Calculation of Inertial Masses Based on their Spacetime Curvature

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Abstract

This paper introduces a relativistic method to calculate the inertial mass along with the purely mathematically derived gravitational constant $\boldsymbol{G}$, which has only been determined experimentally thus far. The limits for a weak-point mass were used to precisely calculate $\boldsymbol{G}$ without any further measurements. The accuracy of $\boldsymbol{G}$ depends only on the measurement accuracy of the speed of light. A mass is revealed not to be scalar, not invariant, and its units can be expressed in terms of time and space.

Keywords: Spacetime Flow Rate — Gravitational Constant — Lorentz Factor

1. Introduction and Preliminary Considerations

The relativistic nature of gravity has long been known; however, to date, it has not impacted the understanding of inertial mass. The strict correlation of an object's size and gravity with its local relativistic transformations leads to the question of whether a supplementary gravitational component or a constant is necessary to determine the inertial mass of the object. If only a certain amount of inertial mass can result from a given mean radius paired with a given surface gravity, then the latter two components might suffice to determine it, just as they suffice to provide the whole profile of time dilation.

We must return to the basics of general relativity to find the overseen pieces. From the perspective of an observer within a gravitational field, everything outside the field would be moving faster because his own time runs out more slowly. However, because the speed of light must remain constant, the universe will have smaller dimensions from its vantage point than from the vantage point of an observer outside the field. What the observer gains in time, he thus loses in space: within a gravitational field, his reality is partially deflected from space to time. This deflection illustrates the gravitational contraction of length - one could say that his surrounding universe is denser. I think that it makes sense, that this omnidirectional increase in density could represent the local phenomenon we call inertial mass.

Gravitational time dilation depicts how space curves into time, generating a maximum deflection at the center of mass and forming a corresponding volume within the curvature. The larger this volume, the better is the temporal progress of the object. This drag may be the reason for its inertia, and hence, its inertial mass. My results show that the specific amount of relativistic gravitational contraction $\boldsymbol{L}$ with respect to the radius of a gravity-generating object is directly proportional to its mass. Its maximum value is known as the Schwarzschild radius $\boldsymbol{r_S}$ and is already accepted by science as being directly proportional to a Black Hole's mass. Not only the extreme case but also any gravitationally caused relativistic contraction of an object is directly proportional to its mass. $\boldsymbol{L}$ produces a mass-specific relativistic spectrum between $\boldsymbol{r_S}$ and a corresponding $\boldsymbol{r_{min}}$ for which the mass volume is large enough for gravity to approach zero.

2. What is Moving - the Spacetime or the Object?

According to common understanding, every object should move through spacetime at the speed of light. The main approach of this study is the assumption that spacetime itself actively spreads with the speed of light in the form of a replicative expansion. Such a spacetime would have an accelerating flow rate $\boldsymbol{Q_S = c^3}$, because the volume of space created increases eightfold with each doubling of the directional distance with regard to a coordinate system.

3. Basic Derivation of Inertial Mass

If matter and thus inertial mass are the result of a condensed spacetime flow, the approach should be similar to how multiplying the material density, volumetric flow rate, and time gives mass in a classic flow scenario:

$$\boldsymbol{M = \varrho \cdot Q \cdot t} \tag{1}$$

For the density $\boldsymbol{\varrho}$ I assumed that it could be substituted by the relativistic contraction $\boldsymbol{L}$ since it should be directly proportional to mass and hence to $\boldsymbol{\varrho}$. Instead of an arbitrary period $\boldsymbol{t}$, I used the proportionality factor $\boldsymbol{k_M}$ to check for correlation:

$$\boldsymbol{M = L \cdot Q_S \cdot k = L \cdot c^3 \cdot k_M} \tag{2}$$

4. Radial Gravitational Lorentz Contraction

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

$$\boldsymbol{\alpha = \sqrt{1 - \frac{{v_{Em}}^2}{c^2}} = \sqrt{1 - \frac{2 g_m r_m}{c^2}}} \tag{3}$$

