.	${}^{36}_{18}$Ar	$9\left[{}^{4}_{2}\text{He}\right]$	stable

5.3 Nuclides Composed Only of Isodeuterons. Some are Spin Paired and the Remaining Spin Unpaired

These consist of nuclides of odd atomic number. We present our observation in the following Table 3.

Table 3: Nuclides composed of spin paired and spin unpaired isodeuterons.

S. No.	Nuclide	Nuclear Configuration	Nuclear Stability/Instability	Nuclear Configuration of Daughter Nuclide
1.	${}^{6}_{3}\mathrm{Li}$	$\left[{}^{4}_{2}\mathrm{He}\right], \hat{d}(\uparrow\uparrow)$	stable	Not applicable
2.	${}^{10}_{05}\mathrm{B}$	$\left[{}^{4}_{2}\mathrm{He}\right], \hat{d}(\uparrow\uparrow), \hat{d}(\uparrow\uparrow), \hat{d}(\uparrow\uparrow)$	stable	Not applicable
3.	${}^{14}_{07}\mathrm{N}$	$3\left[{}^{4}_{2}\mathrm{He}\right], \hat{d}(\uparrow\uparrow)$	stable	Not applicable
4.	${}^{18}_{09}\mathrm{F}$	$4\left[{}^{4}_{2}\mathrm{He}\right], \hat{d}(\uparrow\uparrow)$	unstable decays by β^+ emission to ${}^{18}_{08}\mathrm{O}$ with half life of 1.829517 h	$4\left[{}^{4}_{2}\mathrm{He}\right], \hat{n}(\uparrow), \hat{n}(\downarrow)$
5.	${}^{22}_{11}\mathrm{Na}$	$4\left[{}^{4}_{2}\mathrm{He}\right], \hat{d}(\uparrow\uparrow), \hat{d}(\uparrow\uparrow), \hat{d}(\uparrow\uparrow)$	unstable decays by β^+ emission to ${}^{22}_{10}\mathrm{Ne}$ with half life of 2.60363 y	$5\left[{}^{4}_{2}\mathrm{He}\right], \hat{n}(\downarrow), \hat{n}(\uparrow)$
6.	${}^{26}_{13}\mathrm{Al}$	$4\left[{}^{4}_{2}\mathrm{He}\right], \hat{d}(\uparrow\uparrow), \hat{d}(\uparrow\uparrow), \hat{d}(\uparrow\uparrow), \hat{d}(\uparrow\uparrow), \hat{d}(\uparrow\uparrow)$	unstable decays by β^+ emission to ${}^{26}_{12}\mathrm{Mg}$ with half life of 7.166×10^5 y	$6\left[{}^{4}_{2}\mathrm{He}\right], \hat{n}(\uparrow), \hat{n}(\downarrow)$
7.	${}^{30}_{15}\mathrm{P}$	$7\left[{}^{4}_{2}\mathrm{He}\right], \hat{d}(\uparrow\uparrow)$	unstable decays by β^+ emission to ${}^{30}_{14}\mathrm{Si}$ with half life of 2.4983 m	$7\left[{}^{4}_{2}\mathrm{He}\right], \hat{n}(\uparrow), \hat{n}(\downarrow)$
8.	${}^{34}_{17}\mathrm{Cl}$	$8\left[{}^{4}_{2}\mathrm{He}\right], \hat{n}(\downarrow), p^+(\uparrow)$	unstable decays by β^+ emission to ${}^{34}_{16}\mathrm{S}$ with half life of 1.5264 s	$8\left[{}^{4}_{2}\mathrm{He}\right], \hat{n}(\uparrow), \hat{n}(\downarrow)$

