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Article

Relativistic Radial Density Theory (RRDT)

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Abstract: Starting with Planck scale it is developed the Relativistic Radial Density Theory (*RRDT*). In this theory, the Planck and gravitational parameters can be described as the functions of the radial mass (energy) density value. This density is maximal at the minimal radius and minimal at the maximal radius. This conclusion is based on the fact that the ratio of Planck mass and Planck length (radius) is constant. These radiuses can be described as the function of the energy conservation constant κ. Using *RRDT*, it is possible to develop the connections between Planck's and gravitational parameters as function of the maximal and minimal radial mass (energy) density values. In that sense, the gravitational length, time, energy and temperature can be presented as the function of the Planck length, time, energy and temperature, respectively. This opens possibility to merge of Quantum Field Theory (*QFT*) and the General Theory of Relativity (*GTR*) at the quantum scale in gravitational field. The existence of the maximal radial mass (energy) density value at the minimal radius in gravitational field means that no singularity in that field. Further, the existence of the minimal radial mass (energy) density value at the maximal radius in gravitational field means that no infinity in that field. It follows the postulation: the most minimal radius in a gravitational field belongs to the minimal mass (energy). Since the Planck mass is not the minimal mass in space-time, the Planck length/radius is not the minimal length/radius in the space-time. If the calculated minimal (or maximal) radius is the bigger than the related official radius it means that there exists a dark matter in this object. In that sense, the black holes are presenting the state of the matter at the minimal radius where we have the maximal radial mass (energy) density value. Further, the maximal possible radius of the matter is presenting the state with the minimal radial mass (energy) density value. Thus, the maximal and minimal radial mass (energy) density values are constants and conserved items. Now the question is: do motion of the Universe follows the *RRDT*?

Keywords: Planck length; Gravitational length; General Theory of Relativity; Relativistic Radial Density Theory (RRDT)

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1. Introduction

A quantum theory of gravitation field, the minimum time evolution between two quantum states, the quantum transition, the Fermi-Golden rule and the time-dependent perturbation theory are presented in [1] and [2]. The classical to quantum transition is discussed in [3]. The sudden transition between classical to quantum decoherence in bipartite corelated quantum system can be found in [4]. The quantum critical points can be found by neural network quantum states [5]. The quantum thermodynamics of single particle systems is pointed out in [6]. Further, the probing dynamical phase transitions with a superconducting quantum simulator is presented in [7]. JT gravity and KdV equations and macroscopic loop operators are discussed [8].

Following General Theory of Relativity (*GTR*) [9], recently it has been developed a new Relativistic Alpha Field Theory (*RAFT*) [10]. This theory has a capability to extend application of *GTR* to the extremally strong gravitational field, including Planck's scale. There exist the expansion and contraction phases in the gravitational field. In the expansion phase we have the following prediction: there exists a maximal radial density $\rho_{r\ max}$ at the minimal gravitational radius. Thus, no singularity in a gravitational field. The expansion phase is finished with the minimal radial density, $\rho_{r\ min}$ at the maximal gravitational radius. Thus, no infinity in a gravitational field. The contraction phase is started at the maximal radius with the minimal radial density and is finished at the minimal radius with the maximal radial density.

The repulsive (positive) gravitational force is in the region $GM/2c^2 < r < GM/c^2$. Gravitational force is equal to zero at the radius $r = GM/c^2$. At radius $r > GM/c^2$ gravitational force is attractive (negative), but because of the inertia the expansion is continuing to the maximal radius. Contraction phase started at the maximal radius (minimal radial mass (energy) density) with the negative gravitational force. At the radius $r = GM/c^2$ gravitational force is equal to zero, but because of the inertia, the contraction phase is continuing to the minimal radius with the maximal radial mass (energy) density and the next cycle of the motion can be started. Here M is the mass, c is the speed of the light in vacuum and r is the radius.

