SunQM-5: Using the Interior {N,n//6} QM to Describe an Atom's Nucleus-Electron System, and to Scan from Sub-quark to Universe (Drafted in April 2018)

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Abstract

In this paper, we proposed a brand new nuclear {N,n//6} QM. It showed that like the Sun-planet system, the atom's nucleus-electron system also follows the {N,n//6} QM. By using the nucleus-electron system's interior {N,n//6} QM with the ground state electron's orbit as e1{0,1}, the nuclides of hydrogen (Z=1), He (Z=2), Li (Z=3), Ne (Z=10), Fe (Z=26), Pd (Z=46), and Og (Z=118) atoms have the interior QM structure (in size) of e1{-3,1//6}, e1{-3,2//6}, e1{-3,3//6}, e1{-3,6//6} = e1{-2,1//6}, e1{-2,2//6}, e1{-2,3//6}, and e1{-2,6//6} = e1{-1,1//6}, respectively. Although all nucleons in those nuclides structured in {N,n//6} QM, this property actually is a hidden property (like a "recessive gene") that only showed up at the interior e1{N,n//6} QM using electron's n=1 shell as the reference point. This is because the strong EM-force shrank the orbital r_{1e} to r_{1e}/Z. The study revealed that Fe atom's nucleus is the only one that has the 100% nucleon occupancy in the n = 1 nucleon orbital shell space (among the size n=2 nuclides from Z = 11 to Z = 26), so that Fe element's nucleus has the most stable nuclear {N,n//6} QM structure in comparison to that of its adjacent elements. This result explains why Fe is more abundant than its adjacent elements, and why Fe atom is the heaviest nucleus that a nuclear fusion reaction can go without adding extra energy. This is exactly like why the inert element Ne is chemically most stable among the electron period 2 elements, because it has the outmost electron shell completely filled (or it has the 100% electron occupancy in the n=2 electron orbital shell space). This analysis revealed that the atom's nuclear {N,n//6} QM structure stability played an important role in determining the abundancy of each element in our universe. Therefore, the nuclear {N,n//6} QM structural analysis significantly improved our knowledge on the nuclear physics. Further analysis showed that although the {N,n//q} QM structures of both atom's nucleus shell and atom's electron shells are primarily in {N,n//6} QM at the low Z#, at the high Z#, both of them shifted to the {N,n//7} QM. Another analysis revealed that {-10,1//6} is the maximum (ever-possible) size of an atom. It also revealed that although {N,n//6} is the fundamental {N,n//q} QM structure in our universe, the disruption of either the primary EM-force or G-force formed {N,n//6} QM structure will form {N,n//q} QM structure with q quantum number other than 6.

Introduction

Based on Bohr model's QM and Schrodinger equation's QM, we developed a new version of QM, named {N,n} QM [1~9]. {N,n} QM has 4 bases: 1) interior {N,n} QM structure, 2) multiplier n' for the fine adjustment, 3) using Schrodinger equation's probability density r^2 *|R(n,*l*)|^2 *|Y(*l*,m)|^2 and maximum mass occupancy theory to fill mass in space of {N,n} shell, 4) RF (rotation diffusion, or RotaFusion) of interior {N,n} QM matter wave. The reason why we want to use the {0,1} based interior {N,n} QM is that our ultimate goal is to use {N,n} QM to study our universe. It is much easier to set the universe as {0,1}, and then calculate everything else inward as the interior {N,n} QM structure. So in this paper, we will first explain how we come up the idea that using interior {N,n} QM to study our universe. Then we will present what we

have achieved in using the interior {N,n} QM to analyze our world (from micro- to macro-). Note: for {N,n} QM nomenclature as well as the general notes for {N,n} QM model, please see SunQM-1 section VII. Note: Microsoft Excel's number format is often used in this paper, for example: x^2 = x^2, 3.4E+12 = 3.4*10^{12}, 5.6E-9 = 5.6*10^{-9}. The reading sequence for SunQM series papers is: SunQM-1, 1s1, 1s2, 1s3, 2, 3, 3s1, 3s2, 3s3, 5, 5s1. For all SunQM series papers, reader should check "SunQM-9s1: Updates and Q/A for SunQM series papers" for the most recent updates and corrections.

Note: the original title of this paper is: SunQM-5: {N,n} QM (a new version of QM based on interior {N,n}, multiplier n', |R(n,*l*)|^2 |Y(*l*,m)|^2 guided mass occupancy, and RF) and its application from sub-quark to universe (drafted in April 2018). The minimum revise has been made after April 2018.

I. Our Universe in view of interior QM

Table 1 (copied from paper SunQM-1s2's Table 1) showed a {N,n//6} QM structural scanning from size of sub-quark to universe. The Cold-G r-track (columns 3 to 5) used Sun-mass black hole's r at {-3,1} as the reference value for the calculation (which is equivalent to the current Sun that has no hydrogen fusion's heating caused size expansion). The Hot-G r-track (columns 6 to 8) used Sun surface's r at {0,2} as the reference value for the calculation (so it is with the Sun's hydrogen fusion heating caused size expansion effect). Columns 9 to 11 used proton's r at {-15,1} as the reference value for the calculation (so it is equivalent to a much higher heating and expansion effect due to it has much larger r). Columns 12 to 14 used electron's n=1 ground state's r at {-12,1} as the reference value for the calculation (and it is equivalent to an even higher heating and expansion effect due to it has the even larger r). Although it is better to use different r-track for different size range, for simplicity, we only use Hot-G r-track for all sizes (from macro- to micro-world) in this paper. Columns 15-16 showed the known objects that correlate to theses sizes, and the best fitted N super-shell set with ΔN = 5. Column 17 showed the N super-shell set (with ΔN = 5) that do not belong to the regular N super-shell set in columns 15-16. Also see SunQM-1s2 for more explanations.

With the data in Table 1, now let us change the angle to view our universe by using the concept of interior {N,n} QM. The following discussion reviewed and extended the discussion in paper SunQM-2 section IV.

First let us study the Sun core's interior QM. Take Sun core as the most top structure {0,1}. Its gravitational interior QM generated a stable QM structure at size of {-15,1}, we call it proton (also can be neutron). There are total ~ 1.19E+57 of this {-15,1} structures (Sun's mass / proton's mass = 1.99E+30 kg / 1.67E-27 kg = 1.19E+57). The {-15,1} structures sit not only at the center of {0,1} structure, but also everywhere inside {0,1} structure (and lots of them sit inside {0,2} structure). The distribution of {-15,1} structures inside {0,1} structure follows the gravitational interior QM of {0,1}, so it has high density at the center of {0,1} and low density at the edge of {0,1} structure, and it forms the fine interior QM structures, like Sun's {-1,n=1…5}o, {-2,n=1…5}o, … etc. Here the important thing is, we only have the total mass, and the space limitation (size of Sun core) for this mass, then the gravitational interior QM will determine the elementary particles, the mass distribution, etc. Note: for a matter wave view of Solar interior {N,n} QM, see SunQM-2 section IV-c.

Now let us repeat this analysis by using another system, say the whole Solar system (up to size of {5,1}). For this, we need to reset Solar QM's {5,1} as the most top structure {0,1}, and name it as **solarsys{0,1//6}**. Its gravitational interior QM generated a stable QM structure at size of solarsys{-20,1//6}, we call it proton (or neutron). The distribution of many solarsys{-20,1//6} structures inside solarsys{0,1//6} structure follows the gravitational interior QM of solarsys{0,1//6}, so some of these solarsys{-20,1//6} structures form a stable solarsys{-5,2//6} QM structure (we call it Sun) at the center of solarsys{0,1//6} structure. Some other solarsys{-20,1//6} structures (there are 3.57E+51 of them, calculated as Earth's mass / proton's mass = 5.97E+24 kg / 1.67E-27 kg = 3.57E+51) formed a stable QM structure in shell of solarsys{-4,5//6}, we call it Earth. Again, here we only have the total mass, and the space limitation (size of Solar system) for this mass, then the gravitational interior QM will determine the elementary particles, the mass distribution, etc.

Table 1. {N,n//6} scanning from sub-quark to universe. Start from: 1) Sun black hole {-3,1} r = 2.95E+3 meters; 2) Sun core {0,1} r = 1.74E+8 meters; 3) proton {-15,1} r = 8.4E-16 meters; 4) electron n =1 ground state {-12,1} r = 5.29E-11 meters. Using ΔN = ±1 (or 36×) to scan up and down.

N=	total n=	Cold-G r track m	AU	ly	Hot-G r track m	AU	ly	proton r track m	AU	ly	electron(n=1) r track m	AU	ly	object correlated	{K,N//6,n//6}
-29	2.71E-23	1.01E-37			1.28E-37			1.37E-37			1.85E-37				
-28	1.63E-22	3.65E-36			4.61E-36			4.92E-36			6.65E-36			{-28,4} Planck length 1.6E-35	
-27	9.77E-22	1.31E-34			1.66E-34			1.77E-34			2.39E-34				
-26	5.86E-21	4.73E-33			5.98E-33			6.38E-33			8.61E-33				
-25	3.52E-20	1.70E-31			2.15E-31			2.30E-31			3.10E-31			{-25,1}	{-5,0,1}
-24	2.11E-19	6.13E-30			7.75E-30			8.27E-30			1.12E-29				
-23	1.27E-18	2.21E-28			2.79E-28			2.98E-28			4.02E-28				
-22	7.60E-18	7.94E-27			1.00E-26			1.07E-26			1.45E-26				
-21	4.56E-17	2.86E-25			3.61E-25			3.86E-25			5.21E-25				
-20	2.74E-16	1.03E-23			1.30E-23			1.39E-23			1.88E-23			{-20,1}	{-4,0,1}
-19	1.64E-15	3.71E-22			4.68E-22			5.00E-22			6.75E-22				
-18	9.85E-15	1.33E-20			1.69E-20			1.80E-20			2.43E-20				
-17	5.91E-14	4.80E-19			6.07E-19			6.48E-19			8.75E-19			{-17,1} quark r=4.3E-19	
-16	3.54E-13	1.73E-17			2.19E-17			2.33E-17			3.15E-17				
-15	2.13E-12	6.23E-16			7.87E-16			***8.40E-16***			1.13E-15			{-15,1} proton r=8.4E-16	{-3,0,1}
-14	1.28E-11	2.24E-14			2.83E-14			3.02E-14			4.08E-14				
-13	7.66E-11	8.07E-13			1.02E-12			1.09E-12			1.47E-12				
-12	4.59E-10	2.90E-11			3.67E-11			3.92E-11			***5.29E-11***			{-12,1} H-atom r	
-11	2.76E-09	1.05E-09			1.32E-09			1.41E-09			1.90E-09			{-11,1} Pb atom r=1.8E-9	
-10	1.65E-08	3.76E-08			4.76E-08			5.08E-08			6.86E-08			{-10,1} 50 nm	{-2,0,1}
-9	9.92E-08	1.36E-06			1.71E-06			1.83E-06			2.47E-06				
-8	5.95E-07	4.88E-05			6.17E-05			6.58E-05			8.89E-05				
-7	3.57E-06	1.76E-03			2.22E-03			2.37E-03			3.20E-03				
-6	2.14E-05	6.32E-02			7.99E-02			8.53E-02			1.15E-01				
-5	1.29E-04	2.28E+00			2.88E+00			3.07E+00			4.15E+00			{-5,1} meter	{-1,0,1}
-4	7.72E-04	8.19E+01			1.04E+02			1.11E+02			1.49E+02				
-3	4.63E-03	***2.95E+03***			3.73E+03			3.98E+03			5.37E+03			{-3,1} Sun black hole r=2.95E+3	
-2	2.78E-02	1.06E+05			1.34E+05			1.43E+05			1.93E+05				
-1	1.67E-01	3.82E+06			4.83E+06			5.16E+06			6.96E+06			{-1,1} Earth size	
0	1	1.38E+08			***1.74E+08***			1.86E+08			2.51E+08			Sun core g{0,1} gravity-r	{0,0,1}
1	6	4.95E+09			6.26E+09			6.69E+09			9.02E+09				
2	36	1.78E+11	1.19E+00		2.25E+11	1.51E+00		2.41E+11	1.61E+00		3.25E+11	2.17E+00		Mars {2,1} gravity-r	
3	216	6.42E+12	4.29E+01		8.11E+12	5.42E+01		8.66E+12	5.79E+01		1.17E+13	7.82E+01		Kuiper belt {3,1}	
4	1296	2.31E+14	1.55E+03	2.44E-02	2.92E+14	1.95E+03	3.09E-02	3.12E+14	2.08E+03	3.30E-02	4.21E+14	2.81E+03	4.45E-02	Oort begin {4,1}	
5	7776	8.32E+15	5.56E+04	8.80E-01	1.05E+16	7.03E+04	1.11E+00	1.12E+16	7.51E+04	1.19E+00	1.52E+16	1.01E+05	1.60E+00	Oort end {5,1}	{1,0,1}
6	4.67E+04	3.00E+17	2.00E+06	3.17E+01	3.79E+17	2.53E+06	4.00E+01	4.04E+17	2.70E+06	4.27E+01	5.46E+17	3.65E+06	5.77E+01		
7	2.80E+05	1.08E+19	7.21E+07	1.14E+03	1.36E+19	9.11E+07	1.44E+03	1.46E+19	9.73E+07	1.54E+03	1.96E+19	1.31E+08	2.08E+03		
8	1.68E+06	3.88E+20	2.60E+09	4.10E+04	4.91E+20	3.28E+09	5.19E+04	5.24E+20	3.50E+09	5.54E+04	7.07E+20	4.73E+09	7.47E+04	{8,1} Milky way, r=5~9E+4 ly	
9	1.01E+07	1.40E+22	9.34E+10	1.48E+06	1.77E+22	1.18E+11	1.87E+06	1.89E+22	1.26E+11	1.99E+06	2.55E+22	1.70E+11	2.69E+06	{9,1} to Andromeda Galaxy, {9,2} local group	
10	6.05E+07	5.03E+23	3.36E+12	5.32E+07	6.36E+23	4.25E+12	6.72E+07	6.79E+23	4.54E+12	7.18E+07	9.16E+23	6.13E+12	9.69E+07	{10,1} Virgo SupClst r=5.5E+7 ly	{2,0,1}
11	3.63E+08	1.81E+25	1.21E+14	1.91E+09	2.29E+25	1.53E+14	2.42E+09	2.44E+25	1.63E+14	2.58E+09	3.30E+25	2.21E+14	3.49E+09	{10,2} Laniakea r=2.6E+8ly	
12	2.18E+09	6.52E+26	4.36E+15	6.89E+10	8.24E+26	5.51E+15	8.71E+10	8.80E+26	5.88E+15	9.30E+10	1.19E+27	7.94E+15	1.26E+11	{11,5} observ Univ r=4.4E+26	
13	1.31E+10	2.35E+28	1.57E+17	2.48E+12	2.97E+28	1.98E+17	3.14E+12	3.17E+28	2.12E+17	3.35E+12	4.28E+28	2.86E+17	4.52E+12	{13,1} our Universe?	
14	7.84E+10	8.45E+29	5.65E+18	8.93E+13	1.07E+30	7.14E+18	1.13E+14	1.14E+30	7.62E+18	1.21E+14	1.54E+30	1.03E+19	1.63E+14		
15	4.70E+11	3.04E+31	2.03E+20	3.22E+15	3.85E+31	2.57E+20	4.06E+15	4.11E+31	2.74E+20	4.34E+15	5.54E+31	3.70E+20	5.86E+15	{15,1} our universe?	{3,0,1}
16	2.82E+12	1.10E+33	7.32E+21	1.16E+17	1.38E+33	9.25E+21	1.46E+17	1.48E+33	9.88E+21	1.56E+17	1.99E+33	1.33E+22	2.11E+17		
17	1.69E+13	3.94E+34	2.64E+23	4.17E+18	4.98E+34	3.33E+23	5.27E+18	5.32E+34	3.56E+23	5.62E+18	7.18E+34	4.80E+23	7.59E+18		
18	1.02E+14	1.42E+36	9.49E+24	1.50E+20	1.79E+36	1.20E+25	1.90E+20	1.92E+36	1.28E+25	2.02E+20	2.59E+36	1.73E+25	2.73E+20		
19	6.09E+14	5.11E+37	3.42E+26	5.40E+21	6.46E+37	4.32E+26	6.83E+21	6.90E+37	4.61E+26	7.29E+21	9.31E+37	6.22E+26	9.84E+21		
20	3.66E+15	1.84E+39	1.23E+28	1.94E+23	2.32E+39	1.55E+28	2.46E+23	2.48E+39	1.66E+28	2.62E+23	3.35E+39	2.24E+28	3.54E+23		{4,0,1}
21	2.19E+16	6.62E+40	4.43E+29	7.00E+24	8.37E+40	5.59E+29	8.85E+24	8.94E+40	5.97E+29	9.45E+24	1.21E+41	8.06E+29	1.27E+25		
22	1.32E+17	2.38E+42	1.59E+31	2.52E+26	3.01E+42	2.01E+31	3.18E+26	3.22E+42	2.15E+31	3.40E+26	4.34E+42	2.90E+31	4.59E+26		
23	7.90E+17	8.58E+43	5.74E+32	9.07E+27	1.08E+44	7.25E+32	1.15E+28	1.16E+44	7.74E+32	1.22E+28	1.56E+44	1.04E+33	1.65E+28		
24	4.74E+18	3.09E+45	2.07E+34	3.27E+29	3.91E+45	2.61E+34	4.13E+29	4.17E+45	2.79E+34	4.41E+29	5.63E+45	3.76E+34	5.95E+29		
25	2.84E+19	1.11E+47	7.44E+35	1.18E+31	1.41E+47	9.40E+35	1.49E+31	1.50E+47	1.00E+36	1.59E+31	2.03E+47	1.35E+36	2.14E+31	{25,1} our universe?	{5,0,1}

Note: in this simple scale up/down calculation, the possible non-linearity of space at extreme larger end (and/or extreme small end) is not included.

