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D'addio to Blackness

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Abstract

It is assumed here that the energy of a strong gravitational field creates non-linear effects over enclosed masses. This idea and the rigorous rules of the General Theory of Relativity output a metric that covers strong and weak gravitational fields. The proposed metric could be correct because it included the Schwarzschild's metric as a particular case and has no singularities. Additionally, it appears here that the massive condition of the gravitational fields has properties like the so-called Dark Matter.

1. Introduction

Equations having infinities are avoided in physics when possible. When that is not possible, we call it a singularity. Those singularities are not welcomed because they nullify one of the goals of science that is the application of equations to understand the system under study.

One well-known singularity appears in Schwarzschild's metric [1] applied to the gravity created by a spherically symmetric, non-rotating body, of mass M and radius R. Strong conclusions coming from math deductions are risky as in [1], where it is claiming "The *uniqueness* of the solution resulted spontaneously through the present calculation". That solution appears on page 20 on Carson Blinn [2] pdf paper as,

$$\mathrm{d}s^2 = \left(1 - \frac{2GM}{c^2 r}\right) c^2 \mathrm{d}t^2 - \frac{\mathrm{d}r^2}{1 - \dfrac{2GM}{c^2 r}} - r^2 \mathrm{d}\theta^2 - r^2 \sin^2 \theta \mathrm{d}\phi^2 \qquad (1)$$

In Equation (1) s is the space-time interval, G is the universal gravitational constant, c is the speed of light, t is time, and θ and ϕ are the spherical an-

gles. If the gravitational fraction becomes bigger than one, we are forced to deal with imaginary time and imaginary radial distances.

As soon as 1935 [3] it was proposed to deal with those singularities by applying a change of variables (others propositions in [4]-[12]). That move was a mathematical solution that required some *extra* physical consideration, further complicating the problem. Besides previous note, the same author concluded in 1939 [13] that "...the 'Schwarzschild singularities' do not exist in physical reality". The authors proposed to take those singularities as mathematical concepts and not as real entities.

In [14] it was called to attention about the stability of any of the solutions proposed and clarifying that unstable solutions should not be taken into consideration. It was concluded in [15] that stars approaching the singular condition become unstable and must collapse to a point. In agreement with that idea, in [16] another surprising idea is mentioned by indicating mathematically that the centrifugal force is reversed bellow the Schwarzschild's radius. The intention of removing the Schwarzschild singularity by a change in the coordinates system does not eliminate all the rare physical consequences. Now the authors are pointing to the non-sense of the dynamical inside those singularities.

The conclusion of [17] mentioned "...we are led to the unexpected conclusion that a particle which exerts a gravitational field must travel faster than light". Another call back to the physics was mentioned in [18] by saying "It may be seen that de Sitter's singularity like Schwarzschild' singularity is an artificial singularity, not of the field but of the coordinates introduced to describe this field". It looks as they have given up in [19] after concluding "This perhaps can be attributed to the fact, as remarked by Einstein [20] that the general theory of relativity would break down under such stringent conditions". It is mentioned in [21] that there should be some physics because the Schwarzschild's solution is mathematically stable under small non-spherical perturbations. In [22] appears a strong remark "...the singular character of the surface r = 1 is a feature intimately connected with the non-definiteness of the space-time metric". At this time, it looks like the authors are trapped between the attractiveness and incoherence of the hall picture.

Other's problems arise by connecting gravity with others disciplines of the physics. In [23] was introduced the idea that Quantum Mechanics affect the metric derivations as "Firstly, the event horizon obtained by setting g~ = 0, which occurs at r = L, in the classical theory, should now be modified". Negating the power of theoretical physics, in [24] was claimed "In a real Universe an isolated body cannot be described strictly by the Schwarzschild solution because the body does not exist all alone in the Universe". Professors teaching this material are not happy with its consequences, even in modern times, as in [25] where it was declared "In concluding, it is important to emphasize that the interior structure of realistic black holes has not been satisfactorily determined and is still open to considerable debate". Another metric [26] is introduced with ma-

thematical consequences related to the existence of the superluminal particles called tachyons.

Interesting propositions were made in [27] [28] [29]. Those ideas are pointing in the direction followed here in this paper.

Einstein's General Theory of Relativity (GTR) [30] has been tested many times and its condition of *General* is accepted without questioning. This notion does not imply that any solution coming from applying GTR is going to also be *general* because some internal assumption can reduce its domain. This statement seems trivial, but it is the reason of this paper where the question *Could exist another solution that include the Schwarzschild's solution as a particular one?* will be answer.

