Scalar Gravitational Theory with Variable Rest Mass

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ABSTRACT

In this paper we will present the mechanical dynamics of a gravitational system resulting from a specific, rest mass, scalar potential relation, that is equivalent in predicting orbital and photon motion to that of General Relativity in the weak field solutions. The weak solutions of General Relativity do not appear to be contradicted by this development, and in this range the physical difference may not be measurable. The strong field solutions will be significantly different, however since, in this scalar relation, the rest mass goes to zero at at Scwarzschild boundary. The consequences of the mass dependence gravitational potential results, for large masses, not in the prediction of black holes, but rather mass to Gamma ray converters.

In an earlier paper we presented the relation between the observable mass and what we have designated as the gravitationally field free mass [1]:

$$M_F = M/\alpha \qquad .(1)$$

Where α is a variable, and related to the gravitational interaction by:

$$\alpha = \left(1 - \sum_n^N \frac{\alpha_n \mu_n}{r_n}\right). \qquad .(2)$$

The variable rest mass is not a new concept developed first by Nordstrom, and later by R Wayte [2], using a modified view of the GR field equations. Wayte particularly noted the changed concept of the black hole to that of a mass to gamma converter, which would be the test of this development. The result of the dependence of the rest mass on scalar potential creates a celestial body that as mass accumulates, infalling particles generate progressively higher energy gamma rays. The body eventually approaches a maximum mass at which point, all the infalling mass is completely converted to gamma's and the body ceases to become more massive. Since gamma rays with energies equivalent to the electron and proton would be the maximum cutoff generated by those particles, one could suggest that the defined gamma ray sources emissions of the galactic center may be generated by bodies close to the maximum mass [3].

First noted is that the sum in Eq. (2) is a function defined at all points in the system, and although points may have the same value of alpha, none have the same configuration. Illustrating this we can say for the n configuration, α_n, the rest moment is, $(\mathrm{Mc})_{\mathrm{no}}$. Expression (1) in more detail becomes:

$$(\mathrm{Mc})_{\mathrm{F}}^2 = \frac{(\mathrm{Mc})_{10}^2}{\alpha_1^2} = \frac{(\mathrm{Mc})_{20}^2}{\alpha_2^2} \qquad ,(3)$$

where the 1 and 2 subscripts represent the same particle in a second position. The zero in the subscript implies the rest momentum.

If Eq.(3) is true then, since there can be internal motion in a mass of particles, which would not be distinguishable from the rest mass by an external observer, the relativistic masses must have the same proportion. i.e.:

$$\frac{(\mathrm{Mc})_{10}^2}{\alpha_1^2} = \frac{(\mathrm{Mc})_{20}^2}{\alpha_2^2} \quad \rightarrow \quad \frac{(\mathrm{Mc})_{1}^2}{\alpha_1^2} = \frac{(\mathrm{Mc})_{2}^2}{\alpha_2^2} \qquad .(4)$$

Since the rest, and relativistic masses are related by:

$$\frac{(\mathrm{Mc})_{10}^2}{\alpha_1^2} = \frac{(\mathrm{Mc})_{1}^2}{\alpha_1^2}\left[1 - \frac{(\mathrm{v})_1^2}{(\mathrm{c})_1^2}\right] \qquad \frac{(\mathrm{Mc})_{20}^2}{\alpha_2^2} = \frac{(\mathrm{Mc})_{2}^2}{\alpha_2^2}\left[1 - \frac{(\mathrm{v})_2^2}{(\mathrm{c})_2^2}\right] \qquad ,(5)$$

then c and v have to be proportional, thus we also have:

$$\left(\frac{\mathrm{v}}{\mathrm{c}}\right)_1 = \left(\frac{\mathrm{v}}{\mathrm{c}}\right)_2 \rightarrow \frac{(\mathrm{Mv})_{1}^2}{\alpha_1^2} = \frac{(\mathrm{Mv})_{2}^2}{\alpha_2^2} \qquad .(6)$$

From Eq. (2), and Eq. (6), the ratio for two configurations for a single rest particle, one in free space (1), and one in propinquity to a local gravitating mass (2), is:

$$\frac{\alpha_1^2}{\alpha_2^2}=\frac{(Mc)_{10}^2}{(Mc)_{20}^2}=\frac{\left(1-\sum\alpha_m\frac{\mu_m}{r_m}\right)^2}{\left(\left(1-\sum\alpha_m\frac{\mu_m}{r_m}\right)-\alpha_1\frac{\mu_{loc}}{r_{loc}}\right)^2}=\frac{1}{\left(1-\frac{\mu_{loc}}{r_{loc}}\right)^2} \quad .(7)$$

where (loc) designates variables of the local gravitating mass. This presents the relationship between the rest mass as a function of the gravitational potential.

