SunQM-7: Using {N,n} QM, Non-Born-Probability (NBP), and Simultaneous-Multi-Eigen-Description (SMED) to describe our universe

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Abstract

{N,n} QM contains two major parts: the Bohr formula-based part and the Schrodinger equation-based part. 1) For the Bohr formula-based part, after combining all results from the previous SunQM series papers, a {N,n//6} QM Structure (Master) Periodic Table (with N = -23..15, n = 1..12) is established. A summarized result of the {N,n//6} QM structure has been given for each region of this (Master) Periodic Table, including the cosmic {N,n//6} QM (at N > 5), the Solar {N,n//6} QM (at N= 5..-5), the chemical bond dominated world (at N= -2..-11), the atomic and nuclear {N,n//6} QM (at N= -12..-15), and the elementary particles and sub-quark {N,n//6} QM (at N ≤ -16). The common properties (that across all regions of the Master Period Table) has been discussed. For example, by adding many short-life intermediate states (n' = 1..6^6) in between the major quantum state n=1..5, we can transform a quantum description (with n=1..5} into a (continuous) classical physics description (with n' = 1..6^6). 2) For the Schrodinger equation-based part, we summarized that how to use {N,n//6} QM plus non-Born probability (NBP) plus Simultaneous-Multi-Eigen-Description (SMED) to describe a planet (or an atom in this planet) that orbiting around Sun, and a photon that propagating away (or towards to) a (Bohr) atom (and it can also be used for a 180° scattering). We further discussed the possibility to extend this description for any kind of movement (elliptical/parabolic/hyperbolic orbiting, scattering, etc.), with any inclination/eccentricity/precession. We also discussed how to use Schrodinger equation/solution for the *N*-body movement description. We pointed out that there is a conceptual difference between the {N,n} QM and the traditional QM in describing the H-atom's electron orbit: while the probability (i.e., the Born probability) is the foundation of the traditional QM, the single trajectory (i.e., NBP peak's time-dependent trajectory) is the foundation of the {N,n} QM (although this single trajectory will pick one of the many possible tracks based on the probability). 3) In the cosmic {N,n//6} QM, we explored the possibility that those super large cosmic "great walls" with distances ~ 9E+9 light-years from Earth are the (~ 9E+9 years old) self-images of our own Milky Way galaxy and be viewed at different angles. If this is correct, then our universe may should be a positive curved 3D space, with the circumference of ~ 9E+9 light-years. This means, just like we are practically living in the 2D spherical space on the surface of a 3D ball something (i.e., a planet), we may practically live in the 3D spherical space on the surface of a 4D ball something. 4) We pointed out that the wave mechanics is equally powerful as that of particle mechanics in solving a QM problem, and a particle mechanics based holographic-description and SMED is waiting to be developed. 5) Because the Bohr formula $r_n = r_1 * n^2$ correlates to the (free-fall) accelerated distance formula d = (1/2) *g *t^2 and Newton formula F = m * a, we believed that Bohr formula is the Number-One important formula in physics. We believed that all these results make {N,n} QM theory becomes one of the most (roughly) completed and (roughly) self-consistent theories in physics.

Introduction

The SunQM study opened a new door for the quantum physics. In the previous papers, we have shown that the formation of Solar system was governed by its {N,n//6} QM [1] ~ [16], the non-Born probability (NBP) can be used to describe both macro- and micro-world's phenomena [17] ~ [19], the same {N,n//6} QM method that used for the Solar system can be directly used for the micro world [20] ~ [22], Schrodinger equation and solution can be used not only for the mass distribution and movement, but also for the force field description, thus the four fundamental forces have been re-classified into three pairs: G/RFg-force, E/RFe-force and S/RFs-force, (Note: here a new gravitational force related RFg-force is hypothesized to replace the Dark Matter) [23], and a brand new {N,n} QM field theory is under development [24]. In the current paper, we try to combine all those results and use them to describe our universe. Note: I am neither a cosmologist, nor a particle physicist. I am a {N,n} QM scientist. All I did here is to use {N,n//6} QM to re-describe our world from elementary particle to the whole universe. Note: for {N,n//q} QM nomenclature as well as the general notes for {N,n//q} 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 = $5.6*10^{-9}$. Note: The reading sequence for SunQM series papers is: SunQM-1, 1s1, 1s2, 1s3, 2, 3, 3s1, 3s2, 3s6, 3s7, 3s8, 3s3, 3s9, 3s4, 3s10, 3s11, 4, 4s1, 4s2, 5, 5s1, 5s2, 6, 6s1, and 7. Note: 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.

I. Based on Bohr formula, using {N,n//6} QM Structure (Master) Periodic Table to describe our universe

The most important discovery in the SunQM series studies was that our universe from Virgo super cluster at {10,1//6}, down to Milky way galaxy at {8,1//6}, Solar system at {5,1//6}, Sun at {0,2//6}, black hole at {-3,1//6}, H-atom at {-12,1//6}, proton at {-15,1//6}, and quark at {-17,1//6}, are all mysteriously follow {N,n//6} QM structure in size (or in mass, see SunQM-1s2's Table 1). In SunQM-1's Table 4, and SunQM-3s8's Table 4, we showed that a {N,n//6} periodic table from N = -5 to N = 5 with n =1 to n = 12 is perfect to explain the {N,n//6} QM structure of Solar system. In SunQM-5's Table 3 we showed that a {N,n//6} periodic table from N= -15 to N= -14 with n =1 to n =12 is good to explain the nuclear {N,n//6} QM structure for all nuclides, and a {N,n//6} periodic table at N= -12 with n =1 to n =7 is good to explain the orbital electron's {N,n//6} QM structure in all atoms. In SunQM-5s2's Table 1, we showed a {N,n//6} periodic table from N = -13 to N= -23 with n =1 to n =12 to describe the elementary particle's {N,n//6} QM structure. After combining all above tables, we constructed a new Table 1 (in the current paper) that covered the all possible N periods (from N= -24 to N= 15) with n =1 to n =12 QM state, and we name it as the "**{N,n//6} QM Structure (Master) Periodic Table**". Following sub-sections are the discussions of Table 1.

I-a. The Solar {N,n//6} QM structure (steady state and dynamics)

The most important portion of the {N,n//6} QM Structure (Master) Periodic Table is the Solar system (from N = -5 to N = 5, named as **solar {N,n//6} QM structure**). As SunQM-1 explained, Sun has the size of {0,2//6}, Sun core has the size of {0,1//6}. Mercury, Venus, Earth, and Mars are at {1,n=3..6//6}o orbits, the Asteroid belt is at {1,8//6}o orbital shell space, Jupiter, Saturn, Uranus, Neptune, and Kuiper belt are at {2,n=2..6//6}o orbits. Oort cloud covers all {4,n=1..5//6}o orbital shell spaces. There are four undiscovered planets/belts at orbits of {3,n=2..5//6}o. Also, white dwarf, neutron star, and black hole have the size of {-1,1//6}, {-3,2//6} and {-3,1//6} respectively. A Sun-mass collapsed (observable but undiscovered) celestial body at the size of {-2,1//6} was predicted; and a Sun-mass black hole's stable size at {-5,1//6} was predicted. For planets, they are described as that they all initially formed in p{N,n//2} QM structure (although if using Sun{0,1//6}, both Earth and Venus have the size around {-1,1//6}, and both Jupiter and Saturn have the size around {-1,4//6}). Dynamics: The formation of Solar system was through a series of (mass) quantum collapse of pre-Sun ball from size {6,1//6} down to size {0,1//6}, and a series of quantum expansion of H-fusion shell from size {-7,1//6} up to size {0,1//6}, (see SunQM-1s1, and SunQM-3s8 for details).

Table 1. {N,n//6} QM Structure (Master) Periodic Table (from sub-quark to universe).

			n = "n state" or "n shell" or "n orbit space"											
		{N,n//6}	**1**	**2**	**3**	**4**	**5**	**6**	7	8	9	10	11	12
N =		-24												
"**N period**" or "N super-shell"	particle sub-	-23					0.012 eV/c^2, neutrino <0.12eV							
"-1" Force ?	eV/c^2	-22	0.017 eV/c^2	0.069 eV/c^2	0.155 eV/c^2	0.276 eV/c^2	0.431 eV/c^2	0.621 eV/c^2	0.845 eV/c^2	1.103 eV/c^2	1.396 eV/c^2	1.724 eV/c^2	2.086 eV/c^2	2.483 eV/c^2
	particle	-21	0.6 eV/c^2	2.5 eV/c^2	5.6 eV/c^2	9.9 eV/c^2	15.5 eV/c^2	22.3 eV/c^2	30.4 eV/c^2	39.7 eV/c^2	50.3 eV/c^2	62.1 eV/c^2	75.1 eV/c^2	89.4 eV/c^2
	eV/c^2	-20	22 eV/c^2	89 eV/c^2	201 eV/c^2	357 eV/c^2	559 eV/c^2	804 eV/c^2	1095 eV/c^2	1430 eV/c^2	1810 eV/c^2	2234 eV/c^2	2704 eV/c^2	3217 eV/c^2
	particle	-19	0.8 KeV/c^2	3.22 KeV/c^2	7.24 KeV/c^2	12.87 KeV/c^2	20.11 KeV/c^2	28.96 KeV/c^2	39.41 KeV/c^2	51.48 KeV/c^2	65.15 KeV/c^2	80.44 KeV/c^2	97.33 KeV/c^2	115.83 KeV/c^2
	KeV/c^2	-18	29 KeV/c^2	116 KeV/c^2	261 KeV/c^2	463 KeV/c^2	724 KeV/c^2, electron 511Kev	1042 KeV/c^2	1419 KeV/c^2	1853 KeV/c^2	2345 KeV/c^2	2896 KeV/c^2	3504 KeV/c^2	4170 KeV/c^2
S/RFs force	particle MeV/c^2	-17	1.04 MeV/c^2, up quark 1.9 MeV	4.17 MeV/c^2, down quark 4.4 MeV	9.38 MeV/c^2	16.68 MeV/c^2	26.06 MeV/c^2	37.53 MeV/c^2	51.08 MeV/c^2	66.72 MeV/c^2	84.44 MeV/c^2	104.24 MeV/c^2	126.14 MeV/c^2	150.11 MeV/c^2
		-16	38 MeV/c^2	150 MeV/c^2, strange qk 87 MeV/c^2	338 MeV/c^2	600 MeV/c^2	**938 MeV/c^2, proton, size {-15,1}**	1351 MeV/c^2, tetraquark	1839 MeV/c^2, Pentaquark	2402 MeV/c^2, Hexaquark	3040 MeV/c^2, Haptaquark	3753 MeV/c^2	4541 MeV/c^2	5404 MeV/c^2
	Atom's nuclues, or, particle GeV/c^2	-15	He nucleus, n_{nuc}=2, nucleon orbit {-15,1}o, size {-15,2}	Li nucleus, n_{nuc}=3, out-nucleon orbit {-15,2}o size {-15,3}	Be, B nucleus, n_{nuc}<=4, out-nucleon orbit {-15,3}o size {-15,4}	C, N, nucleus n_{nuc}<=5, out-nucleon orbit {-15,4}o size {-15,5}	O, F,Ne nucleus n_{nuc}<=6, out-nucleon orbit {-15,5}o size {-15,6//6}	Na, Mg, nucleus n_{nuc}<=7, out-nucleon orbit {-15,6}o size {-15,7//6}	Al, Si, nucleus n_{nuc}<=8, out-nucleon orbit {-15,7}o size {-15,8//6}	P, S, Cl, nucleus n_{nuc}<=9, out-nucleon orbit {-15,8}o size {-15,9//6}	Ar, K, Ca, nucleus n_{nuc}<=10, out-nucleon orbit {-15,9}o size {-15,10//6}	Sc, Ti, V, nucleus n_{nuc}<=11, out-nucleon orbit {-15,10}o size {-15,11//6}	Cr,Mn,Fe, nucleus n_{nuc}<=12, nucleon orbit {-15,11}o, size {-15,12//6}= {-14,2}	
		-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						H-atom size						
E/RFe force	atom	-12	H, He, electron shell orbit	electron period 2 element's electron outer shell orbit, max (unshrunk) size of atom {-12,3}	electron period 3 element's electron outer shell (unshrunk) orbit	electron period 4 element's electron outer shell (unshrunk) orbit	electron period 5 element's electron outer shell (unshrunk) orbit	electron period 6 element's electron outer shell (unshrunk) orbit	electron period 7 element's electron outer shell unshrunk orbit					
		-11					{-10,1} max atom theoretical size							
		-10												
		-9												
		-8												
		-7												
		-6					black hole stable size {-5,1}							
		-5												
G/RFg force	collapsed Sun size	-4					**black hole** orbit {-4,5}o, size {-3,1}							
		-3	**neutron star** orbit {-3,1}o, size {-3,2}				possible star size {-2,1}							
		-2					**white dwarf** orbit {-2,5}o, size {-1,1} **Earth** size ≈ {-1,1}	Sun's Ag, Au, Pb core size {-1,1}	Sun's Fe shell	Sun's Fe shell	Sun's Fe shell	Sun's Fe shell	Sun's Fe shell	
	Sun size, Sun internal shell	-1	Sun's Fe shell {-1,1}o	Sun's C, O, Ne, Si, S shell {-1,2}o,	Sun's He shell {-1,3}o, Jupiter, Saturn size {-1,4}	Sun's He shell {-1,4}o	Sun's H-fusion shell {-1,5}o, Sun core size {0,1}	Sun's Radiative zone {-1,6}o	Sun's Radiative zone {-1,7}o	Sun's Radiative zone {-1,8}o	Sun's Radiative zone {-1,9}o	Sun's Convective zone {-1,10}o	Sun's Convective zone {-1,11}o	Sun surface size {0,2}
	Planet size	**0**	**Sun** {0,1}o orbit, size {0,2}	corona shell {0,2}o	corona shell {0,3}o	corona shell {0,4}o	corona shell {0,5}o, size {1,1}, initial rock-evap-line {1,1}							
	Solar system, Planet orbit	**1**		burned out planet {2,1}o, current rock-evap-line {1,3}	**Mercury**	**Venus**	**Earth**, initial ice-evap-line {2,1}	**Mars**		**Asteroid belt**, Ceres	current ice-evap-line {1,9}		Jupiter, {1,11}o merged with {1,12}o	Jupiter, {1,12}o merged with {1,11}o
		2		**Jupiter**	**Saturn**	**Uranus**	**Neptune**, Solar wind stop, Methane-evap-line {3,1}	**Pluto, Kuiper belt** {2,6}o	SDO	SDO	SDO	SDO	SDO	
		3		**{3,2} planet/Belt**	**{3,3} planet/Belt**	**{3,4} planet/Belt**	**{3,5} planet/Belt**, nLL-force stop {4,1}	inner Oort	inner Oort	inner Oort	inner Oort	inner Oort	inner Oort	inner Oort
		4	**inner Oort**	**inner Oort**	**inner Oort**	**outer Oort**	**outer Oort**, Solar system size {5,1}, Sun bound G-force stop {5,1}							
	between stars	5					Sun's unbound G-force stop {6,1}							
		6												
	Galaxy	7					Milky way galaxy orbit {7,5}o, size {8,1} r=5~9E+4 ly							
		8	Halo of a galaxy, size {8,2}, r=2E+5 ly											
"+1" force ?	Super Cluster	9					Virgo SupClst orbit {9,5}o, size {10,1}, r=5.5E+7 ly							
		10	Laniakea supercluster,size {10,2}, r=2.6E+8ly	Laniakea-Coma-Perseus-Hercules-Shapley Superclusters, size {10,3}										
	observable universe	11				observ Univ r=4.4E+26 m, size up to {11,5}	{12,1} sized universe?							
	Universe	12					{13,1} sized universe?							
		13												
		14					{15,1} sized universe?							
		15												

Outside the Sun core (but still inside the Sun), the matter in the Sun's {-1,n=6..9//6}o orbital shell spaces is currently in the radiative (zone) phase, the matter in the {-1,n=10..11//6}o orbital spaces is in the convective (zone) phase. Dynamics: Revealed by {N,n//6} QM analysis (that based on all other previous theories), now we know that when the Sun was initially formed (~5000 mya, million year ago), its {-1,n=6..11//6}o orbital shell spaces were all in the radiative (zone) phase. About 2400 mya, its {-1,11//6}o orbital shell space had a phase (quantum) transition from the radiative phase to the convective phase. About 650 mya, its {-1,10//6}o orbital shell space had a phase (quantum) transition from the radiative phase to the convective phase. The onset of convection in {-1,11//6}o and {-1,10//6}o orbital shells might have caused a short period of random fluctuation of the output heat from the Sun surface, which further caused the onset of two "snowball Earth" periods (the first one at 2400 mya, the second one at 650 mya) in the Earth history. Furthermore, we predicted that ~ 650 million years later, Sun's {-1,9//6}o orbital shell space will have a phase (quantum) transition from the current radiative phase to the convective phase, and will cause a third major "snowball Earth" period on Earth. Then, after every ~1300 million years, each of {-1,n=8..6//6}o orbital shell spaces will quantumly transform from the current radiative phase to the convective phase one by one. (see SunQM-3s8's section II).

Inside the Sun core, the {-1,5//6}o orbital shell space is mainly occupied by hydrogen, and it is the H-fusion shell; the {-1,4//6}o and {-1,3//6}o orbital shells are mainly occupied by He; the {-1,2//6}o orbital space is mainly occupied by the electron period 2 and period 3 chemical elements (e.g., C, O, Ne, Si, S, etc.); the {-1,1//6}o orbital space is mainly occupied by Fe and some other electron period 4 chemical elements; the {-1,1//6} sized core space is mainly occupied by the electron period 5, 6, and 7 chemical elements. Dynamics: The last quantum expansion of H-fusion shell from {-2,5//6}o orbital shell space to {-1,5//6}o orbital shell space (inside Sun) caused the {2,1//6} pre-Sun ball expansion (i.e., the cold-r track switched to the hot-r track, with r increased by 1.26×, and with the spherical volume increased by 2×), and caused {1,11//6}o orbital shell degenerated with {1,12//6}o orbital shell (where Jupiter is currently located, see SunQM-1s1 and SunQM-3s8).

The Solar system has a rock-evap-line initially at {1,1//6}, now expanded to close to {1,3//6}; an ice-evap-line initially at {2,1//6} = {1,6//6}, now expanded to around {1,9//6}; a methane-evap-line currently at {3,1//6}, which is also the Solar wind stop-line; a nLL-QM force stop-line at {4,1//6}; a gravitational bound-force stop-line at {5,1//6}; and a gravitational unbound-force stop-line at {6,1//6}. Dynamics: see SunQM-3s10's Figure 5.

I-b. The cosmic {N,n//6} QM structure

In the size range larger than the Solar system (or N > 5, named as the **cosmic {N,n//6} QM structure**), we see that our Milky Way galaxy has the size of {8,1//6}, a halo of old stars and globular clusters occupies the {8,1//6}o orbit space of the galaxy and ended with the size at around {8,2//6}. Virgo SuperCluster (r = 55 million lys, wiki "Virgo SuperCluster"), is assigned to be the size of {10,1//6}, see Table 2. Laniakea SuperCluster (r ≈ 80 Mpc ≈ 260 million lys, wiki "Laniakea SuperCluster"), is assigned to be the size of {10,2//6}. The observable universe (r ≈ 4.4E+26 meters ≈ 4.65E+10 lys, wiki "observable universe"), is assigned to be the size of {11,5//6}.

According to wiki "Laniakea Supercluster", "*The neighboring superclusters to the Laniakea Supercluster are the Shapley Supercluster, Hercules Supercluster, Coma Supercluster and Perseus-Pisces Supercluster*" (also see Figure 1). According to Figure 1 and Table 2, Shapley SC is 200 Mpc away from Earth on one side, and Perseus-Pisces SC is 76 Mpc away from Earth on the opposite side. Adding two together gives a diameter of ~300 Mpc, or r = 150 Mpc. Thus, according to Table 2, the combined five superclusters is assigned to be the size of {10,3//6}.

In Appendix A, we showed another possible assignment for the cosmic {10,n=2..6//6} in Table 1.

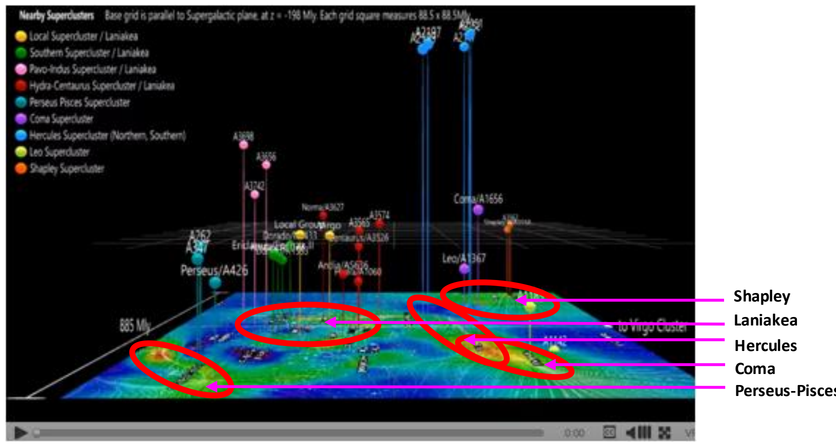


Figure 1. 3D Laniakea and other nearby superclusters of galaxies. Copied from wiki “Laniakea Supercluster”, video “Video showing in 3D Laniakea and other nearby superclusters of galaxies”. Author: Galaxies3D. Copyright: “freely licensed”.