One of the striking features of unstable nuclides of Table 3 is that in each case the daughter nuclide is stable having a spin paired di-isoneutron. Compare this with the high instability of di-neutron. This stability appears to be due to the environment of 8 and more spin paired isodeuterons or 4 and more α-particles. However, we need to understand the details of the interactions that imparts the stability. It is also interesting to note that as we go from the stable He-4 to Li-6 by adding one isodeuteron the nuclear stability is maintained but on adding an additional isodeuteron we obtain Be-8 but the latter is extremely unstable that spontaneously disintegrates to α-particles. Therefore, does it imply that the geometrical arrangements of more than one isodeuterons play role in determining the nuclear stability? Also notice that we have single unpaired isodeuteron in Li-6, N-14, F-18 and P-30 but only the first two are stable, that needs to be explained. Similarly, we have in B-10, Na-22 and Al-26 unpaired isodeuterons 3, 3 and 5 respectively but only the first one is stable nuclide, that also needs to be explained. Whereas in Cl-34 we have an isoneutron spin paired with a proton but still this combination is highly unstable that produces spin paired di-isoneutron in the environment of 16 spin paired isodeuterons.

5.4 Other Nuclides and Their Nuclear Stability

In this Subsection we tabulate those nuclides not covered in the preceding two Subsection.

Table 4: Nuclear stability/instability of nuclides composed of isoneutrons/protons/isodeuterons not covered in Tables 2 and 3

S. No.	**Nuclear Configuration**	**Nuclides Nuclides**	**Nuclear Stability/ Instability**	**Nuclear Configuration of Daughter Nuclide**
1.	$x\left[^4_2\text{He}\right]$, $\hat{n}(\uparrow)$	$^{13}_{06}\text{C}$, $^{29}_{14}\text{Si}$	stable	not applicable
2.	$x\left[^4_2\text{He}\right]$, $\hat{n}(\uparrow)$, $\hat{n}(\downarrow)$	$^{18}_{08}\text{O}$, $^{22}_{10}\text{Ne}$, $^{26}_{12}\text{Mg}$	stable	not applicable
		$^{30}_{14}\text{Si}$, $^{34}_{16}\text{S}$, $^{38}_{18}\text{Ar}$	stable	not applicable
		$^{10}_{04}\text{Be}$	unstable decays by β^- emission to $^{10}_{05}\text{B}$ with half life of	$\left[^4_2\text{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$

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Table 4 – Continued

S. No.	**Nuclear Configuration**	**Nuclides Nuclides**	**Nuclear Stability/ Instability**	**Nuclear Configuration of Daughter Nuclide**
			1.513×10^5y	
		$^{14}_{06}$C	unstable decays by β^- emission to $^{14}_{07}$N with half life of 5.71×10^3y	$3\left[^4_2\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$
3.	$x\left[^4_2\mathrm{He}\right]$, $\hat{n}(\uparrow)$, $\hat{n}(\downarrow)$, $\hat{n}(\uparrow)$	$^{11}_{04}$Be	unstable decays 97% by β^- emission to $^{11}_{05}$B with half life of 13.81 s and 3% through β^-, α to $^7_3$Li	$2\left[^4_2\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\uparrow)$
		$^{27}_{12}$Mg	unstable decays by β^- emission to $^{27}_{13}$Al with half life of 9.4583 m	$5\left[^4_2\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$ $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\uparrow)$
4.	$8\left[^4_2\mathrm{He}\right]$, $\hat{n}(\uparrow)$, $\hat{n}(\uparrow)$, $\hat{n}(\uparrow)$	$^{35}_{16}$S	unstable decays by β^- emission to $^{35}_{17}$Cl with half life of 87.512 d	$8\left[^4_2\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\uparrow)$
5.	$x\left[^4_2\mathrm{He}\right]$, $\hat{n}(\uparrow)$, $\hat{n}(\downarrow)$, $\hat{n}(\uparrow)$, $\hat{n}(\downarrow)$	$^{36}_{16}$S, $^{40}_{18}$Ar	both stable	not applicable
6.	$x\left[^4_2\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\uparrow)$	$^7_3$Li, $^{11}_{05}$B,	both stable	not applicable
		$^{23}_{11}$Na, $^{35}_{17}$Cl	both stable	not applicable
7.	$\hat{d}(\uparrow\uparrow)$, $\hat{n}(\downarrow)$	$^3_1$H	unstable decays by β^- emission to $^3_2$He with half life of 12.33 y	$\hat{d}(\uparrow\uparrow)$, $p^+(\downarrow)$
	$x\left[^4_2\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\downarrow)$	$^{15}_{07}$N, $^{19}_{09}$F, $^{31}_{15}$P	stable	not applicable
8.	$x\left[^4_2\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\uparrow)$, $\hat{n}(\uparrow)$	$^8_3$Li	unstable decays by β^-, α emission to $^4_2$He	$2\left[\hat{d}(\uparrow\uparrow), \hat{d}(\downarrow\downarrow)\right]$ $\equiv 2\left(\left[^4_2\mathrm{He}\right]\right)$

