Nuclear magnetic moments, stretched octaves, tones, and the golden ratio. A symphony.

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Abstract: The boundless variety of oscillatory patterns pervading the vacuum constitutes the background of the physical universe. Nuclear magnetic moments appear to be the partition played by nuclides in relation to this musical universe, conducted by the master golden ratio. A classification of chemical elements through their nuclear moments is set forth with respect to nine stretched octaves and thirty six tones.

1. Introduction

The nuclear magnetic moment is an important observable in physics. It is also a useful tool for testing nuclear theoretical models. A number of nuclear structure models such as the independent particle shell proposed in 1949 by Mayer and Jensen [1], or the more recent covariant density functional theory [2] have been developed in the past decades. However, the application of these models for predicting nuclear magnetic moments is still not satisfactory, and the magnetic dipole moment of most atomic nuclei throughout the periodic table remains unexplained [2].

In fact, the magnetic moment of atomic and subatomic particles could be their most important property, should we say "signature". Further, three other important characteristics are directly related to μ through relation (1): mass, charge and spin. In this relation, g is the g-factor which is a corrective coefficient, Q is the charge, S is the quantized spin angular momentum in units of ħ, and m is the rest mass.

$$\mu = g\frac{QS}{2m} \qquad (1)$$

The presence of a corrective coefficient (g) can readily be interpreted as a limitation of our current understanding and description of the nuclear moment. Further, the intrinsic spin angular momentum S can be coarsely viewed as an angular frequency, linked to a rotational kinetic energy. Consequently, μ may also be regarded as bound to a frequency, or vibrational energy. And each particle's vibrating energy is integrated into the symphony of innumerable oscillatory patterns making this universe alive, as revealed by Einstein theory of spacetime, and as rightly postulated by String/M theories.

In this article, it will be shown that:

i. The ubiquitous golden ratio is embedded in nuclear magnetic moments
ii. The classification of chemical elements may proceed from their nuclear moments in relation to 9 stretched octaves and 36 tones involving the golden spiral
iii. Nucleosynthesis might be driven by the complicit interplay of nuclear moments, stretched octaves, and the golden spiral

From the cosmic scale to the quantum scale, the golden ratio is omnipresent in Nature, emerging from numerous physico-chemical and biological processes, as discoveries have been showing in the last decades.

At the atomic and subatomic scale, it was found at [3-4] that the spin of the spiral proton (ħ/2) is the algebraic sum of two opposing angular momenta ħ/2φ and ħφ/2 respectively (signs omitted). It was further demonstrated that the spiral proton is the precursor of the nucleon via an internal process leading to the emergence of quarks [5]. Contrary to Wilczek affirmation [6], quarks are not born free and, as a result, are devoid of self-existence [5].

At the cosmic scale, the earliest implication of the golden ratio took place most likely at the initial steps of the self-division of the primal cosmic Substance, as described at [7-8].

On the other hand, experiments with cobalt niobate [9] revealed that in some conditions, the chain of nuclear spins magnetically resonate, and the frequency of resonant notes are in the ratio of phi. According to the authors, these findings reflect a "hidden symmetry in the quantum system", a symmetry called E8 by mathematicians, which involves the golden ratio.

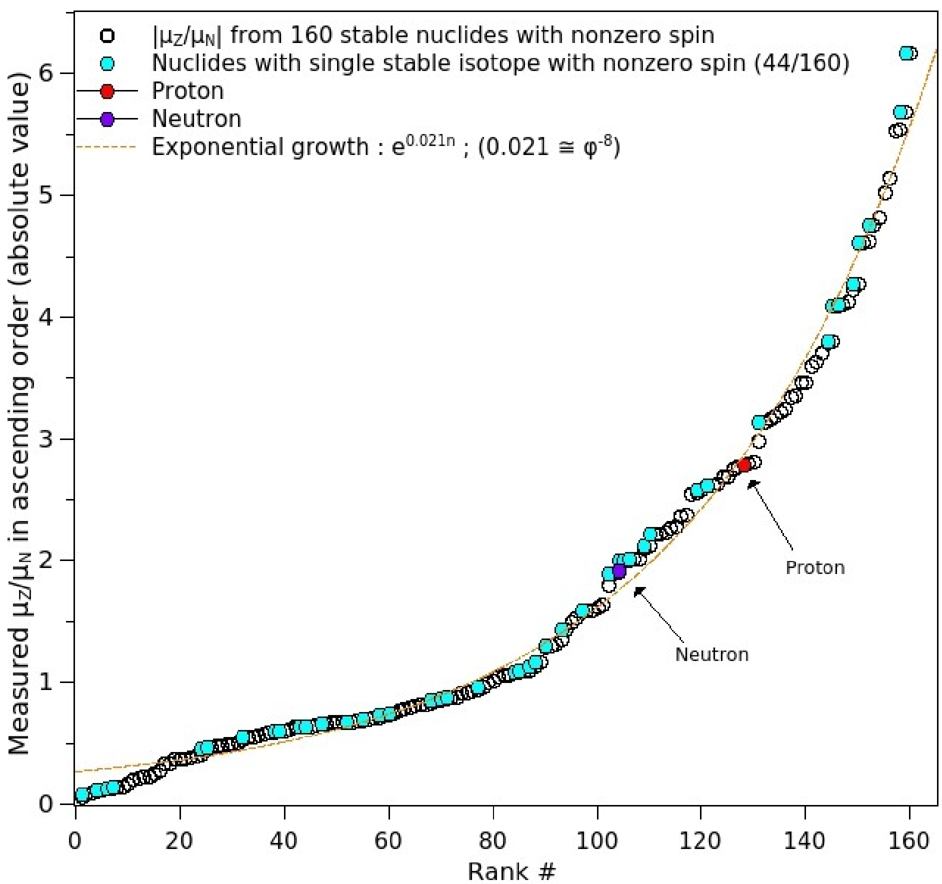
2. Nuclear magnetic moments and the golden spiral

It has been briefly demonstrated at [10] that nuclear moments were somehow linked to the golden spiral. More details are provided in this article.

When the magnetic moments of 160 nuclides [16] from Z=1 to 99 are displayed in ascending order (Fig.1), the exponential growth is readily revealed. The exponential growth factor found was $e^{0.021n}$. Coincidentally the exponent 0.021 is very close to φ^{-8} (~0.0213). In Fig.1, nuclides are successively ranked one unit apart, and those with a single stable nonzero spin isotope (known) are highlighted in light blue. Further, the location of the proton (red) and the neutron (dark blue) are singled out. They readily provide some visual information regarding the positioning of nuclides. The ratio of the highest to the lowest magnetic moment is about 2 orders of magnitude.

Of interest is the sinusoidal profile delineated by the magnetic moments around the exponential fit (dotted green line). This effect is likely caused by the alternate positive or negative magnetic contribution from the electron cloud around the nucleus.