For time-dilation states below the surface of the mass, the Lorentz factor must be adjusted according to the gravitational potential to provide the correct data. Although the density distribution within a celestial body is individual, any body mass can be extrapolated using an idealized, average density, or uniform distribution. Assuming direct proportionality to $\boldsymbol{\varrho}$, the same should hold for $\boldsymbol{L}$. With this in mind, we should be able to obtain the correct masses based on a formula that assumes a uniform density. At a corresponding radius, $\boldsymbol{r_x}$

$$\boldsymbol{\alpha(r_x) = \sqrt{1 - \frac{g_m\,(3{r_m}^2 - {r_x}^2)}{r_m c^2}}} \tag{4}$$

delivers the locally appropriate Lorentz factor. This optimized function can be used to obtain the searched amount of relativistic contraction $\boldsymbol{L}$. To do this, we must integrate $\boldsymbol{1 - \alpha(r_x)}$ from 0 to $\boldsymbol{r_m}$:

$$\boldsymbol{L} = [\boldsymbol{L(r_x)}]_{\boldsymbol{0}}^{r_m} = \boldsymbol{2} \cdot \int_{\boldsymbol{0}}^{r_m} \boldsymbol{(1 - \alpha(r_x))\,dr_x}$$

$$= \int_{\boldsymbol{0}}^{r_m} \left(\boldsymbol{1 - \sqrt{1 - \frac{g_m\,(3{r_m}^2 - {r_x}^2)}{r_m c^2}}} \right) \boldsymbol{dr_x} \tag{5}$$

For our earth $\boldsymbol{L}$ is ~**0.0059** m and for our sun ~**1971.02** m, which is not very far from their Schwarzschild radii $\boldsymbol{r_S}$. In the case of a Black Hole $\boldsymbol{L_{max} = r_m = r_S}$, because $\boldsymbol{\alpha(r_S) = 0}$ leads to $\boldsymbol{L_{max} = (1 - \alpha(r_s)) \cdot r_m = r_S}$. The radius of the object is completely contracted relativistically and is therefore directly proportional to the Black Hole's mass.

$$\boldsymbol{M} = \int_{\boldsymbol{0}}^{r_m} \left(\boldsymbol{1 - \sqrt{1 - \frac{g_m\,(3{r_m}^2 - {r_x}^2)}{r_m c^2}}} \right) \boldsymbol{dr_x} \cdot \boldsymbol{c}^3 \cdot \boldsymbol{k_M} \tag{6}$$

To determine $\boldsymbol{k}$ the derived formula is divided by the classic formula, eliminating the relativistic influence:

$$\boldsymbol{k_M} = \lim_{(g_m, r_m) \to (0,0)} \int_{\boldsymbol{0}}^{r_m} \boldsymbol{(1 - \alpha(r_x))\,dr_x \cdot c^3 : \frac{g_m {r_m}^2}{G}} \tag{7}$$

$$= \boldsymbol{37.5}\,\frac{m^4}{kg \cdot s^3}$$

It becomes obvious that $\boldsymbol{k_M}$ must contain multipliers $\boldsymbol{G}$ and speed (presumably $\boldsymbol{c}$). The remaining, purely numerical proportionality factor, $\boldsymbol{k_{SI}}$ establishes the relationship between the SI unit $\boldsymbol{kg}$ and its spatiotemporal expression.

$$\boldsymbol{M} = \int_{\boldsymbol{0}}^{r_m} \left(\boldsymbol{1 - \sqrt{1 - \frac{g_m\,(3{r_m}^2 - {r_x}^2)}{r_m c^2}}} \right) \boldsymbol{dr_x\, G c^4} \cdot \boldsymbol{k_{SI}} \tag{8}$$

$$\boldsymbol{k_{SI} = 1875} \tag{9}$$

We can now determine the resulting units of my formula:

$$\boldsymbol{M} \;\rightarrow\; kg = m \cdot \frac{m^4}{s^4} \cdot \frac{m^3}{kg \cdot s^2} \;\rightarrow\; kg = \sqrt{\frac{m^8}{s^6}} = \frac{m^4}{s^3} \tag{10}$$

That would lead to:

$$\boldsymbol{1}\; kg = \boldsymbol{1875}\,\frac{m^4}{s^3} \tag{11}$$

We proved that the mass can be expressed in pure spacetime units. The integer value of $\boldsymbol{k_{SI}}$ can only be explained by the meter derived from $\boldsymbol{c}$, which makes $\boldsymbol{c}$ itself an integer. With these units, the gravitational constant $\boldsymbol{G}$ would receive an appropriate role as an expansion pace concerning the condensed spacetime propagation:

$$\boldsymbol{G} \;\rightarrow\; \frac{m^3}{kg \cdot s^2} = \frac{m^3 \cdot s^3}{m^4 \cdot s^2} = \frac{s}{m} \qquad \boldsymbol{1}\;\frac{m^3}{kg \cdot s^2} = \frac{s}{\boldsymbol{1875}\,m} \tag{12}$$