Table 2. A list of cosmic {N,n//6} QM structures at N ≥ 10. (Note: d = distance, not diameter. r = radius).

r=	r=	r=	{N,n//6}	
km	lys	Mpc	size	
4.35E+17	4.59E+04	0.014	{8,1}	
1.74E+18	1.84E+05	0.056	{8,2}	
3.91E+18	4.13E+05	0.127	{8,3}	
6.95E+18	7.35E+05	0.225	{8,4}	
1.09E+19	1.15E+06	0.35	{8,5}	
1.56E+19	1.65E+06	0.51	{9,1}	
6.26E+19	6.61E+06	2.03	{9,2}	
1.41E+20	1.49E+07	4.56	{9,3}	
2.50E+20	2.65E+07	8.11	{9,4}	
3.91E+20	4.13E+07	12.7	{9,5}	
5.63E+20	5.95E+07	18.3	{10,1}	Virgo SC, r=16.5 Mpc
2.25E+21	2.38E+08	73.0	{10,2}	Laniakea SC, r=80Mpc. Coma SC, d= 92 Mpc. Perseus–Pisces SC, d= 76.7 Mpc. Right ascension 01h50m, Declination +36°00′
5.07E+21	5.36E+08	164	{10,3}	Hercules SC (Abell 2147, d= 149 Mpc. Abell 2151, d= 156 Mpc). Shapley SC, d= 200 Mpc. Right ascensio 13h 25m, Declination -30° 0′
9.01E+21	9.53E+08	292	{10,4}	
1.41E+22	1.49E+09	456	{10,5}	Sloan Great Wall, d ≈ 1.3E+9 lys.
2.03E+22	2.14E+09	657	{11,1}	
8.11E+22	8.57E+09	2629	{11,2}	U1.11, d ≈ 8.8E+9 lys. Direction: adjacent to Clowes–Campusano LQG Huge-LQG, d ≈ 9E+9 lys. Direction: adjacent to Clowes–Campusano LQG Giant GRB Ring, d ≈ 9.1E+9 lys. Direction: unknown The Giant Arc, d ≈ 9.2E+9 lys. Direction: unknown Clowes–Campusano LQG, d ≈ 9.5E+9 lys. in Leo constellation, Right ascension 11h; Declination +15° Hercules–Corona Borealis Great Wall, d ≈ 1E+10 lys. Right ascension 17h0m; Declination +27°45′
1.82E+23	1.93E+10	5914	{11,3}	
3.24E+23	3.43E+10	10514	{11,4}	
5.07E+23	5.36E+10	16428	{11,5}	observable universe, r=4.57E+10 ly, 1.4E+4 Mpc
7.30E+23	7.72E+10	23657	{12,1}	

Note: The Virgo SC size data from wiki “Virgo Supercluster”; Laniakea SC size data from wiki “Laniakea Supercluster”; Coma SC distance data from wiki “Coma Supercluster”; Perseus-Pisces SC distance data from wiki “Perseus–Pisces Supercluster”; Hercules SC distance data from wiki “Hercules Superclusters”; Abell 2151 (Hercules Cluster) distance data from wiki “Hercules Cluster”; Abell 2147 distance data from wiki “Abell 2147”; Shapley SC distance data from wiki “Shapley Supercluster”; Sloan Great Wall distance data from wiki “Sloan Great Wall”; U1.11distance data from wiki “U1.11”; Huge-LQG distance data from wiki “Huge-LQG”; Giant GRB Ring distance data from wiki “Giant GRB Ring”; the Giant Arc distance data from wiki “The Giant Arc”; Clowes–Campusano LQG distance data from wiki “Clowes–Campusano LQG”; and Hercules–Corona Borealis Great Wall distance data from wiki “Hercules–Corona Borealis Great Wall”.

I-c. The chemical bond dominated world

In the size range from N = -2 (at {-2,1} with r ≈ 100 km) to N = -11 (at {-11,1} with r ≈ 1 nm), all daily-life-world matter (excluding those collpsed celestail bodies, like white dwarf, neutron star, etc.) is formed by either the chemical bond, or the salt bridge bond, the hydrogen bond, the van der Waals bond, etc. All of these bonds are based on the residue EM-force. Although the {N=-10..0,n//6} size range still follows the {N,n//6} QM as a whole range, the fine physical structures in this size range are no longer follow the{N,n//6} QM's structure. For example, all eight planets have the initial fine p{N,n//q} QM structure with q=2, not q=6. The current fine structure of these planets are even more diversified: Saturn is currently in the superposition of p{N,n//3} and p{N,n//2}QM structure, Jupiter is currently in the superposition of p{N,n//5} and p{N,n//3}QM structure, only Neptune has the initial p{N,n//2}QM structure (also equals to p{N,n//4}QM structure naturally, see SunQM-3s7). A human body does not follow {N,n//6} QM structure at all. This is because in a residue EM-force formed molecule, 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 (see SunQM-5 section-VII for more detailed discussing).

I-d. Atoms and nucleus

The N = -12 period in the Table 1 is characterized by the **atomic {N,n//6} QM structure**. The size of an atom is determined by the out-most electron shell of this atom. For hydrogen atom, its electron occupies the {-12,1//6}o orbit space, so it has a size of {-12,2//6}. For the elements in the electron period 2 through electron period 7, their out-most electrons occupy the {-12,n=2..7//6}o orbital shell space respectively (see Table 1's N = -12 row), so their (unshrunk) sizes are at {-12,n=3...8//6} respectively. However, due to the shrinking of $r_1' = r_1 / Z$, the actual sizes of all atoms are within the size of {-12,2//6}. (See SunQM-5's section II for more detailed discussion). Notice that the whole (Mendeleev) periodic table with 118 elements (or cells) is degenerated and compressed into 7 cells in a single period (N = -12) in the {N,n//6} QM Structure (Master) Periodic Table.

N = -15 and N = -14 periods in the Table 1 are characterized by the **nuclear {N,n//6} QM structure**. The size of a proton well matched to the size of {-15,1//6}, so hydrogen atom's nucleus matter is in the nucleon orbital shell space of {-16,n=1..5//6}o. It has the $n_{nuc} = 1$, meaning this n_{nuc} is for the size, not its orbital space. Similarly, Helium nucleus' $n_{nuc} = 2$, so it has size of {-15,2//6}, and its matter is in the nucleon orbital shell of {-15,1//6}o. Then, the electron period 2 element's nuclides take the nucleon orbital shell space of {-15,n=2..5//6}o, and the electron period 3 through the electron period 7 atom's nuclides take the nucleon orbital shell space of {-14,n=1..5//6}o. See SunQM-5 section II for details.

The result revealed that nuclides of hydrogen (Z=1), Helium (Z=2), Li (Z=3), Ne (Z=10), Fe (Z=26), Pd (Z=46), and Og (Z=118) atoms have the interior {N,n//6} QM structure 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 (in size). It explained why Fe is more abundant than its adjacent elements, and why Fe element is the heaviest nucleus that a nuclear fusion reaction can go without adding extra energy. This is because Fe nucleus is the only one that has the 100% nucleon occupancy in the n = 1 nucleon orbital shell space (among the n=1 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 is exactly like why the inert element Ne is the most (chemically) 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 analysis revealed that the nuclear {N,n} 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.

Furthermore, at high Z#, the relativity effect (seems) pushed both atom's electron orbital structure and nucleon orbital structure from {N,n//6} QM towards to {N,n//7} QM, see SunQM-5 section II for details.

For {-15,n=1..6//6} sized QM structures in Table 1, it contains total 20 nucleons. One interesting finding is that we can divide these 20 nucleons into 5 sub-groups, each contains 4 nucleons. Because we know each nucleon has size of {-15,1//6}, and four of nucleons form size of {-15,2//6}, that means each sub-group as size of {-15,2//6}. Then, combining two sub-groups produces a {-15,3//6} sized QM structure, combining three sub-groups produces a {-15,4//6} sized QM structure, combining four sub-groups produces a {-15,5//6} sized QM structure, and combining five sub-groups produces a {-15,6//6} sized QM structure (see Appendix A for a more detailed explanation). Notice that this explanation needs interior {N,n} QM analysis with the shrunken $r_{e1} \rightarrow r_{e1} / Z$. We name this explanation as the "**5 of {-15,2//6} particles**" effect, because it builds

{-15,6//6} sized QM structure by simply adding five of {-15,2//6} sized "particles" one-by-one. Notice that the "5 of {-15,2//6} particles" effect has a nonlinear relationship between the size increase of {N,n//6} space vs. the mass increase. For example, a standard r increase of {-15,n=1..6//6} for n= 1, 2, 3, 4, 5, and 6 is 1×, 4×, 9×, 16×, 25×, and 36×, while the corresponding mass increase of nucleus is from one nucleon to 4, 8, 12, 16, 20 nucleons, and the radii of these nuclides are increased (nonlinearly) even slower (see SunQM-5's Table 2, column 8).

I-e. Elementary particles and sub-quark "particles"

N = -18 through N = -16 periods in the Table 1 are characterized by the **elementary particle {N,n//6} QM structure**. (Note: since I am not a particle physicist, all study in this section belongs to a "citizen scientist leveled" work). A more complete table of elementary particle {N,n} QM structure (from N = -14 to N = -23) was presented in SunQM-5s2's Table 1. Because all elementary particles are reported as the mass MeV/c^2 (rather than the size), the elementary particle {N,n//6} QM structure was also constructed based on elementary particles' mass, not on their sizes. Although it is hard to say how accurate (or even how correct) these calculated mass values are, by comparing to another set of experimental data from the Standard Model (see SunQM-5s2's Table 3a), we do believe that our calculation is meaningful. The comparative analysis revealed that all the down-type quarks may have orbital n=2, or {N,2//6}o QM structures, while all the up-type quarks may have orbital n=1, or {N,1//6}o QM structures. Also, the 1^{st}, the 2^{nd}, and 3^{rd} generations of quarks may belong to {-17,n//6}, {-16,n//6}, and {-15,n//6} QM structures respectively. If this analysis is correct, then the Charm quark should be the 3rd (instead of the 2nd) generation of up-type quark, and the true 2^{nd} generation of up-type quark is still missing.

This analysis suggested that a proton (at size of {-15,1//6}) is the ground state of both Charm quark and Bottom quark, Charm quark {-15,1//6}o is the first excited state of proton {-15,1//6}, and the Bottom quark {-15,2//6}o is the second excited state of proton {-15,1//6}. Similarly, there should be a ground state at size of {-17,1//6} for the up-quark (which is at the first excited state of {-17,1//6}o), and for the down-quark (which is at the second excited state of {-17,2//6}o). According to {N,n//6} QM, this {-17,1//6} sized particle (with mass ≈ 724 KeV/c^2) is expect to be the true "fundamental particle" of up-quark and down-quark.

Those N < -18 periods in the Table 1 are characterized by the **sub-quark {N,n//6} QM structure**. Like that a nucleon is made of three quarks, we also assumed that a quark at size of {-17,1//6} is made of (an unknown number of) {-20,1//6} sized QM structures (see SunQM-5's Figure 7). Each {-20,1//6} sized QM structure has (rest) mass of 938 * 1E+6 / 36^5 = 15.5 eV/c^2 (see SunQM-5s2's Table 1). We also guessed that a {-20,1//6} sized QM structure is further made of (an unknown number of) {-25,1//6} sized QM structures (see SunQM-5's Figure 8). Each {-25,1//6} sized QM structure has (rest) mass of 15.5 / 36^5 = 2.6E-7 eV/c^2 (not shown in Table 1).

I-f. A ground state {N,1//6} sized QM structure is often "accompanied" by a {N,2//6} sized (i.e., the first excited state {N,1//6}o orbital shell) QM structure

In the {N,n//6} QM Structure (Master) Periodic Table (Table 1), we see that a ground state {N,1//6} sized QM structure is often "accompanied" by a first excited state {N,1//6}o orbital shell QM structure with the size of {N,2//6}. For example, Virgo Super Cluster at the size of {10,1//6} is "accompanied" by Laniakea supercluster at {10,1//6}o orbital shell space with a size of {10,2//6}, Milky Way galaxy at the size of {8,1//6} is "accompanied" by a Halo structure at {8,1//6}o orbital shell space with a size of {8,2//6}, Sun core at the size of {0,1//6} is "accompanied" by a Sun ball at {0,1//6}o orbital shell space with a size of {0,2//6}, a Sun-massed black hole at the size of {-3,1//6} is "accompanied" by a Sun-massed neutron star at {-3,1//6}o orbital shell space with a size of {-3,2//6}. For the nuclides, a hydrogen nucleus has size of {-15,1//6}, it is "accompanied" by a helium nucleus at {-15,1//6}o orbital shell space with a size of {-15,2//6}. Also for the nuclides, an oxygen nucleus (with n_{nuc} = 5.5 ≈ 1 * 6^1, see SunQM-5's Table 2) has effective size of {-14,1//6}, it is "accompanied" by a Fe nucleus (with n_{nuc} = 12.2 ≈ 2 * 6^1, see SunQM-5's Table 2) at {-14,1//6}o orbital shell space with an effective size of {-14,2//6}, (also see SunQM-5's section II-b discussion-2, and discussion-3).

Here, the word "accompanied" has two meanings: 1) the {N,2//6} sized QM state has a solid (or at least an obvious) structure in comparison with the {N,1//6} sized QM structure, while the other {N,n=3..6//6} sized QM states may not have an obvious structure; 2) the {N,2//6} sized QM structure has a relative high abundancy among {N,n=1..6//6} sized QM structures, just like the helium has the abundancy of 24% (relative to hydrogen's 73.9%), and the rest elements (add together) have the abundancy of only ~2.1% (see wiki "chemical element"). The above analysis revealed that, in the {N,n//6} QM, the ground (in size of {N,1//6}) is the most stable QM state, so it has the very stable physical structure; the first excited state (at {N,1//6}o orbital shell space, or in size of {N,2//6}) is the second most stable QM state, so it also has a (relative) stable physical structure; the other higher excited states (in sizes of {N,n=3..6//6}) have much less stability, so they have a much less stable physical structure (or short-life) in the micro-world; in the celestial-world, the stabilities of some higher excited states (in sizes of {N,n=3..6//6}) are so low that their physical structures are often not being observed (because of their short-life, e.g., only exist during the process of a celestial body's quantum collapsing or quantum explosion, see SunQM-1s1's Table 7b). According to this analysis, we believed that there may be a {-1,2//6} sized (celestial) structure to "accompany" the "ground state" {-1,1//6} QM structure of white dwarf, and that there may be a {-2,2//6} sized (celestial) structure to "accompany" the "ground state" {-2,1//6} QM structure of the undiscovered celestial body. Also according to this analysis, we believed that the abundancies of hydrogen (73.9%) and helium (24%) come from the stability of their nucleus (i.e., the Hydrogen's nucleus is more stable than that of Helium's), and nothing to do with their electron shell property.

For this reason, we had explored the possibility that the up-type quarks are the "ground state" quarks that have sizes of {-18,1//6}, {-17,1//6}, and {-16,1//6}, and the down-type quarks are the "first excited" quarks that have sizes of {-18,2//6}, {-17,2//6}, and {-16,2//6} that "accompany" the "ground state" quarks (see SunQM-5s2's Table 3). However, this hypothesis seems has a low possibility due to that proton (938 MeV/c^2) and Charm quark (1.32 GeV/c^2) have to share the same {-16,5//6}o QM state.

Although most {N,n//6} QM structures use {N,1//6} sized QM structure as the ground state, there are some exceptions. For example, electron shell of Hydrogen is at {-12,1//6}o, and electron shell of Helium is at {-12,1//6}o, they do not use {-12,1//6} sized QM structure as the ground state. Thus, it is possible that up-quark {-17,1//6}o and low-quark {-17,2//6}o may not use {-17,1//6} size as ground state (in the case that if a {-17,1//6} sized QM structure can never be found).

In {N,n//6} QM, normally we treat the size n=1 as the ground state, and the orbital n=1 (with size n=2) as the 1st excited state. This is equivalent to treat the whole set of orbital n = 1 … 5 (with size n= 1* 6^1) as the ground state, and treat the whole set of orbital n = 6 … 11 (with size n = 2 * 6^1) as the 1st excited state, and treat the whole set of orbital n = 12 … 17 (with size n = 3 * 6^1) as the 2nd excited state, etc.

Notice that even though {N,1//6} sized QM structure is often "accompanied" by a {N,2//6} sized QM structure, but they usually do not have the (non-linear) "5 of {-15,2//6} particles" effect (except the {-15,n//6}). In Appendix A, we showed that {10,n//6} may (or may not) have the "5 of {-15,2//6} particles" effect. In Appendix B and Appendix C, more explanations have been given for the "ball-torus-6-11-gap effect" and the "accompanied" 1st excited state effect.

I-g. The definition of an orbital electron's ground state is different between {N,n} QM and Bohr-QM.

In SunQM-3s2, we discovered a (simplified) rule that "all mass between r_n and r_{n+1} belongs to orbit n", and for ~100% mass occupancy, its size is n+1. Notice that there is a major difference between a planet in a Sun-planet system's orbit and an electron in proton-electron system's orbit: a planet has < 1% of mass occupancy in its orbital shell space so that it occupies the minimum space with size (or r_n) of {N,n//q}, while an electron has ~ 100% mass occupancy in its orbital shell space so that it occupies the maximum space with size (or r_n) of {N,n+1//q}. That is why the electron in n=1 orbit (or {-12,1//6}o) makes the size of hydrogen atom as n=2, or {-12,2//6}, while a Earth at orbit n=5 (or {1,5//6}o) makes the r_n (equivalent to size) at n=5, (not at n=6 where $r_{n=6}$ is Mars' orbit).

In Bohr-QM, an electron in n=1 orbit is said to be in the ground state, and an electron in n=2 orbit is said to be in the first excited state. However, in {N,n//q} QM, all matter in n=1 orbit (or {N,1//q}o) is said to be in the first excited state, all matter in n=2 orbit (or {N,2//q}o) is said to be in the second excited state, and all matter within the size of {N,1//q}, or in orbits of {N(=N-1,N-2, …),n=1..(q-1)//q}o, is said to be in the ground state. Now let's use {N,n//q} QM to describe $^{12}_{6}C$ atom's electron states: there are 2 electrons in the n=1 first excited state, there are 4 electrons in the n=2 second excited state, and there are 6 electrons in the ground state (Note: all ground state electrons are merged with protons to form neutrons in the nucleus, so that in atom's {N,n//q} QM, the electron number in the ground state is always equals to the neutron number N# in the nucleus). Similarly, $^{293}_{118}$Og atom's {N,n//q} QM description is, there are 293 – 118 = 175 electrons in the ground state (merged with protons to be neutrons in the nucleus), and there are 118 electrons in the excited states.

This analysis revealed that, in the {N,n//q} QM description, at very low Z# (i.e., Z=1), hydrogen atom's ground state electron number (=0) < excited state electron number (=1); at low Z# (i.e., Z=2..14), an atom's ground state electron number = excited state electron number, (or, the number of neutron equals to the number of proton); at high Z# (i.e., Z > 14), an atom's ground state electron number > excited state electron number, (or, the number of neutron is larger than the number of proton).

Alternatively, if the readers really like Bohr-QM's definition, i.e., n=1 is the ground state, and n=2 is the 1st excited state, then we can define n < 1 as the "underground" state.

I-h. A new definition of the black hole (that purely based on the {N,n//6} QM): assuming a star is made of pure H-atom, when all H-atom's electron shells de-excited to the ground state, the shrunk star is called a black hole

In SunQM-5s1's section I, a Sun (at the size of {0,2}) that quantum collapsed to a white dwarf {-1,1}, or a {-2,1} celestial body, or a {-3,1} black hole, was described as directly caused by the shrink of hydrogen atom {-12,1}o (with the size of {-12,2}) to the size of {-13,1}, or {-14,1}, or {-15,1} respectively, with the unchanged total number of atoms (or virtual atoms). Now, in the view of {N,n//6} QM, the electron that in the {-12,1}o orbit is in the excited state, and the ground state of this electron (in an H-atom) is within the size of {-15,1} where the proton located, so that when this electron de-excited to the ground state, it merges with proton to form a neutron. Thus, the size of atom decreasing (during the star collapsing) can also be explained as its (virtual) atom's electron (orbital shell) de-excitation from the orbit of {-12,1}o to the size of {-13,1}, then to {-14,1}, and to {-15,1} respectively. From this, we obtained a new definition for the black hole (that purely based on the {N,n//6} QM): assuming a star (at the size of {0,2//6}) is made of pure H-atoms, when all H-atoms' electron shells de-excited to the ground state (meaning electron merged to the proton in the H-atom's nucleus), the shrunk star is called a black hole, and it will have size of {-3,1//6}.

Notice that in this description, we did not consider the case that one (residue) electron can be shared by many virtual H-atoms, or even by many highly fused atoms (with Z ~ 1E+12, ~1E+24, ~ 1E+48, etc.). If consider that, then a stable black hole is expected to have a size of {-5,1}, (see SunQM-5s1 section II).

