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# Quantum Gravitational Energy Simplifies Gravitational Physics

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## Abstract

We show the simplest form one can express the gravity force that still give all the same predictions of observable phenomena as standard Newton gravity. This new form to express gravity, through quantum gravitational energy, require less constants to predict gravity phenomena than standard gravity theory, this alone should make the physics community interested in investigating this approach. It shows that gravitational energy and other types of energy in its most complete and deepest form are a collision-length. This is consistent with a recent published collision-space-time theory.

While general relativity theory needs two constants for predict gravity phenomena, that is  $G$  and  $c$  our new theory based on gravity energy only needs one constant  $c_g$  that is easily found from gravitational observations with no prior knowledge of any constants. Further we will show at the deepest quantum level quantum gravity needs two constants  $c_g$  and the Planck length, while the standard formulation needs  $c$ ,  $h$  and  $l_p$ . That is our theory gives a reduction in constants and simpler formulas than standard gravity theory. Further it gives insight into the quantum aspects of gravity.

**Keywords:** Gravity force, Newton gravity, gravitational energy, gravity constant, quantum gravity

## 1 Short about the modern Newtonian formula

Today the Newton's gravitational force formula as found in modern text books and research papers is given by

$$F = G \frac{Mm}{R^2} \quad (1)$$

where  $M$  and  $m$  are the mass of the large and the small mass in kilogram and  $G$  is the gravitational constant, and  $R$  is the centre-to-centre distance from  $M$  to  $m$ . It is of great importance to understand the gravity force itself never have been directly observed, only indirectly through observable gravitational phenomena, and the gravity force is not among these. In all observable gravitational phenomena predicted from this formula, the small mass  $m$  always cancels out in the derivation of something that actually can be observed, something we soon will look at in detail<sup>1</sup>. Also be aware that this version of the gravity formula with a gravity constant was introduced in 1873 by Cornu and Baille [1]. They were the first to introduce the gravitational constant and used notation  $f$  for it. Boys [2] in 1894 was likely the first to use the symbol  $G$  for the gravity constant. Isaac Newton's original gravity force formula was

$$F = \frac{Mm}{R^2} \quad (2)$$

as he only stated by word in Principia [3]. However, Newton's mass definition was very different than today's kilogram mass definition (so  $M$  and  $m$  in this formula means something different), see [4] for an in depth analysis of the original Newton gravity force formula. The so called Newtons gravitational constant was pointed out by Thüuring [5] in 1961 to have been introduced somewhat ad-hock, see also Gillies [6]. Thüuring pointed out that the gravitational constant cannot be associated with a unique property of nature. The gravitational constant has dimensions  $|G| = \frac{L^3}{MT^2}$  or in SI units  $m^3 \cdot kg^{-1} \cdot s^{-2}$ . What in nature at a fundamental level is length cubed divided by mass times time squared. One must have a good imagination to come up with something that fits the bill. We think there is no coincident that the gravitational constant has such output units, we have good reasons to think it is a composite constant, something that is discussed in detail in Haug [7].

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<sup>1</sup>In real two body problems where both masses act significantly on each other than the gravity parameter is changed to  $G(M_1 + M_2) = GM_1 + GM_2$

Einstein's [8] general relativity theory has taken the Newton gravitational constant as granted. Already in the same 1916 paper on general relativity Einstein points out that the next step in gravity is to develop a quantum gravity theory, or in his own words.

*Because of the intra-atomic movement of electrons, the atom must radiate not only electromagnetic but also gravitational energy, if only in minute amounts. Since, in reality, this cannot be the case in nature, then it appears that the quantum theory must modify not only Maxwell's electrodynamics but also the new theory of gravitation. – A. Einstein*

One should clearly be allowed still to question even the very foundation of gravity theories. We think in particular one should be allowed to question the gravitational constant, what it represents, and if it can be replaced, as it was inserted ad-hock in 1873. Einstein also mentions *gravitational energy*. Here we will demonstrate that one easily can come up with a formula replacing Newton's formula that uses  $G$  and kilogram masses, to a formula based on gravitational energy and the speed of this gravitational energy which we will see is the speed of gravity that again is identical to the speed of light. Further our suggestions in this paper are directly linked to a recent quantum gravity theory known as collision space-time [9–11], something we will get back to soon.

## 2 A new and simpler gravitational formula rooted in gravitational energy

We will here introduce a new gravity formula that we will demonstrate can replace Newtons gravity formula, it is given by

$$F = c_g \frac{E_g E_g}{R^2} \quad (3)$$

where  $E_g$  and  $\varepsilon_g$  are the gravitational energy of the large and small mass ( $M_g$  and  $m_g$ ). The gravitational energy are in form of collision-length as defined in collision space-time [9–11]. This length is unknown for any mass, but we will soon show how to measure it, second  $c_g$  is the speed of gravity, that we also easily can find from gravity observations. We will also demonstrate that the formula above remarkably will give exactly the same predictions for observable gravity phenomena as Newtons gravitational force formula  $F = G \frac{Mm}{r^2}$ , both in values and in output units, the only exception is for non observable phenomena, such as the gravity force itself, something we soon will come back to.