Note: the size of quark is obtained from [10].

We can expand this analysis to the galaxy, Virgo super cluster, or even to our universe. Now let us apply this analysis to our universe. We set the whole universe as the most top structure {0,1}, and we name it as **univ{0,1//6}**. Its gravitational interior QM generated a stable QM structure at size of univ{-NN,1//6}, we call it proton (or neutron). We do not know exactly what NN number is, but we guess it is around 28~30, (estimated from Table 1, proton is {-15,1}, universe may be {13,1} to {15,1}). The distribution of many univ{-NN,1//6} structures inside univ{0,1//6} structure follows the

gravitational interior QM of univ{0,1//6}, so some of these univ{-NN,1//6} structures form a stable univ{-NN+15+8,1//6) QM structure (we call it Milky Way, in Table 8, at size of {8,1}) inside the univ{0,1//6} structure. Some other of these univ{-NN,1//6} structures form a stable univ{-NN+15+5,1//6) QM structure (we call it Solar system, in Table 1, at size of {5,1}) inside the univ{0,1//6} structure. Here the importance thing is, our universe can be treated as the only most top structure (with fixed total mass and space, the slow expansion of universe is ignored here), its gravitational interior QM will determine the elementary particles, the mass distribution, etc.

The traditional (exterior) QM provides us a bottom-up view of universe, a lot of details, but more difficult to get the whole picture of our universe. In contrast, the interior QM presents us a top-down view of the universe, which may have a profound impact on the current theories of our universe.

Now if somebody says the proton is not element enough as the elementary particles, and want to use quark ({-17,1} in Table 1) as the elementary particle, then in above analysis, we only need to replace -NN by -NN-2, that is all.

For a matter wave view of universe's interior {N,n} QM, see SunQM-2 section IV-c. For why the $r_n = r_1 *n^2$ can be used for 3D {N,n} QM analysis, please see SunQM-3s1. For why the Solar QM {N,n//6} structure analysis can be extended to from sub-quark to universe, please see SunQM-1s2 section V. For the rest part of this paper, we will present how we use the interior {N,n} QM to study our real world (from micro to macro).

II. Treating nucleus as the interior {N,n} QM structure of the ground state electron orbit {0,1//6}o revealed that the all nucleons in a nucleus also follow the {N,n//6} QM structure

(Note: I am not a nuclear physicist. I am citizen scientist of QM. All I did here is to use {N,n//6} QM to study the nuclear physics).

II-a. Uncovering the hidden {N,n//6} QM structure for atom's nucleus-electron system

Since the Bohr model was developed for hydrogen atom's proton-electron system, for {N,n} QM, we also started from the atom's nucleus-electron system. In this section, we treated the nucleus as the interior {N,n} QM structure of the ground state electron {0,1} (named as **e1{0,1}**) for atom's nucleus-electron system. The way to do this is, for each one of 118 chemical elements, we calculated the r for nucleus (named as nuc-r, or $\mathbf{r_{nuc}}$) and r for n = 1 state electron (named $\mathbf{r_{e1}}$). So we can determine their interior {N,n} QM by calculating the n number = sqrt(r_{nuc} /r_{e1}). Then we look for the interior {N,n//6} QM character. To do this, we constructed the Table 2.

In columns 1 through 6 of Table 2, the basic information of 118 elements, was copied from [11], and updated according to wiki "periodic table".

The main purpose of column 7 to 11 in Table 2 is to calculate out each element nucleus' r, and then the interior n (relative to hydrogen element's nucleus r and n). In column 7, all elements (except H) 's nucleus r_{e1} are adjusted to r_1/Z due to its Z protons shrink the r_{e1}. In column 8, all element's (except H's and He's) r_{nuc} were calculated as (see [12]): r_{nuc} = 1.25E-15 * (M#)^(1/3), where M# is the Atomic mass number (the number of protons Z, plus the number of neutrons N). The Hydrogen element's r_{nuc} = 8.4E-16 meters, was from wiki "proton", not from the calculation using the formula. The Helium element's r_{nuc} = 1.92E-15 meters was obtained from experiment data [13], and the formula calculated result was r_{nuc} = 1.98E-15 meters. In column 9, all elements' r_{nuc} were normalized to their own adjusted r_{e1}, named r_{nuc}/r_{e1}. In column 10, each element's r_{nuc}/r_{e1} was further normalized to hydrogen element's r_{nuc}/r_{e1} (=8.4E-16 / 5.29E-11). In column 11 (which took the square-root of column 10), it gave each element r_{nuc}'s (interior) quantum number $\mathbf{n_{nuc}}$ (against to the shrunk r_{e1} of this element) which was normalized to that of Hydrogen element. We can see that r_{nuc} (or size) of nucleus of H, He, Li, B, N, F/Ne has n_{nuc} = 1, 2, 3, 4, 5, 6, against its own shrunk r_{e1}, if we set H's r_{nuc} as n_{nuc} = 1.

Table 2. Calculation of interior {N,n} QM system for nuclear-electron system based on e1{0,1}.

						calc. nuc-n relative to H's nuc-n							calc atom-r use nuc-n		atom size n=2 effect			relativistic n_{nuc}		
						adj. r_{e1}	r_{nuc}						atom-r	atom-r'						
Name	Symbol	proton # Z	Mass #	atomic #	neutron #	$r_{e1}=r_1/Z$	r_{nuc}=1.25E-15*M^(1/3)	r_{nuc}/r_{e1}	$(r_{nuc}/r_{e1})/(H\text{-}r_{nuc}/H\text{-}r_{e1})$	**n_{nuc} =sqrt(r_n/r_1)**	interior r_{nuc} =(n_{nuc}/6^3)^2*r_{e1}	interior {N,n} use adj r_1=e1{0,1}	r=r_{e1}*n_{nuc}^2	r'=r_1*n^2 r_1=r_1/Z, use n_{nuc}	theory calc. atom-r	atom-n =sqrt(atom-r_n/H-r_1)	atom-n =sqrt(atom-r_n/r_{e1})	v_1=sqrt[(Ze^2/4πε$_0$)/r_{e1}/m]	relativistic r_{e1r}=r_1/Z*sqrt(1-v_1^2/c^2)	relativ. n_{nuc} =sqrt(r_n/r_{e1r})
						m	m		m		m		m	m	E-12, m			m/s	m	
Hydrogen	H	1	1	1	0	5.29E-11	*8.4E-16*	1.59E-05	1.00E+00	1.0	1.13E-15	e1{-3,1}	5.29E-11	5.29E-11	53	1.00	1.00	2.19E+06	5.29E-11	1.0
Helium	He	2	4	2	2	2.65E-11	*1.92E-15*	7.26E-05	4.57E+00	2.1	2.59E-15	e1{-3,2}	2.42E-10	1.21E-10	31	0.76	0.77	4.38E+06	2.64E-11	2.1
Lithium	Li	3	7	3	4	1.76E-11	2.39E-15	1.36E-04	8.54E+00	2.9	3.23E-15	e1{-3,3}	4.52E-10	1.51E-10	167	1.78	1.78	6.56E+06	1.76E-11	2.9
Beryllium	Be	4	9	4	5	1.32E-11	2.60E-15	1.97E-04	1.24E+01	3.5	3.51E-15		6.55E-10	1.64E-10	112	1.45	1.46	8.75E+06	1.32E-11	3.5
Boron	B	5	11	5	6	1.06E-11	2.78E-15	2.63E-04	1.65E+01	4.1	3.75E-15	e1{-3,4}	8.75E-10	1.75E-10	87	1.28	1.28	1.09E+07	1.06E-11	4.1
Carbon	C	6	12	6	6	8.82E-12	2.86E-15	3.25E-04	2.04E+01	4.5	3.86E-15		1.08E-09	1.80E-10	67	1.12	1.13	1.31E+07	8.81E-12	4.5
Nitrogen	N	7	14	7	7	7.56E-12	3.01E-15	3.99E-04	2.51E+01	5.0	4.07E-15	e1{-3,5}	1.33E-09	1.90E-10	56	1.03	1.03	1.53E+07	7.55E-12	5.0
Oxygen	O	8	16	8	8	6.61E-12	3.15E-15	4.76E-04	3.00E+01	5.5	4.25E-15		1.59E-09	1.98E-10	48	0.95	0.95	1.75E+07	6.60E-12	5.5
Fluorine	F	9	19	9	10	5.88E-12	3.34E-15	5.67E-04	3.57E+01	6.0	4.50E-15	e1{-3,6}	1.89E-09	2.10E-10	42	0.89	0.89	1.97E+07	5.87E-12	6.0
Neon	Ne	10	20	10	10	5.29E-12	3.39E-15	6.41E-04	4.04E+01	6.4	4.58E-15	e1{-3,6}	2.14E-09	2.14E-10	38	0.85	0.85	2.19E+07	5.28E-12	6.4
Sodium	Na	11	23	11	12	4.81E-12	3.55E-15	7.39E-04	4.66E+01	6.8	4.80E-15		2.46E-09	2.24E-10	190	1.89	1.90	2.41E+07	4.79E-12	6.8
Magnesium	Mg	12	24	12	12	4.41E-12	3.61E-15	8.18E-04	5.15E+01	7.2	4.87E-15		2.72E-09	2.27E-10	145	1.65	1.66	2.63E+07	4.39E-12	7.2
Aluminium	Al	13	27	13	14	4.07E-12	3.75E-15	9.22E-04	5.80E+01	7.6	5.06E-15		3.07E-09	2.36E-10	118	1.49	1.49	2.84E+07	4.05E-12	7.6
Silicon	Si	14	28	14	14	3.78E-12	3.80E-15	1.00E-03	6.33E+01	8.0	5.12E-15		3.35E-09	2.39E-10	111	1.45	1.45	3.06E+07	3.76E-12	8.0
Phosphorus	P	15	31	15	16	3.53E-12	3.93E-15	1.11E-03	7.01E+01	8.4	5.30E-15		3.71E-09	2.47E-10	98	1.36	1.36	3.28E+07	3.51E-12	8.4
Sulfur	S	16	32	16	16	3.31E-12	3.97E-15	1.20E-03	7.56E+01	8.7	5.36E-15		4.00E-09	2.50E-10	88	1.29	1.29	3.50E+07	3.28E-12	8.7
Chlorine	Cl	17	35	17	18	3.11E-12	4.09E-15	1.31E-03	8.28E+01	9.1	5.52E-15		4.38E-09	2.57E-10	79	1.22	1.22	3.72E+07	3.09E-12	9.1
Argon	Ar	18	40	18	22	2.94E-12	4.27E-15	1.45E-03	9.16E+01	9.6	5.77E-15		4.85E-09	2.69E-10	71	1.16	1.16	3.94E+07	2.91E-12	9.6
Potassium	K	19	30	19	21	2.78E-12	3.88E-15	1.40E-03	8.79E+01	9.4	5.24E-15		4.65E-09	2.45E-10	243	2.14	2.14	4.16E+07	2.76E-12	9.4
Calcium	Ca	20	40	20	20	2.65E-12	4.27E-15	1.62E-03	1.02E+02	10.1	5.77E-15		5.38E-09	2.69E-10	194	1.91	1.92	4.38E+07	2.62E-12	10.1
Scandium	Sc	21	45	21	24	2.52E-12	4.45E-15	1.76E-03	1.11E+02	10.5	6.00E-15		5.88E-09	2.80E-10	184	1.86	1.87	4.59E+07	2.49E-12	10.6
Titanium	Ti	22	48	22	26	2.40E-12	4.54E-15	1.89E-03	1.19E+02	10.9	6.13E-15		6.29E-09	2.86E-10	176	1.82	1.82	4.81E+07	2.37E-12	11.0
Vanadium	V	23	51	23	28	2.30E-12	4.64E-15	2.02E-03	1.27E+02	11.3	6.26E-15		6.71E-09	2.92E-10	171	1.80	1.80	5.03E+07	2.27E-12	11.3
Chromium	Cr	24	52	24	28	2.20E-12	4.67E-15	2.12E-03	1.33E+02	11.5	6.30E-15		7.05E-09	2.94E-10	166	1.77	1.77	5.25E+07	2.17E-12	11.6
Manganese	Mn	25	55	25	30	2.12E-12	4.75E-15	2.25E-03	1.41E+02	11.9	6.42E-15		7.48E-09	2.99E-10	161	1.74	1.74	5.47E+07	2.08E-12	12.0
Iron	Fe	26	56	26	30	2.03E-12	4.78E-15	2.35E-03	1.48E+02	12.2	6.46E-15	e1{-2,2}	7.83E-09	3.01E-10	156	1.72	1.72	5.69E+07	2.00E-12	12.3
Cobalt	Co	27	58	27	31	1.96E-12	4.84E-15	2.47E-03	1.56E+02	12.5	6.53E-15		8.23E-09	3.05E-10	152	1.69	1.70	5.91E+07	1.92E-12	12.6
Nickel	Ni	28	58	28	30	1.89E-12	4.84E-15	2.56E-03	1.61E+02	12.7	6.53E-15		8.53E-09	3.05E-10	149	1.68	1.68	6.13E+07	1.85E-12	12.8
Copper	Cu	29	64	29	35	1.82E-12	5.00E-15	2.74E-03	1.73E+02	13.1	6.75E-15		9.13E-09	3.15E-10	145	1.65	1.66	6.35E+07	1.78E-12	13.3
Zinc	Zn	30	65	30	35	1.76E-12	5.03E-15	2.85E-03	1.79E+02	13.4	6.78E-15		9.50E-09	3.17E-10	142	1.64	1.64	6.56E+07	1.72E-12	13.6
Gallium	Ga	31	70	31	39	1.71E-12	5.15E-15	3.02E-03	1.90E+02	13.8	6.95E-15		1.01E-08	3.24E-10	136	1.60	1.60	6.78E+07	1.66E-12	14.0
Germanium	Ge	32	73	32	41	1.65E-12	5.22E-15	3.16E-03	1.99E+02	14.1	7.05E-15		1.05E-08	3.29E-10	125	1.54	1.54	7.00E+07	1.61E-12	14.3
Arsenic	As	33	75	33	42	1.60E-12	5.27E-15	3.29E-03	2.07E+02	14.4	7.12E-15		1.10E-08	3.32E-10	114	1.47	1.47	7.22E+07	1.56E-12	14.6
Selenium	Se	34	79	34	45	1.56E-12	5.36E-15	3.45E-03	2.17E+02	14.7	7.24E-15		1.15E-08	3.38E-10	103	1.39	1.40	7.44E+07	1.51E-12	15.0
Bromine	Br	35	80	35	45	1.51E-12	5.39E-15	3.56E-03	2.24E+02	15.0	7.27E-15		1.19E-08	3.39E-10	94	1.33	1.33	7.66E+07	1.46E-12	15.2
Krypton	Kr	36	84	36	48	1.47E-12	5.47E-15	3.73E-03	2.35E+02	15.3	7.39E-15		1.24E-08	3.45E-10	88	1.29	1.29	7.88E+07	1.42E-12	15.6
Rubidium	Rb	37	85	37	48	1.43E-12	5.50E-15	3.84E-03	2.42E+02	15.6	7.42E-15		1.28E-08	3.46E-10	265	2.24	2.24	8.10E+07	1.38E-12	15.9
Strontium	Sr	38	88	38	50	1.39E-12	5.56E-15	3.99E-03	2.52E+02	15.9	7.50E-15		1.33E-08	3.50E-10	219	2.03	2.03	8.31E+07	1.34E-12	16.2
Yttrium	Y	39	89	39	50	1.36E-12	5.58E-15	4.11E-03	2.59E+02	16.1	7.53E-15		1.37E-08	3.51E-10	212	2.00	2.00	8.53E+07	1.30E-12	16.4
Zirconium	Zr	40	91	40	51	1.32E-12	5.62E-15	4.25E-03	2.68E+02	16.4	7.59E-15		1.42E-08	3.54E-10	206	1.97	1.97	8.75E+07	1.26E-12	16.7
Niobium	Nb	41	93	41	52	1.29E-12	5.66E-15	4.39E-03	2.76E+02	16.6	7.64E-15		1.46E-08	3.57E-10	198	1.93	1.93	8.97E+07	1.23E-12	17.0
Molybdenum	Mo	42	96	42	54	1.26E-12	5.72E-15	4.54E-03	2.86E+02	16.9	7.73E-15		1.51E-08	3.60E-10	190	1.89	1.90	9.19E+07	1.20E-12	17.3
Technetium	Tc	43	98	43	55	1.23E-12	5.76E-15	4.68E-03	2.95E+02	17.2	7.78E-15		1.56E-08	3.63E-10	183	1.86	1.86	9.41E+07	1.17E-12	17.6
Ruthenium	Ru	44	101	44	57	1.20E-12	5.82E-15	4.84E-03	3.05E+02	17.5	7.86E-15		1.61E-08	3.67E-10	178	1.83	1.83	9.63E+07	1.14E-12	17.9
Rhodium	Rh	45	103	45	58	1.18E-12	5.86E-15	4.98E-03	3.14E+02	17.7	7.91E-15		1.66E-08	3.69E-10	173	1.81	1.81	9.85E+07	1.11E-12	18.2
Palladium	Pd	46	106	46	60	1.15E-12	5.92E-15	5.14E-03	3.24E+02	18.0	7.99E-15	e1{-2,3}	1.71E-08	3.73E-10	169	1.79	1.79	1.01E+08	1.08E-12	18.5
Silver	Ag	47	108	47	61	1.13E-12	5.95E-15	5.29E-03	3.33E+02	18.3	8.04E-15	e1{-2,3}	1.76E-08	3.75E-10	165	1.76	1.77	1.03E+08	1.06E-12	18.8
Cadmium	Cd	48	112	48	64	1.10E-12	6.03E-15	5.47E-03	3.44E+02	18.6	8.13E-15		1.82E-08	3.79E-10	161	1.74	1.74	1.05E+08	1.03E-12	19.2
Indium	In	49	115	49	66	1.08E-12	6.08E-15	5.63E-03	3.55E+02	18.8	8.20E-15		1.88E-08	3.83E-10	156	1.72	1.72	1.07E+08	1.01E-12	19.5
Tin	Sn	50	119	50	69	1.06E-12	6.15E-15	5.81E-03	3.66E+02	19.1	8.30E-15		1.94E-08	3.87E-10	145	1.65	1.66	1.09E+08	9.85E-13	19.8
Antimony	Sb	51	122	51	71	1.04E-12	6.20E-15	5.98E-03	3.76E+02	19.4	8.37E-15		1.99E-08	3.90E-10	133	1.58	1.59	1.12E+08	9.63E-13	20.1
Tellurium	Te	52	128	52	76	1.02E-12	6.30E-15	6.19E-03	3.90E+02	19.7	8.50E-15		2.06E-08	3.97E-10	123	1.52	1.52	1.14E+08	9.41E-13	20.5
Iodine	I	53	127	53	74	9.98E-13	6.28E-15	6.30E-03	3.96E+02	19.9	8.48E-15		2.10E-08	3.96E-10	115	1.47	1.47	1.16E+08	9.20E-13	20.7
Xenon	Xe	54	131	54	77	9.80E-13	6.35E-15	6.48E-03	4.08E+02	20.2	8.57E-15		2.16E-08	4.00E-10	108	1.43	1.43	1.18E+08	9.00E-13	21.1
Cesium	Cs	55	133	55	78	9.62E-13	6.38E-15	6.63E-03	4.18E+02	20.4	8.61E-15		2.21E-08	4.02E-10	298	2.37	2.37	1.20E+08	8.81E-13	21.4
Barium	Ba	56	137	56	81	9.45E-13	6.44E-15	6.82E-03	4.30E+02	20.7	8.70E-15		2.27E-08	4.06E-10	253	2.18	2.19	1.23E+08	8.62E-13	21.7
Lanthanum	La	57	139	57	82	9.28E-13	6.48E-15	6.98E-03	4.39E+02	21.0	8.74E-15		2.32E-08	4.08E-10				1.25E+08	8.44E-13	22.0
Cerium	Ce	58	140	58	82	9.12E-13	6.49E-15	7.12E-03	4.48E+02	21.2	8.76E-15		2.37E-08	4.09E-10				1.27E+08	8.26E-13	22.2
Praseodymium	Pr	59	141	59	82	8.97E-13	6.51E-15	7.26E-03	4.57E+02	21.4	8.78E-15		2.42E-08	4.10E-10	247	2.16	2.16	1.29E+08	8.09E-13	22.5
Neodymium	Nd	60	144	60	84	8.82E-13	6.55E-15	7.43E-03	4.68E+02	21.6	8.84E-15		2.48E-08	4.13E-10	206	1.97	1.97	1.31E+08	7.93E-13	22.8
Promethium	Pm	61	145	61	84	8.67E-13	6.57E-15	7.57E-03	4.77E+02	21.8	8.86E-15		2.52E-08	4.14E-10	205	1.97	1.97	1.33E+08	7.77E-13	23.1
Samarium	Sm	62	150	62	88	8.53E-13	6.64E-15	7.78E-03	4.90E+02	22.1	8.96E-15		2.59E-08	4.18E-10	238	2.12	2.12	1.36E+08	7.61E-13	23.4
Europium	Eu	63	152	63	89	8.40E-13	6.67E-15	7.94E-03	5.00E+02	22.4	9.00E-15		2.65E-08	4.20E-10	231	2.09	2.09	1.38E+08	7.46E-13	23.7
Gadolinium	Gd	64	157	64	93	8.27E-13	6.74E-15	8.16E-03	5.14E+02	22.7	9.10E-15		2.72E-08	4.25E-10	233	2.10	2.10	1.40E+08	7.31E-13	24.1
Terbium	Tb	65	159	65	94	8.14E-13	6.77E-15	8.32E-03	5.24E+02	22.9	9.14E-15		2.77E-08	4.26E-10	225	2.06	2.06	1.42E+08	7.16E-13	24.4
Dysprosium	Dy	66	163	66	97	8.02E-13	6.83E-15	8.52E-03	5.37E+02	23.2	9.22E-15		2.84E-08	4.30E-10	228	2.07	2.08	1.44E+08	7.02E-13	24.7
Holmium	Ho	67	165	67	98	7.90E-13	6.86E-15	8.68E-03	5.47E+02	23.4	9.25E-15		2.89E-08	4.32E-10				1.47E+08	6.89E-13	25.0
Erbium	Er	68	167	68	99	7.78E-13	6.88E-15	8.85E-03	5.57E+02	23.6	9.29E-15		2.95E-08	4.34E-10	226	2.06	2.07	1.49E+08	6.75E-13	25.3
Thulium	Tm	69	169	69	100	7.67E-13	6.91E-15	9.01E-03	5.68E+02	23.8	9.33E-15		3.00E-08	4.35E-10	222	2.05	2.05	1.51E+08	6.62E-13	25.6
Ytterbium	Yb	70	173	70	103	7.56E-13	6.97E-15	9.22E-03	5.80E+02	24.1	9.40E-15	e1{-2,4}	3.07E-08	4.39E-10	222	2.05	2.05	1.53E+08	6.50E-13	26.0
Lutetium	Lu	71	175	71	104	7.45E-13	6.99E-15	9.38E-03	5.91E+02	24.3	9.44E-15	e1{-2,4}	3.13E-08	4.40E-10	217	2.02	2.03	1.55E+08	6.37E-13	26.3
Hafnium	Hf	72	178	72	106	7.35E-13	7.03E-15	9.57E-03	6.03E+02	24.6	9.49E-15		3.19E-08	4.43E-10	208	1.98	1.98	1.58E+08	6.25E-13	26.6
Tantalum	Ta	73	181	73	108	7.25E-13	7.07E-15	9.76E-03	6.14E+02	24.8	9.54E-15		3.25E-08	4.45E-10	200	1.94	1.94	1.60E+08	6.13E-13	26.9
Tungsten	W	74	184	74	110	7.15E-13	7.11E-15	9.95E-03	6.26E+02	25.0	9.60E-15		3.31E-08	4.48E-10	193	1.91	1.91	1.62E+08	6.02E-13	27.3
Rhenium	Re	75	186	75	111	7.05E-13	7.14E-15	1.01E-02	6.37E+02	25.2	9.63E-15		3.37E-08	4.49E-10	188	1.88	1.89	1.64E+08	5.90E-13	27.6