If we consider the reciprocal of the speed of light, there might be a connection in this regard. Uncondensed spacetime would have a pace that equals $\boldsymbol{1/c}$ and would be a multiple of $\boldsymbol{G}$. Being a pace, $\boldsymbol{G}$ would express how much time is needed to generate one meter of condensed space. Multiplication between $\boldsymbol{c}$ and $\boldsymbol{G}$ gives a unitless factor, which means that $\boldsymbol{k_M}$ is ultimately also unitless:

$$\boldsymbol{k_M = 37.5} \tag{13}$$

To work with this formula in pure spacetime units, $\boldsymbol{k_{SI}}$ must be set to a power of three:

$$\boldsymbol{M = L \cdot c^4 \cdot G \cdot {k_{SI}}^3} \tag{14}$$

It is time to perform a quick check of the mass result for Earth, still using the experimentally measured $\boldsymbol{G}$:

$$\boldsymbol{r_m} = 6371000\,m \qquad \boldsymbol{g_m} = 9.807\,\frac{m}{s^2}$$

$\boldsymbol{M_{\oplus}}$ ***= 0.00590719828*****299792458^4**__*6.6742*10^-11*__**1875*

$\approx$ **5.97** $\cdot$ $\boldsymbol{10^{24}}$ $\frac{m^4}{1875 s^3}\,(kg)$ → agrees with the NASA reference

Using the derived and fixed values for $\boldsymbol{k_{SI}}$, the results also did not differ from the NASA reference for any other celestial body in our solar system when using the correct mean values for $\boldsymbol{g_m}$ and $\boldsymbol{r_m}$.

5. Precise Calculation of the Gravitational Constant

With the classic formula

$$\boldsymbol{M = \frac{g_m {r_m}^2}{G}} \tag{15}$$

Different $\boldsymbol{g_m}$ and $\boldsymbol{r_m}$ always lead to identical masses as long as the product $\boldsymbol{g_m {r_m}^2}$ is fixed. However, in my formula, they do not provide a constant $\boldsymbol{L}$, but produce a relativistic spectrum. Dividing the limits of $\boldsymbol{L}$ yields

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

$$\boldsymbol{L_{min}} = \int_0^{r_m} \frac{\boldsymbol{g_m} \, (3\boldsymbol{r_m}^2 - \boldsymbol{r_x}^2)}{\boldsymbol{2 r_m c^2}} \, dr_x = \frac{\boldsymbol{4 g_m {r_m}^2}}{\boldsymbol{3c^2}}$$

$$\frac{\boldsymbol{L_{max}}}{\boldsymbol{L_{min}}} = \frac{\boldsymbol{2 g_m {r_m}^2}}{\boldsymbol{c^2}} : \frac{\boldsymbol{4 g_m {r_m}^2}}{\boldsymbol{3c^2}} = \frac{\boldsymbol{1.5}}{\boldsymbol{1}} \tag{16}$$

Evidently, the relativistic spectrum of $\boldsymbol{L}$ closely follows the gravitational potential between the core and surface. This also means that the mass and gravity of any object, according to its classification within this spectrum, would be higher compared to the classic calculation. This is particularly noticeable for its upper limit, and thus, with Black Holes. Nevertheless, the relativistic effects for planets and pre-supernova stars are negligible, and there is almost no relevant difference between the results of the two formulas.

Despite the different assumptions on which both formulas are based, it is possible to calculate $\boldsymbol{G}$ exactly by equating them. However, the equation would only be harmless for the limit value at which $(\boldsymbol{g_m}, \boldsymbol{r_m}) \to (\boldsymbol{0}, \boldsymbol{0})$. In this case, $\boldsymbol{L}$ and, thus, the relativistic effect itself tends to zero, and both formulas should deliver identical results for the assumed point mass, from which $\boldsymbol{G}$ can be determined purely mathematically depending only on the accuracy of $\boldsymbol{c}$.

$$\boldsymbol{L \cdot c^4 \cdot G \cdot 1875 = \frac{g_m {r_m}^2}{G}} \qquad \boldsymbol{G = \sqrt{\frac{g_m {r_m}^2}{L \cdot c^4 \cdot 1875}}} \tag{17}$$

With the limit scenario we get:

$$\boldsymbol{G} = \lim_{(g_m, r_m) \to (0,0)} \sqrt{\frac{\boldsymbol{g_m {r_m}^2}}{\boldsymbol{L \cdot c^4 \cdot 1875}}} = \frac{\boldsymbol{1}}{\boldsymbol{50 \cdot c}} \, \frac{m^4}{kg \cdot s^3} \tag{18}$$

$$\approx \boldsymbol{6.6712819 \cdot 10^{-11}} \, \frac{m^3}{kg \cdot s^2} \approx \boldsymbol{3.5580170 \cdot 10^{-14}} \, \frac{s}{m}$$

This exact result is likely to be the true value of the gravitational constant. This does not mean that they cannot exhibit measurable evolutionary fluctuations.

