SunQM-3s8: Using {N,n} QM to study Sun's internal structure, convective zone formation, planetary differentiation and temperature r-distribution

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Abstract

From previous papers [1] ~ [9], using Bohr's formula $r_n = r_1 * n^2$, we found that Sun's internal structure is correlated to {N,n} QM. In current paper, we find that Sun's internal structure and mass density is formed according to the QM probability density curve's peaks. This result confirms that the formation of Sun and all planets are based on Schrodinger equation and solution! According to Sun QM's probability density r-distribution, Sun's internal structure has been predicted as one Earth-sized core plus 5 shells, each with mass density about 160000, 75000, 45000, 25000, 12000, and 6000→ 0 kg/m^3 from center to edge of the Sun. In Sun's {0,1}o orbit shell, the radiative zone belongs to the {-1,n=6..9}o orbit shells, and the convective zone belongs to {-1,n=10..11}o orbit shells. The onset of convection in {-1,11}o and {-1,10}o orbit shells might have caused the onset of two "snowball Earth" periods in the Earth history. The further analysis of Solar {N,n} QM structure shows that the melting (or convection) of the {-1,n=1..5}o super shell causes elements repositioned as Au, Pb mainly inside {-1,1} Earth-sized core, Fe mainly in {-1,1}o orbit shell, O, C, Ne, mainly in the {-1,2}o orbit shell, He mainly in {-1,n=3..4}o orbit shells, and H mainly in the {-1,5}o orbit shell. As the result, inside the Sun's inner core, the H-fusion is not happening everywhere, but only in {-1,5}o orbit shell. The apparent temperature at Sun surface (=5800 K) is due to that ions shooting out of the Sun surface (at v_{rms} =4.37E+5 m/s) are all in +r dimension and lost the micro randomness, so that this v_{rms} no longer associated with the temperature.

Introduction

In previous paper SunQM-3s6 [10], from studying Earth's known internal structure and mass density distribution, I developed a method which can be used to estimate any planet's internal structure and mass density. This method can be expressed as: Planet mass = 4π ∫ (planet's QM probability density r-distribution) * W *D * r^2 dr, where mass density D = a*r +b, and W is a scaling factor. I applied this method to all rocky planets (in paper SunQM-3s6) and all gas/ice planets (in paper SunQM-3s7, with some modification of method) to predict the internal structure and (close to the true) mass density r-distribution for these planets. In current paper, I will apply the same method to Sun. Note: for {N,n} QM nomenclature as well as the notes for {N,n} QM model, please see my paper 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}.

I. Predict Sun's internal structure and the mass density radial distribution using {N,n} QM probability function

According to the method established in paper SunQM-3s6, first we need to constitute the linear equation of mass density D = a * r + b for Sun. After manual fitting, it is D = -8.16E-6 *r + 5680. It satisfy both conditions 1) ∫ D dV = mass of Sun; 2) at surface r = 6.96E+8 m, D ≈ 0 kg/m^3.

$$\int_0^{6.96\times10^8} 4\pi\left(-8.16\times10^{-6}x+5680\right)x^2\,dx =$$
$$2\,006\,094\,796\,736\,343\,764\,215\,124\,721\,664$$

From previous analysis [1] ~ [9], we know that Sun has a {N,n//6} QM structure. The radial probability for Sun core {-1,n=1..5}o is described by the function r^2 *(|R(1,0)|^2 + |R(2,*l*)|^2 + |R(3,*l*)|^2 + |R(4,*l*)|^2 + |R(5,*l*)|^2), Note: the small contribution from r^2 *|R(6,*l*)|^2 in {-1,5}o orbit shell is ignored here. The radial probability for Sun's {0,1}o orbit shell is described by the function r^2 *(|R(1,0)|^2 + |R(2,*l*)|^2). So if we want to use a simple integration formula of QM probability for Sun's mass radial distribution, it will be something like:

$$\text{Mass}\ (r, \theta, \varphi) = \iiint r\text{^}2 * [(|R(1,0)|\text{^}2 + |R(2,l)|\text{^}2 + |R(3,l)|\text{^}2 + |R(4,l)|\text{^}2 + |R(5,l)|\text{^}2)_{\{-1,n=1..5\}o} + (\cancel{|R(1,0)|\text{^}2} + |R(2,l)|\text{^}2\ )_{\{0,n=1\}o}\ ] * W * D * \sin(\theta) * r\text{^}2\ dr\ d\theta\ d\varphi,\ [r=0,\ 6.96E+8\ m;\ \theta=0,\ \pi;\ \varphi=0,\ 2\pi]$$

or

$$1.99E+30\ \text{kg} = 4\pi \int r\text{^}2 * [(|R(1,0)|\text{^}2 + |R(2,l)|\text{^}2 + |R(3,l)|\text{^}2 + |R(4,l)|\text{^}2 + |R(5,l)|\text{^}2)_{\{-1,n=1..5\}o} + (\cancel{|R(1,0)|\text{^}2} + |R(2,l)|\text{^}2\ )_{\{0,n=1\}o}\ ] * W * D * r\text{^}2\ dr,\ [r=0,\ 6.96E+8\ m;\ \theta=0,\ \pi;\ \varphi=0,\ 2\pi].$$

where $[(|R(1,0)|\text{^}2 + |R(2,l)|\text{^}2 + |R(3,l)|\text{^}2 + |R(4,l)|\text{^}2 + |R(5,l)|\text{^}2)_{\{-1,n=1..5\}o}]$ is for {-1,n} Sun core's super-shell, and $(\cancel{|R(1,0)|\text{^}2} + |R(2,l)|\text{^}2\ )_{\{0,n=1\}o}$ is for Sun's {0,1}o super-shell. Notice that the crossed out (~~|R(1,0)|^2~~) item is due to it is overlap with {-1,n=1..5}o, so in the mass integration, it can't be count in again. So for predicting Sun's internal structure and mass density, the general calculation is similar as that for Saturn, with the Sun core calculation is similar as that for Jupiter (see both in paper SunQM-3s7). Because Sun's {0,1}o orbit shell contains ≥ 60% of Sun's total mass, here the whole calculation is that first to scale up Sun's {0,1}o 's probability according to D curve, then scale up Sun core {-1,n=1..5}o 's probability accordingly.

Table 1. Predict Sun's internal structure and mass density r-distribution using p{N,n} QM probability function.