Figure 1: Nuclear magnetic moments in ascending order from 160 nuclides with nonzero spin, showing an exponential progression linked to the golden ratio.



Further and remarkably, when nuclear magnetic moments in ascending order are displayed in polar coordinates R=f(θ), with the radius R defined as the magnitude of the magnetic moment, and the angle θ chosen so that the 160 nuclides are equally spread over 3.82π radian (≅12 radian), an irrefutable connection to the golden ratio is revealed, as depicted in Fig.2 and Fig.3. Further, 3.82π is the optimum value found, which strangely coincides with $10\pi\varphi^{-2}$.

In Fig.2, the absolute value of magnetic moments is considered. However, the magnetic moment signs are retained in Fig.3, revealing the astonishing and ubiquitous double spiral configuration, source of most phenomena in Nature, from the self-division of the primal cosmic Substance [7-8] or the spiral galaxies [11] at the cosmic scale, to particle creation [3-5] at the quantum scale. This astonishing result unfolds a clear link between nuclear magnetic moments and the omnipresent golden ratio. Of further interest is the ratio of negative vs. positive moments μ^-/μ^+ ≈1/2.

Figure 2: Ascending $|\mu_Z/\mu_N|$ spatially spread over 3.82π radian in polar coordinates revealing the embedded golden spiral. $\Theta_i = i*3.82\pi/N$ (i=1-160 nuclei, N=160)

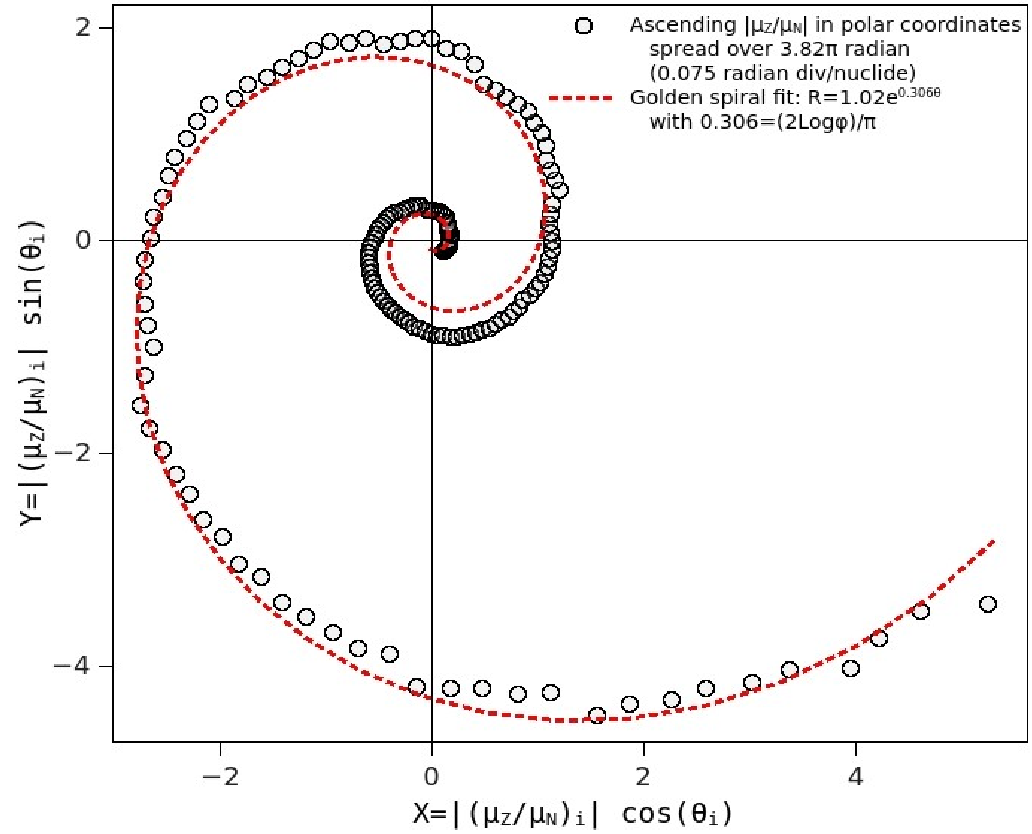
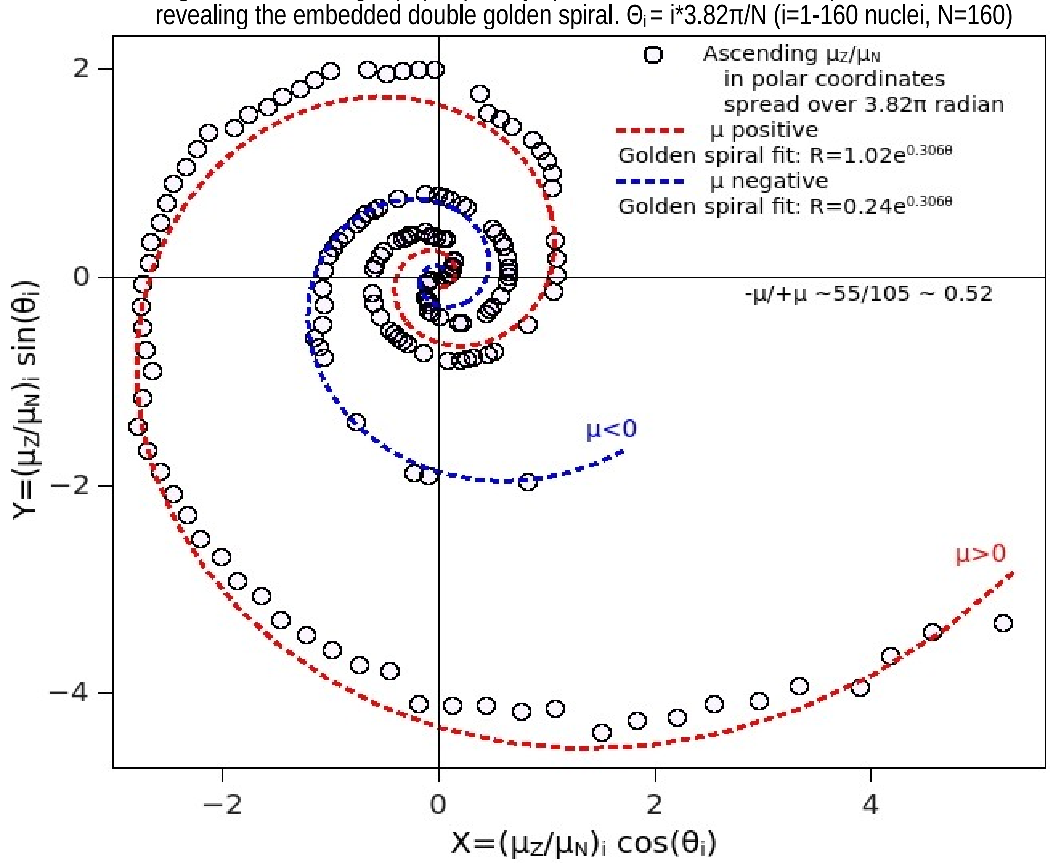


