SunQM-7s2: The Possible Origins of the Relativistic Length Contraction, E=mc^2, and to Fuse the General Relativity's Radial Contraction with the Non-Linear {N,n} QM

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Abstract

The newly established {N,n} QM includes the Bohr-QM based part (see in SunQM-1 series, SunQM-2, SunQM-5 series, and SunQM-7), the Schrodinger-equation based part (see in SunQM-3 series and SunQM-4 series), and the {N,n} quantum field part (see in SunQM-6 series). In SunQM-7s1, I used r'rθφ-4D orbital motion to explain the origins of the lightspeed and the constancy of the lightspeed in our universe. In the current article, first, by degenerating a xy-2D circular motion into a x-1D oscillational motion (that mimic a degeneration of a r'rθφ-4D motion into a rθφ-3D motion), I was able to deduce out the Lorentz transformation equation in 3D. From this, I hypothesized that the projection of a group of "4D thermal motion" in a 3D space may be the origin of both the special relativity's length contraction (SR L-contraction), and general relativity's radial contraction (GR R-contraction). Second, I showed that on a black hole (BH) surface, the rθφ-3D space may be degenerated into a 1D space (for the velocity), and this 1D space may can be treated as either a r-1D space or a φ-1D space (as you like). Third, using "4D thermal oscillation" (and with several examples), I explained the possible origin of the $E = mc^2$. Fourth, many kind of non-linear {N,n} QM effects (that I encountered during the {N,n} QM development, and that may or may not relate to the GR R-contraction) were listed. Furthermore, I was able to construct the non-linear {N,n//q} QM structure near a BH (where q = 6 increased to q = ∞) by fusing the GR R-contraction calculation into the non-linear {N,n//q} QM structure's calculation. This is a huge achievement in unifying the relativity theory to the {N,n} QM theory. Fifth, (Like that the nLL state vs. nL0 state is a pair of brand new parameters in the physics to describe the RF character), the difference between SR L-contraction and GR R-contraction could be another pair of parameters in the physics to describe the relativistic character. Sixth, by using "4D thermal oscillators", I was able to explain the slower speed of the outmost shell of the 3D wave packet for a propagating photon. Finally, because of its completeness and self-consistence, I do believe that the {N,n} QM is qualified to be put into the "Feynman Pool" as one of the many co-existing QM theories.

Key Words: Quantum mechanics, {N,n} QM, general relativity, special relativity

Introduction

In August 2016, I discovered that the Solar system can be described by a brand new {N,n//6} quantum mechanical structure [1]. Based on that result, (during the 10 years of the closed-door research), I further (independently) developed the {N,n} QM theory, and showed that not only the formation of Solar system [1] ~ [16], but also the formation of the whole universe [17] ~ [25], may can be described by the {N,n} QM. (Note: As an independent scientist, some of my research work may belong to a citizen-scientist-leveled work). As part of the {N,n} QM development, I (independently) designed and developed a brand new {N,n} QM field theory (for any point-centered field, like a mass field, a force field, an energy field, etc.) [23] ~ [24],

[26] ~ [34]. The foundation of this theory includes: the four fundamental forces (Gravity, Electromagnetic, Strong, Weak, abbreviated as G-, EM-, S-, W-forces) have been re-classified into three pairs of force (E/RFe-force, G/RFg-force; S/RFs-force, see SunQM-6); all point-centered fields (including the mass field, the force field, and the energy field) can be represented by the Schrodinger equation/solution (in form of non-Born probability as well as in form of a 3D spherical wave packet, see SunQM-6s4); the non-Born probability description (that equals to the re-explanation of the Born probability density) as the collection of all elliptical orbital tracks (or, the Born probability density map's contour lines can be re-explained as the trajectory of a motion electron, see SunQM-6s2's Fig-2), the spherical 3D wave packet description (with each shell's diameter equivalent to about one wavelength of the matter wave), the dis-entanglement of the outmost shell of the 3D wave packet (i.e., the "general decaying" process, see SunQM-6s1, -6s2, -6s3), the "|nL0> elliptical/parabolic/hyperbolic orbital transition model" (see SunQM-6s2, -6s3), the seamless transformation between a quantum process and a continues process through moving the r_1 inward (see SunQM-5s2), and the trick that using the high-frequency n' quantum number to pin-point any small region in the {N,n} QM field (see SunQM-3s11, SunQM-6s1, etc.). So, the {N,n} QM is constituted with two parts: the Bohr-QM part (with {N,n} structure added), and the Schrodinger-equation-QM part (with RF, and {N,n} QM field theory added). In paper SunQM-7s1 [35], I presented my over ten years of thinking on the space formation, transformation, orthogonality, and the possible origin of the lightspeed and its constancy. In the current paper, I further studied the possible origins of either the $E = mc^2$, or the length contraction in the special relativity and the radial contraction in the general relativity. Furthermore, I successfully fused the General Relativity's radial contraction calculation into the non-linear {N,n//q} QM structure's calculation at a black hole's surface. (Note: I am not a relativity physicist. I am a {N,n} QM scientist. All I did here is to develop a {N,n} QM field theory to re-describe some relativistic phenomenon. All these re-descriptions may belong to a citizen-scientist-leveled work).

Note: **QM** means Quantum Mechanics, **RF** means "**R**ota**F**usion" (or rotation diffusion), **BH** means "black hole", **GR** means "general relativity", and **SR** means "Special relativity", |n*l*m> means |n,*l*,m> QM state, "**nLL**" or |nLL> means |n,*l*,m> QM state with *l* = n-1 = L, and *m* = n-1 = L. "**nL0**" or |nL0> means |n,*l*,m> QM state with *l* = n-1 = L, and m = 0. For {N,n} QM nomenclature as well as the general notes, please see SunQM-1's sections VII & VIII. Note: The best reading sequence for the (36 posted) 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, 7, 6, 6s1, 6s2, 6s3, 6s4, 6s5, 6s6, 6s7, 6s8, 6s10, 6s10, 7s1, and 7s2. 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. Note: Microsoft Excel's number format is often used in this paper, for example: x^2 = x^2, 3.4E+12 = $3.4*10^{12}$ = 3.4×10^{12}, 5.6E-9 = $5.6*10^{-9}$. Note: In previous SunQM papers, the current paper was cited as "SunQM-7s2: Relativity and non-linear {N,n} QM … (part-2)".

I. The projection of a group of "4D thermal oscillators" in a 3D space not only may be the origin of a 3D mass particle, but also may be the origin of the length contraction in special relativity, and radial contraction in general relativity

I-a. A brief review of the length contraction in the special relativity, the radial contraction in the general relativity, and the singularity (viewed under the {N,n} QM)

Here is a brief review of the Special Relativity (abbreviated as "**SR**") caused length contraction [36], [37] (abbreviated as "**SR L-contraction**")

$$l = l_0\sqrt{1-\frac{v^2}{c^2}} \qquad \text{eq-1}$$

where l_0 is the length at rest (i.e., at v = 0). Here is a brief review of the General Relativity (abbreviated as "**GR**") caused radial contraction [38] (abbreviated as "**GR R-contraction**")

$$dl = dl_0\sqrt{1-\frac{R_s}{r}} \qquad \text{eq-2}$$

where dl_0 is the radial length at r = ∞ where there is zero radial contraction, and the Schwarzschild radius [39]

$$R_s = \frac{2GM}{c^2} \qquad \text{eq-3}$$

Eq-2 tells us that the closer to a BH, the more contraction for the radial length, until it completely contracted to $dl = 0$ when we reach to the surface of the BH.

Now let's re-explain the above result under the {N,n} QM. According to eq-2, for a BH, the rθφ-3D space only exists at the outside of the BH, and the r-1D dimension is stopped at the surface of the BH. Inside a BH, there is no more rθφ-3D space because the r-1D dimension is contracted to zero. In other words, the r-1D is meaningless inside a BH if we viewed from a rθφ-3D space. Then, because of this, a Sun-massed BH at the size of {-3,1//6} can be viewed as a singular (or a point mass with r = 0, due to that the r-1D is meaningless inside a BH). The "singularity view" is what we learned from the text book, and now I may can explain it in this way. It may also support the {N,n//6} QM structural analysis result at q' = ∞ (see in section VI). However, because of this, the hypothesized super stable {-5,1//6} sized BH (in the paper SunQM-1) may become meaningless.

I-b. The projection of one (or a group of) "4D thermal motion" in a 3D space may be the origin of the length contraction in the special relativity

Figure 1a illustrated a simple circular motion in xy-2D. As explained in Giancoli's physical text book [40], once we degenerate the xy-2D motion into a x-1D motion, it becomes a simple harmonic oscillation **(SHO)**. Notice that by using the right triangle similarity relationship, we can obtain the equation $\frac{\sqrt{A^2-x^2}}{A} = \frac{v_x}{v_{max}}$, or,

$$x = A\sqrt{1-\frac{{v_x}^2}{{v_{max}}^2}} \qquad \text{eq-4}$$

In a 3D space, this physics (that shown in Figure 1) can be used to explain the "3D thermal motion" and the "3D temperature" inside a Sun. First, from the view of micro-world, Figure 1b can be used to represent the (micro) "3D thermal motion" of a H-atom inside the Sun. The random "3D thermal motion" of each H-atom inside a Sun can be simplified as it is doing a (x-1D) simple harmonic oscillation along one x-axis (while this x-axis is further doing random RF all the time, driven by the random collision between the neighboring H-atoms). Alternatively, it can be mimicked as a simple xy-2D (micro) circular motion while the xy-2D plane is doing RF motion all the time (or the angular momentum vector $\vec{\boldsymbol{L}}$ of this (micro) circular motion is doing RF motion all the time). From my previous SunQM-3s8 work, we know that the tangential speed of this xy-2D (micro) circular motion (i.e., the $|v_{max}|$ in Figure 1b) directly gives out the temperature (T) of the Sun at this (macro) position (inside the Sun, at the orbital r relative to the Sun's center). Second, from the view of macro-world, Figure 1b can be used to represent the θφ-2D RF (macro) motion of the matter waves in a spherical orbital single shell space (at the orbital radius r) of the Sun, and we know that the (macro) orbital speed of this spherical orbital shell (i.e., the $|v_{max}|$ in Figure 1b) directly gives the temperature of this spherical orbital shell inside the Sun. (Note: Check SunQM-2's section III for the RF and wave packet inside a Sun, and check SunQM-3s8's section IV for the "3D temperature" and the "3D orbital velocity" inside a Sun).

Similarly, in a 4D space, this physics (in Figure 1) can also be used to explain the "4D thermal motion" and the "4D temperature" inside our universe. In this case, in a point-centered r'rθφ-4D space (as illustrated in Figure 1c), we need to treat

x'-axis as the rθφ-3D, and y'-axis as the 4th dimension r'. In Figure 1c, the micro 4D thermal motion's "$|\vec{v}_{max}| = c$" is equivalent to the tangential speed of this r'rθφ-4D micro circular motion at the macro 4D orbital shell with the macro radius r', and the (macro-world variable) $v_{x'}$ is the projection of "$|\vec{v}_{max}| = c$" (although it is originated from the micro thermal motion, but it can also be treated as the macro matter wave's macro RF motion in the macro r'rθφ-4D space) on the x'-axis (i.e., in our 3D universe). Then, we can use the similar analysis that was used before (for the "3D thermal motion" analysis inside the Sun) for the 4D analysis. First, in view of the micro-world, Figure 1c can be used to represent one (micro) "4D thermal motion" of each "4D thermal oscillator" that projected into our 3D universe. The random (micro) "4D thermal motion" of each "4D thermal oscillator" (once projected into our universe) can be simplified as it is doing a simple harmonic oscillation along one x'-axis (i.e., our 3D universe). It can be further mimicked as a x'r'-2D circular motion (notice that x'r'-2D equals to r'rθφ-4D). And we know that the tangential speed of this (micro) x'r'-2D circular motion (i.e., the "$|\vec{v}_{max}| = c$" in Figure 1c) directly gives out the "4D temperature" at this 4D shell (or this single 4D shell space with macro-world's radius r' = A in Figure 1c) of the onion-like 4D ball space. Second, in view of the macro-world, Figure 1c can be used to represent the (macro) RF motion of the (macro) matter waves in a spherical orbital single shell (macro) space (at the orbital radius r') of the onion-like r'rθφ-4D ball space, and we know that the orbital speed of this 4D spherical orbital shell (i.e., the macro $v_{n,4D}$, or the "$|\vec{v}_{max}| = c$" in Figure 1c) directly give out the "4D temperature" of this spherical orbital shell in the onion-like r'rθφ-4D ball space (i.e., our 3D universe). (Note: Also see SunQM-7s1's section-III for the similar explanation).

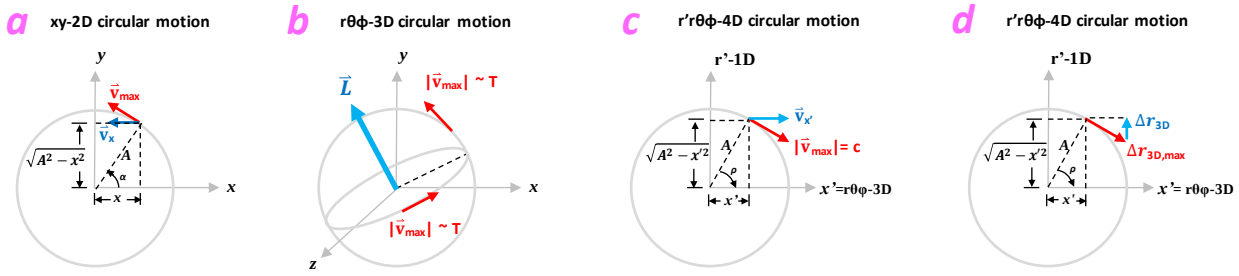

Figure 1a. A simple circular motion in xy-2D that can be transformed into a simple harmonic motion in x-1D.
Figure 1b. To illustrate that the (micro) "3D thermal motion" that correlating to the "3D temperature" inside a Sun (or $|\vec{v}_{max}| \sim T$) is further correlating to the (macro) orbital speed $|\vec{v}_{max}|$ of the orbital shell that inside a Sun.
Figure 1c. To illustrate that a simple circular motion in x'r'-2D (or r'rθφ-4D) can be transformed into a simple harmonic motion in x'-1D (or rθφ-3D), while producing the relativistic length contraction and/or radial contraction.
(Note: This is in 4D , not in 3D). (Note: This explanation is based on a big assumption: for the purpose of analyzing the degeneration of rφ-2D into φ-1D, it can be analyzed as to degenerate a xy-2D into a x-1D, simply because x-1D is orthogonal to y-1D, and r-1D is also orthogonal to φ-1D).
Figure 1d. Similar as that in Figure 1c, but the $|\vec{v}_{max}| = c$ is replaced by $r_{3D,max} = r_0$. Notice that Figure 1d is really a rθφ(Δr)-4D plot, although it is closely related to a r'rθφ-4D plot, see Appendix A for more explanation.

In Figure 1c, if we degenerate the x'r'-2D into a x'-1D (as that we did in Figure 1a), the x'r'-2D circular motion will become a x'-1D Simple Harmonic Oscillation (that equivalents to a SHO in our rθφ-3D spherical space, either a SHO in x-1D, y-1D, z-1D, or a correlated circular motion). Notice that both the micro thermal motion $|\vec{v}_{max}|$ and the macro orbital motion $|\vec{v}_{n,4D}|$ equal to c, (i.e., $|\vec{v}_{max}| = |\vec{v}_{n,4D}| = c$). Then, from the right triangular similarity comparison (shown in Figure 1c)

$$\frac{\sqrt{A^2-x'^2}}{A} = \frac{v_{x'}}{v_{max}}, \text{ or, } \frac{\sqrt{A^2-x'^2}}{A} = \frac{v_{x'}}{c}, \qquad \text{eq-5}$$

and we have $\frac{x'}{A} = \sqrt{1 - \frac{{v_{x'}}^2}{c^2}}$, or

$$x' = A\sqrt{1 - \frac{{v_{x'}}^2}{c^2}} \qquad \text{eq-6}$$

Notice that x' is the length in rθφ-3D space. As shown in Figure 1c, $v_{x'} = v_{3D} = v$ equals to the (macro) speed in 3D space, so the $v_{x'}$ in eq-6 can replaced by (the 3D macro speed) v. (Also notice that on the surface of this 4D ball (i.e., in the rθφ-3D spherical shell space), the variation ranges of θ [0, π] and φ [0, 2π] are always fixed, only the range of r is the variable). Then, when the (macro) motion is limited in one direction in rθφ-3D space (that is, to x-1D direction in a xyz-3D space, as shown in Figure 2b and Figure 3a), eq-6 become exactly the same as eq-1, that is, Einstein's famous formula of the length contraction in the Special Relativity. In this way, by using the model of "4D thermal oscillator" and the "4D thermal motion" that projected into our 3D space, I deduced out the length contraction of the Special relativity.