Osmium	Os	76	190	76	114	6.96E-13	7.19E-15	1.03E-02	6.50E+02	25.5	9.70E-15		3.44E-08	4.53E-10	185	1.87	1.87	1.66E+08	5.79E-13	28.0
Iridium	Ir	77	192	77	115	6.87E-13	7.21E-15	1.05E-02	6.61E+02	25.7	9.73E-15		3.50E-08	4.54E-10	180	1.84	1.84	1.68E+08	5.68E-13	28.3
Platinum	Pt	78	195	78	117	6.78E-13	7.25E-15	1.07E-02	6.73E+02	25.9	9.78E-15		3.56E-08	4.56E-10	177	1.83	1.83	1.71E+08	5.58E-13	28.6
Gold	Au	79	197	79	118	6.70E-13	7.27E-15	1.09E-02	6.84E+02	26.2	9.82E-15		3.62E-08	4.58E-10	174	1.81	1.81	1.73E+08	5.47E-13	28.9
Mercury	Hg	80	201	80	121	6.61E-13	7.32E-15	1.11E-02	6.97E+02	26.4	9.88E-15		3.69E-08	4.61E-10	171	1.80	1.80	1.75E+08	5.37E-13	29.3
Thallium	Tl	81	204	81	123	6.53E-13	7.36E-15	1.13E-02	7.10E+02	26.6	9.93E-15		3.75E-08	4.63E-10	156	1.72	1.72	1.77E+08	5.27E-13	29.7
Lead	Pb	82	207	82	125	6.45E-13	7.39E-15	1.15E-02	7.22E+02	26.9	9.98E-15		3.82E-08	4.66E-10	154	1.70	1.71	1.79E+08	5.17E-13	30.0
Bismuth	Bi	83	209	83	126	6.37E-13	7.42E-15	1.16E-02	7.33E+02	27.1	1.00E-14		3.88E-08	4.67E-10	143	1.64	1.64	1.82E+08	5.07E-13	30.4
Polonium	Po	84	209	84	125	6.30E-13	7.42E-15	1.18E-02	7.42E+02	27.2	1.00E-14		3.92E-08	4.67E-10	135	1.60	1.60	1.84E+08	4.98E-13	30.6
Astatine	At	85	210	85	125	6.22E-13	7.43E-15	1.19E-02	7.52E+02	27.4	1.00E-14		3.98E-08	4.68E-10				1.86E+08	4.88E-13	31.0
Radon	Rn	86	222	86	136	6.15E-13	7.57E-15	1.23E-02	7.75E+02	27.8	1.02E-14		4.10E-08	4.77E-10	120	1.50	1.51	1.88E+08	4.79E-13	31.6
Francium	Fr	87	223	87	136	6.08E-13	7.58E-15	1.25E-02	7.85E+02	28.0	1.02E-14		4.15E-08	4.77E-10				1.90E+08	4.70E-13	31.9
Radium	Ra	88	226	88	138	6.01E-13	7.61E-15	1.27E-02	7.98E+02	28.2	1.03E-14		4.22E-08	4.80E-10				1.93E+08	4.61E-13	32.3
Actinium	Ac	89	227	89	138	5.94E-13	7.63E-15	1.28E-02	8.08E+02	28.4	1.03E-14		4.27E-08	4.80E-10				1.95E+08	4.52E-13	32.6
Thorium	Th	90	232	90	142	5.88E-13	7.68E-15	1.31E-02	8.23E+02	28.7	1.04E-14		4.35E-08	4.84E-10				1.97E+08	4.43E-13	33.0
Protactinium	Pa	91	231	91	140	5.81E-13	7.67E-15	1.32E-02	8.31E+02	28.8	1.04E-14		4.40E-08	4.83E-10				1.99E+08	4.35E-13	33.3
Uranium	U	92	238	92	146	5.75E-13	7.75E-15	1.35E-02	8.48E+02	29.1	1.05E-14		4.49E-08	4.88E-10				2.01E+08	4.26E-13	33.8
Neptunium	Np	93	237	93	144	5.69E-13	7.74E-15	1.36E-02	8.56E+02	29.3	1.04E-14		4.53E-08	4.87E-10				2.03E+08	4.18E-13	34.2
Plutonium	Pu	94	244	94	150	5.63E-13	7.81E-15	1.39E-02	8.74E+02	29.6	1.05E-14		4.62E-08	4.92E-10				2.06E+08	4.09E-13	34.7
Americium	Am	95	243	95	148	5.57E-13	7.80E-15	1.40E-02	8.82E+02	29.7	1.05E-14		4.67E-08	4.91E-10				2.08E+08	4.01E-13	35.0
Curium	Cm	96	247	96	151	5.51E-13	7.84E-15	1.42E-02	8.96E+02	29.9	1.06E-14	e1{-2,5}	4.74E-08	4.94E-10				2.10E+08	3.93E-13	35.4
Berkelium	Bk	97	247	97	150	5.45E-13	7.84E-15	1.44E-02	9.06E+02	30.1	1.06E-14	e1{-2,5}	4.79E-08	4.94E-10				2.12E+08	3.85E-13	35.8
Californium	Cf	98	251	98	153	5.40E-13	7.88E-15	1.46E-02	9.20E+02	30.3	1.06E-14		4.87E-08	4.97E-10				2.14E+08	3.77E-13	36.3
Einsteinium	Es	99	252	99	153	5.34E-13	7.90E-15	1.48E-02	9.31E+02	30.5	1.07E-14		4.92E-08	4.97E-10				2.17E+08	3.69E-13	36.7
Fermium	Fm	100	257	100	157	5.29E-13	7.95E-15	1.50E-02	9.46E+02	30.8	1.07E-14		5.00E-08	5.00E-10				2.19E+08	3.62E-13	37.2
Mendelevium	Md	101	258	101	157	5.24E-13	7.96E-15	1.52E-02	9.57E+02	30.9	1.07E-14		5.06E-08	5.01E-10				2.21E+08	3.54E-13	37.6
Nobelium	No	102	259	102	157	5.19E-13	7.97E-15	1.54E-02	9.68E+02	31.1	1.08E-14		5.12E-08	5.02E-10				2.23E+08	3.46E-13	38.1
Lawrencium	Lr	103	286	103	183	5.14E-13	8.24E-15	1.60E-02	1.01E+03	31.8	1.11E-14		5.34E-08	5.19E-10				2.25E+08	3.39E-13	39.1
Rutherfordium	Rf	104	267	104	163	5.09E-13	8.05E-15	1.58E-02	9.97E+02	31.6	1.09E-14		5.27E-08	5.07E-10				2.28E+08	3.31E-13	39.1
Dubnium	Db	105	268	105	163	5.04E-13	8.06E-15	1.60E-02	1.01E+03	31.7	1.09E-14		5.33E-08	5.08E-10				2.30E+08	3.24E-13	39.6
Seaborgium	Sg	106	289	106	183	4.99E-13	8.26E-15	1.66E-02	1.04E+03	32.3	1.12E-14		5.52E-08	5.20E-10				2.32E+08	3.16E-13	40.6
Bohrium	Bh	107	270	107	163	4.94E-13	8.08E-15	1.63E-02	1.03E+03	32.1	1.09E-14		5.44E-08	5.09E-10				2.34E+08	3.09E-13	40.6
Hassium	Hs	108	269	108	161	4.90E-13	8.07E-15	1.65E-02	1.04E+03	32.2	1.09E-14		5.49E-08	5.08E-10				2.36E+08	3.01E-13	41.1
Meitnerium	Mt	109	278	109	169	4.85E-13	8.16E-15	1.68E-02	1.06E+03	32.5	1.10E-14		5.60E-08	5.14E-10				2.38E+08	2.94E-13	41.8
Darmstadtium	Ds	110	281	110	171	4.81E-13	8.19E-15	1.70E-02	1.07E+03	32.7	1.11E-14		5.67E-08	5.16E-10				2.41E+08	2.87E-13	42.4
Roentgenium	Rg	111	282	111	171	4.77E-13	8.20E-15	1.72E-02	1.08E+03	32.9	1.11E-14		5.73E-08	5.16E-10				2.43E+08	2.79E-13	43.0
Copernicium	Cn	112	285	112	173	4.72E-13	8.23E-15	1.74E-02	1.10E+03	33.1	1.11E-14		5.80E-08	5.18E-10				2.45E+08	2.72E-13	43.6
Nihonium	Nh	113	286	113	173	4.68E-13	8.24E-15	1.76E-02	1.11E+03	33.3	1.11E-14		5.86E-08	5.19E-10				2.47E+08	2.65E-13	44.3
Flerovium	Fl	114	289	114	175	4.64E-13	8.26E-15	1.78E-02	1.12E+03	33.5	1.12E-14		5.93E-08	5.20E-10				2.49E+08	2.57E-13	45.0
Moscovium	Mc	115	290	115	175	4.60E-13	8.27E-15	1.80E-02	1.13E+03	33.7	1.12E-14		5.99E-08	5.21E-10				2.52E+08	2.50E-13	45.6
Livermorium	Lv	116	293	116	177	4.56E-13	8.30E-15	1.82E-02	1.15E+03	33.9	1.12E-14		6.07E-08	5.23E-10				2.54E+08	2.43E-13	46.4
Tennessine	Ts	117	294	117	177	4.52E-13	8.31E-15	1.84E-02	1.16E+03	34.0	1.12E-14		6.12E-08	5.23E-10				2.56E+08	2.35E-13	47.2
Oganesson	Og	118	294	118	176	4.48E-13	8.31E-15	1.85E-02	1.17E+03	34.2	1.12E-14	e1{-2,6}=e	6.18E-08	5.23E-10				2.58E+08	2.28E-13	**47.9**
Table 2b. The estimated virtual Z>137 atom that only exist in the high G-pressured world like in {-3,n=2..6} celestial body, but not in the normal world.																				{0,48//6}=
			2.56																	
ratio of Mass/Atom#		**pseudo Z #**	true mass #	true atomic #	true neutron #						expected n									
Predicted e1{-1,1} nucle		128	320	128	192	4.13E-13	8.55E-15	2.07E-02	1.30E+03	36.1	36	e1{-1,1}	6.89E-08	5.38E-10						
Predicted e{-1,2} nucleu		360	900	360	540	1.47E-13	1.21E-14	8.21E-02	5.17E+03	71.9	72	e1{-1,2}	2.74E-07	7.60E-10						
Predicted e1{-1,3} nucle		670	1675	670	1005	7.90E-14	1.48E-14	1.88E-01	1.18E+04	108.8	108	e1{-1,3}	6.26E-07	9.35E-10						
Predicted e1{-1,4} nucle		1020	2550	1020	1530	5.19E-14	1.71E-14	3.29E-01	2.07E+04	144.0	144	e1{-1,4}	1.10E-06	1.08E-09						
Predicted e1{-1,5} nucle		1420	3550	1420	2130	3.73E-14	1.91E-14	5.12E-01	3.22E+04	179.5	180	e1{-1,5}	1.71E-06	1.20E-09						
Predicted e1{-1,6} nucle		1870	4675	1870	2805	2.83E-14	2.09E-14	7.39E-01	4.65E+04	215.7	216	e1{-1,6}=e	2.46E-06	1.32E-09						

