Unification of Gravity with Quantum Mechanics. The Beauty and the Beast.

Espen Gaarder Haug
Norwegian University of Life Sciences
e-mail espenhaug@mac.com
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Abstract

Isaac Newton did not invent the gravity constant G, nor did he use it, and nor did he need it. Newton's original formula was $F = \frac{\tilde{M}\tilde{m}}{r^2}$ and not $F = G\frac{Mm}{r^2}$ that evolved over time. Newton's formula can easily be unified with quantum mechanics, while the awkward modification to his formula can only be unified with quantum mechanics by introducing difficulties and awkwardness that affect other aspects of physics. Modern physics uses two different definitions for mass; one for gravity and another for the rest of physics. This, we will prove, has made it impossible to unify quantum mechanics with gravity. However, once we understand the cause of the problem it can be fixed easily, by going back to the key insight given by Newton, which leads to a beautiful simple unified theory, in conception and in notation. Alternatively, one can arrive at the same theory, but with very ugly notation that hides the beauty at the depth of reality.

We will show a beautiful way to unify gravity and quantum mechanics and also an ugly way. Both are the essentially the same, but only one way, the Newton inspired way gives the deep insight on matter, energy, time, space, and gravity and even quantum mechanics. Modern physics has ignored Newton's insight on matter and altered the mass definition, and therefore had to modify Newton's gravity formula as well, such that a unified theory seemed to become impossible. Newton himself would probably not have approved of the gravity constant; it is a flaw on the foundation of his theory and his gravity formula. Still, when one understands what the gravity constant really represents, one can also unify standard physics, by adding it in other places, as needed.

Key Words: Quantum gravity, granular matter, unification of QM and gravity and special relativity.

1 Introduction

In 1686, in his *Principia* [1] Newton mentions by words the gravitational force formula (see Appendix) that is equivalent to

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

Yet, Newton does not mention any gravity constant. Based on gravity observations alone he calculates the relative masses between planets as well as the Sun and his results were very close to what we can measure today. Newton could also easily find the density of the Earth relative to that of the Sun. In order to find the density of the Earth relative to a given element, or in terms of kg, one needs to be able to measure gravity impact from a small uniform object where the composition is known ? whether that is a single element, or several, in which case the exact proportions of elements is important). In 1798, Cavendish [2] was the first to measure the density of the earth accurately using what is now known as a Cavendish apparatus.

However, Cavendish does not mention a gravitational constant, even though he is credited for being the first to find it, albeit indirectly. Cavendish determined that the density of the Earth is about 5.48 times that of the density of water, which is very close to today's estimate of approximately 5.51 gram per cm^3. However, Cavendish only explains in in relative terms comparing the Earth and water; he does not give the density in grams, kg, or other specific units of measure. He mentions the weights of the large balls in the Cavendish apparatus in forms of grains, and the weights of the balls in terms of an equivalent volume of water. What is important is that Cavendish finds the density of the Earth relative to the density of water without any mention of a gravity constant. The Cavendish apparatus basically allows one to measure the gravity effects from a certain mass, where one has full control of its composition. The impact is then measured on much smaller objects where one does not necessarily know their elemental composition as long as their masses are much smaller than the two larger balls in the Cavendish apparatus.

Around 1797, the French standardized the mass measure as the kilogram. The kilogram is arbitrary man-made chosen quantity of matter that likely had a main focus on trade. For trade, it was naturally important to have a standard size mass. However, this mass could not be so large that it not was practical to carry, nor could it be so small that the weighting apparatus was not sensitive enough to weigh it. The standard mass was also very useful in physics. However, it only makes sense to have arbitrary clump of matter as the mass standard when we are working with matter in infinite divisible form. If the building blocks of matter at the deepest level are indivisible, then this indivisible unit would be a more fundamental unit than an arbitrary chosen clump of matter like the kilogram. We will soon prove that the kg mass definition without modification cannot lead to a unified theory. Returning to the original Newton formula, there are two masses divided by the distance between them.

The gravitational constant was interestingly first mentioned in a footnote in 1873. The gravity force formula given by Cornu and Baille [3] was $F = f\frac{Mm}{d^2}$, where f is the gravity constant. One can ask why it first was introduced in a footnote, more than 70 years after modern physics claims that Cavendish introduced it. Cornu and Baille were likely fully aware that they were altering Newton's formula in a significant way, but they did not elaborate further on this issue in the main text.

The well know G notation for the gravity constant was introduced in 1894 by Boys [4], who was the first to mention the gravity formula in the notation most often used today. By the 1920s, it had become fairly standard to call the gravity constant G. The specific notation one uses for the gravity constant is not that important, but it is noteworthy that Newton's formula was altered in 1873, nearly 200 years after he had introduced his gravity formula, and oddly enough it became known as Newton's gravitational constant. To understand why this change happened, and to study why it was actually not needed, we need to study the /textit Principia, Newton's other works, and the kilogram more carefully.