See Appendix A for how to deduce out the relativistic time dilation by using the similar method.

I-c. The projection of one (or a group of) "4D thermal motion" in a 3D space may also be the origin of the radial contraction in general relativity

Similarly, I may can use the model of "4D thermal oscillator" and the "4D thermal motion" that projected into our 3D space, to deduce out the radial contraction of the General relativity. As shown in Figure 1d, let's define that the $\Delta r = \Delta r_{3D}$ is the contracted Δr in rθφ-3D due to the macro $|\vec{v}_{x'}|$ change in rθφ-3D, and define the $\Delta r_0 = \Delta r_{3D,max}$ is the non-contracted Δr in rθφ-3D due to the macro $|\vec{v}_{x'}| = 0$. Then, from the right triangular similarity comparison (shown in Figure 1d)

$$\frac{x'}{A} = \frac{\Delta r_{3D}}{\Delta r_{3D,max}}, \text{ or, } \frac{x'}{A} = \frac{\Delta r}{\Delta r_0} \qquad \text{eq-7}$$

and combined with eq-6, $\frac{x'}{A} = \sqrt{1 - \frac{{v_{x'}}^2}{c^2}}$, we have

$$\Delta r = \Delta r_0\sqrt{1 - \frac{v^2}{c^2}} \qquad \text{eq-8}$$

Notice that in eq-8, the 3D macro motion velocity v is in r-1D that pointing to the all 4π directions in rθφ-3D space (as shown in Figure 3b), and it is NOT limited in x-1D direction in a xyz-3D space (as shown in Figure 3a). I believed that eq-8 is equivalent to eq-2, i.e., the radial contraction of general relativity. Then, why I go through all this analysis? Because this analysis showed a different origin of the Lorentz/Einstein transformation factor $\gamma = \frac{1}{\sqrt{1-v^2/c^2}}$, (that is different than the standard deduction in all text books [41]).

In summary, by supposing that our 3D universe is a spherical surface shell of an onion-like 4D ball space, and by supposing that all the mass particles in our 3D universe are the "4D thermal oscillators" that projected into our 3D space, we can naturally obtain the relativistic length contraction and radial contraction. And in turn, this analysis strongly supported the hypothesis that our 3D universe is a spherical surface shell of an onion-like 4D ball space, and the origin of the mass particle (in our 3D universe) is the "4D thermal oscillators" that projected into our 3D space.

I-d. Using Euler's complex space of "x + iy" to explain the relativistic length contraction in Figure 1c

Alternatively, we may can use Euler's complex space of "x + iy" to explain the relativistic length contraction in Figure 1c. Here, we choose our 3D space as the real number dimension (or the real number space, i.e., the x' axis), and choose the 4th dimension radius r' as the imaginary dimension (or the imaginary space) that along iy' axis. At the Euler angle $\alpha = -\rho = 0$, that means, when the involvement of the 4th dimension is zero (or purely in 3D), on the surface of a 4D ball (i.e., in our 3D universe), it must have the zero 3D speed v (see the 4D-to-3D projected $v_x = 0$ in Figure 1c), and it has the normal 3D length (see $r_{3D} = r_{3D,max}$ in Figure 1d). When $\alpha = -\rho$ angle increases more, it gets more and more involved in the 4th dimension, and thus the 3D macro speed v increased more (see the 4D-to-3D projected $v_x > 0$ in Figure 1c), and the 3D length contracted more (see $r_{3D} \leq r_{3D,max}$ in Figure 1d). (Note: In this way, the complex sign "i" may mean the involvement of another (higher) dimension, or the RF into another dimension. See the similar discussion in SunQM-2's section III).

I-e. Examples of using a group of "4D thermal oscillators" to explain either the SR L-contraction or the GR R-construction

Here is one example to use a group of "4D thermal oscillators" to explain the SR length contraction. Using a neutron as the example, and supposing that a neutron is formed by a collection (or a group) of 1000 of "4D thermal oscillators" that projected in the 3D space (i.e., in our 3D universe, and within the size of a 3D neutron). (Note: the number 1000 is a randomly assigned number). When these 1000 "4D thermal oscillators" are all doing the random directional and random phases oscillation, their projections on 3D will make the macro 3D speed (that equals to the averaged 3D speed) $\vec{\mathbf{v}}_{3D,avg} = 0$ for this neutron. In Figure 2a, in a velocity xyz-3D space, at a single time point, a (black thick) vector represents a 3D velocity vector $\vec{\mathbf{v}}$ (from a single "4D thermal oscillator"), and it has the lightspeed c (or the vector length $|\vec{\mathbf{v}}_{3D,avg}| = c$ for the micro 4D thermal motion, and also for the virtual macro 4D orbital motion). When this $\vec{\mathbf{v}}$ is doing RF (rotation diffusion, or RotaFusion, for the purpose of the random thermal motion), it forms a probability density of a sphere (as show in gray in Figure 2a), and it has the time-averaged velocity vector $\vec{\mathbf{v}}_{3D,avg} = 0$ (for both micro and macro). This gray sphere not only can be used to represent a single "4D thermal oscillator" that projected in the (velocity) 3D, but also be used to represent the collection of all 1000 "4D thermal oscillators" that projected in the (velocity) 3D, and that are doing the (random direction and random phase) 3D virtual oscillations (in a neutron). Figure 2b showed that for these 1000 of "4D thermal oscillators", when the randomness of the directions and phases of the oscillation is decreased, and when the directions are more and more aligned to the same +x direction, (and also their phases are more and more synchronized), these 1000 of "4D thermal oscillators" as a whole entity in 3D (i.e., the neutron) will show more and more macro velocity (or faster speed) in 3D in +x direction. Finally, after completely unified the oscillational directions to the +x axis, and completely synchronized the oscillational phases, these 1000 of "4D thermal oscillators" (as a whole entity in 3D) will become a neutron that is flying in +x direction at the speed of light. (Note: In this situation, the grey sphere or the grey prolate is the probability density for the vector $\vec{\mathbf{v}}_{3D,avg}$ (in +x direction). Notice that how thin and how long of the grey prolate density shape correlates to the value of vector $\vec{\mathbf{v}}_{3D,avg}$ (as shown in the red thick arrows along +x axis). Also, the quantum number n = 1, 2, 3, 4, such as |1,0,0>, |2,1,0>, |3,2,0>, |4,3,0>, etc., can be used to roughly represent the QM state of the $\vec{\mathbf{v}}_{3D,avg}$ from zero, to low, to high, and to the maximum). For a single "4D thermal oscillator" that projected on 3D, it will show the length contraction (as shown in Figure 1c and Figure 1d). However, for a group of 1000 "4D thermal oscillators" in random directions and phases, when projected on 3D as one entity, it will not show the length contraction (in the macro-world), because the length contraction in all random directions in 3D are cancelled out each other, and this equals to a neutron at $\vec{\mathbf{v}}_{3D,avg} = 0$. Only when this group of 1000 "4D thermal oscillators" greatly decreased the randomness of both direction and phase (i.e., a neutron at $\vec{\mathbf{v}}_{3D,avg} >> 0$), or even completely removed the randomness (i.e., a neutron at $\vec{\mathbf{v}}_{3D,avg} = c$), then this whole group of 1000 "4D thermal oscillator" that projected on 3D will show the (observable, or complete) length contraction (in the macro-world). Thus, for the special relativity, it is the unified 4D thermal motion of all 1000 "4D thermal oscillators" in one group (at one spot on a 4D ball surface), that makes a spot of 3D spherical space (with the mass or massless particle inside it, in this case, a mass field of a neutron) to move in +x direction with the speed close to the lightspeed c, and caused its motion trajectory contracted (i.e., the length contraction) in 3D (in the macro-world).

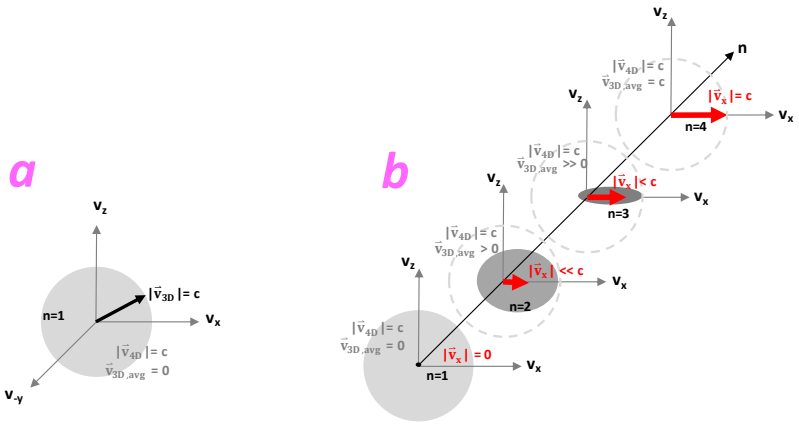

Figure 2a. To illustrate that a single "4D thermal oscillator" with the micro $|\vec{\mathbf{v}}_{4D}| = c$, after projected into the rθφ-3D, it also has the micro $|\vec{\mathbf{v}}_{3D}| = c$. And then, after the time-averaging, it showed the macro $\vec{\mathbf{v}}_{3D,avg} = 0$, (although the vector length $|\vec{\mathbf{v}}_{3D,avg}| = c$).

Figure 2b. To illustrate that a group of 1000 random micro "4D thermal oscillators" in rθφ-3D becomes a group of 1000 random "3D thermal oscillators". Then, as the n increased (or the QM state excited), more and more of these 1000 random "3D thermal oscillators" have their thermal motion direction aligned to $+v_x$, and have their thermal oscillational phases synchronized, so that this group of 1000 "3D thermal oscillators" showed a macro motion with the speed $\vec{\mathbf{v}}_x$ (that represented by the length of the red-thick-arrows in the figure).

Here is a similar explanation for the origin of the GR radial contraction. Using a BH as the example, and supposing that a BH is formed by a group of 1000 of "4D thermal oscillators" that projected in the 3D space (i.e., in our 3D universe, and within the size of a BH). As we hypothesized, our universe may be a 3D spherical space that is on the surface of a 4D ball something, (or one spherical shell in an onion-like 4D space). A BH (with too heavy mass and too high mass density) will cause (the originally perfect spherical 4D sphere surface) to have a dent at the position of BH on the 4D sphere surface, (or sunk-in the 4th dimension significantly, as shown in SunQM-7s1's Figure 2b), and thus caused the "4D thermal oscillator" to increase the 4th dimension effect (as shown in SunQM-7s1's Figure 3a). (Then, inside the dent region, all the "4D thermal oscillators" (inside the BH) are no longer in the complete random "4D thermal motion", they may become oscillating more in the r'-1D of the r'rθφ-4D space?). When projecting all these "4D thermal oscillators" into the 3D space, it caused the rθφ-3D space to have (radiated) length contraction in the r-1D at the outside of the spherical surface of the BH, (this may be because that in the rθφ-3D spherical shell space, the variation ranges of θ [0, π] and φ [0, 2π] are always fixed, only the range of r is the variable, so that in Figure 1d, the relative change of x' (in 3D) versus A (in 4D) directly correlates to the relative change of r_{3D} versus $r_{3D,max}$). Notice that in this situation, the average of the all unified 1000 "4D thermal oscillators" in the BH should cause the macro speed of BH to have $\vec{\mathbf{v}}_{3D,avg} << c$, or even $\vec{\mathbf{v}}_{3D,avg} = 0$. So this r-1D length contraction is not caused by the SR.

Figure 3 showed one simple way to explain the major difference between the SR L-contraction and the GR R-contraction: in the special relativity, the 1000 "4D thermal oscillators" are all aligned in the x-1D and synchronized all the oscillation phases to move to +x direction (as show in Figure 3a), so that it has the x-1D length contraction (and $\vec{\mathbf{v}}_{3D,avg} = \vec{\mathbf{v}}_x >> 0$), while in the general relativity, the 1000 "4D thermal oscillators" are all aligned in the r-1D, and synchronized all the oscillation phases to move to +r direction (as show in Figure 3b, if using the escape velocity for the explanation), so that it has the r-1D length contraction (and the macro $\vec{\mathbf{v}}_{3D,avg} << c$). Then, from the view of singularity, Figure 3b can be re-drawn as Figure 3c.

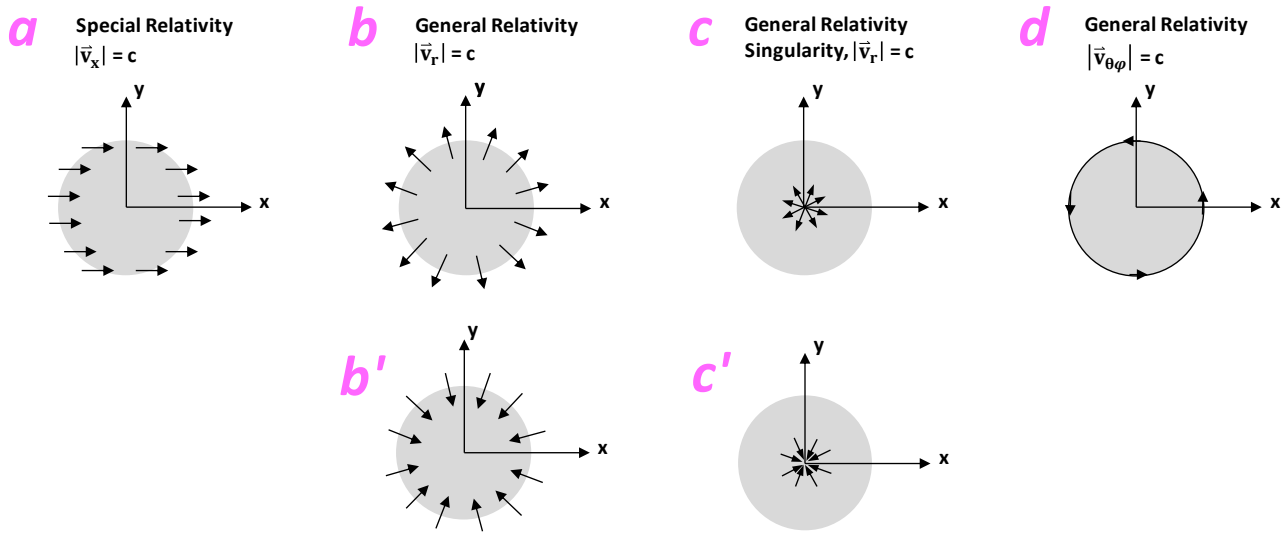

Figure 3a. To illustrate that all "4D thermal oscillators" are lined up in x-1D, so that the special relativity causes the x-1D only length contraction.

Figure 3b (or Figure 3b'). To illustrate that all "4D thermal oscillators" are lined up in r-1D, so that the general relativity causes the r-1D radial contraction in all 4π directions in the spherical 3D. Although they are the micro (thermal) speed, after all "4D thermal oscillators" on a BH's surface unified oscillational directions and phases (as shown in the figure), the combination of them become a macro r-1D speed (i.e., the escape velocity) that correlates to the value shown in eq-10. (Note: On a BH surface, when a 3D space is degenerated into a 1D space, Figure 3b' is equivalent to Figure 3b).

Figure 3c (or Figure 3c'). To illustrate the singularity view of Figure 3b (or Figure 3b'), because inside a BH, the r-1D is degenerated.

Figure 3d. To illustrate that all "4D thermal oscillators" are lined up in either the φ-1D, or the θ-1D, or the θφ-2D, so that the general relativity causes the θφ-2D only length contraction (that equivalent to r-1D only length contraction). See eq-17. (Note: On a BH surface, when a 3D space is degenerated into a 1D space, Figure 3d is equivalent to Figure 3b).

II. On a BH surface, rθφ-3D space may be degenerated into 1D space (for the velocity), and this 1D space can be treated as either a r-1D space or a φ-1D space (as you like)

When using eq-8 to calculate GR R-contraction, should we use the (macro) escape velocity, or, should we use the (macro) orbital velocity?