Under the above situation, a more accurate definition of the ground state vs. excited state may (sometimes) be needed. For example, in {N,n} QM, the ground state electron (of an H-atom) is within the size of {-15,1}, and the natural excited state (i.e., n=1) electron is at {-12,1}o orbital shell space, and it is ΔN = +3 plus Δn = +1 above the ground state. So we may can say that the H-atom's electron is naturally at ΔN ≈ +3 excited state, although the H-atom's electron can also be at ΔN ≈ +2 excited state (e.g., in a white dwarf), or at ΔN ≈ +1 excited state (e.g., in a {-2,1} celestial body). Alternatively, we may can say that for the H-atom's n=1 electron (at {-12,1}o orbital shell space), there is ΔN ≈ -1 ground state (or underground state, at the size of {-13,1}), or there is ΔN ≈ -2 (under) ground state (at the size of {-14,1}), or there is ΔN ≈ -3 (under) ground state (at the size of {-15,1}).

I-i. Expand {N,n//6} QM structure periodic table to n = 6^2 (or even 6^3, 6^4, ...) for all N periods

Although the {N,n//6} QM structure (master) periodic table (Table 1) is presented as n = 1 … 12 for each N, this table can be expanded to n = 1 … 6^2, or even to n = 1 … 6^3, n = 1 … 6^4, etc. (see SunQM-5s2's section IV).

This is true for the particle {N,n//6} QM. For example, in SunQM-5s2's Table 4, the N = -16 period (or the super shell) {-16,n=1..5//6}o contains 5 individual n states from n= 1 to n=5, each separated by the mass difference (ΔM) around ~100 MeV/c^2 to ~300 MeV/c^2. This is using {-16,1//6}o as the unit. If we use the {-17,1//6}o as the unit, then {-16,n=1..5//6}o can be written as {-16,n=1..35//6^2}o, and it contains 35 individual QM states from n= 1 to n=35, each separated by ΔM around ~3 MeV/c^2 to ~100 MeV/c^2. If we use the {-18,1//6}o as the unit, then {-16,n=1..5//6}o can be written as {-16,n=1..215//6^3}o, and it contains 215 individual QM states from n= 1 to n=215, each separated by ΔM around ~0.1 MeV/c^2 to ~10 MeV/c^2, and so on so forth. We can interpret this as, for each N period, we can detect 6^1 – 1 = 5 of different energy leveled (relatively stable) particles, and we can also detect 6^2 – 1 = 35 of (smaller) different energy leveled (relatively unstable) particles, and we can even detect 6^3 – 1 = 215 of (much smaller) different energy leveled (highly unstable) particles, and so on so forth. All these QM states are available according to the {N,n//6} QM, although the newly added states are less stable as the ΔM decreases. When ΔM → 0, the number of intermediate states increases to infinity, the QM goes back to classical physics. This is equivalent to when r_1 moving inward to close to 0, the multiplier n' will goes up to infinity, and the QM goes back to classical physics.

This is also true for the nuclear {N,n//6} QM. For example, although the nuclides of 118 elements was described by {-15,n=1..5//6}o and/or {-14,n=1..5//6}o QM states in Table 1, it should can be described as 35 of {-15,n} QM states naturally (in form of {-15,n=1..35//6^2}o). Under the description of {-15,n=1..35//6^2}o, the first 26 element belongs to {-15,1} size to {-15,11//6}o QM states as shown in Table 1. Then, according to their n_{nuc} (shown in SunQM-5's Table 2 column 11), nuclides of Co, Ni, Cu belong to {-15,12//6}o, (or we can write it as {-15,12//6^2}o), nuclides of Zn, Ga, Ge belong to {-15,13//6^2}o, nuclides of As, Se, Br belong to {-15,14//6^2}o, nuclides of Kr, Rb, Sr, Y belong to {-15,15//6^2}o, nuclides of Zr, Nb, Mo, Tc belong to {-15,16//6^2}o, nuclides of Ru, Rh, Pd belong to {-15,17//6^2}o, nuclides of Ag, Cd, In, Sn belong to {-15,18//6^2}o, nuclides of Sb, Te, I, Xe belong to {-15,19//6^2}o, nuclides of Cs, Ba, La, Ce belong to {-15,20//6^2}o, nuclides of Pr, Nd, Pm, Sm belong to {-15,21//6^2}o, nuclides of Eu, Gd, Tb, Dy belong to {-15,22//6^2}o, nuclides of Ho, Er, Tm, Yb belong to {-15,23//6^2}o, nuclides of Lu, Hf, Ta, W belong to {-15,24//6^2}o, nuclides of Re, Os, Ir, Pt, Au belong to {-15,25//6^2}o, nuclides of Hg, Tl, Pb, Bi belong to {-15,26//6^2}o, nuclides of Po, At, Rn, Fr belong to {-15,27//6^2}o, nuclides of Ra, Ac, Th, Pa, U belong to {-15,28//6^2}o, nuclides of Np, Pu, Am, Cm, Bk belong to {-15,29//6^2}o, nuclides of Cf, Es, Fm, Md, No belong to {-15,30//6^2}o, nuclides of Lr, Rf, Db, Sg, Bh belong to {-15,31//6^2}o, nuclides of Hs, Mt, Ds, Rg, Cn belong to {-15,32//6^2}o, nuclides of Nh, Fl, Mc, Lv, Ts belong to {-15,33//6^2}o, and nucleus of Og belong to either {-15,33//6^2}o or {-15,34//6^2}o. However, we need to pay attention that at high Z, the {N,n//6} becomes less accurate, and it becomes more and more like a {N,n//7} QM.

Also for the nuclear {N,n//6} QM, by adding more intermediate states, we can fit each element's n_{nuc} to between {-15,n=1..5//6}o or {-14,n=1..5//6}o QM intermediate states. For example, for element P (Z=15, n_{nuc} = 8.4, see SunQM-5's Table 2), element S (Z=16, n_{nuc} = 8.7), and element Cl (Z=17, n_{nuc} = 9.1), when in the nuclear {-14,n=1..5//6}o QM, they all belong to {-14,1//6}o orbital shell space (or QM state). If in the expanded nuclear {-14,n=1..35//6^2}o QM, then all three nuclides belong to {-14,8//6^2}o = {-15,8//6}o QM state. If in the double expanded nuclear {-14,n=1..215//6^3}o QM, then P element's nucleus belongs approximately to {-14,48//6^3}o QM state, S element's nucleus belongs approximately to {-14,50//6^3}o QM state, and Cl element's nucleus belongs approximately to {-14,52//6^3}o QM state. Thus, all three nuclides have their QM state differentiated at nuclear {-14,n=1..215//6^3}o QM level.

This is also true for cosmic {N,n} QM. Between galaxy {8,1} to Virgo super cluster {10,1}, by adding more intermediate states in between {8,n=1..5//6}o and {9,n=1..5//6}o orbital shell spaces, we can fit different sized local groups or local clusters to the cosmic {N,n//6^j} with high accuracy.

This property can also be used to explain why the atomic world is naturally described by QM, and the celestial world is naturally described by the classical physics. This is because that atom is the building block of the atomic world, so its r_1 doesn't need to be move inward, and this r_1 produced r_n is naturally in quantum state. In contrast, the celestial world's building block is also atom, according to the Simultaneous-Multi-Eigen-Description (SMED), atom's r_1 is equivalent to a celestial world's r_1 that moved inward to close to 0, so that the corresponding multiplier n' increased to astronomically high, therefore the difference between the two adjacent quantum states close to 0, and it becomes a continues process (of the classical physics).

In {N,n} QM, when setting r_1 at the correct size, the obtained n = 1, 2, 3, ... , then the size of an object (and/or its movement) can be described by the quantum mechanics. When resetting r_1 inward to close to zero, the obtained (high-frequency) n' close to infinitely large, then the size of this object's NBP 3D peak can be described as (or close to) an infinitely small particle, the movement can be described as (or close to) a continuous movement, and the whole description become a particle version of the classical physics. On the other side, when resetting r_1 outward to close to infinitely large, the obtained 0 < n' < 1 (here we named this n' < 1 quantum number as the "**sub-frequency**" quantum number n') closing to zero, and the size of this object's NBP 3D peak may become an infinitely large ball. So far, we don't have a clear view on this end. We guessed that the movement (may be also) close to a continuous movement (i.e., a 3D NBP matter wave (with close to infinitely long wavelength) propagates (and bended) inside a size-limited ball, see SunQM-2's section IV), and the whole description may become a wave version of the classical physics.

In the {N,n//6} QM Master Periodic Table (Table 1), we designed it as n = 1..12 for each N period, and with the number of n = 1..5 in bold fond. This is because the most {N,n//6} QM structural information is in n = 1..5, and the rest information is almost all in n = 6..12, and there is very little useful information in n > 12. According to SunQM-5s2's Table 4, we can also present Table 1's each N period as n = 1..36 (or n = 1..216, or even n = 1..1296, etc.) QM states (for N = -24 to N = +15). Although most of these QM states are short-life (intermediate) QM states, with (practically) no useful information.

See more examples that using {N,n//q} QM to describe a quantum (discontinues) dynamics, while using {N,n//q^j} QM to describe a classical (continues) dynamics in Appendix D.

I-j. The global linear relationship vs. the local nonlinear relationship between the size (of space) and the mass (distribution) based on the {N,n//6} QM structure

From the size of a quark {-17,1//6} to the size of Laniakea {10,2//6} (as a whole), the {N,n//6} QM structure fits (as a whole) for each region on average. Thus we say that there is a global linear relationship (between the size of space and the mass distribution?) based on the {N,n//6} QM structure. However, in some (individual) regions, it deviates from the {N,n//6} structure. For example, under the primary E-force, the space of mass distribution (i.e., electron shells from {-12,1//6}o to {-12,7//6}o of all elements from Helium to Og-118) is compressed to almost within the size of {-12,2//6} (with q → 7). Under the residue force of E-force, the space of mass distribution (from {-11,1//6} with r ≈ 1 nm to {-2,7//6} with r ≈ 100 km, excluding the collapsed celestial bodies) is expanded to q < 6. Under the combination of the residual S-force and primary E-force, the space of mass distribution (i.e., the packing of nucleons from size of {-15,1//6} to {-14, 5//6}) is compressed (to form the "5 of {-15,2//6} particles" effect). Therefore, we say that there is some local non-linear relationship between the size of space and the mass distribution for the {N,n//6} QM structure. In one of our future paper, we will further explore this non-linear relationship, and how it may link to Einstein's relativity.

II. Based on Schrodinger equation, using {N,n//6} QM, non-Born probability (NBP), and Simultaneous-Multi-Eigen-Description (SMED) to describe our universe

{N,n} QM has two main components: the Bohr formula-based {N,n} QM, and the Schrodinger equation-based {N,n} QM. In the section I, we have summarized our previous work [1] ~ [24] on the Bohr formula-based {N,n} QM structural analysis from sub-quark to the whole universe (in Table 1). In the current section, we will summarize our previous work (of the SunQM series studies [1] ~ [24]) on the Schrodinger equation-based {N,n} QM analysis from sub-quark to the whole universe. (Note: Bohr formula can be obtained from Schrodinger equation/solution at nLL QM state, see SunQM-3s1's section II-c5, Result & discussion (for section II-c5), item #4).

II-a. Two-body problem: Bound state (in orbital movement) with Simultaneous-Multi-Eigen-Description (SMED)

In this section, we only discuss the bound state's orbital movement (around a single master object at the orbital center), like a planet bound to a star doing orbital movement, or an electron bound to a nucleus doing orbital movement, etc. (Note: For those bound state orbital movement without a single master object at the orbital center, see section II-c). So far, we also simplified all orbital movements as either a 2D circular (not an elliptic) movement (e.g., planet's orbit around Sun), or a 3D spherical RF (or RotaFusion, or rotation diffusion) movement (e.g., electron's orbit around a nucleus).

Example-1 (in section II-a). **Born probability description, nLL QM state, 2D circular orbit.**

The best example is that in SunQM-3s11's eq-47 through eq-54, we have used the {N,n//6} QM and the Born probability to describe all eight planets (in the Solar system) that are in bound state and doing the circular orbital movement. The amazing thing is, by properly adjusting the high-frequency n' quantum number (that is based on the base-frequency n quantum number), those probability formulas not only described planet's orbital movement (with the base-frequency n quantum number), but also described planet's size (with the high-frequency n' quantum number) at the same time (we named it as the **Eigen description**, see SunQM-3s10's section IV, and SunQM-3s11). Even more amazingly, by further adjusting the high-frequency n' quantum number, those equations can also describe the size of either an atom, or a nucleon, or even a quark that is part of that planet (and that is also doing the circular orbital movement around the Sun). We had named it as **Simultaneous-Multi-Eigen-Description (SMED)**, see SunQM-4's section V.

For example, at the (near) base-frequency quantum number n = 5*6^1 = 30, and high-frequency quantum number n' = 5*6^11 ≈ 1.81E+9, SunQM-3s11's eq-49 (a simplified form of SunQM-3s11's eq-44 at n' >> 1, copied here as eq-1, and for n' ≈ 1.81E+9, we choose the integer δ =1.0E+6. Also notice that eq-1 is calculated as the Born probability (BP) for a nLL QM state in {N,n} QM)

$$r^2|\Psi(r,\theta,\phi-\omega t)_{Earth}|^2_{BP} \approx \left[\frac{r}{1.57\times10^{11}} e^{\left(1-\frac{r}{1.57\times10^{11}}\right)} \sin(\theta)\right]^{2n'} \left\{\frac{1}{1+2\delta} \sum_{-\delta}^{+\delta} \cos[(n'+\delta)\times(\varphi+0-1.86\times10^{-7}t)]\right\}^2 \quad \text{eq-1}$$

describes a celestial body that at orbit of {1,5//6} with orbital r = 1.57E+11 meters, doing circular orbital movement with period = (2π) /1.86E-7 / 24 / 3600 = ~ 391 days, and with the body size at $r_{surface}$ ≈ 7.89E+6 meters (see SunQM-3s11's Table 1, and also see the current paper's Appendix E for the latest correction of that table, and also notice the new update to add "φ+" in SunQM-3s11's eq-47 through eq-54, shown in yellow). This set of data closely matches Earth's orbital r = 1.49E+11 meters, 365 day a year, and $r_{surface}$ = 6.38E+6 meters. In Table 3, we showed that when re-adjusting the high-frequency quantum number to n' = 5*6^55, then $r_{surface}$ (=b) = 6.01E-11 meters, and then it fits to a single hydrogen atom (at size of {-15,1}o, r ≈ 5.29E-11 meters, see SunQM-1s2's Table 1 column 12) in Earth quite well. Thus eq-1 can also be the Eigen description of any hydrogen atom inside Earth (that is orbiting the Sun). Furthermore, when re-adjusting the high-frequency quantum number to n' = 5* 6^67, then $r_{surface}$ (=b) = 1.29E-15 meters, and it fits to a single nucleon (at size of {-15,1}, a proton's r ≈ 8.4E-16 meters, see SunQM-1s2's Table 1 column 9) in Earth quite well, so that eq-1 can also be the Eigen description of any nucleon inside Earth (that is orbiting the Sun). Again, when re-adjusting the high-frequency quantum number to n' = 5*6^75, then $r_{surface}$ (=b) = 9.94E-19 meters, and it fits to a single quark (at size of {-17,1}, r ≈ 6.07E-19 meters, see SunQM-1s2's Table 1 column 6) in Earth quite well, so that eq-1 can also be the Eigen description of any quark inside Earth (that orbiting the Sun).

Notice that eq-1 can be simplified as eq-2 (that combined from SunQM-3s11's eq-44, eq-46 and eq-49, also only valid for nLL QM state and at n' >> 1)

$$r^2|\Psi(r,\theta,\phi-\omega t)_{Earth}|^2_{BP} \approx \left[\frac{r}{1.57\times10^{11}} e^{\left(1-\frac{r}{1.57\times10^{11}}\right)} \sin(\theta)\cos(\varphi+0-1.86\times10^{-7}t)\right]^{2n'} \quad \text{eq-2}$$

where we need to manually ignore the second peak of $[\cos(\varphi-1.86\times10^{-7}t)]^{2n'}$ at $\varphi - 1.86\times10^{-7}t = \pi$ (see SunQM-3s11 for detailed explanation). The physical meaning of eq-2 is simple and straightforward: In r-dimension, the combination of an exponentially uprising function $\left[\frac{r}{1.57\times10^{11}}\right]^{2n'}$ and an exponentially descending function $\left[e^{\left(1-\frac{r}{1.57\times10^{11}}\right)}\right]^{2n'}$ generates a maximum peak at r = 1.57×10^{11} meters (where the {1,5//6} orbit locates), and the higher the high-frequency n' number, the narrow the peak curve (of Born probability in r-dimension) will be; In θ-dimension, $[\sin(\theta)]^{2n'}$ generates a maximum peak at θ = π/2, and the higher the high-frequency n' number, the narrow the peak curve (of Born probability in θ-dimension) will be; Also in φ-dimension, $[\cos(\varphi-1.86\times10^{-7}t)]^{2n'}$ generates a maximum peak at $\varphi - 1.86\times10^{-7}t = 0$, and the higher the high-frequency n' number, the narrow the peak curve (of Born probability in φ-dimension) will be. When $n_r' = n_\theta' = n_\varphi' = n'$, eq-2 generates a spherically shaped Born probability narrow peak (ball) in rθφ-3D space.

Table 3. (Using Born probability) to demonstrate the Simultaneous-Multi-Eigen-Description (SMED) for Earth at the size of a planet, an atom, a nucleon, or a quark.

NASA's data of planets						assigned N, n, period factor			set total n=1 at Sun core calc model n, rn, vn			Determine planet r-dimensional n' & w							Determine planet θ-dimensional n' & w Note: w(ϕ) = w(θ), and $n'_\phi = n'_\theta$					{N,n} calculated ω			
	mass	Sun's body-r or planets' orbit-r_n	vn	orbit period	planet's body-r, b=	N	n	period factor	total n from Sun core	rn= r1*n^2	v_n = sqrt (GM/r_n)	n' = ln(0.1) / [ln(1 + b /r_n) - (b /r_n)]	w= log(n' / n) / log(6)	round up w	n'_r = n*q^w	±b = at n'=n*q^w & Porb =0.01	$r_1 = r_{n'}$ / (n*q^w)^ 2	r_1 at {N,1//6}	w(θ) =	n'_θ = n*q^w	0.01^(1/(2n'))	θ'= acos[0.01 ^(1/(2n'))]	b= r*sin(θ')	phase $\omega_{n,ph} = v_n / r_n/2$	group ω = $\omega_n = v_n / r_n$	period T= 2π/(2ω)/(3600*24)	b_{w-4} / b
unit	kg	m	m/s	days	m					m	m/s					m	m					arc	m	arc/s	arc/s	day	m/m
Sun core		1.74E+08				0	1	6	1	1.74E+08																	
SUN	1.989E+30	6.96E+08				0	2	6	2	6.96E+08																	
Mercury	3.3E+23	5.79E+10	47400	88	2.44E+06	1	3	6	18	5.64E+10	48533	2.46E+09	11.45	11	1.09E+09	3.67E+06	4.76E-08	{-10,1//6}	11	1.09E+09	0.999999997884414	6.50E-05	3.67E+06	4.31E-07	8.61E-07	84	
Venus	4.87E+24	1.08E+11	35000	224.7	6.05E+06	1	4	6	24	1.00E+11	36400	1.26E+09	10.92	11	1.45E+09	5.64E+06	4.76E-08	{-10,1//6}	11	1.45E+09	0.999999998413311	5.63E-05	5.64E+06	1.82E-07	3.63E-07	200	
Earth (planet)	5.97E+24	1.49E+11	29800	365.2	6.38E+06	1	5	6	30	1.57E+11	29120	2.77E+09	11.24	11	1.81E+09	**7.89E+06**	4.76E-08	{-10,1//6}	11	1.81E+09	0.999999998730648	5.04E-05	**7.89E+06**	9.30E-08	1.86E-07	391	
Earth	5.97E+24	1.49E+11	29800	365.2	6.38E+06	1	5	6	30	1.57E+11	29120			15	2.35E+12	2.19E+05	2.83E-14	{-14,1//6}	15	2.35E+12	0.999999999999021	1.40E-06	2.19E+05	9.30E-08	1.86E-07	391	36.00
Earth	5.97E+24	1.49E+11	29800	365.2	6.38E+06	1	5	6	30	1.57E+11	29120			19	3.05E+15	6.10E+03	1.69E-20	{-18,1//6}	19	3.05E+15	0.999999999999999	3.94E-08	6.10E+03	9.30E-08	1.86E-07	391	35.90
Earth	5.97E+24	1.49E+11	29800	365.2	6.38E+06	1	5	6	30	1.57E+11	29120			23	3.95E+18	1.69E+02	1.00E-26	{-22,1//6}	23	3.95E+18	1.000000000000000	0.00E+00	1.69E+02	9.30E-08	1.86E-07	391	36.11
Earth	5.97E+24	1.49E+11	29800	365.2	6.38E+06	1	5	6	30	1.57E+11	29120			27	5.12E+21	4.71E+00	5.98E-33	{-26,1//6}	27	5.12E+21	1.000000000000000	0.00E+00	4.71E+00	9.30E-08	1.86E-07	391	35.88
Earth	5.97E+24	1.49E+11	29800	365.2	6.38E+06	1	5	6	30	1.57E+11	29120			31	6.63E+24	1.31E-01	3.56E-39	{-30,1//6}	31	6.63E+24	1.000000000000000	0.00E+00	1.31E-01	9.30E-08	1.86E-07	391	36.01
Earth (atom)	5.97E+24	1.49E+11	29800	365.2	6.38E+06	1	5	6	30	1.57E+11	29120			55	3.14E+43	**6.01E-11**			55	3.14E+43	1.000000000000000	0.00E+00	**6.01E-11**	9.30E-08	1.86E-07	391	36.01
Earth (nucleon)	5.97E+24	1.49E+11	29800	365.2	6.38E+06	1	5	6	30	1.57E+11	29120			67	6.84E+52	**1.29E-15**			67	6.84E+52	1.000000000000000	0.00E+00	**1.29E-15**	9.30E-08	1.86E-07	391	36.00
Earth (quark)	5.97E+24	1.49E+11	29800	365.2	6.38E+06	1	5	6	30	1.57E+11	29120			75	1.15E+59	**9.94E-19**			75	1.15E+59	1.000000000000000	0.00E+00	**9.94E-19**	9.30E-08	1.86E-07	391	36.00

Note: The top 9 rows of Table 3 were copied from SunQM-3s11's Table 1 (see the Appendix E for the latest correction of SunQM-3s11 Table 1's calculation). The bottom 11 rows are the calculations to show that the size (=b, in column 24, or in column 17) of the Born probability peak (in either θ-dimension, or in r-dimension) can be re-adjusted from the size of the planet Earth, to the size of either an atom, or a nucleon, or a quark (when w_θ in column 20 is increased from 11 to 55, or 67, or 75 for n' = 5* 6^w_θ). Check SunQM-3s11 for detailed calculation method. Here we first calculated the θ-dimension's Born probability peak (because it is easier to calculate). Then those results were used for the calculation of r-dimension's Born probability peak. Blue cells (inside Table 3) were calculated by using WolframAlpha, due to that it needs too many digits after the 0.999999… for Excel to handle (see column 22). Column 28 in Table 3 showed the ratio of $r_{surface}$ (=b) at $w_\theta + 4$ to $r_{surface}$ (=b) at w_θ. This calculation showed that whenever Δw_θ increased by 4, the $r_{surface}$ (=b) decreases to 1/36, and the size of {N,1//6} decreases to {N-1,1//6}. Notice that the similar result had also been observed in SunQM-6s1's Table 2 column 13.