Figure 3: Ascending ± μ_Z/μ_N spatially spread over 3.82π radian in polar coordinates revealing the embedded double golden spiral. $\Theta_i = i*3.82\pi/N$ (i=1-160 nuclei, N=160)



3. The music of nuclear moments: octaves, tones, and golden spirals.

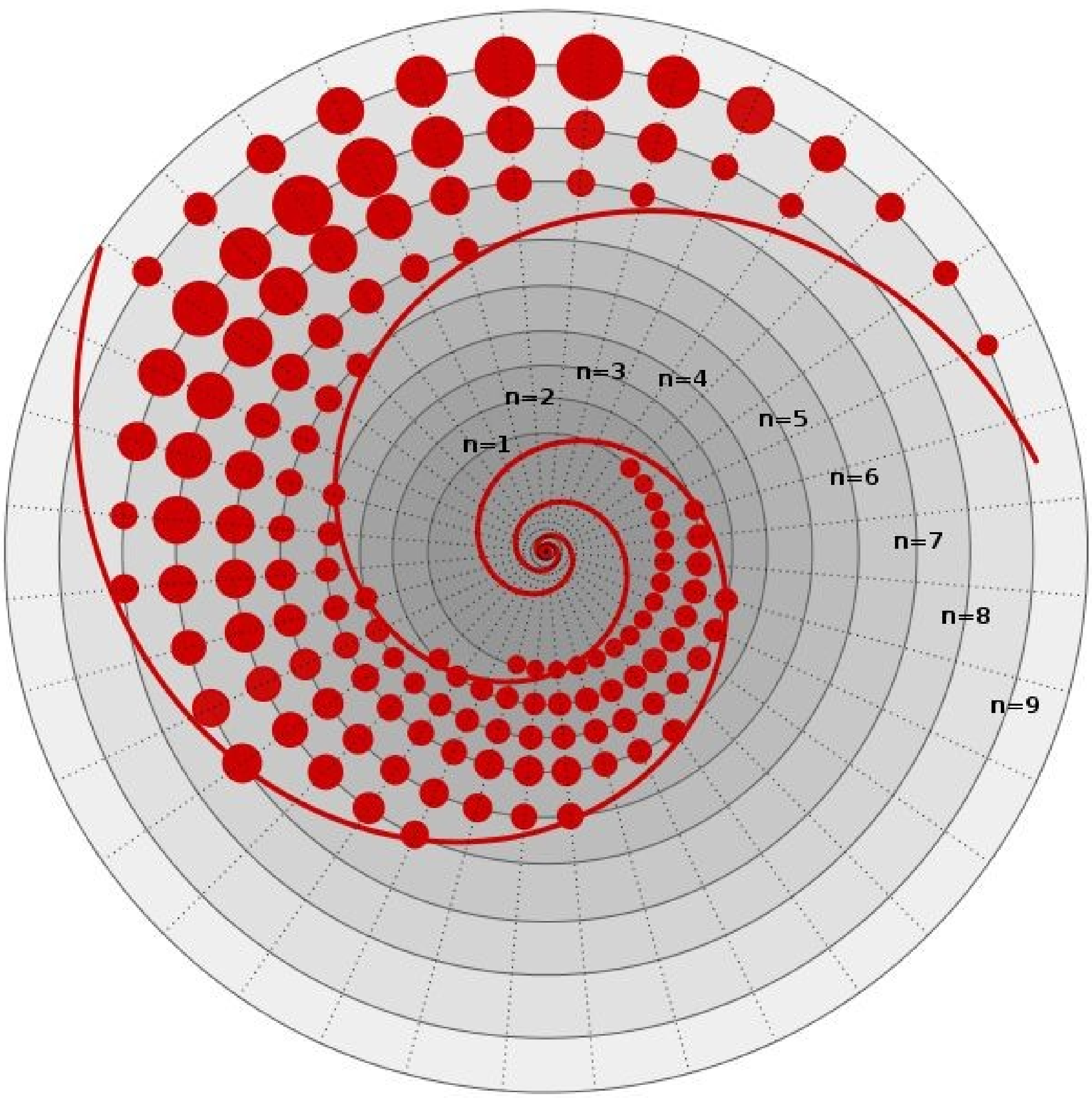
From a global perspective, the true specificity of a nuclide can neither be found in it's mass or size, nor in it's electronic configuration. In this melodic universe where frequencies and oscillation patterns seem to prevail, the genuine identity of a chemical element might reside in it's nuclear moment. In addition, the magnetic moment contains other information about the specific nuclide such as mass, charge, or spin angular momentum. As a corollary, each chemical element would carry at least one nonzero spin isotope, which seems to be the case.

Following these principles, chemical elements can be ordered with respect to their magnetic moments, as represented in Fig.4. In this representation, nuclide radii in red are linearly correlated to magnetic moments $|\mu_Z/\mu_N|$ through formula (2). In this formula, the decimal logarithm reduces the span, while the factor 100 avoids negative logarithm values. For a chemical element Z with multiple stable isotopes with nonzero spin, the magnetic moment displayed in Fig.4 corresponds to the weighted average of all isotopes taking into consideration natural abundances.

$$R = \mathrm{Log}_{10}(\mu_Z/\mu_N * 100) \qquad (2)$$

In Fig.4, the large concentric circles (n=1-9) symbolize nine stretched octaves, whereas tones are illustrated by 36 regularly spaced radial lines. Once more, it can be visually verified that nuclear moments are unmistakably linked to the golden spiral. This model of chemical element classification is astonishing as it outlines many intrinsic features. These features will be reviewed in paragraphs 3.1 to 3.5.

Figure 4: Chemical elements ordered with respect to their nuclear magnetic moments into 9 stretched octaves and 36 tones, revealing the symphony of nuclide magnetic moments under the conductor golden ratio.