Note-1: e1{N,n} (a {N,n} QM structure with the prefix "e1") always has a shrunk (or compressed) r_{e1} unless it is specified as not shrunk. A {N,n} QM structure without any prefix (e.g., {-12,2}) is always r_1 uncompressed since it is under Sun{0,1//6}.
Note-2: Yellow cells in column 2 are inert elements (stable states for $n_{electron}$). Green cells in column 11 are expected stable states (for $n_{nucleus}$) for e1{N,n//6} QM structure. Blue cells in column 21 are expected stable states (for $n_{nucleus}$) for e1{N,n//7} QM structure.
Note-3: For Table 2b, see result & discussion 2.

In column 12, start with the shrunk r_{e1} (in column 7), we calculated back the nucleus r_{nuc} through the interior {N,n} calculation: $r_{nuc} = (n_{nuc}/6\text{^}3)\text{^}2*r_{e1}$, where n_{nuc} is in column 11, and r_{e1} is in column 7. Here we assumed that the EM-force caused (interior) {N,n} QM structure also has base-n = 5*6^. The back-calculated r_{nuc} in column 12 matched the r_{nuc} in column 8 quite well. This confirms that the atom's nucleus-electron (EM-force) system can be described with a {N,n//6} QM structure. Notice that back-calculated r_{nuc} (in column 12) is 1.35× larger than the original one (in column 8). This is because the formula $r_{nuc} = (n_{nuc}/6\text{^}3)\text{^}2 *r_{e1}$ is an approximation. If we use the accurate formula $r_{nuc} =(n_{nuc}/251)\text{^}2*r_{e1}$, where 251 come from SQRT(1/(8.4E-16/5.29E-11)), then we will get exact same r_{nuc} as in column 8. However we like to use $r_{nuc} = (n_{nuc}/6\text{^}3)\text{^}2*r_{e1}$ here because it is purely based on {N,n//6} QM model calculation.

In column 13, the interior {N,n//6} was assigned for each element, with its own shrunk electron ground state r_{e1} (in column 7) as e1{0,1//6}. We can see that while the hydrogen atom's nucleus (proton, r = 8.4E-16 meters) is the e1{-3,1//6} =

e1{0,1/6^3} interior QM structure of Bohr radius (r_{e1} = 5.29E-11 meters), Ne element's nucleus is about the e1{-2,1//6} interior QM structure of its electron's n = 1 shell e1{0,1//6}, and Og element's nucleus is about the e1{-1,1//6} interior QM structure of its electron's n = 1 shell. In this way, we established the interior e1{N,n} QM relationship between element's nucleus and its electron n = 1 shell (see Figure 1 for illustration). If we use exterior {N,n//6} QM, and take Hydrogen atom's r_{nuc} (relative to electron n = 1 shell) as {0,1//6} in size, then He's r_{nuc} is {0,2//6} in size, Ne's nucleus (approximately) finishes the first super-shell of nucleons {0,n=2..6} = {1,1//6} in size, Og's nucleus (approximately) finishes the second super-shell of nucleons {1,n=2..6} = {2,1//6} in size. If we use interior {N,n//6} QM, and take Og atom's nucleus r (relative to electron n=1 shell) as {0,1//6} in size, then Ne's nucleus is (approximately) at {-1,1//6} in size, Hydrogen atom's nucleus is (approximately) at {-2,1//6} in size.

The shrinking of r_{e1} as Z increasing can be explained as that the (strong) EM-force shrinks the space (in comparison with the G-force). In column 14, a pretend atom's r (not a nucleus' r) was calculated by using n_{nuc} and (fixed) r_1 = 5.29E-11 meters, with $r_n = r_1 * n_{nuc}^2$. So this is the idealized r_n (or size of atom) if there is no EM-force caused r_{e1} shrinking (when the nucleus increases its Z from 1 to 118). In column 15, as a comparison to column 14, r_n is calculated by using n_{nuc}, but with r_{e1} = 5.29E-11 /Z. The result is useless because no electron shielding effect is considered (Note: as a citizen scientist, I don't know how to calculate the electron shielding effect).

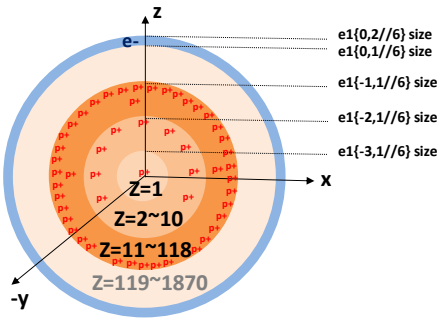

Figure 1. Illustration of the nuclear {N,n//6} QM structure by using the ground state electron's orbit as e1{0,1//6}. To illustrate that e1{-3,1//6} is the size of a single proton, a e1{-2,1//6} sized nucleus contains up to 10 protons, and a e1{-1,1//6} sized nucleus contains up to 118 protons. Note: the r-dimension is not on scale.

More results and discussions on Table 2:

1) For columns 7 to 11, we set e1{0,1//6} at Bohr radius $a_0 = r_1$ = 5.29E-11 meters. Hydrogen atom's r_{nuc} is (1/6^3)^2 of r_{e1}, so its r_{nuc} is at e1{0,1/6^3//6} = e1{-3,1//6} QM state (in size). Helium atom's r_{nuc} is (2/6^3)^2 of its shrunk r_{e1}, so its r_{nuc} is at e1{0,2/6^3//6}= e1{-3,2//6} QM state (in size). Li atom's r_{nuc} is (3/6^3)^2 of its shrunk r_{e1}, so its r_{nuc} is at e1{0,3/6^3//6}= e1{-3,3//6} QM state (in size). Ne (and/or F) atom's r_{nuc} is about e1{0,1/6^2//6} = e1{-2,1//6} interior QM state (in size) of its electron n = 1 shell, Og atom's r_{nuc} is about e1{0,1/6//6} = e1{-1,1//6} interior QM state (in size) of its electron n=1 shell. So as usual, all {N,1//6} sized nuclei are super stable nuclei. Besides the {N,1//6}, those {N,n=2…5//6} sized nuclei with integer n # should be more stable than those non-integer n's nuclei. These integer n(s) are: 1 (for H), 2 (for He), 3, 4, 5, 6, 12, 18, 24, 30, 36, etc. However, this higher stability is for the nucleus, not for electron shells, so they do not necessary to have higher stability in the (chemical element's) periodic table. See section II-b for more detailed explanation. We also hope that the (isotopic) nuclear physics experimental data will support our prediction. This work uncovered that the {N,n//6} QM structure of nucleus is a "recessive gene", it is not a "dominant gene". You will not be able to see it unless you use the interior {N,n} QM analysis based on the ground state electron {0,1} for atom's nucleus-electron system. If using the normal $r_1 = r_{nuc=1}$, then you don't see any {N,n//6} QM structure!

2) For (the bottom) Table 2b, from point view of {N,n} QM structure, the e1{-1,n=2..6//6} sized super large nucleus (or atoms with Z > 118) is OK to exist (although in the traditional Bohr QM, the orbital velocity of n=1 electron has to be smaller than the speed of light, so Z cannot be larger than 137). Those n(s) are 2, 3, 4, 5, 6 (multiply by 6^2 to get the total

n_{nuc} = 72, 108, 144, 180, 216 with r_1 at e1{-3,1//6}, see column 12 of Table 2b). To add the predicted nuclides of e1{-1,n=2..6//6} sizes in Table 2b, we first manually adjusted their Z numbers (in column 3, Z > 118) to get the mass number M# = Z# * 2.5. (Note: this M# / Z# =2.5 was assumed to be a constant for all super large atoms and this is the best "citizen scientist leveled" approximation I can do now). We then got their r_{nuc} = 1.25 * (M#)^(1/3), then calculated the n_{nuc} = sqrt(r/r_1) (in column 11) to match the expected n_{nuc} (in column 12). So the predicted atom's (pseudo) Z# are about 360, 670, 1020, 1420, 1870. The analysis in Table 2b gave the following hypothesis: it is possible to form atom with Z >137. When Z >137, the Z become pseudo-Z, any proton beyond 137 will be merged with electron, so it will keep the true proton number < 137 in a nucleus (even its pseudo-Z > 137, see SunQM-5s1 for more explanation, this may cause M# / Z# ratio increase as Z# increasing). Thus, it will also keep electron's $v_1 < c$ (probably by sharing electrons between nuclei, or forming electron sea). Note: other scientists may already have many discussions about this topic before. Here we repeated this discussion only under the framework of the {N,n//6} QM.

3) Now we try to calculate out the maximum r_{nuc} (which is caused by the maximum n_{nuc} but before the r_{nuc} crash with the electron n = 1 shell, and remember this e1 shell shrinks as Z# increases). At the nucleus size of e1{0,1//6} = e1{-1,6//6}, we obtained r_{nuc} /r_1 =0.739 (in column 9). It is very close to (n=5^2) / (n=6^2) =0.694. We believed that this is the maximum r_{nuc} (without considering the relativity) before crash into its own shrunk e1{0,1//6} electron shell. So (without considering the relativity), e1{0,1//6} = e1{-1,6//6} sized nucleus is the maximum-ever-possible nucleus (without crash into the shrunk r_1 electron shell). At the max r_{nuc} = 2.09E-14 meters (see Table 2b last row, and column 8), electron's r_1 = 2.83E-14 meters, Z ≈ 1870, so the number of electrons ≈ 1870. (Note: it corresponds to the maximum electron shell of n ≤ 22, the detailed calculation of the electron configuration is not shown here, but we can imagine that a chemical element periodical table with 22 electron periods, although most of them may have to merge with the protons in the nucleus?). However, we cannot use r_n = r_1 /Z *n^2 to calculate the maximum electron shell's r_n (or max atom-r), due to that it does NOT count-in the inner electron shield effect that will increase outer electron's r.

4) (Note: here we rename the period in Mendeleev's periodic table as "electron period", to distinguish it from the N period in {N,n} QM). For column 14, if use n_{nuc}, and use unshrunk r_1 = 5.29E-11 and fix this value for all elements, then calculate the maximum electron's r_n = r_1 * n_{nuc}^2 (which may relate to the size of an unshrunk atom, using n_{nuc} in column 11). Then we see that for hydrogen atom, $r_{unshrunk}$ = 5.29E-11 meters, n_{nuc} = e1{-3,1//6}; for Ne atom, $r_{unshrunk}$ = 2.14E-9 meters, n_{nuc} ≈ e1{-2,1//6}; for Og atom, $r_{unshrunk}$ = 6.17E-8 meters, n_{nuc} ≈ e1{-1,1//6}. When comparing these $r_{unshrunk}$ values to the {N,n} of sub-quark to universe in Table 1, we immediately realized that Hydrogen atom's $r_{unshrunk}$ = Z*r' = 5.29E-11 meters matches to {-12,1//6} 's r = 3.67E-11, Ne atom (Z = 10, the end of electron period 2) 's $r_{unshrunk}$ = 2.14E-9 meters closely matches to {-11,1//6} 's r = 1.32E-9, Og atom (Z = 118, the end of electron period 7) 's $r_{unshrunk}$ = 6.16E-8 meters closely matches to {-10,1//6} 's r = 4.76E-8. **So {-10,1//6} super stable {N,n} QM structure is the largest atom Og (Z=118) if there is no Z induced (electron n = 1 shell) r_1 shrink**. For column 15, after including Z induced r_1 contraction, then we are not able to calculate the right electron's r_n due to the inner electron shielding effect, so no useful result is obtained in this column.

There is an even more important result that can be extracted from this analysis of n_{nuc} (in column 13): If taking Hydrogen atom's n_{nuc} =1 as {0,1//6}, named as proton{0,1//6}, or **prot{0,1//6}**, then elements from He to Ne (with n_{nuc} from 2 to ~6, or from Z = 2 to Z = 10, or up to the end of electron period 2 in the chemical element periodic table) will fill the n_{nuc}'s super-shell space prot{0,n=1..5//6}o fully (with the final size at prot{0,6//6} = prot{1,1//6}); and elements from Na to Og (with n_{nuc} from > 6 to ~36, or from Z = 11 to Z = 118, or from electron period 3 to electron period 7 in the electron period table) will fill the n_{nuc}'s super-shell space prot{1,n=1..5//6}o fully (with the final size at prot{1,6//6} = prot{2,1//6}, see Table 3's period N = -16, -15, and -14). If there are electron period 8 elements (Z ≥ 119), they most likely need to start a new n_{nuc}'s super-shell prot{2,n=1..5//6}o and to fill it. But to start a new n_{nuc} super-shell is much more difficult than to finish the rest space in the same super-shell, and this means that the Og may be the last element we can find. Or we may never be able to produce element in electron period 8, not due to it start a new (electron shell) period, but due to it starts a new n_{nuc} (nucleon) super-shell.

5) For columns 16-18. In column 16, atomic radii calculated by Enrico Clementi, et al. [14] (from wiki "Atomic Radius") are listed. This data is very close to the experimental measured atom's r. In column 17, the n of the outmost electron shell is

calculated (relative to Hydrogen atom's n=1, or r = 53E-12 meters) as =sqrt[(column-11) / 53]. In column 18, the n of the out-most electron shell is calculated (relative to r_{e1} = 5.29E-11 meters, or = sqrt[(column-11) *E+12 / 5.29E-11]), and the result is the same as that in Column 17. The result revealed that almost all atoms have theirs n within 2, or their size of $r \leq 4\times$ 5.29E-11 meters = 2.1E-10 meters. Here we call it "**atom size n=2 effect**", meaning although atom's out most electron shell may be up to n=7, but its real size is no more than n=2. Obviously, this effect is due to the strong EM-force induced r_n QM space shrinking.