Example-2 (in section II-a). **non-Born probability (NBP) description, nLL QM state, 2D circular orbit.**

SunQM-4 series study showed that the non-Born probability (NBP) is the more generalized description than the Born probability description, and the wave function can be directly used as the NBP (see SunQM-4's Appendix C). In SunQM-4's eq-66 through eq-73 (see Appendix F of the current paper for the latest correction of these formulas), we have used the same {N,n//6} QM but the non-Born probability (NBP) to described all eight planets (in the Solar system) that is in bound state and doing the circular orbital movement. At the (near) base-frequency quantum number n = 5*6^1 = 30, and high-frequency quantum number n' = 5*6^12 ≈ 1.09E+10, SunQM-4 Appendix C's eq-68cc (a simplified form of SunQM-4 Appendix C's eq-56cc at n' >> 1) is copied here as eq-3, and for n' ≈ 1.09E+10, we choose the integer δ =1.0E+6 here

$$r^2\,|\Psi(r,\theta,\varphi,t)_{Earth}|^2_{NBP} \approx \left[\frac{r}{1.57\times10^{11}}\,e^{\left(1-\frac{r}{1.57\times10^{11}}\right)}\sin(\theta)\right]^{n'}\left\{\frac{1}{1+2\delta}\sum_{-\delta}^{+\delta}\cos\left[(n'+\delta)\left(\varphi+0-\frac{n}{n-1}1.86\times10^{-7}t\right)\right]\right\}$$

eq-3

Eq-3 can be further simplified to eq-4 (that combined SunQM-4 Appendix C's eq-56c, and eq-68c, only valid for nLL QM state and at n' >> 1, also ignore the second peak of $[\cos(\varphi)]^{n'}$ at $\varphi - \frac{n}{n-1}1.86\times10^{-7}t = \pi$)

$$r^2\,|\Psi(r,\theta,\varphi,t)_{Earth}|^2_{NBP} \approx \left[\frac{r}{1.57\times10^{11}}\,e^{\left(1-\frac{r}{1.57\times10^{11}}\right)}\sin(\theta)\cos\left(\varphi+0-\frac{n}{n-1}1.86\times10^{-7}t\right)\right]^{n'} \quad \text{eq-4}$$

Eq-4 also describes a celestial body that at orbit of {1,5//6} with orbital r = 1.57E+11 meters, doing circular orbital movement with period = (2π) /1.86E-7 / 24 / 3600 = ~ 391 days, and with the body size at $r_{surface}$ ≈ 4.55E+6 meters (see SunQM-4 Appendix C's Table 2). This set of data closely matches Earth's orbital r = 1.49E+11 meters, 365 day a year, and $r_{surface}$ = 6.38E+6 meters. In Table 4, we showed that when re-adjusting the high-frequency quantum number to n' = 5*6^56, then $r_{surface}$ (=b) = 3.47E-11 meters, and it fits to a single H-atom (at size of {-15,1}o, r ≈ 5.29E-11 meters, see SunQM-1s2's Table 1 column 12) in Earth quite well, so that eq-3 (or eq-4) can also be the Eigen description of any H-atom inside Earth (that orbiting the Sun). Furthermore, when re-adjusting the high-frequency quantum number to n' = 5* 6^68, then $r_{surface}$ (=b) = 7.44E-16 meters, and it fits to a single nucleon (at size of {-15,1}, a proton's r ≈ 8.4E-16 meters, see SunQM-1s2's Table 1 column 9) in Earth quite well, so that eq-3 (or eq-4) can also be the Eigen description of any nucleon inside Earth (that orbiting the Sun). Again, when re-adjusting the high-frequency quantum number to n' = 5*6^76, then $r_{surface}$ (=b) = 5.74E-19 meters, and it fits to a single quark (at size of {-17,1}, r ≈ 6.07E-19 meters, see SunQM-1s2's Table 1 column 6) in Earth quite well, so that eq-3 (or eq-4) can also be the Eigen description of any quark inside Earth (that orbiting the Sun).

For the negative peak in NBP (when n' is in odd number), in some cases we need to treat it as the minimum probability, in other cases we need to treat it as the anti-mass particle's peak probability (see SunQM-6).

In SunQM-4's section-V, we had given some examples of SMED for r-dimension. The SMED concept also works for θφ-dimension, as shown in SunQM-3s11's Table 1 (corrected here in the current paper's Appendix E), and SunQM-4's Tables 2.

We believed that the similar method can also be used to describe the orbital movement of most stars (bound) in the rotating disk of a (fully developed, i.e., a disk-lyzed) galaxy. Although in that case, we need to figure out how to add in a new potential energy (caused by the RFg-force, see SunQM-6) into the Schrodinger equation (as shown in SunQM-3's eq-1).

Table 4. (Using non-Born probability, or NBP) to demonstrate the Simultaneous-Multi-Eigen-Description (SMED) for Earth at the size of a planet, an atom, a nucleon, or a quark.

NASA's data of planets			{N,n} model			set total n=1 at Sun core calc model n, r_n, v_n		Determine planet r-dimensional n' & w								Determine planet θ-dimensional n' & w Note: w(ϕ) = w(θ), and $n'_\phi = n'_\theta$					
	Sun's body-r or planets' orbit-r_n	planet's body-r, b=	N	n	q	total n from Sun core	$r_n = r_1*n^2$	n' = ln(0.01) / [ln(1 + b /r_n)- (b /r_n)]	w= log(n' / n) / log(6)	round up w	n'_r = n*q^w	b(r) =	[(1+b/r_n) *exp(-b /r_n)]^n' = 0.01	$r_1 = r_{n'}$ / (n*q^w)^ 2	r_1 at {N,1//6}	w(θ) =	n'_θ = n*q^w	b(θ) = r*sin(acos [0.01^(1/n')])	b(r) / b(θ)	planet's body-r /b(θ)	b_{w-4} / b
unit	m	m					m					m		m				m	m/m	m/m	m/m
Sun core	1.74E+08		0	1	6	1	1.74E+08														
SUN	6.96E+08		0	2	6	2	6.96E+08														
Mercury	5.79E+10	2.44E+06	1	3	6	18	5.64E+10	4.91E+09	11.84	12	6.53E+09	2.12E+06	0.010	1.32E-09	{-11,1//6}	12	6.53E+09	2.12E+06	1.00	1.15	
Venus	1.08E+11	6.05E+06	1	4	6	24	1.00E+11	2.52E+09	11.31	11	1.45E+09	7.98E+06	0.010	4.76E-08	{-10,1//6}	11	1.45E+09	7.98E+06	1.00	0.76	
Earth (planet)	1.49E+11	6.38E+06	1	5	6	30	1.57E+11	5.55E+09	11.62	12	1.09E+10	**4.55E+06**	0.010	1.32E-09	{-11,1//6}	12	1.09E+10	**4.55E+06**	1.00	1.40	
Earth	1.49E+11	6.38E+06	1	5	6	30	1.5653E+11			16	1.41E+13	1.26E+05	0.010			16	1.41E+13	1.26E+05			36.00
Earth	1.49E+11	6.38E+06	1	5	6	30	1.57E+11			20	1.83E+16	3.52E+03	0.010			20	1.83E+16	3.52E+03			35.90
Earth	1.49E+11	6.38E+06	1	5	6	30	1.57E+11			24	2.37E+19	9.79E+01	0.010			24	2.37E+19	9.79E+01			36.00
Earth	1.49E+11	6.38E+06	1	5	6	30	1.57E+11			28	3.07E+22	2.72E+00	0.010			28	3.07E+22	2.72E+00			36.00
Earth	1.49E+11	6.38E+06	1	5	6	30	1.57E+11			32	3.98E+25	7.55E-02	0.010			32	3.98E+25	7.55E-02			36.01
Earth (atom)	1.49E+11	6.38E+06	1	5	6	30	1.57E+11			56	1.89E+44	**3.47E-11**	0.010			56	1.89E+44	**3.47E-11**			36.02
Earth (nucleon)	1.49E+11	6.38E+06	1	5	6	30	1.57E+11			68	4.10E+53	**7.44E-16**	0.010			68	4.10E+53	**7.44E-16**			36.02
Earth (quark)	1.49E+11	6.38E+06	1	5	6	30	1.57E+11			76	6.89E+59	**5.74E-19**	0.010			76	6.89E+59	**5.74E-19**			36.06

Note: The top 9 rows of Table 4 were copied from SunQM-4 Appendix C's Table 2. The bottom 11 rows are the calculations to show that the size (=b, in column 19, or in column 13) of the NBP peak (in either θ-dimension, or r-dimension) can be re-adjusted from the size of the planet Earth, to the size of either an atom, or a nucleon, or a quark (when w_θ in column 17 is increased from 12 to 56, or 68, or 76 for n' = 5* 6^w_θ). Check SunQM-4 for detailed calculation method. Then we copied the θ-dimension's result for the r-dimension's NBP peak, and confirmed it by using WolframAlpha. Blue cells (inside Table 4) were calculated by using WolframAlpha, due to the values of 0.999999… need too many digits for Excel to handle. Column 22 in Table 4 showed the ratio of $r_{surface}$ (=b) at w_θ + 4 to $r_{surface}$ (=b) at w_θ. This calculation also showed that whenever Δw_θ increased by 4, the $r_{surface}$ (=b) decreases to 1/36, and the size of {N,1//6} decreases to {N-1,1//6}.

II-b. Two-body problem: Any kind of bound, unbound, or scattering movement (NBP description, general |n,*l*,m> QM state, 3D orbit)

In {N,n} QM, the movement of the electron in a H-atom is described by its (single) orbital track (in form of a series of NBP peak's time-dependent trajectory, almost like what the classical physics did, although it follows Schrodinger equation's solution). (Note: here "tracks" means a collection of many available orbits (in circular, elliptic, hyperbolic, etc. with different inclinations) that is formed by the interference of the matter wave, and "trajectory" means a single track that a single particle picked at one particular time). When large amount of these orbital tracks (with all different eccentricities, inclinations and precessions) is averaged, it can be statistically re-presented as the Born probability. This is illustrated in Figure 2. Figure 2a showed that in a H-atom, an electron's n=1 orbital movement can be described by many single orbital tracks with all kinds of different eccentricities (Note: the value of the eccentricity can change in continues). Figure 2b showed that the same electron's n=1 movement can be further described by many single orbital tracks with all kinds of different eccentricities, plus all kinds of different inclinations, and all kinds of different precessions. The electron can freely and smoothly switch to anyone of these tracks (under the random thermal motion? or through the quantum fluctuation? or determined by the probability of matter-wave interference? or determined by a hidden variable?), and the electron likes to stay in the dark/thick-line tracks more than the light/thin-line tracks. Figure 2c showed that the sum (or the averaged) of the n=1 tracks after many (e.g., 10^{10}) orbital periods equivalents to a Born probability. On the other hand, the traditional QM uses only Born probability (but not an individual track) to describe an electron's n=1 orbit. Therefore, there is a significant conceptual difference between the {N,n} QM and the traditional QM in describing the H-atom's electron orbit: **while the probability (i.e., the Born probability) is the foundation of the traditional QM, the single trajectory (i.e., NBP peak's time-dependent trajectory) is the foundation of the {N,n} QM** (although this single trajectory will pick one of the many possible tracks based on the probability). This concept is the same for both the micro-world and the macro-world, even though it appears more obvious in the micro-world (because its trajectory viewed as the sum of ~10^{10} rounds of orbital tracks), and it appears un-obvious in the macro-world (because its trajectory viewed as one (or a few) round of orbital tracks). Example-1 (in section II-b): although Earth's orbital movement trajectory follows a single (near circular) track (orbital eccentricity = 0.017, ignore the minor precession), the significant precession of Mercury's (elliptic) orbital motion trajectory (orbital eccentricity = 0.205) can be explained as it switches between many different (elliptic) orbital tracks. Example-2 (in section II-b): assuming that we collected 100 rounds of Mercury's precessional orbital movement trajectory, and found it can be described by nLL QM state with n' = 3*6^4 = 3888, or |3888,3887,3887> QM state, then we collect 100 rounds of an electron (in a H-atom, also at |3888,3887,3887> QM state)'s orbital motion trajectory, we should find the electron's trajectory is very similar as that of planet Mercury's trajectory in terms of their inclination, eccentricity, and precession.

The solution of Schrodinger equation was initially developed for the bound state, now we have used it to the un-bound states (see SunQM-6s1). We can use a series of excited states (from the low excited state to the high excited state, or vice versa) to describe the unbound state. For example, we used

$$r^2|\Psi(r,\theta,\varphi,t)|^2_{NBP} = r^2|R(r)|^2_{NBP}\,|\Theta(\theta)|^2_{NBP}\,|\Phi(\varphi,t)|^2_{NBP} = r^2|R(r)|^2_{NBP}\,|\Theta(\theta)|^2_{NBP}\,|\Phi(\varphi)|^2_{NBP}|T(t_\varphi)|^2_{NBP} \quad \text{eq-5}$$

(copied from SunQM-4's eq-56cc) for a bound state's circular orbital movement at the equator, and we used

$$r^2|\Psi(r,\theta,\varphi,t)|^2_{NBP} = r^2|R(r)|^2_{NBP}|T(t_r)|^2_{NBP}\,|\Theta(\theta)|^2_{NBP}|T(t_\theta)|^2_{NBP}\,|\Phi(\varphi)|^2_{NBP}|T(t_\varphi)|^2_{NBP} \quad \text{eq-6}$$

(copied from SunQM-6s1's eq-33), or

$$r^2|\Psi(r,\theta,\varphi,t)|^2_{NBP} = r^2|R(n(t),l(t))|^2_{NBP}|Y(l(t),m(t))|^2_{NBP} \quad \text{eq-7}$$

(copied from SunQM-6s1's eq-37) for a general unbound (or scattering) movement.

In Figure 3a, we plotted the spherical harmonic function of Re[Y(50,25)], which equals to a visualized θφ-2D dimensional NBP function at *l*=50, m=25. The protruding parts (on the spherical surface) are the θφ-2D wave function's positive peaks, and they are also the NBP peaks. A series of NBP peaks (marked in red dots) can be used to represent the trajectory of an electron (in H-atom) that is doing the circular orbital movement with the orbital plane inclined at ~70°

relative to the equator plane (marked in black dots, see Figure 3a). If readers think the red dots are too discrete to represent a trajectory of a continues motion, then (using the principle in section I-i), we can increase the *l* number to very high (e.g., $l \approx$ 6^10), and set m ≈ *l*/2, and it will give (practically) a continues line (formed with almost countless of red dots) to represent a trajectory of a continues motion. (Note: *l*=50 is the highest *l* value that this software can plot. Note: in SunQM-4s2, a hurricane's time-dependent trajectory on Earth's surface can also be described by using this kind of method).

Using function of Re[Y(*l*,m)], Figure 3a can only describe a circular trajectory at any inclination. Then after adding the radial wave function, the NBP formed by using Re[R(n,*l*) Y(*l*,m)] should be able to describe any motion trajectory (circular, elliptical, parabolic, hyperbolic, etc.), in either an orbital movement governed by the attractive force, or a scattering movement governed by the repulsive force (see Figure 3b), with any inclination, eccentricity, and precession, and at any resolution. Unfortunately, currently we don't have any (free) plotting software to illustrate that.

In SunQM-6s1, we had described a photon's propagation either away from a Bohr atom, or towards a Bohr atom, by using a series of NBP peaks (under {N,n//q} QM, with nLL QM states, with either increasing or decreasing the quantum number n, and with the fixed θ = π/2 and φ = 0 angles). We may can directly use this method to (roughly) describe the trajectory of a 180° angle scattering of a particle (see Figure 3b), although we still need to add-in the energy description part and/or the detailed dynamics description part. Besides that, we need to further develop this method by expending the variable from r-1D only to rθφ-3D, so that it can be used to describe any bound, unbound, or scattering movement. For example, an asteroid (coming from the outside of the solar system) is attracted by the Sun to do a parabolic motion, at a very high inclination relative to the ecliptic plane, its trajectory should can be described by eq-6 (or eq-7) at extremely high n'. (Note: it is still an unfinished task).

Thus, the new task become: in a Schrodinger-equation-based space, and in a Schrodinger-equation-based force field, to develop a trajectory formula for a motion object. So far we have successfully done two (both for the special cases): the first one is the planet's circular orbit (which can only be used for nLL QM state with the circular orbital motion, see section II-a); the second one is the emission/absorption of a photon (which can also be used for a particle's 180° angle elastic scattering, see SunQM-6s1). Now we need to expand (or to develop) this kind of trajectory formula for any kind of movement (circular, elliptical, parabolic, hyperbolic, orbiting movement, scattering movement, etc.), with any inclination/eccentricity/precession, based on Schrodinger equation's solution, follow the conservation rule of energy, momentum, and angular momentum, etc. (Note: I don't know whether this idea is similar to the "pilot wave" theory or not. As a citizen scientist, I only know that theory superficially (through wiki "Wave–particle duality" section "de Broglie–Bohm theory"), without any detailed knowledge).

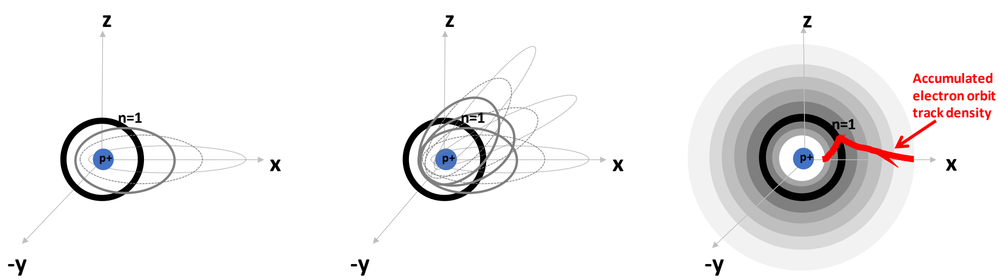
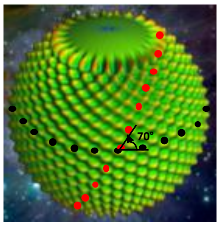


Figure 2. To illustrate that in {N,n} QM, how a single orbital track of an electron (in H-atom, at n=1 QM state) can have many different eccentricities (in Figure 2a, left), and many orbital tracks (of n=1) with all kinds of eccentricities, inclinations, and precessions (in Figure 2b, middle) can be averaged and represented statistically as the Born probability at n=1 (in Figure 2c, right). (Note: in Figure 2c, the r-dimensional probability density distribution is a smooth curve (as shown in the red curve along x-axis), and it is not a quantumly changing curve. Sorry as a citizen scientist, I don't have any plotting software to plot a continues density change in r-dimension).



