Newton Did Not Invent or Use the So-Called Newton's Gravitational Constant G.
Big G is not needed in Physics; it has mainly caused confusion!

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Abstract

Newton did not invent or use the so-called Newton's gravitational constant G. Newton's original gravity formula was $F = \frac{Mm}{r^2}$ and not $F = G\frac{Mm}{r^2}$. In this paper, we will show how a series of major gravity phenomena can be calculated and predicted without the gravitational constant. This is to some degree well known, at least for those that have studied a significant amount of the older literature on gravity. However, to understand gravity at a deeper level, still without G, one needs to trust Newton's formula. It is first when we combine Newton's observation that matter and light ultimately consist of hard indivisible particles with new insight in atomism that we can truly begin to understand gravity. This leads to a quantum gravity theory that is unified with quantum mechanics where there is no need for G and even no need for Planck's constant. We claim that two mistakes have been made in physics, which have held back progress towards a unified quantum gravity theory. First, it has been common practice to consider Newton's gravitational constant almost holy and untouchable. Thus we have neglected to see an important aspect of mass, namely the indivisible particle that also Newton held in high regard. Second, we have built our version of quantum mechanics around the de Broglie wavelength, rather than the Compton wavelength. We claim the de Broglie wavelength is merely a mathematical derivative of the Compton wavelength.

Key Words: Newton's gravitational constant, Schwarzschild radius, quantum gravity

1 Newton neither invented nor used G

In his book, the Principia [1], Newton mentions the gravitational force formula (see Appendix) that is equivalent to

$$F = \frac{Mm}{r^2} \tag{1}$$

However, he does not make a single mention of any gravitational constant (with the notation of G or through any other notation), nor does he ever use such a constant himself (This appears to be something that few physicists today know or acknowledge). In the Principia, Newton's focus is on relative masses, although he actually mentions the word "mass" only once in the Principia, but it is clear that he means mass is an amount of matter. Based on easily observable gravitational observations, such as the orbital time of satellites (moons and planets) he find the relative mass (weight) of Saturn, Jupiter, the Earth, and the Sun, see also Cohen [2] for much detail on this. Cohen also points out that Newton's focus is on relative masses,'*That is, since Newton is concerned with relative masses and relative densities, the test mass can take any unity"*.

The kg definition of mass was invented more than 100 years after he publish the Principia and thus came into being long after Newton's death. Newton was, in several of his texts, clear on the idea that matter (and energy) at the deepest level is based on indivisible fully hard particles with spatial dimension. He took this idea from atomism, a source that he refers to several times in his work [3, 4]. Newton was focused on atomism before his started to publish his work; this is evident from his unpublished notebook. He was also clear on this in Principia, and in particular in his later book Opticks. Newton thought that the amount of mass was related to the quantity of indivisible particles in the chosen mass. He even assumed that light was made up of such indivisible particles. He knew that it was impossible to find the number of indivisible particles in any observable mass at that time, an assertion that he mentions in Principia. It was therefore natural for him to focus on relative masses when he worked with gravity. In short, to find the relative mass of two heavenly objects, Newton utilized satellite orbital time and the distance from the satellite to the center of the mass he wanted to find the relative mass of; this is a method we return to shortly.

Newton also explained that weight is proportional to mass. In other words, twice the mass gives twice the weight; that is in relation to two masses located the same distance from the gravitational object.

The kg definition of mass was most likely first introduced likely in 1796. In 1798, Henry Cavendish [5] measured the weight and density of the Earth using a Cavendish balance. Earlier, Newton had found the relative density between planets, and for this no Cavendish apparatus or similar was needed. However, when we want to find the density of the Earth relative to a given substance - water or iron, for example, that we need to know the gravity properties of a mass that we know are formed uniformly of the chosen substance. The Cavendish balance was needed to measure the gravitational effect on a small practical mass, namely the chosen kg, that had suddenly become the standard definition for mass. So, the Earth's mass is still a relative mass, but now relative to a practical small mass, namely the kg. And this small practical mass will constitute the same amount of a substance, for example water, iron, or gold, by weight. Even Cavendish does not mention a gravitational constant, but the kg definition of mass made it necessary to introduce a gravitational constant to perform gravity predictions. This, as we will see, is because the kg definition of mass is an incomplete definition of mass that needs G to become a complete mass measure.