This new gravity force formula has output units  $m \cdot s^{-1}$  in SI units, or in dimensions  $|F| = L/T$ , in other words the gravity force is a speed in this formulation. This in contrast to the standard modern version of the Newton gravitational force which has output  $m \cdot kg \cdot s^{-2}$ . So, one could easily do the mistake to think our gravity force formula must be wrong as it not even matches the output units for the standard gravity force. A basic first check in physics that I even myself typically use when coming up with a formula is if I got the output units right. If not, that is typically a sign one has done something wrong or based the derivation on wrong assumptions. Still, the gravity force has never been observed, the output units have partly been arbitrary chosen, what is important is the formula predict accurately everything that can be observed with respect to both values and naturally there the correct output units. Also, our new gravitational energy is a length, this seems totally inconsistent with standard Joule energy. However as we [11] have already demonstrated in a paper on a new quantum gravity theory this view is fully consistent with such things as the standard relativistic energy momentum relation.

It is as we have demonstrated that both standard energy (Joule) and Einstein's relativistic energy momentum relations are derivatives of simpler and deeper relations.

We will show that this gravitational model can be calibrated and used to predict a long series of observable gravitational phenomena. We have previously [9, 12] shown that a formula that predicts the same as Newton gravitational force formula is given by

$$F = c_g^3 \frac{M_g m_g}{R^2} \quad (4)$$

where  $M_g$  is the collision time mass. That is indeed mass when also incorporating gravity is time, well it is the duration of the aggregates of the collisions of the indivisible particles making up the mass, see [9] for detailed discussion. Further, this mean we have  $E_g = M_g c_g$  which at first eyesight seems to be totally inconsistent with  $E = mc^2$ , but it is not, it is fully consistent also with this. The reason for the difference is simply different energy and mass definitions. For example, we could define a new energy  $E_2 = E/c$ , then we would have  $E_2 = mc$ , there is nothing mathematical wrong with this as it simply a change of units in the energy done in a consistent way. However, why should energy be re-defined as joule divided by the speed of light? A re-definition of energy and or mass must be able to explain something new or make things more intuitive. Simply by taking the joule energy and divide by  $c$  to define a new energy do not seem to simplify intuition or teach us something new. Our

new energy definition  $E_g$  on the other hand is just a length, and we can go from the joule energy to this energy (collision length) by multiplying the joule energy,  $E$ , with  $\frac{l_p^2}{hc}$ , and in  $E = Mc^2$  we need to do the same on both sides, so  $M_g = M \frac{l_p^2}{h}$ . It is hard to see intuition here yet, except that we end up with a length for energy and time for mass. Length is something most of us find easier to understand than Joule. To go from  $E$  and  $M$  to  $E_g$  and  $M_g$  the way just described one needs to know  $\hbar$  and  $l_p$  and also  $c$ . So is this not some fancy change of units? As we soon will see  $E_g$  (and also  $M_g$ ) can easily be extracted from gravity phenomena with no knowledge of  $G$ ,  $h$  or  $c$ . We will end up needing knowledge of less constants than Newton and Einstein gravity to do the same predictions. Just to shortly demonstrate that our new energy and mass definitions are consistent with the relativistic energy momentum relation, we must have

$$\begin{aligned}
E_g &= m_g \gamma c_g \\
E_g^2 &= m_g^2 c_g^2 \gamma^2 \\
E_g^2 &= m_g^2 c^2 \gamma^2 - m_g^2 c^2 + m_g^2 c^2 \\
E_g^2 &= \frac{m_g^2 c^2}{1 - v^2/c^2} - m_g^2 c^2 + m_g^2 c^2 \\
E_g^2 &= \frac{m_g^2 c^2}{1 - v^2/c^2} - \frac{m_g^2 c^2 (1 - v^2/c^2)}{1 - v^2/c^2} + m_g^2 c^2 \\
E_g^2 &= \frac{m_g^2 c^2}{1 - v^2/c^2} - \frac{m_g^2 c^2 - m_g^2 v^2}{1 - v^2/c^2} + m_g^2 c^2 \\
E_g^2 &= \frac{m_g^2 v^2}{1 - v^2/c^2} + m_g^2 c^2 \\
E_g^2 &= p_g^2 + m_g^2 c^2 \\
E_g &= \sqrt{p_g^2 + m_g^2 c^2}
\end{aligned} \tag{5}$$

where  $p_g = m_g v \gamma$  is the relativistic gravitational momentum and  $\gamma$  as usual is the Lorentz factor,  $\gamma = \sqrt{1 - v^2/c^2}$ . That is the same as the standard relativistic momentum except  $m$  is replaced with  $m_g$ . Now it is only to multiply each side of equation 5 with  $\frac{\hbar}{l_p} c$  (or  $\frac{c^4}{G}$ ) as well as setting  $c_g = c$  (as we know it is from measurements and theory) and we end up with the standard  $E = \sqrt{p^2 c^2 + m^2 c^4}$ . We will claim the standard mass and standard energy are incomplete mass and energy definitions, they can almost be seen as derivatives of a deeper theory, where the deeper relation is the first line in the derivation above. The incomplete mass and energy are enough to describe energy and mass relations not related to gravity, but they fall short when we work with gravity.

The standard mass and energy have no information about the Planck scale as the Planck length embedded in  $E_g$  is taken out of it, something that will soon be more clear. We will claim the Planck scale is the essence of gravity. When the Planck scale is not incorporated in standard mass and energy this is in our view one of the main reasons why one not have been able to unify gravity and quantum mechanics, at least until perhaps very recently, see [11] for a much more in depth discussion about this point.