Since a moving particle experiences the "relativistic mass" of the gravitating mass μ_{loc}, in the event the particle, (2) in Eq. (7) is moving, the mass must be:

$$M_{loc}=M_{0\,loc}/\sqrt{1-v_2^2/c_2^2} \quad .(8)$$

Then restating Eq.(7), we have:

$$\frac{(Mc)_{10}^2}{(Mc)_2^2-(Mv)_2^2}=\left(1-\frac{\mu_{0\,loc}}{r_{loc}\sqrt{1-v_2^2/c_2^2}}\right)^{-2} \quad ,(9)$$

or:

$$(Mc)_{10}^2\left(1-\frac{\mu_{0\,loc}}{r_{loc}\sqrt{1-v_2^2/c_2^2}}\right)^2=(Mc)_2^2-(Mv)_2^2 \quad .(10)$$

And since we have from Eq. (6):

$$(Mv)_2^2=(Mv)_1^2\frac{\alpha_2^2}{\alpha_1^2} \quad ,(11)$$

we can write Eq (10) as:

$$(Mc)_{10}^2\left[1-\frac{\mu_{0\,loc}}{r_{loc}}\left(1+\frac{1}{2}\frac{v^2}{c^2}\right)\right]^2=(Mc)_2^2-(Mv)_1^2\left(1-\frac{\mu_{0\,loc}}{r_{loc}}\right)^2 \qquad .(12)$$

Note that the velocities v, and v_1 are just opposites, one being the velocity of the particle, and the other being the relative velocity of the local mass with respect to the particle. The squares can thus be equated.

We now have a differential expression relating, the rest mass of the particle outside the influence of a local mass, the relativistic mass within the influence of the local mass, the velocity, and the distance to the local mass. We should thus be able to solve for the orbital equations for the test mass.

In the following it will be shown that the equations of motion defined by Eq. (12) produces orbital relations equivalent to the weak field GR relations, with the same perihelion advance:

Rearranging we have:

$$\frac{(Mc)_{10}^2-(Mc)_2^2}{(Mc)_{10}^2}c^2-2\left(1+\frac{1}{2}\frac{v^2}{c^2}\right)\frac{\mu_{0\,loc}c^2}{r_{loc}}+\frac{(Mv)_1^2\,c^2}{(Mc)_{10}^2}\left(1-2\frac{\mu_{0\,loc}}{r_{loc}}\right)=0 \qquad .(13)$$

Noting that the first term is constant, we can rearrange, and write this in the usual form:

$$2\in -2c^2\frac{\mu_{0\,loc}}{r_{loc}}+(v)_1^2\left(1-3\frac{\mu_{0\,loc}}{r_{loc}}\right)=0 \qquad .(14)$$

Replacing r with $u=1/r$, and dropping the subscripts we have:

$$2\in -2\mu uc^2+v^2(1-3\mu u)=0 \qquad .(15)$$

or:

$$2\in -\; c^2\,2\mu u\;+\left(\frac{dr}{dt}\right)^2(1-3\mu u)\;+\;u^2\left(r^2\,\dot{\theta}\right)^2(1-3\mu u)=0 \qquad .(16)$$

using the relations:

$$h = \left(r^2 \dot{\theta} \right) \qquad \left(\frac{dr}{dt} \right)^2 = h^2 \left(\frac{du}{d\theta} \right)^2$$
$$\frac{d}{d\theta}\left(u^2 h^2 - 3\mu u^3 h^2 \right) = 2uh^2 \frac{du}{d\theta} - 9\mu h^2 u^2 \frac{du}{d\theta} \qquad ,(17)$$

and noting that :

$$\frac{d}{d\theta}\left[\left(\frac{dr}{dt} \right)^2 (1 - 3\mu u) \right] = 2h^2 \left(\frac{du}{d\theta} \right)\left(\frac{d^2u}{d\theta^2} \right)(1 - 3\mu u) - 3\mu \left(\frac{dr}{dt} \right)^2 \left(\frac{du}{d\theta} \right) \qquad .(18)$$