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Table 4 – Continued

S. No.	**Nuclear Configuration**	**Nuclides Nuclides**	**Nuclear Stability/ Instability**	**Nuclear Configuration of Daughter Nuclide**
			with half life of 840.3 ms	
		$^{20}_{09}$F	unstable decays by β^- emission to $^{20}_{10}$Ne with half life of 11.163 s	$4\left[^4_2\text{He}\right], \hat{d}(\uparrow\uparrow), \hat{d}(\downarrow\downarrow) \equiv 5\left[^4_2\text{He}\right]$
		$^{36}_{17}$Cl	unstable decays 98% by β^- emission to $^{36}_{18}$Ar with half life of 3.01×10^5y	$8\left[^4_2\text{He}\right], \hat{d}(\uparrow\uparrow), \hat{d}(\downarrow\downarrow) \equiv 9\left[^4_2\text{He}\right]$
9.	$x\left[^4_2\text{He}\right], \hat{d}(\uparrow\uparrow), \hat{n}(\uparrow), \hat{n}(\downarrow)$	$^{32}_{15}$P	unstable decays by β^- emission to $^{32}_{16}$S with half life of 2.4983 m	$7\left[^4_2\text{He}\right], \hat{d}(\uparrow\uparrow), \hat{d}(\downarrow\downarrow) \equiv 8\left[^4_2\text{He}\right]$
10.	$8\left[^4_2\text{He}\right], \hat{d}(\uparrow\uparrow), \hat{n}(\uparrow), \hat{n}(\downarrow), \hat{n}(\uparrow)$	$^{37}_{17}$Cl	stable	not applicable
11.	$x\left[^4_2\text{He}\right], \hat{d}(\uparrow\uparrow), \hat{n}(\uparrow), \hat{n}(\uparrow), \hat{n}(\uparrow)$	$^{21}_{09}$F	unstable decays by β^- emission to $^{21}_{10}$Ne with half life of 4.158 s	$4\left[^4_2\text{He}\right], \hat{d}(\uparrow\uparrow), \hat{d}(\uparrow\uparrow), \hat{n}(\downarrow)$
		$^{25}_{11}$Na	unstable decays by β^- emission to $^{25}_{12}$Mg with half life of 0.985 m	$5\left[^4_2\text{He}\right], \hat{d}(\uparrow\uparrow), \hat{d}(\uparrow\uparrow), \hat{n}(\uparrow)$
12.	$8\left[^4_2\text{He}\right], \hat{d}(\uparrow\uparrow), \hat{n}(\uparrow), \hat{n}(\downarrow), \hat{n}(\uparrow), \hat{n}(\uparrow)$	$^{38}_{17}$Cl	unstable decays by β^- emission to $^{38}_{18}$Ar with half life of 37.233 m	$9\left[^4_2\text{He}\right], \hat{n}(\uparrow), \hat{n}(\downarrow)$
13.	$x\left[^4_2\text{He}\right], \hat{d}(\uparrow\uparrow), \hat{d}(\uparrow\uparrow), \hat{n}(\uparrow)$	$^{17}_{08}$O, $^{25}_{12}$Mg	both stable	not applicable
14.	$x\left[^4_2\text{He}\right], \hat{d}(\uparrow\uparrow), \hat{d}(\uparrow\uparrow), \hat{n}(\downarrow)$	$^{9}_{4}$Be	stable	not applicable