3.1 Stretched octaves and the golden ratio

As seen earlier, chemical elements through their nonzero spin isotopes, can be arranged with respect to nine stretched octaves (corresponding to circles n=1-9 in Fig.4). These stretched octaves are defined by Eq. (3), where φ is the golden ratio, k & k' are constants. In this formula, the octave progression factor is 2.178 instead of typically 2, reason why it is referred as "stretched" octave.

$$k(\varphi^{\varphi})^{n} + k' = k(2.178)^{n} + k' \qquad (3)$$

However, and in order to limit the size of Fig.4 so that the whole graph can be fitted in one single display with maximum explicitness, the two following contrivances were applied:

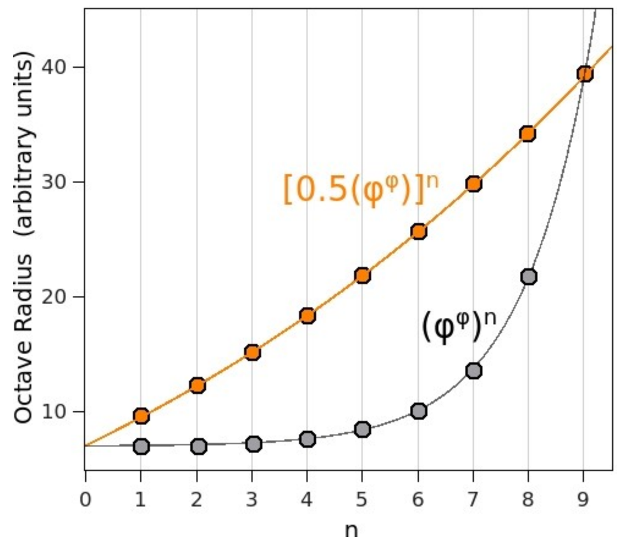
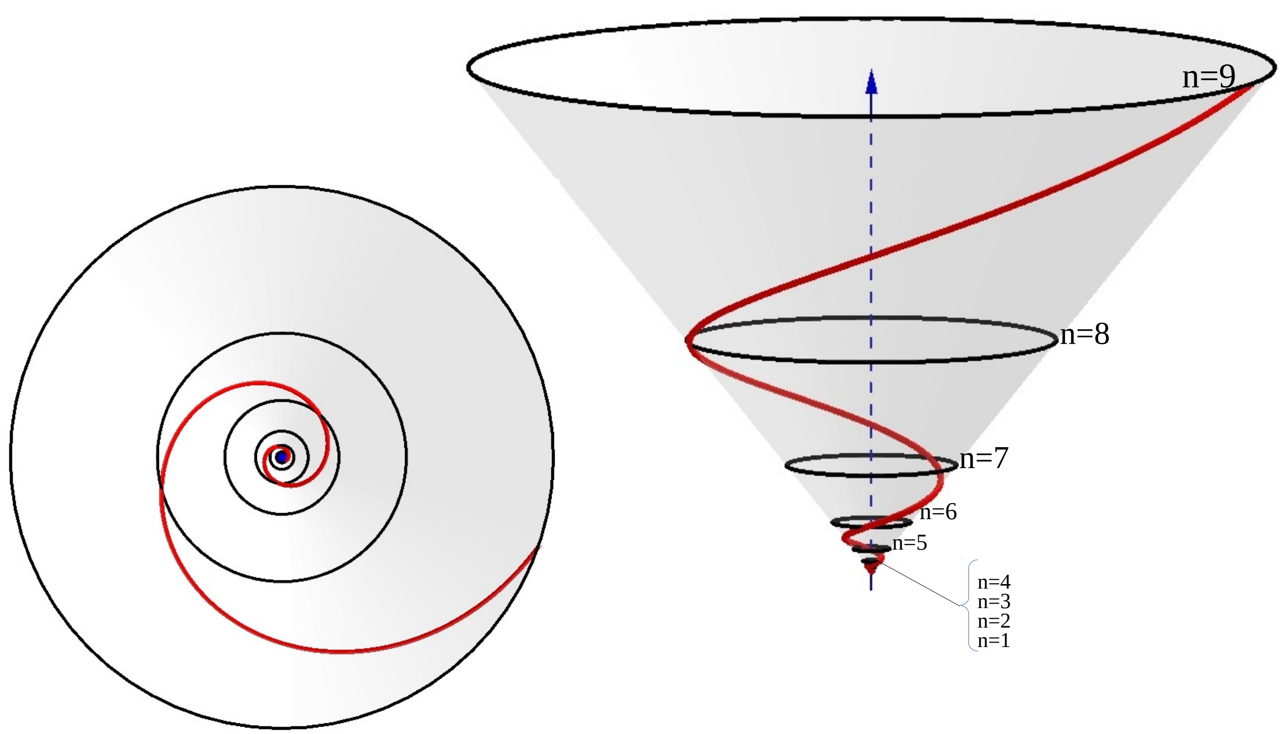


Figure 5: Reduced geometric progression used only for graphing purposes

- The octave factor 2.178 was divided by 2 to get a progression factor of 1.089. This artifice enables adequate distinction and visualization of the nine octave-circles in one display. As can be seen in Fig.5 the two geometric progressions depicted side by side clearly indicate that using the real stretched octave progression 2.178 would lead to poor graphic distinction of the early octaves. The true picture of stretched octaves using Eq. (3) is displayed in Fig.6.
- Magnetic moments of known stable nuclides stretch over ≈2 orders of magnitude. In order to reduce this span and fit adequately magnetic moments in one graph with optimum visual distinction based on radius, the Eq. (2) was used as the correlation factor to determine graphically the corresponding nuclide radius in Fig.4.

Figure 6: Real scale concentric circles representing 9 stretched octaves, as defined by Eq. 3 progression. The golden spiral (red line) reaches n=9 after 6.48π rotation.



3.2 Graphing the progression of nuclear moments in stretched octaves

In Fig.7 nuclear moments are depicted in ascending order, and a mean progression factor of 1.026^n is obtained. In Fig.8, nuclear moments are displayed the way they successively appear in the nine stretched octaves in ascending order from n=1 to 9.

Figure 7: Nuclear moments $|\mu_Z/\mu_N|$ of chemical elements in ascending order. Nuclides with single nonzero spin isotope are displayed for comparison. A tiny shift of ranking is observed, but both progressions are very close.