The gravitational constant is mentioned for the first time (to our knowledge) in a footnote by the French physicists Cornu and Baille [6] in1873. Their footnote mentions the gravity force formula in the form $F = fmm' : r^2$, where f is the gravitational constant. The fact that they are the first to mention the gravitational constant directly and they chose to mention it only in a footnote could indicate that they were uncertain how this would be received in the scientific community. If they were certain that the gravitational constant was important and would be easily accepted among leading scientists, then they would likely have mentioned it in the main text and developed the description of it more completely. One can expect scientists back then to have great respect for Newton, and since Newton not had mentioned a gravitational constant, it was not obvious that one could introduce such a thing with confidence.

However, the idea took hold and in 1894, the gravitational constant was first called G rather than f by Boys [7] in a proceeding at the Royal Society that followed shortly after he published in the prestigious journal Nature. To switch the notation from f to G is simply cosmetic[1]. Although Max Planck still used notation f for the gravity constant in 1899, 1906, and 1928 [8–10]. the use of G continued and by the 1930s, G had become the standard notation for the gravitational constant. Keep in mind that it took two hundred years from the publication of Newton's gravitational theory to the first mention of the gravitational constant first was mentioned, thus is was, to some degree a breakthrough, but from another perspective, it could also be seen as a disaster, as it led to an inferior definition of mass.

2 Demonstration that Newton's gravity formula; $F = \frac{\tilde{M}\tilde{m}}{r^2}$ can do all the gravity predictions that $F = G\frac{Mm}{r^2}$ can do!

As the original Newton formula is not compatible with the kg definition of mass (without adding a gravitational constant), we will call the Newton mass $\tilde{M}$ to distinguish it from the modern kg definition of mass M. We will later explain why the mass we obtain from the original Newton formula is superior to the kg definition of mass.

The centripetal force in the Newtonian theory is given by $\frac{\tilde{m}v^2}{r}$. For a planet or moon to be in equilibrium within their orbit, the centripetal force must balance with the gravitational force, so under the original Newton theory we must have

$$\frac{\tilde{m}v^2}{r} - \frac{\tilde{M}\tilde{m}}{r^2} = 0 \tag{2}$$

Solved with respect to v, this gives an orbital velocity of

$$v = \sqrt{\frac{\tilde{M}}{r}} \tag{3}$$

As we can see, this is quite different from the modern orbital velocity formula that is $v = \sqrt{\frac{GM}{r}}$. The difference is the Newton gravitational constant G, which, as we have noted, Newton himself never used. We can then ask, "Does the formula work without the Newton gravitational constant?" And, in fact, it does. Newton used the square of the orbital time and the distance between two masses to find the relative masses of heavenly objects. The orbital time is the circumference of the orbiting object (for example the moon) divided by the orbital velocity. In other words,

[1]But Boys also had some interesting information in his paper on measurement methods in relation to G, for example.

$$\frac{L}{v} = \frac{L}{\sqrt{\frac{2M}{r}}}$$
$$T = \frac{L}{\sqrt{\frac{2M}{r}}} \tag{4}$$

This formula we can then solve with respect to mass, and we get

$$\begin{aligned} M &= \frac{L^2 r}{T^2} \\ M &= \frac{(2\pi r)^2 r}{T^2} \\ M &= \frac{4\pi^2 r^3}{T^2} \end{aligned} \tag{5}$$

Assume we decide to measure orbital time in days (as Newton did) and distance in km (although naturally Newton used a different length measure). The distance to the Sun can be found by parallax, and it is about 149.6 million km. The time it takes for the Earth to orbit the Sun is 365 days. So now we can calculate the mass of the Sun as

$$M_s = \frac{4\pi^2 149600000^3}{365^2} \approx 9.92 \times 10^{20}\ km^3/\text{days}^2$$

As we can see, the mass has very strange notation and does not seem to be very recognizable or intuitive, but this is also partly due to the fact that we are accustomed to thinking of mass in terms of kg (or pounds). Next, let us calculate the mass of the Earth; for this we will use the orbital time of the Moon, which is about 27.3 days. The distance from the Earth to the Moon is about 384,400 km. The mass of the Earth must therefore be

$$M_E = \frac{4\pi^2 384400^3}{27.3^2} \approx 3 \times 10^{15}\ km^3/\text{days}^2$$