First, let's try to use the escape velocity to calculate eq-8. Wiki "Schwarzschild radius" mentioned that the expression of Schwarzschild radius "*had previously been calculated, using Newtonian mechanics, as the radius of a spherically symmetric body at which the escape velocity was equal to the speed of light*". In wiki "escape velocity", the escape velocity is calculated as: under the gravitational force $F=\frac{GMm}{r^2}$, (where G = gravitational constant, M is mass of Earth, m is the escaping particle's mass, r is the distance from the escaping particle to the center of the Earth), the total work for a particle from the surface r (r_{surf}) to r = ∞ is $W=\int_{r_{surf}}^{\infty}\frac{GMm}{r^2}\,dr=\frac{GMm}{r_{surf}}$. (Note: for a BH, $r_{surf} = R_s$). Then, the particle's minimal kinetic energy at departure (this must be the speed in r-1D, or, v_r) must match this work, so the escape velocity $v_{r,surf}$ satisfies

$$\frac{1}{2}m{v_{r,surf}}^2=\frac{GMm}{r_{surf}} \qquad \text{eq-9}$$

the escape velocity [42]

$v_{r,surf} = \sqrt{\frac{2GM}{r_{surf}}}$ (valid for a pointer-centered rθφ-3D space) eq-10

Comparing eq-2 with eq-8, and comparing Figure 3a with Figure 3b, I guessed that the GR R-contraction factor $\sqrt{1-\frac{R_S}{r}}$ should be equivalent to the SR L-contraction factor $\sqrt{1-\frac{v^2}{c^2}}$. According to eq-3, $R_s c^2 = 2GM$, and according to eq-10, $r_{surf} {v_{r,surf}}^2 = 2GM$, so on the surface of BH, we have $R_s c^2 = 2GM = r_{surf} {v_{r,surf}}^2$, or $\frac{R_S}{r_{surf}} = \frac{{v_{r,surf}}^2}{c^2}$, and we may can write $\sqrt{1-\frac{R_S}{r}} = \sqrt{1-\frac{v^2}{c^2}}$. Then, we may can re-write eq-2 as

$\Delta r = \Delta r_{surf}\sqrt{1-\frac{{v_r}^2}{c^2}}$ eq-11

where Δr is the contracted r-1D space at the outside of a BH surface, Δr_{surf} is the zero contracted r-1D space at r = ∞, and v_r is the (escape velocity kind of) speed in r-1D with the maximum value $v_{r,surf}$ = c at BH surface and $v_{r,\infty} = 0$ at r = ∞. Notice that eq-11 is the same as eq-8, and it was confirmed in the column 7 of Table 1 (where a Sun-massed BH surface at {-3.1//6} has the calculated $v_{r,n}$ = c). This result showed that the (macro) escape velocity is the right one to be used in the eq-8. Note: From this result, in Figure 3b, I drew the r-1D unified "4D thermal oscillation" motion directions in the unified +r direction, because these velocity vectors come from the escape velocity (on the BH surface).

Second, let's try to use the orbital velocity to calculate eq-8. According to the classical physics (with the basic Bohr-QM), after the gravitational attractive force F_g balanced out the centrifugal force F_c, the bound state orbital speed is calculated as,

$F_g = \frac{GMm}{{r_n}^2}$, $F_c = m\frac{{v_n}^2}{r_n}$, $F_g = F_c$, $\frac{GMm}{{r_n}^2} = m\frac{{v_n}^2}{r_n}$, or $v_n = \sqrt{\frac{GM}{r_n}}$ eq-12

In SunQM-3s8's Table 6 column 6, using the hot-r, I calculated the bound state n orbital velocity v_n for any H-atom inside the Sun ball (note: because the n orbit can be simplified as the circular orbit, so v_n is in the θφ-2D space, and we can re-write the orbital velocity $v_n = v_{\theta\varphi,n}$):

$v_{\theta\varphi,n} = \sqrt{\frac{GM}{r_n}}$ (valid for a pointer-centered rθφ-3D space) eq-13

Notice that by comparing eq-10 to eq-13, we see $v_{r,n} = \sqrt{2}v_{\theta\varphi,n}$. If use eq-13 for the eq-8,

$\Delta r = \Delta r_{surf}\sqrt{1-\frac{{v_{\theta\varphi}}^2}{c^2}}$ (incorrect) eq-14

However, the resulted r-1D contraction at a Sun-massed BH surface {-3,1//6} does not equal to zero (as it should be in eq-2), or the $v_{n,\theta\varphi} = \sqrt{\frac{GM}{r_n}} < c$ at a Sun-massed BH surface {-3,1//6}, (as shown in the column 6 of Table 1). Therefore, the orbital velocity (or eq-13) should not be used in the eq-8.

Then, in eq-8 for a BH, why the escape velocity eq-10 is correct, but the orbital velocity eq-13 is not correct? Here is the answer. When a "4D thermal oscillator" projected in a rθφ-3D space, it becomes a virtual (rθφ-3D) thermal oscillator. For a single virtual (rθφ-3D) thermal oscillator (that projected from a "4D thermal oscillator") on a BH's surface, it has the

maximum oscillation speed (or the intrinsic oscillation speed) = c, and its velocity vector (at any time point) can point to either r-1D, or θ-1D, or φ-1D, or any combination of rθφ-3D. Although it is a micro (thermal) speed, after all "4D thermal oscillators" on a BH's surface unified oscillational directions and phases (as shown in Figure 3b), the combination of them become a macro speed (i.e., the escape velocity) that correlates to the value given in eq-10. According to eq-10 and eq-11, I believed that (on a BH surface, for these virtual 3D oscillators) we should have either $\left|\vec{v}_{r,BHsurf}\right| = c$, and/or $\left|\vec{v}_{\theta,BHsurf}\right| = c$, and/or $\left|\vec{v}_{\varphi,BHsurf}\right| = c$, and/or $\left|\vec{v}_{r\theta\varphi,BHsurf}\right| = c$. This further means, (on a BH surface, for these virtual 3D oscillators) we should have

$\left|\vec{v}_{r,surf}\right| = \sqrt{\frac{2GM}{r_{surf}}} = c$, (that correlate to eq-10) eq-15

and/or $\left|\vec{v}_{\theta,surf}\right| = \sqrt{\frac{2GM}{r_{surf}}} = c$, (that correlate to eq-10, but maybe as $v_{\theta,surf} = \sqrt{\frac{2GM}{r_{surf}}}$) eq-16

and/or $\left|\vec{v}_{\varphi,surf}\right| = \sqrt{\frac{2GM}{r_{surf}}} = c$, (that correlate to eq-10, but maybe as $v_{\varphi,surf} = \sqrt{\frac{2GM}{r_{surf}}}$) eq-17

and/or $\left|\vec{v}_{r\theta\varphi,surf}\right| = \sqrt{\frac{2GM}{r_{surf}}} = c$, (that correlate to eq-10, but maybe as $v_{r\theta\varphi,surf} = \sqrt{\frac{2GM}{r_{surf}}}$) eq-18

So, eq-15 through eq-18 showed that no matter this "4D thermal oscillator" points to what direction in rθφ-3D, the $\sqrt{\frac{2GM}{r_{surf}}}$ is the only correct value for the micro thermal speed (that correlates the macro speed). This explains that in eq-8 for a BH, only eq-10 is correct to use, but not the eq-13.

Thirdly, why I concern so much on whether we can use the (macro) orbital speed (eq-13) for the calculation of GR R-contraction (in eq-8)? Here is the reason. According to the text book knowledge, our Sun's internal (macro) temperature is only r-1D dependent, and it directly correlates to the (micro) thermal motion of those ions. Then, after assuming the Sun is made of pure H-atoms, I found that the (micro 3D) thermal motion speed of those H-atoms (at the r_n distance from the Sun's center) may correlate to the (macro) orbital speed (i.e., eq-13, $v_{\theta\varphi,n} = \sqrt{\frac{GM}{r_n}}$) of the bound state (pseudo) binary motion between Sun and the H-atom (see SunQM-3s8's Table-6). In other words, on the Sun surface, a H-atom's micro 3D thermal motion (maximum) speed equals to the same H-atom's matter wave's (macro 3D) orbital velocity that is doing orbital motion around the Sun. Then why Sun decreased temperature from ~ millions K° to only 5800 K° across the surface? I explained it as that "*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 … 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*". Extended from this result, in the current paper, on the surface of a Sun-massed BH at size of {-3,1//6}, I initially supposed that all the " r'rθφ-4D thermal oscillators " (that projected in rθφ-3D) have the 3D (micro and maximum) virtual thermal speeds also equal to the 3D orbital speed (eq-13, $v_{\theta\varphi,n} = \sqrt{\frac{GM}{r_n}}$) at the r_n of {-3,1//6} for each of the "pseudo binary" (that between one BH and one of many virtual 3D oscillators).

However, eq-15 through eq-18 showed that on a BH's surface, a single virtual (rθφ-3D) thermal oscillator (that projected from a "4D thermal oscillator" with the intrinsic maximum speed = c) has its velocity vector (at any time point) pointing to either r-1D, or θ-1D, or φ-1D, or any combination of rθφ-3D, with the value of the (macro) escape velocity $v_{r,surf}$, and with the "true" $\left|\vec{v}_{\varphi,surf}\right| = \left|\vec{v}_{r,surf}\right| = \sqrt{\frac{2GM}{r_{surf}}} = c$. Now let's name $\left|\vec{v}_{r,surf}\right| = \sqrt{\frac{2GM}{r_{surf}}}$ in eq-16, $\left|\vec{v}_{\theta,surf}\right| = \sqrt{\frac{2GM}{r_{surf}}}$ in eq-

16, and $\left|\vec{v}_{\varphi,surf}\right| = \sqrt{\frac{2GM}{r_{surf}}}$ in eq-17 as the "**1D orbital velocity**", and name the eq-13 $v_{\theta\varphi,n} = \sqrt{\frac{GM}{r_n}}$ as the "**2D orbital velocity**". In this way, we can say that in eq-8, only the "1D orbital velocity" can be used, the "2D orbital velocity" cannot be used. After tried many different explanations, my best explanation for this is that the rθφ-3D space at the outside of BH is now degenerated into a 1D space on the BH surface. When we treat this 1D space as the r-1D (as shown in Figure 3b), it can explain the radial contraction to Δr = 0 on the BH surface (that caused by the general relativity). Simultaneously, we can treat this 1D space as either the φ-1D or the θ-1D, or even as θφ-1D (because the original θφ-2D now become θφ-1D, as shown in Figure 3d), then it can explain the (macro) "1D orbital velocity" increased to the lightspeed c on the BH surface.

Note: On a BH surface, when a 3D space is degenerated into a 1D space, besides the Figure 3d equals to Figure 3b, I also believed that the +r direction is the same as the -r direction. In this sense, Figure 3b' equals to Figure 3b, and Figure 3c' equals to Figure 3c.

Note: In Figure 1d, the contracted-distance vector $\overrightarrow{\Delta r_{3D}}$ is in the 4th dimension, or perpendicular to the x'-1D (i.e., in perpendicular to our rθφ-3D space). This analysis may reveal that when this 4th dimension is projected into our spherical rθφ-3D space, it can appear as that it is simultaneously either along the r-1D (as shown in Figure 3b in +r direction, or as shown in Figure 3b' in -r direction), or along the φ-1D (as shown in Figure 3d), or along the θ-1D, or along the RFed θφ-1D. So, when apparently all mass on a BH surface is flying inward at the lightspeed c (see in Figure 3b'), actually it is that all mass on the BH surface is also doing the circular 1D orbital motion in the lightspeed c (see in Figure 3d). (Note: This is one kind of space transformation, see SunQM-7s1's section I-b-6). (Note: This degenerated 1D space on BH surface may only apply to the velocity). (Note: This explanation may also apply to a single (rθφ-3D) thermal oscillator on the Sun's surface, except that the maximum speed of the thermal oscillation << c).

Although the "singularity view" is the mainstream view on the BH (as illustrated in Figure 3c, and I have no objection on it), here I'd like to present the new "**RF view**" on the BH under the {N,n} QM (as illustrated in Figure 3d). The above analysis made me to think that maybe we can use the RF theory for the explanation. According to the RF theory, (using E/RFe-force as the example), a static charge's primary E-force is doing RF by radiating its force lines to all 4π directions in r-1D (and to the distance of infinity). This caused its orthogonal companion force RFe-force also to do RF by circulating around all the E-force lines, and thus showed no observable magnetic force field (by sealing the magnetic force lines completely). Similarly, for a static G/RFg-force field, the primary G-force is doing RF by radiating its force lines to all 4π directions in r-1D (and to the distance of infinity). Now let's fuse the GR theory into the RF theory to be a new RF-GR theory: it would say that "the primary G-force is doing RF by radiating its force lines to all 4π directions in r-1D (and to the distance of infinity), and at the distance of infinity this G-force causes zero GR radial contraction, (i.e., a fully relaxed r-1D space)". When a r-1D is fully relaxed (or r-1D is fully in RF), it is completely orthogonal to the θφ-2D. Then, while approaching to the surface of a BH, the RF of the primary G-force (in r-1D) is decreased, not by decreasing the 4π directions, but by decreasing the relaxed r-1D space (i.e., by increasing the GR R-contraction). When a r-1D decreased the relaxation (or decreased the RF in r-1D space), it may have to transfer some RF from r-1D space to the θφ-2D space, so that the RF in θφ-2D space is increased (the RF conservation?). Finally, when approached to the surface of a BH, the RF of the primary G-force (in r-1D) is decreased to zero (by decreasing the relaxed r-1D space to zero, or by decreasing r-1D to zero, or by increasing the GR R-contraction to maximum), and all (G-force lines') RF that was in r-1D is now transferred to the θφ-2D space (now become θφ-1D), so that the primary G-force is transformed (from a r-1D-only force) to be a θφ-1D-only force, and thus it is sealed off from the outside rθφ-3D space (beyond the BH surface). Therefore, we may can use RF to explain the GR R-contraction on the BH surface.

(Note: Also see the discussion in SunQM-7s1's section-I-f, on a BH surface, the rθφ-3D space is degenerated into a **θφ-2D "mass" space**, besides it is also degenerated into a **1D "velocity" space**).

(Note: For eq-13, after the RFed (meaning RotaFusioned, or rotational diffused) θφ-2D motion is (apparently) degenerated into a φ-1D motion, we may often re-write eq-13 to be

$$v_{\varphi,n} = \sqrt{\frac{GM}{r_n}} \qquad \text{(valid only for a pointer-centered rφ-2D space, not for a rθφ-3D)} \qquad \text{eq-19}$$

Notice that eq-19 is valid only for the rφ-2D space, or a rφz-3D cylinder space, not for a pointer-centered rθφ-3D space).