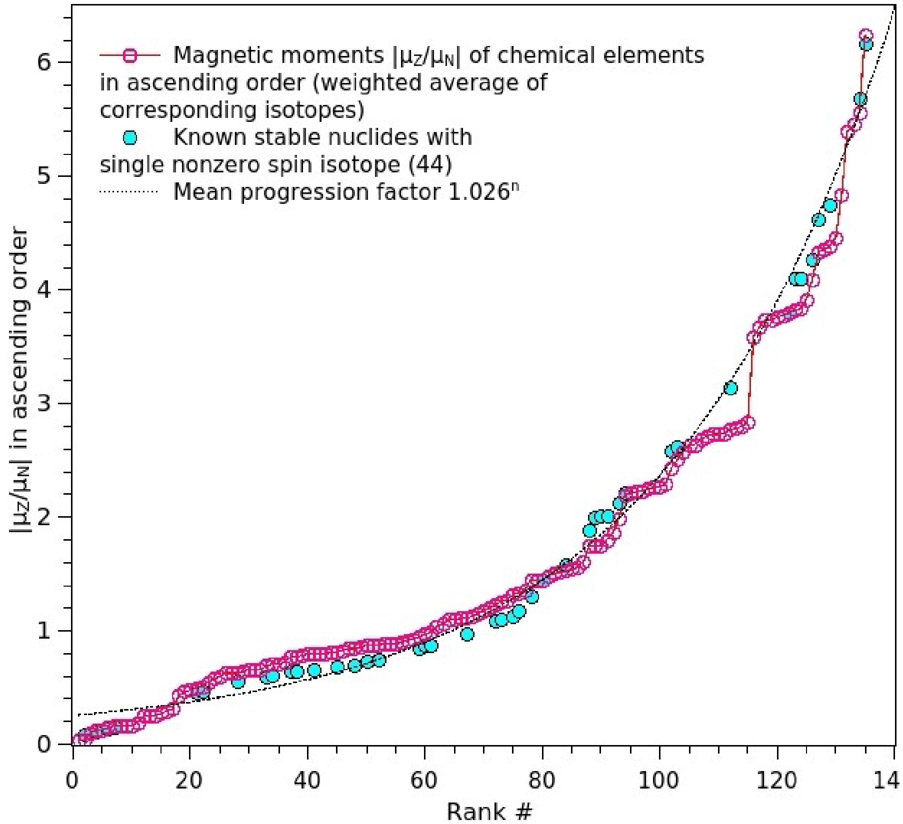
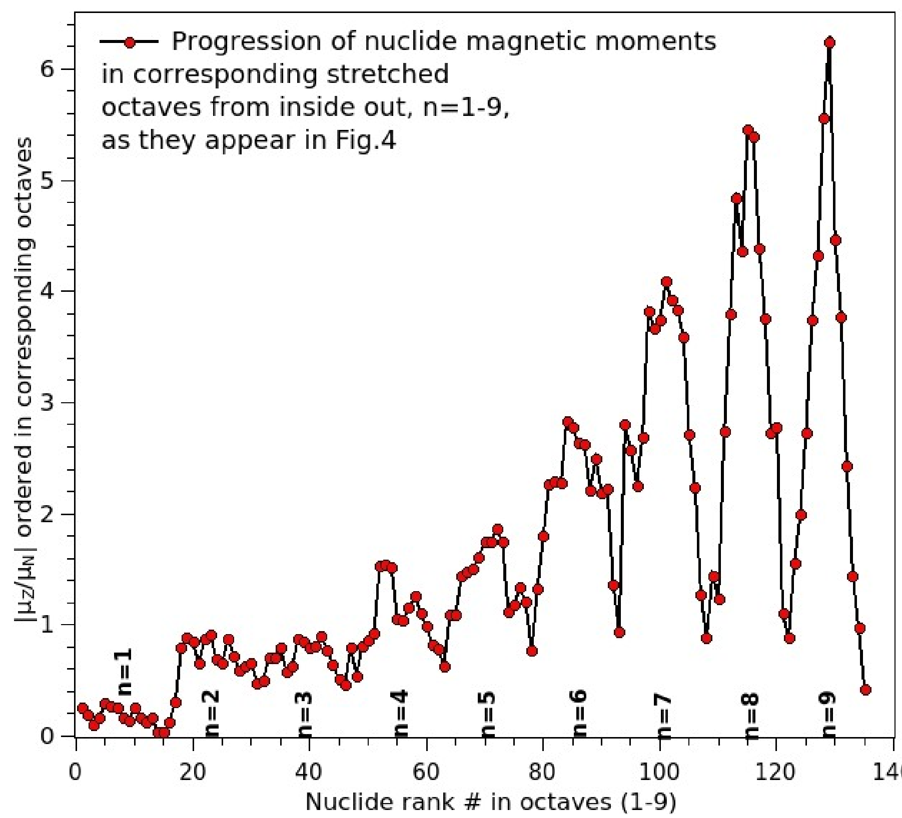


Figure 8: $|\mu_Z/\mu_N|$ of chemical elements progression within each ascending octave (n=1-9). Magnetic moments in each octave express appearance and disappearance, growth and decline.