### 3 Finding the speed of gravity and the gravitational energy without any knowledge off $G$ , $h$ or $c$

In our new gravitational model, we need to know  $E_g$  and  $c_g$ , they are both unknown, even if we could assume  $c_g = c$  we want to see if we can find it ‘experimentally’ with no knowledge of  $c$  in a simple way by utilizing the implications of our theory. The radius  $R$  from the center of the gravitational object to the center of the small mass the gravitational field acts on we can typically easily measure directly or indirectly. Remarkably, there is an easy way to find both the speed of gravity  $c_g$  and the gravitational energy without any prior knowledge off any constants or of the mass of the gravitational object. Also, in our formulation we must have

$$m_g a = F \tag{6}$$

that when we replace  $F$  with our new gravity force formula leads to

$$\begin{aligned}
m_g a &= c_g \frac{E_g E_g}{R^2} \\
\frac{E_g}{c_g} a &= c_g \frac{E_g}{R^2} \\
a &= c_g^2 \frac{E_g}{R^2}
\end{aligned} \tag{7}$$

That is the gravitational acceleration field is given by  $g = a = c_g^2 \frac{E_g}{R^2}$ , this only depend on one constant, the speed of gravity  $c_g$ . There are two unknowns here, both  $c_g$  and the gravitational energy  $E_g$  of the mass in question. Let us solve the gravitational acceleration field with respect to  $E_g$  this gives

$$E_g = \frac{gR^2}{c_g^2} \tag{8}$$

However we still do not know  $c_g$  so we cannot from this find  $E_g$  yet. The gravitational red-shift for a beam sent in a weak gravitational acceleration field from  $R_h$  to  $R_L$  ( $R_h > R_L$ ) is given by

$$z = \frac{f_h - f_L}{f_L} \approx \frac{\sqrt{1 - \frac{2E_g}{R_L}}}{\sqrt{1 - \frac{2E_g}{R_h}}} - 1 \tag{9}$$

Next replace  $E_g$  with  $E_g = g \frac{R^2}{c_g^2}$  in the formula above and we get

$$\begin{aligned}
z = \frac{f_h - f_L}{f_L} &\approx \frac{\sqrt{1 - \frac{2g_L \frac{R_L^2}{c_g^2}}{R_L}}}{\sqrt{1 - \frac{2g_L \frac{R_L^2}{c_g^2}}{R_h}}} - 1 \\
z &\approx \frac{\sqrt{1 - \frac{2g_L R_L}{c_g^2}}}{\sqrt{1 - \frac{2g_L \frac{R_L^2}{c_g^2}}{R_h}}} - 1
\end{aligned} \tag{10}$$

$$\tag{11}$$

Solved with respect to  $c_g$  this gives

$$c_g \approx \frac{\sqrt{2g_L R_L (\frac{R_h - R_L}{z} + 2R_L + R_L z)}}{\sqrt{R_h (2 + z)}} \tag{12}$$

This is actually equal to the strong field exact solution one can get in general relativity theory as we recently have demonstrated [13], but it is still in our view just an approximation as general relativity and also so far in our model we have not taken into account Lorentz [14] relativistic mass, something we will get back to. That is to find the speed of gravity all we need to do is to measure the gravitational acceleration at the surface of the earth, for example at sea level ( $R_L$ ) and then also measure the gravitational red shift from a laser beam going from  $R_h$  to  $R_L$ , where  $R_h > R_L$ . This result in itself is remarkable, because it means one can measure the speed of gravity easily by combining two types of gravitational observations, there is no need for advanced LIGO measurements of gravitational waves to do this, see also [12]. Inputting measured values into this formula reveals that the speed of gravity,  $c_g$ , indeed is identical to the speed of light,  $c$ , as also assumed in general relativity theory and it seems confirmed by complex experiments, see [15, 16].

To measure the speed of gravity  $c_g$  all we need is a measurement of the gravitational acceleration and the gravitational red shift. This can easily be done without any knowledge of any other constants. One can easily misunderstand here and think we are simply getting out  $c$  as we have inputted  $c$ , this is not the case. In standard physics we have  $g = \frac{GM}{R^2}$  and  $z \approx \frac{GM}{c^2 R}$ , so, one could think we here are getting  $c$  out since it is an input in the red shift formula. However, this is just if one predicts the gravitational red-shift. There is no need to know  $c$  to measure the frequency shift in a light beam in a gravitational field, we only need to know  $c$  to predict the gravitational red shift in standard theory. However, here we are not predicting these, but measuring them and then finding  $c_g$  which indeed has the the same value as  $c$ . Based on our deeper understanding of. our theory we also know that  $c_g = c$ , naturally based on some assumptions, see [11].

Next, we can now find  $E_g$  from formula 8 as we now know  $c_g$ ,  $g$  and  $R$ . As soon as we know  $E_g$  and  $c_g$  we can predict all kinds of other observable gravitational phenomena from the gravitational objects gravitational energy  $E_g$ , which is the gravitational energy of the large mass. For example we can predict all types of gravitational

effects from the Earth. A long series of predictions we can do are illustrated in table 1. Here we show both the modern standard Newton and GR formulations as well as the predictions from our new framework. For all observable phenomena they give the same output in values and in terms of output units. Actually, the standard method is less accurate as it needs  $G$  that typically is calculated first from a smaller test mass, for example in a Cavendish apparatus. This will bring an additional measurement error over when we work with larger masses, such as for example the mass of the Earth. This is outside the scope of this paper but will be looked at in detail in another paper we are working on.