III. Using "4D thermal oscillation" to explain the possible origin of the $E = mc^2$, (or, $\Delta E = \Delta m\, c^2$)

First, let's discuss the relationship between the "3D thermal (micro) oscillation" and the "3D (macro) orbital motion". In a (macro) rθφ-3D ball space, although the (circular) orbital motion is a macro-motion, it may can be correlated to (many) micro-motions (i.e., the thermal motion). For example, in a Sun (supposing Sun is made of pure H-atoms), each H-atom's thermal motion is the micro-motion (because it is the 3D oscillation in the micro-world) with the root-mean-square speed $v_{rms} = \sqrt{\overline{v^2}} = \sqrt{\frac{3kT}{m}}$, (see [43]), and the (macro) position of this H-atom in the Sun's 3D macro-world is always nearly "localized". At the same time, all H-atoms in the Sun can be re-described as that the (collective) matter waves of all H-atoms are doing the circular orbital motion (in the macro-world) inside the Sun (with the orbital speed $v_n \approx v_{rms}$, see SunQM-3s8's Table-5 and Table-6). From thermodynamics, we know that the temperature directly related to the averaged kinetic energy of the molecules. If treating the H-atoms on the Sun surface as the idea gas (that under the idea gas law *PV = NkT*), then they should (approximately) follow

$$\frac{1}{2}m\overline{v^2} = \frac{3}{2}kT \qquad \text{eq-20}$$

(see [44]), where m is the mass of one molecule of the gas, k is Boltzmann constant, and T is the temperature in Kelvin. Because $\overline{v^2} = \overline{v_x{}^2} + \overline{v_y{}^2} + \overline{v_z{}^2}$, and by assuming $\overline{v_x{}^2} = \overline{v_y{}^2} = \overline{v_z{}^2}$, we can have

$$\frac{1}{2}m\overline{v_x{}^2} = \frac{1}{2}kT,\ \frac{1}{2}m\overline{v_y{}^2} = \frac{1}{2}kT, \text{ and } \frac{1}{2}m\overline{v_z{}^2} = \frac{1}{2}kT \qquad \text{eq-21}$$

or equivalently, $\overline{v^2} = \overline{v_r{}^2} + \overline{v_\theta{}^2} + \overline{v_\varphi{}^2}$, and by assuming $\overline{v_r{}^2} = \overline{v_\theta{}^2} = \overline{v_\varphi{}^2}$, we have

$$\frac{1}{2}m\overline{v_r{}^2} = \frac{1}{2}kT,\ \frac{1}{2}m\overline{v_\theta{}^2} = \frac{1}{2}kT, \text{ and } \frac{1}{2}m\overline{v_\varphi{}^2} = \frac{1}{2}kT \qquad \text{eq-22}$$

This is for a (micro) thermal motion (that can be analyzed as a micro-oscillator's micro-3D oscillational motion with the position "localized" in the macro-3D world). It may also can be used for a bound state particle's (macro-matter wave's) orbital motion in a point-centered mass field (when the many micro-3D oscillational motions collectively formed the macro-3D circular orbital motion). Because the θ-1D and φ-1D is naturally in RF, so they usually can be (or even they should be) treated as $\frac{1}{2}m\overline{v_\theta{}^2} + \frac{1}{2}m\overline{v_\varphi{}^2} = \frac{2}{2}kT$, or $m\overline{v_{\theta\varphi}{}^2} = kT$, so for a binary bound state 3D orbital motion we have

$$\frac{1}{2}m\overline{v_r{}^2} = \frac{1}{2}kT\ , \text{ and } m\overline{v_{\theta\varphi}{}^2} = kT \text{ (in micro-world)} \qquad \text{eq-23}$$

In eq-23, initially "$\frac{1}{2}$kT " is one energy unit in one (averaged) dimension of rθφ-3D micro-world thermal oscillation, and now we can (mimicly) treat it as the "one energy unit in one (averaged) dimension of rθφ-3D macro-world orbital motion (for this bound state particle's macro orbital motion)". In this case, $m\overline{v_{\theta\varphi}{}^2}$ mimics to the total kinetical energy of a particle with mass m that is doing the orbital motion in a bound state in an averaged (macro) θφ-2D space, and (according to the Newtonian mechanics), it should mimic to the potential energy of this bound particle at the (macro) orbital radius r_n , see

$$K = \frac{1}{2}mv_n{}^2,\ V = \frac{-GMm}{r_n} = -mv_n{}^2 = -2K, \text{ (in macro-world, where K is the macro kinetical energy)} \qquad \text{eq-24}$$

Second, by using the similar analysis, combined with the model of "4D thermal oscillation" (that projected in 3D space), now I may can explain the origin of the $E = mc^2$, (or, $\Delta E = \Delta m\ c^2$). As mentioned before, all "4D thermal oscillators" have the intrinsic oscillation speed = c (in the r'rθφ-4D space), and each massed particle in 3D is the projection of a group of "4D thermal oscillators" in the rθφ-3D space. Now let's suppose that initially there is a "virtual massed particle" in 3D (with the virtual mass Δm) that is composed by a group of 99 "4D thermal oscillators" (in random direction/phases, note: the number 99 is a randomly chosen number for the illustration), and that is in bound state at a (virtual) orbital-r in 3D with the un-detectable "virtual 3D potential energy" $\Delta m\ \overline{v_{\theta\varphi}{}^2}$. Then, after all 99 of "4D thermal oscillators" unified their oscillational direction/phases so that they collectively as one group to fly away in r-1D (more often is in x-1D, as shown in a nuclear reaction) in a 3D space, this "virtual Δm particle" is excited to a (virtual) orbital $r = \infty$, so this "virtual Δm particle" (that composed by 99 synchronized "4D thermal oscillators") should carry away an amount of energy ΔE (that was originally un-detectable "4D potential energy" of) $\Delta m\ \overline{v_{\theta\varphi}{}^2} = \Delta m\ c^2$, or, this "virtual Δm particle" carries $\Delta E = \Delta m\ c^2$.

In other words, the binding energy can be treated as a "virtual binding force particle" with the "virtual mass Δm" in the bound state (that is a group of 99 random "4D thermal oscillators" with the intrinsic thermal speed c, and projected in 3D space). The releasing of this binding energy to be $\Delta E = \Delta m\ c^2$ can be treated as that (after removed the randomness and unified all 99 "4D thermal oscillators" so that they (as one group) obtained velocity c in the macro 3D space), the "binding force particle Δm" (of this 99 unified "4D thermal oscillators") is spun-off (under the "|nL0> elliptical/parabolic/hyperbolic orbital transition model") at the perihelion site of the (virtual) elliptical orbit and become a (un-localized) photon in 3D space. The virtual (macro) potential energy of this "binding force particle Δm" (notice that it may can be mimicked by the micro (averaged) oscillation energy $\overline{V}_r \to \overline{K}_{\theta\varphi} \to \frac{1}{2}\Delta m\ \overline{v_\theta{}^2} + \frac{1}{2}\Delta m\ \overline{v_\varphi{}^2} = \Delta m\ \overline{v_{\theta\varphi}{}^2}$) becomes (the 3D detectable) $\Delta E = \Delta m\ c^2$ (because all these 99 of "4D thermal oscillators" are unified in direction/phases) and then becomes the energy of this photon (i.e., the frequency/color of this photon), and the (macro orbital) kinetical energy (notice that it may can be mimicked by the micro averaged oscillation energy $\overline{K}_r \to \frac{1}{2}\Delta m\ \overline{v_r{}^2}$) of this "binding force particle Δm" becomes the speed of this photon (because all these 99 of "4D thermal oscillators" are unified in direction/phases in x-1D) and thus this photon should have the lightspeed c.

Therefore, by using the "4D thermal oscillation", I may can explain the origin of the $E = mc^2$, (or, $\Delta E = \Delta m\ c^2$). (Note: I started to realize this in 2018 after writing the SunQM-3s8's section-IV). Note: Also see the alternative explanation in Appendix B, and see more discussions in Appendix C.

IV. Examples that using "4D thermal oscillation" to explain the origin of the $E = mc^2$, (or, $\Delta E = \Delta m\ c^2$)

Here, I will use three examples to illustrate how to use this explanation to describe the process in the real world.

Example-1: (Nuclear fusion).

According to one example in Giancoli text book [45], when two H-atoms (each mass = 1.007825 u) plus two neutrons (each mass = 1.008665 u) combined to form a He-atom (mass 4.002603 u), the lost mass [$\Delta m = (2\times1.007825 + 2\times1.008665) - 4.002603 = 0.030377$ u] that equivalents to [(0.030377 u) ×(931.5 MeV/u) =] 28.30 MeV "*would appear as energy of another kind (such as γ radiation, or kinetic energy)*". Here let's suppose that all the lost mass becomes a γ photon. Then, for the fusion process of $2\,{}^1_1\mathrm{H} + 2\mathrm{n} \to {}^4_2He + \gamma$, by randomly assuming that one atomic mass unit (u) contains 10^6 of "4D thermal oscillators", we may can re-explain it as: one H-atom may can be described by a group of 1007825 of "4D thermal oscillators" (with random oscillational directions and phases) that projected in the 3D space (so that the position of this group must be localized in 3D space, with the 3D macro speed << c, i.e., the H-atom's 3D speed << c), and one neutron may can be described by a group of 1008665 of "4D thermal oscillators" (with random oscillational directions and phases) that projected in the 3D space (so that this group must also be localized in 3D space). After they fussed together, among the total (2×1007825 + 2×1008665 =) 4032980 of "4D thermal oscillators", 4002603 formed a new single group of "4D thermal oscillators" (with random oscillational directions and phases) and then projected in the 3D space (that must be localized in 3D space, or the 3D speed << c) as a He-atom. The rest (4032980 - 4002603 =) 30377 "4D thermal oscillators" unified their

oscillational directions and synchronized their oscillational phases (in 4D space), and formed a new single (tiny) group. Thus, when projected into the 3D space, this new tiny group of 30377 of synchronized "4D thermal oscillators" showed the macro-motion with the speed of light, and become a γ photon that emitted out in x-1D direction.

Furthermore, using the "|nL0> elliptical/parabolic/hyperbolic orbital transition model", we can explain it as, before fusion, the four separated particles (all in the excited QM state) are doing the (macro-3D) orbital motion around their mass center. Then, the three particles de-excited to form a single nucleus, and transferred their energy collectively to the fourth particle (it must be a proton, because the next step is a γ decay, and I had hypothesized that "*the γ decay may can be attributed to the nuclear proton's pure E/RFe-force energy level deexcitation*", see SunQM-6s6's section-IV-c), and it becomes a proton is doing orbital motion around a nucleus. And finally, this proton de-excited (by spin-off a γ photon at the perihelion site of the elliptical orbit) to become the part of the nucleus (of the newly formed He-atom). (Note: This may be a little bit similar as that shown SunQM-6s3's Fig-6 for the β decay process).

Example-2: (Nuclear decay, or nuclear fission).

According to one example in Giancoli text book [46], an atom of Uranium (m = 232.03714 u) may decay to an atom of thorium (m = 228.02873 u) plus an atom of helium (m = 4.00260 u), and lost mass Δm = 0.00581 u. Then, by randomly assuming that one atomic mass unit (u) contains 10^5 of "4D thermal oscillators", we may can explain it as: one Uranium-atom may can be described by a group of 23203714 of "4D thermal oscillators" (with random oscillational directions and phases) that projected in the 3D space (so that the position of this group must be localized in 3D space, with the 3D speed << c). After decayed, this group is separated into three new smaller groups: First, a major group with 22802873 of the "4D thermal oscillators" (still with random oscillational directions and phases) that projected in the 3D space (so that the position of this group must be localized in 3D space, with the 3D speed << c, and we call it a thorium-atom); Second, a minor group with 400260 of the "4D thermal oscillators" (still with random oscillational directions and phases) that projected in the 3D space and we call it a He-atom; Third, the last 581 of the "4D thermal oscillators" have unified their oscillational directions and synchronized their oscillational phases (in 4D space), and can be further separated into two parts: the first part (randomly assuming it contains 400 out of the 581 "4D thermal oscillators", unified their oscillational directions in He-atom's out-flying direction) is associated with the He-atom, and become the kinetic energy of the out-flying He-atom, (and 3D speed of the out-flying He-atom may can be calculated by averaging the 400260 "4D thermal oscillators" that have 3D macro speed = 0, and the 400 "4D thermal oscillators" that have 3D macro speed = c, so that the averaged 3D speed << c); the second part (randomly assuming it contains 181 out of the 581 "4D thermal oscillators", unified their oscillational directions in a γ photon's out-flying direction) become an out-flying γ photon with the 3D speed of c, (because all 181 "4D thermal oscillators" (that with the intrinsic oscillation maximum speed of c) formed a single group that has unified oscillational directions and phases).

Example-3: Atomic de-excitation (by electron de-excitation and photon emission).

As shown in Giancoli text book [47], after combining one proton (mass ≈ 1.00727646677 u, see Giancoli book's front page table) and one electron (≈ 0.00054857991 u) to form one H-atom (≈ 1.007825 u, at n=1 ground state), the lost mass (Δm = 1. 00727646677 + 0.00054857991 - 1.007825) ≈ 13.6 eV/c^2 becomes the electron-proton binding energy of H-atom at n=1 ground state, where Δm = (13.6 eV/c^2) / (931.5 MeV/u) ≈ 1460E-11 u. After the back-calculation, one H-atom at n=1 ($^1_1H_{n=1}$) has mass 1. 00727646677 (u) + 0.00054857991 (u) - 13.6 eV/c^2 = 1.00782503208 (u). Supposing that only electron lost mass and proton does not lost mass, then, according to Bohr H-atom model, in comparison with the free electron, the n=1 electron has mass 0.00054857991 (u) - 1460E-11 (u) = 0.00054856531 (u), the n=2 electron has mass 0.00054857991 (u) – (1460E-11) / 2^2 (u) = 0.00054857626 (u), and the n=3 electron has mass 0.00054857991 (u) – (1460E-11) / 3^2 (u) = 0.00054857829 (u). Then, for the process of $^1_1H_{n=3} \rightarrow {}^1_1H_{n=2} + \nu$, by randomly assuming that one atomic mass unit (u) contains 10^{11} of "4D thermal oscillators", we may can explain it as: in one H-atom, the n=3 orbital electron may can be described by a group of 0.00054857829E+11 of "4D thermal oscillators" (with random oscillational directions and phases) that projected in the 3D space (so that the position of this group must be localized in 3D space, with the 3D speed < c), and the n=2 orbital electron may can be described by a group of 0.00054857626E+11 of random "4D thermal oscillators". Then, the process of a n=3 electron de-exciting to a n=2 electron (in an H-atom) and emitting a 656.1 nm photon can be explained

as, a group of 0.00054857829E+11 of "4D thermal oscillators" (with random oscillational direction and phases) split into two: a large group of 0.00054857626E+11 of "4D thermal oscillators" (with random oscillational directions and phases, and we call it a n=2 electron), plus a small group of (0.00054857829E+11 - 0.00054857626E+11 =) 203 of "4D thermal oscillators" that have the unified oscillational direction and synchronized oscillational phase, and this small group of synchronized "4D thermal oscillators" become a photon with the equivalent mass Δm = (1460E-11) × $\left(\frac{1}{2^2}-\frac{1}{3^2}\right)$ (u), or with energy ΔE = 13.6× $\left(\frac{1}{2^2}-\frac{1}{3^2}\right)$ = 1.889 (eV), or with the wavelength λ = 656.1 nm, and emitted out in the tangential direction (of the elliptical orbit) at the speed of light. (Note: It is interesting to see that, according to the classical physics calculation (see in SunQM-6s2's eq-5), at the perihelion site of the elliptical orbit, an n=3 electron (in the H-atom) has the tangential linear speed $v_{n=3,p} \approx$ 2.99550594E+8 m/s, and it is very close the to the lightspeed c = 2.99790000E+8 m/s. So, we may can say that right before emission of the 656.1 nm photon, large number of the 0.00054857829E+11 of "4D thermal oscillators" in the n=3 electron already unified their oscillational directions. Then, a small number of them (only 203 out of the 0.00054857829E+11) split out to form a new small group and becomes the newborn photon).

Of cause, using the "|nL0> elliptical/parabolic/hyperbolic orbital transition model", we can explain it as, at the perihelion site, a n=3 electron (that is doing the elliptical orbital motion around the proton) is de-excited into a n=2 electron (that is also doing the elliptical orbital motion around the proton), and spin-off a 656.1 nm photon.

So, from these three examples, we see that all ΔE = Δm c^2 kind of binding energy can be treated as the outmost shell of a 3D wave packet, that can be (or will be) spin-off under a "|nL0> elliptical/parabolic/hyperbolic orbital transition model".

V. A list of the non-linear effect in the {N,n} QM structure (that may or may not relate to the GR radial contraction)

As shown in SunQM-1s2's Table-1 and SunQM-7's Table-1, not only our Solar system (form {-3,1//6} size to {5,1//6} size) follows the {N,n//6} QM structure, but also our universe (from {-17,1//6} size to {10,2//6} size) follows the {N,n//6} QM structure. However, although our universe (as a whole) does follow the {N,n//6} QM structure, in some (size) regions it more or less deviated from the {N,n//6} QM structure. The non-linear {N,n} QM structural effect is defined as: any {N,n} structure that does not strictly follow the simplest Sun{N,n//6} structure. In some cases, it still follows the standard {N,n//q} QM but with q ≠ 6. In other cases, it may not follow {N,n//q} structure at all. Here are some examples:

1) In the Solar system's N=2 super shell (i.e., in {2,n=1..5//6}o orbital shell), it is {N,n//5.33} with q=5.33, not q=6. It is must be not caused by the GR radial contraction, simply because both {1,n=1..5//6}o and {3,n=1..5//6}o orbital shells are the perfect {N,n//6}. Similarly, in the Solar system's N = -1 super shell (i.e., in {-1,n=1..5//6}o orbital shell), it may be a {N,n//6.75} with q=6.75, not q=6, see SunQM-6s8's Fig-3. Notice that 5.33×6.75 = 6×6, so it means that the {N=0..1,n//6}o orbital super shells are displaced outward, with the orbital r increased by 1.28x, and the spherical 3D volume increased by 2x (notice that $1.28^3 \approx 2$ and a ball volume = $\frac{4}{3}\pi r^3$), and this must be caused by the hot Sun's thermal expansion, (see SunQM-1s1's Table-1).