																			A=	5.00E+05					
																			B=	0.2		p{0,1}		p{-1,1}	
Sun r_1=	1.74E+08	meters			p{0,1}	500		1.13E+30	0.5	1.18E+30	p{-1,1}			1.01E+29	0.039	2.22E+29			C=	8485		1.13E+30	0.0833	3.70E+29	curved
r/r_1=	$r^2 * \|R_{1,0}\|^2$	$r^2 * \|R_{2,0}\|^2$	$r^2 * \|R_{2,1}\|^2$	Porb(n=1..2)	r= r/r_1*1.74E+8	p{0,1}, Prob(1..2)*1E+9*500	D= -0.00000816*r +5680	mass= D*ΔV	p{0,1}, D*Prob*1E+9*0.5	mass= (D*Prob*1E+7*0.5)*ΔV	r= r/r_1*1.74E+8 /36	p{-1,1}, Prob(n=1..5)*1E+9	D= -0.00000816*r +5680	mass= D*ΔV	p{-1,1}, Prob(n=1..5)*1E+9*D *0.039	mass= (D*Prob*1E+9*0.039) *ΔV	r= p{-1,1} & p{0,1}	predicted D		D=A/r^B-C	(A/r^B-C)*Prob*1E+9	mass= ((A/r^B-C)*Prob*1E+9)*ΔV	(A/r^B-C)*Prob(core)*1E+9*0.0833	mass= ((A/r^B-C)*Prob(core)*1E+7*0.0833)*ΔV	predicted D
unit					m		kg/m^3	kg	kg/m^3	kg	m		kg/m^3	kg	kg/m^3	kg	m	kg/m^3			kg/m^3	kg	kg/m^3	kg	kg/m^3
0.02	8.835E-12	1.104E-12	3.76E-17	9.939E-12	3.48E+06	5.0	5652	9.98E+23	28	4.96E+21	9.67E+04	26.281	5679	2.15E+19	5821	2.20E+19	9.67E+04	2.80E+04		16099	160	2.82E+22	9.17E+04	3.47E+20	1.60E+05
0.1	1.882E-10	2.347E-11	2.17E-14	2.117E-10	1.74E+07	105.9	5538	1.21E+26	586	1.28E+25	4.83E+05	26.281	5676	2.68E+21	5818	2.75E+21	4.83E+05	2.80E+04		9333	1976	4.36E+25	6.13E+04	2.88E+22	1.60E+05
0.2	6.164E-10	7.623E-11	3.14E-13	6.929E-10	3.48E+07	346.5	5396	8.34E+26	1870	2.89E+26	9.67E+05	26.281	5672	2.15E+22	5814	2.20E+22	9.67E+05	2.80E+04		7027	4869	8.60E+26	5.10E+04	1.69E+23	1.60E+05
0.4	1.653E-09	1.972E-10	4.11E-12	1.854E-09	6.96E+07	927.0	5112	6.32E+27	4739	5.86E+27	1.93E+06	70.245	5664	1.50E+23	15517	4.11E+23	1.93E+06	2.80E+04		5019	9305	1.15E+28	1.12E+05	2.97E+24	1.60E+05
0.6	2.493E-09	2.782E-10	1.7E-11	2.788E-09	1.04E+08	1393.9	4828	1.62E+28	6730	2.26E+28	2.90E+06	105.463	5656	4.07E+23	23265	1.67E+24	2.90E+06	2.80E+04		3967	11059	3.71E+28	1.50E+05	1.07E+25	1.60E+05
0.8	2.97E-09	2.975E-10	4.41E-11	3.312E-09	1.39E+08	1656.0	4544	2.97E+28	7525	4.92E+28	3.87E+06	125.099	5648	7.91E+23	27558	3.86E+24	3.87E+06	2.80E+04		3271	10832	7.08E+28	1.62E+05	2.27E+25	1.60E+05
1	3.111E-09	2.643E-10	8.81E-11	3.464E-09	1.74E+08	1731.8	4260	4.59E+28	7378	7.94E+28	4.83E+06	130.733	5641	1.30E+24	28759	6.64E+24	4.83E+06	2.80E+04		2757	9550	1.03E+29	1.58E+05	3.66E+25	1.60E+05
2	1.684E-09	0	5.19E-10	2.203E-09	3.48E+08	1101.4	2840	4.39E+29	3128	4.83E+29	9.67E+06	89.243	5601	1.85E+25	19495	6.45E+25	9.67E+06	2.20E+04		1302	2868	4.43E+29	8.59E+04	2.85E+26	7.50E+04
3	5.128E-10	3.219E-10	9.66E-10	1.8E-09	5.22E+08	900.2	1420	5.96E+29	1279	5.36E+29	1.45E+07	87.949	5562	5.00E+25	19077	1.71E+26	1.45E+07	2.20E+04		540	972	4.07E+29	7.33E+04	6.58E+26	7.50E+04
4	1.234E-10	8.421E-10	1.12E-09	2.088E-09	6.96E+08	1044.1	0.64	5.23E+26	0.67	5.46E+26	1.93E+07	105.199	5522	9.66E+25	22656	3.96E+26	1.93E+07	2.20E+04		35	73	6.00E+28	7.86E+04	1.37E+27	7.50E+04
5	2.609E-11	1.089E-09	1.01E-09	2.124E-09	8.70E+08	1061.8					2.42E+07	104.585	5483	1.58E+26	22363	6.45E+26	2.42E+07	2.20E+04					7.15E+04	2.06E+27	7.50E+04
6	5.085E-12	1.026E-09	7.69E-10	1.8E-09	1.04E+09	900.0					2.90E+07	92.529	5443	2.34E+26	19643	8.45E+26	2.90E+07	1.80E+04					5.86E+04	2.52E+27	4.50E+04
7	9.367E-13	8.025E-10	5.24E-10	1.328E-09	1.22E+09	663.9					3.38E+07	83.686	5404	3.25E+26	17637	1.06E+27	3.38E+07	1.80E+04					4.96E+04	2.98E+27	4.50E+04
8	1.656E-13	5.552E-10	3.29E-10	8.845E-10	1.39E+09	442.2					3.87E+07	83.074	5364	4.29E+26	17380	1.39E+27	3.87E+07	1.80E+04					4.64E+04	3.71E+27	4.50E+04
9	2.836E-14	3.519E-10	1.94E-10	5.458E-10	1.57E+09	272.9					4.35E+07	87.331	5325	5.47E+26	18137	1.86E+27	4.35E+07	1.80E+04					4.62E+04	4.74E+27	4.50E+04
10	4.738E-15	2.087E-10	1.09E-10	3.175E-10	1.74E+09	158.7					4.83E+07	91.118	5286	6.77E+26	18783	2.41E+27	4.83E+07	1.80E+04					4.59E+04	5.88E+27	4.50E+04
12	1.25E-16	6.356E-11	3.05E-11	9.407E-11	2.09E+09	47.0					5.80E+07	87.724	5207	1.79E+27	17813	6.13E+27	5.80E+07	1.80E+04					4.04E+04	1.39E+28	4.50E+04
14	3.115E-18	1.686E-11	7.65E-12	2.451E-11	2.44E+09	12.3					6.77E+07	76.742	5128	2.46E+27	15347	7.37E+27	6.77E+07	1.40E+04					3.26E+04	1.57E+28	2.50E+04
16	7.453E-20	4.056E-12	1.77E-12	5.823E-12	2.78E+09	2.9					7.73E+07	71.270	5049	3.23E+27	14034	8.97E+27	7.73E+07	1.40E+04					2.81E+04	1.80E+28	2.50E+04
18	1.728E-21	9.075E-13	3.83E-13	1.29E-12	3.13E+09	0.6					8.70E+07	72.253	4970	4.08E+27	14005	1.15E+28	8.70E+07	1.40E+04					2.67E+04	2.19E+28	2.50E+04
20	3.907E-23	1.919E-13	7.9E-14	2.709E-13	3.48E+09	0.1					9.67E+07	73.309	4891	5.02E+27	13984	1.43E+28	9.67E+07	1.40E+04					2.54E+04	2.61E+28	2.50E+04
22	8.658E-25	3.88E-14	1.56E-14	5.444E-14	3.83E+09	0.0					1.06E+08	70.273	4812	6.03E+27	13189	1.65E+28	1.06E+08	1.40E+04					2.30E+04	2.88E+28	2.50E+04
24	1.887E-26	7.561E-15	3E-15	1.056E-14	4.18E+09	0.0					1.16E+08	63.803	4733	7.11E+27	11778	1.77E+28	1.16E+08	8.00E+03					1.97E+04	2.96E+28	1.20E+04
27	5.92E-29	6.152E-16	2.39E-16	8.544E-16	4.70E+09	0.0					1.31E+08	54.058	4615	1.28E+28	9730	2.70E+28	1.31E+08	8.00E+03					1.54E+04	4.27E+28	1.20E+04
30	1.812E-31	4.743E-17	1.82E-17	6.558E-17	5.22E+09	0.0					1.45E+08	49.327	4497	1.56E+28	8651	2.99E+28	1.45E+08	8.00E+03					1.31E+04	4.52E+28	1.20E+04
33	5.434E-34	3.503E-18	1.32E-18	4.826E-18	5.74E+09	0.0					1.60E+08	48.076	4378	1.85E+28	8209	3.47E+28	1.60E+08	8.00E+03					1.18E+04	5.00E+28	1.20E+04
36	1.603E-36	2.496E-19	9.33E-20	3.429E-19	6.26E+09	0.0					1.74E+08	46.072	4260	2.16E+28	7655	3.88E+28	1.74E+08	8.00E+03					1.06E+04	5.37E+28	1.20E+04
40	6.639E-40	7.051E-21	2.6E-21	9.656E-21	6.96E+09	0.0					1.93E+08	38.799	4102		6208	5.09E+28	1.93E+08	3.90E+03					8.16E+03	6.69E+28	6.00E+03
45	3.814E-44	7.7E-23	2.81E-23	1.051E-22	7.83E+09	0.0					2.18E+08	25.249	3905		3846	4.93E+28	2.18E+08	3.70E+03					4.77E+03	6.12E+28	4.00E+03
50	2.138E-48	7.981E-25	2.89E-25	1.087E-24	8.70E+09	0.0					2.42E+08	13.351	3708		1931	3.09E+28	3.00E+08	3.10E+03					2.27E+03	3.64E+28	2.00E+03
55	1.174E-52	7.933E-27	2.85E-27	1.078E-26	9.57E+09	0.0					2.66E+08	5.986	3511		820	1.60E+28	4.00E+08	2.30E+03					9.20E+02	1.80E+28	9.00E+02
60	6.346E-57	7.618E-29	2.72E-29	1.034E-28	1.04E+10	0.0					2.90E+08	2.355	3314		304	7.14E+27	5.00E+08	1.50E+03					3.27E+02	7.67E+27	3.00E+02
65	3.381E-61	7.108E-31	2.52E-31	9.63E-31	1.13E+10	0.0					3.14E+08	0.834	3116		101	2.81E+27	6.00E+08	8.00E+02					1.05E+02	2.90E+27	1.00E+02
70	1.78E-65	6.471E-33	2.29E-33	8.757E-33	1.22E+10	0.0					3.38E+08	0.271	2919		31	9.98E+26	6.96E+08	0.00E+00					3.07E+01	9.91E+26	0.00

Note-1: if use r_1 = 0.174 (with unit of 1E+9 m), then maximum Probability = 3.11. If use r_1 = 1.74E+8 (with unit of meter), then maximum Probability = 3.11E-9. E-9 probability is due to this R(n,*l*) is normalized for $r_1 = a_0$ = 5.29E-11 m. So when using this probability, I need to scale it up by ~1E+9 times to make it around to 1. We can avoid this trouble by deducing out the radial wave function R(n,*l*) that specifically normalized for Sun's r_1 =1.74E+8 m. But I am only a citizen scientist of QM, it is too much work for me to do it. Note-2: in column 7, the only purpose to scale up 500× is to plot this curve in Figure 1a.

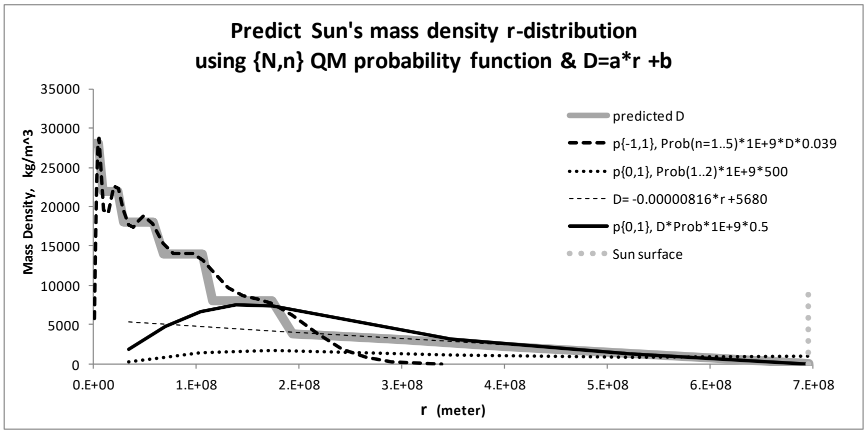

Figure 1a. Predict Sun's internal structure and the mass density radial distribution using p{N,n} QM probability function and a linear (D = a*r +b) scaling up.

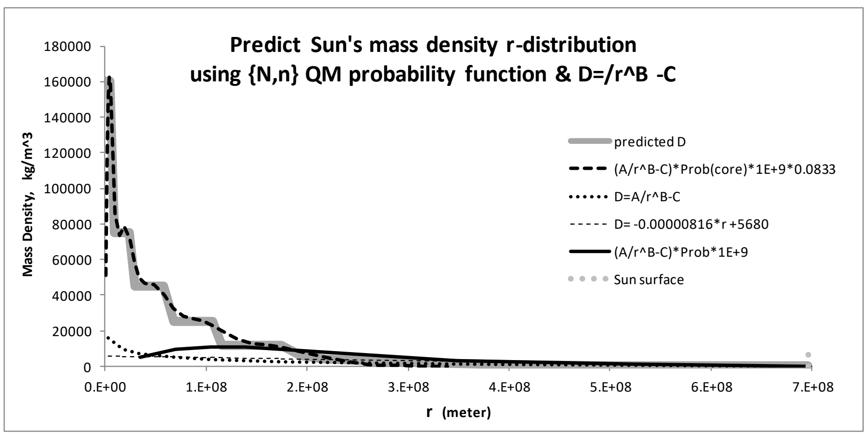

Figure 1b. Predict Sun's internal structure and the mass density radial distribution using p{N,n} QM probability function and a curved (D = A / r^B - C) scaling up.

In Table 1, Sun's p{0,1}o orbit shell probability is scaled down according to D = -0.00000816*r +5680 by adjusting W factor to 0.5 (see column 10 "p{0,1}, D*Prob*1E+9*0.5" in Table 1). Sun core's p{-1,n=1..5}o 's probability (column 13) is first scaled up also according to D = -0.00000816*r +5680, and further scaled down by 0.039× to match the heights of its n=5's peak to the heights of column 10 "p{0,1}, D*Prob*1E+9*0.5" curve's n=1 peak (see Figure 1a at r_1 ≈1.74E+8 m), so it become column 16 "p{-1,1}, Prob(n=1..5)*1E+9*D*0.039" curve. Then I construct a stepped line (see the grey thick line in Figure 1a) according to both "p{-1,1}, Prob(n=1..5)*1E+9*D*0.039" curve and "p{0,1}, D*Prob*1E+9*0.5" curve. Note: for more detailed explanation, please review Table 5 and Table 1 in paper SunQM-3s7, and Table 1 in paper SunQM-3s6.