	<b>Standard:</b>	<b>Alternative:</b>
Mass	$M$ (kg)	$M_g$ (collision-time mass)
Energy	$E = Mc^2$ (joule)	$E_g = M_g c_g$ (gravitational energy)
Gravitational constant	$G$	$c_g$ m/s
<b>Non observable</b> (contains $GMm$ )		
Gravity force	$F = G \frac{Mm}{R^2}$ ( $kg \cdot m \cdot s^{-2}$ )	$F = c_g \frac{E_g E_g}{R^2}$ m/s
<b>Observable predictions, identical for the two methods:</b> (contains only $GM$ )		
Gravity acceleration	$g = \frac{GM}{R^2}$	$g = c_g^2 \frac{E_g}{R^2}$
Orbital velocity	$v_o = \sqrt{\frac{GM}{R}}$	$v_o = c_g \sqrt{\frac{E_g}{R}}$
Orbital time	$T = \frac{2\pi R}{\sqrt{\frac{GM}{R}}}$	$T = 2\pi \sqrt{R^3/E_g}$
Velocity ball Newton cradle	$v_{out} = \sqrt{2 \frac{GM}{R^2} H}$	$v_{out} = \frac{c_g}{R} \sqrt{E_g H}$
Periodicity Pendulum (clock)	$T = 2\pi \sqrt{\frac{L}{g}} = 2\pi R \sqrt{\frac{L}{GM}}$	$T = \frac{2\pi R}{c_g} \sqrt{\frac{L}{E_g}}$
Frequency Newton spring	$f = \frac{1}{2\pi} \sqrt{\frac{k}{m}} = \frac{1}{2\pi R} \sqrt{\frac{GM}{x}}$	$f = \frac{c_g}{2\pi R} \sqrt{\frac{E_g}{x}}$
<b>Gravitational redshift</b>		
	$z = \frac{\sqrt{1 - \frac{2GM}{R_1 c^2}}}{\sqrt{1 - \frac{2GM}{R_2 c^2}}} - 1$	$z = \frac{\sqrt{1 - \frac{2E_g}{R_L}}}{\sqrt{1 - \frac{2E_g}{R_h}}} - 1$
<b>Time dilation</b>		
	$T_R \approx T_f \sqrt{1 - \frac{2GM}{R} / c^2}$	$T_R \approx T_f \sqrt{1 - \frac{2E_g}{R}}$
<b>Time dilation exact</b>		
	$T_R = T_f \sqrt{1 - \frac{2GM}{Rc^2} + \frac{G^2 M^2}{c^2 R^2}}$	$T_R = T_f \sqrt{1 - \frac{2E_g}{R} + \frac{E_g^2}{R^2}}$
<b>Gravitational deflection (GR)</b>		
	$\delta = \frac{4GM}{c^2 R}$	$\delta = \frac{4E_g}{R}$
<b>Advance of perihelion</b>		
	$\sigma = \frac{6\pi GM}{a(1-e^2)c^2}$	$\sigma = \frac{6\pi E_g}{a(1-e^2)}$
<b>Micro lensing</b>		
	$\theta = \sqrt{\frac{4GM}{c^2} \frac{d_s - d_L}{d_s d_L}}$	$\theta = 2 \sqrt{E_g \frac{d_s - d_L}{d_s d_L}}$
<b>Cosmology:</b> (contains only $GM$ )		
Cosmological redshift	$z_H \approx \frac{dH_0}{c} = \frac{1}{\frac{2GM_e}{c^2 d}}$	$z_H \approx \frac{R}{E_g}$
Hubble constant	$H_0 = \frac{c^3}{2GM_e}$	$H_0 = \frac{c_g}{E_g}$
Hubble radius	$R_H = \frac{c}{H_0} = \frac{2GM_e}{c^2}$	$R_H = E_g$
<b>Indirectly/“hypothetical“ observable predictions:</b> (contains only $GM$ )		
Gravitational parameter	$\mu = GM$	$\mu = c_g^2 E_g$
Two body problem	$\mu = G(M_1 + M_2)$	$\mu = c_g^2 (E_{g,1} + E_{g,2})$
Constants needed	$G, c$ and $H_0$	Only $c_g$ ( $c_g = c$ )

**Table 1:** The table shows that all observable gravity are linked to  $GM$  in the standard Newton and general relativity formulation. Pay attention to that standard gravity theory needs knowledge of two constants to predict gravity phenomena, namely  $G$  and the speed off light. The alternative theory only needs one constant, namely  $c_g$ . The gravitational energy  $E_g$  as well as  $c_g$  can be found directly from gravity observations without knowledge of any known physical constants. Standard theory need  $G, c$  and  $M$ . Both theories naturally in addition needs to know the distance to the centre of the gravitational object.

## 4 What about quantum gravity energy?

At a deeper level the gravitational energy (collision-length) is given by (see [11])

$$E_g = l_p \frac{l_p}{\bar{\lambda}} \quad (13)$$

where  $l_p$  is the Planck length first described by Max Planck [17, 18] in 1899, and  $\bar{\lambda}$  is the reduced Compton [19] wavelength. Max Planck introduced the Planck length in 1899 by the formula  $l_p = \sqrt{\frac{G\hbar}{c^3}}$ . So it looks like we need to know  $G$  and  $\hbar$  to find the Planck length. In recent years it has been shown this is not the case. The Planck length can be found totally independent of  $G$  and  $\hbar$ , see [12, 20, 21]. We will also in this paper devote a short section on how to find the Planck length independent of knowledge off  $G$  and  $h$ .

So the first  $l_p$  in the gravitational energy formula represents the collision length of a single collision (Planck event). This collision-length of one Planck event is always the Planck length, see [10, 22] for a discussion why it is invariant. The next part:  $\frac{l_p}{\bar{\lambda}}$ , is the number of Planck mass events in the gravitational mass over an observational time window of the Planck time. It is not that we need to observe anything in the Planck time, it is what this represents, and we can measure it indirectly. For a Planck mass then the reduced Compton wavelength is the Planck length, then this factor is 1. For a mass smaller than the Planck mass, then  $\frac{l_p}{\bar{\lambda}}$  is less than one, it is then a probability for a Planck mass event in the Planck time. Elementary particles consist in this view of Planck mass events (collisions) happen at the reduced Compton frequency. If the gravitational mass is larger than the Planck mass (and it is typically much larger) then  $\frac{l_p}{\bar{\lambda}}$  typically consist of a large integer number plus a small fraction. The integer part then represents the number of Planck mass events in the Planck time. In other words, this is where the quantization comes in. The quantization is linked to the Planck length, that in our view is a the diameter of an indivisible particle, see [9, 10].

