Calculation of Inertial Masses Based on their Spacetime Curvature

Ivo Draschkow[1]

[1] Independent researcher

E-mail: ivo@draschkow.de

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Abstract

This paper introduces a new way to perform the calculation of inertial mass along with the purely mathematically derived gravitational constant $\boldsymbol{G}$, which has only been determined experimentally so far. The limits for a weak point mass are used to precisely calculate $\boldsymbol{G}$ without any further measurments. The accuracy of $\boldsymbol{G}$ concerning the point mass depends solely on the accuracy of the measurement of the speed of light. Mass is non-scalar, not invariant, and its units can be expressed in terms of time and space. The results prove my hypothesis that it is spacetime itself that always moves with $\boldsymbol{c}$ and deflections in its flow rate lead to its condensation into masses. This paper goes back to the foundations of general relativity.

Keywords: Spacetime Flow Rate — Gravitational Constant — Lorentz Factor

1. Introduction and Preliminary Considerations

The relativistic nature of gravity has long been known but 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, whether a supplementary gravitational component or constant is really 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 give us its whole profile of time dilation.

We need to go back 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 is running out more slowly. However, since the speed of light must remain constant, the universe is going to have smaller dimensions from his 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 would be partially deflected from space to time. That deflection illustrates the gravitational contraction of length - one could say his surrounding universe is denser. I think that it makes sense, that this omnidirectional increase in density could give rise to the local phenomenon we call inertial mass.

Gravitational time dilation causes space to curve into time, generating a maximum deflection at the center of mass and forming a corresponding volume within the curvature. The larger this volume is, the better the object eludes temporal progress. This drag may be the reason for its inertia and hence its inertial mass, since no other action mechanisms of matter in relation to spacetime are known to science. In this work, therefore, the specific amount of relativistic contraction with respect to the diameter of a spherical gravity-generating object is used for the calculation of its mass. I give it the symbol $\boldsymbol{L}$.

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

By common understanding, every object should be moving through spacetime at the speed of light. A very important approach of this work is the assumption, that not contained objects, but spacetime itself actively moves with the speed of light in the form of a replicative expansion. This would give spacetime a frequency that isotropically and periodically generates a pair of spatial wavelengths that don't develop as a continuation but drift away from each other with $\boldsymbol{c}$. The universe would represent a resonant cavity whose frequency I assumed to be the speed of light translated into the microwave range. With exactly $\boldsymbol{f_c} = 299792458000\ Hz$ I got perfectly accurate results. Such a spacetime would have an accelerating flow rate $\boldsymbol{Q_S} = \boldsymbol{c^3}$, since the volume of space created increases eightfold with each directional doubling of the wavenumber.

3. Basic Derivation of Inertial Mass

If matter and thus inertial mass were the result of a condensed spacetime flow, the approach should be similar to how multiplying between material density, volumetric flow rate and the number of volumetric flow units gives mass in a classic flow scenario.The unit count would stand for the count of generated spatial wavelengths in a mass-free environment. It would be the product of $\boldsymbol{f_c}$ and the specific time $\boldsymbol{t_G}$ it would take to generate a condensed wavelength of space. With this in mind, the initial formula should be as follows:

$$\boldsymbol{M = L \cdot Q_S \cdot f_c \cdot t_G} \tag{1}$$

Which amount of time $\boldsymbol{t_G}$ should be considered here? It depends on the SI units that we use. If the spatial SI units are meters then more time would be needed to generate the corresponding wavelengths compared to millimeters.

Should we really be able to use my formula to calculate masses equal to the known ones, this would also lead to an exciting new way to express mass units as pure spacetime:

$$\boldsymbol{M \;\rightarrow\; kg = m \cdot \frac{m^3}{s^3} \cdot \frac{1}{s} \cdot s = \frac{m^4}{s^3}} \tag{2}$$

With these units the currently used gravitational constant $\boldsymbol{G}$ would receive a very appropriate role as an expansion pace concerning the condensed spacetime propagation:

$$\boldsymbol{G \;\rightarrow\; \frac{m^3}{kg \cdot s^2} = \frac{m^3 \cdot s^3}{m^4 \cdot s^2} = \frac{s}{m}} \tag{3}$$

If we look at the reciprocal of the speed of light, there might be a connection in this regard. Uncondensed spacetime would have a pace that equals $1/c$, and if my approach is correct, it should be a multiple of $\boldsymbol{G}$. Being a pace, $\boldsymbol{G}$ would express how much time $\boldsymbol{t_G}$ is needed to generate one meter of condensed space. Against this background we may assume the following:

$$\boldsymbol{f_c \cdot t_G = c \cdot G \cdot 10^3} \tag{4}$$

$$\boldsymbol{M = L \cdot c^4 \cdot G \cdot 10^3} \tag{5}$$

Units confirmation:

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

$\boldsymbol{L}$ and possibly the experimentally determined $\boldsymbol{G}$ remain the only variables of my basic formula and are detailed below.