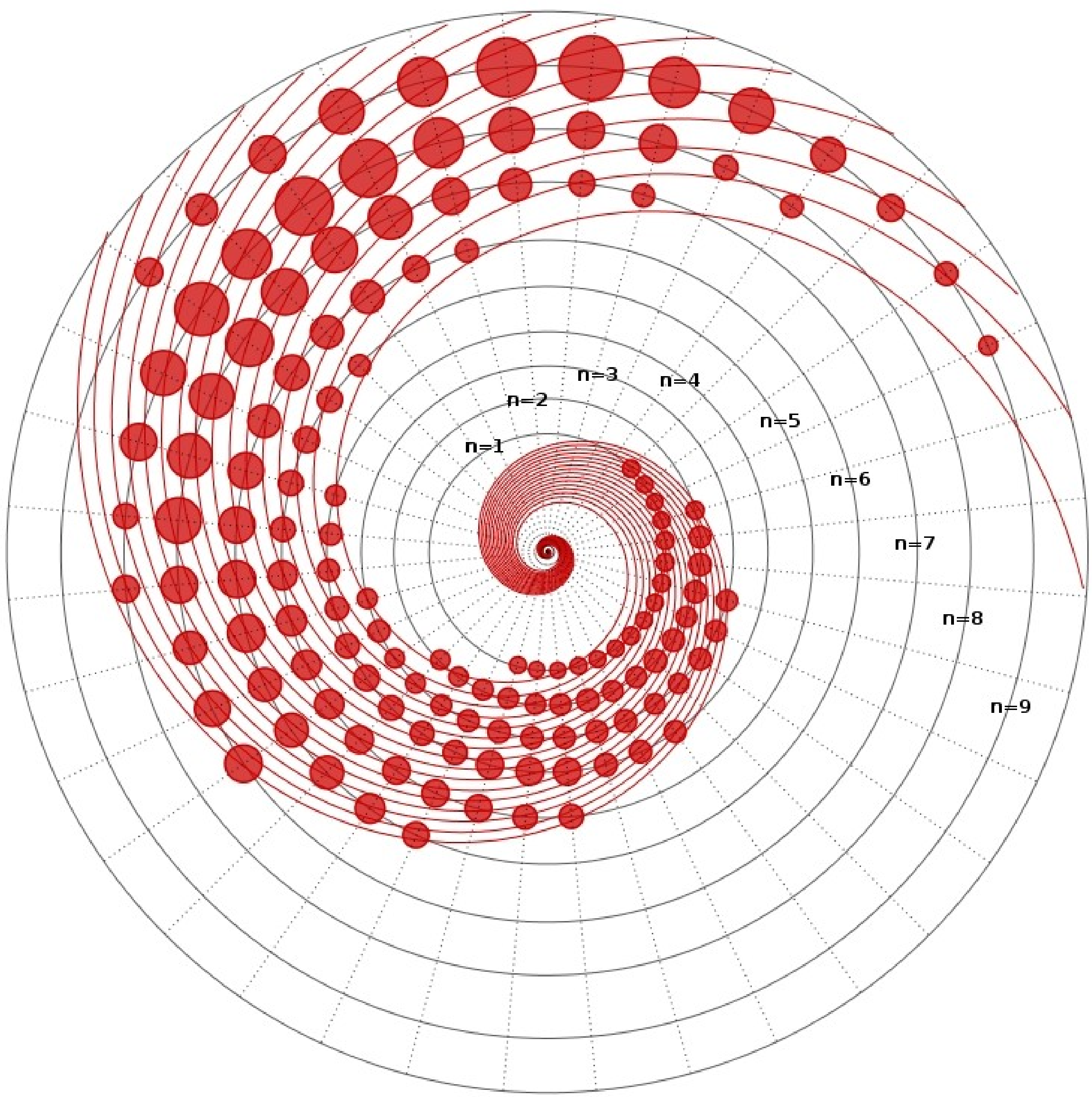


3.3 16 golden spirals, 9 octaves, 36 tones: the nuclear moments' recital

Each nuclear moment within an octave is equivalent to a tone, in reference to musical language, and each octave in Fig.4 carries 13–16 tones. The octave n=1 carries 16 elements, and these 16 elements correspond to the inception of 16 golden spirals bridging all chemical elements, as depicted in Fig.9. Some of them are present in multiplicate as starting points initiating the 16 spirals, while others are yet unknown. Further, this also establishes a bridge with the 16 “pure sounds” previously described at [12].

A total number of Z=135 chemical elements are displayed in Fig.9 due to multiplicate in octave n=1 as cited above. It was conjectured at [12], that the number of chemical elements was Z_{max} =128 for positive mass and Z_{max} =123 for negative mass. A table containing the nuclear moments of those 135 elements is provided in Annex 2. The complete identification of those 135 elements is not yet finalized.

Figure 9: Manual fit of magnetic moments with 16 golden spirals bridging all chemical elements. Stretched octaves (circles) and tones (radial lines) are indicated. Further work using computerized algorithms might be required for a perfect fit.



Matter consists of atomic and sub-atomic constituents that are in constant motion, vibrating and spinning. And in this musical universe, matter has a specific partition, where chemical elements appear related to specific vibratory patterns. As in the words of the 12th century mystic and philosopher Mawlana Jalal-al-Din Rumi: *“Poems are rough notations for the music we are...”* [13].

3.4 Nuclear moments in cycles of appearance and disappearance

Are chemical elements driven by nuclear moments to cycles of appearance and disappearance, growth and decline? Are these cycles linked to nuclide half-life as we understand it? As a matter of fact, Fig.8 and Fig.9 strongly express orderly cycles of appearance and disappearance, indicating that positive mass chemical elements constantly evolve and devolve just like all other visible forms of life. Therefore nuclides seem to progress in an orderly and periodic manner through cycles, driven by their magnetic moments. In each octave, elements evolve through the whole gamut, transmuting from one element to the next until the last tone (or magnetic moment) is reached. At that time, the element goes up the next octave and so forth. When octave n=9 is completed, elements return to octave n=1 and cycle repeats.

This process strangely correlates to some of the concepts posited by Walter Russell about 100 years ago [14]. However, his intuitive postulates have been constantly ignored, despite their luminous insight at times.

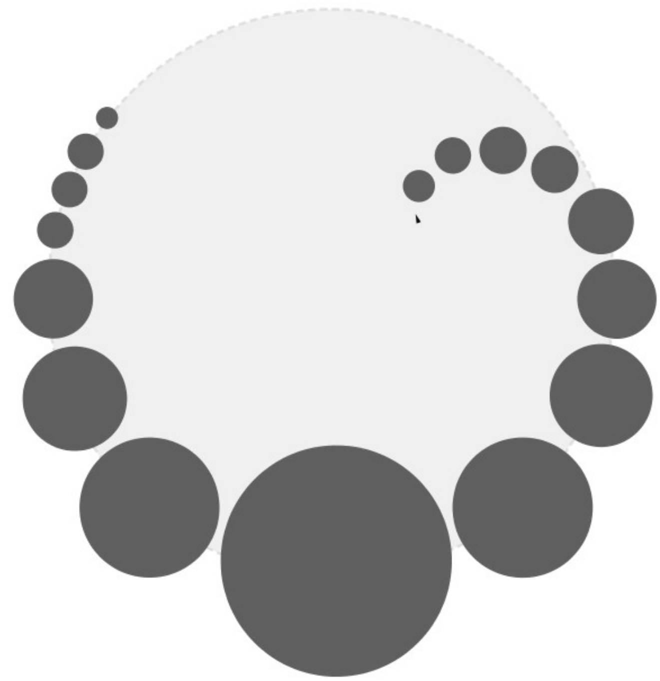


Figure 10: Nuclides are subjected to appearance and disappearances cycles, as exquisitely depicted in this drawing

3.5 Is nuclear moment the driving force to nucleosynthesis?

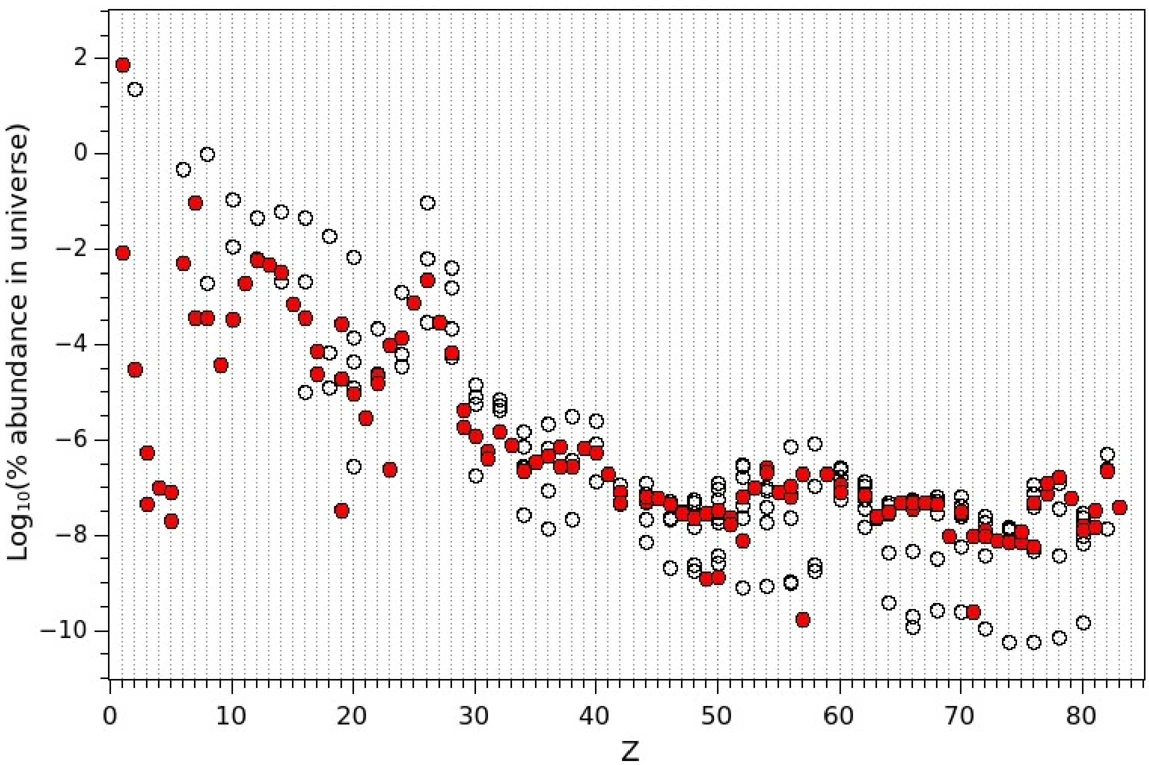
What is the force driving nucleosynthesis? This potency would obviously not benefit from any increase in atomic mass or number of nucleons, nor it's radius. On the other hand, fusing nuclei requires tremendous amounts of energy to overcome electrostatic repulsion, and the nuclear force becomes efficient only at distances ~1 fm. Likewise, the fusion of nuclei is obviously a decrease in entropy, which violates the 2nd law of thermodynamics. Furthermore, the number of existing chemical elements appears much larger than the few nuclides required for the emergence of life (essentially C, H, N, O, P, S), in convergence with the anthropic principle. So what strange potency impels nuclei to fuse, creating heavier elements?