Below we summarize some of the most important developments in gravity, including development that have caused confusion.

- 1673: Huygens calculates the Pendulum periodicity from gravity.
- 1687, 1713, and 1726 - - Three versions of the textit Principia: Isaac Newton introduce his gravity force formula in words, that is equivalent to $F = \frac{Mm}{d^2}$. However, be aware that his mass definition is very different than the later definition of mass. Newton was clear that he thought mass ultimately consisted of indivisible particles; he also mentions indivisible time and these are fundamental to the philosophy behind his entire body of work, yet lie in strong contrast to the modern point particle view.
- 1797: the kilogram mass (kg) is introduced as the standard mass in France. Similar mass standards are adopted in England.
- 1798: Cavendish has accurately measured the density of the Earth and came up with a figure very close to what we know the density is today.
- 1873: Cornu and Baille introduce the gravity constant in a footnote. They were well aware this was a modification of Newton's formula, and they may have been uncertain about how this would be received in the scientific communities. However, as the gravity constant clearly was needed when working with mass as kg (to get it to fit experiments), it soon became the accepted method.
- 1894: Boys is likely the first to refer to the gravity constant with the notation G. Cornu and Baille had used notation f. What notation is used is used for a single constant is of minimal importance, but it is worth mentioning that the G notation had become the standard around 1920.
- 1916: Einstein introduces with his theory of general relativity, where he relies heavily ron the so-called Newton gravitational constant G.
- 2017: Haug shows that the Planck length can be measured and found without any knowledge of G, and even without relying on the Planck constant.[1]
- 2019: Haug [7] shows how to unify gravity with quantum mechanics. This is the theory highlighted in this paper.

Newton assumed that the ultimate building blocks of nature were indivisible particles this line of thought also led to the idea that the ultimate time unit was indivisible and Newton follows up with the comments:

> *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 nowhere.* 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 his book itOptica he is even more clear on the idea of matter consisting of fully hard forever-lasting particles, that is to say, indivisible particles

[1] See [5, 6].

All these things being consider'd it seems probable to me, that Godin the Beginning form'd Matter in solid, massy, hard, impenetrable, movable Particles, of such Sizes and Figures, and in such Proportion to Space, as most conduce to the End for which he form'd them; and that these primitive Particles being Solids, are incomparably harder than any porous Bodies compounded of them; even so very hard, as never to wear or break in pieces; no ordinary Power being able to divide what God himself made one in the first Creation. While the Particles continue entire, they may compose bodies of one and the same Nature and Texture in all Ages; But should they wear away, or break in pieces, the Nature of Things depending on them, would be changed. Those minute rondures, swimming in space, from the stuff of the world: the solid, coloured table I write on, no, less than the thin invisible air I breathe, is constructed out of small colourless corpuscles; the world at close quarters looks like the night sky – a few dots of stuff, scattered sporadically through and empty vastness. Such is modern corpuscularianism.

There are many more quotations that demonstrate how Newton assumed mass is ultimately indivisible particles, and that there is also an indivisible time period. The indivisible particles are his building blocks of light as well. The idea of indivisible particles dates back to Leucippus and Democritus [8, 9] and their work on atomism. Several physicists in modern times have written on atomism, including Schödinger [10], but the extent of its influence on their work is not clear. Obviously Newton was working long before relativity theory and quantum mechanics has been developed, and in his time, accurate instrumentation was also an issue. Yet, in spite of the challenges in both theoretical and empirical work, looking back at the work of Leucippus and Democritus, we will claim that Newton was the last great atomist and by bringing his ideas forward in their original form, we can find a way to unify gravity with quantum mechanics and relativity theory.

Our theory is based on two postulates; that everything (energy and matter) consists of two elements:

- Indivisible particles that are either always moving at the same speed, or are colliding and then standing still during those collisions relative to the indivisible particles that are simply traveling along.
- Void (empty space) that the indivisible particles can travel in.

Interestingly, Democritus suggested approximately 2,500 years ago that the indivisible particles themselves had no weight (mass), but at the same time had weight (mass), in particular when mentioned in relation to size and density. This controversy that they do not have mass (weight) and at the same time they have mass in other circumstances has lead to confusion for historians. This also has a parallel to modern discussions concerning whether or not photons have mass, [11, 12]. This paper will show how mass is indeed linked to indivisible particles that have rest-mass and are also massless. We will also explain the photon mass and the massless photon, and incorporate these and other observations on the process for unifying gravity with quantum mechanics.