Following the predictions of *RAF* Theory, one can see that there exists the region of the extremally strong gravitational field. This is the consequence of the solution of the field equations by including gravitational energy-momentum tensor (*EMT*) on the right side of the field equations [11]. The important conclusion is that there exists the possibility for application of Quantum Field Theory (*QFT*) to the extremally strong gravitational field [12]. Meanwhile, there also exists the thinking that the any attempt to investigate the possible existence of smaller distances of Planck length, by using higher energy collisions, would result in black hole production [13]. This is the consequence of the vacuum solution of the Einstein's field equations [9], that predicts the singularities at the extremely strong field and the existence of the related black holes.

The minimum time transition between quantum states in gravitational field, the unification of potential fields, connection between Planck's and gravitational parameters and the generation of the repulsive gravitational force are presented in [14,15,16,17], respectively. The one particle transition and correlation in quantum mechanics is systematically illustrated in [18]. The experimental protocol for testing the mass-energy-information equivalence principle is presented in [19]. The discussion of the black holes behavior and the related thermodynamics is illustrated in [20]. Further, the presentation of the quantum hair, black hole information and the quantum hear from gravity is presented in [21,22], respectively.

Here it is introduced the new notion "the radial density value" as the ratio of the mass (energy) and radius. This is very important value, because the most of the physical items can be described by the radial density value. There exist the maximal and the minimal radial density values. The maximal radial density value for the related mass (energy) is at the minimal radius. On the other hand, the minimal radial density value is happened at the maximal radius. The maximal and minimal radial density values are constants for the all amounts of masses (energies). The larger masses (energies) have the larger minimal and maximal radiuses. Of course, the smaller masses (energies) have the smaller minimal and maximal radius values. Since the Planck's mass is not the smallest mass in the space-time, the Planck's length (radius) is not the smallest length (radius) in it.

The quantization of the gravitational field is dominant in the region between minimal length (radius) and twice of that length (radius). Therefore, the quantization is applied to the mentioned region. It is determined the minimal distance between two quantum states and the related minimal transition time by using the speed of the light in vacuum. The calculation of the items as the energy uncertainty, the shortest transition time, the generic state, the shortest physically possible time and the time effectively spent by the controlled system or control algorithm are presented systematically. Finally, it is determined that the minimal distance between two quantum states should be less than 10^{-35} m [23].

2. Planck and Gravitational Parameters as Functions of Radial Mass (Energy) Density

As it is the well-known in physics, the Planck length, L_p, and Planck mass, M_p, are the units of length and mass, respectively, in the system of natural units known as Planck units. It has been employed in [8,14,18,19,21]. To this system also belong Planck time, t_p, Planck energy, E_p and Planck temperature, T_p, that have been derived as the functions of Planck length and Planck mass.

The maximal radial mass (energy) density $\rho_{rm\ max}$ in a gravitational field is a constant and is valid for gravitational mass M, Planck mass M_p, as well as for any amount of the mass. Using the Einstein's relation between mass and energy, $E=Mc^2$, one can define the maximal radial energy density $\rho_{re\ max}$. As the consequence, the following relations can be derived:

$$\begin{aligned} \rho_{rm\ max} &= \frac{M_p}{r_p} = \frac{M}{r_{min}} = \frac{2c^2}{G}, \\ \rho_{re\ max} &= \frac{E}{r_{min}} = \frac{2c^4}{G}, \\ r_p &= \frac{GM_p}{2c^2} = r_{min} = \frac{GM}{2c^2} = \frac{GE}{2c^4}. \end{aligned} \tag{1}$$

Here r_{min} is the minimal radius of mass M, r_p is the minimal radius of Planck mass M_p , c is a speed of light in vacuum, G is gravitational constant and E is energy equivalent to mass M.