As in the words of Fred Hoyle, the father of modern nucleosynthesis and originator in 1949 of the expression "Big Bang", a theory he nevertheless rejected until his death in 2001: "...*there are no blind forces worth speaking about in nature...*", obviously referring to the Big Bang theory and stellar nucleosynthesis of heavier elements under violent conditions of temperature and pressure. Talking about ^{12}C, F. Hoyle added: "*Some super-calculating intellect must have designed the properties of the carbon atom, otherwise the chance of my finding such an atom through the blind forces of nature would be utterly minuscule...*" [15]

It seems that the nuclear moment (and associated spin / angular frequency) might be the true force driving nucleosynthesis, not as a blind and violent force, but as a subtle impulse from the vacuum energy, guided by specific oscillation patterns, frequency templates, and spiral motifs. As a matter of fact, Einstein theory of spacetime revealed that the universe was not silent but alive with vibrating energy. Electromagnetic frequencies, sound vibrations, gravitational waves (and possibly other yet unknown types of vibrational energies) give rise to a symphony of oscillatory patterns throughout this "musical" universe. And chemical elements are not isolated and independent entities dispersed across the cosmos. Indeed, they are integral part of a global cosmic web structure which is mostly vibrational in nature.

In Fig.11 below was highlighted in red nuclides with nonzero spin amongst 285 stable or long-lived isotopes, as a function of Z. With a very few exceptions, the visible effect is a significant smoothing of dispersion.

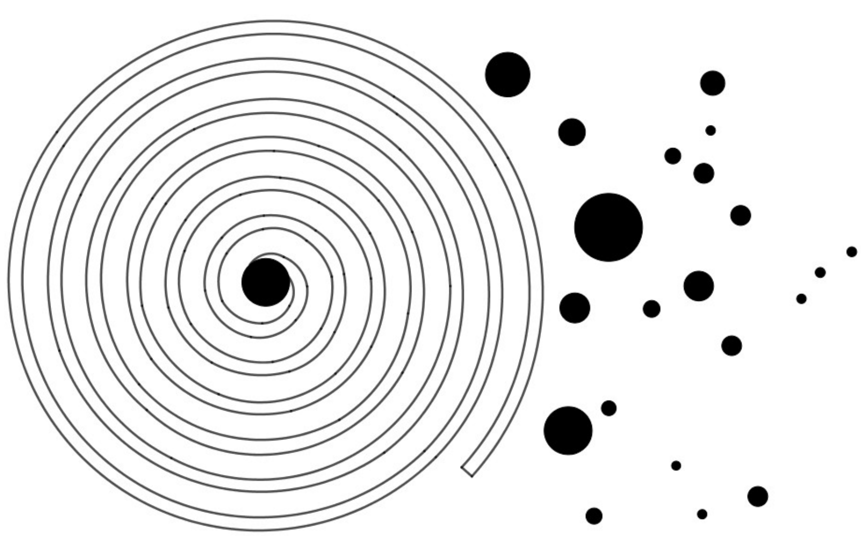
Figure 11: Decimal logarithm of % abundances of 285 stable or long-lived nuclides in the universe as a function of Z. Highlighted in red are nuclides with nonzero spin, which leads to a dramatically reduced coefficient of dispersion.



4. Spiral motion, angular momentum acquisition, particle creation

Spiral motion and angular momentum acquisition are ubiquitous in the visible and invisible universe at various scales. Fig.12 elegantly highlights the spiral process at the heart of continuous particle creation in the vacuum, and leading further to the emergence of matter. The standard model of particle physics and the Big Bang theory require a paradigm shift. Resistance to that effect might further delay our full apprehension of the universe.

Figure 12: Spiral motion and angular momentum acquisition at the heart of continuous particle creation in the vacuum