The differential with respect to θ, is:

$$\begin{bmatrix} -\ 2\mu c^2 \dfrac{du}{d\theta} & + 2h^2 \dfrac{du}{d\theta} \dfrac{d^2u}{d\theta^2} (1 - 3\mu u) \\ -3\mu h^2 \left(\dfrac{du}{d\theta} \right)\left(\dfrac{du}{d\theta} \right)^2 & + 2h^2 u \dfrac{du}{d\theta} - 9\mu h^2 u^2 \dfrac{du}{d\theta} \end{bmatrix} = 0 \qquad ,(19)$$

Factoring: $2h^2 \dfrac{du}{d\theta}$ we have:

$$-\frac{c^2\mu}{h^2} + \frac{d^2u}{d\theta^2}(1 - 3\mu u) - \frac{9}{2}\mu u^2 + u - \frac{3}{2}\left(\frac{du}{d\theta} \right)^2 \mu = 0 \qquad ,(20)$$

or:

$$\frac{d^2u}{d\theta^2} + \frac{u}{(1 - 3\mu u)} - \frac{u_0}{(1 - 3\mu u)(1 - e^2)} - \frac{9\mu u^2}{2(1 - 3\mu u)} - \frac{3}{2}\left(\frac{du}{d\theta} \right)^2 \frac{\mu}{(1 - 3\mu u)} = 0 \qquad ,(21)$$

where:

$$\frac{u_0}{1 - e^2} = \frac{c^2\mu}{h^2} \qquad ,(22)$$

and e is the eccentricity.

Taking out terms in second order of μ, then this is:

$$\frac{d^2u}{d\theta^2} + u - \frac{u_0}{\left(1-e^2\right)} - \frac{3}{\left(1-e^2\right)}\mu u_0 u + 3\mu u^2 - \frac{9}{2}\mu u^2 - \frac{3}{2}\mu\left(\frac{du}{d\theta}\right)^2 = 0 \qquad .(23)$$

The orbital equation is then:

$$\frac{d^2u}{d\theta^2} + u = \frac{u_0}{\left(1-e^2\right)} + \left[\frac{3}{2}\mu u^2 + \frac{3}{2}\mu u_0\left(\frac{2u}{\left(1-e^2\right)} + e^2\frac{u_0}{\left(1-e^2\right)}\sin^2\theta\right)\right] \qquad ,(24)$$

which is not exactly the Einstein orbital equation, but does have the same perihelion advance.

The perihelion advance factor, by the procedure of Robertson Noonan [4] is:

$$\sigma = \frac{1}{2}\frac{d}{du}\left[\frac{3}{2}\mu u^2 + \frac{3}{2}\mu u_0\left(\frac{2u}{\left(1-e^2\right)} + e^2\frac{u_0}{\left(1-e^2\right)^2}\sin^2\theta\right)\right]\Bigg|_{u=u(0)} \qquad ,(25)$$

or

$$\sigma = \left[\frac{3}{2}\mu u + \frac{3}{2}\mu u_0\left(\frac{1}{\left(1-e^2\right)} + e^2\frac{u_0}{\left(1-e^2\right)}\cos\theta\sin\theta\frac{d\theta}{du}\right)\right]_{u=u(0)} \qquad ,(26)$$

or

$$\sigma = \left[\frac{3}{2}\mu u + \frac{3}{2}\mu\frac{u_0}{\left(1-e^2\right)}\left(1 + e\cos\theta\right)\right]_{u=u(0)} = \frac{3\mu}{p} \qquad ,(27)$$

which compares within experimental error with a more exact value of the Einstein perihelion advance by Powell [5]:

$$\frac{3\mu}{p}\left[1 + \frac{3\mu}{p}\frac{\left(1+e\right)^2}{2e}\right] \qquad ,(28)$$

Photon Deflection

From the basic relation between rest masses at internal and external points of a gravitation mass, Eq. (6), we have:

$$(\mathrm{Mc})_{10} = (\mathrm{Mc})_{20}\frac{\alpha_1}{\alpha_2} = (\mathrm{Mc})_{20}\left(1-\frac{\mu_{loc}}{r_{loc}}\right)^{-1} \quad .(29)$$

For a photon traveling through the system, at the near position (2) the value will be:

$$c_2 = c_1^{'}\frac{\alpha_2}{\alpha_1} = c_1^{'}\left(1-\frac{\mu_{loc}}{r_{loc}}\right). \quad ,(30)$$

where $c_1^{'}$ is the value of c as measured by the apparatus at position (1), and c_2 is the value of c measured buy the same apparatus at position (2). We presume that the change in wavelength is proportional to change in the speed of light, thus we know this from the gravitational red shift as well as the Pound-Rebka-Snider, Mossbauer effect experiment (1960–1965)[6].