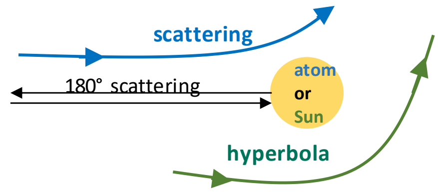


Figure 3a (left). Spherical surface (or solid) plot of Re[Y(50,25)]. Plotted by using the (free) online plotter at "http://icgem.gfz-potsdam.de/vis3d/tutorial".
Figure 3b (right). Illustration of a scattering trajectory (in blue), a 180° scattering, and a hyperbolic orbital trajectory (in green).

II-c. *N*-body movement described (averagely) by Schrodinger equation and Born (or non-Born) probability

(Note: This section was moved here from SunQM-5's section IX. Note: In this paper, the italic *N* means *N*-body's *N*, not {N,n} 's N). By far we have studied two kinds of interior {N,n} QM structure: 1) a single-body-core's interior {N,n} QM structure, for example: Sun-planet system, planet-moon system, atom's nucleus-electron system; 2) *N*-body-core's interior {N,n} QM structure, for example: nucleus (with multiple nucleons inside), proton (with 3 quarks inside). We can easily see that Milky Way galaxy follows the single-body-core's interior {N,n} QM, and Virgo super cluster, and universe follow the *N*-body-core's interior {N,n} QM.

Text books told us that unlike two-body problems which can be solved precisely with Newtonian mechanics, the three-body (or *N*-body) problem has no simple analytical solution in classical mechanics, therefore the numerical method is needed to solve *N*-body problem. In SunQM-5, we showed an alternative way to describe *N*-body problem by using the interior{N,n} QM structure analysis.

For three-body, the best example is that the three quarks (each with size of {-17,1}) forms a nucleon with size of {-15,1}. It is described (in view of the elementary particle {N,n} QM) as: three {-17,1} sized particles doing RF orbit movement to form a 36^2 = 1296× larger (in r) sized object, (or, inside a {-15,1} sized orbit space there are three 1/1296× sized particles doing RF movement). The (averaged) motion trajectories of these three particles can be described by the {N,n} QM orbits in two of N super-shell: {-17,n=1..5}o and {-16,n=1..5}o. Within each N super-shell, their (averaged) motion trajectories can be (more detailly) described by Schrodinger equation and quantified as probability density (see SunQM-5's Figure 6).

We can also describe the three-body problem in view of wave-based interior{N,n} QM (still using proton-quark as example, also referring to paper SunQM-2 section IV-c): In a {-15,1//6} sized matter wave resonance chamber (**MWRC**), there are all kinds of 3D spherical matter waves in this i{0,1//6} chamber (Note: i({N,n} means interior {N,n}, see {N,n} QM nomenclature in SunQM-1 section VII). MWRC amplifies only some of them (by resonance), so they become stable matter wave. Most of other matter waves in the chamber are suppressed. Controlled by the S/RFs-force (see SunQM-6), only three stable 3D spherical matter wave packets are in resonance, each doing RF movement within size of {-17,1//6} and we call them quark. These three matter wave-packets also doing (higher level) RF movement in a larger space of {-17,n=1..5//6}o and {-16,n=1..5//6}o, this (higher level) RF movement is also amplified and stabilized by the same MWRC. Within each {N,n=1..5//6}o super-shell, their wave property can be described by Schrodinger equation and their occupancy can be quantified as probability density.

For *N*-body, the best example is the Og-118's 294 nucleons (each with size of 8.4E-16 meters) that forms a nucleus (with size of ~ 8.3E-15 meters in r, see SunQM-5's Table 2). Similar as that in three-body problem, the (averaged) motion trajectories of these 294 nucleons can be described by the interior {N,n} QM orbits in three N super-shell: e1{-1,n=1..5//6}o, e1{-2,n=1..5//6}o, and e1{-3,n=1..5//6}o (see SunQM-5's Figure 4). Within each N super-shell, their (averaged) motion trajectories can be (more detailed) described by Schrodinger equation and quantified as probability density. Besides nucleus, Sun can also be described as *N*-body {N,n} problem (with *N* = Sun's mass / proton's mass = 1.99E+30 kg / 1.67E-27 kg = 1.19E+57), and then can be described by the interior {N,n} QM analysis (see SunQM-2 section IV-c).

Now let us use the *N*-body interior {N,n} QM to describe the Solar system. First, let us set the new i{0,1//6} at the outer edge of the Solar system (at {5,1}), and name it as SolSys{0,1//6}. Then let us define the Sun core at the size of SolSys{-5,1//6} as the SolSys{0,1//6} QM's ground state. From wiki "Solar core", "*the core inside 0.20 of the solar radius contains 34% of the Sun's mass, but only 0.8% of the Sun's volume*". Let's assume that there is 34% of Sun's mass inside Sun core {0,1//6} = SolSys{-5,1//6}, then we can say that the ground state of the interior SolSys{0,1//6} QM is made of *N*-body with 1.19E+57 *34% = 4.05E+56 of nucleons (with the total size at SolSys{-5,1//6}), and we call it Sun core. Then, the first excited state of the interior SolSys{0,1//6} QM is made of *N*-body with 1.19E+57 *66% = 7.85E+56 of nucleons (with the total size at SolSys{-5,2//6}), and we call it Sun. Also, there are *N*-body (with *N* = Earth's mass / proton's mass = 5.97E+24 kg / 1.67E-27 kg = 3.57E+51) of nucleons at the SolSys{-4,5//6}o orbital shell space, or at the excited state of n = 5*6^1=30 of the interior SolSys{0,1//6} QM, and we call it Earth. Similarly, we can describe all Solar planets, belts and clouds (that is made of *N*-body nucleons) as the excited states of the interior SolSys{0,1//6} QM. Of course, this *N*-body interior SolSys{N,n} QM follows Schrodinger equation and solution.

The above {N,n} QM discussion trigged us to propose a new explanation for the alpha-particle radiation [25]. Inside a heavy nucleus, nucleons random moving in multi-modes. The basic mode (of course) is the single nucleon (n_{nuc} = 1) movement mode. One of the **sub-base-frequency modes** is that all these nucleons grouped as He-nucleus (n_{nuc} = 2, the second most stable n_{nuc}). This mode equivalents to that there are $N \approx$ Mass# / 4 of pseudo "He-nucleus" randomly moving in a nuclear energy well (equals to a *N*-body problem), and the quantum fluctuation of the kinetical energy (KE) distribution inside nucleus makes one of them has outstanding high KE at (uncertainty principle time) $\Delta t \approx \hbar / \Delta E$, so that this particular pseudo "He-nucleus" escapes out of the nuclear energy well (or tunneling out of the energy barrier). Why not the single nucleon particle radiates out? Because a single nucleon's KE is too low to overcome the barrier of the nuclear energy well. "He-nucleus" particle has 4× of KE of a single nucleon's KE. Why not the 3-nucleons (or 5-nucleons) particle radiate out? Because a 3-nucleons particles random motion mode is an unstable QM state in {N,n} QM (due to its $1 < n_{nuc} < 2$), so it has practically zero probability to exist (or this mode's life-time equals to zero) inside a nucleus (even though it has enough KE to escape the well). So a 3-nucleons particle radiation probability → 0. Why not the "Li-nucleus" particle radiates out? Because its n_{nuc} = 3, so it has much lower probability (or shorter life-time) than a "He-nucleus" (n_{nuc} = 2) particle (as the random moving mode) inside a heavy nucleus. (Note: this is exactly the effect of "the ground state (n_{nuc} = 1 mode) is often "accompanied" by a 1st excited state (n_{nuc} = 2 mode)", see section I-f).

Note: under the interior {N,n} QM, the (non-center attraction) *N*-body problem may can be transformed into a virtual center-force caused mass (or charge) distribution probability in 3D space.

II-d. Summery (of the section II)

The purpose of the whole section II is to show that each level of our universe's structure (from the universe as a whole structure, to a single sub-quark structure) can be described by Schrodinger equation and NBP, besides that it can be described by the Bohr-QM based Table 1. (Note: some of the following discussions are only the expectation).

1) Following structures (from big to small) can be described by Schrodinger equation and NBP in the form of *N*-body description (see section II-c), and in a general |n,*l*,m> QM state, and with ~100% mass occupancy, and with SMED property: the whole universe {N≥11,1//6}, Laniakea {10,2//6}, the Virgo super cluster {10,1//6}, the local group of galaxies at the sizes of {9,n//6} and {8,n//6}, the early stage of (dwarf) galaxies with the spherical shape (not the disk shape) at smaller than {8,1//6}, (inside) a star at size of around {0,2//6}, (inside) a planet/moon that has a size around {-1,1//6}, (inside) a white dwarf {-1,1//6}, (inside) a neutron star {-3,2//6}, electron orbits inside an atom at size around {-12,1//6} and larger, a number of nucleon orbits (inside an atom's nucleus) at size around {-15,1//6} and larger, three quarks' orbits (inside an nucleon) at size around {-17,1//6} and larger, an unknown number of {-20,1//6} particle's orbits inside a quark {-17,1//6}, etc.

2) Following structures (from big to small) can be described by Schrodinger equation and NBP in the form of two-body description (see section II-a), and in nLL QM state, and with < 1% mass occupancy, and with SMED property: a disk-lyzed galaxy (in the disk region, within size of {8,1//6}), a solar system (in the disk region, within size of {5,1//6}), a planet-moon system, a photon's emission and propagation from a Bohr atom, etc.

3) Following structures (from big to small) may can be described by Schrodinger equation and NBP in the form of two-body description (see section II-a), and in n*l*0 QM state, and with < 1% mass occupancy, and with SMED property: the propagation of alpha-particle emission, beta-particle emission, gamma-particle emission, a photon's emission and propagation from a Bohr atom, etc.
4) Following structures (from big to small) may can be described by Schrodinger equation and NBP in the form of two-body description (see section II-b), and in the general |n,*l*,m> QM state, and with < 1 % mass occupancy, and with SMED property: (particle) scattering, etc.

III. Using {N,n//6} to explore the sizes of our universe and the smallest sub-quark structure through the number guessing

(Note: This section was moved here from SunQM-5's section X. Note: This section belongs to citizen-scientist-leveled thinking). Notice that a Sun at {0,2} (close to a {0,1} QM structure) is composed of (Sun's mass / proton's mass) ~ 1.19E+57 nucleus (each with a single proton, or nucleon, with the maximum electron available, meaning all electrons are not merged with protons), a {-5,1} QM structure (as a stable "black hole") is composed of a single nucleus with ~ 1.19E+57 nucleons (with zero electron available, meaning all electrons are merged with protons to form neutrons), a {-10,1} QM structure (as a maximum "atom") is composed of a single nucleus with ~ 1870 nucleons (with the maximum electron available, see SunQM-5's Table 2), and a {-15,1} QM structure (as a "fundamental blocker") is composed of a single nucleus with a single nucleons (with the maximum electron available for a proton, or zero electron available for a neutron). Thus, in the {N,n//6} QM, we can further assume that N is a base-5 number system, and also assume that {-15,1}, {-10,1}, {-5,1}, {0,1}, {5,1}, {10,1} are the super-super stable {N,n//6} QM structures (or QM states). Based on that, we can use three digital number system {K,N,n//6} to represent the {N,n//6}, with the conversion formula {N=K*5,n//6}. Notice that this definition only works for that N is an integer multiple of 5. For example, {-15,1} = {-3*5,1} = {-3,0,1}, {0,1} = {0*5,1} = {0,0,1}, {10,1} = {2*5,1} = {2,0,1}, etc. Therefore, {-15,1}, {-10,1}, {-5,1}, {0,1}, {5,1}, {10,1} can be rewritten as {-3,0,1}, {-2,0,1}, {-1,0,1}, {0,0,1}, {1,0,1} and {2,0,1} respectively.

One (citizen-scientist leveled) guess is to assume the {5,0,1} super-super stable QM structure as the size of our universe, and the {-5,0,1} super-super stable QM structure as the size of the smallest sub-quark structure (see Table 5's column 6-7). Now the question is where we should set the {0,0,1}. In Table 5's column 6, we chose Sun core {0,1} as {0,0,1}. So the {5,0,1} QM structure will be at {25,1} with r = 1.4E+47 meters, or 1.49E+31 lys (see SunQM-1s2's Table 1, column 6 and 7), and the {-5,0,1} QM structure will be at {-25,1} with r = 2.15E-31 meters. It means that if the Sun core {0,1} is the super-super stable {0,0,1} QM structure, then (under this model) our universe has size of {25,1}, and the smallest sub-quark structure has size of {-25,1}.

From the current (mainstream) physics, we know that the biggest physical meaningful size is the observable universe that correlates to size of {11,5//6} in Table 1, and the smallest physical meaningful size is the Planck length (~ 1.6E-35 meters, see wiki "Planck length") that correlates to size of {-28,4//6} in SunQM-2's Table 1. In Table 5, if we re-set the {0,0,1} at {-10,1}, (see Table 5's column 7), then our universe will have the size of {15,1}, and the smallest sub-quark structure will have the size of {-35,1}. Alternatively, if using galaxy {8,1//6} as the fundamental building block, then ΔN = +5 at size of {13,1//6} could be the candidate for the size of our universe. Or, if using Virgo supercluster {10,1//6} as the fundamental building block, then ΔN = +5 at size of {15,1//6} could be the candidate for the size of our universe.

If using "rhodopsin-type" universe model, then there is no big-bang, no (major) expansion of universe, and no "observable universe". Then, the size of our universe could be {N,1//6} with any N that equals to or great than 11. Does this kind of tries have any meaning in physics? We do not know. The only thing we know is that our Solar QM {N,n} structure was born from this kind of tries.

Table 5. {K,N,n//6} QM structure using either Sun{0,1}, or {-10,1}, as {0,0,1}.

{N,n}					{K,N,n}	
N (= N + ΔN)						
ΔN = 0	ΔN = +1	ΔN = +2	ΔN = +3	ΔN = +4		
{-35,1} sub-quark						{-5,0,1}
{-30,1} sub-quark						{-4,0,1}
{-25,1} sub-quark					{-5,0,1}	{-3,0,1}
{-20,1} sub-quark			{-17,1} quark		{-4,0,1}	{-2,0,1}
{-15,1} r=8.4E-16 meter, proton			{-12,1} H-atom		{-3,0,1}	{-1,0,1}
{-10,1} 50 nm, max atom					{-2,0,1}	{0,0,1}
{-5,1}, r=2 meters, quark star		{-3,1} black hole			{-1,0,1}	{1,0,1}
{0,1}, r=1.74E+8 meters, Sun core		{2,1} Mars orbit	{3,1} Kuiper belt		{0,0,1}	{2,0,1}
{5,1} Oort end			{8,1} Milky way		{1,0,1}	{3,0,1}
{10,1} r=5.5E+7 ly, Virgo SupClst					{2,0,1}	{4,0,1}
{15,1} universe?					{3,0,1}	{5,0,1}
{20,1} universe?					{4,0,1}	
{25,1} Universe?					{5,0,1}	

IV. A positive curvature (3D spherical) space may be the best description for a {N,n//6} QM structural based universe

(Note: this section belongs to citizen-scientist-leveled thinking). Suppose we have found the size of our universe based on {N,n} QM structural estimation in section III, then it must be a rθφ-3D space. Then, what is the edge of this universe looks like? Many physics text books already gave us one possible answer: "*If the universe had a positive curvature, the universe would be closed, or finite in volume … There is no boundary or edge in such a universe. The universe is all there is. If a particle were to move in a straight line in a particular direction, it would eventually return to the starting point – perhaps eons of time later*" [26]. It can be explained as a 3D spherical space on a 4D ball surface. The intuitive view of a 2D spherical space on a 3D ball surface is often used as a simplified explanation (see wiki "3-sphere"). Here, we use the 1D infinitely deep square potential well QM (named as "**1D-well-QM**") and 1D circular orbit QM (named as "**1D-circular-QM**") to explain.

In 1D-well-QM, the one dimension has two edges at the two ends (see SunQM-4s1's Figure 3b). However, a 1D-well-QM can be seamlessly transformed into a 1D-circular-QM (see SunQM-4s1's Figure 3a). After the transformation, its two end edges disappeared, so it become edgeless. Strictly to say, a 1D circle has to exist in a 2D space, Thus, under a special case, a 1D edged QM can be transformed into a 2D edgeless QM. This can be generalized as: under a special case, a k dimensional edged QM can be transformed into a (k+1) dimensional edgeless QM (where k is a positive integer, also see wiki "n-sphere"). This is exactly what happened for our {N,n} QM: in a our regular rθφ-3D space, it is edged; while in a 4D ball surface's 3D spherical space (i.e., a positive curvature 3D space), it becomes edgeless. Or, in a small region of the rθφ-3D space, it is edged; while in a whole rθφ-3D space (which is a positive curvature space), it is edgeless.

Also notice that in the 1D-circular-QM, any object (or any point) in the 1D-circular space can be chosen as the origin of the coordinate for the 1D-circular-QM. Similarly, any object (or any point) in the 3D (positive couverture) space can be chosen as the origin of the coordinate for the 3D {N,n} QM.

We can also describe the 3D positive curvature space in view of wave-based interior{N,n} QM by defining a {N,1//6} sized universe as a i{0,1//6} matter wave resonance chamber (MWRC). There are all kinds of 3D spherical matter waves in this i{0,1//6} chamber (like the "1D-well-QM" shown in SunQM-4s1's Figure 3b). This i{0,1//6} sized MWRC has no edge, because it is in a positively curved 3D space. So the base-wave of this 3D matter wave has the wave length the same size of MWRC, but edgeless, and endless (like the "1D-circular-QM" shown in SunQM-4s1's Figure 3a). MWRC amplifies only some of them (by resonance), so they become stable matter wave. Most of other matter waves in the chamber are suppressed. Governed by the G/RFg-force, E/RFe-force, and S/RFs-force, only certain number of stable 3D spherical matter wave packets are in resonance, each doing RF movement within size of {N',1//6} with N' = 10, 8, 5, 1, -3, -12, -15, -17, respectively, and we call it a supercluster of galaxies, a single galaxy, Solar system, Sun core, a black hole, H-atom, a proton, a quark, respectively.

Using a 4D ball surface's 3D spherical space property, we can explore the size of this sphere (i.e., the size of our universe). Now let us use 3D ball surface's 2D spherical space (with latitude from +90° to 0° to -90°, and with longitude from -180° to 0° to 180°) to explain. Below, we explained how to explore the size (i.e., circumference = 2πr) of this 2D spherical space in some special situations. Note: In all situations, it always assumed that we, or the Earth, or the Solar system, or the Milky Way, or the local galaxy cluster, is located at the north pole (latitude +90° longitude 0°) of this 2D spherical space.

IV-a. A 3D spherical space with circumference 2πr = 9E+9 lys, (explained by using a 2D spherical space).

In a 2D spherical space, it is obvious that all lights emitted from the south pole (to all directions) will be converged (or focused) at the north pole, (just like all longitude lines radiated from the point of south pole will converge at the point of north pole). So, if there is a star (or a galaxy) locates exactly at the south pole, then looking at all directions (in this 2D spherical surface space) we (at the north pole) will see a (solid) wall made of stars (or galaxies) at the distance of d = πr (see Figure 4a, Note: d in this section means distance, not diameter). Considering the light may be bend a little bit during the propagation (by the gravity of other galaxies that randomly located on the way between north and south poles), the wall (of stars or galaxies) that we see is no longer solid, it becomes discrete walls of galaxies, although all of these discrete walls are still exactly at the distance of d = πr. If considering our own star/galaxy's position also moved (away from the north pole) during the long time (many billions of years) of the light propagation (from south pole to north pole), then these discrete walls are moving away from d = πr, so that these observed discrete walls of galaxies are spread out in the range of d = π(r ± Δr). If the range of spread is very large, then these spread discrete walls of galaxies (now we name it as the **galactic walls**) may will be submerged in the background (noise) of galaxy clusters, and not so easy to be observed. Because (at any one direction) the space is in circular, edgeless and endless, we can see the same star/galaxy at the distance not only d = πr, but also d = kπr, where k is a positive integer (Note: here we named it as the **"d = kπr" effect**). Although the higher the k, the higher the noise, and the lower the observability the galactic walls will be. So only those galactic walls at k=1 (d = πr) and k=2 (d = 2πr) have relative high chance to be observed. In the case of k=1, the chance that there happened to be a star/galaxy in the south pole while we were in the north pole (many billions of years ago) is very low. In the case of k=2, or the galactic walls at d = 2πr, we (at the north pole) are looking our own star/galaxy (also at the north pole) after the light propagated a complete circumference of the universe, so it is 100% guaranteed that there was a star/galaxy at the north pole (because that is our own Milky Way many billions of years ago). Therefore, if we have observed many discrete galactic walls (in all directions of the out space, and in the quite similar distance from us), then there is a good chance that all these (walls of) galaxies are the images of our own Milky Way galaxy (or the local galaxy cluster) that was at many billions of years ago!