Again, this seems to be a strange mass that is hard for us relate to, but the mass of the Sun relative to the Earth is now $\frac{9.92\times10^{20}}{3\times10^{15}} \approx 329,750$. This is a number many of us do recognize; it is by looking at the mass of the Sun relative to the Earth that we also obtain if we look at the modern kg definitions of the Sun and the Earth. The $4\pi^2$ will even cancel out in the relative mass formula, which can be described by

$$\frac{\frac{r_1^3}{T_1^2}}{\frac{4r_2^3}{T_2^2}} \tag{6}$$

Further, if the satellites were orbiting the objects we wanted to find the mass of at the same distance $r_1 = r_2$, then the relative mass is simply the orbital time squared divided by each other. This is very similar to Newton's reasoning in the Principia. As Newton pointed out, one could use any units one wanted (for distance or time) when the focus was on relative masses. When we say the Sun's mass is 329,750 times that of the Earth, then we have chosen the Earth as the unit mass. We could just as well have used the Earth mass as the unit mass even when handling small objects on Earth. However, the mass of the Earth is enormous compared to any object we handle in our daily lives and so it would be hard to conceptualize it. Therefore, in order to have a better intuition on the mass, it makes sense to choose a smaller unit mass. The kg is a unit mass that is an arbitrary chosen mass, but it is practical – not so small so that it was hard to measure on an old fashioned scale, and yet not so big that it could not be carried around. Weights, we must remember, were important to standardize trade, for example. So, we can say an almost arbitrary amount of weight (mass) was chosen as a kg. When we deal with a small practical mass, we can also quite easily know what substance it consists of – we can make a lead ball, gold ball, or iron ball, or we can simply fill a container with water. When we deal with planets, we know they likely consist of many types of elements, and it is harder to say for certain what their cores consist of completely.

Now to find the mass of the Earth in kg, we must first find a method to test gravity's effect on small practical masses, e.g., that we already know the kg mass of. Remember to find the mass of the Sun, Newton needed something orbiting the Sun, but obviously there are plenty of planets to choose from. To find the mass of the Earth, he needed something that orbited the Earth, and indeed, the Moon fit the bill. However, in order to measure a small practical mass, we need something "orbiting"[2] that is also very small (very small compared

[2] Also other methods where thought of here, with varied sucess.

to planets, but still massive compared to atoms and molecules). This was a difficult task and many attempts where undertaken, but it was first done accurately in 1798 by Henry Cavendish through what is known today as a "Cavendish apparatus" and consists of some small balls (made of lead or gold, for example) "orbiting" some larger (but still small) balls. Interestingly, the mass of a large lead ball in the Cavendish apparatus will have a Newton mass of

$$\tilde{M} = \frac{2\pi^2 L r^2 \theta}{T^2} \tag{7}$$

where T is the oscillation time, and θ is the equilibrium angle when the balance has been stabilized and r is the distance from the small lead ball to the large lead ball, and L is the distance between the two small balls. This formula is quite similar to the formula we used before, but it has the angle parameter. In the previous example of measuring the Earth, when we are looking at the Moon's orbital time, we do not need to look at the entire orbit - we can for example only look at the quarter of the orbital time, although we will need to adjust the formula 5 with an angle θ to

$$\tilde{M} = \frac{4\pi^2 r^3 \theta}{T^2} \tag{8}$$

We know how to find this Newtonian type mass with the torsion balance, formula 7. We do not need to know its kg mass or any other mass measure for this. However, we can find its kg mass by comparing it with the kg standard by using a scale calibrated to kg. This now gives us a connection between the mysterious Newton mass and the kg (or pound if we prefer). We can now also find the kg mass of the Earth, and the density of the Earth in terms of kg. The Cavendish apparatus that by modern science was said to first indirectly find the gravitational constant is both true and not true. Cavendish never mentioned a gravitational constant, and it is actually not needed in any circumstance as we soon will see. The reason the Cavendish apparatus was needed was because one needed a way to measure the Newtonian type mass of a small object, so one could use the small unit as unit mass instead of for example the Earth. And yes the Cavendish apparatus also made it possible to accurately find the density of the Earth, not because of any gravitational constant, but because a small practical mass can be made of one substance where the density (weight) is known relative to other substances (gold versus water, for example). In this way, one could find the density of the Earth very accurately relative to a given substance. If one had known a planet in our solar system consisted of a homogenous substance, take iron, for example, then there would have been no need for a Cavendish apparatus to find the density of the Earth relative to material objects. But we know of no such planet consisting of only one substance, and it would also be hard to check if that was really the case, even if it could be imagined. So the breakthrough of the Cavendish apparatus was actually that one could find the gravity (Newtonian mass) of even a small practical mass. Naturally we can find the relative densities of different substances simply by using a weight.