In order to find out the existence of the minimal radius in a gravitational field one can start with the line element [10,11,23]:

$$\begin{aligned} ds^2 = &-\left(1-\frac{GM}{rc^2}\right)^2 c^2dt^2 \\ &+2\sqrt{\frac{2GM}{rc^2}\left(1-\frac{GM}{2rc^2}\right)}\, cdt\,dr \\ &+dr^2+r^2d\theta^2+r^2\sin^2\theta\, d\phi^2. \end{aligned} \tag{2}$$

The line element (2) can also be described as the function of the maximal radial mass density:

$$\begin{aligned} ds^2 = &-\left(1-\frac{G\rho_{rmmax}}{c^2}\right)^2 c^2dt^2 \\ &+2\sqrt{\frac{2G\rho_{rmmax}}{c^2}\left(1-\frac{G\rho_{rmmax}}{2c^2}\right)}\, c\,dt\,dr \\ &+dr^2+r^2d\theta^2+r^2\sin^2\theta\, d\phi^2 . \end{aligned} \tag{2a}$$

The second possibility is description of the line element (2) as the function of the maximal radial energy density:

$$ds^2 = -\left(1 - \frac{G\rho_{remax}}{c^4}\right)^2 c^2 dt^2$$
$$+2\sqrt{\frac{2G\rho_{remax}}{c^4}\left(1 - \frac{G\rho_{remax}}{2c^4}\right)}\, c\, dt\, dr \tag{2b}$$
$$+dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta\, d\phi^2 \; .$$

It is easy to prove that the questions of the line elements (2), (2a) and (2b) are regular if the following conditions are satisfied:

$$\left(1 - \frac{GM}{2rc^2}\right) \geq 0 \rightarrow \frac{GM}{2rc^2} \leq 1 \rightarrow \frac{GM}{2c^2} \leq r < \infty,$$
$$\left(1 - \frac{G\rho_{rmmax}}{2c^2}\right) \geq 0 \rightarrow \frac{G\rho_{rmmax}}{2c^2} \leq 1 \rightarrow \rho_{rmmax} \leq \frac{2c^2}{G}, \tag{3}$$
$$\left(1 - \frac{G\rho_{remax}}{2c^4}\right) \geq 0 \rightarrow \frac{G\rho_{remax}}{2c^4} \leq 1 \rightarrow \rho_{remax} \leq \frac{2c^4}{G}.$$

From (3) it can be concluded that there exists the minimal gravitational radius r_{min}, the corresponding maximal radial mass density $\rho_{rm\,max}$ and related maximal radial energy density $\rho_{re\,max}$ which still preserve regularity of the line element (2), (2a) and (2b), respectively:

$$r_{min} = \frac{GM}{2c^2},$$
$$\rho_{rmmax} = \frac{2c^2}{G}, \tag{4}$$
$$\rho_{remax} = \frac{2c^4}{G}.$$

For the radiuses less than minimal gravitational radius, r_{min} , or for the radial mass density ρ_{prm} greater of the maximal radial mass density, $\rho_{prm\,max}$, or for the radial energy density ρ_{pre} greater of the maximal radial energy density, $\rho_{pre\,max}$, the line element (2), (2a) and (2b) become imaginary items.

Now, applying of the Planck mass M_p, or the corresponding maximal radial mass density, $\rho_{prm\,max}$ and the maximal radial energy density $\rho_{pre\,max}$ to the relation (3) it is obtained the minimal gravitational radius of the Planck mass and related maximal radial mass and energy densities which are the same as in (4):

$$r_{pm} = \frac{GM_p}{2c^2},$$
$$\rho_{prmmax} = \frac{2c^2}{G}, \tag{5}$$
$$\rho_{premax} = \frac{2c^4}{G}.$$

As it is well-known, the Planck mass M_p and the Planck length L_p are defined from three fundamental physical constants: the speed of light in vacuum c, the reduced Planck constant $\hbar$ and the gravitational constant G:

$$
\begin{aligned}
&M_p = \sqrt{\frac{\hbar c}{G}}, \\
&L_p = \sqrt{\frac{\hbar G}{c^3}}, \\
&\frac{M_p}{2r_{pm}} = \frac{c^2}{G}, \\
&\frac{M_p}{L_p} = \frac{\sqrt{\hbar c / G}}{\sqrt{\hbar G / c^3}} = \frac{c^2}{G} = const. \\
&\rightarrow \quad 2r_{pm} = L_p \quad \rightarrow \quad r_{pm} = \frac{L_p}{2}.
\end{aligned} \tag{6}
$$