According to this stepped line, I predict that there are 6 layers with 5 interfaces for Sun's internal structure: The (Earth-sized) inner core (or {-1,1//6} core, 0 m < r < ~ 4.83E+6 m) has D ≈ 28000 kg/m^3. The {-1,2//6} core (~4.83E+6 m < r < ~2.42E+7 m) has D ≈ 22000 kg/m^3. The {-1,3//6} core (~2.42E+7 m < r < ~5.8E+7 m) has D ≈ 18000 kg/m^3. The {-1,5//6} core (~5.8E+7 m < r < ~1.06E+8 m) has D ≈ 14000 kg/m^3. The {-1,6//6} core (~1.06E+8 m < r < ~1.74E+8 m) has D ≈ 8000 kg/m^3. The out {0,1//6}o orbit shell (~1.74E+8 m < r < ~6.96E+8 m) has D ≈ 4000 → 0 kg/m^3.

Obviously D = 28000 kg/m^3 is too low for Sun's {-1,1//6} core (due to by using the linear D = a*r + b for scaling up). Wiki "Sun" mentioned that a modeled Sun's center density is at 162 g/cm^3 = 1.62E+5 kg/m^3 [11]. Therefore, same as that for Saturn and Jupiter in paper SunQM-3s7, D = A / r^B - C model is used with following four conditions:

1) The total mass integration of D*Porb*1E+9 from r = 0 to 6.96E+8 m equals to Sun's mass;

2) At Sun surface, D*Porb*1E+9 ≈ 0 kg/m^3.
3) At r = 1.74E+8 m, the Sun core's probability "(A/r^B-C)*Prob(core)*1E+9" in column 24 has to scale-up to match Sun out-shell's probability "(A/r^B-C)*Prob*1E+9" at column 22 (see two cells colored in light blue in Table 1).
4) The inner core has mass density around 1.6E+5 kg/m^3.
Then I manually adjust parameters A, B, and C, and obtain one good fitting as D = 5E+5 / r^0.2 - 8485. After constructing a stepped line (see the grey thick line in Figure 1b), I finally predict that there are 6 layers with 5 interfaces for Sun's internal structure:
The (Earth-sized) inner core (or {-1,1//6} core, r ≤ 4.83E+6 m) has D ≈ 160000 kg/m^3.
Around {-1,1//6}o orbit shell (~4.83E+6 m < r < ~2.42E+7 m) has D ≈ 75000 kg/m^3.
Around {-1,2//6}o orbit shell (~2.42E+7 m < r < ~5.8E+7 m) has D ≈ 45000 kg/m^3.
Around {-1,n=3..4}o orbit shells (~5.8E+7 m < r < ~1.06E+8 m) has D ≈ 25000 kg/m^3.
The {-1,5//6}o orbit shell (~1.06E+8 m < r < ~1.74E+8 m) has D ≈ 12000 kg/m^3.
The out {0,1//6}o orbit shell (~1.74E+8 m < r < ~6.96E+8 m) has D ≈ 6000 → 0 kg/m^3.

I believe that these values are very close to the true mass density value inside the Sun.

II Using {-1,n=6..11}o QM model to explain how Sun's radiative zone was transformed into convective zone

The classical physics tells us that heat transfers in three ways: conduction, radiation, and convection. I believe that the conduction (through molecular collision) should belong to radiation because it can be explained as the infrared photon emitted from one molecule and absorbed by another one molecule. So there are only two major ways to transfer heat: radiation and convection. Therefore, in Sun's {0,1}o orbit shell there are two major zones: radiative zone and conductive zone. Wiki "Sun" mentions that Sun's radiative zoon starts from ~ 25% of r to ~70% of r, and the convective zoon starts from ~ 75% of r to ~100% of r. I further believe that as the temperature increasing (or as the thermal pressure decreasing), the Sun matter in {0,1}o orbit shell has three forms: pre-melt form where only radiation, no convection exist; melted form where convection starts; boiled form where the Sun surface matter eruption happens.

In my previous paper SunQM-2, I explained that for Solar QM {N,n} structure, we can choose Sun's any super shell's {N,1} as n=1 QM ground state. In paper SunQM-1s1, I also explained that if we choose {N,1} as n=1, then its QM will not only generate a set of strong QM orbit at {N,n=1..5}o, but also a set of weak QM orbit at {N,n=6..11}o. For our current Sun, if we choose its {-1,1} core as n=1 ground state, then it will generate a set of strong QM orbit at {-1,n=1..5}o, which all belong to Sun's inner core {0,1}. It will also generate a set of weak QM orbits at {-1, n=6..11}o orbit shells, which locates exactly at Sun's {0,1}o orbit shell space. Therefore, Sun's {0,1}o shell is composed by {-1,n=6..11}o orbits.

In Table 2, I calculated r(s) for each of {-1,n=6..11}o orbit shells, and then correlate them to the known structure of Sun. We can see that {-1,n=6..9}o four orbit shells are perfectly belong to the radiative zone (25%r ~ 70%r), and {-1,n=10..11}o two orbit shells are perfectly belong to the convective zone (70%r ~ 100%r). After further study, I realized that this is not a coincidence. It actually means the formation (and even the dynamics) of radiative zone and convective zone in Sun follows the {-1,n=6..11}o QM.

Table 2. Using {-1,n=6..11}o QM to analyze the Sun's radiative zone and convective zone.

{-1,n=1..12} size	{-1,n=1..11}o orbit shell	Sun, r	% r(surface)	
		m		
1		4.83E+06	1%	
6	{-1,5}o	1.74E+08	25%	Sun core, H-fusion
7	{-1,6}o	2.37E+08	34%	Radiative zone (25%r ~ 70%r)
8	{-1,7}o	3.09E+08	44%	Radiative zone (25%r ~ 70%r)
9	{-1,8}o	3.92E+08	56%	Radiative zone (25%r ~ 70%r)
10	{-1,9}o	4.83E+08	69%	Radiative zone (25%r ~ 70%r)
11	{-1,10}o	5.85E+08	84%	Convective zone (70%r ~ 100%r)
12	{-1,11}o	6.96E+08	100%	Convective zone (70%r ~ 100%r)

Before I explaining how Sun's radiative and convective zones were formed under {-1,n=6..11}o QM's quantum dynamics, let me first introduce two new effects.

First, the "photon thermos core" effect, or PTC effect. The classical physics tells us that the light ray will bend toward to the more mass-densed direction. Just like when driving in a hot Sun shine day, the road far ahead of you looks like a mirror. In section I, we see that Sun's mass r-distribution can be described roughly by D = -a*r +b, or by D = A / r^B - C. Both equations have mass density D decreases with r increasing. So the light ray inside Sun closing to Sun surface will have more chance to bend back into the Sun rather than radiate out of Sun. So if photon radiation is the major heat trnasfer for Sun, then Sun become a pretty good thermos (of photon). I named this as "photon thermos core effect", or PTC effect.

In Figure 1b, we see that {N,n} QM forms stepped mass density in r dimension for each n shell (and each N super shell as well). Because the neighboring shell has stepped-down (or -up) mass density, an interface is formed. We know that light ray at a interface of cliff-fall mass density (from high to low) will have most part of ray reflected, only small part of ray refracted (depends on the incident angle, see Giancoli's book, pp854, Figure 32-31). So the cliff-fall mass density interface strongly reflects the light ray back, or for each n shell, photons are much easier to refract into n-1 shell, and much difficult to refract into n+1 shell. This causes each n shell space become a PTC, which will further homogenize the temperature, pressure, and mass density inside each n shell. Therefore, each n shell (or the core) becomes a thermos! This thermos effect causes the whole n shell warming or cooling as a single entity, and the large heat capacity causes it to take long time to melt (or to cool) the whole n shell. The long duration of heating/melting or cooling make this duration becomes the stable QM state of the Solar {N,n} QM dynamics, and the short period between two QM states become the transitional phase.

This long duration of heating or cooling that forms the stable state of the Solar {N,n} QM's quantum dynamics can be found in many places. For example, the quantumization of each N super shell's collapse is the quantum thermal dynamics (of heating and cooling) caused by the mass density cliff-fall as r (and N) increases (see paper SunQM-1s1); the quantumization of Solar internal {N,n} QM structure formation is the quantum thermal dynamics of melting caused by the mass density cliff-fall as r (and n) increases (I will explain this in current paper); the quantumization of a planet's p{N,n} QM structure's original atmosphere shell evaporation is the quantum thermal dynamics of melting caused by the mass density cliff-fall along r (and n) increases (see paper SunQM-3s6).

Between each N super shell, the cliff-fall of mass density is even bigger (see Figure 1b, the mass density cliff-fall at {-1,1} interface with r = 4.83E+6 m). So it will generate even stronger PTC effect. In summary, Sun's mass distribution D = A / r^B - C causes a mild PRC effect. Each n shell's (with n > 1) small step down of mass density causes a little bit larger PRC effect at the interfaces between two n shells. Each N super shell's large step down of mass density (at {N,1}) causes a large PRC effect at the interfaces between two N super shells. So Sun actually is a super big spherical-shaped thermos (of photon). However, the higher D at inner interface of each shell makes no PRC effect, so the inner core always get photon and heat from the outside H-fusion shell.

Second, the "lower mass density causes lower point of convection, boiling or melting" effect. The common knowledge that the water boiling point gets lower at higher altitude makes me believe that for the same material (like gas, or ionic gas, or compressed liquid ionic gas), the lower pressure will cause lower boiling (and melting, convection) point. Among {-1,n=6..11}o orbit shells, n=11 orbit shell has the lowest mass density and lowest pressure, so {-1,11}o orbit shell of Sun will get melt (or boil, or convection) first under a roughly unified temperature for Sun's {0,1}o orbit shell. Wiki "Solar rotation" demonstrated a figure of "*Internal rotation in the Sun, showing differential rotation in the outer convective region and almost uniform rotation in the central radiative region*" (figure not shown here). My interpretation for this figure is that it strongly suggests that the convection zone is a melted region while the radiative zone is a pre-melted region.