2) The "5 of {-15,2//6} particles" effect (see SunQM-7's section I-d and SunQM-7's Appendix A) has a nonlinear relationship between the size increase of {N,n//6} space versus the mass increase. For example, {-15,n=1..6//6} for n= 1, 2, 3, 4, 5, 6, it should have a standard radial increase of 1×, 4×, 9×, 16×, 25×, and 36×, but 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). (Note: Unlikely this is caused by the GR effect).

3) In the {N=-15..-14,n=1..5//6}o = {-15,n=1..35//6^2}o range, the atomic nuclei may become {N,n//7} rather than {N,n//6}, or the superposition of these two, see SunQM-5's Table-2. (Note: The GR radial contraction may be the cause, see section VI and Table 1).

4) In the {-12,n=1..7//6}o range, the atomic electron shell may also be the superposition of {N,n//6} and {N,n//7}, see SunQM-5's Table-2. (Note: The GR radial contraction may be the cause).

5) As pointed out in the SunQM-7, in the chemical bond dominated {N=-11..-1,n//6} range, (i.e., in the size range of about 1E-9 meter $\lesssim$ r $\lesssim$ 1E+7 meter), all daily-life-world matter (excluding those collapsed celestial 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 E/RFe-force. Although the {N=-11..-1,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} structure. For example, all eight primitive planets have the initial 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 still keeps the initial p{N,n//2} QM structure (that also equals to p{N,n//4} QM structure naturally, see SunQM-3s7). A human body does not follow {N,n//q} QM structure at all. This is because that in a residue E/RFe-force formed molecule, the chemical bond force expanded the size of this molecule so that it is no longer follow the primary E/RFe-force formed {N,n//6} QM structure (see SunQM-5 section-VII for more detailed discussing). (Note: no GR effect is involved).

6) Due to either the decreased r_1, or the increased r_1, the size of our 3D universe may (or may not) have the "5 of {-15,2//6} particles" effect (see SunQM-7's Appendix A). (Note: unclear whether GR effect is involved or not).

7) In SunQM-5's section II-c, I pointed out: In {N,n} QM, the "*analysis showed us several true examples that the quantum number q can be in values of 7 (the {N,n//7} QM structure of nuclides at high Z#), 6 (the standard {N,n//6} QM structure from N = -17 to N = 10), 5 (Jupiter's internal and surface p{N,n//5} QM structure), 4 (equivalent to {N,n//2} QM naturally), 3 (Saturn's internal and outer ring p{N,n//3} QM structure, and Jupiter's outer ring p{N,n//3} QM structure), 2 (the initial p{N,n//2} QM structure for all original planets, the current Neptune's p{N,n//2} QM structure), 1 (Earth's initial p{N,n//2} QM structure is now become p{N,n//2//2} → p{N,n//4} QM structure with q = 2 *1/2 =1, after stripping off 24/25 = 96% of mass). So far, we have not seen any obstacle for q quantum number to take the even higher values of 8, 9, etc., or the even lower values of 2*½*½= 1/2, or even 2*½*½* ½=1/4, etc.*". (Note: unclear whether GR effect is involved or not).

8) In SunQM-5's section II-a, I pointed out: "*The shrinking of r_{e1} as Z increasing can be explained as that the (strong) EM-force shrinks the space (in comparison with the G-force)*", and "*can we attribute the shrinking of r_{e1} (= r_1 / Z …) and the shrinking of r_n (= r_{e1} * n^2) as Z increasing (equivalent to EM-force increasing) to the general relativity effect? ... It will be studied in our future paper SunQM-7s1*".

VI. The non-linear {N,n//q} QM structure near a BH (where q = 6 increased to q = ∞) can be achieved by fusing the General Relativity's radial contraction calculation into the non-linear {N,n//q} QM structure's calculation

From the previous study, I realized that in {N,n//q} QM, the radial space contraction near a black hole (BH) surface may can be achieved by increasing the q value from the standard q = 6 to a higher number of 7, or 8, etc. But, how to seamlessly fuse the General Relativity's radial contraction calculation into the non-linear {N,n} QM structure's calculation for the radial space contraction near a BH surface at {-3,1//6}? After many tries, I figured out one way (as shown in eq-25, and calculated in Table 1 and Table 2). In Table 1, columns 1 ~ 6 and columns 8 ~ 9 were initially copied from SunQM-3s8's Table 6. In column 4, based on $r_n = r_1 n^2$, the orbital radius of {N,n//q} QM structure for a Sun-massed BH (that has r = Rs = 2.95E+3 meters) was calculated. In the column 7, using eq-10, the escape velocity $v_{r,n}$ (instead of the orbital velocity $v_{\theta\varphi,n}$ in eq-13) was calculated. At the surface of a Sun-massed BH {-3,1//6}, the calculated $v_{r,n}$ = c, so that using the GR R-contraction formula eq-11 it will produce the $\Delta r = 0$ at the BH surface (as the text books told us).

Table 1. To correlate the {N,n//q} QM structure with the superposition of q = 6, 7, … ∞, to the radial contraction of the general relativity, in the r-1D range from the surface of a Sun-massed BH at $r_{Schwarzschild}$ = 2.95E+3 meters to r = ∞.

N=	n=	total n = 6^N	Cold-r track	Hot-r track	$v_{orbit,n}$ = $v_{\theta\phi,n}$ = sqrt(GM/$r_{n,cold}$)	$v_{r,n}$ = $v_{escape,n}$ = sqrt(2GM/$r_{n,cold}$)	v_n /c	T= GMm /(3k$r_{n,hot}$)		new q' = q/sqrt(1-v^2/c^2) while old q=6	new r_1 = r_n/q'^2, based on {0,1//q'}
			m	m	m/s	m/s	(m/s) / (m/s)	K			m
-4	1	1/6^4	8.19E+01	1.04E+02	1.27E+09	1.80E+09	6.00	5.17E+13		∞	
-4	2	2/6^4	3.28E+02	4.14E+02	6.36E+08	9.00E+08	3.00	1.29E+13		∞	
-4	3	3/6^4	7.38E+02	9.32E+02	4.24E+08	6.00E+08	2.00	5.74E+12		∞	
-4	4	4/6^4	1.31E+03	1.66E+03	3.18E+08	4.50E+08	1.50	3.23E+12		∞	
-4	5	5/6^4	2.05E+03	2.59E+03	2.55E+08	3.60E+08	1.20	2.07E+12		∞	
-3	1	1/6^3	***2.95E+03***	3.73E+03	2.12E+08	**3.00E+08**	1	1.44E+12	Sun black hole r=2.95E+3 (m)	∞	r_1 = 0
-3	2	2/6^3	1.18E+04	1.49E+04	1.06E+08	1.50E+08	1/2	3.59E+11		6.9282	1.24E+03
-3	3	3/6^3	2.66E+04	3.36E+04	7.07E+07	1.00E+08	1/3	1.60E+11		6.3640	2.07E+03
-3	4	4/6^3	4.72E+04	5.97E+04	5.30E+07	7.50E+07	1/4	8.97E+10		6.1968	2.43E+03
-3	5	5/6^3	7.38E+04	9.32E+04	4.24E+07	6.00E+07	1/5	5.74E+10		6.1237	2.61E+03
-2	1	1/6^2	1.06E+05	1.34E+05	3.54E+07	5.00E+07	1/6	3.99E+10	{-2,1//6} sized pulsar?	6.0851	2.71E+03
-2	2	2/6^2	4.25E+05	5.37E+05	1.77E+07	2.50E+07	1/12	9.97E+09		6.0209	2.89E+03
-2	3	3/6^2	9.56E+05	1.21E+06	1.18E+07	1.67E+07	1/18	4.43E+09		6.0093	2.92E+03
-2	4	4/6^2	1.70E+06	2.15E+06	8.84E+06	1.25E+07	1/24	2.49E+09		6.0052	2.93E+03
-2	5	5/6^2	2.66E+06	3.36E+06	7.07E+06	1.00E+07	1/30	1.60E+09		6.0033	2.94E+03
-1	1	1/6	3.82E+06	4.83E+06	5.89E+06	8.33E+06	1/36	1.11E+09	{-1,1//6} sized white dwarf	6.0023	2.94E+03
-1	2	2/6	1.53E+07	1.93E+07	2.95E+06	4.17E+06	1/72	2.77E+08		6.0006	2.95E+03
-1	3	3/6	3.44E+07	4.35E+07	1.96E+06	2.78E+06	1/108	1.23E+08		6.0003	2.95E+03
-1	4	4/6	6.12E+07	7.73E+07	1.47E+06	2.08E+06	1/144	6.92E+07		6.0001	2.95E+03
-1	5	5/6	9.56E+07	1.21E+08	1.18E+06	1.67E+06	1/180	4.43E+07		6.0001	2.95E+03
0	1	6/6 = 1	1.38E+08	***1.74E+08***	9.82E+05	1.39E+06	1/216	3.08E+07	{0,1} Sun core	6.0001	2.95E+03

Table 2. Same as Table 1, but at near the {-3,1//6} surface of a BH, using the non-integer "quantum number" 1 < n < 2 from {-3,(1+5/5)//6} down to {-3,(1+1/5^12)//6}, to approach to n= 1.

N=	n=	total n = 6^N	Cold-r track	Hot-r track	$v_{orbit,n}$ = $v_{\theta\phi,n}$ = sqrt(GM/$r_{n,cold}$)	$v_{r,n}$ = $v_{escape,n}$ = sqrt(2GM/$r_{n,cold}$)	v_n /c	T= GMm /(3k$r_{n,hot}$)		new q' = q/sqrt(1-v^2/c^2) while old q=6	new r_1 = r_n/q'^2, based on {0,1//q'}	distance above BH surface
			m	m	m/s	m/s	(m/s) / (m/s)	K			m	m
-3	1		***2.95000000E+03***	3.73E+03		**3.00E+08**	1	1.44E+12	Sun black hole r=2.95E+3 (m)	∞	r_1 = 0	= 0
	1+(1/5^12)		2.95000002E+03			3.00E+08				66291.3	1.62E-21	≈ 0
	1+(1/5^6)		2.9504E+03			3.00E+08				530.4	6.18E-09	0.000024
	1+(1/5^2)		3.191E+03			2.88E+08				21.8	1.27E+00	0.378
	1+(1/5)		4.25E+03			2.50E+08				10.9	8.42E+01	241
	1+(2/5)		5.78E+03			2.14E+08				8.6	3.47E+02	1298
	1+(3/5)		7.55E+03			1.87E+08				7.7	6.68E+02	2832
	1+(4/5)		9.56E+03			1.67E+08				7.2	9.75E+02	4602
-3	2		1.18E+04	1.49E+04		1.50E+08	1/2	3.59E+11		6.9282	1.24E+03	6608

Then, I hypothesized that outside of the BH, the q quantum number for the {N,n//q} QM structure is modulated by the Einstein-Lorentz transformation factor to be the new q'

$$q' = \frac{q}{\sqrt{1-\frac{v_r{}^2}{c^2}}} \qquad \text{eq-25}$$

The calculated result (in the column 11 of Table 1) revealed that: for a Sun-massed BH, at the surface of the Sun at {0,2//6}, the q' ≈ 6.0001 (and it is perfectly q =6); at the size of a Sun-massed white dwarf {-1,1//6}, q' ≈ 6.002 (and it is still perfectly q =6); at the size of a Sun-massed {-2,1//6}, q' ≈ 6.08 (and it is still about q =6); at the size of a Sun-massed neutron star {-3,2//6}, q' ≈ 6.93 ≈ 7; and (see Table 2) at a Sun-massed size of {-3,(1+(1/5))//6} or at a distance 241 meters (see column 13) above the BH surface, q' ≈ 10.9 ≈ 11; at a Sun-massed size of {-3,(1+(1/5^2))//6} or at a distance 0.387 meters above the BH surface, q' ≈ 22; at a Sun-massed size of {-3,(1+(1/5^6))//6}, q' ≈ 530; … etc. Finally, at a Sun-massed BH surface at the size

of {-3,1//6}, q' = ∞. Therefore, for a {N,n//6} QM structure, to show the radial contraction of general relativity, we can use the superposition of the Σ{N,n//q'} QM structures with q' = 6, 7, 8, … ∞ to describe: at each radial position (i.e., depends on the distance from the BH surface), there is only one q' valued {N,n//q'} QM structure is dominant, and the closer to the BH surface, the higher the q' value for the {N,n//q'} QM structure. The superposition of q=6 with a higher q' makes sure that although locally the high q' caused r-1D contraction, but globally it still follow the {N,n//6} QM structure. In this way, I have seamlessly fused the General Relativity's radial contraction calculation into the non-linear {N,n} QM structure's calculation for the radial space contraction near a BH.

According to {N,n//q} QM, the increasing value of q' must be caused by the decreasing the r_1 value, or the r_1 has to move inward. In the column 12 of Table 1 and Table 2, the new r_1 was calculated as: new $r_1 = \frac{r_n}{q'^2}$, where r_n was chosen to anchor at the size of the Sun core {0,1//6} at the cold-r, i.e., $r_{n,cold}$ = 1.37635200E+8 ≈ 1.38E+8 meters. We see that when q' increased from q' ≈ 6 at {0,1//q'}, to q' ≈ 7 at {-3,2//q'}, to q' ≈ 11 at {-3,(1+1/5)//q'}, finally to q' = ∞ at {-3,1//q'}, the r_1 decreased from 2.95E+3 meters, to 1.24E+3 meters, to 8.42E+1 meters, and finally to 0 meter. This means, at outside of a BH, when move to the surface of this BH, the q' increased from =6 to =∞, and the r_1 decreased from r_1 = 2.95E+3 meters to r_1 = 0 meters. Because a {N,n//q} QM structure with r_1 = 0 must be a singular, so, at the surface of a Sun-massed BH at the size of {-3,1//6}, or when q' = ∞, the (general relativity caused) radial contraction become the maximum, the r-1D space is contracted to zero, and this Sun-massed BH becomes a singular. Furthermore, this means that all those r_1 values smaller than the Rs = 2.95E+3 meters (e.g., r_1 = 1.24E+3 meters, or r_1 = 8.42E+1 meters, etc.) are only meaningful to the space at the outside of a Sun-massed BH, and they have no meaning inside the BH. From the surface of a BH to the inside, the whole r-1D space collapsed to r = 0, so that the whole BH can be treated as a singular (start from {-3,1//6} and inward for a Sun-massed BH).

Before, when reading other people's popular science articles (that I read over 20 years ago, citation ?) that talking about BH's singularity, or BH's surface mass, or our universe may be a BH, I did not fully understand the meaning. After my own research result, now I understand what they really mean. Because from a BH's surface to the inward, the r-1D is collapsed, or r = 2.95E+3 meters equals to r = 1.24E+3 meters, and equals to r = 8.42E+1 meters, and all of them equal to r = 0 meter, so the whole BH (from surface to the inward) is a singular (even though from the outside of the BH, we do see a Sun-massed BH has a size of {-3,1//6}, see the illustration in Figure 3b and Figure 3c). Because inside a BH there is no r-1D, then all mass of the BH can be treated as on the BH surface (so that people were talking about BH surface mass). Because BH's surface mass has no mass center, and our 3D universe (if it is the spherical 3D space on the surface of a 4D ball something) has no mass center either, so our universe may can be treated as a BH.

VII. Non-linear {N,n//q} produces many different unusual phenomena, and the GR R-contraction may be only one of them

By now, we see two different descriptions for the radial contraction (that caused by either the super strong G/RFg-force (near a BH), or the super strong E/RFe-force, or the super strong S/RFs-force): the first description is using the GR, the second description is using the non-linear {N,n//q} QM with the rapidly increasing the value of q from 6 to infinity. Here I need to emphasize that the non-linear {N,n//q} produces many different unusual phenomena (see the list in section V), and the radial contraction (that originated from the GR) is only one of them. The relationship of these two descriptions may be more like either the thermodynamics vs. statistic physics, or Bohr-QM vs. Schrodinger-equation-QM, or the kinetic-potential energy cycle vs. radiation-absorption cycle in a binary orbital motion (see in SunQM-6s2's Fig-8).