From the previous relations one can derive the connections between Planck's and gravitational parameters:

$$\frac{L_g}{L_p} = \frac{M_g}{M_p} \rightarrow L_g = L_p \frac{M_g}{M_p} = \sqrt{\hbar G / c^3}\, \frac{M_g}{M_p}. \tag{7}$$

Following (7), one can described the minimal gravitational length (radius) in gravitational field which is proportional to the gravitational mass:

$$L_{g\,min} = L_p \frac{M_g}{M_p} \; \rightarrow \; L_{g\,min} = 2r_{g\,min} = 2r_{p\,min} \frac{M_g}{M_p} = \sqrt{\hbar G / c^3}\, \frac{M_g}{M_p}. \tag{8}$$

The postulation. The most minimal radius in a gravitational field belongs to the minimal mass. Since the Planck mass is not the minimal mass in the space-time, the Planck length/radius is not the minimal length/radius in the universe. If the calculated minimal (or maximal) radius is the bigger than the related official radius it means that there exists a dark matter in this object. Or the official radius is not correctly calculated. This is very important discovery for the new investigations in physics. The relations (7) can also be employed for quantization of a gravitational field.

Further, using Planck mass and Planck length it is calculated the energy conservation constant κ, that has been introduced in [23]:

$$
\begin{aligned}
&L_p = \frac{2GM_p}{(1+\kappa)c^2}, \; \kappa = \frac{2GM_p}{L_p c^2} - 1 = 0.99993392118, \\
&\rho_{rmmax} = \frac{M_p}{r_{p\,min}} = \frac{(1+\kappa)c^2}{G} = 2.693182 \cdot 10^{27} \frac{kg}{m}, \\
&\rho_{remax} = \frac{E_p}{r_{p\,min}} = \frac{(1+\kappa)c^4}{G} = c^2 \cdot 2.693182 \cdot 10^{27} \frac{kg\,m}{s^2}.
\end{aligned} \tag{9}
$$

Further, it is also important to know the value of the minimal radial mass and energy densities in the nature:

$$\rho_{rmmin} = \frac{M_p}{r_{p\,max}} = \frac{M_g}{r_{g\,max}},$$
$$\rho_{rmmin} = \frac{(1-\kappa)c^2}{G} = 0.888779 \cdot 10^{23} kg\,/\,m, \tag{10}$$
$$\rho_{remin} = \frac{(1-\kappa)c^4}{G} = c^2 \cdot 0.888779 \cdot 10^{23} \frac{kg\,m}{s^2}.$$

As it is well-known Planck time t_p is defined as the time needed for the light to pass through one Planck length. From the previous relations one can derive the gravitational time t_g:

$$t_p = \frac{L_p}{c} = \sqrt{\hbar G / c^5},$$
$$t_g = \frac{L_g}{c} = \frac{L_p}{c}\frac{M_g}{M_p},$$
$$t_g = t_{g\,min}, \tag{11}$$
$$t_{g\,min} = \frac{\hbar\,(1+\kappa)M_g}{2c^2},$$
$$t_{g\,min} = \frac{\hbar\,(1+\kappa)}{2c^2}\rho_{rmmax} r_{g\,min}.$$