2. A Variation Solving GTR for Spherical Symmetry

The differential equation on page 19 [2], where $\mathbb{R}$ appears as the Ricci temporal tensor and the Ricci scalar is

$$\mathbb{R}_{00} - \frac{1}{2}g_{00}\mathbb{R} = \frac{1}{r}\frac{V'}{V^2} + \frac{1}{r^2}\left(1 - \frac{1}{V}\right) = \frac{8\pi G}{c^2}T_{00}. \tag{2}$$

Normally Equation (2) is solved by nulling the temporal energy-stress tensor T_{00}. Let's apply a fundamental variation. Here it will be assumed that the GTR is about the general properties of any field in the space-temporal reality and gravity should be treated as any other field. Then, the tensor T_{00} could not be zero. Because the intensity of the Newtonian's gravity decreases with the squared of the radius and the energy density of other fields are proportional to its intensity squared, it will be assumed that T_{00} decreases inversely with the quartic of the distance. In that way, it is close to zero for regular gravitational fields. Mathematically the constrain $8\pi G c^{-4}T_{\mu\nu} \approx Ar^{-4}$ will be used because in weak fields that constrain includes the Schwarzschild's solution as a particular case. Equation (2) becomes Equation (2a)

$$\mathbb{R}_{00} - \frac{1}{2}g_{00}\mathbb{R} = \frac{1}{r}\frac{V'}{V^2} + \frac{1}{r^2}\left(1 - \frac{1}{V}\right) = \frac{A_{(r)}}{r^4}. \tag{2a}$$

The reader can check out that Equation (3) is solution of Equation (2a)

$$V_{(r)} = 1 + \frac{2GM}{C^2 r}, \tag{3}$$

if $A_{(r)}$ satisfices

$$A_{(r)} = \frac{4G^2 M^2}{C^4 \left(1 + \frac{2GM}{C^2 r}\right)^2}. \tag{4}$$

Realize that for weak gravitational fields
$V_{(r)} = 1 + 2GMc^{-2}r^{-1} \approx \left(1 - 2GMc^{-2}r^{-1}\right)^{-1}$, and $A \approx 0$ as is in the Schwarzschild's solution.

Similarly, the solution of the equivalent differential equation on the same page 19 [2], where now the tensor is pure radial,

$$\mathbb{R}_{11} - \frac{1}{2}g_{11}\mathbb{R} = -\frac{1}{r}\frac{U'}{UV} + \frac{1}{r^2}\left(1 - \frac{1}{V}\right) = \frac{A_{(r)}}{r^4} \tag{5}$$

becomes identical to Equation (2a) as expected if $U = V^{-1}$ holds.

Because on page 12 [2] the squared space-time interval was characterized as

$$ds^2 = \sum_{\mu\nu} g_{\mu\nu} dx^\mu dx^\nu = U_{(r)}c^2 dt^2 - V_{(r)} dr^2 - r^2 d\theta^2 - r^2 \sin^2\theta d\phi^2,$$

the substitution of Equation (3) and its inverse into the equation above output,

$$ds_{r\geq R}^2 = \left(1 + \frac{2GM}{C^2 r}\right)^{-1} C^2 dt^2 - \left(1 + \frac{2GM}{C^2 r}\right) dr^2 - r^2 d\theta^2 - r^2 \sin^2\theta d\phi^2. \tag{6}$$

The math done pays off because Equation (6) does not carry on any singularity, not even at the center of the gravitational body. This can be noticed in **Figure 1** where it was assumed a constant average density defined as the ratio between the mass contained in the spherical volume of radius r, and that volume.
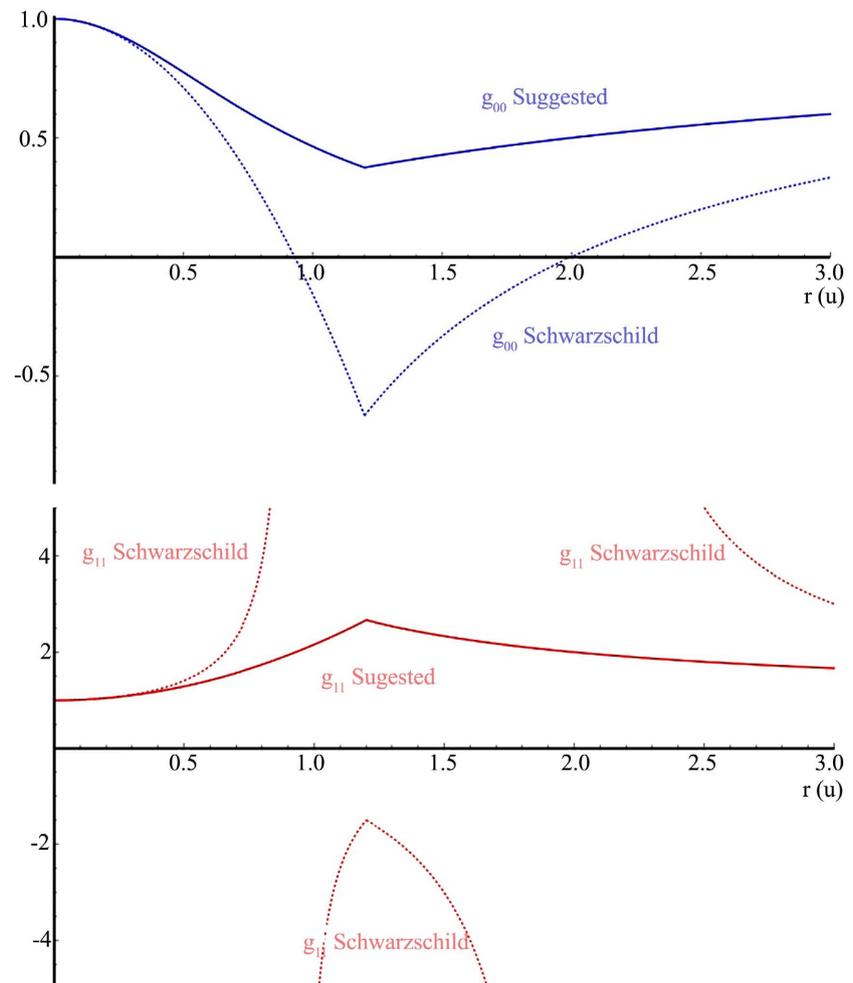