Now I can explain how Sun's radiative and convective zones were formed under {-1,n=6..11}o QM's quantum dynamics. Immediately after the pre-Sun ball collapsed to today's {0,1} as well as the H-fusion ball expanded to today's {0,1}, I believe that the {0,1}o orbit shell, or the equivalent {-1,n=6..11}o orbit shells, had much lower temperature than that of today. So all {-1,n=6..11}o orbit shells of Sun were in the form of radiative zone. As the {0,1} H-fusion radiated heat accumulated more and more inside the {0,1}o orbit shell, its temperature increased almost uniformly (due to Sun's PTC effect). Once the temperature passed above {-1,11}o 's convection point, the {-1,11}o orbit shell started to quantumly transform from radiative zone into convective zone (due to it has the lowest convection point among all {-1,n=6..11}o orbit shells). Then the {0,1} H-fusion kept heating {0,1}o orbit shell, and increased the temperature almost uniformly. Once above certain temperature, the {-1,10}o orbit shell also started to quantumly transform from radiative zone into convective zone.

That is the status of our Sun today, with both {-1,n=10..11}o orbit shells in convection form, and rest {-1,n=6..9}o still in radiation form. Interestingly, a similar situation can be found on Earth: current Earth's {-1,1//4} solid iron core is equivalent to a radiative zone, while current Earth's {-1,1//4}o orbit shell (liquid iron) is equivalent to a convective zone (see paper SunQM-3s6).

From this analysis, we can predict that the Sun will not keep current state for the next 5 billion years before all H fuel inside {0,1} burns out. During this period, the convection zone will quantumly expand inward from current {-1,10}o orbit shell to {-1,9}o orbit shell, and then to n=8, 7, 6 orbit shells one by one. What may happen after Sun's {-1,9}o orbit shell changed from radiative zone to convective zone? Here is some of my predictions: Higher Sun light output will push the rock-evap line outward, even closer to {1,3} Mercury orbit. All light elements on Mercury's p{-1,2//4}o orbit shell will be evaporated, only the inner core p{-1,2//4} with will be left. So Mercury will decrease its r from 2.44E+6 m to 1.87E+6 m. Venus' CO_2 atmosphere will be ripped of completely. Then the bared Venus' surface (like current Mars') will start to evaporate its light elements directly. I don't want to predict what will happen to Earth, except Earth will get more CO_2 and other light elements from Venus the Mercury. Mars will keep unchanged. The ice-evap line will move from current {1,8} to near {1,9}. So Jupiter may start to slowly evaporate its surface Hydrogen, and the evaporated hydrogen will be mostly captured by Saturn.

The quantum change of Sun's each {0,n=11..6}o orbit shell from radiative zone to convective zone will undoubtedly bring a catastrophic atmospheric change on Earth. The question is when it happened in Earth history, and when the next change will happen again? We know that during the rest ~5 billion years, Sun needs to convect four more n shells {-1,n=9..6}o. Assuming it take same amount of time for melting each n shell to start the convection, so on average each n shell may need ~1300 million years to be melted.

Now let us try to find out when was the last two convection transitions occurred? The best place to looking for is the history of the Earth because it has been relatively well characterized by other scientists. The biggest two similar events happened in Earth history are the "snowball Earth", one happened in 2100 Mya ~ 2400 Mya, another one in ~650 Mya (see wiki "Snowball Earth").

The story below is from my scientific imagination.

The quantum change of {-1,11}o orbit shell from radiative zone to convective zone might temporarily decrease Sun light output (only for a hundred years) and caused the onset of the first Earth snowball phase (2400 Mya). Then it immediately increased the Sun light output to much higher level (see Figure 2), which expanded the rock-evap line to beyond {1,1} and close to {1,2}. This in turn evaporated all Mercury's original (could be ~1000 km thick) CO_2 atmosphere. Then 80% of evaporated CO_2 was captured by Venus and the ~20% captured by Earth (same as ice evaporated from {2,1} core was ~80% captured by Jupiter and ~20% captured by Saturn). It took ~100 Myr for Earth to capture enough CO_2 (evaporated from Mercury) to increase CO_2 % in its atmosphere high enough to end the snowball phase. Also the multi-kilometers thick ice on Earth surface dragged and slowed down the tectonic movement, built up torque force between Earth crust and mantle. Eventually, after passing a break point, it caused a series of massive earthquake and volcano eruptions, and released large amount of CO_2, which (as other scientist have pointed out) might also helped to end the Earth's snowball phase.

Similarly, the quantum change of {-1,10}o orbit shell from radiative zone to convective zone might have trigged the second Earth snowball phase (650 Mya) by a temporary decreasing of Sun light output. Then again the Sun immediately increased the light output to a much higher level, which expanded the rock-evap line from close to {1,2} to beyond {1,2}. This in turn evaporated most of Mercury's mantle, and most of Venus' original (~1000 km thick) CO_2 atmosphere. Then ~80% of evaporated CO_2 was captured by Earth during the following ~100 million years. The increased CO_2 in Earth's atmosphere (captured from Venus and released from Earth's massive volcano) eventually ended Earth's second snowball phase.

So if the start of two snowball Earth was caused by the Sun's radiation → convection transition, then it takes ~ 2100 - 650 ≈ 1450 million years between two occurrence. From this I predict that the next quantum transition of {-1,9}o orbit shell from radiative zone to convective zone may happen in 650 ~800 Million years late.

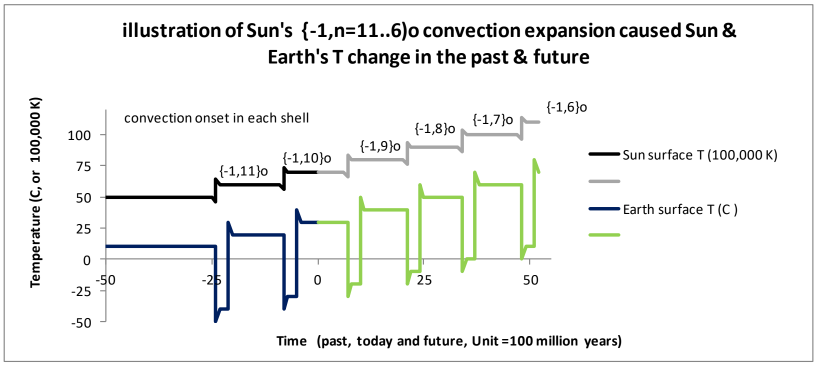

Figure 2. Illustration of Sun's {-1,n=11..6}o orbit shell convection expansion caused Sun and Earth's surface temperature change in history and in future.

According to this imaged story, I draw the Figure 2 to demonstrate the both Sun and Earth's surface temperature change in history and in future caused by the Sun convective shell expansion. The first onset of the convection was guessed to be ~ 2600 million years after the Sun's H-fusion ball was expanded to {0,1} size (or ~2400 Mya). The averaged onset of a new convection is estimated to be every ~1500 to ~ 1300 million years. Purely from my guess, the each onset of a new convection in {N,n=11..6}o orbit shells will increase Sun's surface temperature by ~1E+6 K (notice this is Sun's true surface temperature calculated from v_{rms}, not the residue temperature 5800 K, see section IV for details). Also purely from my guess, the each onset of a new convection in {N,n=11..6}o orbit shells will increase Earth surface's temperature by ~10 C.

III Using {N,n=1..5}o QM model to analyze the planetary differentiation and the quantum expansion of Sun's H-fusion ball

Since we have obtained the Sun's (close to the true) mass density distribution in r-dimension, we can calculate out the mass for each n shell inside the Sun. In Table 3, I used the predicted mass density in Table 1 column 26 (vs. r in column 18) to calculate out the mass in each n shell of Sun. Column 9 of Table 3 shows the mass % of each n shell against the total mass of Sun. Column 10 shows the mass % of each n core (n shell plus all inside shells) against the total mass of Sun. Note: Column 8 bottom line's Sun total mass =1.23E+30 kg < Sun's total mass = 1.99E+30 kg. This is due to that I used the Δr 's lower end mass density for mass calculation. This is the same method I used to calculate the mass per shell in top line of Table 1 column 9 and column 11. Although the absolute mass values have some error, the relative mass values in columns 9 & 10 have very low error due to the errors in both numerator and denominator are mostly cancelled out.

Table 3. Using {-1,n=1..5}o QM to analyze the Sun's internal structure.

{-1,n=1..12} size	{-1,n=1..11}o orbit shell	Sun, r	% r (surface)	volume	Vol %	mass density	mass per shell	shell mass %	core mass %	Sun differentiation model-II	shell mass %	Sun differentiation model-I Sun core ~60% He
		m		m^3		kg/m^3	kg	kg/kg	kg/kg		kg/kg	
1		4.83E+06	1%	4.73E+20	0.00003%	1.60E+05	7.57E+25	0.006%	0.006%	Au, Pb core	0.02%	Au, Pb, Fe core
2	{-1,1}o	1.93E+07	3%	2.98E+22	0.0021%	75000	2.23E+27	0.18%	0.19%	Fe core	0.56%	Fe, Mg, Si core
3	{-1,2}o	4.35E+07	6%	3.15E+23	0.022%	50000	1.57E+28	1.27%	1.46%	C, O, Ne, Mg, Si, S, core	3.91%	C, O, Ne, Mg, Si, S, He, core
4	{-1,3}o	7.73E+07	11%	1.59E+24	0.113%	45000	7.17E+28	5.81%	7.27%	He core	17.82%	He core
5	{-1,4}o	1.21E+08	17%	5.45E+24	0.386%	25000	1.36E+29	11.04%	18.31%	He core	33.90%	He core
6	{-1,5}o	1.74E+08	25%	1.47E+25	1.04%	12000	1.76E+29	14.27%	32.58%	8% H, 6% He, H-fusion layer	43.80%	6% He, 38% H, H-fusion layer
7	{-1,6}o	2.37E+08	34%	3.36E+25	2.38%	6000	2.01E+29	16.32%	48.90%	H, convective?	radiative	75% H, 23.5% He, 1.5% metal
8	{-1,7}o	3.09E+08	44%	6.83E+25	4.84%	3000	2.05E+29	16.61%	65.51%	H, convective?	radiative	75% H, 23.5% He, 1.5% metal
9	{-1,8}o	3.92E+08	56%	1.27E+26	9.02%	1500	1.91E+29	15.48%	80.99%	H, convective?	radiative	75% H, 23.5% He, 1.5% metal
10	{-1,9}o	4.83E+08	69%	2.22E+26	15.7%	600	1.33E+29	10.77%	91.76%	H, convective?	radiative	75% H, 23.5% He, 1.5% metal
11	{-1,10}o	5.85E+08	84%	3.65E+26	25.8%	200	7.30E+28	5.91%	97.67%	H, convective zone	convective	in differentiating
12	{-1,11}o	6.96E+08	100%	5.74E+26	40.7%	50	2.87E+28	2.33%	100.00%	H, convective zone	convective	in differentiating
SUM				1.41E+27	100.0%		1.23E+30	100.00%			100.00%	