From (11) one can see that the minimal gravitational time t_{gmin} is proportional to the gravitational mass M_g. Thus, for larger gravitational mass the minimal gravitational time t_{gmin} is longer. This is because the larger mass has the lager inertia. On the other hand, the maximal gravitational time t_{gmax} is proportional to the maximal gravitational length L_{gmax} . At this point the radial mass (or energy) density is the smallest:

$$\rho_{rmmin} = \frac{M_g}{r_{g\,max}} = \frac{M_g}{L_{g\,max}/2} = \frac{2M_g}{L_{g\,max}} = \frac{(1-\kappa)c^2}{G},$$
$$t_{g\,max} = \frac{\hbar\,(1-\kappa)M_g}{2c^2}, \tag{12}$$
$$t_{g\,max} = \frac{\hbar\,(1-\kappa)}{2c^2}\rho_{rmmin} r_{g\,max}. \quad t_{ge\,max} = \frac{\hbar\,(1-\kappa)}{2c^4}\rho_{remin} r_{g\,max}.$$

Now it is also of the interests to derive Planck and gravitational energy as functions of the radial mass density at the minimal radius:

$$E_p = \sqrt{\frac{\hbar c^5}{G}} = \rho_{rmmax} r_{p\,min} c^2 = \frac{(1+\kappa)c^4}{G} r_{p\,min},$$
$$E_g = \sqrt{\frac{\hbar c^5}{G}}\frac{M_g}{M_p} = \frac{M_g}{M_p}\rho_{rmmax} r_{p\,min} c^2, \tag{13}$$
$$E_g = \frac{M_g}{M_p}\frac{(1+\kappa)c^4}{G} r_{p\,min}.$$

The Planck and gravitational energy at the maximal radiuses are also functions of the radial mass density at this point:

$$\rho_{rmmin} = \frac{(1-\kappa)c^2}{G} = 0.888779 \cdot 10^{23} kg/m,$$
$$E_{p\,min} = \rho_{rmmin}\, r_{p\,max}\, c^2 = \frac{(1-\kappa)c^2}{G} r_{p\,max}\, c^2, \quad (14)$$
$$E_{g\,min} = \frac{M_g}{M_p}\frac{(1-\kappa)c^2}{G} r_{p\,max}\, c^2.$$

It follows the derivation of Planck and gravitational temperature as functions of the radial mass density. The Planck temperature is defined as the ratio of the Planck energy and Boltzmann constant k. At the minimal gravitational radius, the related temperature T_g is:

$$T_p = \frac{E_p}{k} = \sqrt{\frac{\hbar c^5}{Gk^2}} = \frac{\rho_{rmmax} r_{p\,min} c^2}{kG} = \frac{(1+\kappa)c^2}{kG} r_{p\,min} c^2,$$
$$T_g = \frac{E_g}{k} = \sqrt{\frac{\hbar c^5}{Gk^2}}\frac{M_g}{M_p} = \frac{M_g}{M_p}\frac{\rho_{rmmax} r_{p\,min} c^2}{kG}, \quad (15)$$
$$T_{g\,max} = \frac{M_g}{M_p}\frac{(1+\kappa)c^2}{kG} r_{p\,min} c^2.$$

The Planck and gravitational temperature at the maximal radius are also functions of the radial mass density at this point:

$$T_{p\,min} = \frac{\rho_{rmmin}\, r_{p\,max}\, c^2}{kG} = \frac{(1-\kappa)c^2}{kG} r_{p\,max}\, c^2,$$
$$T_{g\,min} = \frac{E_{g\,min}}{k} = \frac{M_g}{M_p}\frac{\rho_{rmmin}\, r_{p\,max}\, c^2}{kG}, \quad (16)$$
$$T_{g\,min} = \frac{M_g}{M_p}\frac{(1-\kappa)c^2}{kG} r_{p\,max}\, c^2.$$

From (15) and (16) it can be concluded that the maximal and minimal gravitational temperature is proportional to the gravitational mass.