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Table 4 – Continued

S. No.	**Nuclear Configuration**	**Nuclides Nuclides**	**Nuclear Stability/ Instability**	**Nuclear Configuration of Daughter Nuclide**
		${}^{21}_{10}\text{Ne}$	stable	not applicable
		${}^{33}_{16}\text{S}$	stable	not applicable
		${}^{37}_{18}\text{Ar}$	unstable decays by β^+ emission to ${}^{37}_{17}\text{Cl}$ with half life of 35.035 d	$8\left[{}^{4}_{2}\text{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\uparrow)$, $\hat{n}(\downarrow)$, $\hat{n}(\uparrow)$
15.	$8\left[{}^{4}_{2}\text{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\uparrow)$, $\hat{n}(\uparrow)$, $\hat{n}(\uparrow)$	${}^{39}_{18}\text{Ar}$	unstable decays by β^- emission to ${}^{39}_{19}\text{K}$ with half life of 269.2 y	$9\left[{}^{4}_{2}\text{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\uparrow)$
16.	$4\left[{}^{4}_{2}\text{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\uparrow)$, $\hat{n}(\downarrow)$, $\hat{n}(\uparrow)$	${}^{23}_{10}\text{Ne}$	unstable decays by β^- to ${}^{23}_{11}\text{Na}$ with half life of 37.24 s	$5\left[{}^{4}_{2}\text{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\uparrow)$
17.	$4\left[{}^{4}_{2}\text{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$	${}^{22}_{11}\text{Na}$	unstable decays by β^+ emission to ${}^{22}_{10}\text{Ne}$ with half life of 2.60363 y	$5\left[{}^{4}_{2}\text{He}\right]$, $\hat{n}(\downarrow)$, $\hat{n}(\uparrow)$
18.	$5\left[{}^{4}_{2}\text{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\downarrow)$	${}^{27}_{13}\text{Al}$	stable	not applicable
19.	$5\left[{}^{4}_{2}\text{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\uparrow)$, $\hat{n}(\downarrow)$	${}^{28}_{13}\text{Al}$	unstable decays by β^- emission to ${}^{28}_{14}\text{Si}$ with half life of 2.24133 m	$7\left[{}^{4}_{2}\text{He}\right]$
20.	$4\left[{}^{4}_{2}\text{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\uparrow)$, $\hat{n}(\uparrow)$	${}^{24}_{11}\text{Na}$	unstable decays by β^- emission to ${}^{24}_{12}\text{Mg}$ with half life of 0.985 m	$6\left[{}^{4}_{2}\text{He}\right]$
21.	$x\left[{}^{4}_{2}\text{He}\right]$, $p^+(\uparrow)$	${}^{13}_{07}\text{N}$	unstable decays by β^+ emission to ${}^{13}_{06}\text{C}$ with half life	$3\left[{}^{4}_{2}\text{He}\right]$, $\hat{n}(\uparrow)$