Wiki "Sun" mentions that "*At this time in the Sun's life*", Hydrogen and Helium "*account for 74.9% and 23.8% of the mass of the Sun in the photosphere, respectively. All heavier elements, called metals in astronomy, account for less than 2% of the mass, with oxygen (roughly 1% of the Sun's mass), carbon (0.3%), neon (0.2%), and iron (0.2%) being the most abundant*". If we assume that the whole Sun has the similar chemical elements % as that of the photosphere, then from the mass % in column 8 & 9, we can guess that the {-1,2} core contain ~0.19% of total Sun mass, so it is likely formed primarily by iron (since Fe is ~0.2% of Sun mass). Inside it, the {-1,1} Earth-sized core contains ~0.006% of total Sun mass, so it is likely formed primarily by elements heavier than the Fe (like Au, Pb, Ni). Then the {-1,2}o orbit shell space (up to {-1,3}) contains ~1.27% of Sun mass, and it is most likely formed by a mixture of C. O, Ne, etc. The {-1,3}o orbit shell space (up to {-1,4}) contains ~5.81% of Sun mass, and it is most likely formed primarily by He. The {-1,4}o orbit shell space (up to {-1,5}) contains ~11.04% of Sun mass, and it is most likely formed primarily also by He. Then the {-1,n=6..11}o orbit shell space which has about 67% of Sun's total mass, has to be composed of almost pure H. And the {-1,5}o orbit shell space (up to {-1,6}={0,1}) contains ~14.27% of Sun mass, and it is most likely formed primarily by equal amount of H and He (calculated as ~8% of H and ~6% of He), and this is the shell where H-fusion is going. I named this model as "Sun differentiation model-II" (see analysis in columns 9 ~ 11 in Table 3). The good thing about this model is that it has clear cut structure of Au/Pb core, Fe core, C, O, Ne core, etc. The bad thing about this model is that its {0,1}o orbit shell is composed of pure H, so it does not fit to the current Sun. I believe that model-II reflects the situation at ~5 billion years late with all {-1,6..9}o orbit shell become convective zone, and all "metal" elements in {-1,n=6..11}o orbit shell have been differentiated into Sun core. So it is the structure at the end of Sun's normal life, and right before Sun's red giant phase.

In comparison, I construct a differentiation model for the current Sun, named as "Sun differentiation model-I" (see analysis in columns 12 -13 in Table 3). The most important part of model-I is that the elements in {-1,n=6..9}o orbit shells are in perfect mixture state (not differentiated at all, because they are in radiative zone). Even the elements in {-1,n=10..11}o orbit shells are in differentiating (because of the convection), they do not re-position into Sun core. Instead, they re-position just between {-1,10}o and {-1,11}o orbit shells. This matches wiki "Sun" 's description "*In the current photosphere the helium fraction is reduced, and the metallicity is only 84% of what it was in the protostellar phase (before nuclear fusion in the core started)*". However, inside Sun core, all elements are completely differentiated. So in column 12, I calculate the shell mass % only for {0,1} core (not include {0,1}o orbit shell). Notice that inside {-1,1} Au/Pb core, there is not enough Au/Pb because 2/3 of them are still in {0,1}o orbit shell. Meanwhile, the size of {-1,1} core is determined by the total mass of Sun, so it can't be shrunk. So it ends up to use a lot of Fe elements to fill in the empty position. For the same reason, the {-1,1}o Fe shell uses a lot of C, O, Ne elements to fill in the empty position, and the {-1,2}o C, O, Ne shell uses a lot of He elements to fill in the empty position, and so on. As the result, the clear cut structure of Au/Pb core, Fe shell, C, O, Ne shell, He shell inside Sun core is blurred (see column 13 of Table 3). Wiki "Sun" mentioned that "*Over the past 4.6 billion years, ... Within the core, the proportion of helium has increased from about 24% to about 60% due to fusion*". Using this information, in column 13, I adjusted {-1,4}o orbit shell's mass to be all He, while {-1,5}o orbit shell's mass (total = 43.8%) to be ~6% of He and ~38% of H.

The most surprising result of this analysis (at least for me) is that for both model-I and model-II, the H-fusion is not taking place everywhere inside {0,1} Sun core. Instead, H-fusion takes place only in {-1,5}o orbit shell space (between r = 1.21E+8 m and r = 1.74E+8 m, or right below the Sun core's surface)!

In my previous paper SunQM-1s1 Table 7b, I had hypothesized a quantum dynamics of the heat expansion for the Solar {N,n} QM structure (which accompanies with the quantum collapse of Solar {N,n} QM structure). Based on the new analysis result in current paper, now I can add more details to this heat expansion quantum dynamics of Solar {N,n} QM structure evolution. Here we still use pre-Sun ball's series quantum collapse {N,1} as timeline for the Sun evolution (see SunQM-1s1, Table 7b, column 1). The early H-fusion in the pre-Sun core probably had size much smaller than {-7,1} in millimeters, and sporadically here and there in the pre-Sun core (quantum fluctuation). With continues mass condensation (driven by G-force), and pressure/temperature building up, the mm-size sporadic H-fusion gradually grew its size to (-5,1} meter-size, and it became a stable H-fusion ball at the center of pre-Sun core. It continues (quantumly) grew to {-4,1}, {-3,1} km-size. Now let us start to add detailed dynamics after a {-3,1} H-fusion ball had formed. Let us look a {-2,1} pre-Sun ball. It had a {-3,1} km-sized H-fusion core, its {-3,n=1..5}o super shell space had a perfect mixture of ~75% H, ~23% He, ~2% mixture of O, C, Ne, Fe, etc. The mass density r-distribution of this {-3,n=1..5}o orbit shells mostly followed D = A / r^B - C function, because it was formed by the gravity mass condensation. This was a stable QM state.

As mentioned in the section II, the strong PTC effect makes the temperature increases almost uniformly within each N super shell. It took long time for a {-3,1} H-fusion ball to heat and melt {-3,n=1..5}o super shell. As the temperature increasing, the {-3,5}o orbit shell first started to melt and convect (due to it has the lowest mass density and thermal pressure, therefore the lowest melting point and convection point among all {-3,n=1..5}o states). So {-3,5}o orbit shell quantumly transformed from radiative zone to convective zone.

One major result of the convection was that the original perfect mixture of Au, Pb, Fe, O, C, Ne, He, H, etc. was differentiated, with the heavy atoms moved to the inner side (by gravity) and the light atoms were pushed to the outer side (I just learned that this is called planetary differentiation). Then, as the temperature further increasing, the {-3,4}o orbit shell also quantumly transformed from radiative zone to convective zone, and differentiated the elements in r-dimension. Then, one by one, all {-3,n=5..1}o orbit shells were melted and the whole super shell (or {-2,1} ball) became convection zone. As the result, all chemical elements inside {-2,1} ball repositioned with the heavy ones moving to the center, and light ones moving to the outer. Therefore, each of {-3,n=1..5)o orbit shell was populated with specific elements according to its atom weight. Similar as that in Table 3, the {-3,1} core was then occupied by Au, Pb, etc., the {-3,1}o orbit shell was then occupied by Fe, the {-3,2}o orbit shell was then occupied by O, C, Ne, etc., the {-3,3}o and {-3,4}o orbit shells were then occupied by He, and the {-3,5}o orbit shell was then occupied by H (because H is the lightest element). This transformed the {-2,1} pre-Sun ball's mass density r-distribution from the original D = A / r^B - C function's smooth curve into a QM probability density r^2 *(|R(1,0)|^2 + |R(2,l)|^2 + |R(3,l)|^2 + |R(4,l)|^2 + |R(5,l)|^2) function's stepped curve! (So the smooth of D = A / r^B - C curve is due to ~75% H, ~23% He, ~1% O, ~1% of C, Ne, Fe, etc. is perfectly mixed, while the steps comes from the differentiated elements in each shell. All these are in a single super shell). At the same time, the original hydrogen (in fusion reaction) in {-4,5}o orbit shell was pushed out to {-3,5}o orbit shell too (because {-4,5}o was repositioned by Au, Pb, etc). Therefore {-3,5}o orbit shell's H started to fuse, and this caused the original {-3,1} H-fusion ball quantumly expanded to a {-2,1} H-fusion ball.

Notice that although all elements were repositioned within {-2,1} H-fusion ball, they were still a perfect mixture outside of {-2,1} ball. So for the {-1,1} pre-Sun ball, this process happened repeatedly. In a slow phase (a period of > 10 million years? Purely from my guess), a {-2,1} H-fusion ball heated the {-2,n=1..5}o super shell until the whole super shell was melted. After completely melted, a quick transitional phase (a period of ~ 1 million years? Also purely from my guess) happened, including repositioning elements upon their weight, out pushing {-3,5}o orbit shell's H-fusion to the new edge shell, i.e., {-2,5}o shell, therefore quantumly expanded H-fusion from {-2,1} ball to {-1,1} ball.

Then today's {0,1} H-fusion core was formed in the exactly same way. In a slow phase (a period of > 10 million years?), a {-1,1} H-fusion ball heated the {-1,n=1..5}o super shell until the whole super shell was melted. After completely melted, a quick transitional phase (a period of ~ 1 million years?) happened (including reposition elements upon their weight, out pushing {-2,5}o orbit shell's H-fusion to the new edge shell, i.e., {-1,5}o shell, therefore quantumly expanded H-fusion from {-1,1} ball to {0,1} ball). This {0,1} H-fusion ball has a {0,n=1..5}o super shell (actually only {0,1}o orbit shell has mass) with perfect mixture of ~75% H, ~23% He, and ~2% mixture of O, C, Ne, Fe, etc.,

Today's {0,1} H-fusion ball is heating {0,n=1..5}o super shell (it is the same as the rock-evap line). If this super shell had ~ 100% mass occupancy, then it would have a strong PTC effect, then within ~ 10 million years, all mass would have melted. Then after element reposition, the H-fusion ball would quantum expand to {1,1}. However, today's {0,1}o orbit shell has only ~ 50% mass occupancy, and {0,n=2..5}o orbit shells (or the Sun's corona super shell) have << 0.1% mass occupancy, so it has only the weak n shell's (not the strong N super shell's) PTC effect. So the heat (that generated by {0,1} H-fusion ball and refracted into the {1,1} corona super shell) will mostly not be retained in this super shell. Instead it lost to the outer space. Therefore the dynamics is completely changed. The {0,n=1..5}o super shell (or the actual {0,1}o orbit shell) can never be heated and melted within ~10 million years. In fact, the result of section II demonstrated that it will take ~10 byr to melt the {0,1}o = {-1,n=6..11}o orbit shells ! Even the {0,n=1..5}o super shell has been heated and melted, there is not enough (Au, Pb, etc.) mass to reposition into {-1,5}o orbit shell to push the H (in fusion) out to {0,5}o (or {0,1}o) orbit shell. Therefore the {0,1} H-fusion ball will keep burning for 10 billion years until all H fuel in {-1,5)o orbit shell burned out. This is the foundation of the old explanation (in paper SunQM-1s1) that because today's {0,1} H-fusion ball has the same size of today's mass collapsed {0,1} Sun core, it is a super stable QM state. It has a lifetime of ~10 billion years.