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 $\boldsymbol{G}$.

$$\boldsymbol{\alpha = \sqrt{1 - \frac{v_{Em}{}^2}{c^2}} = \sqrt{1 - \frac{2g_m r_m}{c^2}}} \tag{7}$$

For time dilation states below the surface of the mass, science resorts to the gravitational potential although the Lorentz factor is also able to provide correct data. For this, it has to be adjusted to include the increase of $\boldsymbol{v_E}$ on its way from the surface to the center of mass. At a corresponding radius $\boldsymbol{r_x}$

$$\boldsymbol{\alpha(r_x) = \sqrt{1 - \frac{v_{Em}{}^2 + dv_E{}^2}{c^2}}}$$
$$\boldsymbol{= \sqrt{1 - \frac{2g_m r_m + \frac{(2g_m r_m - 2g_m r_x)}{2}}{c^2}} = \sqrt{1 - \frac{3g_m r_m - g_m r_x}{c^2}}} \tag{8}$$

is going to deliver the locally appropriate Lorentz factor.

We can use this optimized Lorentz function to obtain the searched amount of relativistic contraction $\boldsymbol{L}$ concerning the diameter of a spherical object. To do this, we need to integrate $\boldsymbol{1 - \alpha(r_x)}$ from 0 to $\boldsymbol{r_m}$ and double the result:

$$\boldsymbol{L = 2 \cdot [L(r_x)]_0^{r_m} = 2 \cdot \int_0^{r_m} \left(1 - \alpha(r_x)\right) dx}$$
$$\boldsymbol{= 2\left(r_m - \frac{2c^2 \cdot \left(\left(1 - \frac{2g_m r_m}{c^2}\right)^{\frac{3}{2}} - \left(1 - \frac{3g_m r_m}{c^2}\right)^{\frac{3}{2}}\right)}{3g_m}\right)} \tag{9}$$

We should now be able to determine the inertial mass of celestial bodies, but to do that we would still have to plug the measured and rather imprecise $\boldsymbol{G}$-value into my basic formula:

$$\boldsymbol{M = 2\left(r_m - \frac{2c^2\left(\left(1-\frac{2g_m r_m}{c^2}\right)^{\frac{3}{2}} - \left(1-\frac{3g_m r_m}{c^2}\right)^{\frac{3}{2}}\right)}{3\,g_m}\right) c^4 \cdot G \cdot 10^3} \tag{10}$$

Verification with Earth data: $\boldsymbol{r_m} = 6371000\,m \qquad \boldsymbol{g_m} = 9.807\,\frac{m}{s^2}$

$\boldsymbol{M_\oplus}$ = *2*(**6371000**-(2*299792458^2*((1-(2***9.807*****6371000**)/ 299792458^2)^1.5-(1-(3***9.807*****6371000**)/299792458^2)^1.5)) /(3***9.807**))*299792458^4***6.6742*10^-11***10^3*

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

5. Precise Calculation of the Gravitational Constant

Due to the fact, than in my formula $\boldsymbol{G}$ is not in the denominator of a fraction, which it is in the classic ones, there is finally a possibilty to calculate it exactly by equating with one of them:

$$\boldsymbol{L \cdot c^4 \cdot G \cdot 10^3 = \frac{g_m r_m{}^2}{G} \qquad G = \sqrt{\frac{g_m r_m{}^2}{L \cdot c^4 \cdot 10^3}}} \tag{11}$$

For the weak point mass with $\boldsymbol{(g_m, r_m) \rightarrow (0, 0)}$ we receive

$$\boldsymbol{G_{max} = \lim_{(g_m, r_m) \to (0,0)} \sqrt{\frac{g_m r_m{}^2}{L \cdot c^4 \cdot 10^3}} = \frac{0.02}{c}} \tag{12}$$

$\approx \boldsymbol{6.6712819 \cdot 10^{-11} \frac{s}{m}}$ → this pace is exactly 50 times lower than spacetime's $1/c$.