Our simple gravitational force formula  $F = c_g \frac{E_g E_g}{R^2}$  has embedded quantum gravity. That is gravitational energy and gravitational mass comes in quanta. The quanta is linked to the Planck length and the reduced Compton wavelength through the factor  $\frac{l_p}{\bar{\lambda}}$  that is embedded in the gravitational energy as it at the deepest level is described by equation 13. We will even claim standard Newton gravity has hidden quantum gravity in it. Not on purpose or by design, but by coincidence, as gravity when calibrating  $G$  to observations gets in  $l_p$ , see a lengthy discussion and review of the composite view of the gravitational constant view by Haug [7].

## 5 Finding the Planck length and the Compton wavelength independent on any knowledge of $G$ and $\hbar$ and even $c$

We can do all gravitational predictions simply from the gravitational energy  $E_g$  and the speed of gravity  $c_g$  and these we have already shown how to find. It is only when we want to understand the deeper aspects of  $E_g$  (and  $M_g$ ) that we need the Planck length. The Planck length can easily be found without any knowledge off  $G$ ,  $c$  and  $\hbar$ , something that is controversial in standard gravity theory, but that we have demonstrated recently is possible in a series of published papers. Still, we will also demonstrate it here, that it is possible also when we write our formulas from gravitational energy.

The gravitational acceleration as before (section 3) is given by

$$g = c_g^2 \frac{E_g}{R^2} \quad (14)$$

further  $E_g$  at the quantum level is given by  $E_g = l_p \frac{l_p}{\bar{\lambda}}$ , where  $\bar{\lambda}$  is the reduced Compton wavelength of the gravitational energy in question. We can now simply solve the formula above for  $l_p$ , this gives

$$l_p = \sqrt{g \frac{R^2}{c_g^2} \bar{\lambda}} \quad (15)$$

That is to find the Planck length independent of  $G$  and  $\hbar$  we need to find  $g$  and the reduced Compton wavelength independent of these. The gravitational acceleration we can find simply by measuring how long it takes for a ball dropped at height  $H$  above the ground to hit the ground. It is given by  $g = \frac{2H}{T^2}$ .

Still, how do we find the reduced Compton wavelength of for example the Earth? The reduced Compton wavelength [19] for a fundamental particle like the electron is given by

$$\bar{\lambda} = \frac{\hbar}{mc} \quad (16)$$

That is if you know the kilogram mass of the particle  $m$  and the reduced Planck constant and the speed of light. However, it is not needed to know the kilogram mass of the particle or the Planck constant to find the Compton wavelength (or reduced Compton wavelength). In photon scattering of an electron, we have

$$\lambda_e = \frac{\lambda_{\gamma,2} - \lambda_{\gamma,1}}{1 - \cos\theta} \quad (17)$$

where  $\lambda_e$  is the Compton wavelength of the electron, and  $\lambda_{\gamma,1}$  and  $\lambda_{\gamma,2}$  are respectively the wavelength of the incoming and outgoing photon see [23]. So, there is no need to know the Planck constant to measure the Compton wavelength. The reduced Compton wavelength is simply this divided by  $2\pi$ .

Next we can utilize that electrons and protons have the same absolute value of the charge. The cyclotron frequency is given by

$$f = \frac{qB}{2\pi m} \quad (18)$$

This means we must have

$$\frac{f_e}{f_p} = \frac{\frac{qB}{2\pi m_e}}{\frac{qB}{2\pi m_p}} = \frac{m_p}{m_e} = \frac{\bar{\lambda}_e}{\lambda_P} \approx 1836.15 \quad (19)$$

That is to find the reduced Compton wavelength of the proton we can simply take the reduced Compton wavelength of the electron and divided it by 1836.15. This is why cyclotron experiments also have been used to find the proton electron mass ratio, see [24–26]. Research on the proton Compton wavelength goes at least back to 1958 by the paper of Levitt [27]. Next, we can simply count the number of protons in the mass of question and divide the Compton wavelength of the single proton by this number and we have the Compton wavelength of the mass in question. Neutrons we can for simplicity and even practical purpose treat as the same mass as protons, or alternatively doing the small corrections for the slightly different mass. This way of finding the Compton wavelength of a large mass ignored nuclear binding energy, but this will maximum give an error in the Compton wavelength of about 1%. This is naturally a considerably additional error, but we can even remove this more or less by treating the binding energy as mass equivalent  $m = E/c^2$  and adjust for it.

To count the number of atoms in a mass in practice is no easy task, but for smaller macroscopic masses one can count the number of atoms also in practice. This was one of the competing methods to re-define the kilogram, see [28–30]. Silicon 28 has a very uniform crystal structure, so if one can count the number of atoms in a very small volume of this material and next create a very accurate sphere of such material, then one can find with high precision the number of atoms in this sphere. Such a sphere can then for example be used in a Cavendish apparatus to measure gravitation effects, such as the gravitational acceleration from this uniform sphere.