About 5 billion years late, all {-1,n=6..11}o orbit shells will be in convection. This convection will cause the majority elements (represented by Au, Fe, O, C, He, H) to be repositioned as the heavy ones going to the {-1,6} end, and the light ones going to the {-1,11}o end. Before all H fuel in {-1,5)o orbit shell completely burned out, the decreased H-fusion will cause contraction of {-1,5}o orbit shell, so that majority of heavy mass (Au, Fe, O, C, even part of He, etc.) in {0,n=6..7}o orbit shell will (de-excited and) move into {-1,5}o orbit shell. This will increase the mass ratio of {0,1} core vs. {0,1}o orbit shell of Sun from the original 41:59 (calculated from the predicted D in column 26 of Table 1) to around 50:50 (by purely guess).

Before analyzing the red giant, let us first discuss about the He-fusion. When H-fusion moved to {-2,5}o orbit shell, the elements repositioning had finished inside {-2,1} ball, and the heaviest elements inside {-2,1} ball were mostly repositioned in the {-3,1} core. This greatly increased the mass density in the {-3,1} core, and it might start the He-fusion there. The limited He inside {-3,1} core (Au/Pb core) quickly burned out, but the heat it generated would increase the temperature of {-3,1}o orbit shell, and started He-fusion there. Again, the limited He inside {-3,1}o orbit shell (iron shell) quickly burned out, and then its heat turned on He-fusion inside {-3,2}o orbit shell. This process keeps going until the He-fusion gradually moved to the most out {-3,5}o orbit shell (which equals {-2,1} in size). So now inside a {-1,1} H-fusion ball, there is a {-2,1} He-fusion ball. Then inside a {0,1} H-fusion ball, there is a {-1,1} He-fusion ball. This explains the hypothesis (in paper SunQM-1s1) that inside Sun's H-fusion ball, there is a He-fusion ball which is ΔN= -1 smaller.

Now let us analyze the red giant. After the H-fusion in {-1,5}o orbit shell burned out, the cooling and contracting moves He-fusion from {-2,5}o, to {-1,1}o, then to {-1,2}o, and then one by one up to {-1,5}o orbit shell (equals to {0,1} in size). The much higher temperature of He-fusion (than H-fusion) excites the mass in {0,1}o orbit shell and spread it into the whole {0,n=1..5}o super shell, so the Sun become a red giant (in size of {1,1}). After He fuel in {-1,5}o orbit shell burned out, the cooling and gravity contraction causing all mass (now mostly in form of carbon) inside {0,1} ball (or {-1,n=1..5}o QM states) collapse into the ground state {-1,1} by implosion, and it forms a {-1,1} ball we call it white dwarf. All mass in {0,n=1..5}o super shell (~50% of Sun mass) will be excited to the much higher QM state by explosion, moving mass first into {1,n=1..5}o super shell, then into {2,n=1..5}o super shell, and so on. (Note most of above explanation come from wikipedia and contributed by other scientists. I only add the {N,n} QM result into the explanation).

Note-1: Here is a simple calculation: Suppose 3/4 heat is retained in the H-fusion core (or N super shell), 1/4 leaks out. Among this 1/4 heat, there will be 1/4 - (1/4)^2 = 3/16 of the heat retained in N+1 super shell, and (1/4)^2 = 1/16 goes into N+2 super shell. For N+1 super shell, this 3/16 slowly heats N+1 super shell, increases temperature in the whole super shell (almost) uniformly. Once passed the critical point, it quantumly melt and convect each n shell (within N+1 super shell) from n=5 down to n=1 (just like explained in section II).

Note-2: For easy explaining, an over-simplified model says the gravity generates D = A / r^B - C (smooth) curved mass density r-distribution, and elements reposition generated QM probability (steps) curved mass density r-distribution. In the real world, the gravity generates mass density r-distribution with QM probability curve on top of the D = A / r^B - C curve, and after elements repositioning, it adds more contribution from QM probability (stepped) curve.

Note-3: The hot-r is 1.26× of the cold-r, so in turns of ball volume, the hot ball is 1.26^3 = 2.000× larger than the cold ball! For each N super shell volume or each n shell volume, the hot one is also 2× larger than the cold one! So the current Sun is 2× volume of the cold one, so it has 50% cold mass occupancy, and become 100% hot mass occupancy due to increased thermal pressure.

We can update above results into the "Solar QM {N,n//6} structure Periodic Table" in paper SunQM-1. Here in Table 4, I added the result of Sun's internal structure to the {-1,1} ball and {-1,n=1..11}o orbit shells. Note: for the meaning of each sign, please see paper SunQM-1 Table 4.

Table 4. Solar QM {N,n//6} structure Periodic Table

		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+1,2//6}
N=	-5	#####	#####	#####	#####	#####	####						
"N period" or "N super-shell"	-4	####	####	####	####	black hole orbit	black hole surface						
	-3	neutron star orbit	neutron star surface	###	###	###	##						
	-2	##	##	##	##	white dwarf orbit	white dwarf surface, Ag, Au, Pb core in Sun						
	-1	Fe shell	C, O, Ne, Si, S shell	He shell	He shell	H-fusion shell	Sun core surface, Radiative zone	Radiative zone	Radiative zone	Radiative zone	Convective zone	Convective zone	Sun surface
	0	Sun {0,1}o orbit	Sun surface	*	*	*	*						
	1	*	*	Mercury	Venus	Earth	Mars	**	Ceres_ Asteroid belt	**	**	Jupiter$^+$	Jupiter$^+$
	2	Mars/Asteroid belt	Jupiter	Saturn	Uranus	Neptune	Pluto_ Kuiper belt	*** SDO	*** SDO/Eris	***	***	***	****
	3	Pluto_ Kuiper belt	****	****	****	****	inner Oort						
	4	inner Oort/belt	inner Oort	inner Oort	outer Oort	outer Oort	outer Oort edge						
	5	*****	*****	*****	*****	*****	*****						

IV. Using {N,n} QM to explain why Sun surface's T=5800 K but Sun corona's T=5E+6 K.

Wiki "Sun" mentioned that Sun core's (modeled) temperature ≈ 1.57E+7 K, Sun surface's temperature ≈ 5800 K, and Sun corona's temperature ≈ 5E+6 K. It has been always a question that why Sun has an exceptional low surface temperature and a super high corona temperature?

From thermodynamics, we know that the temperature directly related to the average kinetic energy of molecules. For idea gas, $(1/2)mv^2_{avg} = (3/2)\ kT$, (see Ginacoli's book, pp478, eq-18-4). Or, the root-mean-square speed v_{rms} is the measure of the speed of particles in a gas: $v_{rms} = \text{sqrt}(3kT/m)$, (see Ginacoli's book, pp479, eq-18-5), where m is the mass of one molecule of the gas, k is Boltzmann constant, and T is the temperature in Kelvin. In Table 5, I calculated the v_{rms} in Sun's core, surface, and corona, with the simplified model that Sun only contains hydrogen. Then I try to find these v_{rms} correlate to what velocity in the Solar {N,n} QM model.

Table 5. Calculate v_{rms} for Sun from its temperature, using hydrogen's m = 1.67E-27 kg.

	T= K	v_{rms}= sqrt(3kT/m) m/s
core	1.57E+07	6.24E+05
Sun surface	5800	1.20E+04
Corona	5.00E+06	3.52E+05

In Table 6, I calculated the Solar {N,n} QM model's orbital velocity. From columns 1 to 5, I construct a {N,n} model from N = -15 to N = +15, calculate $r_n = r_1 *n\hat{}2$ for both Cold-r and Hot-r tracks (see Table 1 of paper SunQM-1s2 for details). In column 6, I used the classical physics calculation, $F = ma = mv_n^2 / r_n$, $F = G*Mm / r_n^2$, $mv_n^2/r_n = G*Mm / r_n^2$, $r_nv_n^2$

= GM, v_n = sqrt(GM / r_n), and used the hot-r, to calculate the orbital v_n . In column 7, v_n is normalized to the light speed c. In column 8, The temperature of each super shell is calculated by assuming the orbital v_n directly equals to v_{rms} , and using Sun's mass M = 1.99E+30 kg, and hydrogen's mass m = 1.67E-27 kg. So $(1/2)mv_n^2 = (3/2)$ kT, v_n = sqrt(GM / r_n), or T = GMm / (3kr_n).

Table 6. Calculate Solar {N,n} QM model's orbital v_n and then correlate v_n to v_{rms}.