Verification:

*(**0.000001*0.000001**^2/(10^3*(2*299792458^4*(**0.000001**-(2*299792458^2*((1-2***0.000001*0.000001**/299792458^2)^1.5-(1-3***0.000001*0.000001**/299792458^2)^1.5))/(3***0.000001**)))))^0.5*

As soon as $\boldsymbol{g_m}$ and $\boldsymbol{r_m}$ increase, $\boldsymbol{G}$ decreases relativistically, but extremely slowly. For our sun it only makes a difference from the fifth decimal place compared to the weak point mass:

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

*(**274*695700000**^2/(10^3*(2*299792458^4*(**695700000**-(2*299792458^2*((1-2***274*695700000**/299792458^2)^1.5-(1-3***274*695700000**/299792458^2)^1.5))/(3***274**)))))^0.5*

$$\boldsymbol{G \approx 6.6712774 \cdot 10^{-11}\,\frac{s}{m}}$$

$\boldsymbol{G}$ represents a pace of condensed spacetime propagation which develops a narrow relativistic spectrum in between the limits $(\boldsymbol{g_m}, \boldsymbol{r_m}) \to (\boldsymbol{0}, \boldsymbol{0})$ and $(\boldsymbol{3g_m r_m}) \to (\boldsymbol{c^2})$. The assumption that $\boldsymbol{G}$ is a constant could occur out of ignorance that its spectrum is barely apparent within the framework of planets and pre-supernova stars. $\boldsymbol{G}$ can be constant only for fixed amounts of mass. For its significant decrease $\boldsymbol{3g_m r_m}$ has to be very close to $\boldsymbol{c^2}$. This would be the case for neutron stars. If we use a typical size of a neutron star with a radius of about 11 km and a surface gravity of around $2 \cdot 10^{12}\,\frac{m}{s^2}$, we get:

$$\boldsymbol{G \approx 6 \cdot 10^{-11}\,\frac{s}{m}}$$

The minimum pace occurs in the singularity case:

$$\boldsymbol{G_{min}} = \lim_{(3\cdot g_m \cdot r_m)\to(c^2)} \sqrt{\frac{\boldsymbol{g_m \cdot r_m}^2}{\boldsymbol{L \cdot c^4 \cdot 10^3}}} \tag{13}$$

$$= \frac{\sqrt{\dfrac{\boldsymbol{1}}{\boldsymbol{6 \cdot \left(1 - \sqrt{\frac{4}{27}}\right) \cdot 10^3}}}}{\boldsymbol{c}} \approx \boldsymbol{5.4907399 \cdot 10^{-11}\,\frac{s}{m}}$$

6. Ready-to-Use Formula

As soon as we replace the variables $\boldsymbol{L}$ and $\boldsymbol{G}$ with their above derived terms in my basic $\boldsymbol{M = L \cdot c^4 \cdot G \cdot 10^3}$, we get the finished formula:

$$\boldsymbol{M} = \boldsymbol{r_m c^2} \sqrt{\boldsymbol{2}\left(\boldsymbol{r_m} - \frac{\boldsymbol{2c^2}\left(\left(\boldsymbol{1} - \frac{\boldsymbol{2g_m r_m}}{\boldsymbol{c^2}}\right)^{\frac{3}{2}} - \left(\boldsymbol{1} - \frac{\boldsymbol{3g_m r_m}}{\boldsymbol{c^2}}\right)^{\frac{3}{2}}\right)}{\boldsymbol{3g_m}}\right)\boldsymbol{g_m \cdot 10^3}} \tag{14}$$

To work with data from orbiting celestial bodies the surface gravity can of course be replaced as usual with

$$\boldsymbol{g_m} = \frac{\boldsymbol{4 \cdot \pi^2 \cdot r_T}^3}{\boldsymbol{r_m}^2 \cdot \boldsymbol{T^2}} \tag{15}$$

where $\boldsymbol{r_T}$ and $\boldsymbol{T}$ are the respective mean orbital radius and orbital period of the secondary celestial body.