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Table 4 – Continued

S. No.	**Nuclear Configuration**	**Nuclides Nuclides**	**Nuclear Stability/ Instability**	**Nuclear Configuration of Daughter Nuclide**
			of 9.965 m	
		${}^{29}_{15}\text{P}$	unstable decays by β^+ emission to ${}^{29}_{14}\text{Si}$ with half life of 4.142 s	$7\left[{}^4_2\text{He}\right], \hat{n}(\uparrow)$
22.	$6\left[{}^4_2\text{He}\right], p^+(\uparrow), p^+(\downarrow)$	${}^{26}_{14}\text{Si}$	unstable decays by β^+ emission to ${}^{26}_{13}\text{Al}$ with half life of 2.234 s. This further disintegrates by β^+ emission to ${}^{26}_{12}\text{Mg}$ with half life of 7.166×10^5 y	$4\left[{}^4_2\text{He}\right], \hat{d}(\uparrow\uparrow), \hat{d}(\uparrow\uparrow), \hat{d}(\uparrow\uparrow)$ $\hat{d}(\uparrow\uparrow), \hat{d}(\uparrow\uparrow)$ $6\left[{}^4_2\text{He}\right], \hat{n}(\uparrow), \hat{n}(\downarrow)$
23.	$8\left[{}^4_2\text{He}\right], \hat{n}(\downarrow), p^+(\uparrow)$	${}^{34}_{17}\text{Cl}$	unstable decays by β^+ emission to ${}^{34}_{16}\text{S}$ with half life of 1.5264 s	$8\left[{}^4_2\text{He}\right], \hat{n}(\uparrow), \hat{n}(\downarrow)$
24.	$8\left[{}^4_2\text{He}\right], p^+(\uparrow), \hat{d}(\uparrow\uparrow)$	${}^{35}_{18}\text{Ar}$	unstable decays by β^+ emission to ${}^{35}_{17}\text{Cl}$ with half life of 1.775 s	$8\left[{}^4_2\text{He}\right], \hat{d}(\uparrow\uparrow), \hat{n}(\uparrow)$
25.	$p^+(\downarrow), \hat{d}(\uparrow\uparrow)$	${}^{3}_{2}\text{He}$	stable	not applicable
	$3\left[{}^4_2\text{He}\right], p^+(\downarrow), \hat{d}(\uparrow\uparrow)$	${}^{15}_{08}\text{O}$	unstable decays by β^+ emission to ${}^{15}_{07}\text{N}$ with half life of 2.03733 m	$3\left[{}^4_2\text{He}\right], \hat{d}(\uparrow\uparrow), \hat{n}(\downarrow)$
26.	$\left[{}^4_2\text{He}\right], p^+(\uparrow)$ $p^+(\uparrow), \hat{d}(\uparrow\uparrow)$	${}^{8}_{5}\text{B}$	unstable decays by β^+ emission to α-particles with half life of 770 ms	$\left[{}^4_2\text{He}\right], \hat{d}(\uparrow\uparrow), \hat{d}(\downarrow\downarrow)$ $\equiv 2\left[{}^4_2\text{He}\right]$
27.	$5\left[{}^4_2\text{He}\right], \hat{d}(\uparrow\uparrow), \hat{d}(\uparrow\uparrow), p^+(\uparrow)$	${}^{25}_{13}\text{Al}$	unstable decays by β^+ emission to ${}^{25}_{12}\text{Mg}$ with half life	$5\left[{}^4_2\text{He}\right], \hat{d}(\uparrow\uparrow), \hat{d}(\uparrow\uparrow), \hat{n}(\uparrow)$

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Table 4 – Continued

S. No.	**Nuclear Configuration**	**Nuclides Nuclides**	**Nuclear Stability/ Instability**	**Nuclear Configuration of Daughter Nuclide**
			of 7.183 s	
28.	$5\left[{}^4_2\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $p^+(\downarrow)$	${}^{27}_{14}\mathrm{Si}$	unstable decays by β^+ emission to ${}^{27}_{13}\mathrm{Al}$ with half life of 4.16 s	$5\left[{}^4_2\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\downarrow)$

Table 4 provides a summary of nuclear stability/instability of nuclides not covered in Tables 2 and 3. Notice that the following nuclear configurations belong solely to nuclear stability, namely:

1. $3\left[{}^4_2\mathrm{He}\right]$, $\hat{n}(\uparrow)$ and $7\left[{}^4_2\mathrm{He}\right]$, $\hat{n}(\uparrow)$; the nuclides are ${}^{13}_{06}\mathrm{C}$ and ${}^{29}_{14}\mathrm{Si}$ respectively. Thus we see that while isoneutron is unstable but it gets stabilized in the environment of 6 and 14 spin paired isodeuterons.

2. $8\left[{}^4_2\mathrm{He}\right]$, $\hat{n}(\uparrow)$, $\hat{n}(\downarrow)$, $\hat{n}(\uparrow)$, $\hat{n}(\downarrow)$ and $9\left[{}^4_2\mathrm{He}\right]$, $\hat{n}(\uparrow)$, $\hat{n}(\downarrow)$, $\hat{n}(\uparrow)$, $\hat{n}(\downarrow)$; the nuclides are ${}^{36}_{16}\mathrm{S}$ and ${}^{40}_{18}\mathrm{Ar}$ respectively. Notice that the four isoneutrons are spin paired. The environment of spin paired isodeuterons 16 and 18 seems to provide nuclear stability to four spin paired isoneutrons. Is the geometrical arrangement of nucleons plays a role in determining nuclear stability of these nuclides?