Figure 1. Graphic introduction of the differences between the Schwarzschild's metric and the one suggested in this paper as Equation (6). A gravitational factor of $2GM\cdot C^{-2} = 2$ was used for all curves and a radius of R = 1.2 u. The metric proposed by Equation (9) showing not singularity and no exotic time or space at any point.

3. Interesting Consequences

The metric described by Equation (6) becomes important for strong gravitational fields. In no circumstance does that metric show any skyrocket tendency, not even for the maximum gravitational potential at the surface of the body. Also, the temporal part of the metric has no negative values as expected. Additionally, the gravitational potentials approach flat values faster than in the Schwarzschild's metric. That means that in any experimental observation of Kerr's dragging or Yukawa's potential, effects should be intended as close as possible to the source. The work in [31] is an example of negative observations attempted too far away from the center of our galaxy. In principle, it is possible that the idea proposed in this paper could explain that negative result.

3.1. Body on the Center of the Milky Way

In [32] the Schwarzschild's metric was used assuming that the metric can be applied in strong gravitational fields. This approach establishes an upper limit for the mass of neutron stars. Star S2, according to [33], is moving with a velocity of 7650 km·s^{-1} at 120 AU from the center of the Milky Way. Those numbers can be associated with a gravitational mass around 4.1×10^6 times the mass of the Sun. The metric of Equation (6) does not have any theoretical condition that forces matter to crush and become a black hole. With the new metric, it is now possible to assume that the strong nuclear pressure can completely equilibrate the gravitational pressure. Then it is possible to visualize a neutron star at the center of our galaxy. The radius of that neutron star will be 1.5×10^3 km and it will be a black star, not a black hole. On the other hand, if the mass acting on S2 is only the gravitational field filling the 120 AU radius, it implies that field has a 6×10^{-4} kg·m^{-3} average density. This value makes sense because it is around 100 times smaller than the hydrogen gaseous density. Of course, because we are dealing with big numbers here, a logical combination of both masses can play the necessary gravitational role on the center of our galaxy.

3.2. A Bonus

What other properties does the gravitational field have? If the gravitational field becomes radiative after some distance to the center, then its density should decrease inversely with the square of the radius. That means a constancy of the product $2Gm \cdot C^{-2} \cdot r^{-1}$ and the gravitational mass m must increase with the distance r. In our galaxy, the rotating stars move with constant velocities around 200 km·s^{-1} from 0.2 kpc [34]. Those numbers require that inside 0.2 kpc must be a total mass of around three billion times the mass of the Sun. The hypothesis developed in this paper is pointing in the direction that the so called "Dark Matter" could now be seen as gravitational mass. Some numbers for the budge of our galactic gravitational field are 6×10^{-18} kg·m^{-3} average density and $2Gm \cdot C^{-2} \cdot r^{-1} = 1.4 \times 10^{-6}$ gravitational factor.

4. Conclusions

Einstein understood that the GTR metric of space included Newtonian gravity because gravity produces the curvature of space-time. This is an example of the interplay between mathematics and physics that results in progress in both disciplines. However, it is important to realize that mathematical solutions can correspond to regions that predict exotic physical behavior of space and time.

The idea mentioned above was split into two ideas. Here, it was assumed that the GTR is about the relativistic connections in the space-time coordinates and the fields filling those coordinates. Then it became natural to manipulate the gravitational field as is done with any other field. It looks like a simple idea, but it allows to find an exact solution of the GTR equations that included the Schwarzschild's solution as an approximate solution for weak gravitational fields. Our approach was based on the idea that gravitational field has energy and that energy can behave as a gravitational mass.

In [35] a sacrifice was made assuming that photons have rest mass and that makes the existence of exotic Dark Energy unnecessary. Here, applying the same logic to the possible particles of gravity, the idea of Dark Matter becomes unnecessary to explain what happens in regions where gravity is strong. If the model proposed here is correct, exotic, and yet unobserved phenomena may be unnecessary.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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