7. Exemplary Calculations on Celestial Bodies

According to my previous derivations, we observed that $\boldsymbol{G}$ is subject to a relativistic decrease which mainly affects objects under extreme conditions. As a result, the mass of Black Holes with a Schwarzschild radius $\boldsymbol{r_s}$ would be about $\frac{\boldsymbol{\sim 0.02}}{\sqrt{\frac{1}{6\cdot\left(1-\sqrt{\frac{4}{27}}\right)\cdot 10^3}}} \approx \boldsymbol{1.215}$ times their former mass as a star:

$$\boldsymbol{M_B = r_s} \cdot \sqrt{\left(\boldsymbol{1} - \sqrt{\frac{\boldsymbol{4}}{\boldsymbol{27}}}\right) \cdot \boldsymbol{1.5 \cdot 10^3}} \cdot \boldsymbol{c^3} \tag{16}$$

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

Moon: $\boldsymbol{r_m} = 1737400\,m \qquad \boldsymbol{g_m} = 1.62\,\frac{m}{s^2}$

$\boldsymbol{M_{☾}} =$ ***1737400****299792458^2*(2*(**1737400**-(2*299792458^2*((1-2***1.62*1737400**/299792458^2)^1.5-(1-3***1.62*1737400**/299792458^2)^1.5))/(3***1.62**))***1.62***10^3)^0.5*

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

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

$\boldsymbol{M_{♀}} =$ ***6051800****299792458^2*(2*(**6051800**-(2*299792458^2*((1-2***8.87*6051800**/299792458^2)^1.5-(1-3***8.87*6051800**/299792458^2)^1.5))/(3***8.87**))* **8.87***10^3)^0.5*

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

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

$\boldsymbol{M_{\oplus}} =$ ***6371000****299792458^2*(2*(**6371000**-(2*299792458^2*((1-2***9.807*6371000**/299792458^2)^1.5-(1-3***9.807*6371000**/299792458^2)^1.5))/(3***9.807**))***9.807***10^3)^0.5*

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

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

$\boldsymbol{M_{\odot}} =$ ***695700000****299792458^2*(2*(**695700000**-(2*299792458^2*((1-2***274*695700000**/299792458^2)^1.5-(1-3***274*695700000**/299792458^2)^1.5))/(3***274**))***274***10^3)^0.5*

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

The calculated results agree with the NASA reference values.

8. Conclusions

As initially assumed, inertial mass can be fully calculated by just knowing r_m and g_m. The relevant variable in my basic formula is L and it determines the resulting masses almost entirely by itself, apart from the limiting cases, when G starts to play a more important role. L proves that relativity is not just a curiosity that produces pointless time dilation scenarios in our universe. The defining effect of relativity is the formation of inertial mass, which is thus of relativistic origin. L ultimately yields the mass amount and G is the relativistic slider that forms the masses according to their parameters between the limits described. Lower pace leads to higher mass. Moreover, the assumption that mass experiences an additional more or less pronounced relativistic effect with increasing gravitational force and radius is quite conclusive. This is where my results differ from the classic computational methods. The values of G measured by science so far appear less accurate than assumed and generally too high.

Since $(3g_m r_m) \rightarrow (c^2)$ 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. The singularity would already form at

$$r_{Si} = \frac{3g_m {r_m}^2}{c^2} \tag{17}$$

which is 1.5 times the Schwarzschild radius.

Last but not least, the resulting spacetime units for mass as well as the mandatory requirement of the 10^3 multiplier within the equations is hard evidence for the actual existance of the assumed f_c and its possibly exciting consequences. For this reason, I consider the validity of my approach to be proven.

The impact of my results could be significant. It may mean that spacetime has undergone an evolution leading to its condensed states (matter) and the Big Bang could have never happened. The universe may have come into being with the advent of quantum ability to systematically replicate and distribute similar states and events that depict time and space. It would be a holistic but open construct of evolving reference systems. All of the energy in our universe would be the result of the ever self-expanding spacetime and it would keep increasing in total. The very similar behaviour of the assumed dark energy is another indication that my approach might be correct. Evolution may have elegantly misused this process for its main goal - quantum distribution and condensation. In this way it may have nested the diffusion strive energy by shaping it into higher complexity that we call matter. If so, it might be up to us to open up this primary source of energy ourselves - it could be inexhaustible. In contrast, the universe of the Standard Model is a closed machine that consistently unfolds according to given design principles and is condemned to an immutable energy volume.

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