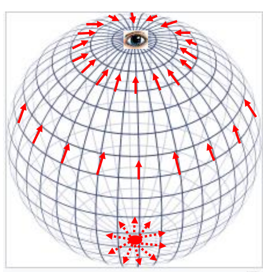
By searching wiki, a number of cosmic "great wall" with distance around 9E+9 lys was listed in Table 2, including U1.11 (d ≈ 8.8E+9 lys), Huge-LQG (d ≈ 9E+9 lys), Giant GRB Ring (d ≈ 9.1E+9 lys), The Giant Arc (d ≈ 9.2E+9 lys), Clowes–Campusano LQG (d ≈ 9.5E+9 lys), and Hercules–Corona Borealis Great Wall (d ≈ 1E+10 lys). According to the Cosmological principle (see wiki "Cosmological principle"), these super large cosmic structures should not be there. If more and more of this kind of super large galactic walls are found at distance around 9E+9 lys (and also if results are confirmed), then we may use the "d = kπr" effect to explain it, and there is a good chance that 9E+9 lys is the d = 2πr we are looking for. If so, then

1) Our universe (as a 3D spherical space) may should have a circumference of 9E+9 lys, which equivalent to the size of {11,2//6}, (see Table 2);
2) This means that at any one direction, our universe has a unique distance of d = 2πr = 9E+9 lys, anything we see beyond that is merely the repeating of the previous unique distance of d = 2πr = 9E+9 lys;
3) All galaxies in the galactic walls (of U1.11, Huge-LQG, Giant GRB Ring, the Giant Arc, Clowes–Campusano LQG, and Hercules–Corona Borealis Great Wall, etc.,) are the images of our own Milky Way galaxy (or the local cluster of galaxies) at about 9E+9 years ago, and are viewed at all different angles. Suppose our Milky Way galaxy is at the origin of a xyz-coordinate (and if our galaxy was never rolling around during last 9E+9 lys), then, a) when looking to the outside at +z direction from our Milky Way galaxy, we see a ~ 9E+9 years old Milky Way galaxy (also at the origin of a xyz-coordinate) from -z to the origin; b) when looking to the outside at -z direction from our Milky Way galaxy, we see a ~ 9E+9 years old Milky Way galaxy from +z to the origin; c) when looking to the outside at +x direction from our Milky Way galaxy, we see a ~ 9E+9 years old Milky Way galaxy from -x to the origin; and so on so forth (see Figure 4b for an illustration). Thus, by

looking all directions outward (from our galaxy to the out space), we can have a whole 4π solid angle view of our (9E+9 years old) galaxy (from the outside world to view our galaxy). However, due to that our galaxy may have been rolling around during last 9E+9 lys, although we still can see the whole 4π solid angle images of our (9E+9 years old) galaxy by looking all directions outward, when looking to the outside at +z direction, the image of our (9E+9 years old) galaxy we see could be at any direction (besides from -z to origin direction).

In 1592, the first circumnavigation (led by Magellan-Elcano) proved that the Earth is a 3D ball, and we are practically living in the 2D spherical space on the surface of a 3D ball something (i.e., a planet). In another ~50 years from today, if cosmologists find more and more super large galactic walls at d ≈ 9E+9 lys, then we may have a good chance to prove that our universe is (part of) a 4D ball something, and we are practically live in the 3D spherical space on the surface of this 4D ball something. I started to realize this in January 2017 after watching the "nature video" of "Laniakea: Our home supercluster" [27] and read the article [28], (although some people might have realized this many years before me).

We need to emphasize that so far the current section is only a "citizen-scientist-leveled" hypothesis. Here are some issues: 1) The existence of these super large galactic walls may still in dispute among cosmologists (see wiki "Huge-LQG"); 2) In Table 1, we expected that our universe should have {N,1//6} QM structure, with the smallest (possible) size of {12,1//6} or {13,1//6}. Then, is the d ≈ 9E+9 lys with size of {11,2//6} too small for our universe? If so, there may be a non-linear relationship at the whole universe scale, while the {12,1//6} or {13,1//6} is the effective-size of our universe's QM structure, the true size of our universe may be only {11,2//6}, (see Appendix A for more explanation). 3) If we use the steady state universe model, then there is no limitation of "observable universe", then it is possible for us to find the super large galactic walls at d = 2πr (even at d is greater than the "observable universe" at size of {11,5//6}); 4) If we use the big bang universe model, and if d = 2πr is larger than "observable universe", then we are not able to prove the hypothesis of the positive curvature universe by using the super large galactic walls (because they are beyond the observable distance).



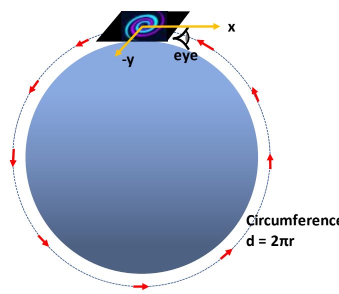


Figure 4a (left). To illustrate that in a 2D spherical space, a star at the south pole will be viewed by an eye at the north pole as a solid wall (made of stars and in all directions) at the distance of d = πr (if the light speed is infinitively fast). The red arrows represent the light propagation. The eye (at north pole) was drawn by SHAWNTE, copied from https://feltmagnet.com/drawing/How-to-draw-a-cartoon-eye.

Figure 4b (right). To illustrate that in a 2D spherical space, an eye view (from inside a galaxy) at +x direction will see the same galaxy (at distance = 2πr, and from the outside of the galaxy) at the opposite site (if the light speed is infinitively fast). The red arrows represent the light propagation.

IV-b. An eyeball-type universe model, in a 2D spherical space with circumference = 9E+8 lys.

In a 2D spherical space (and assuming the light propagation infinitively fast), if there is a major galaxy supercluster at the position of longitude 0° and latitude -30°, then we (at the north pole) can see one image of this galaxy supercluster with $d = \frac{90°+30°}{180°}\pi r = \frac{2}{3}\pi r$ at one direction (or at longitude 0°), and see a second image of this same galaxy supercluster with $d = \frac{180°+60°}{180°}\pi r = \frac{4}{3}\pi r$ at the exactly the opposite direction (or at longitude 180°). In Table 2 we noticed that on the sky, Shapley SC (Right ascension 13h 25m, Declination -30° 0′) is at almost exactly the opposite direction of Perseus-Pisces SC (Right ascension 01h 50m, Declination +36° 00′). From wiki, we can't find the mass of Shapley SC or the mass of Perseus-Pisces SC. If they have the same mass, then it is possible that Shapley SC and Prseus-Pisces SC are the two images of the same single supercluster that we viewed in the two opposite directions. If so, then the 3D spherical space of this universe has a circumference d = 2πr = 200 Mpc + 80 Mpc = 280 Mpc ≈ 9E+8 lys, and all the cosmic structures beyond that are the duplicated images at d = kπr (where k = 4, 6, 8, …). With only 1/10 of the circumference in comparison to that in the section IV-a, it makes this model even less possible. The advantage of this model is that it may can be viewed as 2D spherical space in the inner surface of an eyeball, with the Shapley SC (which now equals to the Perseus-Pisces SC) sit at the blind spot (where the retinal blood vessels and the optic nerves converged, see Figure 5. Notice that the retinal blood vessels and the optic nerves may equivalent to the cosmic web [29], and the converged blind spot may equal to a great "great attractor"). In Figure 5, a photon (= a mega-"photon") goes through a lens (= void) and trigs the optic nerve (= superclusters) to send an electrical signal out (= mega "black hole") at the blind spot (= the great "great attractor") can be used to illustrate that our universe (i.e., a 3D spherical space) may accept a mega-"photon" from the outside of our universe through the void, and trigs the Z-spectrum up-shifting in all superclusters, and send a mega-"black hole" out of our universe at Shapley SC (= Perseus-Pisces SC). If this model is correct, then at d = 2πr = 9E+8 lys behind either Shapley SC or Perseus-Pisces SC, we will have a good chance to see another supercluster (if the relative positions of all superclusters in Figure 5 were relative static during the last 2*9E+8 years). Although the probability that this model to be correct is close to zero, the real purpose of Figure 5 is to inspire and encourage other scientists to view our universe as a positive curved 3D space (or a 3D spherical space) and to propose better models.

Note: One thing we need to point out is, due to our Laniakea SC (or Earth) might have migrated away from the original position during the last 9E+8 lys, right now, Perseus-Pisces SC is not exactly at the opposite direction of the Shapley SC in the sky. Also, for the duplicated images of Shapley SC (or Perseus-Pisces SC) that at d = kπr (where k = 4, 6, 8, …), due to the migration of both Laniakea SC and Shapley SC (during the photon propagation time), their exact positions may have changed a lot. So we need to develop a sophisticated calculation software to restore their original positions before to determine whether there are duplicated images of Shapley SC (or Perseus-Pisces SC) at d = kπr (where k = 4, 6, 8, …) or not. Also, we need to repeat this kind of search for a (possible 3D spherical) universe at any possible circumference d = 2πr (e.g., 9E+8 lys, 9E+9 lys, etc.). We think this is the one of the most important jobs that the cosmologists need to do.

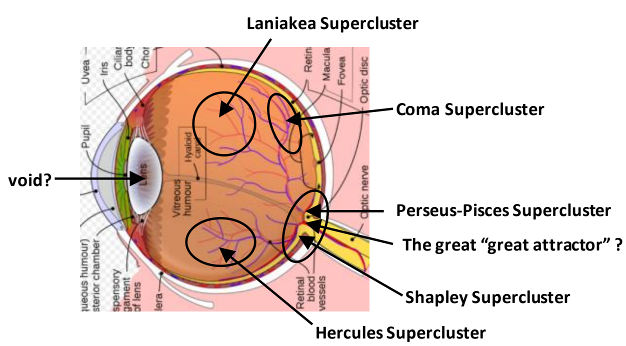


Figure 5. To explain a 3D spherical space universe model based on a 2D spherical space in the inner surface of an eyeball, with the retinal blood vessels and the optic nerves equivalent to the cosmic web. Perseus-Pisces SC and Shapley SC are assumed to be the same single supercluster. The distance from Laniakea SC to Perseus-Pisces SC is around 1/3 circumference (at one direction), and the distance from Laniakea SC to Shapley SC is around 2/3 circumference (at the opposite direction). Notice that we have some difficulties to correctly assign the positions for Coma SC, Hercules SC, and voids in Figure 5. Of cause, for our real universe, you need to further imagine this picture into a 3D spherical space on a 4D ball surface (instead of a 2D spherical space on a 3D eyeball's inner surface). The background picture of the human eye is copied from wiki "Eye", drawn by Rhcastilhos and Jmarchn, copyright: CC-BY-SA 3.0.

V. A possible dynamic model for a "rhodopsin-type" universe

(Note: this is a citizen-scientist-leveled guess). Many steady state universe models (see Figure 6b) have been proposed long before the big-bang model (see Figure 6a). In SunQM-5s1's Appendix, we had proposed a possible dynamic model of our universe by using a rhodopsin-type model with pseudo Z# and Z-spectrum (also see SunQM-6 for the old version of the same model). Notice that in this model, the cosmic red-shift is explained as the natural attribute of the photon propagation, so that there is no dark energy, no big bang, no observable universe, even no universe (major) expansion in this model. Figure 6c showed this dynamic model. In Figure 6c, the cycle of a small size expansion followed by a small size shrink of universe is caused by the absorption a mage-"photon" from the outsize of our universe, followed by the spit-out a mega-"black hole" to the outsize of our universe. Each absorption and/or spit-out may cause a "small bang" and produces a CMB. Thus, current CMB is caused by either the absorption of a mega-"photon" at the beginning of the current cycle, or the spit-out a mega-"black hole" during the last cycle.

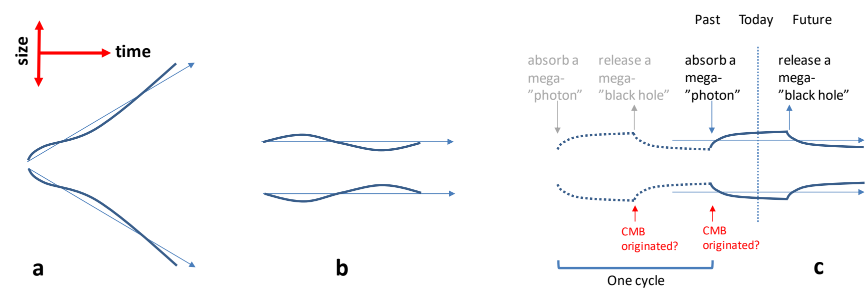


Figure 6a. An expanding universe started from a big bang. The diagram was drawn according to [30].
Figure 6b. A steady state universe with the (minor) size breathing. The diagram was modified according to Figure 6a.
Figure 6c. A "rhodopsin-type" steady state universe with cycles of a mega-"photon" absorption (that causes a minor expanding of universe) and a mega-"black hole" release (that causes a minor contracting of universe).

VI. Wave mechanics is equally powerful as that of particle mechanics in solving a QM problem, and a particle mechanics based holographic-description and SMED is waiting to be developed

From Newton era to Einstein era, physics was always dominated by the particle description, and the wave description was used only when the particle description has difficulties. After de Broglie proposed the matter's particle-wave duality, and Schrodinger developed the matter's wave function, people still like to use the matrix-based (equivalent to the particle-based) QM rather than the wave-based QM. Hence, it seemed that the matrix-based QM is more powerful than the wave-based QM in solving a (general) QM problem. With the success of {N,n} QM, we demonstrated that the wave-based QM is equally powerful as that of the particle-based QM in solving a (general) QM problem. Here are the two examples. Exanple-1 (of section VI): in a Bohr atom, a matter wave at n = 3 QM state with the (phase) frequency $f_{ph,n=3}$ = 3.66E+14 Hz (usually we call it orbit n=3 electron), de-excited to n = 2 QM state with the (phase) frequency $f_{ph,n=3}$ = 8.22E+14 Hz (usually we call it orbit n=2 electron), and released a new matter wave with the (phase) frequency $f_{ph,3-2}$ = 8.22E+14 Hz - 3.66E+14 Hz = 4.56E+14 Hz (usually we call it photon with λ = 656.1 nm, see SunQM-6s1 's Table 1 for details), and this new matter wave propagated from $r_{n=3}$ to $r_{n=\infty}$. Notice that this description is purely a wave description (which only uses phase frequency), no particle (which need to use group frequency) is needed at all. Example-2 (of section VI): as shown in either SunQM-3s11 or SunQM-4, all eight planets (that doing orbiting movement around the Sun) were well described by the solution of Schrodinger (wave) equation (with the wave packages), and no particle description is needed.

So far, the major advantage of using the wave mechanics are: 1) we can obtain a complete (holographic-like) picture of the whole QM system, (e.g., using {N,n} QM to analyze the Solar system revealed that there must exist four un-discovered planets at {3,n=2..5//6} orbits, and there might have a burned-out planet at {1,2//6} orbit); and 2) we also can obtain the description of the whole system at different resolutions at the same time through the Simultaneous-Multi-Eigen-Description (SMED, see section II of this paper, and also see SunQM-4's section V). Because the particle-wave duality is a nature attribute of a matter, we predict that there must be a particle QM version of both holographic-description and SMED. Therefore, we are waiting for a (or a group of) talented physicist(s) to develop both the particle QM based holographic-description and the particle QM based SMED.

VII. Bohr formula $\mathbf{r_n = r_1 n^2}$ correlates to the (free-fall) accelerated distance formula $\mathbf{d = \frac{1}{2} g t^2}$ and Newton formula F = ma. Therefore, Bohr formula is the Number-One important formula in physics.

Wiki "Gravity", mentioned that "*An initially stationary object which is allowed to fall freely under gravity drops a distance which is proportional to the square of the elapsed time … During the first 1/20 of a second the ball drops one unit of distance; by 2/20 it has dropped at total of 4 units; by 3/20, 9 units and so on*". Using the equation for a falling body (see wiki "Gravity" section "equations for a falling body …"), the distance d travelled by an object for time t under the acceleration g (= 9.80 m/s^2) is $d = \frac{1}{2} g\, t^2$. At t = 1 (unit), $d_1 = \frac{1}{2} g\, 1^2$; At t = n (unit), $d_n = \frac{1}{2} g n^2$; if divided d_n by d_1, then we have $d_n / d_1 = \left(\frac{1}{2} g n^2\right) / \left(\frac{1}{2} g\, 1^2\right) = n^2$, or $\mathbf{d_n = d_1 n^2}$. This is exactly the same as the Bohr formula $r_n = r_1 n^2$. This analysis revealed that:

1) A classical physics' free-falling formula is equivalent to Bohr-QM's formula (or, they have the same origin), or a continues process of free-falling can also be indirectly (or even directly?) described quantumly by Bohr-QM. Of course, to do that, we need to add (close to the infinity number of) transient QM states in between the limited quantum number of QM states (see section I-i for how to do it). Also notice that once all methods in section II are fully developed, all classical physical movements (bound state, unbound state, scattering, *N*-body problems, etc.) may can be described by using Schrodinger equation with extremely large quantum number n.

2) This explanation applies to all range of G-force, from larger than {10,1//6}, down to {-5,1//6} (or smaller than 1 meter). It also applies to all range of E-force, down to {-15,1//6} (or 8.40E-16 meters). It is also expected to be valid for all range of S-force, down to much smaller than the size of {-15,1//6}. Therefore, our known universe's structure (from {10,2//6} Laniakea down to {-17,1//6} quark) follows {N,n//6} QM structure which is based on Bohr's formula $r_n = r_1 n^2$.

3) Broadly to say, Newton's second law F = ma (where $a = \frac{d^2 x}{dt^2}$ is the acceleration) may also can be indirectly (or even directly?) described quantumly by Bohr-QM. If true, then Newton's force may can be indirectly (or directly?) described quantumly by Bohr-QM. Therefore, the gravity force field may can be indirectly (or directly?) described quantumly by Bohr-QM. Because Bohr-QM is a special case of (the more general) Schrodinger-QM, we can (comfortably) say that a primary G-force formed space may can also be described with Schrodinger-QM. Thus, it may support the hypothesis (in SunQM-6) that a primary G-force field itself can be described with Schrodinger-QM's radial wave function.

4) Before publish this paper, I checked wiki "Schrödinger equation", and found its recent update also gave the similar description: "*Conceptually, the Schrödinger equation is the quantum counterpart of Newton's second law in classical mechanics. Given a set of known initial conditions, Newton's second law makes a mathematical prediction as to what path a given physical system will take over time. The Schrödinger equation gives the evolution over time of a wave function, the quantum-mechanical characterization of an isolated physical system*".

From Bohr formula $r_n = r_1 n^2$, when n is very large (e.g., high-frequency n'=1E+6), and the increment of n is very small (e.g., $\delta n < 10$), then the $r + \delta r$ can be approximated as

$\mathbf{r_n + \delta r = r_1 (n + \delta n)^2} = r_1 (n^2 + 2n\, \delta n + O[(\delta n)^2]) \approx r_n + 2nr_1 (\delta n)$, or, $\mathbf{\delta r \approx 2nr_1 (\delta n)}$ eq-8

where $2nr_1 \approx$ constant (under the condition of $\delta n << n$). It means, when increasing the high-frequency n by very small amount, Bohr formula will have an approximate linear relationship between the n increment (δn) and r increment (δr), rather than the original non-linear relationship of $r_n = r_1 n^2$. We know that when n is very large, a quantum process becomes to a continues process. Then in a (classical physics of) free-fall process, we also have

$\mathbf{d = ½\, g t^2}$, $\mathbf{d + \delta d = ½\, g(t+\delta t)^2} = ½\, g(t^2 + 2t\, \delta t + O[(\delta t)^2]) \approx d + g(t\, \delta t)$, or, $\mathbf{\delta d \approx g t\, (\delta t)}$ eq-9 where gt ≈ constant at t >> δt. It means, when increasing t by very small amount (i.e., δt << t), the free-fall's non-linear formula will become a linear formula. In the (classical physics) formula of d = vt, we see that d and t has a linear relationship. Does the root of linear d = vt come from the (non-linear) Bohr-QM formula $r_n = r_1 n^2$ in which n is extremely large and δn increment is extremely small, so that a QM process becomes a continuous process, and δr and δn becomes a linear relationship? If so, then in the classical formula d = vt, the change of t and d must be (relatively) very small, but compare to what? Does it compare to a QM-world's t and d?

When I was a high school student (before 1978) or a college student (before 1982), I learned that Newton's F=ma and Einstein's $E=mc^2$ were the two most famous formulas in physics. With the discovery of {N,n} QM, now I believe that Bohr's $r_n = r_1 n^2$ should be the Number-One important formula in physics. In the world of physics, Bohr formula governs the size of an object (and/or the distance between objects) from the sub-quark to the whole universe (see Table 1). In the world of creatures, determine the body size (and/or distance) is also the number one important task for all creatures to survive.

Summary and Conclusion

{N,n} QM contains two major parts: the Bohr formula-based part and the Schrodinger equation-based part. For the Bohr formula-based part, the theory is mostly completed and the result is summarized in the {N,n//6} QM Structure (Master) Periodic Table. For the Schrodinger equation-based part, so far we only can do two (special cases): the planet's circular orbit, and the emission/absorption of a photon (which can also be used for a particle's 180° angle elastic scattering). However, we need to expand this kind of trajectory formula for any kind of movement (elliptical, parabolic, hyperbolic, orbiting movement, scattering movement, etc.), with any inclination/eccentricity/precession. There is a possibility that our universe is a positive curved 3D space, with the circumference of ~ 9E+9 light-years.