Next to find the Compton wavelength of much larger objects, like for example the Earth we can utilize for example the following relation

$$\frac{g_1 R_1^2}{g_2 R_2^2} = \frac{\bar{\lambda}_2}{\lambda_1} \quad (20)$$

After we have done this, we know the Planck length as well as the Compton wavelength of the gravitational object in question and we can next predict all gravity phenomena from only using two constant, namely the Planck length and the speed of gravity (light) plus variables. We can actually now also directly see that the modern Newton formulation and our new gravity theory at the deepest level is identical. To see this we need to replace  $G$  in the standard gravitational framework with  $G = \frac{l_p^2 c^3}{h}$ , which is simply the Max Planck length formula  $l_p = \sqrt{\frac{G\hbar}{c^3}}$  solved with respect to  $G$ , see [7, 31]. One should be aware that the idea of expressing  $G$  from Planck units goes at least back to 1984 by Cahill [32, 33] that suggested  $G = \frac{\hbar c}{m_p^2}$ . However as pointed out by Cohen [34] in 1987 this seemed to lead to a circular problem, as it seemed one had to know  $G$  to find  $m_p$ , so to express  $G$  from Planck units seemed to be useless. This has been a view held to very recently. It was first in 2017 that we showed one could find the Planck length independent of any knowledge of  $G$ . In addition to writing  $G$  as a composite constant one need to solve the reduced Compton wavelength formula with respect to  $m$ , this means we can express any kilogram mass as  $m = \frac{\hbar}{\lambda c}$ . Now inserting this composite gravity constant as well as this way to express the mass in the standard Newtonian framework we see that it leads to exactly the same formulas for all observable phenomena as our new gravitational energy framework. In other words, they give the same output both in forms of values and units as can be seen from table 2. Non-observable phenomena such as the gravitational force itself has different output units in the two approaches.

The two approaches are only identical when we ignore Lorentz relativistic mass as general relativity theory and standard Newtonian gravity theory do. We are of the opinion that for strong gravity fields one should in addition consider Lorentz relativistic mass. Considering Lorentz relativistic mass, for example this means a micro black hole in our theory matches all the properties of the Planck scale, while general relativity theory that ignores Lorentz relativistic mass



## 6 Finding the Gravitational Energy and the Planck length Using a Cavendish Apparatus

Here we will look at how to find the collision-length that again is the gravitational energy using a Cavendish [35] apparatus. Moment of force, or better known as torque is given by:

$$\kappa\theta \quad (21)$$

where  $\theta$  is the deflection angle of the balance and  $\kappa$  is the torsion coefficient of the suspending wire. Next, we have the following well-known relationship:

$$\kappa\theta = LF \quad (22)$$

where  $L$  is the length between the two small balls in the Cavendish apparatus. Further,  $F$  can be set equal to the gravitational force given by:

$$F = c_g \frac{E_g E_g}{R^2} \quad (23)$$

This means we have:

$$\kappa\theta = Lc_g \frac{E_g E_g}{R^2} \quad (24)$$

Further the natural resonant oscillation period of a torsion balance given by:

$$T = 2\pi\sqrt{\frac{I}{\kappa}} \quad (25)$$

The moment of inertia  $I$  of the balance is given by:

$$I = m_g \left(\frac{L}{2}\right)^2 + m_g \left(\frac{L}{2}\right)^2 = \frac{m_g L^2}{2} \quad (26)$$

from this we must have

$$T = 2\pi\sqrt{\frac{m_g L^2}{2\kappa}} \quad (27)$$

We now solve this with respect to  $\kappa$ , this gives

$$\begin{aligned} \frac{T^2}{2^2\pi^2} &= \frac{m_g L^2}{2\kappa} \\ \kappa &= \frac{m_g L^2 2\pi^2}{T^2} = \frac{E_g L^2 2\pi^2}{c_g T^2} \end{aligned} \quad (28)$$

Now in equation 24 replace  $\kappa$  with this expression, and then we solve this equation with respect to the gravitational energy, this gives:

$$\begin{aligned} \kappa\theta &= LF \\ \frac{E_g L^2 2\pi^2}{c_g T^2} \theta &= Lc_g \frac{E_g E_g}{R^2} \\ E_g &= \sqrt{\frac{L 2\pi^2 R^2 \theta}{T^2 c_g^2}} \end{aligned} \quad (29)$$

again  $T$  is the oscillation time, further  $L$  is the distance between the small balls in the Cavendish apparatus, and  $R$  is the distance center to center between the small ball and the large ball in the Cavendish apparatus. Further  $\theta$  is the angle of the arm when the arm is deflected. In other words, there is no need to know  $G$  or  $h$  to measure this in a Cavendish apparatus, however the speed of gravity is there that we from previous sections already know is identical to the speed of light.

That is we know the gravitational energy in the large ball in the Cavendish apparatus. It is indeed an incredible short length, the collision-length. It is the aggregated collision-length of all the collisions in the mass making up the gravitational energy in the mass during only the Planck time. Pay attention to that we need less information to find this than to find  $G$  or  $M$  from a Cavendish apparatus. To find  $G$  in a cavendish apparatus one have

$$G = \frac{L 2\pi^2 R^2 \theta \bar{\lambda}}{T^2 M} \quad (30)$$

That is one need to know  $M$  in addition to  $L$ ,  $R$  and  $T$  as is all that is needed to find  $E_g$ . The large mass in the Cavendish apparatus one can find by simply weighting the mass, but then this adds measurement errors compared to only finding  $E_g$ . If the  $G$  found from the Cavendish apparatus only is used in combination with the large mass in the Cavendish apparatus then this error from measure  $M$  will cancel out with the error this gave to  $G$ , but if  $G$  from the Cavendish apparatus is next used in combination with the mass from the Earth to predict observable gravitational phenomena, then this will give bigger errors than simply using  $E_g$  from the earth directly.