3. (i) $\left[{}^4_2\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\uparrow)$, (ii) $2\left[{}^4_2\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\uparrow)$, (iii) $5\left[{}^4_2\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\uparrow)$ and (iv) $8\left[{}^4_2\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\uparrow)$; the nuclides are ${}^{7}_{3}\mathrm{Li}$, ${}^{11}_{05}\mathrm{B}$, ${}^{23}_{11}\mathrm{Na}$ and ${}^{35}_{17}\mathrm{S}$ respectively. Herein single unpaired isoneutron seems to get stabilized even in the presence of one unpaired isodeuteron in combination with spin paired isodeuterons.

4. $8\left[{}^4_2\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\uparrow)$, $\hat{n}(\downarrow)$, $\hat{n}(\uparrow)$, nuclide is ${}^{37}_{17}\mathrm{Cl}$. Notice that out of the three isoneutrons two are spin paired and this combined with one unpaired isodeuteron in the environment of 16 spin paired isodeuterons seems to provide nuclear stability.

5. $3\left[{}^4_2\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\uparrow)$ and $5\left[{}^4_2\mathrm{He}\right]$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\uparrow)$; the nuclides are ${}^{17}_{08}\mathrm{O}$ and ${}^{25}_{12}\mathrm{Mg}$ respectively. This case seems to be similar to that of

1 above. That is a single unpaired isoneutron is in the environment of 6 spin paired isodeuterons and 2 spin unpaired isodeuterons instead of one in 1 above.

6. $5\,[{}^4_2\mathrm{He}]$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $\hat{d}(\uparrow\uparrow)$, $\hat{n}(\downarrow)$; the nuclide is ${}^{27}_{13}\mathrm{Al}$. Its nuclear stability appears to be governed by one spin paired isoneutron in the environment of 10 spin paired isodeuterons even though there are three spin unpaired isodeuterons. It seems that the geometry of packing of nucleons plays a role in determining nuclear stability.

Out of the rest of nuclides of Table 4 in a given type of nuclear configuration some are stable and some are unstable. Why it is so — still needs to be investigated. These nuclides also include spin paired isodeuterons - proton combinations, spin paired isodeuteron-isoneutron-proton combinations and spin paired isodeuterons-spin unpaired isodeuterons-proton combinations. In that only $p^+(\downarrow), \hat{d}(\uparrow\uparrow)$ nuclear configuration, which is of ${}^3_2\mathrm{He}$ isotope, is stable.

6 Some Preliminary Inferences

The fact is that the deuteron is a stable nuclide and neutron is unstable. Therefore, the main line of thinking in developing the above presented nuclear configurations has been that the stability of nuclei against the radioactivity should get reflected in the favourable isodeuteron-isoneutron combinations coupled with the observation that the isolated di-isonutrons and diprotons are unstable. However, from above description we find that there doesn't get evolved a single yard stick for nuclear stability in terms of isodeuteron-isoneutron combination, though we have only analyzed so far the first, second and third row elements of the periodic table. However, as we go to higher mass number elements the neutron number becomes much larger than the atomic number. There we will encounter isodeuteron numbers much less than the isoneutron numbers. To explain the corresponding nuclear stability would be a challenging task unless we are able to identify other factors than the isodeuteron-isoneutron combination.

Of course, we have seen it is difficult to predict, almost in all the cases analyzed, the correct nuclear magnetic moments. This too forces us to identify additional aspects of nuclear stability over and above the isodeuteron-isoneutron combination. Does it points to use genomathematics instead of isomathematics used in the cases of unstable nuclides? This we have already hinted in Section 5.1.2 in connection with our discussion on tritium. Indeed, it appears to be a formidable task but is worth pursuing because it promises a simplistic explanations of the nuclear stability against radioactivity.

Acknowledgement

This work is financially supported by the R. M. Santilli Foundation, Florida, U.S.A.

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