6) For columns 19-21, the orbital electron's high speed caused relativity effect is included for the calculation (at the citizen scientist level). Once add relativity, for large Z, the relativistic

$$r_{e1r} = r_{e1} / Z^* \text{ sqrt}(1-v_1^2/c^2) \qquad \text{eq-1}$$

become even smaller [15], then n_{nuc} = sqrt($r_{n\text{-}nuc}$ / r_{e1r}) will become even bigger. (Note: For $r_{n\text{-}nuc}$, the relativity is not calculated because I don't how to calculate it. Also, as a citizen scientist, I don't know how correct the eq-1 is. Therefore, the whole Discussion-6 is a citizen scientist leveled discussion). For example, Og-118's r_{e1} = a_0 / 118 = 4.48E-13 meters, but due to its v_1 = 2.58E+8 m/s close to light speed c, its r_{e1r} shrunk to 50.8% (= 2.28E-13 meters). So the relativistic n_{nuc} = sqrt(r_n / r_{e1r}) = 47.9 for Og-118 element (see column 21). If it is {N,n//6} QM structure, then {0,48//6}={1,8//6} ≈{2,1.3//6}. If it is {N,n//7} QM structure, then {0,48} ≈ {0,49} = {1,7//7} = {2,1//7}, which 49 = 7^2, and Z = 118 is the end of electron period 7.

At beginning, we assumed that the EM-force caused (interior) {N,n} QM structure also has the base-pFactor-n = 5*6^. (Note: we should **change the name of "pFactor" into "qFactor"**, because it is same as the quantum number q in {N,n//q} or |qnlm>). The reason is that G-force has {N,n//6} QM system, and this n//6 "gene" should come from its ancestor of either the F4-force (the degenerated G-, EM-, S-, W-forces, see SunQM-2), or the unified three pair (G/RFg, E/RFe, S/RFs) forces (see SunQM-6). So it is expected that F4-force's another descendant EM-force also carries the same n//6 "gene". It is also expected that F4-force's 3rd descendant, the S-force (including its residue force, i.e., the nuclear force), also carries the same n//6 "gene". This expectation is supported by the resulted n_{nuc} in column 11 (without relativity) that matches the nuclear {N,n//6} QM structure (due to H's n_{nuc} = 1 at e1{-3,1//6}, Ne's n_{nuc} ≈ 6 at e1{-2,1//6}, and Og's n_{nuc} ≈36 at e1{-1,1//6}, and this nuclear structure is caused by the nuclear force plus the EM-force).

But after adding relativity, it seems that the {N,n//7} QM structure matches even better at high Z (due to H's n_{nuc} = 1 at e1{-3,1//7}, Ne's n_{nuc} = 6.4 ≈7 at e1{-2,1//7}, and Og's n_{nuc} ≈ 48 ≈ 7^2 at e1{-1,1//7}, see column 21). So it seems that due to the shrink of the electron ground state r_{e1}, the electron's r_n is also shrunk, and it frees up the original electron's r_n = 5 (or even r_n = 4) orbital shell space so that the higher n (n = 6, 7, or even higher electron orbit) can fill in. Due to that we do not know how to calculate the shrunk electron's r_n, we are not able to estimate how many extra n (=7, 8, etc.) shells of electron can be added to fill-in the left-over electron shell space (for the shrunk electron's r_n orbital space). According to the "atom size n=2 effect" in discussion 5, it can be ≥ 7.

General relativity tells us that when Gravity-force getting stronger, the space getting shrink (in force direction). It can be expanded to as F4-force (or its descendants S-force and EM-force) getting stronger, the space getting shrink. So can we attribute the shrinking of r_{e1} (= r_1 / Z, in column 7) and the shrinking of r_n (= r_{e1} * n^2) as Z increasing (equivalent to EM-force increasing) to the general relativity effect? The form of eq-1 may suggest that these are two different effect. The relativity effect of the {N,n} QM calculation is a too big topic for this paper. It will be studied in our future paper SunQM-7s1 (hopefully). Note: I am not a relativity physicist, Discussion 6 contained "citizen scientist leveled" calculations, and I am not sure they are correct or not. I want to present these discussions because they are very novel (at least to me), and they might inspire other scientists (even my calculations might be not correct).

II-b. The {N,n//6} (and {N,n//7}) QM structural stability of the nuclides played an important role in determining the abundancy of each element in our universe

Combining the results of Table 2 and Table 1, we constructed Table 3, the {N,n//6} QM structural periodic table for atom's nuclide structures (N = -15..-14), and for atom's electron structures (N = -12). Because H nucleus has the size of {-

15,1//6}, then, nuclides of He through Ne belong to the {-15,n=1..5//6}o orbital super shell space, and nuclides of Na through Og belong to the {-14,n=1..5//6}o orbital super shell space (see Table 3). Similarly, because H atom has its outmost electron orbital shell at {-12,1//6}o, then, electron period 1 through electron period 7 elements belong to the {-12,n=1..7//6}o orbital super shell space.

By comparing the {N,n//6} QM structural information of nuclides (in Table 2) to the abundancy of these elements in our galaxy (in Figure 2), it provided us some new knowledge on the nuclear physics. The size n = 2 nuclides at {-14,2//6} (with $n_{nuc} \leq 12 = 2 * 6\text{^}1$, or all nucleons in the orbital shell space of {-14,1//6}o, see Table 2 and Table 3) ended at Fe element's nucleus. It means that Fe nucleus is the only completely filled nucleus (or it has 100 % nucleon occupancy in the {-14,1//6}o nucleon orbital shell space) among the nucleon orbital n = 1 nuclides (Z = 11 … 26, n_{nuc} = 7 … 12, or among Na, Mg, Al, Si, P, S, Cl, Ar, K, Ca, Sc, Ti, V, Cr, Mn, and Fe), and even among the orbital n = 2 nuclides (Z = 27 … 45, n_{nuc} = 13 … 17), so it is the most stable {N,n//6} QM structure among the (orbital) n = 1 (and even orbital n = 2) nuclides. This is exactly like why the inert element Ne is chemically most stable atom among the electron period 2 elements because it has the outmost electron shell completely filled (or it has the 100% electron occupancy in the n = 2 electron orbital shell space). This explained why Fe element is relatively abundant in the universe (in comparison to its adjacent elements, like Cr, Mn, Co, Ni, etc., see Figure 2), simply because its nucleus (and not its electron shell) is more stable than that of its adjacent elements. This also explained why Fe atom is the heaviest element that a nuclear fusion reaction can form without adding extra energy.

Next, for the size n = 3 nuclides (or all nucleons in the nucleon orbital shell space of n = 2), if still using {N,n//6} QM structure, the nuclides will end at {-14,3//6}, between Pd (Z= 46, $n_{nuc} = 18.0 = 3 * 6\text{^}1$) and Ag (Z= 47, $n_{nuc} = 18.1 \approx 3 * 6\text{^}1$). However, Figure 2 showed that while none of them has a high abundancy, Xe (Z= 54 and the adjacent) nuclides showed the abnormal high abundancy. Since Xe has the relativistic $n_{nuc\text{-}rel}$ = 21.1 which fits to {-14,3//7} sized QM structure (see Table 2), it revealed that from Z = 26 (Fe) to Z = 54 (Xe), the nuclides {N,n//q} structure transformed from {-14,2//6} to {-14,3//7} structurally, so that Xe (and the adjacent) nuclides have relative high stability (and therefore, the relative higher abundancy). Again next, for size n = 4 nuclides (or all nucleons in the nucleon orbital shell space of n = 3), they should follow the {N,n//7} QM structure, and we are looking for $n_{nuc\text{-}rel}$ = 28 in Table 2. Figure 2 showed that a group of elements from Os (Z= 76, $n_{nuc\text{-}rel}$ =28), to Pb (Z= 82, $n_{nuc\text{-}rel}$ = 30) have relative high abundancy, and they fitted to the {-14,4//7} sized QM structure quite well. Thus, this analysis revealed that the nucleus' {N,n} QM structure stability played an important role in determining the abundancy of each element in our universe.

More interestingly, Xe is also an inert element that ends the electron period 5 in the chemical element periodic table. This may implies that when adding electron to the 4d orbit of the electron period 5 elements, the electron orbital {N,n//q} QM structure starts to transform from {N,n//6} QM to {N,n//7} QM, so that at the end of electron period 5 (and for the rest element with Z > 54), not only their nuclides become the {N,n//7} QM, but also the electron orbit structure become the {N,n//7} QM.

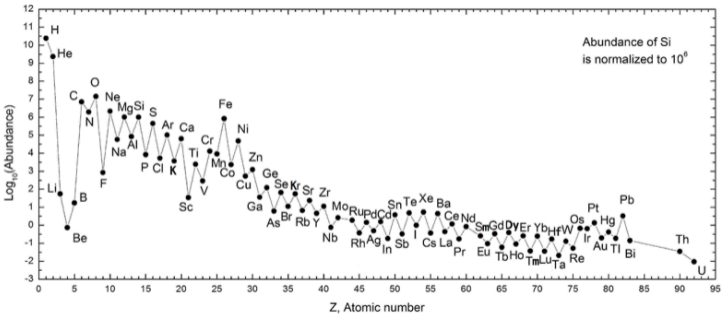

Figure 2. Abundances of the chemical elements in the Solar System. Copied from wiki "chemical element". Author: Ken Croswell. Copyright: CCBY-SA 3.0.

Table 3. {N,n//6} QM structural periodic table for atom's nuclide structures (N = -15..-14), and for atom's electron structures (N = -12).

		n= "n state" or "n shell" or "n orbit space"											
{N,n//6}		**1**	**2**	**3**	**4**	**5**	6 ={N+1,1//6}	7	8	9	10	11	12 = {N+1,2//6}
N=	**-16**					H nucleus n_{nuc}=1, orbit {-16,5}o size {-15,1}							
nuclide	**-15**	He nucleus n_{nuc}=2, orbit {-15,1}o size {-15,2}	Li nucleus n_{nuc}=3, orbit {-15,2}o size {-15,3}	Be, B nuclides n_{nuc}<=4, orbit {-15,3}o size {-15,4}	C, N, nuclides n_{nuc}<=5, orbit {-15,4}o size {-15,5}	O, F,Ne nuclides n_{nuc}<=6, orbit {-15,5}o size {-15,6//6} ={-14,1}	Na, Mg, nuclides n_{nuc}<=7, orbit {-15,6}o size {-15,7//6}	Al, Si, nuclides n_{nuc}<=8, orbit {-15,7}o size {-15,8//6}	P, S, Cl, nuclides n_{nuc}<=9, orbit {-15,8}o size {-15,9//6}	Ar, K, Ca, nuclides n_{nuc}<=10, orbit {-15,9}o size {-15,10//6}	Sc, Ti, V, nuclides n_{nuc}<=11, orbit {-15,10}o size {-15,11//6}	Cr,Mn,Fe, nuclides n_{nuc}<=12, orbit {-15,11}o size {-15,12//6} ={-14,2}	
nuclide	**-14**	orbit {-14,1}o, size {-14,2}, n_{nuc}=7..12, Z=11..26 nuclides Na,Mg,Al,Si,P,S,Cl ,Ar,K,Ca,Sc,Ti,V,Cr ,Mn,Fe	orbit {-14,2}o, size {-14,3}, n_{nuc}=13..18, Z=27..47 nuclides Co,Ni,Cu,Zn,Ga, Ge,As,Se,Br,Kr, Rb,Sr,Y,Zr,Nb,Mo ,Tc,Ru,Rh,Pd,Ag	orbit {-14,3}o, size {-14,4}, n_{nuc}=19..24, Z=48..70 nuclides	orbit {-14,4}o, size {-14,5}, n_{nuc}=25..30, Z=71..96 nuclides	orbit {-14,5}o, size {-14,6} ={-13,1}, n_{nuc}=31..36, Z=97..118 nuclides	Og118 nucleus size {-13,1}						
	-13						{-12,1} H-atom size						
atom	**-12**	H, He, electron shell orbit	period 2 atom's electron outer shell (unshrunk) orbit, max actual size of atom {-12,3}	period 3 atom's electron outer shell unshrunk orbit	period 4 atom's electron outer shell unshrunk orbit	period 5 atom's electron outer shell unshrunk orbit	period 6 atom's electron outer shell unshrunk orbit	period 7 atom's electron outer shell unshrunk orbit					
	-11					{-10,1} max atom theoretical size							

Note: For the complete {N,n//6} QM master periodic table (N = -24 … 15, and n = 1 … 12), see SunQM-7's Table 1.
Note: n_{nuc} is defined by the size of nucleus. According to the rule of "all matter between r_n and r_{n+1} belongs to orbit n", its matter's nucleon orbital shell space is at n_{nuc} -1. For example, Helium's nucleus has n_{nuc} = 2 for its size, and its nucleon orbital shell space should be at n = n_{nuc} -1 = 1, or {-15,1//6}o.

More discussions on Table 3 and Figure 2:
1) In Table 3, the (Mendeleev) electron periodic table of elements (the electron configuration) is compressed into N = -12 (as a single period) with n = 1 to 7. The information of the electron configuration and the chemical property of these elements are buried after this compression.

2) It is interesting to see that a hydrogen nucleus (with n_{nuc} = 1, see Table 2) has size of {-15,1//6}, it is "accompanied" by a helium nucleus (with n_{nuc} = 2) at {-15,1//6}o nucleon orbital shell space with a size of {-15,2//6}. Also, an oxygen nucleus (with n_{nuc} = 5.5 ≈ 1 * 6^1) has size of {-14,1//6}, it is "accompanied" by a Fe nucleus (with n_{nuc} = 12.2 ≈ 2 * 6^1) at {-14,1//6}o nucleon orbital shell space with a size of {-14,2//6}. Notice that in Figure 2, among n = 1 ... 6 of n_{nuc} = n * 6^0 nuclides, or from H to Ne nuclides, hydrogen nucleus (n_{nuc} = 1) has the highest abundancy (= stability), and the "accompanied" helium nucleus (n_{nuc} = 2) has the second highest abundancy (= stability). Also among n = 1 ... 6 of n_{nuc} = n * 6^1 nuclides, or from O to Og nuclides, Oxygen nucleus (n_{nuc} ≈ 1 * 6^1) has the highest abundancy/stability, and the "accompanied" Fe nucleus (n_{nuc} ≈ 2 * 6^1) has the second highest abundancy/stability. A more detailed discussion will be given in SunQM-7's section I-e, and SunQM-5s2's section III.

3) If we apply (a kind of) Fourier analysis to Figure 2, then it is expected to see that the Δn_{nuc} = 1 is the primary base "frequency", the Δn_{nuc} = 2 is the secondary base "frequency". Or, if we apply (a kind of) Principal Component Analysis (PCA, or similarly the SVD), then the first principal component vector must point to Δn_{nuc} = 1, and the second principal component vector must point to Δn_{nuc} = 2. (Note: as a citizen scientist, I don't know how to do those calculations right now, but I can guess how the result looks like).

II-c. As the force (or mass) increased, the quantum number q also increased in {N,n//q} QM structure

The above analysis revealed that although the {N,n//q} QM structures of both atom's nucleus shells and atom's electron shells are primarily in {N,n//6} QM at the low Z#, at the high Z#, both of them shifted to the {N,n//7} QM. This result suggested that as the force (or electron, or mass) increases, the original {N,n//q} QM structure may increase the

quantum number q from low value to high value. Actually, this is not the first time we see this kind phenomenon. Before (in SunQM-3s7) we have showed that the {N,n//q} QM (which can also be expressed as |qnlm>) can have superposition of different QM states, in the current case, between quantum number q = 6 and q = 7. We may can explain the above result as: in the low Z range, the superposition (equilibrium) shifted to {N,n//6} side; and in the high Z range, the superposition (equilibrium) shifted to {N,n//7} side. Og (Z=118, n_{nuc} = 34.2 ≈ 36 under q=6) fits to {-14,5//6}o, which ends the N= -14 super shell, and the same Og (Z=118, n_{nuc} = 47.9 ≈ 49 under q=7) fits to {-14,6//7}o, which also ends the N= -14 super shell. Thus, the superposition of q = 6, and q = 7 gives the self-consistent explanation. Especially a {N,n//7} QM structure fits to both the atom's nucleus {N,n//q} QM (see Table 2 last column) and the atom's electron shell {N,n//q} QM (see Table 3, N = -12 period), this really makes us to believe that {N,n//7} QM is also correct for (at least the high Z numbered) atoms (probably due to the increased relativity effect).