Still what we call the Newtonian mass, $\tilde{M}$, is still difficult to fully understand, although it is no stranger than the kg. Up until now we have used arbitrary, units such km for length, and Earth days as time. As we will see, when we first switch to more fundamental units and then explore the quantum world that we truly see the beauty of Newton's formula.

Switching to more fundamental units

At this stage we can still choose any time unit we want ? years, days, hours, or seconds. More important than the choice of time interval (time unit) is now to link both time and length to something very fundamental in nature. This something very fundamental is light. We know from the writings of Aristotle (in his work De sensu) that the Greek ancient philosopher Empedocles about 2500 BC understood or at least assumed that the speed of light had a finite limit:

> *Empedocles says that the light from the sun arrives first in the intervening space before it comes to the eye, or reaches the earth. This might plausibly seem to be the case. For whatever is moved through space, is moved from one place to another, hence, there must be a corresponding interval of time also in which it is moved from one place to the other.*

In 1676 ,Ole Christensen Rømer was likely the first to make a quantitative measurement of the speed of light and he concluded that it was finite. In 1704, in his book Opticks [11], Newton reported Rmer's calculations of the finite speed of light and gave a value of "seven or eight minutes" for the time it would take for light to travel from the Sun to the Earth, an estimate that is not far from its real speed. So, Newton could have linked length to time through the speed of light, even if his calculations and predictions would have been somewhat inaccurate. In 1728, (one year after Newton's death) the English physicist James Bradley estimated the speed of light in a vacuum to be approximately 301,000 km per second, which is quite close to today's value.

Here we will choose seconds as the time unit, and will link this to length through the speed of light. Our length unit will be the distance light travels in any given time unit, here we choose the second; this is a well-known unit distance in modern physics, known as light-second (length). Now time and length units are suddenly related to something very fundamental. From modern physics, the speed of light is considered to be the same in every reference frame; it is known as c and it is today per definition exactly 299,792,458 meters per second. But here we have chosen the length unit that represents how long light travel in one second, so the speed of light will then be 1 light-second per second in this unit system. In other words, we can set $c = 1$, something that is often done in modern physics. Again, what is important is that time and length are linked through something very fundamental, namely the speed of light.

Now the distance to from the Earth to the Sun will be about $r = 149,600,000,000$ m$/299,792,458$ m/s $= 499$ light-seconds. The circumference of the orbit of the Earth around the Sun is therefore about $L = 2\pi \times 499$ light seconds. Further, we can find the mass of the Sun

$$M_S = \frac{4\pi^2 r^3 \theta}{T^2} = \frac{4\pi^2 499^3}{(365 \times 24 \times 60 \times 60)^2} \approx 4.93 \times 10^{-6} \text{ Light-seconds} \tag{9}$$

This looks like a very unfamiliar mass, but soon we will see it makes much more sense than expressing the mass of the Sun in kg. (The Sun's mass in kg is approximately 1.98×10^{30}).

Similarly, for the Earth we can use the Moon orbital time to find the mass of the Earth. The orbital time of the Moon is about 27 days, or $27 \times 24 \times 60 \times 60$ seconds. The distance to the Moon is about 1.28 light-seconds. The mass of the Earth must therefore be

$$M_E = \frac{4\pi^2 1.28^3}{(27 \times 24 \times 60 \times 60)^2} \approx 1.52 \times 10^{-11} \text{ Light-seconds} \tag{10}$$

This means the mass of the Sun relative to the Earth must be approximately $\frac{4.93\times10^{-6}}{4.93\times10^{-6}} \approx .324,342$. This is close to the actual accepted number.

Next let us use the orbital velocity formula $v = \sqrt{\frac{\tilde{M}}{r}}$ to predict the orbital velocity of Saturn. The distance from the Sun to Saturn is about 1.434 billion km, which is about 4783.3 light-seconds. The mass of the Sun we have estimated to be 4.93×10^{-6} light seconds, and inputted in the formula, we get

$$v = \sqrt{\frac{4.93 \times 10^{-6}}{4783.3}} \approx 3.21 \times 10^{-05} \text{ Light-seconds per second}$$

That is, the orbital velocity is now on the dimensionless form; it is identical to $\frac{v}{c}$. In order to obtain meters per second, we need to multiply by c and this gives us about 9,625 meters per second, which is the same as is observed in experiments. That our orbital velocity can actually be seen as $\frac{v}{c}$ means it is a dimensionless number. For example, Langacker [12] in his book Can the Laws of Physics Be Unified? (2017) indicates that such dimensionless units as $\frac{v}{c}$ are more fundamental.