We can also find  $M$  in a Cavendish by

$$M = \frac{L2\pi^2 R^2 \theta \bar{\lambda}}{T^2 G} \quad (31)$$

But then one need  $G$ , and one needed  $M$  to find  $G$  so this makes little sense. To find the gravitational energy (or the collision-time mass) of the large mass in the cavendish apparatus require no  $G$  or no kilogram measurements

To separate out the Planck length we in addition need to know the reduced Compton wavelength of the gravitational mass, we get

$$\begin{aligned} \kappa\theta &= LF \\ \frac{E_g L^2 2\pi^2}{c_g T^2} \theta &= L c_g \frac{E_g E_g}{R^2} \\ l_p &= \sqrt{\frac{L2\pi^2 R^2 \theta \bar{\lambda}}{T^2 c_g^2}} \end{aligned} \quad (32)$$

That is the Planck scale (here the Planck length) can be measured (detected) without any knowledge off  $G$  or  $h$ , but also here we see that we need the reduced Compton wavelength to do so, and this can be found independent of knowledge of  $G$ ,  $h$  and  $c$ . This is rather amazing as it has been thought for more than 100 years that to detect the Planck scale is almost impossible, despite large efforts to do so. That we can indirectly measure the Planck length without knowledge of  $G$ ,  $c$  or  $h$ , in our view simply means to detect gravity is to detect the Planck scale. This is highly controversial and perhaps a shocking view. What one has been searching for, the Planck scale is already something one have detected all the time, namely almost any observable effects of the gravity force. However, we are measuring an aggregate of these Planck events, and it is first when one understands the relationship between Compton frequency and Planck mass events one really gets to the depth of it. This paper is however not going in great depth about the depth of the quantum scale as this has been a topic in other papers we recently have published and cited here. This paper is mainly about that we can replace the Newtonian formula with a considerably simpler gravitational energy formula  $F = c_g \frac{E_g E_g}{R^2}$ . The gravitational constant here is linked to something physical understandable, this is not the case for  $G$ . Even our energy is simpler to understand, it is simply a length (a collision-length), while Joule is very diffuse, or as beautifully illustrated by Feynman

*It is important to realize that in physics today, we have no knowledge what energy is.* Richard Feynman

Our new collision-length energy demystifies energy, it is a more complete energy definition that incorporates gravity into standard energy. Standard joule energy is an incomplete derivative of this energy, not by purpose, but based on physics like most sciences have developed mostly top-down. It is therefore natural that energy over time has been understood better and better. We suspect collision-length (energy) and collision-time (mass) is the ultimate depth of reality. This is just one paper in a series of papers trying to explain different aspects of this new and promising theory. We naturally do not ask other researchers to take any of this for granted, but to take time study this new theory before one prematurely reject it.

## 7 Conclusion

We have shown how the modern very well-known Newtonian formula  $F = G \frac{Mm}{R^2}$  can be replaced with the simpler and more intuitive formula  $F = c_g \frac{E_g E_g}{R^2}$ . These formulas gives the same predictions, but the later one only need the speed of light (gravity) as a constant, so it do not need  $G$ . This is likely the simplest way one can express Newtonian gravity. We have further shown that there is a deeper quantum gravity hidden behind this as well as the Newtonian formula. Both formulas are consistent with weak field gravitation based on the new quantum gravity theory known as collision space-time.