In SunQM-1s3 and SunQM-3s7, we have shown that the original Saturn (when it was just formed ~4.5 billion years ago) had only ~20% of current mass, and had a {N,n//2} QM structure. After it captured large amount of mass (of the evaporated H/He/H_2O/CH_4, etc. from inside the {1,6//6} pre-Sun ball), its mass increased to 100% of the current mass, and its p{N,n//2} QM structure changed to the superposition of p{N,n//3} and p{N,n//2}. Similarly, the original Jupiter (when it was just formed ~4.5 billion years ago) had only ~10% of current mass, and had a p{N,n//2} QM structure. After it captured large amount of mass (of the evaporated H/He/H_2O/CH_4, etc. from inside the {1,6//6} pre-Sun ball), its mass increased to 100% of the current mass, and its p{N,n//2} QM structure changed to the superposition of p{N,n//5} and p{N,n//3}. On the other hand, the original Earth (when it was just formed ~4.5 billion years ago) had ~25x of current mass, and had a p{N,n//2} QM structure. After it lost 96% of mass (24x of Earth mass, the whole original atmosphere shell with ~2000 km thickness of H/He/H_2O/CH_4, etc.), its mass decreased to 1x of the current mass, and its p{N,n//2} QM structure changed to the p{N,n//2//2}, meaning its original q=2 decreased to ½ of q=2, and the leftover p{N,n//2} QM structure re-structured to be a new p{N,n//4} QM structure (see SunQM-3s7's section I-e and section V). Therefore, we do have the evidences that not only the increasing of force/mass will increase the q value of {N,n//q}, but also the decreasing of force/mass will decrease the q value of {N,n//q}. Furthermore, this analysis showed us several true examples that the quantum number q can be in values of 7 (the {N,n//7} QM structure of nuclides at high Z#), 6 (the standard {N,n//6} QM structure from N = -17 to N = 10), 5 (Jupiter's internal and surface p{N,n//5} QM structure), 4 (equivalent to {N,n//2} QM naturally), 3 (Saturn's internal and outer ring p{N,n//3} QM structure, and Jupiter's outer ring p{N,n//3} QM structure), 2 (the initial p{N,n//2} QM structure for all original planets, the current Neptune's p{N,n//2} QM structure), 1 (Earth's initial p{N,n//2} QM structure is now become p{N,n//2//2} → p{N,n//4} QM structure with q = 2 *1/2 =1, after stripping off 24/25 = 96% of mass). So far, we have not seen any obstacle for q quantum number to take the even higher values of 8, 9, etc., or the even lower values of 2*½*½= 1/2, or even 2*½*½* ½=1/4, etc.

II-d. The definition of an electron's ground state vs. excited state in an atom is different for {N,n} QM, and for Bohr-QM.

See SunQM-7's section I-f.

II-e. Using {N,n} QM to analyze the 3D distribution of protons inside a atom's nucleus

{N,n} QM can also be used to analyze the 3D distribution of protons and neutrons inside an atom's nucleus. Here let's use Fe element's nucleus as the example. A Fe element's nucleus contains total 56 nucleons, including 26 protons and 30 neutrons. All of them are doing orbital movement (or at least their matter waves are doing orbital movement, while the nucleon particles may be apparently doing random collision) inside the size of {-14,2//6}. According to Table 3, the size of {-14,2//6} contains {-15,n=1..11//6}o orbital shells, and the higher the n, the higher the QM state energy it will have. Because of the Coulomb repulsive potential energy, all (positively charged) protons should have higher QM state energy (than that of

neutrons). So protons mostly take the high n orbital shells (e.g., {-15,11//6}o orbital shells, close to the outer edge of the nucleus, see Figure 1), while neutrons are pushed inward to take the low n orbits. Without the outside force, the distribution of protons is isotropic. Thus, the 3D distribution of protons (or neutrons) can be described by Born probability (because it is in equilibrium state) of r^2 * |R(n,*l*)|^2 * |Y(*l*,m)|^2, (where n = 1 ... 11, *l* = 0 ... (n-1), and m = -*l*, … +*l*), and can be further simplified to r^2 * |R(n)|^2 (because of the isotropic, |Y(*l*,m)|^2 = 1). When added the outside magnetic force, the nucleus has the orientation with the z-axis overlap to the outside magnetic force-line. Those nucleons (proton? neutron?) that can interact with the outside magnetic force to strongly decrease their QM state energy will take (the relatively low QM state energy of) nLL orbits, while the rest nucleons (neutron? proton?) will be pushed to the two poles (with the relative high QM energy orbit of n*l*0). Thus, the distribution of protons (which is always mostly at high n orbit, or near the out-edge of nucleus) become anisotropic. (Note: because I am only a citizen scientist of QM, not a nuclear physicist, I don't know whether it is proton or neutron that will be pushed to the two poles of the nucleus under the outside magnetic field. If any reader knows, please teach me).

Alternatively, the size of {-14,2//6} can be roughly divided into two (spherical or shell) spaces: the {-14,1//6} sized core (which has relatively low QM state energy, or it can be defined as the (relative) ground state), and the {-14,1//6}o orbital shell (which has relatively high QM state energy, or it can be defined as the 1st excited state). Protons will (mostly) take the {-14,1//6}o orbital shell (due to they have higher QM state energy). The {-14,1//6}o orbital shell has n=1, so the |1,0,0>, or |R(1,0)|^2 * |Y(0,0)|^2, perfectly describes the isotropic distribution of protons inside Fe element nucleus (when without outside force). Under the outside magnetic field, the outer-edge nucleons (of Fe nucleus) has size of n ≈ 2, and can be roughly treated as partially in |2,1,m> QM state. Then those nucleons (proton? neutron?) that can interact with the outside magnetic force to strongly decrease their QM state energy will take the |2,1,1> orbit (or be pushed to the equator, because |2,1,1> orbit has the lower QM state energy), while the rest nucleons (neutron? proton?) will be forced to take |2,1,0> orbit (or be pushed to the two poles, because |2,1,0> orbit has the higher QM state energy).

The similar analysis can be used for any element's nucleon 3D distribution inside the nucleus (see the illustration in Figure 3). We also believed that the proton's 3D re-distribution information inside a nuclear {N,n//6} QM structure will soon be added in the explanation a number of nuclear physical processes, including nuclear fission, alpha-decay, beta-decay, even the difference between ferromagnetism vs. ferrimagnetism, etc.

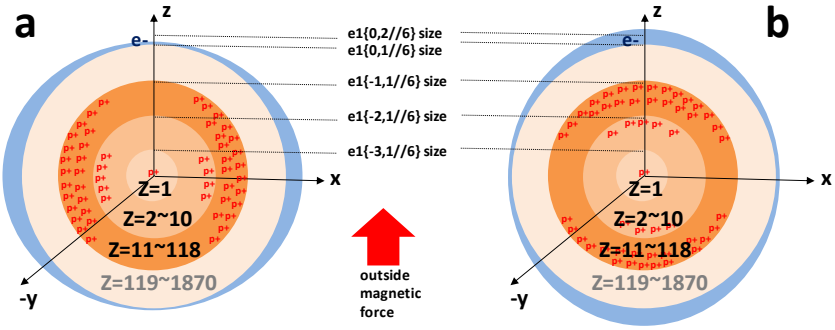

Figure 3a (left). To illustrate that if protons interact with the outside force will decrease their QM state energy more than that of neutrons, then more protons in each nuclear super-shell will move to the approximate |2,1,1> QM state (near equator). Figure 3b (right). To illustrate that if neutrons interact with the outside force will decrease their QM state energy more than that of protons, then more protons in each nuclear super-shell will be pushed to the approximate |2,1,0> QM state (near two poles). Note: the r-dimension is not on scale.

II-f. Using Schrodinger equation and probability r-distribution to describe an atom's nucleus-electron system (and *N*-body problem)

(Note: In this paragraph, the italic *N* means *N*-body's *N*, not {N,n} 's N). The interior {N,n} QM of atom's nucleus-electron system reveals that the core of this {N,n} QM structure is *N*-body (rather than the one-body core in the Solar system's interior {N,n} QM structure). Likewise, the (one-body) Sun core {0,1} could be treated as that there were 4 of quarter-massed small-Sun doing RF movement (exactly like the nucleus of Helium with 4 nucleons), or could be treated as there were ~20 of small-Sun doing RF movement (exactly like the nucleus of Ne with 20 nucleons), or, could be treated as there were ~300 of Jupiter-sized small-Sun doing RF movement (like Og-118 nucleus with ~294 nucleons). Or, it even could be treated as there were (Sun's mass / proton's mass =) 1.19E+57 of nucleons doing RF movement. Since Sun's interior {N,n} QM is described by using Schrodinger equation's probability density r^2 *|R(n,*l*)|^2 *|Y(*l*,m)|^2 to fill in mass, (He, Ne, and all other atoms') nuclides can also be treated by using Schrodinger equation's probability density r^2 *|R(n,*l*)|^2 *|Y(*l*,m)|^2 to fill in one (fundamental) mass to orbital shell spaces of e1{-1,n=1..5//6}o, e1{-2,n=1..5//6}o, and e1{-3,n=1..5//6}o, and this (fundamental) mass is a e1{-3,1//6} sized RF QM structure which we call it proton (and/or neutron). All this interior e1{N,n} is relative to the electron ground state e1{0,1//6} as r_1. For e1{-2,1//6} sized orbital spherical space it has the maximum occupancy number of ~20 of e1{-3,1//6} RF ball structures, and for e1{-1,1//6} sized orbital shell space it has the maximum occupancy number of ~300 of e1{-3,1//6} RF ball structures. Note: it is easy to understand that using Schrodinger equation's probability density r^2 *|R(n,*l*)|^2 *|Y(*l*,m)|^2 to fill in mass (*N* point mass, with large *N* number, billions, like gas molecule) to orbit space. It is not easy to think *N*-body problem (with *N*= 3 ~10) can also be treated in the same way as *N* in billions. Just think for a 3-body, each point center has some probability to stay in orbital shell space. (See SunQM-7's section II-c for more discussion on this topic).

Therefore, the nucleus can be described as the interior {N,n} QM structure of the ground state electron's orbital shell e1{0,1//6}, i.e., e1{-1,n=1..5//6}o, e1{-2,n=1..5//6}o, and e1{-3,n=1..5//6}o, with the 1st, 2nd, and 3rd level of RF^ (note: see SunQM-2 's section IV-c for the definition of RF^), with matter wave $\lambda = 1\times$, $6\times$, or $36\times$ of $2\pi r_{1N}$, where r_{1N} is r of e1{N,1//6}. We can use Schrodinger equation's probability density r^2 *|R(n,*l*)|^2 *|Y(*l*,m)|^2 to fill in a number of e1{-3,1//6} RF QM structures (we called them as protons/neutrons, see Figure 4). and the maximum occupancy for e1{-3,1//6} spherical space, e1{-2,1//6} orbital spherical space, and e1{-1,1//6} orbital shell space is 1, ~20, ~300 of proton/neutron respectively. According to this understanding, we plotted the Figure 4 to show that nucleus as the interior e1{N,n//6} QM structure of its own shrunk e1{0,1//6} electron ground state, and all of them are governed by Schrodinger equation's probability density r^2 *|R(n,*l*)|^2 *|Y(*l*,m)|^2.

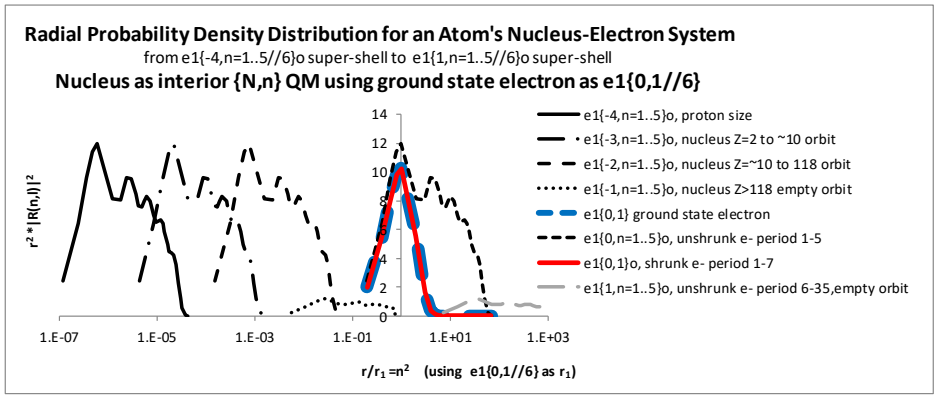

Figure 4. Plot of the radial probability density r^2 * |R(n,*l*)|^2 vs. r/r_1 for the interior {N,n//6} QM of an atom's nucleus-electron system from e1{-4,n//6} to e1{1,n//6}. Note: the y-axis is not on scale. Note: The thick red curve of r^2 * |R(n=1,*l*)|^2 has the size of n=2 and it fits the "atom size n=2 effect" of the shrunk electron shells (of the electron period 1 through 7). Notice that in this representation, only the Z=1 element is well represented; all Z > 1 elements should have $r_{e1} = r_1/Z$ and those r_{e1} are ignored in the red curve representation in Figure 1. For example, the Z=36 element should have r_{e1} =

$r_1/Z = r_1/36$ and it is ignored in the Figure 1's red curve representation. Part of reasons for the ignorance is that Figure 1 needs to represent Z = 1..118 at one time.

Table 4. r^2*|R(n,*l*)|^2 vs. r/r_1 for n=1 to 5, (for Figure 4 through Figure 6).

															r/r1 log compress at 4
a_0=	0.0529	nm													4
r/a0 =	$r^2\|R5,0\|^2$	$r^2\|R5,1\|^2$	$r^2\|R5,2\|^2$	$r^2\|R5,3\|^2$	$r^2\|R5,4\|^2$	n=1,l=0	n=2,Σl=0,1	n=3,Σl=0..2	n=4,Σl=0..3	n=5,Σl=0..4	Σn=1..5,Σl	0.1X Σn=1..5	Σn=1.2	log(r/r1)
0.2	0.015998	8.44E-05	3.03E-08	1.82E-12	2.07E-17	2.027433	0.25175842	0.07450383	0.03141784	0.01608275	2.4011959	0.24012	2.279191	0.2
0.4	0.040984	0.001099	1.7E-06	4.22E-10	1.95E-14	5.436116	0.66229479	0.19530913	0.08225982	0.0420848	6.4180646	0.641806	6.098411	0.4
0.6	0.056701	0.004516	1.69E-05	9.78E-09	1.04E-12	8.198859	0.97105424	0.28490991	0.11978578	0.06123341	9.6358428	0.963584	9.169914	0.6
0.8	0.058719	0.011529	8.28E-05	8.83E-08	1.7E-11	9.770418	1.12346398	0.32803181	0.13768822	0.0703318	11.429933	1.142993	10.89388	0.8
1	0.049544	0.022638	0.000275	4.76E-07	1.46E-10	10.23329	1.15904046	0.33806031	0.14186273	0.07245751	11.944713	1.194471	11.39233	1
2	0.001911	0.112167	0.008734	7.33E-05	1.01E-07	5.539702	1.70554862	0.54844411	0.23732733	0.12288537	8.1539072	0.815391	7.24525	2
3	0.087288	0.143192	0.047879	0.001123	3.89E-06	1.686863	4.23519485	1.28863674	0.54548692	0.27948548	8.0356675	0.803567	5.922058	3
4	0.140406	0.074903	0.124776	0.006661	4.63E-05	0.405853	6.46298537	1.70577778	0.69034111	0.34679285	9.6117498	0.961175	6.868838	4
5	0.081866	0.006064	0.210513	0.02339	0.000289	0.085822	6.8992841	1.60685839	0.64161136	0.32212309	9.5556991	0.95557	6.985106	4.30103
6	0.009006	0.019887	0.260754	0.058728	0.001199	0.016725	5.9040222	1.51828863	0.66553062	0.34957334	8.4541401	0.845414	5.920747	4.477121
7	0.015773	0.107725	0.248857	0.116501	0.003753	0.003081	4.36404759	1.87526001	0.91112496	0.49261016	7.6461236	0.764612	4.367128	4.60206
8	0.100597	0.202397	0.181739	0.193653	0.009563	0.000545	2.90861106	2.69618312	1.29699366	0.68794882	7.5902813	0.759028	2.909156	4.69897
9	0.197087	0.242533	0.092774	0.279865	0.020816	9.33E-05	1.79515774	3.71109967	1.63977488	0.8330755	7.9792011	0.79792	1.795251	4.778151
10	0.241285	0.210098	0.022511	0.360169	0.040019	1.56E-05	1.04416978	4.60002243	1.80695536	0.87408091	8.3252441	0.832524	1.044185	4.90309
12	0.133588	0.047385	0.035228	0.445349	0.111337	4.11E-07	0.30941742	5.28209782	1.65071641	0.77288663	8.0151187	0.801512	0.309418	5
14	0.003249	0.01506	0.217312	0.386333	0.233707	1.02E-08	0.08061689	4.55040985	1.5250704	0.85566032	7.0117575	0.701176	0.080617	5.079181
16	0.077737	0.178673	0.377637	0.224532	0.399169	2.45E-10	0.01915154	3.21879457	2.01605722	1.25774797	6.5117513	0.651175	0.019152	5.146128
18	0.27589	0.356738	0.377952	0.064715	0.582433	5.68E-12	0.00424424	1.97692646	2.96268514	1.65772775	6.6015836	0.660158	0.004244	5.20412
20	0.392865	0.384808	0.237482	0	0.75056	1.28E-13	0.00089096	1.09228161	3.83918001	1.76571553	6.6980681	0.669807	0.000891	5.255273
22	0.337164	0.258853	0.074238	0.065063	0.874735	2.85E-15	0.00017908	0.55590065	4.25450181	1.61005302	6.4206346	0.642063	0.000179	5.30103
24	0.174224	0.091491	0.000229	0.234567	0.938267	6.21E-17	3.4734E-05	0.2649428	4.12576476	1.43877838	5.8295207	0.582952	3.47E-05	5.361728
27	0.002603	0.007221	0.134416	0.555149	0.917695	1.95E-19	2.8103E-06	0.07905793	3.24298461	1.61708413	4.9391295	0.493913	2.81E-06	5.414973
30	0.112528	0.20552	0.445905	0.79272	0.79272	5.96E-22	2.1572E-07	0.02150134	2.13598278	2.34939336	4.5068777	0.450688	2.16E-07	5.462398
33	0.417615	0.527699	0.725881	0.864958	0.619289	1.79E-24	1.5873E-08	0.00543514	1.23167877	3.15544177	4.3925557	0.439256	1.59E-08	5.50515
36	0.706667	0.773864	0.850368	0.791595	0.445272	5.27E-27	1.128E-09	0.0012949	0.64042136	3.56776632	4.2094826	0.420948	1.13E-09	5.556303
40	0.852436	0.842775	0.77556	0.580112	0.257828	2.18E-30	3.176E-11	0.00017749	0.23604795	3.3087107	3.5449361	0.354494	3.18E-11	5.612784
45	0.686303	0.62964	0.504996	0.314748	0.113309	1.25E-34	3.4571E-13	1.3448E-05	0.0579471	2.24899649	2.306957	0.230696	3.46E-13	5.662758
50	0.406218	0.355021	0.259695	0.142494	0.04398	7.03E-39	3.5746E-15	9.3656E-07	0.01244192	1.2074081	1.219851	0.121985	3.57E-15	5.70757
55	0.195242	0.164811	0.112749	0.056266	0.015438	3.86E-43	3.546E-17	6.098E-08	0.00240651	0.5445057	0.5469123	0.054691	3.55E-17	5.748188
60	0.080542	0.06622	0.043037	0.01995	0.004988	2.09E-47	3.3996E-19	3.7582E-09	0.00042806	0.21473734	0.2151654	0.021517	3.4E-19	5.78533
65	0.029529	0.023778	0.014837	0.006483	0.001503	1.11E-51	3.1674E-21	2.2126E-10	7.1083E-05	0.0761291	0.0762002	0.00762	3.17E-21	5.819544
70	0.009852	0.0078	0.004708	0.00196	0.000427	5.86E-56	2.8802E-23	1.2532E-11	1.1145E-05	0.02474613	0.0247573	0.002476	2.88E-23	5.880814