3. Quantization of Gravitational Field as functions of Radial Density Value

In order to quantize gravitational field, it is started with the radial mass density at the minimal and maximal gravitational radiuses:

$$\rho_{rm\,\max} = \frac{M_g}{r_{\min}} = \frac{(1+\kappa)c^2}{G} = 2.693182 \cdot 10^{27} kg/m,$$
$$\rho_{rm\,\min} = \frac{M_g}{r_{\max}} = \frac{(1-\kappa)c^2}{G} = 0.888779 \cdot 10^{23} kg/m. \quad (17)$$

From (17) it can be seen that the maximal radial density is at the minimal gravitational radius. On the other hand, the minimal radial density is at the maximal gravitational radius. Further, let $U_{g\,min}$ and $U_{g\,max}$ are the potential energies at the minimal and maximal gravitational radiuses:

$$M_g = \rho_{rm\max} r_{\min}, \; L_{g\min} = \frac{2m_0 G \rho_{rm\max} r_{\min}}{U_{g\min}} = \frac{2m_0 G \rho_{rm\max} r_{p\min}}{(1+\kappa)c^2}, \quad L_{g\max} = \frac{2m_0 G \rho_{rm\min} r_{\max}}{U_{g\max}} = \frac{2m_0 G \rho_{rm\min} r_{p\max}}{(1-\kappa)c^2}. \tag{18}$$

Thus, the gravitational quantum effect for masses less than the Plank's mass is dominant in the region between L_{gmin} and $2L_{gmin}$. Therefore, the quantization of the gravitational field should be determined in that region:

$$\frac{2m_0 G \rho_{r\max} r_{\min}}{L_d U_{g\min}} = \frac{2m_0 G \rho_{r\max} r_{p\min}}{L_d (1+\kappa)c^2} = n, \quad n = 1,2,\ldots,n_{\max}, \quad n_{\max} \le \frac{4G \rho_{r\max} r_{\min}}{\pi \hbar c^3} \frac{\Delta H^\wedge}{(1+\kappa)}. \tag{19}$$

Here $\Delta H^\wedge$ is the energy uncertainty, L_d is the minimal distance between two quantum points and ΔT is the shortest time during which the average value of a certain physical quantity is changed by an amount equal to the standard deviation or uncertainty of time. This time should satisfy the relations:

$$\Delta H^\wedge \Delta T \ge \frac{\hbar}{2}, \Delta_\psi H^\wedge = (\langle \psi | H^{\wedge 2} | \psi \rangle - \langle \psi | H^\wedge | \psi \rangle^2)^{1/2}, \quad \eta_t \equiv t_{\min} / \tau_{CQS}, \quad \eta_{\psi \to \psi \perp} \equiv \frac{\tau_{\psi \to \psi \perp}}{\tau_{CQS}}, \quad \eta_{\psi \to \psi \perp} = \frac{\pi \hbar}{2\Delta H^\wedge \tau_{CQS}}, \quad \tau_{\psi \to \psi \perp} \ge \pi \hbar / 2\Delta H^\wedge. \tag{20}$$

In the case that the maximal transition velocity between two quantum points is equal to the speed of light, one can obtain the limitation to the maximal number of quantum points:

$$v = c \to L_{d\min} = c\,\tau_{\psi \to \psi \perp}, \; n_{\max} \le \frac{2L_{g\min} - L_{g\min}}{c\,\tau_{\psi \to \psi \perp}}, \quad n_{\max} \le \frac{m_0 G \rho_{r\max} r_{\min}}{U_{g_{\min}}} = \frac{2G \rho_{r\max} r_{p\min}}{L_{d\min}(1+\kappa)c^2}. \tag{21}$$

As an example of the application of the previous relations to the quantum system, one can start with the determination of the minimal distance L_{dmin} between two quantum states:

$$L_{d\min} = c\,\tau_{\psi \to \psi \perp} \le 10^{-35} m, \quad U_{g_{\min}} \le \frac{m_0 G \rho_{r\max} r_{\min}}{n_{\max}}, \quad n_{\max} \le \frac{1.616254}{L_{d\min}} 10^{-35}. \tag{22}$$