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Note: A series of my papers that to be published (together with current paper):
SunQM-4s4: More explanations on non-Born probability (NBP)'s positive precession in {N,n}QM.
SunQM-6s2: Using Bohr atom, {N,n} QM field theory, and non-Born probability to describe a photon's emission and propagation (part 2).
SunQM-6s3: Schrodinger equation and {N,n} QM ... (drafted in January 2020).
SunQM-7s1: Relativity and {N,n} QM
SunQM-9s1: Addendums, Updates and Q/A for SunQM series papers.

Note; Major QM books, data sources, software I used for SunQM series study:
Douglas C. Giancoli, Physics for Scientists & Engineers with Modern Physics, 4th ed. 2009.
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(Free) online math calculation software: WolframAlpha (https://www.wolframalpha.com/)
(Free) online spherical 3D plot software: MathStudio (http://mathstud.io/)
(Free) offline math calculation software: R
Microsoft Excel, Power Point, Word.
Public TV's space science related programs: PBS-NOVA, BBC-documentary, National Geographic-documentary, etc.
Journal: Scientific American.

Note: I am still looking for endorsers to post all my SunQM papers (including the future papers) to arXiv.org. Thank you in advance!

Appendix A. {10,n//6} QM structure may (or may not) have the non-linear "5 of {-15,2//6} particles" effect

(Note: since I am not a cosmologist, all study in Appendix A belongs to a "citizen scientist leveled" work). In Appendix A, we showed another possible assignment for Table 1's row of N = 10 (shown in Table 6). It is possible only when each of four other superclusters (Shapley, Hercules, Coma and Perseus-Pisces) has the same mass as that of Laniakea Supercluster (or Laniakea SC).

According to wiki "Laniakea Supercluster", "*Laniakea Supercluster consists of four subparts, ... 1) Virgo Supercluster ... 2) Hydra-Centaurus Supercluster ... 3) Pavo-Indus Supercluster; 4) Southern Supercluster ...*". (Note: we name these four superclusters as the **low-level supercluster**). Let's assume that these four low-level superclusters have roughly similar size (and mass) as that of Virgo SC {10,1}. Thus, we can simplify it as four of Virgo SC sized (or {10,1} sized, or low-level supercluster) QM structures form one {10,2} sized QM structure (or named as a **high-level supercluster**), i.e., Laniakea Supercluster. To simplify the analysis, we further assumed that all the five high-level Superclusters (Laniakea SC, Coma SC, Perseus SC, Hercules SC, and Shapley SC, Note: here we use "Perseus SC" to represent "Perseus-Pisces Supercluster" in the lined-up name of the multiple superclusters) have the roughly similar size (and mass). That means, (under this assumption), each high-level supercluster contains four of Virgo SC sized (or {10,1} sized) QM structures, thus each high-level supercluster itself forms a {10,2} sized QM structure (like Laniakea does). Thus, five of these high-level superclusters contain total 20 of Virgo SC sized (or {10,1} sized) QM structures.

To build up the {10,n=1..6//6} sized QM structure for these 20 of {10,1//6} sized QM structures, we can directly copy the rule in the nuclear {-15,n=1..6//6} QM structure, where a single nucleon at size of {-15,1//6} works as the "fundamental particle" or the "ground state" QM structure, then a nucleus with a single nucleon has {-15,1//6} QM size, a nucleus with 4 nucleons has {-15,2//6} QM (effective) size, a nucleus with 8 nucleons has {-15,3//6} QM (effective) size, a nucleus with 12 nucleons has {-15,4//6} QM (effective) size, a nucleus with 16 nucleons has {-15,5//6} QM (effective) size, and a nucleus with 20 nucleons has {-15,6//6} QM (effective) size (see SunQM-5's Table 2). In other words, the 20 nucleons can be sub-grouped as 5 of equal-sized sub-groups, each sub-group contains 4 nucleons, and each sub-group forms a {-15,2//6} sized (1st-excited state) QM structure. Then, increase the (effective) size of QM structure of {-15,n//6} from n=2 to n=3, 4, 5, 6 is simply by adding four more {-15,2//6} sized (1^{st}-excited state) QM structures one-by-one. (Note: in section I-d, this is named as the "**5 of {-15,2//6} particles**" effect. Note: here {-15,n=2..6//6} are the effective-size of QM structures, the true sizes are much smaller. See more explanation later).

Thus, using the same rule, with the Virgo-SC as the "fundamental particle" or the "ground state" QM structure in size of {10,1//6}, Laniakea Supercluster containing 4 equivalent Virgo-SC is assigned to be at {10,2//6} QM size, the combined Laniakea-Coma Superclusters (Note: according to wiki "Coma Supercluster", "*The Coma Supercluster is the nearest massive cluster of galaxies to our own Virgo Supercluster*") containing 8 equivalent Virgo-SC is assigned to be at {10,3//6} QM (effective) size, the combined Laniakea-Coma-Perseus Superclusters containing 12 equivalent Virgo-SC is assigned to be at {10,4//6} QM (effective) size, the combined Laniakea-Coma-Perseus-Hercules Superclusters containing 16 equivalent Virgo-SC is assigned to be at {10,5//6} QM (effective) size, and the combined Laniakea-Coma-Perseus-Hercules-Shapley Superclusters (named as **LCPHS-SC**) containing 20 equivalent Virgo-SC is assigned to be at {10,6//6} QM (effective) size (see Table 6).

Table 6. An alternative assignment for the cosmic {10,n=1..6//6}.

			n= "n state" or "n shell" or "n orbit space"											
	{N,n//6}		1	2	3	4	5	6	7	8	9	10	11	12
N=		-24												
		10	Laniakea supercluster r=2.6E+8ly	Laniakea-Coma Superclusters	Laniakea-Coma-Perseus Superclusters	Laniakea-Coma-Perseus-Hercules Superclusters	Laniakea-Coma-Perseus-Hercules-Shapley Superclusters							

However, according to Table 1 and Table 2, LCPHS-SC has a (true) size of {10,3//6} with r ~ 150 Mpc, and it is too small for a {10,6//6} sized QM structure which should have size of r ~ 600 Mpc (i.e., ~ 36× of size {10,1//6} with r ≈ 33/2×36 = 16.5×36 Mpc). So, some corrections to the above size assignment need to be made. There are many possible corrections, below we only mention two.

The first possible correction is: assuming that {10,3} is the correct size for the LCPHS-SC, then the total size (and mass) of the combined Laniakea-Coma-Perseus-Hercules-Shapley Superclusters should contain only 8 (rather than 20) equivalent Virgo-SC. If so, then Laniakea SC has the size of {10,2//6}, and the combined Laniakea-Coma-Perseus-Hercules-Shapley Superclusters have the size of {10,3//6}, as shown in Table 1. We need more accurate data of size/mass for these 5 high-level supercluters to verify if this is correct or not.

The second possible correction is: assuming the LCPHS-SC does contain 20 equivalent Virgo-SC, and it does have {10,6//6} QM (effective) size. A standard ratio of {10,6//6} size vs. {10,1//6} size, or $r_{n=6} / r_{n=1}$ = 6^2 / 1^1 = 36. A standard ratio of {10,6//6} size vs. {10,2//6} size, or $r_{n=6} / r_{n=2}$ = 6^2 / 2^2 = 36/4 = 9. Notice that in SunQM-5's Table 2 column 8, the r-ratio of Ne element nucleus (i.e., the effective size of {-15,6//6}) to that of Helium element nucleus (i.e., the size of {-15,2//6}) is 3.39E-15 meters / 1.92E-15 meters ≈ 1.77, much less than 9. (Note: here we do not compare to the size of Hydrogen nucleus (i.e., the size of {-15,1//6}) because it does not follow the formula of r_{nuc} = 1.25E-15 * (M#)^(1/3)). Therefore, the true size of Ne element nucleus is only 1.77× (in radius) of the true size of He element nucleus, it is equivalent to say that the effective size of {-15,6//6} is much smaller than 36× (in radius) of the size of {-15,1//6}. To make Ne element nucleus's size to be the effective size of {-15,6//6} QM, we need to use the interior {N,n//q} QM with a shrunken $r_{e1} \rightarrow r_{e1}$ / Z. This means, the "standard out-space" of r_{1e} (i.e., the size of the electron ground state shell) that we used to compare to (in the interior {N,n} QM) is not constant, it is shrinking as the Z increasing! Now back to the LCPHS-SC. It has the true size of {10,3}, or 9× (in radius) of the size of {10,1//6}, significantly smaller than the assigned {10,6//6} which should have 36× (in radius) of {10,1//6} size. So, if we want to force LCPHS-SC to be {10,6//6}, then this {10,6//6} must be an effective size. Next, we can switch the {10,n=1..6//6} QM structure to the interior {N,n} QM structural analysis and use the entire universe as the "standard out-space" of r_1 (where r_1 is the size of universe). Then, because of the effective size of {10,6//6} is much smaller than the true size of {10,6//6}, we need a shrunken $r_1 \rightarrow r_1$ / X, which means the size our universe is not a constant, it is shrinking as we include larger and larger cosmic space (or more and more cosmic mass) into the interior {N,n} QM system, (even though the whole universe still follows the {N,n//6} QM). Therefore, in section IV-a, we said that "there may be a non-linear relationship at the whole universe scale, while the {12,1//6} or {13,1//6} is the effective-size of our universe's QM structure, the true size of our universe may be only {11,2//6}".

The true correction may be the combination of these two corrections. So far, we can't find the data of mass for the four high-level supersclusters (Coma SV, Perseus SV, Hercules SV, and Shapley SV) in wiki. After obtaining more accurate data of cosmic space/mass (maybe in another ~50 more years?), the question may can be answered.

Notice that we don't have to choose Laniakea SC to be the center of the {10,n=1..6//6} QM structure. We can choose Perseus-Pisces Supercluster first, and let it to combine with Laniakea Supercluster to form {10,3} sized QM structure, then combine with Coma SC, Hercules SC and Shapley SC to form {10,4}, {10,5} and {10,6} QM sized structures. Or, instead of join with Laniakea SC, we may even can choose Shapley SC to combine with superclusters on the other side (away from Laniakea SC, i.e., out of Figure 1) to form a {10,n=1..6//6} QM structure, nothing to do with Laniakea SC.

Because multiple nucleons formed {-15,n} sized QM structures is mainly caused by the S-force's residue force (plus E-force), so multiple {10,1} structures formed {10,n} sized QM structures is expected to be caused by the G-force's residue force. Also, the residue force of G/RFg force may be the true force that forms the cosmos-web, just like a C60 Buckyball's web structure is made by the E/RFe force's residue force.

The {10,n=1..6//6} QM structural analysis showed that a {10,1//6} QM structure may work as the "ground state structure" to produce {10,n=2..6//6} different sized QM (excited) structures. We believe that at even higher N level (e.g., N = 11, equivalent to r ~ 600 Mpc to r ~ 24000 Mpc, see Table 2), it may still use the {N,1//6} QM structure as the "ground state structure", to produce {N,n=2..6//6} different sized QM (excited) structures. Wiki "Cosmological principle" mentioned that, "*the spatial distribution of matter in the universe is homogeneous and isotropic when viewed on a large enough scale, since the forces are expected to act uniformly throughout the universe, and should, therefore, produce no observable irregularities in the large-scale structuring over the course of evolution of the matter field that was initially laid down by the Big Bang*". However, if using {N,1//6} as the unit to measure the different sized {N,n=2..6//6} QM structures, we believe that the cosmic {N,n//6} QM structure will disobey the Cosmological principle (because the matter distribution in the universe is piled up by many {N,1//6} sized mass blockers). However, if using {N+2,1//6} as the unit (i.e., using a ~1000× larger size as a unit) to measure the different sized {N,n=2..6//6} QM structures, then the cosmic {N,n//6} QM structure should closely follow the Cosmological principle (because those detailed structures are averaged-out in a too large unit).

Appendix B. The correction of the "ball-torus-7-11-gap effect", the formation and the initial size of the original Mars, and the evolution of Kuiper Belt

Why we need to change "ball-torus-7-11-gap effect" into "ball-torus-6-11-gap effect"? Because at the beginning I thought that the mass (during the formation) of Mars came from the (independent) n = 6 shell (i.e., the {1,6//6}o orbital shell), so that the "ball-torus-gap effect" should be countered only from 7 to 11 orbital shells (see SunQM-1s1). However, now we realized (see SunQM-3s10's section VIII, discussion 3) that the mass of Mars was NOT come from the {1,6//6}o orbital shell, it came from the residue |6,5,m> QM states that was embedded at the outer edge of the |5,0,0> orbital spherical shell of a {2,1//6} sized pre-Sun ball (see a similar situation in SunQM-3s3's Figure 4, where Jupiter's current atmosphere cloud bands are the residue |5,4,m> QM state embedded at the outer edge of |4,0,0> QM state spherical shell of the Jupiter). After this {2,1//6} sized pre-Sun ball (containing {1,n=1..5//6}o orbital shells) collapsed to a {1,1//6} sized pre-Sun ball, the mass in the {1,1//6}o orbital shell fell into the {1,1} pre-Sun ball (according to the "ball-torus-6-11-gap effect"), the residue mass in {1,n=2..5//6}o orbital shells formed {1,2} planet (now burned out), {1,3} planet (now Mercury), {1,4} planet (now Venus), and {1,5} planet (now Earth), respectively. The tiny mass in the residue |6,5,m> QM state at the out edge of {1,5//6}o orbital shell formed Mars, and stayed at {1,6//6}o orbit. Therefore, the "ball-torus-gap effect" should be countered from 6 (instead of 7) to 11 orbital shells.

Because the mass of Mars was formed from the residue |6,5,m> QM states, the mass must be much less than that from the whole {1,6//6}o orbital shell. In comparison, Earth was made from the mass in n=5 shell's *l* = 0..4 all five sub-shells' orbits of |5,*l*=0..4,m=-*l*..+*l*>, so it is much massive than that of Mars. So the mass of Mars no longer follows the equation of D = 4.37E+28 / r^3.279 (kg/m^3) in SunQM-1s1's section VI, and the original Mars had a mass much less than that of the original Earth. Thus, comparing to that the planet Mercury has lost most of its solid mass (i.e., the low Z# element mass, mainly the chemical element period 2 & 3 elements) due to it has been evaporated by the Sun's heat, the planet Mars (like that of Earth and Venus) still retains almost all of its original solid mass (notice that here we only concern the chemical element period 2 & 3 elements that makes the mantle of a planet). Therefore, we need to make one modification for the SunQM-3s6's Table 6: the original Mars had the size of current Earth (with $r_{surface} \approx$ 6.16E+6 meters, not 2.48E+7 meters), with the solid mass the same as that of the current Mars (up to r ≈ 3.44E+6 meters), and with the original atmosphere (of H/He/CH_4/H_2O, etc.) from r ≈ 3.44E+6 meters to $r_{surface}$ ≈ 6.16E+6 meters. However, when the ice-evap-line expanded and passed through {1,n=2..5} planets, the original atmosphere of Mercury, Venus, and Earth, was evaporated one by one, and large amount of evaporated H/He/CH_4/H_2O out-flying mass passed through the orbit of {1,6//6}, and some must have been captured by the original Mars. So, during this short period, the original Mars was much larger than it was initially formed. Then, after the ice-evap line passed {1,6//6}, all Mars' atmosphere (including the newly captured H/He/CH_4/H_2O mass) was evaporated, and Mars became a bared rock planet (as the current one).

For the same reason, the current mass in the Kuiper belt (including the dwarf planet Pluto) did NOT come from the {2,6//6}o orbital shell, it came from the residue |6,5,m> QM states that was embedded at the outer edge of the |5,0,0> orbital spherical shell of a {3,1//6} sized pre-Sun ball. Currently, almost all mass in |6,5,m=-*l*..+*l*> states has been disk-lyzed and moved to |6,5,5> QM state (because in a self-spinning |n,*l*,m> QM system with n = 6, *l* = n-1 = 6 – 1 = 5 and m = +*l* =5 has the lowest QM state energy, see SunQM-3s1), and we now call it Kuiper belt object (KBO, see SunQM-3s11). Meanwhile, small amount of mass has been further disk-lyzed and moved to nLL QM state with n = 6^3 = 216, or in the real current n = 6*6*5.33 ≈ 192, or |192,191,191> QM state, and we now call it the "cold-KBO". Based on the current Mars (that it is the only planet at the orbit of {1,6//6}o) and based on the current Asteroid belt (that its mass is still spread in the whole space of in the orbit shell of {1,8//6}o, or, n = 8*6 = 48, or |48,47,47> QM state), we predicted that in the next 2 ~ 5 billion years, driven by the expansion of methane-evap-line of the Sun, the "cold-KBO" (with the current mass in {2,6//6}o orbit and in |192,191,191> QM state's space) will gradually be excited to {2,7//6}o orbit, and then to {2,8//6}o orbit, while its mass will be further disk-lyzed to n =7*6*5.33 ≈ 224, or, |224,223,223> QM state, and then to n =8*6*5.33 ≈ 256, or, |256,255,255> QM state. Meanwhile, all the rest mass in the region of {2,6//6}o orbit shell (including all the dwarf planets, e.g., Pluto, Haumea, Makemake, etc.) will be accreted into a single planet at {2,6//6} orbit.

Appendix C. The "accompanied" 1st excited state effect vs. the "ball-torus-6-11-gap effect" in {N,1//6}o QM structure

The "accompanied" 1st excited state effect (see section I-f) and the "ball-torus-6-11-gap effect" both act in the {N,1//6}o orbital shell space, and apparently contradict with each other: while the former one stabilized the QM structure in the n=1 orbital shell space, the later one completely destabilize (or empty) the mass in the n=1 orbital shell space. After a detailed analysis, we found they do not contradict with each other. The "accompanied" 1st excited state effect only happens in the situation that n =1 orbit (or even all n = 1 … 5 orbit) shell spaces have ~ 100% mass occupancy. For example, in a Sun, or in a Fe nucleus, or in the Laniakea, both n = 1 orbital shell space and within n = 1 space are ~ 100% mass occupied; or, in another set of examples, in a Fe atom (not Fe nucleus, and only considering the orbital electrons), or in a Milky Way galaxy plus the Halo, the n = 1 orbital shell space is ~ 100% mass occupied (even though within the size n = 1 space may be not). On the other side, the "ball-torus-6-11-gap effect" happens in the situation that all n = 1 … 5 orbital shell spaces have < 1% mass occupancy, only within size n =1 space has ~ 100% mass occupancy (i.e., only in the situation where the pre-Sun ball was collapsing quantumly).

Appendix D. Examples that using {N,n//q} QM to describe a quantum (discontinues) dynamics, while using {N,n//q^j} QM to describe a classical (continues) dynamics

In many cases, the {N,n//q} QM states provided us a series of "snap shot" pictures that revealing how a QM dynamic process is roughly going. This is like reading a (discontinues) comic strip book. Furthermore, the {N,n//q^j} QM allows us to add more intermediate QM states in between the original QM states, so that a quantum dynamic process can be viewed as a classical dynamic process (like watching a (continues) cartoon movie).

Example-1: The solar {N,n//6} QM structure revealed the quantum dynamic formation process of the Solar system: it was formed through a series of quantum collapses from the initial size of around {6,1//6}, down to {5,1//6}, {4,1//6}, {3,1//6}, {2,1//6}, {1,1//6}, then to the current {0,1//6} Sun core, and then to the future {-1,1//6} white dwarf, one by one (see SunQM-1s1). Besides these major (relative stable) QM states, with the {N,n//6^j} QM, we can add a (close to infinity) number of intermediate (or unstable) QM states in between those relative stable {N,1//6} QM states. So now we can accurately describe the formation of the Solar system as a continues collapse (with the infinity number of unstable QM states) besides several major quantum collapse steps from {6,1//6} to {0,1//6}. Now let us make an example for a pre-Sun ball quantum collapse process from size {4,1//6} to size {3,1//6}. After the pre-Sun ball collapsed to {4,1//6}, assuming it stayed in this relative stable QM state (size) for 1E+5 years, then it took (assumed) 1E+5 years to further collapse to {3,1//6}, and then it stayed in this relative stable QM state (size) for (assumed) 1E+5 years. Now, from {4,1//6} = {3,6//6} to {3,1//6} QM state (size), instead of using Δn = 5, we use Δn' = 6^16 - 6^15 = 2.35E+12, or {3,n=6^16..6^15//6^16} to describe. Let us further assume that the speed of collapse between each of Δn' = 2.35E+12 states is constant, so each n' state has a stability of 1E+5(yrs) / 2.35E+12 ≈ 1.34 seconds. Now we can say that when a pre-Sun ball collapsed to {4,1//6} = {3,n=6^16//6^16} size, it stayed there of 1E+5 years. Then it further collapsed (or de-excited) to {3, n(=6^16-1)//6^16} QM state (size), {3,n(=6^16-2)//6^16} QM state (size), … , down to {3, n(=6^15)//6^16} QM state (size) one by one, each QM state (size) with stability of 1.34 seconds, finally to the {3,6^15//6^16} = {3,1//6} QM state (size), and stayed there for another 1E+5 years. With 2.35E+12 intermediate states, and each with a short life of 1.34 second, this (quantum) collapse process becomes a typical classical (continues) process.