Note (for Table 4 and Figure 4):

1) The purpose of this plot is to demonstrate that the nucleus is an interior {N,n} QM structure of e1{0,1//6} electron shell. The probability density scale between different N super-shells is not on scale.

2) For super-shells from e1{-4,n//6} to e1{-1,n//6}, orbit n = 1..5, size n = 2..6.

3) Proton size is at e1{-3,1//6}, but its orbit covers e1{-4,n=1..5//6}o. n=1 electron at orbit e1{0,1//6}o, it covers space from e1{0,1//6} to e1{0,2//6}, not {-1,n=2..5//6}o.

4) For e1{-1,n//6} super-shell in the Figure 4, the probability density is scaled down to 0.1×, to illustrate that: a) there is no (Z > 118) nucleus has been found in this super-shell yet; b) for the Z ≤ 118 nuclides, nucleons never go to this super-shell space.

5) Due to that I am not able to obtain R(n,*l*) for n=6, or n=7, so the probability density distribution of e1{0,n=1..7//6}o is actually Σn=1..5.

6) The e1{1,n//6} super-shell (uncompressed space) of electron is empty for (electron orbital) period 6 to 35, so its amplitude is scaled down to 0.1×.

III. Treat atom as the interior {N,n//6} QM structure of a theoretical e6{0,1//6} electron shell

There are two questions that we are going to discuss here.

First question, how to explain n=7 (or electron period 7) electron shell in a {N,n//6} QM system? As shown in Figure 4, when we take ground state electron as e1{0,1//6}, then e1{0,6//6}= e1{1,1//6} size (with e1{0,5//6}o orbital space completely filled in) is expected to be a super stable state in {N,n//6} QM. If so, then the element (i.e., electron

configuration) period table should end at Xe (Z=54) at the end of electron period 5. According to {N,n//6} QM structure, if more electrons need to be added, then the next electron shell should be e1{1,1//6}o= e1{0,n=6..11 //6}o orbital space, or n = 6..11, and then e1{1,2//6}o = e1{0,n=12..17//6}, or n = 12..17 (similar as Jupiter's n=12 which covered n=12..17 orbital space relative to four rocky planets' n=3, 4, 5, 6 orbital space in Solar system). Although we do not know how to calculate the shrunk electron's r_n, but wiki "atomic radius" [14] gives the empirically measured atomic radius for electron period 7, and it is in the range between 216E-12 to 175E-12 meters. Comparing it to the un-shrunk n = 6 's r = 36*5.29E-11 = 1904E-12 meters, it seems that besides n=7, more extra n(s) can be added in to this gap.

One possible (and the less favorite) answer is, like Asteroid belt orbit at {1,8//6}o, between shell {1,6//6} = {2,1//6} and shell {1,12//6} = {2,2//6}, there is enough space to put (orbital) n=6, 7, 8, …, 11, for {N,n} super shell, if needed. If so, then according to the bottom part of Table 2, the maximum Z for nucleus could be ~1870 before the r_{nuc} crashes to the shrunk r_{e1} , and electron shell could be ≈ 22 (according to Table 2b, Z=1870). Another possible (and our favorable) answer is, the shrinking of the electron's ground state r_{e1} causes the r_n shrinks coordinately, so that the new electron periods (n=7, 8, …) can be directly add in. That means, the original {N,n//6} structure is now changed to {N,n//x}, where x=7, 8, etc.

The second question is, how to apply the interior {N,n//6} QM to electron's n shells? In Figure 4, the electron n shell is an exterior {N,n}, with ground state at e1{0,1}. Now we try to use the maximum n of electron shell as {0,1} (named as **e6{0,1//6}**) for the interior {N,n//6} calculation. But the problem is (same as before), we do not know how to calculate the shrunk electron's r_n (due to that we do not know how to calculate the electron shielding effect). Result/Discussion 4 on Table 2 (in section II-a) provides some clue. After a second thought, we suddenly realized that this is exactly an externalized r_1 (or $r_1 > r_{surface}$) effect, because that the too strong EM-force shrinks the r_n space. For element Ag (in electron period 5), although its real $r_{n=5}$ shrunk to 165E-12 meters (see Table 2 column 16), its original $r_{n=6}$ (at 36*5.29E-11=1.9E-9 meters) still functions as e6{0,1//6} for the interior{N,n//6} purpose (for electron shells of n=1…5). For element Pb (in electron period 6), although its real $r_{n=6}$ shrunk to 180E-12 meters, its original $r_{n=6}$ (at 36^2*5.29E-11=6.86E-8 meters) is still function as e6{0,6//6} = e6{1,1//6} for the interior{N,n} purpose. This externalization effect is exactly the opposite of the internalization effect that was discussed in the section XI of the paper SunQM-1s3, where the meter-sized body has too small G-force so that its gravity r_1 is << of its $r_{surface}$, or r_1 is internalized. So for the interior {N,n} QM, the e6{0,1//6} for electron period 1 to 5 elements is at 1.9E-9 meters (which is {-11,1//6} size under Sun{0,1}, see Table 1, notice that if use Sun{0,1}, the 1.9E-9 meters becomes 1.32E-9 meters). The e6{0,1//6} for electron period 6, 7 (and up) elements is at r ≈ 6.86E-8 meter (which is {-10,1} size under Sun{0,1} at 4.76E-8 meters). Since {-10,1} is the unidentified super-super stable QM structure in {N//6,n//6} QM theory, so now we can assign {-10,1} as the maximum atom's externalized r_1 (which is hidden by the strong EM force induced r_n QM space shrink). This maximum atom's externalized r_1 at {-10,1} size is just like the "recessive gene", it is there, but it does not show up (or it is hidden by the strong EM force induced r_n QM space shrink).

Figure 5 showed the interior {N,n} QM structure for electron period 1 through 7 shells using r_{e6} =1.9E-9 meters as e6{0,1}. The result is similar as that in Figure 4, except the r_1 is shifted up by ΔN = +1 (from r_{e1} to r_{e6}).

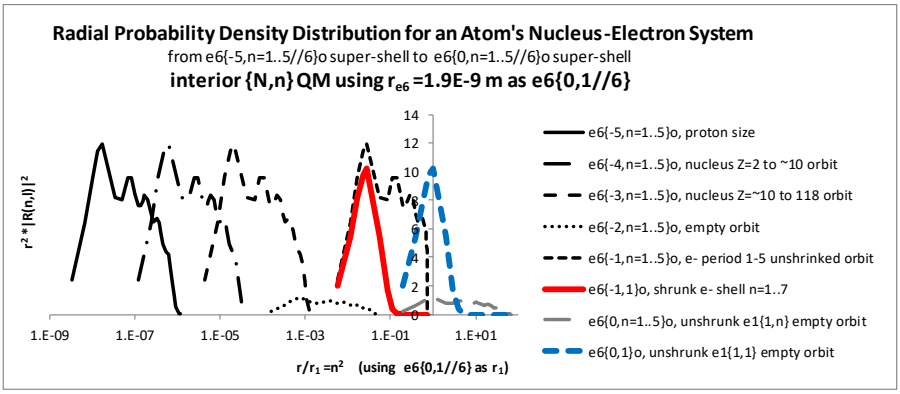

Figure 5. The interior {N,n//6} QM structure for electron period 1 to 7 shells using r_{e6} =1.9E-9 meters as e6{0,1//6}. Note: the y-axis is not on scale.

IV. Interior {N,n} QM analysis for a proton (or neutron) in a proton-quark system

Particle physics told us that each proton (or neutron) is made of three (different) quarks. Table 1 showed that quark is an interior ΔN = -2 of {N,1//6} QM structure of a nucleon. So if we treat proton as {0,1//6} (named **prot{0,1//6}**), then quark will be its interior prot{-2,1//6} QM structure. We can use Schrodinger equation's probability density r^2 *|R(n,*l*)|^2 *|Y(*l*,m)|^2 to fill in a number of prot{-2,1//6} sized ball structures (we call it quark) into the size space of prot{-2,1//6}, or prot{-1,1//6}, or prot{0,1//6}, and the maximum (and the minimum) occupancy for prot{0,1//6} size space is 3.

Figure 6 plotted the radial probability density r^2 *|R(n,*l*)|^2 vs. r/r_1 for interior {N,n} QM for a proton made of quarks. The purpose of this plot is to demonstrate that the quark prot{-2,1//6} is an interior {N,n} QM structure of prot{0,1//6} proton shell. Note: 1) The probability density between different N super-shells is not on scale. Does the inner one has higher probability than the outer one? (actually we don't know the answer); 2) This is a typical 3-body problem: each one quark has size of prot{-2,1//6}, three of them doing RF movement in the orbital space of {-2,n=1..5}o and {-1,n=1..5}o to form a proton with size of prot{0,1//6}. So a 3-body doing RF movement problem can be described under {N,n} QM structure with Schrodinger equation determined probability radial distribution. (For more discussions, also see SunQM-7's Table 1, or SunQM-5s2).

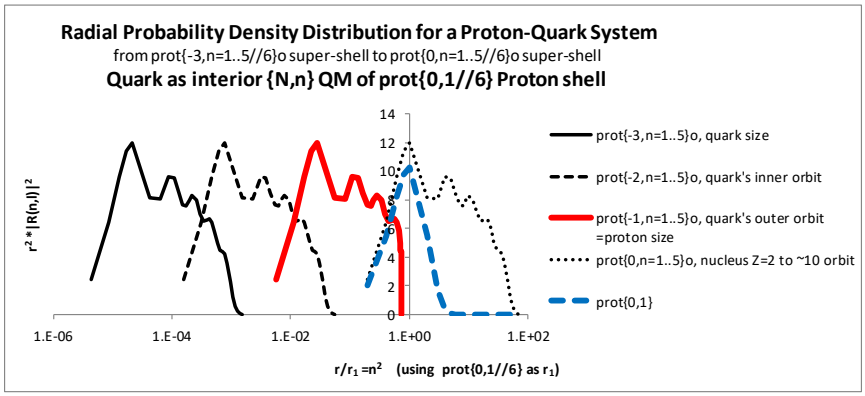

Figure 6. Plot of r^2 *|R(n,*l*)|^2 vs. r/r_1 for interior {N,n} QM for a proton-quark system from prot{-2,n//6} to prot{0,n//6}. Note: the y-axis is not on scale.

V. Exploring the interior {N,n//6} QM structure of a quark, made of ΔN= -3 and ΔN= -8 super stable {N,n//6} QM structure (similar to different levels of strings)

The analysis of Figure 4 through Figure 6 demonstrated that we can use this kind of figure as a general tool to explore the internal structure of a fundamental particle (like an atom, a nucleus, etc.) if we know its structure is based on {N,n//6} QM. From Table 1, we had hypothesized that at the size range much below quark, it also follows the {N//6,n//6} QM. So in this section, we will use this tool to further explore the possible sub-structure of quark.

Table 1 showed that there are (at least) two levels of super stable {N,n//6} QM structures inside quark, we call them **string{-20,1//6}** and **string{-25,1//6}**, one at ΔN = -3, another one at ΔN = -8 if quark is {0,1//6} (named **qk{0,1//6}**). So these super stable QM structures can be treated as the interior {N,n} QM structure of quark. Figure 7 plotted the radial probability density r^2 *|R(n,*l*)|^2 vs. r/r_1 for interior {N,n//6} QM of a quark made of string{-20,1//6} using qk{0,1//6}. So a (unknown) number (that equivalent to the mass occupancy, or equivalent to 3 quarks per nucleus) of super stable string{-20,1//6} moving in 3 levels of super-shell spaces from qk{-3,n=1..5//6}o to qk{-2,n=1..5//6}o to qk{-1,n=1..5//6}o, under qk{0,1//6}.

Figure 8 plotted the radial probability density r^2 *|R(n,*l*)|^2 vs. r/r_1 for the interior {N,n//6} QM using string{-20,1//6} as {0,1//6} (named as **str{0,1//6}**). So a (unknown) number (that also equivalent to the mass occupancy, or

equivalent to 3 quarks per nucleus) of super stable string{-25,1//6} moving in 5 levels of super-shell spaces from str{-5,n=1..5//6}o through str{-1,n=1..5//6}o, under str{0,1//6}.

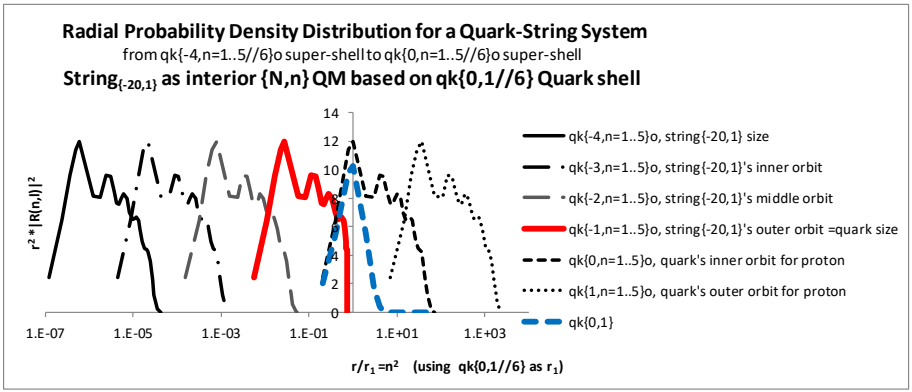

Figure 7. Plot of r^2 *|R(n,*l*)|^2 vs. r/r_1 for interior {N,n//6} QM of a quark made of string{-20,1//6} under qk{0,1//6}. Note: the y-axis is not on scale.

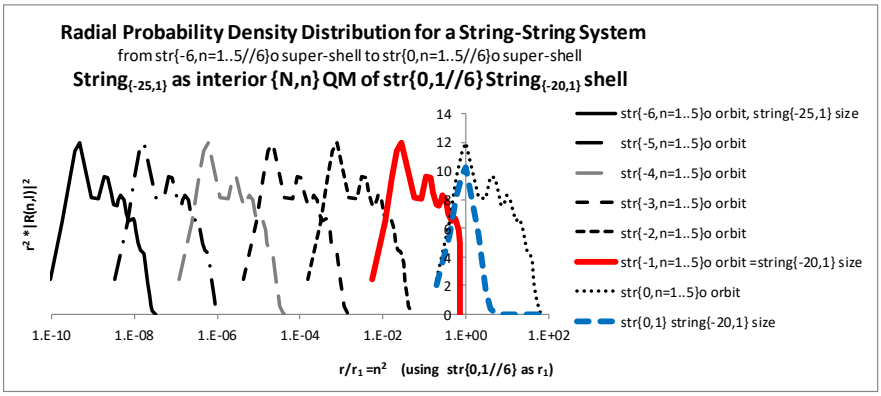

Figure 8. Plot of r^2 *|R(n,*l*)|^2 vs. r/r_1 for the interior {N,n//6} QM using string{-20,1//6} as {0,1//6}. Note: the y-axis is not on scale.