6. Ready-to-Use Formula

As soon as we replace the variables $\boldsymbol{L}$ and $\boldsymbol{G}$ with their above-derived data in the basic $\boldsymbol{M = L \cdot c^4 \cdot G \cdot {k_{SI}}^3}$, we obtain the following formula:

$$\boldsymbol{M = k_M \cdot k_{SI} \cdot L \cdot c^3} \tag{19}$$

$$= \boldsymbol{k_M \cdot k_{SI}} \cdot \int_0^{r_m} \left(\boldsymbol{1} - \sqrt{\boldsymbol{1} - \frac{\boldsymbol{g_m} \, (3\boldsymbol{r_m}^2 - \boldsymbol{r_x}^2)}{\boldsymbol{r_m c^2}}} \right) \boldsymbol{dr_x \cdot c^3}$$

7. Exemplary Calculations on Celestial Bodies

According to my previous derivations, we observed that $\boldsymbol{L}$ is subject to a relativistic increase, which mainly affects objects under extreme conditions. As a result, the mass of Black Holes with a Schwarzschild radius $\boldsymbol{r_s}$ is:

$$\boldsymbol{M_B = k_M \cdot k_{SI} \cdot r_s \cdot c^3 = 70312.5 \cdot r_s \cdot c^3} \tag{20}$$

To prove the accuracy of my formula, I calculated the masses of four celestial bodies in our solar system. In addition, $\boldsymbol{c}$, $\boldsymbol{r_m}$ and $\boldsymbol{g_m}$ are the only inputs required and are sourced from the referenced NASA and NIST websites.

Moon: $\boldsymbol{r_m} = 1737400\,m$ $\quad \boldsymbol{g_m} = 1.622\,\frac{m}{s^2}$

$$\boldsymbol{M_{☾}} = \mathit{37.5{*}\boldsymbol{0.00007263531}{*}299792458^\wedge 3}$$

$$\approx \boldsymbol{7.34 \cdot 10^{22}} \; \frac{m^4}{1875\,s^3} \; (kg)$$

Venus: $\boldsymbol{r_m} = 6051800\,m$ $\quad \boldsymbol{g_m} = 8.87\,\frac{m}{s^2}$

$$\boldsymbol{M_{♀}} = \mathit{37.5{*}\boldsymbol{0.00481936794}{*}299792458^\wedge 3}$$

$$\approx \boldsymbol{4.87 \cdot 10^{24}} \; \frac{m^4}{1875\,s^3} \; (kg)$$

Earth: $\boldsymbol{r_m} = 6371000\,m$ $\quad \boldsymbol{g_m} = 9.807\,\frac{m}{s^2}$

$$\boldsymbol{M_{\oplus}} = \mathit{37.5{*}\boldsymbol{0.00590719828}{*}299792458^\wedge 3}$$

$$\approx \boldsymbol{5.97 \cdot 10^{24}} \; \frac{m^4}{1875\,s^3} \; (kg)$$

Sun: $\boldsymbol{r_m} = 695700000\,m$ $\quad \boldsymbol{g_m} = 274\,\frac{m}{s^2}$

$$\boldsymbol{M_{\odot}} = \mathit{37.5{*}\boldsymbol{1967.39934309588}{*}299792458^\wedge 3}$$

$$\approx \boldsymbol{1.99 \cdot 10^{30}} \; \frac{m^4}{1875\,s^3} \; (kg)$$

The calculated results agree with the NASA reference values.

8. Conclusions

As initially assumed, the inertial mass can be fully calculated by simply determining $\boldsymbol{r_m}$ and $\boldsymbol{g_m}$. The relevant variable in this basic formula is $\boldsymbol{L}$ which determines the resulting masses entirely by itself. The defining effect of relativity could be the formation of inertial mass, which would thus be relativistic in origin. $\boldsymbol{L}$ ultimately yields the mass amounts by being a relativistic slider that forms them according to the parameters between the limits described. Moreover, the assumption that mass experiences an additional pronounced relativistic effect with increasing gravitational force is quite conclusive. This is where my results differ from those of the classic computational methods. A 1.5 times greater mass of a Black Hole compared to its former mass inside a star would be something that science would have to observe astronomically to fully prove my approach.

