Calculation of Masses Based on their Spacetime Curvature

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Abstract

This study introduces a method for calculating the mass of celestial bodies that contribute to gravity, based on gravitational relativistic contraction. The mass is non-scalar and non-invariant.

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1. Introduction

The relativistic nature of gravity has not yet impacted our understanding of the supposedly invariant mass. My results show that the specific amount of gravitational relativistic contraction, which I denote by the symbol $\boldsymbol{L}$, with respect to the radius of a gravity-generating object, is directly proportional to an object's mass. The maximum value of $\boldsymbol{L}$ is known as Schwarzschild radius $\boldsymbol{r_S}$. This study proves that not only this extreme case, but also every gravitationally conditioned relativistic contraction of an object shows the mentioned proportionality. $\boldsymbol{L}$ produces a mass-specific relativistic spectrum between $\boldsymbol{r_S}$ and the corresponding $\boldsymbol{L_{min}}$ for which the mass volume is large enough for gravity to tend to zero.

2. Gravitational Relativistic Contraction

The classic formula for the mass of a black hole

$$\boldsymbol{M_B = \frac{1}{2} \cdot \frac{r_S c^2}{G}} \tag{1}$$

uses the radius at which an event horion occurs. Not only does it represent a complete standstill of time, but also a complete relativistic contraction of the radius. Because gravitational time dilation must be caused by all objects, I investigated how their corresponding radial contraction might be related to the mass.

Typically, to obtain the gravitational time dilation on a mass surface, the reciprocal Lorentz factor $\boldsymbol{\alpha}$ depending on the surface escape velocity $\boldsymbol{v_E}$, which is expressed by the mean radius $\boldsymbol{r}$ and surface gravity $\boldsymbol{g}$, can be used to avoid $\boldsymbol{G}$:

$$\boldsymbol{\alpha = \sqrt{1 - \frac{{v_E}^2}{c^2}} = \sqrt{1 - \frac{2gr}{c^2}}} \tag{2}$$

For time dilation states below the surface of a uniformly dense mass, the Lorentz factor must be adjusted according to the gravitational potential to provide the correct data. At the corresponding radius, $\boldsymbol{r_x}$

$$\boldsymbol{\alpha(r_x) = \sqrt{1 - \frac{g\,(3r^2 - {r_x}^2)}{rc^2}}} \tag{3}$$

represents the distance-dependent factor related to the center of mass. This optimized function can be used to obtain the searched amount of contraction. To do this, we must integrate $\boldsymbol{1 - \alpha(r_x)}$ from 0 to $\boldsymbol{r_m}$:

$$\boldsymbol{L = \int_0^r \big(1 - \alpha(r_x)\big)\, dr_x}$$

$$\boldsymbol{= \int_0^r \left(1 - \sqrt{1 - \frac{g\,(3r^2 - {r_x}^2)}{rc^2}}\right) dr_x} \tag{4}$$

For a black hole

$$\boldsymbol{L_{max} = (1 - 0) \cdot r = r_S} \tag{5}$$

is completely contracted relativistically and becomes directly proportional to its mass. The formula

$$\boldsymbol{M = k \cdot \frac{Lc^2}{G} = k \cdot \int_0^r \left(1 - \sqrt{1 - \frac{g\,(3r^2 - {r_x}^2)}{rc^2}}\right) dr_x \cdot \frac{c^2}{G}} \tag{6}$$

should be valid if that proportionality applies to every object.

To determine $\boldsymbol{k}$ the classic formula

$$\boldsymbol{M} = \frac{\boldsymbol{gr^2}}{\boldsymbol{G}} \tag{7}$$

is divided by the derived one, eliminating its relativistic influence:

$$\boldsymbol{k} = \lim_{(g,r)\to(0,0)} \frac{\boldsymbol{gr^2}}{\boldsymbol{Lc^2}} = \mathbf{0.75} \tag{8}$$

