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Physical Aspects of Penrose's Black Hole Singularities

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Abstract

Penrose's mathematical formalism of black holes singularities suggested that in the centre of a black hole, the curvature of space-time there is infinite and thus with infinite gravity. The measurement from NASA in 2014 shows that universal space has a Euclidean shape which means that Penrose's mathematical formalism does not describe some actual curvature of space in the centre of the black hole, but rather it indicates that in the centre of a black hole there are some special physical circumstances that we do not understand well yet. We suggest that in the centre of a black hole energy density of superfluid quantum space is so low that atoms become unstable, they fall apart into elementary particles. Black holes are rejuvenating systems of the universe.

Keywords: black holes, space-time singularities; curvature of space-time; energy density of superfluid quantum space

1. Introduction

We have in physics in recent decades a new perspective where universal space is understood as a superfluid vacuum named also superfluid quantum space (SQS) [2,3,4]. Space is a type of energy and we suppose that the energy density of space is related to the mass of a given physical object. In General relativity (GR), mass is the result of the curving space, in our model mass diminishes the energy density of space. More space is curved in GR, less is the energy density of space in our model. In general, the mathematical geometrical approach is upgraded with the physical approach of variable energy density. We extended the mass-energy equivalence principle to the universal space. Superfluid quantum space is the physical origin of the universal space. In the centre of a given stellar object, the energy density of SQS diminishes exactly for the amount of its mass m and its correspondent energy E:

$$\rho_{cE} = \rho_{PE} - \frac{mc^2}{V} \tag{1}$$

where ρ_{cE} is energy density in the center of the stellar object, ρ_{PE} is Planck energy density, and V is the volume of the given stellar object [4]. When we rearrange equation (1) we get:

$$E = mc^2 = (\rho_{PE} - \rho_{cE})V \tag{2}$$

Equation (2) shows that the energy E of a given physical object is in equilibrium with the energy density of SQS. Energy density of SQS is diminished exactly for the value of E of a given physical object. Gravity force is the result of this equilibrium. That's why gravity force in order to exist, does not need a source. Gravity is the result of the variable energy density of SQS. Gravity force F_g is pointing towards the centre of a given stellar object in the direction from the higher energy density of SQS towards the lower energy density of SQS: F_g: $\rho_{PE} \rightarrow \rho_{cE}$. Gravity force is embedded in a quantum structure of the universal space which is defined by the presence of a given stellar object [5]. Gravity is not emitted or received directly by the stellar object.

In Newtonian physics, gravity is decreasing going towards the centre of a given stellar object accordingly to the Newton shell theorem. We calculate gravity force between stellar objects on the basis of Newtonian physics which means that Newton physics still is the best model to calculate gravity force. Our proposal is that the Newton shell theorem is valid also for black holes [6]. In the centre of the black hole, the energy density of SQS is so low that atoms become unstable and fall apart into elementary particles. Penrose's singularities are pointing out the view that there is something special in the centre of the black hole that we do not understand yet. The "infinite gravity" has no physical meaning. In our model in the centre of a black hole, there is no gravity force as there is no gravity force in the centre of the Earth. It is common for every stellar object that is diminishing the energy density of space and that minimal energy density is in the centre of the stellar object.

Having's "infinite gravity" in black hole singularity means that atoms are smashed into elementary particles. In our model, there is no gravity there because there is no "energy density gradient" of space. The energy density of space is at the

minimum and atoms become unstable and fall apart into elementary particles that are different structures of the space itself. We are sympathizing with Ervin Schrödinger: "What we observe as material bodies and forces are nothing but shapes and variations in the structure of space".

2. Variable energy density of space and gravitational potential

We can calculate the energy density of space in every single point T at a given distance from the centre of a given physical object:

$$\rho_{TE} = \rho_{PE} - \frac{3mc^2}{4\pi(r+R)^3} \quad (3)\ [7]$$

where P_{PE} is Planck energy density of the space in the interstellar space, m is the mass of the stellar object, r is the radius of the stellar object, and R is the distance from the centre of the stellar object to the point where we calculate the energy density of space. When R tends to infinity, ρ_{TE} tends to become equal to ρ_{PE}. When R is zero Eq. (3) turns in Eq. (1), ρ_{TE} turns into ρ_{cE}.