5. References

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ANNEX 1

Table of 160 nuclides from [16] in ascending order of $|\mu_Z/\mu_N|$

#	Id	A	Z	μ_Z/μ_N	#	Id	A	Z	μ_Z/μ_N	#	Id	A	Z	μ_Z/μ_N	#	Id	A	Z	μ_Z/μ_N
1	Os	187	76	0.065	41	Cd	113	48	−0.622	81	Sn	119	50	−1.047	121	I	129	53	2.621
2	Rh	103	45	−0.088	42	Hf	179	72	−0.641	82	Ce	139	58	1.06	122	F	19	9	2.627
3	Fe	57	26	0.091	43	Ru	99	44	−0.641	83	Nd	143	60	−1.065	123	Sb	125	51	2.63
4	Ag	107	47	−0.114	44	Pd	105	46	−0.642	84	Ce	141	58	1.09	124	B	11	5	2.689
5	W	183	74	0.118	45	S	33	16	0.644	85	Sr	87	38	−1.093	125	La	137	57	2.695
6	Ag	109	47	−0.131	46	Nd	145	60	−0.656	86	Ac	227	89	1.1	126	Rb	87	37	2.752
7	Y	89	39	−0.137	47	Os	189	76	0.66	87	Ti	49	22	−1.104	127	La	139	57	2.783
8	Au	197	79	0.148	48	Ne	21	10	−0.662	88	P	31	15	1.132	128	H	1	1	2.793
9	Ir	191	77	0.151	49	Sm	149	62	−0.672	89	Be	9	4	−1.177	129	Al	26	13	2.804
10	Ir	193	77	0.164	50	Dy	163	66	0.673	90	K	40	19	−1.298	130	I	127	53	2.813
11	Pu	239	94	0.203	51	Yb	173	70	−0.68	91	Zr	91	40	−1.303	131	T	3	1	2.979
12	K	41	19	0.215	52	Pu	241	94	−0.68	92	Ca	43	20	−1.318	132	Np	237	93	3.14
13	Tm	171	69	−0.228	53	Po	209	84	0.68	93	Rb	85	37	1.353	133	Lu	176	71	3.169
14	Tm	169	69	−0.231	54	Cl	37	17	0.684	94	As	75	33	1.439	134	Re	185	75	3.187
15	Gd	155	64	−0.257	55	Xe	131	54	0.692	95	Am	243	95	1.5	135	Re	187	75	3.22
16	N	15	7	−0.283	56	C	13	6	0.702	96	Eu	153	63	1.532	136	Li	7	3	3.256
17	Fe	59	26	−0.336	57	Pb	205	82	0.712	97	Am	241	95	1.58	137	V	50	23	3.346
18	Gd	157	64	−0.337	58	Ru	101	44	−0.716	98	Ar	39	18	−1.59	138	Sb	121	51	3.363
19	Cm	247	96	0.37	59	Ra	225	88	−0.734	99	Ca	41	20	−1.595	139	Mn	55	25	3.469
20	Mo	99	42	0.375	60	Te	123	52	−0.737	100	Tl	203	81	1.622	140	Eu	151	63	3.472
21	U	235	92	−0.38	61	Ni	61	28	−0.75	101	Tl	205	81	1.638	141	Ho	166	67	3.6
22	K	39	19	0.391	62	Xe	129	54	−0.778	102	B	10	5	1.801	142	Al	27	13	3.641
23	N	14	7	0.404	63	Ti	47	22	−0.788	103	O	17	8	−1.894	143	La	138	57	3.714
24	Cm	243	96	0.41	64	Hf	177	72	0.793	104	n	1	0	−1.913	144	Co	60	27	3.799
25	Th	229	90	0.46	65	Sm	147	62	−0.815	105	Bk	249	97	2	145	Pm	145	61	3.8
26	Cr	53	24	−0.474	66	Cl	35	17	0.822	106	Pa	231	91	2.01	146	Es	253	99	4.1
27	Dy	161	66	−0.48	67	Li	6	3	0.822	107	Tb	159	65	2.014	147	Bi	209	83	4.11
28	Er	169	68	0.485	68	Ba	135	56	0.834	108	Ga	69	31	2.016	148	Ho	165	67	4.132
29	Yb	171	70	0.494	69	Mg	25	12	−0.855	109	Br	79	35	2.106	149	Ho	163	67	4.23
30	Cm	245	96	0.5	70	D	2	1	0.857	110	He	3	2	−2.127	150	Pr	141	59	4.275
31	Hg	199	80	0.506	71	Zn	67	30	0.875	111	Na	23	11	2.218	151	Fr	212	87	4.62
32	Se	77	34	0.535	72	Ge	73	32	−0.879	112	Cu	63	29	2.227	152	Co	59	27	4.627
33	Si	29	14	−0.555	73	Te	125	52	−0.888	113	Lu	175	71	2.232	153	Sc	45	21	4.756
34	Hg	201	80	−0.56	74	Mo	95	42	−0.914	114	Br	81	35	2.27	154	Ta	180	73	4.825
35	Er	167	68	−0.564	75	Sn	115	50	−0.919	115	Ta	179	73	2.289	155	Mn	53	25	5.024
36	Pb	207	82	0.582	76	Mo	97	42	−0.933	116	Ta	181	73	2.37	156	V	51	23	5.149
37	U	233	92	0.59	77	Ba	137	56	0.937	117	Cu	65	29	2.382	157	In	113	49	5.529
38	Cd	111	48	−0.595	78	Kr	83	36	−0.971	118	Sb	123	51	2.55	158	In	115	49	5.541
39	Rn	211	86	0.601	79	Sn	117	50	−1.001	119	Ga	71	31	2.562	159	Tc	99	43	5.685
40	Pt	195	78	0.609	80	Se	79	34	−1.018	120	Cs	133	55	2.582	160	Nb	93	41	6.17

ANNEX 2

List of 135 μ_Z/μ_N from chemical elements in order of ascending octave from n=1-9. The values of μ_Z/μ_N are weighted average of all nonzero spin isotopes from a particular element taking into consideration natural abundances in the universe.

1	0.2533	46	0.4625	91	2.224
2	0.1912	47	0.7986	92	1.36
3	0.1016	48	0.5465	93	0.9457
4	0.1656	49	0.8142	94	2.801
5	0.2935	50	0.858	95	2.577
6	0.2734	51	0.9311	96	2.254
7	0.2533	52	1.53	97	2.686
8	0.1702	53	1.542	98	3.827
9	0.1473	54	1.518	99	3.674
10	0.2533	55	1.058	100	3.74
11	0.1656	56	1.044	101	4.087
12	0.129	57	1.153	102	3.92
13	0.1656	58	1.258	103	3.834
14	0.0377	59	1.112	104	3.592
15	0.0377	60	0.9877	105	2.712
16	0.129	61	0.8288	106	2.234
17	0.3117	62	0.784	107	1.271
18	0.7986	63	0.6278	108	0.8873
19	0.8873	64	1.099	109	1.446
20	0.8434	65	1.099	110	1.232
21	0.6598	66	1.446	111	2.74
22	0.8726	67	1.483	112	3.799
23	0.9165	68	1.507	113	4.84
24	0.6909	69	1.613	114	4.363
25	0.6598	70	1.75	115	5.455
26	0.8726	71	1.75	116	5.398
27	0.7228	72	1.86	117	4.383
28	0.5958	73	1.75	118	3.762
29	0.6278	74	1.126	119	2.731
30	0.6598	75	1.18	120	2.784
31	0.4789	76	1.334	121	1.112
32	0.4963	77	1.206	122	0.8873
33	0.7073	78	0.7685	123	1.554
34	0.7073	79	1.322	124	1.989
35	0.7986	80	1.805	125	2.731
36	0.5794	81	2.264	126	3.74
37	0.6278	82	2.293	127	4.33
38	0.8726	83	2.274	128	5.561
39	0.8434	84	2.836	129	6.249
40	0.7986	85	2.775	130	4.462
41	0.8142	86	2.641	131	3.777
42	0.9019	87	2.632	132	2.437
43	0.7685	88	2.215	133	1.446
44	0.6443	89	2.503	134	0.974
45	0.5127	90	2.194	135	0.4278