$\boldsymbol{k}$ is exactly 1.5 times larger compared to its equivalent in the non-relativistic formula for black holes. The reason for this is the now considered spectrum of the gravitational potential between the surface and the core of the object. With the classic formula different $\boldsymbol{g}$ and $\boldsymbol{r}$ always lead to identical masses as long as product $\boldsymbol{gr^2}$ is fixed. However, in my formula, they do not provide a constant $\boldsymbol{L}$, but contribute to a relativistic increase. Dividing the limits of $\boldsymbol{L}$ yields

$$\boldsymbol{L_{max}} = \boldsymbol{r_s}$$

$$\boldsymbol{L_{min}} = \int_0^r \frac{\boldsymbol{g}\,(3\boldsymbol{r}^2 - \boldsymbol{r_x}^2)}{\boldsymbol{2rc^2}}\, dr_x = \frac{\boldsymbol{4gr^2}}{\boldsymbol{3c^2}}$$

$$\frac{\boldsymbol{L_{max}}}{\boldsymbol{L_{min}}} = \frac{\boldsymbol{2gr^2}}{\boldsymbol{c^2}} \cdot \frac{\boldsymbol{3c^2}}{\boldsymbol{4gr^2}} = \frac{\mathbf{1.5}}{\mathbf{1}} \tag{9}$$

and that is why for an assumed weak point mass the result is

$$\boldsymbol{M} = \frac{\mathbf{3}}{\mathbf{4}} \cdot \frac{\boldsymbol{Lc^2}}{\boldsymbol{G}} \tag{10}$$

Using this formula, the calculated masses also agree with those from the NASA reference for every celestial body in our solar system, provided that the correct mean values for $\boldsymbol{g}$ and $\boldsymbol{r}$ are populated. This is not surprising because the contribution of the relativistic effect to planets and pre-supernova stars is almost negligible and there is hardly any relevant difference between the results of the two formulas. Evidently, the relativistic spectrum of $\boldsymbol{L}$ closely follows the gravitational potential between the core and the surface. This also means that, if $\boldsymbol{k}$ is constant, the mass and gravity of each object according to its classification in this spectrum would be higher than those in the classical calculation. This is particularly noticeable for its upper limit, and thus with black holes, where the initial mass increases by half:

$$\boldsymbol{M_B} = \frac{\mathbf{3}}{\mathbf{4}} \cdot \frac{\boldsymbol{r_s c^2}}{\boldsymbol{G}} \tag{11}$$

From a scientific perspective, there is no discernible or plausible reason for why $\boldsymbol{k}$ should be variable and compensate for relativity. Using the example of moving objects, we know that they also do not compensate for relativistic energy and mass gains.

3. Exemplary Calculations on Celestial Bodies

To prove the accuracy of my formula, I present the resulting masses of four celestial bodies in our solar system.

Moon: $\boldsymbol{r} = 1737400\,m$ $\boldsymbol{g} = 1.622\,\frac{m}{s^2}$

$\boldsymbol{M}_{☾}$ =*0.75****0.00007263531 m****c^2/G*

$\approx \mathbf{7.34 \cdot 10^{22}}\ kg$

Venus: $\boldsymbol{r} = 6051800\,m$ $\boldsymbol{g} = 8.87\,\frac{m}{s^2}$

$\boldsymbol{M}_{♀}$ =*0.75****0.0048193679 m****c^2/G*

$\approx \mathbf{4.87 \cdot 10^{24}}\ kg$

Earth: $\boldsymbol{r} = 6371000\,m$ $\boldsymbol{g} = 9.807\,\frac{m}{s^2}$

$\boldsymbol{M}_{\oplus}$ =*0.75****0.00590719828 m****c^2/G*

$\approx \mathbf{5.97 \cdot 10^{24}}\ kg$

Sun: $\boldsymbol{r} = 695700000\,m$ $\boldsymbol{g} = 274\,\frac{m}{s^2}$

$\boldsymbol{M}_{\odot}$ =*0.75****1967.3993430 m****c^2/G*

$\approx \mathbf{1.99 \cdot 10^{30}}\ kg$

The calculated results agree with the NASA reference values.

4. Conclusions

As initially assumed, the gravitationally contributing mass can be calculated by determining the gravitational relativistic contraction. $\boldsymbol{L}$ ultimately yields mass amounts by being a relativistic slider that forms them according to the parameters between the described limits. This is where my results differ from those of the classic computational methods. Any measured gravity is caused in part by relativistic mass. A 1.5 times greater mass of a black hole compared to its former mass inside a collapsing star would therefore be something that science would have to observe astronomically to fully prove my approach.

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