The difference between the energy density of space at a given point T above the surface and in the centre of a given stellar object, denoted by $\Delta\rho_E = \rho_{TE} - \rho_{cE}$ is the key physical law that defined gravitational potential. Going from T to the centre of a given stellar object the value of gravitational potential energy is decreasing and is in the centre equal to zero. That's why there is no gravity there. We suggest that this is also valid in the centre of a black hole.

Gravitational potential, denoted by V_G, depends on the delta energy density $\Delta\rho_E$ of the space between two points. At the infinite distance from a given stellar object, the gravitational potential V_G is zero and the energy density of the space has value of Planck energy density.

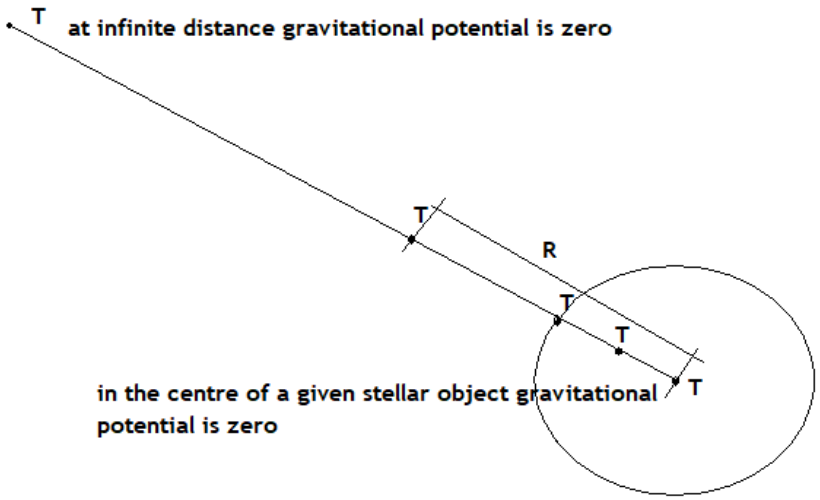

Figure 1: Gravitational potential V_G

At point T above the surface of the stellar object, the value of V_G is calculated as follows:

$$V_G = \frac{Gm}{R} \quad (4) \quad [8]$$

where R is the distance from the centre of the stellar object, G is the gravitational constant and m is the mass of the stellar object. Combining Eq. (4) and Eq. (2) we get:

$$V_G = \frac{G(\rho_{PE}-\rho_{cE})V}{c^2R} \quad (5)$$

We see that gravitational potential depends on the delta of energy density of space in the centre of a given stellar object ρ_{cE} and Planck energy density ρ_{PE}in the interstellar space: $\Delta\rho_E = \rho_{PE} - \rho_{cE}$.

On the stellar object surface and inside the stellar object at a given point T the gravitational potential is calculated by Eq. (10):

$$V_G = -Gm\frac{3R^2-r^2}{2R^3} \quad (6) \; [8]$$

where R is the distance from the centre to the point T under the surface, r is radius of the stellar object. In the centre of the stellar object R is zero and the gravitational potential V_G is zero too. Combining Eq. (6) and Eq. (2) we get:

$$V_G = -\frac{GV\Delta\rho_E}{c^2} * \frac{3R^2-r^2}{2R^3} \quad (7)$$

We see that the gravitational potential V_G is defined by the minimal energy density of space in the centre of a given stellar object. We propose that also in the centre of a black hole the same physical law is valid. Passing the Schwarzschild Radius R_S gravity is not increasing; it is decreasing accordingly to the Newton shell theorem.