Actually, the mass we find in this way without depending or known G is identical to half the Schwarzschild radius in meters divided by the speed of light. In other words, this is the Schwarzschild radius in light-seconds. We would propose that the Schwarzschild radius (divided by the speed of light) could be a much better model of mass than the kg defined mass. although, so far no one should be fully convinced that light seconds are a better mass measure than for example kg. It is first when we get to the quantum part this comes clear. Still, as explained previously, we have demonstrated that we can predict relative masses, we can find the density of planets, we can perform orbital velocity predictions, all with no knowledge of the gravitational constant. We will expand further on this before returning looking at the light-second mass from a quantum perspective.

3 Escape velocity and such things as time dilation

Leibniz suggested the kinetic energy was given by mv^2 a formula that "soon" was empirically confirmed by Gravesande [13] at around 1720. We know today this should be corrected to $\frac{1}{2}mv^2$. The escape velocity in Newton's formula can be derived by the following

$$\frac{1}{2}\tilde{m}v^2 - \frac{\tilde{M}\tilde{m}}{r^2} \tag{11}$$

and then we solve this with respect to v, this gives

$$v \approx \sqrt{\frac{2M}{r}} \tag{12}$$

We can also find expected gravitational time dilation by taking into account that the time of a clock at distance r_2 must move faster than the clock at a distance of $r_2 = r_1 + h$ from the center of the gravity object by

$$\begin{aligned}
\frac{T_2}{\sqrt{1-v_2^2}} &= \frac{T_1}{\sqrt{1-v_1^2}} \\
\frac{T_2}{\sqrt{1-\frac{2M}{r_2}}} &= \frac{T_1}{\sqrt{1-\frac{2M}{r_1}}} \\
T_2 &= T_1\frac{\sqrt{1-\frac{2M}{r_2}}}{\sqrt{1-\frac{2M}{r_1}}}
\end{aligned} \tag{13}$$

Assume the clock T_1 is at sea level and clock T_2 is 2,000 meters above the see level, which corresponds to $r_1 \approx= 6,371,000/c = 0.0212514$ light-seconds and $r_2 = (6,371,000 + 2,000)/c = 0.0212580$ light-seconds. For every second at the ocean level, the following numbers of seconds will go by as observed from the mountain level

$$T_2 = 1\frac{\sqrt{1-\frac{2\times 1.52\times 10^{-11}}{0.0212514}}}{\sqrt{1-\frac{2\times 1.52\times 10^{-11}}{0.0212580}}} = 1.00000000000022 \text{ s} \tag{14}$$

which is the same as predicted by general relativity theory. The point is that we here have done it without any knowledge of G. What is even more important is our mass. The mass of the Earth, as we have said, is about 1.52×10^{-11} light-seconds. We can convert this to meters instead by multiplying by $c = 299792458\ m/s$. This means the mass of the Earth is $1.52 \times 10^{-11} \times c = 0.0046$ m. This is actually half of the Schwarzschild radius of the Earth. This is no coincidence. From Newton's formula, one finds that the mass is half the Schwarzschild radius of the Earth (when using length units linked to how far light travel in the arbitrary chosen time unit, here seconds). One naturally gets the Schwarzschild radius in modern physics by $r_s = \frac{GM}{c^2}$; however, modern physics has not recognized that half the Schwarzschild radius actually is a better mass definition.