VI. White dwarf, neutron star, and black hole re-analyzed by using the interior {N,n} QM structure of nucleus-electron system

Note: due to the size limitation of this paper, this section is moved into the next paper SunQM-5s1.

VII. Interior {N,n} QM for molecules and solids, using carbon (diamond) or H_2O (ice) as example

In previous sections, we used the interior {N,n//6} QM to describe structures of atom, nucleus, quark, string{-20,1}, and string{-25,1}. Now we try to use the same interior {N,n//6} QM to describe the structures of molecule, daily-life-world mass body, celestial body, and up to our universe.

First let us use the interior {N,n//6} QM to describe the structure of a molecule, using carbon (diamond) molecules as the example. we should admit that the molecule is the most difficult part to use interior {N,n} QM to describe, and we still have a lot of confusion for our selfies.

For a molecule (that is made of many atoms)'s interior {N,n} QM, we have nucleus-electron's EM-force caused QM {N,n//6}, and G-force caused QM {N,n//6}. For nucleus-electron's EM-force caused QM {N,n//6}, we believe that it is most reasonable to choose (the compressed) e6{0,1//6} 's $r_{e6} = 36 * r_{e1}$ as the molecule's r_1, and use molecule's (ball-like) body surface r as the interior {0,1} (and we named it as **bs{0,1//6}**, meaning this {0,1} is using (ball-like) **b**ody **s**urface r as {0,1}). For a single carbon molecule (or atom), Z = 6, its measured $r_{surface} \approx$ 7E-11 meters (from wiki "atomic radius", also see Table 2 column 16), or, its bs{0,1//6} at $r_{surface} \approx$ 7E-11 meters. From the calculation, its $r_1 = r_{e6} = 36 * 5.29E\text{-}11 / (Z=6) = 3.17E\text{-}10$ meters. Therefore, its r_1 is externalized relative to its real $r_{surface}$ (or it has the externalized e6{0,1} effect, or $r_1 > r_{surface}$).

For a (diamond carbon) molecule made of five carbon atoms (named **C5**, see Figure 9) using chemical bond (which is a residue force of the EM-force between the neighboring nucleus-electron), the C-C (sp3-sp3) bond length = 1.54E-10 meters (from wiki "Bond length"). This C5 molecule is always rotating around, making an effective $r_{surface} \approx$ 1.89E-10 meters (see Table 5 column 2) for its bs{0,1}. Its r_1 increases extremely slow (comparing to the single C-atom), so it is still r_1 = 3.17E-10 meters. Thus, this C5 molecule still has externalized r_1 ($> r_{surface}$). For this C5 molecule, electrons in the (n=1) inner shell of carbon are completely localized to each C atom. Electrons in the (n=2) outer shell are shared with immediate neighboring carbon atoms, so they are partly delocalized. Although practically there is no electron orbiting the outer surface of (the ball-like) C5 molecule, but by constructing the contour line of C5 molecule's electron density 3D map, we can imagine that each C atom may contribute < 0.01% of one electron to (spherically) orbit directly at the C5-molecule's out surface with r ≈ 1.89E-10 meters. Here the point is, for a molecule, the r_1 for interior {N,n} QM is no longer associated with the molecule's outer most electron shell (like atom did in Figure 5) which is related to $r_{surface}$. It is only associated with each (or averaged) atom's e1{1,1//6} = e6{0,1//6} 's r_1, and this r_1 increases extreme slowly with the increasing number of bound atoms (associated with $r_{surface}$). Why? Because the r_1 is only related to the nucleus-electron system's (primary) EM-force caused QM effect. Notice that here the crystal lattice QM effect inside the carbon molecule (or inside the diamond ball) is not within our spec (because it does not belong to the (primary) EM-force caused QM effect). We only study the {N,n} QM effect exerted by a carbon molecule to its (molecular) surface and the outside space. So when adding more C atoms to a carbon (diamond) molecule, we can practically ignore the extreme small increases of bs{0,1//6} 's r_1.

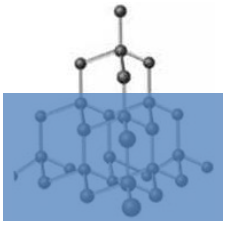

Figure 9. A diamond molecule made of five carbon atoms (the top un-shield part). Copied from: Dr Stan Fowler, "The difference between diamond and graphite, giant covalent structures", https://www.youtube.com/watch?v=FeZIIR50XoY. 0:48 / 4:19.

Table 5. Calculation of a carbon ball's $r_{surface}$ from its C atom numbers. Note: Diamond carbon mass density D≈3500 kg/m^3 obtained from wiki "Diamond".

D=3500 kg/m^3, 1 carbon =1.99E-26 kg				
# of C atoms	5	100	1.00E+06	7.50E+29
kg	9.95E-26	1.99E-24	1.99E-20	1.49E+04
Vol = Mass / Density, m^3	2.84E-29	5.69E-28	5.69E-24	4.26E+00
$r_{surface}$ =, m	**1.89E-10**	**5.14E-10**	**1.11E-08**	**1.01E+00**
r_1=36*5.29E-11/(Z=6), m	3.17E-10	3.17E-10	3.17E-10	3.17E-10

For a carbon (diamond) molecule with ~ 100 of C atoms, its $r_{surface}$ is estimated to be almost same as the bs{0,1//6} 's r_1 (see Table 5 column 3). For a carbon (diamond) molecule with 1E+6 of C atoms, its $r_{surface}$ (≈ 1.1E-8 meters, see Table 5

column 4) is > bs{0,1//6} 's r_1 (≈ 3.17E-10 meters). For a carbon (diamond) ball with $r_{surface}$ = 1 meter (about 7.5E+29 of C atoms), its $r_{surface}$ >> bs{0,1//6} 's r_1 .

Remember this is (primary) EM-force related r_1. What it means is that for a carbon diamond ball (with 1E+6 of C atoms), there is practically no (primary) EM-force caused {N,n} QM effect on its surface (at the gigantic molecule level). If you want to study the (primary) EM-force caused interior {N,n} QM of the meter-sized carbon ball, it is basically meaningless because it is within the range that comparable to (the interior QM's) r_1, which is << $r_{surface}$. So for a molecule composed of ≥ 1E+6 atoms, the nucleus-electron system's (primary) EM-force caused bs{N,n} interior QM can be completely ignored, because the true structure of these atoms is formed under the (residue) EM-force (e.g., chemical bond force, etc.). It can be explained as that in a residue EM-force formed molecule, the residue EM-force (the chemical bond force) expanded the size of this molecule so that it is no longer follow the primary EM-force formed {N,n//6} QM structure.

This explanation is also valid for the G-force caused {N,n//6} QM analysis. For a molecule composed of many atoms, the G-force caused bs{N,n//6} interior QM can be completely ignored (because the true structure of these atoms is formed under the (residue) EM-force, e.g., chemical bond force, etc.), and the chemical bond increase the $r_{surface}$ dramatically. This causes G-forced QM's r_1 << $r_{surface}$. Because G-force produces QM effect only near r_1, so at $r_{surface}$ (>> r_1), there is practically no G-force produced QM effect. So for the same carbon (diamond) ball with $r_{surface}$ = 1 meter, its $r_{surface}$ is much greater than not only the EM-force caused bs{0,1//6} 's r_1, but also the G-force caused bs{0,1//6} 's r_1. As the mass of the carbon ball further increases to equal or above the mass of Earth, then its $r_{surface}$ will be dominated by G-force (not the chemical bond force anymore), then its $r_{surface}$ will be comparable to the G-forced r_1 (notice that G-forced r_1 has nothing to do with the primary EM-forced r_1, and apparently the G-forced r_1 increases as $r_{surface}$ increasing). So then we can use the interior {N,n} QM to study the G-force caused interior {N,n} QM structure of Earth, Jupiter, Sun, Solar system, … etc. (as shown in paper SunQM-1s3).

We can also use the water molecules (or ice ball) to explain the interior {N,n} at molecular level. For a single H_2O molecule, its effective $r_{surface}$ is smaller than the (primary) EM-force caused effective bs{0,1//6} 's r_1. So the r_1 is externalized. For multiple H_2O molecules that form a tiny ice ball, they are bound by hydrogen-bond force (which is a residue force of the EM-force between atoms). Around 100 water H_2O molecules is expected to have its $r_{surface}$ to be the same as (or larger than) the (primary) EM-force caused effective bs{0,1//6} 's r_1. For an ice ball with r = 0.25 meter, its $r_{surface}$ >> not only the (primary) EM-force caused bs{0,1//6} 's r_1, but also the G-force caused bs{0,1//6} 's r_1. So if you want to study the (either EM-force or G-force caused) {N,n} QM of the meter-sized ice ball, it is basically meaningless because it is in range of r_1, which is << $r_{surface}$. As the r of the ice ball further increases to the size of the ice-planet Neptune, then its $r_{surface}$ is dominated by G-force (not by H-bond anymore) so that it is become comparable to G-forced QM's r_1. So then we can use the interior {N,n} QM to study the G-force caused interior {N,n} QM structure of the icy-planet Neptune (as shown in paper SunQM-1s3 and SunQM-3s7).

For the daily-life-world objects, they are made of molecules (with chemical bond), or a collection of molecules like biological cells, or even human body (formed with chemical bond, salt bridge, hydrogen bond, van der Waals bond, etc., all belong to the residue EM-force). Their interior {N,n} QM structures should be analyzed in the same way as that for the water/ice ball. We spend so much effect to study the meter-sized carbon (or H_2O) giant molecule's (or ball's) {N,n} QM, simply because I was a biophysicist. So I interested in human body's {N,n} QM more than the celestial body's {N,n} QM. Unfortunately, the result showed that the chemical bond force expanded the size of an (C-C and C-H composed) mass to meter-size, and it makes the $r_{surface}$ (which is controlled by chemical bond force, not by the primary EM- or G-force) >> r_1 of (either the (primary) EM-force caused or G-force caused) {N,n} QM, so that the (EM- or G-forced) {N,n} QM analysis is not suitable for (meter-sized) human body. Alternatively, **does this analysis implies that the {N,n} QM structure is not able to produce any life structure, because {N,n} QM is a too simple physical process, lack of the diversity (that is required for the life structure)?**

In the size range of N= -10 to N=0 super shells, because both the (primary) EM-force caused {N,n//6} QM structure and the G-force caused {N,n//6} QM structure is disrupted by the strong (residue) EM-force (such as the chemical bond, etc.), the fine physical structures in this size range are no longer follow the{N,n//6} QM's structure. For example, Solar system's eight planets have the size in the range of {-1,n=1..4//6}, and all of them have the initial fine {N,n//q} QM structure of q=2, not q=6. The current fine structure of these planets are even more diversified: Saturn is currently in the superposition of {N,n//3} and {N,n//2}QM structure, and Jupiter is currently in the superposition of {N,n//5} and {N,n//3}QM structure

(see section II-c). This analysis revealed that {N,n//6} is the fundamental {N,n//q} QM in our universe, and the disruption of either the primary EM-force or G-force formed {N,n//6} QM will causes a {N,n//q} QM structure with q other than 6. For this reason, although the {N=-10..0,n//6} sized range still follows the {N,n//6} QM as a whole, we are not able (or it is meaningless) to plot a general figure based on {N,n//6} QM structure (like the Figure 4 through Figure 8) to explore the fine structures in this size range.

VIII. Interior {N,n//6} QM analysis for Virgo super cluster, Milky way galaxy, and Solar system

(Continued from the section I of this paper). Figure 10 plots the radial probability density r^2 *|R(n,*l*)|^2 vs. r/r_1 for the interior {N,n//6} QM structural analysis using Virgo Super Cluster {10,1//6} as {0,1} (named as **VSC{0,1//6}**). So a (unknown) number (that also equivalent to the mass occupancy, or equivalent to 3 quarks per nucleus) of galaxies at size of VSC{-2,1} that moving in 2 levels of super-shell spaces from VSC{-2,n=1..5//6}o through {-1,n=1..5//6}o, under VSC{0,1//6}. Also there are unknown number (that also equivalent to the mass occupancy, or equivalent to 3 quarks per nucleus) of stars at size of VSC{-10,2//6} that moving in 10 levels of super-shell spaces from VSC{-10,n=2..5//6}o through {-1,n=1..5//6}o, under VSC{0,1//6}.

Notice that in Figure 10 (and also in Figures 2 through 6), the y-axis is not on scale. In the future, with more research added, we may be able to generate the (closed to the true) probability values for each N super shell and n-shell. All this work suggested that the structure of our universe (from the whole universe down to the sub-quark) can be described by Schrodinger equation and solution (in terms of probability).

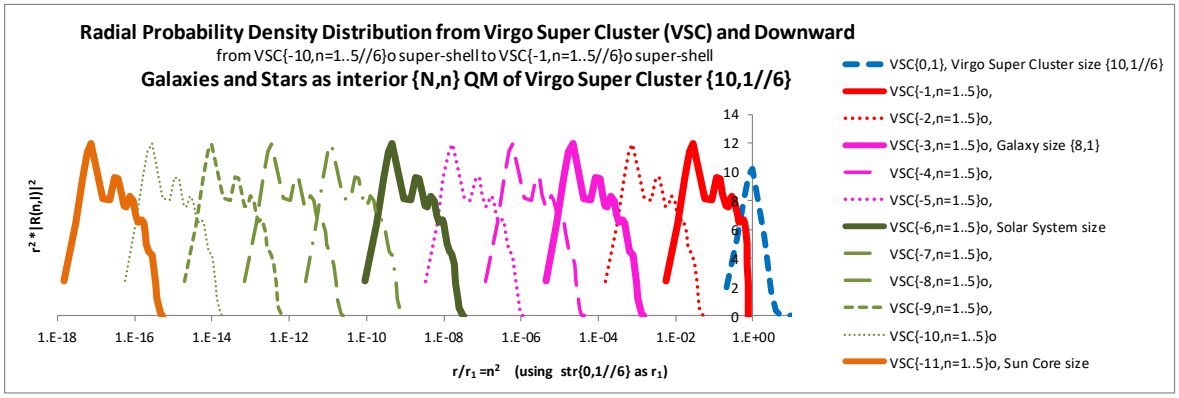

Figure 10. Plot of r^2 *|R(n,*l*)|^2 vs. r/r_1 for the interior {N,n} QM using Virgo Super Cluster (VSC) {10,1} as VSC{0,1}. Note: the y-axis is not on scale.

IX. Using interior {N,n} QM to describe three-body (or *N*-body) problem

Moved to SunQM-7 (due to the size limitation of this paper).

X. Using interior {N,n} to explore the size of our universe and the smallest string through the number guessing

Moved to SunQM-7 (due to the size limitation of this paper).

Conclusion

The interior {N,n} QM structural analysis is a novel method to study a atom's nucleus-electron system. The hidden property of {N,n//6} QM structure of nucleons inside a nucleus is uncovered only by using the n=1 ground state electron as e1{0,1//6}. The result reveals that nuclides of hydrogen (Z=1), He (Z=2), Li (Z=3), Ne (Z=10), Og (Z=118) atoms have the interior QM structure of e1{-3,1}, e1{-3,2}, e1{-3,3}, e1{-3,6} = e1{-2,1//6}, and e1{-1,1//6}, respectively. This result revealed that because Fe element is the only element that has ~100% nucleon occupancy in the n =1 nucleon orbital shell space (among the n = 1 nuclides of Z = 11 … 26, and also among its adjacent nuclides in n = 2 nuclides of Z = 27 … 45), so it has the most stable {N,n//6} QM nucleus structure among its adjacent nuclides.

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a constant density and therefore the nuclear radius R can be approximated by the following formula, $R = r_0 * A^{(1/3)}$, where A = Atomic mass number (the number of protons Z, plus the number of neutrons N) and $r_0 = 1.25$ fm = 1.25 × 10-15 m. In this equation, the "constant" r_0 varies by 0.2 fm, depending on the nucleus in question, but this is less than 20% change from a constant. In other words, packing protons and neutrons in the nucleus gives approximately the same total size result as packing hard spheres of a constant size (like marbles) into a tight spherical or almost spherical bag (some stable nuclei are not quite spherical, but are known to be prolate"

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SunQM-7: Using {N,n} QM and Simultaneous-Multi-Eigen-Description (SMED) to describe our universe.
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(Free) offline math calculation software: R
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