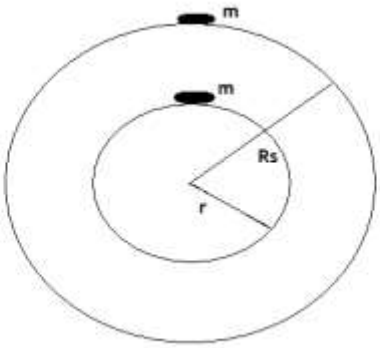

Figure 2: Gravity inside the Schwartzschild radius

The gravity force of a given mass m on the surface of a black hole outside the Schwarzschild radius is following:

$$F_g = \frac{(\rho_{PE} - \rho_{cE})VmG}{c^2R_S^2} \quad (8)$$

where ρ_{PE} is Planck energy density of space in interstellar space, ρ_{cE} is the minimal energy density in the centre of a black hole, V is volume of a black hole, m is the mass of a given physical object, R_S is Schwarzschild radius and G is gravitational constant. On the distance r from the center of the black hole gravity force on a given object is following:

$$F_g = \frac{(\rho_{PE} - \rho_{cE})VmG}{c^2r^2} \quad (9)$$

At the centre of the black hole gravity force on the object is zero. The object will transform into elementary particles as the energy density of space is so low that atoms become unstable. Centre of a black hole is a rejuvenating point of the universe. Matter with high entropy is falling apart into elementary particles that are fresh energy, row material for formation of new galaxies.
With Eq. (1) we calculated the value of energy density ρ_{cE} in the centre of a black hole with the mass of the Sun, in the centre of proton, Earth, Moon and Sun [6]:
Black hole with the mass of the Sun: $\rho_{cE} = \rho_{PE} - 1.58 \cdot 10^{36} Jm^{-3}$
In the centre of the proton: $\rho_{cE} = \rho_{PE} - 5.45 \cdot 10^{34} Jm^{-3}$
In the centre of the Sun: $\rho_{cE} = \rho_{PE} - 1.27 \cdot 10^{20} Jm^{-3}$
In the centre of the Moon: $\rho_{cE} = \rho_{PE} - 3.01 \cdot 10^{20} Jm^{-3}$
In the centre of the Earth: $\rho_{cE} = \rho_{PE} - 4.97 \cdot 10^{20} Jm^{-3}$
In the centre of a proton, the minimal energy density of space is for the order of 10^2 too high for the proton to become a mini black hole as proposed by Hawking [9]. Voyager did not discover mini black holes in interstellar space [10]. The energy density of space in the proton centre is lower than in the centre of Sun, Earth, and Moon because these stellar objects are made out of atoms where there is a vast empty space between the nucleus and electrons orbits.

3. Penrose's black hole singularities and variable energy density of space

NASA has measured back in 2014 that universal space has a Euclidean shape [11]. Knowing this we must admit that curved space in GR is only a mathematical description of some intrinsic physical properties of space, we propose this is the variable energy density of space. Therefore, Penrose's mathematical singularities of black holes are a sign of extreme low energy density of space.

In his article in 1965 Penrose stated following proposal: "If, as seems justifiable, actual physical singularities in space-time are not to be permitted to occur, the conclusion would appear inescapable that inside such a collapsing object at least one of the following holds: (a) Negative local energy occurs. (b) Einstein's equations are violated. (c) The space-time manifold is incomplete. (d) The concept of space-time loses its meaning at very high curvature – possible because of quantum phenomena. In fact (a), (b), (c), (d) are somewhat interrelated, the distinction being partly one of attitude of mind" [12]. Our comments are following:
(a) Term "negative energy" has no exact meaning and so this possibility is excluded
(b) Einstein's equations are not violated because they represent the geometrization of gravity that is valid
(c) Space-time manifold sure is not incomplete
(d) Yes, at the very high curvature space-time curvature loses its meaning because of the low energy density of space that makes atoms unstable
Yes, (a), (b), (c), (d) are interrelated, the solution is in the understanding of the special physical circumstances, the low energy density of space where atoms become unstable. Our proposal that because of the extremely low energy density of

space in the centre of AGN-s matter is disintegrating into elementary particles that form huge relativistic jets that are verified by astronomical observations [13]. Matter cannot disappear in the centre of AGNs in some exotic areas of the universe denoted as "singularities" with infinite gravity; matter is transforming back into elementary particles; first law of thermodynamics remains in place. In the centre of AGNs, there is no gravity because gravitational potential there has value zero.

4. Conclusions

Penrose's mathematical singularities are the puzzle of theoretical physics. We propose the physical solution that has support in astronomical observations and keeps in place the first law of thermodynamics. The mystery of the universe is that we can understand it when we stick with the astronomical observations which confirm that black holes are rejuvenating systems of the universe.

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