4 Getting down to the quantum level

Any rest-mass in terms of kg can be expressed as

$$m = \frac{\hbar}{\bar{\lambda}}\frac{1}{c} \tag{15}$$

where $\hbar$ is the Planck constant, $\bar{\lambda}$ is the reduced Compton length, and c is the well-known speed of light. This formula can describe any rest-mass in terms of kg, including both subatomic and cosmological objects. The Planck constant is indeed a constant, and so is the speed of light. The only factor that differs between masses of different sizes (weights) is then the Compton wavelength of the mass. The Compton wavelength has only been measured for fundamental particles such as the electron. However, even larger masses that don't have their own Compton wavelengths still consist of a series of subatomic particles that must have a Compton wavelength. The Compton wavelengths of elementary particles are additive based on the following formula

$$\bar{\lambda} = \sum_{i=1}^{n} = \frac{1}{\frac{1}{\bar{\lambda}_1} + \frac{1}{\bar{\lambda}_2} + \frac{1}{\bar{\lambda}_3} + + + \frac{1}{\bar{\lambda}_n}} \tag{16}$$

This means that the formula 15 can be used for composite masses and even astronomical objects like the Sun or the Moon. But what does the formula truly represent? The Planck constant is linked to the quantization of energy. Some will find it strange that the speed of light is embedded in the mass formula. We are all familiar with $E = mc^2$, but few physicists are familiar with the idea that the speed of light is integrated in the mass at a deeper level. This indicates something inside a fundamental particle a mass is linked to the speed of light, and also to composite masses, as they consist of fundamental particles. But how? Mass is known at the quantum level to be a wave-particle duality. But what is a wave-particle duality exactly? Newton assumed light consisted of indivisible particles; later, the view that light was a wave evolved from some experiments strongly indicating wave behavior. Then Einstein introduced his photoelectronic effect and again showed that light had particle-like properties, and light was redefined as having a mystical wave-particle duality. Not mystical in the terms of math, but in terms of the interpretation of the math. Then Louis de Broglie suggested that matter, in addition to particle properties, also likely had wave properties, and he suggested that the matter wave was given by the following formula $\lambda_B = \frac{\hbar}{mv\gamma}$, where $\gamma = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$. Einstein quickly endorsed the idea, and some years later it was confirmed that masses such as electrons had wave properties. This was considered almost a proof that the de Broglie hypothesis was rooted in reality. Next, in a series of steps, an entire quantum wave theory emerged from this line of thought, based on the important work of Heisenberg, Schrodinger, Klein Gordon, Pauli, and Dirac. The quantum mechanical theory fitted experiments extremely well. And just before this development, gravity theory had evolved into Einstein's general relativity theory. Since then, for more than 100 years a series of the world's most brilliant physicists have tried to unify gravity with quantum mechanics, into a so-called quantum gravity theory without much success.

However, in our rest-mass formula, $m = \frac{\hbar}{\bar{\lambda}}\frac{1}{c}$ we do not have the de Broglie wavelength but the Compton wavelength. Compton was more of an experimental researcher than de Broglie and he had measured a wavelength of the electron around the same time that de Broglie had presented his hypothesis of the matter wave. That is, the Compton wavelength has been measured. There is a very simple mathematical relation between the Compton wavelength and the de Broglie wavelength, namely $\bar{\lambda} = \bar{\lambda}_B \frac{v}{c}$. However, if $v = 0$, then the de Broglie wavelength is infinite when $v = 0$ and the corresponding Compton wavelength is zero. An infinite matter wave for a subatomic particle is, to put it mildly, a bizarre prediction. We will claim, as we have done in other papers, that the de Broglie wavelength is not a physical wavelength; it should be seen as a mathematical derivative of the true physical Compton wavelength. In short, the de Broglie wavelength is more or less simply a mathematical artifact. A theory built around the de Broglie wavelength will, in general, give a series of correct predictions, but the interpretations will often be absurd, as one has not discerned what matter is directly linked to the Compton wavelength and to the de Broglie wavelength.

Let's return to our mass definition in kg in terms of the Compton wavelength. The formula can be rewritten as

$$\frac{\hbar}{\bar{\lambda}}\frac{1}{c} = \frac{\frac{c}{\bar{\lambda}}}{\frac{c}{\frac{\hbar}{1\times c}}} \tag{17}$$

We can see that the kg of the mass in question simply is the Compton frequency of the mass in question divided by the Compton frequency of one kg. That is, the kg definition of mass at a deeper quantum level is a frequency ratio. At each Compton time we will claim there is a Planck mass event. Such Planck mass events consist of two indivisible particles colliding. Such indivisible particles, when not colliding with other particles, move at the speed of light over the Compton length. For example, an electron will then have the following number of Planck mass events per second

$$f_e = \frac{c}{\bar{\lambda}_e} \approx 7.76 \times 10^{20} \tag{18}$$

Each Planck mass event is 10^{-8} kg, but the Planck mass event only lasts for one Planck second, so this gives a mass in kg for the electron of

$$m_e = \frac{c}{\bar{\lambda}_e} \approx 7.76 \times 10^{20} \times m_p t_p = \frac{\frac{c}{\bar{\lambda}}}{\frac{c}{\frac{\hbar}{1\times c}}} = 10^{-31} \text{ kg} \tag{19}$$