Besides the GR effect (continuously) contracts the r-1D space, {N,n} QM also (quantumly) contracts the r-1D (or rθφ-3D) space in its own way. For example, by comparing the mass to its size for each chemical element, I realized that the formation of each chemical element from small to large (e.g., from H, He, to Ne, Ar, Kr, Xe, etc.) is a perfect example to show that how QM quantumly contracts the mass field in r-1D space. The higher the Z#, the more r-1D (or rθφ-3D) mass field space contraction it has. Notice that this r-1D (or rθφ-3D) mass field space contraction is quantumly, so it must be a pure QM effect, nothing to do with the GR effect (that must be continuously). Also, the formula of $r_{e1} = r_1/Z$ in SunQM-5's

Table-2 column-7 is a different expression of the mass field r-1D contraction through QM. The r-1D mass field space quantum contraction is through the fusion of the outside nucleon (or H-atom) one by one into the nucleus.

Here is a second example: in SunQM-3s8's Table-3, inside the Sun core {0,1//6} size = {-1,6//6} size, I estimated that the {-1,5//6}o orbital shell is filled mainly with H-atoms, the {-1,n=3..4//6}o orbital shells are filled mainly with He-atoms, the {-1,2//6}o orbital shell is filled mainly with the period two and period three elements (like C, O, Na, Mg, etc.), the {-1,1//6}o orbital shell is filled mainly with the period four and period five elements (like, Fe, Ag, etc.), and within the size of {-1,1//6} core it is filled mainly with the period six and period seven elements (like, Au, Pb, etc.). If treating the 100% H-atom filled space (inside a Sun) as the zero r-1D contraction (of a point-centered mass field), then, from {-1,4//6}o orbital shell to {-1,3//6}o, {-1,2//6}o, {-1,1//6}o, and {-1,1//6} core, we see that the mass field space is r-1D contracted more and more, and it is mainly based on the {N,n} QM, not on the GR.

From the above analysis, we see that the {N,n} QM only causes a relatively weak r-1D contraction with the q' > 6 increases finitely (in the most cases), while the GR (always) causes a relatively strong r-1D contraction with the q' increases infinitely ($\rightarrow \infty$).

Furthermore, I guessed that some of the unusual GR effects may also can be explained by the {N,n} QM. For example, the precession of the perihelion [48] may can be explained by the "*non-Born probability (NBP)'s positive precession in {N,n}QM*" (that my unfinished paper SunQM-4s4 is pursuing), the "gravitational wave" may can be explained by using the "|nL0> elliptical orbital transition model" of the G-photon (see SunQM-6s3's Fig-2), the "gravitational lensing" effect may can be explained by using a point-centered G/RFg-force field (that interacting with a propagating photon), etc.

In one version of the (bamboo-tree-like multi-stem) tree-diagram of physics, Newtonian physics (with the concept of force) is one stem, GR/SR (with the concept of spacetime and without force) is a second stem, QM (in either the wave mechanics or the matrix mechanics) is a third stem. However, from the development of {N,n//q} QM, there might also be another apple-tree-like (single-stem) tree-diagram of physics, in which the Newtonian physics is the root, QM (including the collection of wave mechanics, matrix mechanics, QCD, String theory, {N,n} QM, etc.) is a stem, and the GR/SR might be at the more branch side than that of QM (because it might can be described as one class of special cases in QM). (Here are some question: Based on the above analysis, can we build a new kind of GR (with the temperature-dependency) to dilate the r-1D space for the Sun's hot-r in the range of {N=-1..1,n=1..5//6}o orbital shell space (that increased the length by1.26x, and increased the volume by 2x)? Or, can we build a new kind of GR to make the "5 of {-15,2//6} particles" effect (see SunQM-7's Appendix A) kind of radial contraction? If we can, then GR and QM should be at the same level in the tree-diagram of physics). After all, I believe that the bamboo-tree-like (multi-stem) tree-diagram of physics is what we should pursuing. The greater the number of diversified descriptions (i.e., the stems), the better; and the more diversified description, the better (see SunQM-6s8's Fig-13 of the "Feynman Pool"). I believe that in the next few decades, several completely new theories on the mechanics in the physics will sprout out. These future theories that invented by other scientists will be the new stems (in a bamboo-like multi-stem tree), and they will be in parallel with the young {N,n} QM theory, the (~30 years old?) string theory, the (~50 years old?) QCD theory, the (100 years old) traditional QM and relativity theories, the (300 years old) classical mechanics, etc. (Also see the "Feynman Pool" description in SunQM-6s8's Fig-13 and in SunQM-7's Appendix G).

In my {N,n} QM development work, not only I tried to develop the {N,n} QM by fitting to the traditional Bohr-QM, Schrodinger-equation-QM, and the classical physical mechanics, but also I tried to develop the {N,n} QM by diversifying the description so that it is different from those in the current physics text books.

VIII. (Like that the nLL state vs. nL0 state is a pair of brand new parameters in the physics to describe the RF character), the difference of the length contraction between GR and SR could be another pair of parameters in the physics to describe the relativistic character

Interestingly, I found that we may can use the 2D spherical space on a 3D ball surface (as in Figure 4) to explain the relativistic length contraction difference: the GR R-contraction may correlate to the point A in Figure 4 (in which all "4D thermal oscillators" re-directed into the θ-1D in a θφ-2D space), and the SR L-contraction may correlate to the point B in Figure 4 (in which all "4D thermal oscillators" re-directed into the φ-1D in a θφ-2D space). If it is correct, then in Figure 4,

we cannot make a single object at both point A and point B simultaneously. This means, for a BH, we cannot simultaneously have 100% of the GR R-contraction (in r-1D), and 100% of the SR L-contraction (in x-1D). (I guessed that) this should be valid either for the 2D spherical space on a 3D ball surface, or for the 3D spherical space (i.e., in our 3D universe) on a 4D ball surface. (Note: In the similar way, in SunQM-6s8's Fig-2a, we cannot make an E-force field to have both maximum in the translation motion and in the spinning motion).

In this way, the relativistic length contraction difference between GR and SR could be a new property (or a new parameter) in the physics, and the 2D spherical space on a 3D ball surface (in Figure 4) may be a new way to describe this parameter. For example, for everything in our 3D universe, based on its averaged (macro) speed in our 3D space, we can assign a position on the 2D spherical surface in Figure 4:

1) For photons, because all photons (in either 3D or 2D space) have the motion in speed of light (and their "4D thermal motion" is non-localized in either 3D or 2D space), they have 100% of the SR L-contraction (in x-1D), so they (or their QM state) may can be assigned at the equator (or 0° latitude) in Figure 4 (like the B point in Figure 4).

2) For (averaged) H-atoms (or protons, neutrons, etc.), in either 3D or 2D space, each of them has the motion speed < c (and each of their "4D thermal motion" is localized in a relative small region in either 3D or 2D space), and on average they have << 100% of the SR L-contraction (in x-1D), so they (or their QM state, or each H-atom's QM state) may can be represented by the 10° latitude in Figure 4 (or, like the C point in Figure 4).

3) For (averaged) He-atoms (or alpha particles), in either 3D or 2D space, they have the averaged macro motion speed less than that of H-atoms (and their "4D thermal motion" is more localized in either 3D or 2D space than that of H-atoms), and on average they have even less % of the SR L-contraction (in x-1D) than that of H-atoms, so they (or their QM state) may can be represented by the 20° latitude in Figure 4.

4) For atoms with $3 \le Z \le 118$, due to they have the averaged 3D (macro) motion speed less than that of He-atoms, and they have even less % of the SR L-contraction (in x-1D) than that of He-atoms, they (or their QM state) may can be represented by the even higher latitudes in Figure 4 (like in the range of 30° to 40° latitude).

5) For the even larger (quasi) Z number atoms (like Sun-massed black hole, or SMBH), they (or their QM state) may can be represented by 70° or 80° latitude in Figure 4.

6) For a super-super-super gigantic BH with (quasi) Z = 3.59E+77, (i.e., 1% of our universe's total mass/energy, it was calculated as: assuming that the observable universe's mass 1.5E+53 kg (see wiki "observable universe") equals to our universe's total mass, then 1% of it generated a single super-super-super gigantic (virtual) atom's nucleus will have a quasi Z = 1.5E+53 kg *0.01 / 1.67E-27 kg / 2.5 = 3.59E+77, see SunQM-5s1's Appendix), it (or its QM state) may can be represented by 90° latitude (or the north pole) in Figure 4.

7) Thus, photon, H-atom, He-atom, and all other atoms, star, BH, galaxy, supercluster, etc., are the QM states, and all these QM states can be represented by the latitude degrees on the 2D spherical surface shown in Figure 4.

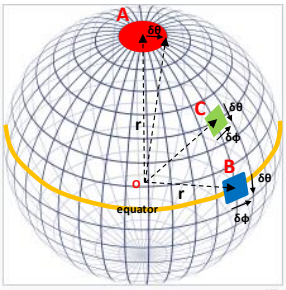

Figure 4. To illustrate that a spherical θφ-2D can be used to describe either a point-centered rφ-2D field (as shown at the point A, that may correlate to GR) or a flat xy-2D field (as shown at the point B, that may correlate to SR). Notice that when in static, the θ-1D and φ-1D of the θφ-2D are indistinguishable. Figure copied from SunQM-7s1's Fig-4.

Table 3. To estimate the numbers of photons, H-atoms, He-atoms, Sun-massed black holes, etc., that equivalent to 1% of the observable universe's mass/energy.

	mass	mass	rest Energy	calculation (# per 1% Univ. mass)	calculated number of objects per (1% Univ. mass)	name (of objects)
	kg	eV/c^2	eV			
Univ. mass (assumed)	1.5E+53					
1% mass	1.5E+51				**1**	
1 proton (or 1 H-atom)	1.67E-27	9.38E+08	9.38E+08	= (1.5E+51 kg / 1.67E-27 kg)	**8.98E+77**	H-atoms
1 photon (656 nm, 1.89 eV)			1.89	= (1.5E+51 kg / 1.67E-27 kg) * (938 MeV / 1.89 eV)	**4.46E+86**	1.89 eV (656 nm) photons
Z# = proton # / 2.5				= (1.5E+51 kg / 1.67E-27 kg) / 2.5	**3.59E+77**	psuedo Z#
He-atoms				number of H-atoms /4	**2.25E+77**	He-atoms
…						
Fe-atoms				number of H-atoms /56	**1.60E+76**	Fe-atoms
…						
Sun mass (black hole)	1.99E+30			= (1.5E+51 kg / 1.99E+30 kg)	**7.54E+20**	Suns
SMBH of Milky Way	2.29E+42			= (1.5E+51 kg) / [(1.15E+12) * (1.99E+30 kg)]	**6.55E+08**	SMBH of Milky Way
Virgo Super cluster				= (1.5E+51 kg) / [(1.48E+15) * (1.99E+30 kg)]	**5.09E+05**	Virgo Super clusters

	mass, kg			calc. (pseudo Z#)	pseudo Z#	
Sun mass (black hole)	1.99E+30			= (1.99E+30 kg / 1.67E-27 kg) / 2.5	4.77E+56	
SMBH of Milky Way	2.29E+42			= (2.29E+42 kg / 1.67E-27 kg) / 2.5	5.49E+68	

Then, how to use this new parameter (i.e., GR R-contraction vs. SR L-contraction) to describe the dynamic process in our universe? Here is one example. In SunQM-5s1's Appendix (also see SunQM-7's Fig-6c, and SunQM-6), I had proposed a steady state universe model with the repetitive cycles of absorbing/releasing 1% of our universe's total mass/energy. At beginning of a cycle, one mega-"photon" from outside of our universe (that has 1% of our universe's total mass/energy, and as the pure energy with "Z = 0", that may be simplified and represented by 4.46E+86 of 656.1 nm photons, see Table 3 for the estimative calculation, and see SunQM-5s1's Table-2 for how to calculate the quasi Z#) was absorbed by our universe. Then, under the G/RFg-force, E/RFe-force, and S/RFs-force, the Z-spectrum of these photons is up-shifted, first transformed into H-atoms (Z = 1, and decreased the number to 8.98E+77 of them), then fused to be He-atoms (Z = 2, and decreased the number to 2.25E+77 of them), then further fused to be $3 \leq Z \leq 118$ atoms, then further fused to be stars (with quasi Z >> 118), then to Sun-massed black hole (with quasi Z ≈ 4.77E+56, and decreased the number to 7.54E+20 of them), then to SMBH (with quasi Z ≈ 5.49E+68, and decreased the number to 6.55E+8 of them), finally to a single super-super-super gigantic BH (with quasi Z ≈ 3.59E+77, and decreased the number to only one of it), and then it was spitted-out from our universe. (Note-1: In each step, the newly formed photons, H-atoms, He-atoms, … were first mixed with the pre-existing photons, H-atoms, He-atoms, … in our universe, then part of the mixed photons, H-atoms, He-atoms, …, were transformed further into the down-stream H-atoms, He-atoms, etc. Note-2: The number of photons, H-atoms, He-atoms, … that correlates to the 1% of our universe's total mass/energy was estimated as shown in Table 3).

Now we can use a 2D spherical surface space in Figure 4 (that is projected from the "4D thermal motion" or "4D thermal oscillators" from a 4D space) for the re-description. Based on the above assignments, the whole process of the transformation from photon (Z = 0), to H-atom (Z = 1), to He-atom (Z = 2), to $Z \leq 118$ atoms, then to a (quasi) Z ≈ 4.77E+56) "atom" (i.e., a SMBH), then finally to (quasi) Z = 3.59E+77 "atom", is a dynamic mass-condensation, (or mass-space collapsing) process, and it equivalents to that in Figure 4, this 1% universe mass/energy (quantumly) shifts its quantum state from equator at 0° latitude, to 10° latitude, to 20° latitude, to 30° latitude, … to 80° latitude, then finally to 90° latitude (north) pole. The decreasing length of the circumferences at each degree of latitude (from 0°, 10°, … 90°) fits to the decreasing of the total numbers (through fusion) from 4.46E+86 photons, to 8.98E+77 H-atoms, to 2.25E+77 He-atoms, … to 7.54E+20 Sun-massed black holes, and finally to a single super-super gigantic BH. After extended this description from a 2D spherical space (in Figure 4) to a 3D spherical space (i.e., our 3D universe), this description revealed that the transformation process from a mega-"photon" to a mega-"black hole" is a transformation process from the SR length contraction (with each single object has low mass, high $v_{n,3D}$, low attractive G-force, low sink-in the 4th dimension, and high x-1D only length contraction) to the GR radial contraction (with each single object has high mass, low $v_{n,3D}$, high attractive G-force, high sink-in the 4th dimension, and high radiated r-1D length contraction), and it is caused by the projection of "4D thermal oscillators"

into the 3D spherical surface space. Or, more precisely, this is changed from a large number of (separated) SR L-contractions to a small number of (condensed) GR R-contractions.

Note: The whole process of "injecting" 4.46E+86 photons at the 4D equator (or the 3D virtual equator of our universe) and then "ejecting" a single (or a few) super-super gigantic BH out of our 3D universe (at the 4D pole, or the 3D virtual pole), is much like that in a X-ray binary of black hole and companion star, the matter is injected at the equator of a spinning BH, and X-ray is ejected out from the two poles (see SunQM-6s3's Fig-3a). In this way, it may support some other scientists' hypothesis that our universe is a BH (that I read over 20 years ago, citation ?).

Similarly, combining the above analysis with the previous SunQM paper's result, I guessed that

a) A massless photon (or any massless particle) will expand its size forever (because of its massless, a photon has to anchor on its "mother" massed particle, e.g., a 656.1 nm photon emitted from a H-atom has to anchor on this "mother" H-atom, and then expand its size forever based on its anchor while propagating), and then lose its rest mass (or rest energy) through the redshift (or through spin-off the outmost shell of its 3D wave packet);

b) A mass particle will most likely keep its size (as time increasing);

c) A large mass object may will decrease its size, by forming BH, or SMBH, (as time increasing);

d) The whole universe does not collapse into a single mass point (neither big-banging from a single mass point?), because the universe is fixed to n=1 QM state with the full and complete RF (like the n=1 electron in an H-atom does not collapse its orbital shell). (Note: This is from my citizen-scientist-leveled guess, it could be wrong).

Notice that the GR R-contraction and SR L-contraction is not the only brand new physical parameter that extracted from the newly developed {N,n} QM physics. The RF (RotaFusion, or Rotation Diffusion) may also be a new physical parameter that extracted from the newly developed {N,n} QM physics (see SunQM-2's Table-6 for the %RF, and SunQM-6's Table-1 for the %deRF). Plus, the nLL QM-state versus the nL0 QM-state may be a similar brand new physical parameter that extracted from the newly developed {N,n} QM physics, (see SunQM-3s1 for the explanation of a collapsing pre-Sun's (nLL effected) disk-forming and (nL0 effected) bipolar outflow, also see SunQM-6s5 for the explanation of a propagating photon's ABCBA cycle, also see SunQM-6s8 for the explanation of a E/RFe-force field, G/RFg-force field, etc.). Note: Only n=1, or |1,0,0>, describes the complete RF, all n > 1 Born probability maps describe the self-spinning field (that must be at least partly decreased RF).