Example-2: The solar {N,n//6} QM structure revealed a series of quantum expansion of the hydrogen fusion shell (inside the Sun) from the initial size of around {-7,1//6}, up to the current Sun core at size of {0,1//6}, and then to the future red giant at size of {1,1//6}, then explode to {2,1//6}, {3,1//6}, {4,1//6}, {5,1//6}, etc., one by one (see SunQM-1s1). With the {N,n//6^j} QM, we can add a (close to infinity) number of intermediate (or unstable) QM states in between those relative stable {N,1//6} QM states. So now we can accurately describe the continues H-fusion expansion (with the infinity number of unstable QM states), and with several major quantum expansion steps from {-7,1//6} to {0,1//6}. For example, the rock-evap-line expansion (that is directly caused by the Sun's H-fusion ball expansion) is currently passed {1,2//6}, or is closing to {1,3//6}, and we can assume that its size expansion is at a rate of 1 millimeter/year. Now we can increase the quantum number j in {N,n//6^j} so that the size of rock-evap-line is adjusted to expand at Δn' ≈ 1 per a few years (to correlate to the expansion rate of ~1 millimeter/year), and the stability at the n' QM state is a few years (before transits to the next (n' + 1) QM state).

Example-3: The p{N,n//4} QM structural analysis (in SunQM-3s6) predicted that Earth should have an inner-inner core with r ≈ 400 km. After that, scientists did find a new core with r ≈ 650 km [31] (that within Earth's inner core, although larger than the predicted r ≈ 400 km). It has been reported that Earth's "*inner core … grows in radius by an average of 1 millimeter per year*" (https://news.berkeley.edu/2021/06/03/is-earths-core-lopsided-strange-goings-on-in-our-planets-interior/). Assuming Earth's inner-inner core also grows r ≈ 1 mm/yr, we can (roughly) explain it as that the inner-inner core was formed initially at r ≈ 400 km, then at ~ 250 mya, it started to grow r ≈ 1mm/yr, till today's r ≈ 650 km. We can use p{N,n//4^j} QM and increase the quantum number j so that the growing r ≈ 1 mm/yr can be adjusted to increase Δn' ≈ 1/yr.

Example-4: The quantum (or major) rip off vs. the continues (or minor) rip off of the planet Mercury. As explained in SunQM-3s6's Table 6, when Mercury was initially formed, it had a core (made of the heavy elements with chemical element's electron period ≥ 3, similar as Earth's current iron core) at the size p{-1,1//4}, with r = 1.87E+6 meters; a (Earth-sized) solid shell (made of the medium-heavy elements with chemical element's electron period = 2 ~ 3, similar as Earth's current mantle) at the size p{-1,2//4}, with r = 7.46E+6 meters; and an atmosphere shell (made of the light elements with chemical element's electron period ≈ 1, similar as Neptune's current atmosphere) at the size p{-1,4//4}, with r = 2.98E+7 meters; and with the total mass ~ 51× of the current Earth's mass. So the initial Mercury was like (a larger-sized) Neptune, and it was a (relative) stable QM state. After the ice-evap-line passed orbit {1,3//6}, the whole original atmosphere shell of Mercury was quantumly ripped off, so that Mercury became (Earth-sized, bared) rocky planet, and it was also a (relative) stable QM state. (Notice that this is an over-simplified explanation. The ice-evaporation might happen before Mercury was accreted). Now the rock-evap-line is passing Mercury's orbit {1,3//6}, it caused the whole rock (or mantle) shell of Mercury was quantumly ripping off (although this "quantum" transition takes billions of year), so that Mercury is on the way of evaporating to the next (relative) stable QM state (i.e., a bare iron core planet). These are the major steps of the quantum ripping-off of Mercury described by the p{N,n//4} QM. Now suppose that (the Sun core's H-fusion size expansion caused) rock-evap-line size expansion is 1 meter/year, and it causes the heating up of Mercury surface by 0.001 °C per year (assumed), and it evaporates the Mercury by decreasing its radius at a rate of 1 millimeter/year (also assumed). By using p{N,n//4^j} and increasing the quantum number j, we can match the decrease Δn' ≈ 1 per year to correlate to the radius decreasing of Mercury (at ~1 millimeter/year). Then, the stability at the (high frequency) n' QM state is about one year (before transits to the next (n' - 1) QM state).

Example-5: In the physics dealing with the micro-world, a photon's quantum propagation can be described by using {N,n//q} QM with nLL QM state and with the quantum number n from low to high (see SunQM-6s1). To describe a continues propagation of a photon, we can use {N,n//q^j} QM and increase the quantum number j so that the propagation can be adjusted to increase Δn' ≈ 1 per nanometers (for example). Then, the stability (or the life-time) at the n' QM state equals to (distance) / (light speed) = (1E-9 meters) / (3E+8 m/s) = 3.33E-18 second (before transits to the next (n' + 1) QM state).

Appendix E. The latest correction (8/8/2021) to SunQM-3s11's Table 1 column 11.

SunQM-3s11's Table 1 (the corrected version). Born probability calculation of a planet's Eigen n' (in both r- and θ-dimension), orbital angular velocity ω (group-ω and phase-ω), φ position (day-0 and day-60).

NASA's data of planets						assigned N, n, period factor			set total n=1 at Sun core calc model n, rn, vn			Determine planet r-dimensional n' & w							Determine planet θ-dimensional n' & w Note: w(ϕ) = w(θ), and n'ϕ = n'θ					{N,n} calculated ω			initial ϕ= day-0	day-0	day-60	day-60
	mass	Sun's body-r or planets' orbit-rn	vn	orbit period	planet's body-r, b=	N	n	period factor	total n from Sun core	rn= r1*n^2	vn = sqrt(GM/rn)	n' = ln(0.1) / [ln(1 + b /rn) - (b /rn)]	w= log(n' / n) / log(6)	round up w	n'r = n*q^w	±b = at n'=n*q^w & Porb =0.01	r1 = rn' / (n*q^w)^2	r1 at {N,1//6}	w(θ) =	n'θ = n*q^w	0.01^(1/(2n'))	θ'= acos[0.01^(1/(2n'))]	b= r*sin(θ')	phase ωn,ph = vn / rn/2	group ω = ωn = vn / rn	period T= 2π/(2ω)/(3600*24)	day-0, 8/14 /2019	day-0	60	60
unit	kg	m	m/s	days	m					m	m/s					m	m					arc	m	arc/s	arc/s	day	degree	arc	degree	Δdegree
Sun core		1.74E+08				0	1	6	1	1.74E+08																				
SUN	1.989E+30	6.96E+08				0	2	6	2	6.96E+08																				
{0,3} corona						0	3	6	3	1.57E+09																				
{0,4} corona						0	4	6	4	2.78E+09																				
{0,5} corona						0	5	6	5	4.35E+09																				
{0,6} corona end						0	6	6	6	6.26E+09																				
{1,2}						1	2	6	12	2.50E+10																				
Mercury	3.3E+23	5.79E+10	47400	88	2.44E+06	1	3	6	18	5.64E+10	48533	2.46E+09	11.45	11	1.09E+09	3.67E+06	4.76E-08	{-10,1//6}	11	1.09E+09	0.999999997884414	6.50E-05	3.67E+06	4.31E-07	8.61E-07	84	62	1.08	318	256
Venus	4.87E+24	1.08E+11	35000	224.7	6.05E+06	1	4	6	24	1.00E+11	36400	1.26E+09	10.92	11	1.45E+09	5.64E+06	4.76E-08	{-10,1//6}	11	1.45E+09	0.999999998413311	5.63E-05	5.64E+06	1.82E-07	3.63E-07	200	180	3.14	288	108
Earth	5.97E+24	1.49E+11	29800	365.2	6.38E+06	1	5	6	30	1.57E+11	29120	2.77E+09	11.24	11	1.81E+09	7.89E+06	4.76E-08	{-10,1//6}	11	1.81E+09	0.999999998730648	5.04E-05	7.89E+06	9.30E-08	1.86E-07	391	0	0.00	55	55
Mars	6.42E+23	2.28E+11	24100	687	3.40E+06	1	6	6	36	2.25E+11	24266	2.03E+10	12.25	12	1.31E+10	4.23E+06	1.32E-09	{-11,1//6}	12	1.31E+10	0.999999999823701	1.88E-05	4.23E+06	5.38E-08	1.08E-07	676	191	3.33	223	32
Asteroid belt	2.92E+21	4.02E+11				1	8	6	48	4.01E+11	18200													2.27E-08	4.54E-08	1601				
Jupiter	1.90E+27	7.78E+11	13100	4331	7.15E+07	2	2	5.33	64.0	7.12E+11	13658	4.56E+08	10.67	11	7.26E+08	5.67E+07	1.35E-06	{-9,1//6}	11	7.26E+08	0.999999996826621	7.97E-05	5.67E+07	9.60E-09	1.92E-08	3788	304	5.31	310	6
Saturn	5.68E+26	1.43E+12	9700	10747	6.03E+07	2	3	5.33	95.9	1.60E+12	9106	3.25E+09	11.54	12	6.53E+09	4.25E+07	3.75E-08	{-10,1//6}	12	6.53E+09	0.999999999647402	2.66E-05	4.25E+07	2.84E-09	5.69E-09	1.28E+04	329	5.74	331	2
Uranus	8.68E+25	2.97E+12	6800	30589	2.56E+07	2	4	5.33	127.9	2.85E+12	6829	5.71E+10	12.98	13	5.22E+10	2.67E+07	1.04E-09	{-11,1//6}	13	5.22E+10	0.999999999955925	9.39E-06	2.67E+07	1.20E-09	2.40E-09	3.03E+04	73	1.27	74	1
Neptune	1.02E+26	4.51E+12	5400	59800	2.48E+07	2	5	5.33	159.9	4.45E+12	5463	1.48E+11	13.39	13	6.53E+10	3.73E+07	1.04E-09	{-11,1//6}	13	6.53E+10	0.999999999964740	8.40E-06	3.73E+07	6.14E-10	1.23E-09	5.92E+04	30	0.52	30	0
Kuiper belt	1.46E+22	5.91E+12				2	6	5.33	191.9	6.40E+12	4553													3.55E-10	7.11E-10	1.02E+05				
{3,2}	7.12E+25				2.18E+07	3	2	6	383.8	2.56E+13	2276	6.35E+12	16.00	16	5.64E+12	2.31E+07	8.05E-13	{-13,1//6}	16	5.64E+12	0.999999999999592	9.03E-07	2.31E+07	4.44E-11	8.89E-11	8.18E+05				
{3,3}	3.99E+25				1.80E+07	3	3	6	575.6	5.76E+13	1518	4.73E+13	16.89	17	5.08E+13	1.74E+07	2.24E-14	{-14,1//6}	17	5.08E+13	0.999999999999955	3.01E-07	1.73E+07	1.32E-11	2.63E-11	2.76E+06				
{3,4}	2.75E+25				1.59E+07	3	4	6	767.5	1.02E+14	1138	1.92E+14	17.51	18	4.06E+14	1.09E+07	6.21E-16	{-15,1//6}	18	4.06E+14	0.999999999999994	1.06E-07	1.09E+07	5.55E-12	1.11E-11	6.55E+06				
{3,5}	1.98E+25				1.42E+07	3	5	6	959.4	1.60E+14	911	5.67E+14	18.00	18	5.08E+14	1.53E+07	6.21E-16	{-15,1//6}	18	5.08E+14	0.999999999999995	9.54E-08	1.53E+07	2.84E-12	5.69E-12	1.28E+07				

Note: In the old version, column-17 of Table 1 in SunQM-3s11 was calculated wrong. After correction, the new b(r) in column-17 now equals to b(θ) in column-24.

Appendix F. The latest correction (8/8/2021) to SunQM-4's eq-56a, eq-55, eq-57, eq-60, eq-61, eq-65 through eq-79.

All these equations should use (or based on) SunQM-4's eq-56b:

$$r^2\left|\Psi(r,\theta,\varphi,t)_{planet}\right|^2_{NBP} = r^2|R(r)|^2_{NBP}|\Theta(\theta)|^2_{NBP}|\Phi(\varphi)|^2_{NBP}|T(t)|^2_{NBP} \propto \left[\frac{r}{r_n}e^{\left(1-\frac{r}{r_n}\right)}\right]^n \left\{\left[\frac{1+\sin\theta}{2}\right]\left[\frac{1+\cos(\varphi-\frac{n}{n-1}\omega_n t)}{2}\right]\right\}^{2(n-1)}$$

eq-56b (in SunQM-4)

The SunQM-4's Appendix B will produce the same NBP (non-Born probability) as that of SunQM-4's Table 2. Thus, SunQM-4's eq-56b produces the same NBP peak width as that of eq-56c in SunQM-4. This further confirmed that the SunQM-4's eq-56c is the best form and the most correct form of NBP. Then, among four versions (version-a, -b, -c -d, as shown in SunQM-4's Appendix A, B, C, D) of NBP formula, version-c is the most favorite, version-b is the second favorite.

Appendix G. Two levels of "global fitting", first at "single brain" level, and second at "collective brain" level, will greatly increase the chance to jump out of the "local energy minimum" trap

When I first time learned quantum mechanics (i.e., the Bohr-QM and Schrodinger-QM) about 40 years ago (in 1982, in Fudan University, major in theoretical physics), the most impressive concept to me was the "eigenvalue-eigenvector" description: a physical variable (e.g., a particle's position, or momentum) can be described in any arbitrary complete vector space (like a Hilbert space?) with a set of very complicated coefficient matrix, but once it is described in its eigenvector space, it gets the simplest description with a simple diagonal coefficient matrix (made of a set of eigenvalues). Now let us use this concept to describe {N,n} QM. In {N,n} QM, we classified the fundamental forces as three pairs: G/RFg, E/RFe, and S/RFs forces. If using these three pairs of forces as the vector space, we believe that the {N,n//q} QM can get the simplest description with a simple diagonal coefficient matrix (equivalent as made of a set of eigenvalues), so that these three pairs of forces are the "Eigenvectors" of {N,n//q} QM, and {N,n//q} QM can be "Eigen described" under the G/RFg, E/RFe, and S/RFs forces formed "Eigenvector" space. Because our universe can be described by {N,n//q} QM as a whole, we may can say that the G/RFg, E/RFe, and S/RFs forces formed vector space is the "Eigenvector" space for describing our universe. However, we know that in the range of {N=-10..0,n//6}, once it is dominated by the residue force of E-force, the fine structure of our universe does not follow {N,n//6} QM (or even not a {N,n//q} QM) anymore. Thus, if we add the residues forces to the three pairs of forces (so now there are 9 individual forces, instead of 6 individual forces) to form a new vector space, then, our universe cannot be "Eigen described" by this 9 forces formed new vector space {N,n//6} QM (because {N=-10..0,n//6} range does not follow {N,n//q} QM), even though a sub-space of this 9-forces vector space (i.e., the G/RFg, E/RFe, and S/RFs forces formed 6-vector space) is the "Eigenvector" space for describing our universe.

By comparing other QM theories to {N,n//q} QM, we may describe the quantum chromodynamics (QCD) as that it may be the "Eigen description" in the E/M-force, W-force, and S-force formed vector space; the quantum electrodynamics (QED) may be the "Eigen description" in the E/M-force and W-force formed vector space; and the string theory may be the "Eigen description" in the E/M-force, W-force, S-force and G-force formed vector space.

In my early study (during 1978 ~ 1989, at Fudan University, as an undergraduate student, then a graduate student, then an assistant teacher, then a lecturer), I obtained basic (global) training in the theoretical physics, biophysics, and physical chemistry. In my Ph.D. research (during 1989 ~ 1994, biophysics, at UCI), while modeling the photobiological kinetics, I learned the concept of "global fitting". In my post-doctor research (on protein engineering, during 1994 ~ 1997, at TSRI), while determining and optimizing the x-ray structure of the mutant proteins, I learned the concept of "global energy minimization". In my drug discovery study (during 1997 ~2005), while (occasionally) doing the molecular modeling for enzyme-inhibitor binding, I learned the concept that we need to jump out of the "local minimum of the binding energy trap" to optimize the binding configuration. Now let's borrow these (similar) concepts to describe our SunQM series study.

The whole purpose of SunQM series study is to test the newly discovered {N,n} QM theory through (a quick and rough) "global fitting" or "global energy minimization" (spanning from Solar system up to universe and down to sub-quark). Notice that this "global fitting" is done in a single scientist's brain (named here as "**single brain**"). For each subject (e.g., a new {N,n} QM theory), we need more than ten excellent scientists to independently develop each own version of self-consistent and complete theory (by doing the close-door thinking for ~ 10 years, completely isolated from each other and from the group). Each individual's theory should be as complete as possible (may even sacrifice self-consistency a little bit at this early stage). Between each individual, keep thinking divergent as much as possible, avoid convergent thinking as much as possible. There is a significant advantage to do that: now we may have two-levels of "global fitting" or "global energy minimization". The first level is at each individual scientist's single brain thinking (at this level, we have many "global fittings", each from one "single brain"), the second level is at a scientific community's "**collective brain**" thinking. (Notice that only when the first level's individual results are diversified enough or independent enough, then the second level's "collective brain" thinking is meaningful). On the other hand, if each individual scientist doesn't do the close-door independent thinking, instead, they talk to each other all the time at the beginning, then each scientist's thinking will not be diversified, and we practically ruin the first level "global fitting", only have the second level of "global fitting", or, we degenerate a two-level "global fitting" into a one-level "global fitting". Then, in case trapped in a "local energy minimum", we will have much less probability to jump out of the "local energy minimum" to get the "global energy minimum".

This two-leveled "global fitting" explanation can also be explained by using Richard Feynman's philosophical thought of path integral formulation. The first-level "global fitting" from many diversified individual brains equivalents to the all (or many, if not all) possible paths from point A to point B simultaneously (and here we name it as the "**Feynman Pool**"); the second-level "global fitting" from the scientific community's collective brain equivalents to apply the principle of the least action on the "Feynman Pool". Again, without many scientists doing (the close-door) diversified thinking, the "Feynman pool" of "many possible paths" is small and not diversified enough, then the least action become a "local" rather than "global".

My individual thinking of {N,n} QM comes from the intuition that based on the general physics, (and thanks Shoucheng Zhang who used "First principle thinking" to describe it [32]). It is like a series of weak signals, and the first-level "global fitting" is based on these weak signals. Only the close-door thinking will keep these weak signals alive and keep the "global fitting" going. The "open-door" discussion will soon destroy most of these weak signals, and the individual thinking will soon slip into the group thinking.

Just like when a software doing "global fitting", the first fit is always has low accuracy (i.e., it is a strongly biased fitting), and it always needs many iterations to get the good fit (i.e., a less biased fitting or even non-biased fitting), now I am doing the first round of single brain's "global fitting" for {N,n} QM theory, started from 2015, hopefully can be finished in 2023. I hope that the {N,n//q} QM theory can get into the "Feynman pool" (meaning that the SunQM series papers will get published by either the high-quality physical journals or the arXiv.org). If not, I may have to do a second round of "global fitting" at the single brain level to refine and polish the {N,n} QM theory (if I still have the energy to do it).

Although in most time the professional scientists made the main contribution to the science, occasionally, a good independent scientist (or citizen scientist, like Albert Einstein was a typical citizen scientist in 1905 when he proposed the special relativity) may provide an independent and divergent thinking. Large amount of good citizen scientists can broaden the foundation of the "collective brain" (even though the chance is extremely low for a citizen scientist to make a significant contribution to the "Feynman Pool"). Two major factors determined that we will see an increasing number of citizen scientists to make good contribution to the "Feynman pool": 1) more and more (close to retire or retired) highly STEM-educated and STEM-hands-on-experienced professionals are available, and many of them have interest to contribute to the theoretical science (using their cross-field knowledge, with their own "First principle thinking", and without the pressure of obligation or time limitation); 2) the internet have made the world become flat in terms of the knowledge distribution, and the personal computer and software have made the (simple level) modeling become a toy that everyone can play. However, we still need to establish the publication system and evaluation system for citizen scientists so that those truly breakthrough results can stand out (rather than be submerged).

Here I suggest those talented physicists to develop your own "big theory" of physics (or pick one of your favorite physics theory), and do the single brain's "global fitting" by applying it from sub-quark to universe, and modify it as needed. The trick to increase the possibility of success is that to simplify the model (and ignore the details) as much as possible, only pick those successful fitting stories, ignore those failed fittings (in the early stage), sacrifice the "self-consistency" of the theory if needed (in the early stage), emphasize the "completeness" of the theory to cover from sub-quark to universe, do ten-years close-door thinking to keep your thinking diversified from the group thinking (like that Einstein did from 1905 to 1915). If you have a good luck, you may obtain a meaningful result (meaning diversified enough and roughly good enough) at the single brain's "global fitting" level to contribute to the "Feynman Pool". Then, after large amount of these talented physicists to provide a few (or a few tens) truly diversified candidate theories to the "Feynman Pool", the 2^{nd}-level "global fitting" at the collective brain level will become more global. (Note: the problem of the (early stage) bias may can be solved later by either the 2^{nd}-level "global fitting" at the collective brain level, or by the 2^{nd}-round "global fitting" at the single brain level (if your big theory is not interested by others)).