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	<b>Standard:</b>	<b>Alternative:</b>
Mass	$M = \frac{\hbar}{\lambda} \frac{1}{c}$ (kg)	$M_g = t_p \frac{l_p}{\lambda}$ (collision-time)
Energy	$E = Mc^2$ (joule)	$E_g = M_g c_g = l_p \frac{l_p}{\lambda}$ (collision-time)
Gravitational constant	$G = \frac{l_p^2 c^3}{\hbar}$	$c_g$
<b>Non observable</b> (contains $GMm$ )		
Gravity force	$F = G \frac{Mm}{R^2}$ ( $kg \cdot m \cdot s^{-2}$ )	$F = c_g \frac{E_g E_g}{R^2}$ m/s
<b>Observable predictions, identical for the two methods:</b> (contains only $GM$ )		
Gravity acceleration	$g = \frac{GM}{R^2} = \frac{c^2}{R^2} \frac{l_p^2}{\lambda_M}$	$g = c_g^2 \frac{E_g}{R^2} = \frac{c_g^2}{R^2} \frac{l_p^2}{\lambda_M}$
Orbital velocity	$v_o = \sqrt{\frac{GM}{R}} = cl_p \sqrt{\frac{1}{R\lambda_M}}$	$v_o = c_g \sqrt{\frac{E_g}{R}} = c_g l_p \sqrt{\frac{1}{R\lambda_M}}$
Orbital time	$T = \frac{2\pi R}{\sqrt{\frac{GM}{R}}} = \frac{2\pi\sqrt{\lambda} R^3}{cl_p}$	$T = 2\pi \sqrt{\frac{R^3}{E_g}} = \frac{2\pi\sqrt{\lambda} R^3}{c_g l_p}$
Velocity ball Newton cradle	$v_{out} = \sqrt{2 \frac{GM}{R^2} H} = \frac{c_g l_p}{R} \sqrt{\frac{H}{\lambda}}$	$v_{out} = \frac{c_g}{R} \sqrt{E_g H} = \frac{c_g l_p}{R} \sqrt{\frac{H}{\lambda}}$
Periodicity Pendulum (clock)	$T = 2\pi \sqrt{\frac{L}{g}} = 2\pi R \sqrt{\frac{L}{GM}} = \frac{2\pi R}{c_g l_p} \sqrt{L\lambda}$	$T = \frac{2\pi R}{c_g} \sqrt{\frac{L}{E_g}} = \frac{2\pi R}{c_g l_p} \sqrt{L\lambda}$
Frequency Newton spring	$f = \frac{1}{2\pi} \sqrt{\frac{k}{m}} = \frac{1}{2\pi R} \sqrt{\frac{GM}{x}} = \frac{c_g l_p}{2\pi R} \sqrt{\frac{1}{\lambda x}}$	$f = \frac{c_g}{2\pi R} \sqrt{\frac{E_g}{x}} = \frac{c_g l_p}{2\pi R} \sqrt{\frac{1}{\lambda x}}$
Gravitational redshift	$z = \frac{\sqrt{1 - \frac{2GM}{R_1 c^2}}}{\sqrt{1 - \frac{2GM}{R_2 c^2}}} - 1 = \frac{\sqrt{1 - \frac{2l_p^2}{R_1 \lambda_M}}}{\sqrt{1 - \frac{2l_p^2}{R_2 \lambda_M}}} - 1$	$z = \frac{\sqrt{1 - \frac{2l_p^2}{R_1 \lambda_M}}}{\sqrt{1 - \frac{2l_p^2}{R_2 \lambda_M}}} - 1$
Time dilation		$T_R \approx T_f \sqrt{1 - \frac{2E_g}{R}} = T_f \sqrt{1 - \frac{2l_p^2}{R\lambda_M}}$
Time dilation exact	$T_R = T_f \sqrt{1 - \frac{\sqrt{\frac{2GM}{R}}}{c^2}} = T_f \sqrt{1 - \frac{2l_p^2}{R\lambda_M}}$	$T_R = T_f \sqrt{1 - \frac{2E_g}{R} + \frac{E_g^2}{R^2}} = T_f \sqrt{1 - \frac{2l_p^2}{\lambda_M R} + \frac{l_p^4 \lambda_M^2}{R^2}}$
Gravitational deflection (GR)	$\delta = \frac{4GM}{c^2 R} = \frac{4}{R} \frac{l_p^2}{\lambda_M}$	$\delta = \frac{4E_g}{R} = \frac{4}{R} \frac{l_p^2}{\lambda_M}$
Advance of perihelion	$\sigma = \frac{6\pi GM}{a(1-e^2)c^2} = \frac{6\pi}{a(1-e^2)} \frac{l_p^2}{\lambda_M}$	$\sigma = \frac{6\pi E_g}{a(1-e^2)} = \frac{6\pi}{a(1-e^2)} \frac{l_p^2}{\lambda_M}$
Micro lensing	$\theta = \sqrt{\frac{4GM}{c^2} \frac{d_s - d_L}{d_s d_L}} = 2l_p \sqrt{\frac{1}{\lambda_M} \frac{d_s - d_L}{d_s d_L}}$	$\theta = 2\sqrt{E_g \frac{d_s - d_L}{d_s d_L}} = 2l_p \sqrt{\frac{1}{\lambda_M} \frac{d_s - d_L}{d_s d_L}}$
<b>Indirectly/“hypothetical“ observable predictions:</b> (contains only $GM$ )		
Gravitational parameter	$\mu = GM = c^2 \frac{l_p^2}{\lambda_M}$	$\mu = c_g^2 E_g = c_g^2 \frac{l_p^2}{\lambda_M}$
Two body problem	$\mu = G(M_1 + M_2) = c^2 \frac{l_p^2}{\lambda_1} + c^2 \frac{l_p^2}{\lambda_2}$	$\mu = c_g^2 (E_{g,1} + E_{g,2}) = c_g^2 \frac{l_p^2}{\lambda_1} + c_g^2 \frac{l_p^2}{\lambda_2}$
<b>Cosmology</b> ( $\lambda_c$ : reduced Compton wavelength critical universe mass $M_c$ ) (contains only $GM_c$ )		
Cosmological redshift	$z_H \approx \frac{dH_0}{c} = \frac{1}{2GM_c} = \frac{d\bar{\lambda}_c}{2l_p^2}$	$z_H \approx \frac{R}{E_g} = \frac{d\bar{\lambda}_c}{2l_p^2}$
Hubble constant	$H_0 = \frac{c^3}{2GM_c} = \frac{\bar{\lambda}_c}{2t_p l_p}$	$H_0 = \frac{c}{E_g} = \frac{\bar{\lambda}_c c}{2l_p^2} = \frac{\bar{\lambda}_c}{2t_p l_p}$
Hubble radius	$R_H = \frac{c}{H_0} = \frac{2GM_c}{c^2} = \frac{2ct_p l_p}{\lambda_c}$	$R_H = E_g = \frac{2l_p^2}{\lambda_c} = \frac{2c_g t_p l_p}{\lambda_c}$
<b>Quantum analysis:</b>		
Constants needed	$G, \hbar,$ and $c$ or $l_p, \hbar,$ and $c$	$l_p$ and $c_g$ , for some phenomena only $l_p$ ( $c_g = c$ )
Variable needed	one for mass size	one for mass size

**Table 2:** The table shows that all observational gravity phenomena are predicted from  $GM$  and not  $GMm$ . The gravity constant is needed to remove the embedded Planck constant in the kilogram mass and to get in the Planck length. Our alternative formula only has a gravity constant that simply is the speed of gravity  $c_g$ . From a deeper understanding we see the two models are the same and both can be represented by the Planck length and the speed of gravity as constants and naturally variables.