N=	n=	total n=	Cold-G r track	Hot-G r track	v_n= sqrt(GM/r_n)	v_n /c	T= GMm /(3kr_n)	
			m	m	m/s	(m/s) / (m/s)	K	
-15	1	2.13E-12	6.25E-16	7.87E-16	4.11E+17	1.37E+09	6.80E+30	{-15,1} proton r=8.4E-16
-14	1	1.28E-11	2.25E-14	2.83E-14	6.84E+16	2.28E+08	1.89E+29	
-13	1	7.66E-11	8.10E-13	1.02E-12	1.14E+16	3.80E+07	5.25E+27	
-12	1	4.59E-10	2.91E-11	3.67E-11	1.90E+15	6.34E+06	1.46E+26	{-12,1} H-atom r
-11	1	2.76E-09	1.05E-09	1.32E-09	3.17E+14	1.06E+06	4.05E+24	
-10	1	1.65E-08	3.78E-08	4.76E-08	5.28E+13	1.76E+05	1.13E+23	
-9	1	9.92E-08	1.36E-06	1.71E-06	8.80E+12	2.94E+04	3.13E+21	
-8	1	5.95E-07	4.90E-05	6.17E-05	1.47E+12	4.89E+03	8.68E+19	
-7	1	3.57E-06	1.76E-03	2.22E-03	2.44E+11	8.16E+02	2.41E+18	
-6	1	2.14E-05	6.34E-02	7.99E-02	4.07E+10	1.36E+02	6.70E+16	
-5	1	1.29E-04	2.28E+00	2.88E+00	6.79E+09	2.27E+01	1.86E+15	
-4	1	7.72E-04	8.22E+01	1.04E+02	1.13E+09	3.78E+00	5.17E+13	
-3	1	4.63E-03	***2.96E+03***	3.73E+03	1.89E+08	0.629	1.44E+12	{-3,1} Sun black hole r=2.95E+3
-2	1	2.78E-02	1.07E+05	1.34E+05	3.14E+07	0.105	3.99E+10	
-1	1	1.67E-01	3.84E+06	4.83E+06	5.24E+06	0.017	1.11E+09	{-1,1} Earth size
0	1	1	1.38E+08	***1.74E+08***	8.73E+05		3.08E+07	Sun core
0	2	2	5.52E+08	6.96E+08	4.37E+05		7.69E+06	Sun surface
0	3	3	1.24E+09	1.57E+09	2.91E+05		3.42E+06	corona
0	4	4	2.21E+09	2.78E+09	2.18E+05		1.92E+06	corona
0	5	5	3.45E+09	4.35E+09	1.75E+05		1.23E+06	corona
1	1	6	4.97E+09	6.26E+09	1.46E+05		8.55E+05	corona
1	5	30	1.24E+11	1.57E+11	2.91E+04		3.42E+04	Earth
2	1	36	1.79E+11	2.26E+11	2.43E+04		2.37E+04	Mars {2,1} gravity-r
2	2	72	7.16E+11	9.02E+11	1.21E+04		5.94E+03	Jupiter
3	1	216	6.44E+12	8.12E+12	4.04E+03		6.60E+02	Kuiper belt {3,1}
4	1	1296	2.32E+14	2.92E+14	6.74E+02		1.83E+01	Oort begin {4,1}
5	1	7776	8.35E+15	1.05E+16	1.12E+02		5.09E-01	Oort end {5,1}
6	1	4.67E+04	3.01E+17	3.79E+17	1.87E+01		1.41E-02	
7	1	2.80E+05	1.08E+19	1.36E+19	3.12E+00		3.93E-04	
8	1	1.68E+06	3.90E+20	4.91E+20	5.20E-01		1.09E-05	{8,1} Milky way, r=5~9E+4 ly,
9	1	1.01E+07	1.40E+22	1.77E+22	8.67E-02		3.03E-07	
10	1	6.05E+07	5.05E+23	6.36E+23	1.44E-02		8.42E-09	{10,1} Virgo SupClst r=5.5E+7 ly
11	1	3.63E+08	1.82E+25	2.29E+25	2.41E-03		2.34E-10	{10,2} Laniakea r=2.6E+8ly
12	1	2.18E+09	6.54E+26	8.24E+26	4.01E-04		6.49E-12	{11,5} observ Univ r=4.4E+26
13	1	1.31E+10	2.36E+28	2.97E+28	6.69E-05		1.80E-13	{13,1} our Universe?
14	1	7.84E+10	8.48E+29	1.07E+30	1.11E-05		5.01E-15	
15	1	4.70E+11	3.05E+31	3.85E+31	1.86E-06		1.39E-16	{15,1} our universe?

Comparing Table 5 to Table 6, it is obvious that Sun core's v_{rms} = 6.24E+5 m/s is in between orbital v_n = 8.73E+5 m/s at {0,1} and orbital v_n = 4.37E+5 m/s at {0,2}, and corona's v_{rms} = 3.52E+5 m/s matches orbital v_n = 2.91E+5 m/s at {1,3} reasonably well. So it is likely that at both inside Sun and at corona space, the molecular orbital velocity's (macro, non-random movement) kinetic energy is directly transformed into temperature (micro and random movement) as thermokinetic energy. I calculated out this correlation in April 2017, but did not think about why this correlation exists until August 2018 (right before I publish this paper). Actually there is a perfect reason why this correlation exists. If we assuming the pre-Sun ball is made of purely hydrogen atoms, then in each N super shell and n shell, all H-atoms are doing random eccentric orbital movement (meaning random in both eccentricity and rotation direction) around the center of Sun with the averaged velocity value equals to the n shell's orbital velocity value v_n. The randomness of these H-atoms' velocity (the vector's directional randomness in r, θ, φ, 3D-dimension, plus the velocity value's randomness around the Boltzmann distribution) makes it equals to the v_{rms} and forms the basis of temperature in this n shell. Then after the N super shell collapsed, > 99.9% of H-atoms fall into the N-1 super shell, only << 0.1% H-atom that happened to have the velocity exactly in +φ dimension will be leftover and transformed to be the true orbital circular movement. This explains the molecular basis of the correlation between v_{rms} and orbital v.

According to this explanation and the calculation in Table 6, the super shell between {0,1} and {1,1} is expected to have 3.08E+7 K ~ 8.55E+5 K, therefore Sun surface's T=5800 K is abnormal, and corona's high temperature is normal. Then how does the low surface temperature of Sun form? Is it come from the Sun's (slow) spin speed? Sun spins with period= 25.05 days at equator (see wiki "Sun"), generated the v_{spin} = 2* 3.14* 6.96E+8 / (25.05d*24*3600) = 2018 m/s. If we assume this spin velocity equals to the v_{rms}, then T = (1/2)m v^2_{avg} / [(3/2) k], the corresponding temperature is only 164 K, too low for Sun surface's T = 5800 K. So Sun surface temperature is not related to Sun's spin velocity.

Actually we can explain Sun's low surface temperature by using the idea gas law PV = *n*RT, where the italic *n* is number of moles, R = 8.314 J/mol/K is the universal gas constant. In a small cubic volume (r + dr, θ+dθ, φ+ dφ) at right below Sun surface, on all 6 faces of this cube, V≈ constant (or =V ± dV), *n* ≈ constant (or = *n* ±d*n*). On 5 faces of this cube (-r, ±θ, ±φ), P ≈ constant (or = P ± dP), only at +r face, P ≈ 0. So at the position of +r + dr, (P≈0)V = *n*RT, it has to have T ≈ 0. So the idea gas law shows that Sun surface (at outward face) should have very low temperature due to the cliff-fall of gas pressure. This is exactly the same mechanism as an air conditioner produces the cold Freon gas.

Now let us use the molecular based thermodynamics to explain: In the same small cube (r + dr, θ + dθ, φ + dφ) at right below Sun surface, a group atoms/ions have the v_{rms} (correlates to Sun's surface T), but the direction of these v_{rms} vector diffused completely (equivalent to rotation diffusion, or RF). Among them, only very small % (let us suppose 1 PPT, Parts Per Trillion) of atoms/ions have their v_{rms} direction almost exactly at +r direction, and they fly out of Sun surface to the {0,n=2..5}o orbit shells and become Sun's corona mass. So at right out of Sun surface (r + dr shell), all these flown-out atoms/ions lost their (micro and random) thermal motion, and only have +r direction (macro) motion. Because the macro motion does not associate with the T, therefore these atoms/ions have T close to 0 K. The residue of small (left over) random motion in θφ-dimension causes Sun surface (out)'s real temperature = 5800K. So at Sun surface where the apparent T = 5800 K, atom/ion molecular v_{rms} is not low at all.

Then let us use the Solar {N,n} QM model calculation to explain this. In Table 6, using Solar {N,n} QM model, we calculate out that at Sun surface {0,2}, the orbital v = 4.37E+5 m/s. Suppose the v_{rms} ≈ orbital v, then it is equivalent to T = 7.69E+6 K. Now let's suppose that at Sun (just below) surface, the temperature is 7.69E+6 K. So all ions have v_{rms} = 4.37E+5 m/s with velocity vector direction diffused (or RF) completely. Among them, there are very small % (let us suppose 1 PPT, Parts Per Trillion) of ions have their v_{rms} direction almost exactly at +r direction, so they will shoot out of Sun surface {0,2} to corona's {0,n=1..5}o orbit shell space. Using classical physics energy conservation, (1/2)mv^2 – GMm /r_1 = 0 – GMm /r_2 , a hydrogen atom with mass (m) of proton, at Sun surface with r_1 =6.96E+8 m, with v =4.37E+5 m/s, will shoot out and then stop at r_2 = -GMm / [(1/2)mv^2 – GMm /r_1] , or r_2 =1.39E+9 m, near the r of {0,3}. Since this part of ions shows T = 5800 K, which correspond to v_{rms} = 1.2E+4 m/s, so these out-shooting ions have r-dimension v_{rms} = 4.37E+5 m/s, and θφ-dimension v_{rms} = 1.2E+4 m/s.

Now let us see what v_{rms} is needed for an ion to be shot to r of {1,1}. (1/2)mv^2 – GMm /r_1 = 0 – GMm /r_2, where r_2 at {1,1} = 6.26E+9 m, so it needs v = sqrt(2GM(1/r_1 - 1/r_2)) = sqrt(6.67E-11 *1.99E+30*(1/6.96E+8 -1/6.26E+9)*2) = 5.82E+5 m/s.

So now things become more clear: at beneath Sun surface T = 7.67E+6 K, the atom's v_{rms} =4.37E+5 m/s. Tiny amount of atoms (< 1 TTP) having v_{rms} vector direction at exactly +r direction shoot out and then (mainly) stops at {1,3} and become corona ions. When ions just leave the Sun surface, their r-direction-only v_{rms} (still the same value =4.37E+5 m/s) causes the apparent T decreased to very low. Their v_{rms} 's random deviation in θφ dimension is 1.2E+4 m/s, which causes its T = 5800 K. Small amount of ions at the high-end of Boltzmann distribution of v will shot out to {1,1} and beyond, forming Solar wind.

Then the next question is what makes these shot out ions regain the random movement? The previously shot out ions will fall back to Sun under the gravity attraction, and newly shooting out ions have a lot of chances to collide with the falling back ions, then the collision generates the random movement. The {0,n=2..5}o (strong) orbits generated by the Solar {N,n} QM (at birthday) have retained large amount of the random moving ions that have the right v_{rms} in θφ-dimension, so it forms the corona ion shells. Therefore in corona shell, the new shot out ions transformed their positive r-direction only v_{rms} back into the random direction v_{rms}, and restored T from 5800 K back to ~3.52E+6 K. Why to ~3.52E+6 K? Because it is determined by Solar QM at {0,3} orbit! Also ions in corona are in kinetic equilibrium, always coming (newly shooting out) and go (falling back). So now we have everything nicely explained under Solar {N,n} QM model.

As a result of this analysis, now I name 5800 K as Sun surface's residue (or apparent) temperature, and 7.67E+6 K as Sun surface's true temperature.

Carefully looking at the Solar {N,n} QM generated temperature (shown in Table 6 column 8, now I call it Sun QM's T), we can see that our real world matches it quite well at the shell space of inside the Sun {0,2}, or corona from {0,3} to {1,1}. At the shell space outside of {5,1}, T <1 K, so Sun's orbital v has no effective affect to generate T beyond {5,1}. Beyond {5,1}, the electromagnetic field energy caused temperature is ~2.7 K, so I guess the molecular temperature is also close to the same value (if we ignore the Milky way galaxy's affect). However, besides the Sun surface's temperature is much lower than the Sun QM's T, there is one more shell space, from around {1,1} to nearly {5,1}, has its temperature significantly lower than the Sun QM's T. For example, at (2,2}, Sun QM's T = 5.94E+3 K. If it is real, then Jupiter on {2,2}o orbit would have evaporated most part of its mass already. Also at {1,5}, Sun's QM T = 3.42E+4 K, if true, then our Earth would have everything (including the inner core) evaporated. Then how to explain it? Again, Sun QM's T is the up-limitation of T for Solar QM because is calculated based on the solar system is made by purely hydrogen atom. In reality, Sun QM's T correlates more to the solar wind's velocity (partly because solar wind is close to r-direction only, also partly because the ionic particles that make solar wind are not too larger than hydrogen atom). Since the movement of ions in solar wind lost the 3D randomness, this v is no longer associated with the temperature.