However, this mass definition that indeed is a collision ratio does not tell anything about how long each collision lasts, it disappears in the equation, as the Planck length will cancel out between the Planck mass in terms of kg and the Planck time. The standard kg definition of mass is a collision ratio, and that is all we need when working with most observable phenomena. An exception to this is gravity. Gravity is not some magical force; all mass is also gravity. That is, gravity is the collisions between the indivisible particles that existing in matter. The collision only lasts for a Planck second, as we can find out from gravity observations. This is, however, not embedded in today's mass definition, and it has to come from somewhere in the gravity models to make the gravity formulas predict correctly. This is where the gravity constant comes in. The so-called Newton's gravitational constant adds to the formula what is missing in the kg definition off mass. Luckily what is missing is only something that is constant, namely the Planck length, and also, we need to take something out, namely the Planck constant. The Planck constant is the units of energy relative to the collision ratio in a kg. That is, the Planck constant is the amount of energy in an indivisible particle in the form of a collision ratio where the collision ratio is relative to the collisions in one kg per second.

The quantum aspects of this theory and a unified quantum gravity theory is explained in much more detail in [14–16]. Just as important is that one can find the Planck length (and other Planck units such as the Planck time and the Planck mass) totally independent on any knowledge off G, see [17, 18]. The Newton gravitational constant that Newton never invented or used is at a depper level a composite constant of the form $G = \frac{l_p^2 c^3}{\hbar}$ as described by Haug in some of the working papers just mentioned as well as in [19, 19, 20].

5 The Newton Mass from a quantum perspective, the true mass

This section comes in next version.

6 Conclusion

As we have seen, it is by using Newton's original formula that we obtain the correct mass. The kg definition of mass is a man-made, arbitrary unit of mass that has caused great confusion in modern physics. The kg definition and similar man-made arbitrary units (such as the pound) of mass are why the gravitational constant had to be invented. Nature does not work in kg; it has its own more fundamental units. Arbitrary incomplete units have added an unnecessarily layer of complexity to modern physics, but Newton's original theory is superior in many ways. Naturally, the theory was not complete in terms of quantum mechanics and relativity theory. However, if the field of physics had stayed with Newton's original formula, it is possible that a full understanding of mass and a unified quantum theory might have been developed much earlier.

References

[1] I Newton. *Philosophiae Naturalis Principia Mathematica*. London, 1686.

[2] I. B. Cohen. Newton's determination of the masses and densities of the sun, jupiter, saturn, and the earth. *Archive for History of Exact Sciences*, 53(1), 1998.

[3] Alan Chalmers. *Newton's Atomism and its Fate*. Volume 279 of the series Boston Studies in the Philosophy of Science: in the Book: The Scientist's Atom and the Philosopher's Stone, Springer, 2009.

[4] R. E. Schofield. Atomism from newton to dalton. *American Journal of Physics*, 49(211), 1981.

[5] H. Cavendish. Experiments to determine the density of the earth. *Philosophical Transactions of the Royal Society of London, (part II)*, 88, 1798.

[6] A. Cornu and J. B. Baille. Détermination nouvelle de la constante de l'attraction et de la densité moyenne de la terre. *C. R. Acad. Sci. Paris*, 76, 1873.

[7] C. V. Boys. The newtonian constant of gravitation. *Nature*, 50, 1894.

[8] M. Planck. *Natuerliche Masseinheiten*. Der Königlich Preussischen Akademie Der Wissenschaften, p . 479., 1899.

[9] M. Planck. *Vorlesungen über die Theorie der Wärmestrahlung*. Leipzig: J.A. Barth, p. 163, see also the English translation "The Theory of Radiation" (1959) Dover, 1906.

[10] M. Planck. *Einführung in die allgemeine Mechanik*. Verlag von Hirtzel, Leipzig, 1928.

[11] I Newton. *Opticks*. London, 1704.

[12] P. Langacker. *Can the Laws of Physics Be Unified?* Princeton University Press, 2017.