Figure 4 showed that the point A provides a (out-radiating) point source that can be used to describe a point charge's E-force field (with radiated and opened force-line), while the point B provides a non-radiating point source that can be used to describe a point charge's RFe-force field (non-radiated and closed circular force-line). So, Figure 4 can also be used to describe the E/RFe-force pair, or G/RFg-force pair, or S/RFs-force pair. Furthermore, the relationship between GR and SR may be like the relationship between G-force and RFg-force (in the G/RFg-force pair): in the GR/SR pair, GR may be the primary effect, while SR may be the orthogonal companion effect of the GR effect. Similarly, in the nL0/nLL pair, the nL0 may be the primary mode, while the nLL may be the orthogonal companion of the nL0 mode.

So, by now, we have found (at least) five of RF related pairs: G/RFg-force, E/RFe-force, S/RFs-force, nL0/nLL pair, and GR/SR pair. They all can be described by the quantized latitude levels in Figure 4.

Although there is similarity between G/RFg-force pair and GR/SR pair, there is also difference between them. Using the equivalent E/RFe-force as the example for G/RFg-force (because the magnetic force is easier to be understood), and using a BH as the example for the GR/SR pair, the similar part is, when at rest (zero translation, and zero spin), the E-force-lines radiate in r-1D (from a single point to all 4π direction in 3D) and RFe-force is averaged to be zero due to the complete RF, the GR R-contraction also radiate in r-1D (from a single ball to all 4π direction in 3D) and SR may can be treated as it is averaged to be zero due to the complete RF. The different part is, when the translational speed closes to lightspeed in the +z direction, a point charge's RFe-force deRF (meaning decreased RF) and shows up in φ-1D (as the circular magnetic force-line in xy-2D plane), while a black hole's SR L-contraction shows up in +z direction (but not in φ-1D in xy-2D plane). (Note: In the case of when a BH is moving in the +z direction in lightspeed, (I guessed that) the GR R-contraction loses the 4π direction radiation in 3D, but only retains 2π direction radiation in xy-2D like a cylinder, and completely loses the GR R-contraction in the ±z direction. In the +z direction, it is replaced by the SR L-contraction, and in the -z direction, it may have zero length contraction?). Also, when the spin speed vector increased in +z direction, a fast-spinning point charge's RFe-force decreases RF and then shows up in the (quasi) z-1D (as the magnetic force-line along z-1D), and in contrast, (I guessed that) a fast-spinning black hole's SR L-contraction may show up in φ-1D (but not in z-1D), and it is equivalent to the length

contraction only in the (circular) xy-2D but not in z-1D (just like a cylinder contracts to a thin line). (Note: In the case that a BH is spinning in z direction in the maximum speed, I guessed that the GR R-contraction lost the 4π direction radiation in 3D, it only retains the GR R-contraction in the ±z direction, while the xy-2D is replaced by the circular SR L-contraction).

In other words, GR and SR may be kind of "mutual orthogonal". On the 2D spherical surface in Figure 4, GR R-contraction may can be treated as in θ-1D, while SR L-contraction may can be treated as in φ-1D. In a rθφ-3D spherical space, GR R-contraction may can be treated as is in r-1D, while SR L-contraction may can be treated as in θφ-2D (and more often, this θφ-2D is degenerated into x-1D).

For the nL0/nLL pair, (similar as that a single object cannot be simultaneously at both point A and point B for GR/SR pair in in Figure 4), a single object cannot be simultaneously at both point A and point B for nL0/nLL pair in Figure 4. (Note: Only a collection of many objects can be simultaneously at both point A and point B for nL0/nLL pair in Figure 4, and it means that these many objects are in the complete RF QM state. For example, the collection of all H-atoms inside current Sun's {0,1//6}o orbital shell is at both point A and point B for nL0/nLL pair in Figure 4, and they are doing the complete RF motion). See Appendix D for more discussions on the similar topic.

IX. Using "4D thermal oscillators" to describe the cosmic redshift of a 656.1 nm photon

In SunQM-6s2, I estimated that "*to satisfy Hubble constant … a 656.1 nm photon, after propagating each ~2.7E+10 meters (about a half distance from Sun to Mercury), it will split-out a 0.02 Hz low-f photon*". Now I may can use the "4D thermal oscillators" to describe this process. Let's first suppose that a 656.1 nm photon is made of 1000E+15 of the same "4D thermal oscillators" as one (large) group. Then suppose that this large group can be further divided into 1E+15 sub-groups, each sub-group contains 1000 "4D thermal oscillators", and suppose a 0.02 Hz "low-f" photon is made of 1000 "4D thermal oscillators". For a "newborn" and/or a "matured" 656.1 nm photon, all of 1000E+15 "4D thermal oscillators" have the 100% unified oscillational directions and synchronized oscillational phases, so that they fly as a single (large) group with the lightspeed (as one photon in 3D) in x-1D direction. Then, during propagation, a photon is disturbed by the surrounding environment and thus it collects the outside randomness (so that the entropy of this photon is increased) and thus more and more "4D thermal oscillators" in this large group become randomized. At the end of 2.7E+10 meters propagation, among 1000E+15 "4D thermal oscillators", let's suppose that there are 10 got fully randomized. Then, collectively, these 10 fully randomized "4D thermal oscillators" have the (collective) macro 3D speed equals to zero (rather than the lightspeed) in x-1D direction.

1) "**Particle view**": each sub-group with 1000 "4D thermal oscillators" is treated as one (virtual) particle. Somehow this propagating photon is able to transfer all 10 randomized "4D thermal oscillators" into a single sub-group of 1000 "4D thermal oscillators" (among 1E+15 sub-groups), so that this single sub-group has 990 of unified "4D thermal oscillators" that can propagate in 3D in lightspeed, and 10 random "4D thermal oscillators" that can propagate in 3D in zero speed. After weighted averaging, $(990 \times 1c + 10 \times 0c)/1000 = 0.99c$, it means that these 1000 "4D thermal oscillators" as a whole sub-group will propagate in 3D in 99% of lightspeed in x-1D direction. Then, because this single sub-group has only 99% lightspeed, it will fall behand the rest 1E+15 sub-groups that have 100% lightspeed, and then get disentangled to become a "newborn" low-f photon (with the assumption that 99% lightspeed is the cut-off to start the disentanglement).

2) "**Spherical 3D Wave Packet view**": Based on SunQM-6s4's Fig-6c, suppose that each n shell of a spherical 3D wave packet contains 1000 of "4D thermal oscillators". During the propagation, the outmost shell of a photon's spherical 3D wave packet has the highest probability to be disturbed by the surroundings and thus collect the randomness, the second outmost shell has the second highest probability to collect the surrounding randomness, and so on so forth. At the end of 2.7E+10 meters propagation, suppose that the outmost shell have collected the enough randomness to make 10 (out of the 1000) "4D thermal oscillators" to fully randomized (so that the outmost shell has the propagation speed of 0.99c), the second outmost shell have collected the randomness to make 5 (among 1000) "4D thermal oscillators" to fully randomized (so that the second outmost shell has the propagation speed of 0.995c), and the third outmost shell have collected the randomness to make 2 (among 1000) "4D thermal oscillators" to fully randomized (so that the third outmost shell has the propagation speed of

0.998c), and so on so forth. Because the diameter of each shell of the spherical 3D wave packet may equal to one wavelength (see SunQM-6s3), the outer shells should have the lower frequency than that of inner shells. Then, the combined above results perfectly matches to that described in wiki "Group velocity": "*If the wavepacket has a relatively large frequency spread, … or if the packet travels over very long distances, … the envelope of the wave packet not only moves, but also distorts, in a manner that can be described by the material's group velocity dispersion. Loosely speaking, different frequency-components of the wavepacket travel at different speeds, with the faster components moving towards the front of the wavepacket and the slower moving towards the back. Eventually, the wave packet gets stretched out*". Similarly, if 0.99c is the cut-off to start the disentanglement, then at end the of 2.7E+10 meters propagation, the outmost shell of this (stretched) spherical 3D wave packet of the 656.1 nm photon (that contains 1000 of "4D thermal oscillators" with the speed of 0.99c) will get to be "spin-off" as a newborn low-f photon (at 0.02 Hz). In this way, the "Spherical 3D Wave Packet view" is obviously better than the "Particle view".

X. The "4D thermal oscillation" may also can be used to explain the force particle, and the origin of "color confinement" may also be one kind of "GR R-contraction"

In the previous sections, we used a group of "4D thermal oscillators" to explain a mass particle and the origin of the associated relativistic length contraction. Similarly, I guessed that we may also the same "4D thermal oscillators" to explain a "force particle" (or a "**force-on**", like a gluon, etc.) and the possibly associated relativistic length contraction. As wiki "Strong interaction" pointed out: "*The strong interaction is observable at two ranges and mediated by two force carriers. On a larger scale (of about 1 to 3 fm), it is the force (carried by mesons) that binds protons and neutrons (nucleons) together to form the nucleus of an atom. On the smaller scale (less than about 0.8 fm, the radius of a nucleon), it is the force (carried by gluons) that holds quarks together to form protons, neutrons, and other hadron particles. In the latter context, it is often known as the color force. … color confinement, and it prevents the free "emission" of the strong force: instead, in practice, jets of massive particles are produced*". Here, I hypothesized that the origin of the "color confinement" may also be one kind of "general relativity radial contraction". In this case, each gluon (that is doing the virtual "3D thermal oscillation" inside a nucleon) may can be treated as the projection of a group of "4D thermal oscillators" in the 3D space (inside a nucleon). Within a nucleon at the size of {-15,1//6}, all gluons (that are doing "3D thermal oscillation") can be treated as that their matter waves are doing the circular orbital motion (with the intrinsic speed equals to the lightspeed c, and in the orbital shell of {-16,5//6}o). Because all these RF circular orbital motions have the lightspeed c, on the surface of the nucleon, the rθφ-3D space should be degenerated into 1D, either φ-1D, or θ-1D, r-1D (as shown in Figure 3). Because the "3D thermal motion" of the gluons (with the intrinsic speed of c) degenerated into a synchronized 1D motion (that can be treated as in r-1D), then, for the S-force field, the rθφ-3D space at the (immediate) outside of the nucleon is radial contracted to zero, and this is exactly the same as the general relativity radial contraction (not for the G-force, but for the S-force). In this way, after the "general relativity" kind of radial contraction to the maximum, the S-force becomes the color force, and it is confined within the nucleon. The nuclear force (or the residue S-force) may can be treated as that: it is the S-force that exerted in the 4^{th} dimension of the r'rθφ-4D space that projected back to the (curved) spherical rθφ-3D space (as shown in SunQM-7s1's Fig-3a). If this description is correct, then we may can unify the description for either the color-force (or S-force) confinement on a nucleon's surface, and the 3D G-force confinement on a BH surface.

Then, why "the rθφ-3D space on a Sun surface is not radial contracted to zero for the G-force"? This may because that in comparison with the (virtual) "3D thermal motion" of the gluons on a nucleon surface, the (real) "3D thermal motion" of the H-atoms on the Sun surface has the oscillational speed much slower than the lightspeed, so it cannot cause the rθφ-3D space on the Sun surface to radial contract to zero. Even so, it does partially degenerate the rθφ-3D space to r-1D on the Sun surface, so that it caused H-atoms (ions) that flying out of Sun surface to have the velocity vector strictly in +r direction, and thus caused the Sun surface temperature decreased to 5800 K° (see SunQM-3s8's section-IV).

XI. All force-on ("positive/negative G-photon", "positive/negative S-photon", "positive/negative E-photon") may have the similar "general relativity radial contraction" kind of effect

In the "Standard Model of elementary particles" [49], the G-force is mediated by the graviton, the EM-force is mediated by the photon, and the S-force is mediated by the gluon. Borrowed from that idea, and using the photon as the foundation, here I proposed a citizen-scientist-leveled hypothesis:

1) A graviton is a "negative G-photon" that carries the negative momentum, and it is an attractive G/RFg-force carrier. Once absorbed by a particle, it will push the particle to move to the opposite direction of the "negative G-photon" motion direction (see SunQM-6s3's section-I-b);

2) There might be a "positive G-photon" that carries the positive momentum, and it is a repulsive (or a neutral) G/RFg-force carrier. Once absorbed by a particle, it will push (or zero-push) the particle to move to the motion direction of the "positive G-photon" (see SunQM-6s3's section-I-b). It may be the component of the gravitational wave (see SunQM-6s3's Fig-2b);

3) A gluon is a "negative S-photon" that carries the negative momentum, and it is an attractive S/RFs-force carrier. Once absorbed by a particle, it will push the particle to move to the opposite direction of the "negative S-photon" motion direction;

4) There might be a "positive S-photon" that carries the positive momentum, and it is a repulsive (or a neutral) S/RFs-force carrier. Once absorbed by a particle, it will push (or zero-push) the particle to move to the motion direction of the "positive S-photon";

5) A photon is a "positive E-photon" that carries the positive momentum, and it is a repulsive E/RFe-force carrier. Once absorbed by a particle, it will push the particle to move to the motion direction of the "positive E-photon";

6) There might be a "negative E-photon" that carries the negative momentum, and it is an attractive (or a neutral) E/RFe-force carrier. Once absorbed by a particle, it will push (or zero-push) the particle to move to the opposite direction of the "negative E-photon" motion direction.

Furthermore, all these force-on ("positive/negative G-photon", "positive/negative S-photon", "positive/negative E-photon") may have the similar "general relativity radial contraction" kind of effect. For example,

a) On a BH surface, the true general relativity radial contraction gets maximum, r-1D is contracted to zero (for the G-force in rθφ-3D space), so that the attractive G-force is not propagating in rθφ-3D space. A BH's G-force in rθφ-3D space may come from the r'rθφ-4D G-force that projected back to the (curved) spherical rθφ-3D space (as shown in SunQM-7s1's Fig-3a).

b) On a nucleon surface, the kind of "general relativity radial contraction" effect gets maximum, r-1D is contracted to zero (for the S-force in rθφ-3D space), so that the attractive S-force is not propagating in rθφ-3D space at outside of a nucleon (and thus caused the color confinement). A nucleon's residue S-force (or the nuclear force) in rθφ-3D space may come from the r'rθφ-4D S-force that projected back to the (curved) spherical rθφ-3D space (as shown in SunQM-7s1's Fig-3a).

c) On a neutron surface, (for the E-forces of the proton and electron inside a neutron in rθφ-3D space), the kind of "general relativity radial contraction" effect gets maximum, r-1D is contracted to zero, so that the attractive E-force is not propagating in rθφ-3D space (at the outside of a neutron). Both the proton's and the electron's project their r'rθφ-4D E-force back to the (curved) spherical rθφ-3D space (as shown in SunQM-7s1's Fig-3a), and they cancelled out with each other (because they have the same strength but opposite exerting direction), so that there is still zero E-force in rθφ-3D space (at the outside of a neutron).

d) Therefore, all these force-on(s) may can be described as that they are composed by a group of "4D thermal oscillators", and these forces's "general relativity radial contraction" kind of effect may can be explained as that all these "4D thermal oscillators" unified their oscillational directions and synchronized their oscillational phases (in 4D space). This is for the point-centered force field.

e) For the point-centered mass field, due to the "general relativity radial contraction" kind of effect, the mass cannot escape from a BH surface (same as the G-force line cannot escape from a BH surface in rθφ-3D space), the mass (i.e., the quarks) cannot escape from a nucleon's surface (same as the S-force line cannot escape from a nucleon surface in rθφ-3D space). However, unlike that the E-force line cannot escape from a neutron's surface in rθφ-3D space, the mass can occasionally escape from a neutron's surface (through a spontaneous β-decay). Does it mean that this description is not perfect, and needs further improvement?

Note: Even some of these ideas may be too wild to be correct, I still want to put forward them. Because first, I always try to use the classical (or the traditional) way to explain the physical process if I can. Second, the key duty of a citizen scientist is to provide the diversified idea to the scientific community (for the purpose to broaden the foundation of science), even these ideas may (mostly) be wrong, it may (抛砖引玉) inspire others to think the better idea.