The second explanation is (let's using {1,5}o orbit shell mass to explain), before pre-Sun collapsing, all mass in the {1,5}o orbit shell had high randomness (or RF, or entropy) of molecular movement. If all mass was in form of H-atom, then all mass in {1,5}o orbit shell should have v_{rms} =2.91E+4 m/s, or T=3.42E+4 K. However, large part of mass was in fragment of ice, rock, etc., so the actual T of all mass in {1,5}o shell was much lower (but I believe it was still above 1000 K). After pre-Sun ball collapsed, collapsed mass (>99%) carried all RF movement into the current Sun ball. The left over mass (<1%) all had the same one direction movement in the positive φ-dimension, so just like that the Solar wind still has the Sun QM's v_{rms}, but it lost the micro randomness so its v_{rms} dissociated from T, the {1,5}o orbit moving mass carries the same v_{rms} of Sun QM's T, but it lost the micro randomness so its v_{rms} also dissociated from T. This is the second main reason that the current shell space of {1,1} to {5,1} has true temperature much lower than that of Sun QM's T.

Furthermore, immediately after pre-Sun collapse, although all mass in the {1,5}o orbit ring had same v_{rms}, there was still residue randomness (or entropy) in each fragment or molecule. After accreted into a planet, the residue randomness becomes the heat of the newly accreted Earth. Then the hot new Earth slowly cooled down, and much of the randomness lost as the infrared radiation which randomly shoots out into the outer space. Therefore most part of the residue randomness/entropy of mass in {1,5}o orbit shell had been transformed into the randomness of IR photons in the out space. This is the third reason that the current shell space of {1,1} to {5,1} has true temperature much lower than that of Sun QM's T.

Note: wiki "solar wind" mentioned that "*In near-Earth space, the slow solar wind is observed to have a velocity of 300–500 km/s*", it equals to the orbit velocity at between {0,2} and {0,3} (see Table 6 column 6). Wiki "*heliosphere" mentioned that "The termination shock is the point in the heliosphere where the solar wind slows down to subsonic speed (relative to the Sun) because of interactions with the local interstellar medium… The shock arises because solar wind particles are emitted from the Sun at about 400 km/s, while the speed of sound (in the interstellar medium) is about 100 km/s*". So the solar wind at termination shock is ~ 1E+5 m/s, which equals to the orbit velocity at ~ {1,1} (see Table 6 column 6). I guess that the values of solar wind speed mentioned by wiki are those at the high end of the Boltzmann distribution of the v_{rms}.

V. Sun's magnetic field and sunspot can be explained by using {N,n} QM dynamics

Due to the size limitation of this paper, this part has been moved to the paper SunQM-3s9.

VI. More discussion on the geometry and the building block of Solar {N,n} QM structure

Solar {N,n//6} QM can also be described by as a {N,n//2} QM, with {-1,3//6} = {-1,1//2}, {-1,6//6} = {0,1//6} = {0,1//2}, and {0,2//6} = {0,2//2}. All original planets can be described by a {N,n//2} QM (see paper SunQM-3s6 Table 2). Moon can be described by a {N,n//2} QM too (see paper SunQM-1s3 section III). So **the {N,n//2} QM structure is the most basic {N,n} QM structure in our universe**, it fits to our Sun, all planets, moons, etc.

The Earth-size r = 6E+6 (+/- 2E+6) m is one of the most basic sizes of the building block for celestial body. It has been seen in Sun's {-1,1//6} Au/Pb core, all planets' Earth-sized core (or C, O, Mg, core), all starts' white dwarf.

Neptune size is one the basic size of the building block for celestial body, probably due to it is n=2 of Earth-size (n=1). It is common because all original planets had size around Neptune's.

Saturn's size is also one of the basic sizes of the building block for celestial body, probably due to it is n=3 of Earth (n=1). Jupiter's size is also one of the basic sizes of the building block for celestial body. It is common because it constitute a class of largest planets before start the H-fusion. Examples like Jupiter, and also Sun's {-1,3} C, O, core which will never start C-fusion in Sun's whole life.

Sun core size {0,1} is also one of the basic sizes of the building block for celestial body, probably due to it is n=2*3=6 of Earth-size (n=1). It is common because it constitutes a stable H-fusion core for all main stars. It may also be the common size for many red dwarf stars.

One correction for paper SunQM-3s1: Bipolar overflow is better to be written as n*l*0 effect, *l* can be any or combination of *l* = 1, 2 … n-1, but not include 0 because *l* = 0 is a sphere, no bipolar. So nL0 is only one of the possible bipolar overflow modes.

One minor modification for Solar QM {N,n} structure periodic plot in paper SunQM-1 (see Figure 3). The period factor for N = -1 super shell is changed from 6 to 6.75, so that {-3,1} QM structure's r can be the exact value of the Sun mass's Schwarzschild radius 2.95E+3 m. For detailed explanation, see Table 1 of paper SunQM-1s1.

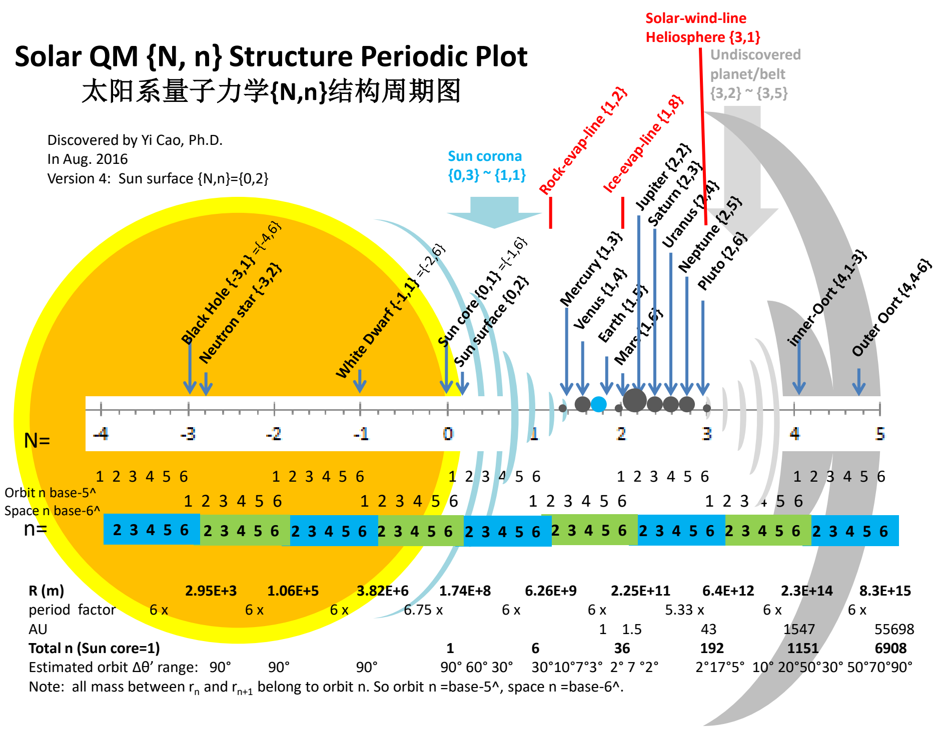

Figure 3. Solar QM {N,n} structure periodic plot (modified from paper SunQM-1 Figure 2).

Conclusion

1) According to the Sun {N,n} QM's probability density r-distribution, Sun's internal structure has been predicted as one Earth-sized core plus 5 shells. The (close to the true) mass densities for {-1,1} core, {-1,1}o, {-1,2}o, {-1,3..4}o, {-1,5}o, and {0,1}o orbit shells are ~160000, 75000, 45000, 25000, 12000, and 6000→ 0 kg/m^3 respectively.

2) In Sun's {0,1}o = {-1,n=6..11}o orbit shells, the radiative zone belongs to the {-1,n=6..9}o orbit shells, and the convective zone belongs to {-1,n=10..11}o orbit shells. According to "photon thermos core (PTC)" effect, the {0,1}o = {-1,n=6..11}o shell uniformly increases the temperature. According to "lower mass density causes lower convection point" effect, {-1,11}o and {-1,10}o orbit shells started convection one after another. These two onsets of convection might directly cause the onset of two "snowball Earth" period in the Earth history. The timeline of the possible future onset of Sun's new convection is estimated.

3) Solar {N,n} QM analysis shows that the melting (or convection) in the {-1,n=1..5}o super shell causing elements repositioned as Au, Pb mainly inside {-1,1} Earth-sized core, Fe mainly in {-1,1}o orbit shell, O, C, Ne, mainly in the {-1,2}o orbit shell, He mainly in {-1,n=3..4}o orbit shells, and H mainly in the {-1,5}o orbit shell. As the result, inside the current Sun's inner core, the H-fusion is not happening everywhere, but only in {-1,5}o orbit shell.

4) The true (v_{rms} related) temperatures at Sun's core (~3.8E+7 K, v_{rms} = 8.73E+5 m/s), Sun's surface (~7.69E+6 K, v_{rms} = 4.37E+5 m/s) and corona (~3.42E+6 K, v_{rms} = 2.91 m/s) are continuously decreasing as expected. The apparent (or the residue) temperature at Sun surface (= 5800 K) is due to that ions shooting out of the Sun surface (at v_{rms} = 4.37E+5 m/s) are all in +r dimension and lost the micro randomness, so that this v_{rms} no longer associate with the temperature. When ions just leave the Sun surface, their θφ dimension's v_{rms} is 1.2E+4 m/s, which causes its T = 5800 K.

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[10] A series of my papers that to be published (together with current paper):
SunQM-3s6: Predict mass density r-distribution for Earth and other rocky planets based on {N,n} QM probability distribution.
SunQM-3s7: Predict mass density r-distribution for gas/ice planets based on {N,n} QM probability distribution.
SunQM-3s8: Using {N,n} QM to study Sun's internal structure, convective zone formation, planetary differentiation and temperature r-distribution
SunQM-3s9: Using {N,n} QM to explain Sun's and Earth's dynamo, the sunspot drift, and the continental drift.
SunQM-5: A new version of QM based on interior {N,n}, multiplier n', |R(n,*l*)|^2 |Y(*l*,m)|^2 guided mass occupancy, and RF, and its application from string to universe.
SunQM-5s1: White dwarf, neutron star, and black hole re-analyzed by using the internal {N,n} QM.

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