Further, as an illustration of the previous results one can use the official masses of the proton M_{pr} and of the Universe M_u and calculate the maximal and the minimal radiuses of the proton and Universe. Thus, using official mass of the proton one obtains the minimal and the maximal radiuses and their ratio:

$$
\begin{aligned}
&M_{pr} = 1.672621 \cdot 10^{-27} kg, \\
&r_{\min} = \frac{M_{pr}}{\rho_{rm\max}} = 6.210579 \cdot 10^{-55} m, \\
&r_{\max} = \frac{M_{pr}}{\rho_{rm\min}} = 1.881932 \cdot 10^{-50} m, \\
&n = \frac{r_{\max}}{r_{\min}} = 3.030204 \cdot 10^{4}.
\end{aligned} \tag{23}
$$

On the other hand, using official mass of the Universe one obtains the minimal and the maximal radiuses and their ratio n:

$$
\begin{aligned}
&M_{u} = 1.775786 \cdot 10^{53} kg, \\
&r_{\min} = \frac{M_{u}}{\rho_{rm\max}} = 6.593635 \cdot 10^{25} m, \\
&r_{\max} = \frac{M_{u}}{\rho_{rm\min}} = 1.998006 \cdot 10^{30} m, \\
&n = \frac{r_{\max}}{r_{\min}} = 3.030204 \cdot 10^{4}.
\end{aligned} \tag{24}
$$

In connection with the previous presentation one can consider the Stephen Hawking's black hole paradox [20] as the fundamental law of quantum mechanics. On the other side in [21,22] it is supposed that the black holes are collapses as the compact objects and then, according to the quantum theory, there is no absolute separation between the interior and the exterior of black hole. Further in the Relativistic Alpha Field Theory (*RAFT*) [10] and the Relativistic Radial Density Theory (*RRDT*), in this manuscript, there exist the minimal and the maximal radiuses, which are proportional to the related masses. Thus, the black hole is the matter state at the minimal radius. Generally, the any mass (of particles, planets, stars and even the Universe) can be contracted to the minimal radius with the maximal radial mass (or energy) density. From this point it is started with the expansion to the maximal radius with the minimal radial mass (or energy) density. At the maximal radius there are enough conditions for starting with contraction to the minimal radius with maximal radial mass, or energy, density. Thus, we have the cyclic process in it.

Following the previous consideration, one can conclude that there is no absolute separation between the interior and the exterior of black hole [14,15,16,23]. The all information of the mass (or energy) in the black hole are preserved. Black holes, curved spacetime, quantum computing and a static orbit in rotating spacetimes are presented in [24] and [25] respectively. New black hole simulation, presented in [26], incorporates quantum gravity and shows a new prediction: when a black hole dies, it produces a gravitational shock wave that radiates information. This discovery could solve the information paradox [20]. Further, the stellar-mass black hole is fined-out in the Large Maggelanic Cloud [20]. Further, it is discovered very important item that there exist the speed limits for macroscopic transitions [28]. Recently, in [29,30] it is measured proton electromagnetic structure deviates from theoretical prediction. In the same references the physicists confirm hitch in proton structure. The presented relations and conclusions may have the significant influence in the application to the modern physics.

4. Conclusion

In the Relativistic Radial Density Theory (*RRDT*), Planck and gravitational parameters can be described as the functions of the radial mass (or energy) density. The maximal radial mass (or energy) density is at the minimal radius. On the other hand, the minimal radial mass (or energy) density is at the maximal radius. Further, the maximal and the minimal radial mass (or energy) densities can be described as the functions of the energy conservation constant κ. In that sense, the gravitational length, time, energy and temperature can be presented as the functions of the Planck length, time, energy and temperature, respectively. This opens possibility to merge the Quantum Field Theory (*QFT*) and the General Theory of Relativity (*GTR*) at the quantum scale level in gravitational field. The existence of the minimal radius in gravitational field means that no singularity in that field. On the other hand, the existence of the maximal radius in gravitational field means that no infinity in that field. Thus, the Relativistic Radial Density Theory (*RRDT*) gives the enough conditions for the real cyclic motions, without singularity and without infinity, valid for the particles and more massive objects including the Universe.

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