[13] Jacob Gravesande, Willem. *Mathematical Elements of Physicks, prov'd by Experiments: Being an Introduction to Sir Isaac Newton's Philosophy... Made English, and illustrated with 33 copper-plates, Revis'd and corrected, by Dr. John Keill*. London, 1720.

[14] E. G. Haug. *Unified Revolution, New Fundamental Physics*. Oslo, E.G.H. Publishing, 2014.

[15] E. G. Haug. *Finally a Unified Quantum Gravity Theory! Collision Space-Time: the Missing Piece of Matter! Gravity is Lorentz and Heisenberg Break Down at the Planck Scale. Gravity Without G*. ViXrA or Research-gate, 2019.

[16] E. G. Haug. *Collision Space-Time. Unified Quantum Gravity. Gravity is Lorentz Symmetry Break Down at the Planck Scale*. https://www.preprints.org/manuscript/201905.0357, 2019.

[17] E. G. Haug. Can the planck length be found independent of big g ? *Applied Physics Research*, 9(6), 2017.

[18] E. G. Haug. Finding the planck length independent of newton's gravitational constant and the planck constant: The compton clock model of matter. *https://www.preprints.org/manuscript/201809.0396/v1*, 2018.

[19] E. G. Haug. Planck quantization of newton and einstein gravitation. *www.viXra.org March 19 2016*, 2016.

[20] E. G. Haug. Planck quantization of newton and einstein gravitation for planck masses and smaller size objects. *www.viXra.org 1610.0328 2016*, 2016.

Appendix: Some quotations from Newton

> Since every particle of space is always and every indivisible moment of duration is everywhere, certainly the Maker and Lord of all things cannot be never and no where. p. 505.

> ?and thence we conclude the least particles of all bodies to be also extended, and hard and movable, and endowed with their proper vires inertia. And this is the foundation of all philosophy.

In the Principia, Newton is also clear on the idea that the smallest particles of all bodies have spatial extension and are hard (indivisible) and can move. And he follows up with the comment, "And this is the foundation of all philosophy."

> For if a body by means of its gravity revolves in a circle concentric to the Earth, this gravity is the centripetal force of that body. p.109

If there be several bodies consisting of equal particles whose forces are as the distances of the places from each, the force compounded of all the forces by which any corpuscle is attracted will tend to the common centre of gravity of the attracting bodies; and will be the same as if those attracting bodies, preserving their common centre of gravity, should unite there, and be formed into a globe. p 236

> I say, that the whole force with which one of these spheres attracts the other will be reciprocally proportional to the square of the distance of the centres. The force with which one of these attracts the other will be still, by the former reasoning, in the same ratio of the square of the distance inversely. Cor. 3. The motive attractions, or the weights of the spheres towards one another, will be at equal distances of the centres as the attracting and attracted spheres conjunctly; that is, as the products arising from multiplying the spheres into each other. p. 223.

> Cor.2 The force of gravity towards several equal particles of any body is reciprocally as the square of the distance of the places of the particles. p. 393.

> Cor.2 The force of gravity which tends to any one planet is reciprocally as the square of the distance of places of that planet's center. p. 393.

> That all bodies gravitate towards every planet; and that the weights of bodies towards any the same planet, at equal distances from the centre of the planet, are proportional to the quantities of matter which they severally contain. p. 394, book 3.

> If two spheres mutually gravitating each towards the other, if the matter in places on all sides round about and equidistant from the centres is similar, the weight of either sphere towards the other will be reciprocally as the square of the distance between their centres.

> Wherefore the absolute force of every globe is as the quantity of matter which the globe contains; but the motive force by which every globe is attracted towards another, and which, in terrestrial bodies, we commonly call their weight, is as the content under the quantities of matter in both globes applied to the square of the distance between their centres (by Cor. IV, Prop. LXXVI), to which force the quantity of motion, by which each globe in a given time will be carried towards the other, is proportional. And the accelerative force, by which every globe according to its quantity of matter is attracted towards another, is as the quantity of matter in that other globe applied to the square of the distance between the centres of the two (by Cor. II, Prop. LXXVI): to which force, the velocity by which the attracted globe will, in a given time, be carried towards the other is proportional.

> That there is a power of gravity tending to all bodies, proportional to the several quantities of matter which they contain. p. 397.

Newton only uses the word "mass" once in his book:

> The quantity of matter is the measure of the same, arising from its density and bulk conjunctly. It is this quantity that I mean hereafter everywhere under the name of body or mass.

In other words, mass is the quantity of matter.