The apparatus however is subject to the condition that its rest mass, and thus its atomic clock is slowed by the relation (29). The value of c_1 as measured by the apparatus at the bound position (2) is:

$$c_1^{'} = c_1\frac{(\mathrm{Mc})_{20}}{(\mathrm{Mc})_{10}} = c_1\left(1-\frac{\mu_{loc}}{r_{loc}}\right) \quad .(31)$$

Putting this into Eq. (30), the relation between the speed of light at the bound position (2), and the unbound position (1) is:

$$c_2 = c_1\left(\frac{\alpha_2}{\alpha_1}\right)^2 = c_1\left(1-\frac{\mu_{loc}}{r_{loc}}\right)^2 \quad .(32)$$

This is then the relative value of the speed of light as observed by an external observer independent of the measuring apparatus, which is equivalent to the measured Shapiro velocity. Using (32) as the value of c for the index of refraction can be shown to give the proper deflection of a stellar grazing photon using Fermat’s principle [7].

The change in the rest mass of the measuring device is identified to be the source of the difference in radial and tangential velocity, as defined by

General Relativity. In the Relativistic case the effect is the slowing of time by the gravitational potential, thus resulting in a difference in the radial and tangential velocities.

$$c_{tan} = c_0\left(1 - \frac{2\mu}{r}\right) \qquad c_{rad} = c_0\left(1 - \frac{\mu}{r}\right) \quad .(33)$$

In the present case, the time is constant and the radial and tangential velocities are the same. Both procedures result in the proper Shapiro velocity as measured by an external observer, and give correct results.

$$c_{rad} = c_{tan} = c_0\left(1 - \frac{\mu_{loc}}{r_{loc}}\right)^2 \quad .(34)$$

The present case thus allows a scalar description rather than a tensor description of light propagation.

The distinction between this theory and GR in regard to the velocity of light is that the GR time potential slows the oscillation of an atomic clock as well as slowing down the radial velocity of light. In this theory the clock is also slowed but here the clock is slowed by virtue of the reduction in the rest mass of the clock.

Photon Energy and Momentum Considerations

From the gravitational red shift as well as the Pound-Rebka-Snider, Mossbauer effect experiment (1960–1965)[6], we note from the increase in the wavelength of a photon rising from position (2) to position (1) as measured by the same apparatus at both locations is:

$$\lambda_2 = \lambda_1'\left(1 - \frac{\mu_{loc}}{r_{loc}}\right) \quad ,(35)$$

but as we have discussed from Eq. (29) the increase in rest mass of the apparatus and thus the frequency of the atomic clock of the apparatus in position (1) increases the apparent wavelength by:

$$\lambda_1' = \lambda_1 \frac{(Mc)_{20}}{(Mc)_{10}} = \lambda_1 \left(1 - \frac{\mu_{loc}}{r_{loc}}\right) \quad ,(36)$$

so that the actual ratio, from an external observer, of the wavelengths is:

$$\lambda_2 = \lambda_1 \left(1 - \frac{\mu_{loc}}{r_{loc}}\right)^2 \quad .(37)$$

From the ratio of Eq. (37) and Eq. (32), it can be seen that the frequency of the photon is the same in both positions and thus there is no change in the energy of the photon in going from position (2) to Position (1).

$$E = h\nu = h\frac{c_1}{\lambda_1} = h\frac{c_2}{\lambda_2} \quad .(38)$$

The Photon momentum however does increase as the particle rises from the field due to the increase in c:

$$P = \frac{E}{c} = \frac{h}{\lambda_1}\left(1 - \frac{\mu_{loc}}{r_{loc}}\right) \quad .(39)$$

The decrease in energy of the photon noted by the apparatus located at position (1) is the result of the increase in the rest mass of the apparatus and the frequency of it's clock as given by Eq. (29). The difference in the energy of the measured photons is in the difference between the measuring systems, not a loss of energy of the photon as a result of rising in the field. The photon's energy is not a function of the gravitational field, and there is no need to ascribe any energy to the field.

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