Summery and Conclusion

The projection of a group of "4D thermal oscillators" in a 3D space may can be the origin of both the length contraction in special relativity and the radial contraction in general relativity. It may also can be the origin of $E = mc^2$. On a BH surface, rθφ-3D space is degenerated into 1D space, and you may can treat this 1D space as either a r-1D or a φ-1D. The non-linear {N,n//q} QM structure near a BH (where q = 6 increased to q = ∞) can be achieved by fusing the general relativity's radial contraction calculation into the non-linear {N,n//q} QM structure's calculation. Like that of G/RFg-force pair, E/RFe-force pair, S/RFs-force pair, and nL0/nLL pair, the length contraction difference between GR and SR pair could be another brand new parameter in the physics.

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Note: A series of SunQM papers that I am working on:
SunQM-4s4: More explanations on non-Born probability (NBP)'s positive precession in {N,n}QM. (in drafting since 2020)
SunQM-8: {N,n} QM and the condensed matter physics … (drafted in Jan. 2024).
SunQM-9s1: Addendums, Updates and Q/A for SunQM series papers. (in drafting since 2019).

Note: Major QM books, data sources, software that I used for the study (in the SunQM series papers):
Douglas C. Giancoli, Physics for Scientists & Engineers with Modern Physics, 4th ed. 2009.
David J. Griffiths, Introduction to Quantum Mechanics, 2nd ed., 2015.
Stephen T. Thornton & Andrew Rex, Modern Physics for Scientists and Engineers, 3rd ed. 2006.
John S. Townsend, A Modern Approach to Quantum Mechanics, 2nd ed., 2012. (Figure 9.11, Figure 10.5)
Wikipedia at: https://en.wikipedia.org/wiki/
(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!
So far, my identity (for the {N,n} QM development) is: a former lecturer of Fudan University, and a (10 years closed-door, 2014 ~ 2024) citizen scientist of California.

Note: With my 36 of SunQM papers that have been posted out so far, I believe that the framework of the {N,n} QM has been fully established. It is clear now that the {N,n} QM description is suitable not only for the mass field, but also for the force field (or the energy field, etc.). Thus, my (10 years of closed-door) research phase on the {N,n} QM will end (most likely in the summer of 2024). After that, I will re-write the SunQM papers (~ 36 of them) in form of a text book. The initial plan is, 1) Try to formally publish all ~36 of SunQM papers as the original version (version-1, or version 2018) if possible; 2) Using ~ 2 years, to brief (by re-writing) all ~36 of SunQM papers (as version-2, or version 2025), the main purpose is to unify the nomenclature and the description, compress the total words from over 400,000 to less than 200,000, (and publish it if possible), make it ready for the text book writing; 3) Using 2 ~ 4 years, to write a Bohr-QM based {N,n} QM text book with ~ 100,000 words (as version-3, for college and high-school students), formally publish it if possible, and may make a few online video lectures; 4) Using 2 ~ 4 years, to add Schrodinger-equation-QM based {N,n} QM into the version-3 text book with final ~ 200,000 words (as version-4), formally publish it if possible, and may make a few online video lectures. It may take me total 6 ~10 years (2024 ~ 2035, semi-retired) to finish all the work. I may go back to Shanghai to do this work, either as a citizen scientist of Shanghai, or, if lucky, as a (semi-retired) professor in Fudan university.

Appendix A. Can we explain the origin of the relativistic time dilation by using the projection of a 4D spacetime in a 3D space?

Using Figure 1c but switch to the rθφt-4D spacetime (rather than r'θφt-4D), it only produces a time-contraction, not the time dilation. I also tried the irregular rθφ(vt)-4D spacetime, it still doesn't produce the time dilation. To produce the standard result of time dilation (as shown in the equation [37]), I was force to plot an irregular rθφ(1/Δt)-4D spacetime (as shown in Figure 5), with the x' axis represents the rθφ-3D, and y' axis represents the (1/Δt)-1D. Then, using the right triangular similarity between Figure 5 and Figure 1c, with $t_0 = t_{max}$, and $v_{max} = c$, we obtained the correct relativistic time dilation equation

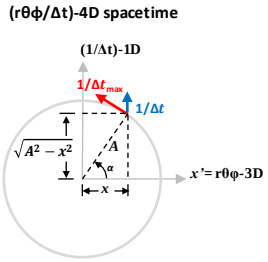

Figure 5. Using the projection of rθφ(1/Δt)-4D spacetime into rθφ-3D space to deduce out the time dilation of the special relativity.

$$\frac{1/\Delta t}{1/\Delta t_{max}} = \frac{\sqrt{{v_{max}}^2 - {v_{x'}}^2}}{v_{max}}, \text{ or, } \frac{1/\Delta t}{1/\Delta t_0} = \frac{\sqrt{c^2 - {v_{x'}}^2}}{c}, \text{ or, } \frac{\Delta t_0}{\Delta t} = \sqrt{1 - \frac{{v_{x'}}^2}{c^2}}, \qquad \text{eq-26}$$

or,

$$\Delta t = \frac{\Delta t_0}{\sqrt{1 - {v_{x'}}^2/c^2}} \qquad \text{eq-27}$$

However, it is really unexpected for me that to use the projection of 4D spacetime to 3D space for the time dilation, I have to use the rθφ(1/Δt)-4D, not the regular rθφt-4D. Although, we may be forced to explain it as: during deduction, we need to compare the right triangular similarity between Figure 5 and Figure 1c, and Figure 1c is about the velocity, and v = Δx/Δt, that is, v ∝ 1/Δt, so that the y' axis in Figure 5 should be 1/Δt (rather than t).

Notice that from Figure 1a and Figure 1c, we can use the standard classical physics to naturally deduce out the SR L-contraction (meaning, we may can deduce this result out even without knowing the SR L-contraction ahead). However, for the eq-27 that deduced out by using the rθφ(1/Δt)-4D projection into rθφ-3D, it is not naturally deduced out (meaning, I am unable to deduce this result out the result without knowing the eq-27 ahead).

Similarly, for the eq-8 (GR R-contraction) that deduced out by using the r'rθφ-4D projection into rθφ-3D (in Figure 1d), it is not naturally deduced out (meaning, I am unable to deduce out this result without knowing it ahead). This is because that strictly to say, Figure 1d is really a rθφ(Δr)-4D plot, and it is not a true r'rθφ-4D plot. Although, we may also be forced to explain it as: during deduction, we need to compare the right triangular similarity between Figure 1d and Figure 1c, and Figure 1c is about the velocity, and v = Δr/Δt, that is, v ∝ Δr, so that the y' axis in Figure 1d should be Δr.

By compering eq-25 to eq-27, we see that both have a dilation factor of $\frac{1}{\sqrt{1-v^2/c^2}}$. So I guessed that the relativistic properties of the q in a point-centered {N,n//q} QM (notice that in some way, q is equivalent to the quantum number n), and the time in a point-centered acceleration motion, may have the same origin. This guess can be further supported by that, in SunQM7's section VII, I have mentioned that the Bohr's formula $r_n = r_1 n^2$ and the (free-fall) accelerated distance formula $d = \frac{1}{2} g t^2$ may have the same origin, or, in these two formulas, the quantum number n and the time t are equivalent.

Appendix B. An alternative explanation for the origin of the $E = mc^2$, (or, $\Delta E = \Delta m\, c^2$)

After many years of thinking, here is my second way to explain the origin of the $E = mc^2$. When an electron (with mass m) of H-atom is doing the φ-1D circular orbital motion in xy-2D plane, it may contain three parts of (kinetical) energy (let's use kind of thermal energy to represent): $E_r = \frac{1}{2}m\overline{v_r{}^2}$, $E_\theta = \frac{1}{2}m\overline{v_\theta{}^2}$, and $E_\varphi = \frac{1}{2}m\overline{v_\varphi{}^2}$. Among them, only $E_\varphi = \frac{1}{2}m\overline{v_\varphi{}^2}$ belongs to electron itself, and not belongs to the proton-electron system energy, (because once the proton is removed, the free electron will carry this kinetical energy $E_\varphi = \frac{1}{2}m\overline{v_\varphi{}^2}$ to fly away along the tangential direction of the circular orbit). On the other hand, after many years thinking, I realized that the $E_r = \frac{1}{2}m\overline{v_r{}^2}$ energy is used to fix electron's orbit at $r = r_n$ (i.e., it is the potential energy in r-1D), and the $E_\theta = \frac{1}{2}m\overline{v_\theta{}^2}$ energy is used to fix electron's orbit at $\theta = \pi/2$ (i.e., it is the potential energy in θ-1D). These two (potential) energies added together become the potential energy of the orbital electron, and it is not belonging to the electron along, it is belonging to the proton-electron system, because once the proton is removed, the (free) electron will lose this potential energy. Therefore, the sum of these two parts $\frac{1}{2}m\overline{v_r{}^2} + \frac{1}{2}m\overline{v_\theta{}^2}$ (that may equivalent to the averaged thermal motion energy of $\frac{2}{2}m\overline{v_r{}^2}$) becomes the system's (potential) energy, or system's binding energy, and it equivalents to the $\Delta E = \Delta m\, c^2$ in the nuclear fusion/fission reaction (that released from the micro thermal virtual 4D motion and that projected to the macro true 3D motion). If the electron fly away from the system, the system loses not only the electron and its kinetic energy $E_\varphi = \frac{1}{2}m\overline{v_\varphi{}^2}$, but also the system energy (of the equivalent $\frac{2}{2}m\overline{v_r{}^2}$).

Under the zero external force, the electron orbit (in an H-atom) become RF. Thus θ-1D is not locked to $\theta = \pi/2$, only r-1D is locked to $r = r_n$. In this way, the proton-electron system may have lowered its system energy. Therefore, the proton-electron system wants to have its electron orbit in RF. However, if the electron fly away at this time, it will carry away one part of energy $E_\varphi = \frac{1}{2}m\overline{v_\varphi{}^2}$, and the system will lose the second part of energy $E_r = \frac{1}{2}m\overline{v_r{}^2}$, but the third part of energy $E_\theta = \frac{1}{2}m\overline{v_\theta{}^2}$ is still missing. So, my best guess is that the RF electron will not be released. It may only can be released when the RF electron obtained extra energy of $E_\theta = \frac{1}{2}m\overline{v_\theta{}^2}$ and be fixed to $\theta = \pi/2$, then it can fly away. When it do so, the system will release the total system energy of $\frac{1}{2}m\overline{v_r{}^2} + \frac{1}{2}m\overline{v_\theta{}^2}$ (that may equivalent to $\frac{2}{2}m\overline{v_r{}^2}$, and it may also be the origin of $E = mc^2$).

Appendix C. More discussions on the origin of the $E = mc^2$, (or, $\Delta E = \Delta m\, c^2$)

(Note: This is for my own record). Thirdly, from the previous section, we know that on a BH surface, the "true" macro 1D orbital velocity is $|\vec{v}_{\varphi,surf}| = |\vec{v}_{r,surf}| = \sqrt{\frac{2GM}{r_{surf}}} = c$. Then, what is the meaning for the "2D orbital velocity" $v_{\theta\varphi,n} = \sqrt{\frac{GM}{r_n}}$ in eq-13? Eq-23 may have (partly) answered this question. In comparison with the escape velocity $v_{n,r} = \sqrt{\frac{2GM}{r_n}}$ that equals to a "1D orbital velocity" and that comes from the one dimensional kinetical energy $\frac{1}{2}mv_{r,surf}{}^2$ in eq-9, the "2D orbital velocity" $v_{n,\theta\varphi} = \sqrt{\frac{GM}{r_n}}$ comes from the θφ-2D kinetical energy (that may can be mimicked in the micro thermal motion as $\overline{K}_{\theta\varphi} = \overline{K}_\theta + \overline{K}_\varphi \rightarrow$ ½ Δm $\overline{v_\theta{}^2}$ + ½ Δm $\overline{v_\varphi{}^2}$ = Δm $\overline{v_{\theta\varphi}{}^2}$, see in eq-23) and this $K_{\theta\varphi}$ directly correlates to the value of the (macro bound state) potential energy V_r , (or the binding energy), that further directly correlates to $E = mc^2$.

Interestingly, we have seen a similar situation before (in which $K_{\theta\varphi}$ and V_r were grouped together) in SunQM-6s9's eq-31, $E = K + iV^* = (K_{\theta\varphi} + V_r) + i(K_r + V_{\theta\varphi})$. So far, I am still unable to explain the exact meaning of this equation. I

guessed that this formula may use the imaginary number operator "i" to reflect the $K_{\theta\varphi}$ from the θφ-2D to the r-1D as the $\frac{1}{2}mv^2$, and simultaneously, to reflect the V_r from the r-1D to the θφ-2D as the $\frac{2}{2}mv^2$. Interestingly again, in SunQM-1s1's section-II, we may have seen this kind of "energy space transformation" from r-1D to θφ-2D: when the pre-Sun ball quantum collapsed from the {N+1,1//6} size to {N,1//6} size, the inward flying fragments transformed their r-1D kinetic energy $\frac{1}{2}mv^2$ (that is the uni-directional macro motions in the -r direction) into the θφ-2D (random) kinetic energy (something like $\frac{2}{2}m\overline{v^2}$, through the random collision with the pre-existing fragments in the {N-1,n//6}o orbital shell, and thus increased the random-directional θφ-2D macro motions). This not only increased the macro thermal motion in the {N-1,n//6}o orbital shell (at the fragment objects level), but also increased the micro thermal motion in the {N-1,n//6}o orbital shell (at the atomic level). Thus, "*the collapse of {N,n=1..5}o super-shell increases the thermal pressure of {N-1,n=1..5}o super-shell and prevent it from immediate collapse*" (see SunQM-1s1). At the end of this process, after transforming the r-1D (uni-direction, macro) kinetic energy to the θφ-2D (random, macro) kinetic energy, then to the θφ-2D (random, micro) kinetic energy, the final θφ-2D (random, micro, thermal-like) kinetic energy become the "$E = mc^2$" kind of energy that saved in the system (in the 3D version, not in the 4D version, so that it is not with the lightspeed c, but with the orbital speed v_n). If you can reverse this process, then you can release this pre-saved "$E = mc^2$" kind of (random, micro, thermal-like) energy to be the r-1D uni-directional macro kinetic energy (although it is not flying out in x-1D direction, but in r-1D's 4π directions). Furthermore, If you are able to not only reverse this process, but also release this pre-saved "$E = mc^2$" kind of (random, micro, thermal-like) energy in a single x-1D direction, then you have mimicked a nuclear fusion/fission process (that released energy of $E = mc^2$ as a gamma photon), although the real energy you released is $E = m\overline{v_{\theta\varphi}{}^2}$ (as a G-photon).

Appendix D. The right triangle relationship $c^2 = a^2 + b^2$ for the energy conservation E = K + V

When a xy-2D (or rφ-2D) circular motion (see in Figure 1a) degenerated into a x-1D oscillation, the total energy E = K + V conserved in x-1D between the kinetic energy K and potential energy V. If we treat the x-axis as the square-root of K (i.e., $\sqrt{K}$), treat the y-axis as the square-root of V (i.e., $\sqrt{V}$), and treat the r = A in Figure 1a as the square-root of E (i.e., $\sqrt{E}$), then the right triangle (with the Euler angle α) in Figure 1a (that has the $A^2 = x^2 + \left(\sqrt{A^2 - x^2}\right)^2$) now become $\sqrt{E}^2 = \sqrt{K}^2 + \sqrt{V}^2$, that further equals to E = K + V. In this way, the oscillational energy conservation E = K + V can be connected to the right triangle formula of $c^2 = a^2 + b^2$ with a variable Euler angle.

In the right triangle $c^2 = a^2 + b^2$, a and b are mutual orthogonal. Thus, in the energy conservation E = K + V, the kinetic energy K and the potential energy V may also have the kind of "mutual orthogonal" property. That may be the reason why I can write down the SunQM-6s9's eq-31 as $E = K + iV^* = \left(K_{\theta\varphi} + V_r\right) + i\left(K_r + V_{\theta\varphi}\right)$.

Furthermore, $E^2 = p^2c^2 + m^2c^4$ also follows the right triangle formula of $c^2 = a^2 + b^2$, although this time it is the squared energy E^2, not the original energy E.

Even more, there may exist a kind of "mutual orthogonal" and "conservation" relationship in the G/RFg-force pair, the E/RFe-force pair, the S/RFs-force pair, the GR-SR pair, and the nL0-nLL pair, and they may also can be described by the kind of $c^2 = a^2 + b^2$ relationship (as well as by the Figure 4 kind of analysis as shown in the section VIII). All of these become another interesting topic that I may study in the future.