Thus far, the values of $\boldsymbol{G}$ measured by science appear to be less accurate than assumed and are generally too high.

Because $(\boldsymbol{3g_m r_m}) \rightarrow (\boldsymbol{c^2})$ determines the extreme case for time dilation, the singularity of a Black Hole and thus a complete standstill in time at the center of mass would occur before a mass implosion reaches the Schwarzschild radius. Singularity begins to form at

$$\boldsymbol{r_{Si}} = \frac{\boldsymbol{3g_m r_m{}^2}}{\boldsymbol{c^2}} \tag{21}$$

which is 1.5 times the Schwarzschild radius.

Finally, the resulting spacetime units indicated the actual existence of the assumed spacetime flow and its potentially exciting consequences.

8.1 Hypotheses

My results could lead to the insight that spacetime has undergone an evolution leading to its condensed states (matter), and the Big Bang does not have to have happened. The universe may have come into being with the advent of the quantum ability to systematically replicate and distribute similar states and events that depict time and space. This would be a holistic but open construct for evolving reference systems. The elementary space is the primary quantum field and time its progression. These spatial fields of possible spacetime quanta would merge with one another, thereby allowing the total amount of space and thus our universe to grow.

All the energy in our universe could be the result of the ever-expanding spacetime, and it would continue to increase in total. The similar behavior of the assumed density-stable dark energy with regard to the expansion of the universe is a further indication that my approach could be correct. We assume that our universe possesses a definite and fixed amount of energy from the start, which does not make more sense than assuming that this energy could be due to external sources. We have abolished the static universe but not yet its energetic static, which could change now.

There could even be a very interesting connection with the CMB if, contrary to current assumptions, the CMB were constant and not decreasing: the universe would be working like a sustained cavity resonator i.e. replicator. Being an open system, such a spacetime resonator would not deviate from the characteristics of a black body object: full absorption in its direction of expansion with the CMB temperature generating periodic, replicative vibrations representing an excitation frequency. The classic formula describing damped natural frequencies.

$$\boldsymbol{\omega_d = \omega_n \cdot \sqrt{1 - \zeta^2}} \tag{22}$$

corresponds to the escape velocity resulting from the Lorentz factor:

$$\boldsymbol{v_{Em} = c \cdot \sqrt{1 - \alpha^2}} \tag{23}$$

When comparing both formulas, there is a clear analogy: unattainable states for both $\boldsymbol{\omega_d}$ and $\boldsymbol{v_{Em}}$, system pre-determining constants, and damping/contraction ratios. In such a scenario, $\boldsymbol{c}$ per distance could play the role of a natural, undamped diffusion frequency of spacetime, whereas the CMB would generate the excitation and thus spacetime replication frequencies.

Evolution may have elegantly misused this entire process for its main goal of quantum distribution and condensation. In this way, it may have nested the diffusion strive energy by shaping it into a higher complexity, which we call matter. There is, of course, a catch on my calculation basis: should this primary form of replication ever end, spacetime would vanish instantaneously. By contrast, the universe of the Standard Model is a closed machine that consistently unfolds according to the given design principles and is condemned to an immutable energy volume.

References

[1] NASA Space Science Data Coordinated Archive, Moon Fact Sheet. Retrieved from https://nssdc.gsfc.nasa.gov/planetary/factsheet/moonfact.html

[2] NASA Space Science Data Coordinated Archive,Venus Fact Sheet. Retrieved from https://nssdc.gsfc.nasa.gov/planetary/factsheet/venusfact.html

[3] NASA Space Science Data Coordinated Archive, Earth Fact Sheet. Retrieved from https://nssdc.gsfc.nasa.gov/planetary/factsheet/earthfact.html

[4] David B. Newell and Eite Tiesinga,Editors,NIST SP 330, 2019 edition,The International System of Units (SI),46. https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.330-2019.pdf

[5] NASA Space Science Data Coordinated Archive, Sun Fact Sheet. Retrieved from https://nssdc.gsfc.nasa.gov/planetary/factsheet/sunfact.html

[6] The NIST Reference on COnstants, Units, and Uncertainity, Newtonian constant of gravitation. Retrieved 17 January 2023 from https://physics.nist.gov/cgi-bin/cuu/Value?bg

[7] University of Washington Big G Measurement, Jens H. Gundlach and Stephen M. Merkowitz. Retrieved from https://asd.gsfc.nasa.gov/Stephen.Merkowitz/G/Big_G.html