2 Kg is a Mass Ratio

Mass standards like the kilogram and pound likely have their origin in trade, where it is important to have a standardized mass measure. This standardized mass (often used to make a weight) could not be too large, as it would be difficult to carry around. It also could not be too small, as that would lead to an inaccurate weight based on the technology of the times. For about 200 years the kg has indeed been an arbitrary clump of matter stored in Paris, and other countries have calibrated their kg towards that standard. The kg has been directly linked to the Planck constant through the Watt balance, see [13–16], and in recent years the kg has been redefined based on this.

Every rest-mass in kg (or pound etc.) can be expressed mathematically as

$$m = \frac{\hbar}{\bar{\lambda}} \frac{1}{c} \tag{2}$$

That is every rest-mass in the form of kg can be expressed using only the Planck constant, the speed of light, and the reduced Compton wavelength. Alternatively, the Compton wavelength could be used instead of the reduced form by using the Planck constant on the non-reduced form. The Planck constant and the speed of light are constants. This means the only things that distinguish masses of different sizes are their reduced Compton wavelengths. And if the Planck constant and the speed of light are known, the we only need to measure the Compton wavelength of a particle to find its mass in kg. The Compton wavelength can be found by Compton scattering [17], or alternatively from the hydrogen spectrum (see the Appendix). In order to find the mass of an electron, for example, we only need to measure its Compton wavelength with Compton scattering, see [18].

The formula given above for kg mass also holds for all masses, from the smallest to the largest. There may be some debate on this, as composite masses do not have one Compton wavelength, but consist of many elementary particles that all must have Compton wavelengths. These Compton wavelengths are additive according to the formula below

$$\bar{\lambda} = \sum_{i=1}^{n} = \frac{1}{\frac{1}{\bar{\lambda}_1} + \frac{1}{\bar{\lambda}_2} + \frac{1}{\bar{\lambda}_3} + \cdots + \frac{1}{\bar{\lambda}_n}} \tag{3}$$

So, a composite mass does not have an observable or physical Compton wavelength, but rather it has many. If we add the Compton wavelengths of the elementary particles it consists of, we get an equivalent Compton wavelength of the composite mass that can be used to calculate its mass.

The Compton wavelength can also be found if we know the mass by the following well-known formula that holds for a mass at rest

$$\bar{\lambda} = \frac{\hbar}{mc} \tag{4}$$

This means the Compton wavelength of one kg is

$$\bar{\lambda}_{1kg} = \frac{\hbar}{1 \times c} = \frac{\hbar}{c} \approx 3.52 \times 10^{-43} \text{ m} \tag{5}$$

This means one kg has a reduced Compton frequency of

$$f_{1kg} = \frac{c}{\bar{\lambda}_{1kg}} = \frac{c}{\frac{\hbar}{1 \times c}} = \frac{c^2}{\hbar} \approx 8.52 \times 10^{50} \tag{6}$$

The reduced Compton frequency of an electron is

$$f_{1kg} = \frac{c}{\bar{\lambda}_e} \approx 7.76 \times 10^{20} \tag{7}$$

To find the kg mass of an electron, we can simply take its reduced Compton frequency and divide by the Compton frequency of one kg. This gives

$$m_e = \frac{\frac{c}{\bar{\lambda}_e}}{\frac{c}{\frac{\hbar}{1 \times c}}} \approx \frac{7.76 \times 10^{20}}{8.52 \times 10^{50}} \approx 9.1 \times 10^{-31} \text{ kg} \tag{8}$$

That is the well-known mass of an electron. We will claim that the kg mass is a frequency ratio, or more precisely a collision ratio. A frequency is observational time dependent. The reduced Compton frequency we have given for the electron is for a one second observational time window. If we reduce the observational time window to half a second, this frequency is approximately half of what we calculated. However, the same is the case for a one kg mass, its Compton frequency will be cut in half. This means in general that masses in kg are observational time independent. An electron is 9.1×10^{-31} kg, no matter whether we observe the electron over one second, half a second, a nano-second or over several days. However, when we have an observational time window very close to the Compton time, the mass of the electron will be affected by the observational time window. If we observe an electron in a observational time window of $t = 1.5 \times \frac{\bar{\lambda}_e}{c}$, then it will only have a frequency of one, while the frequency of one kg in the same observational time window will now only be $me \approx 6.07 \times 10^{-31}$ kg

Further will claim the shortest possible frequency we can observe above zero must be one. This means the smallest possible mass in terms of kg is one divided by the collision frequency in one kg. This gives a minimum mass above zero of

$$m_\gamma = \frac{1}{f_{1,kg}} = \frac{1}{\frac{c}{\frac{\hbar}{1 \times c}}} = \frac{\hbar}{c^2} \tag{9}$$

This means that not only is energy coming in units linked to the Planck constant, but also masses. This means we both have the energy gap and the mass gap, the energy gap is $\hbar$ and the mass gap is $\frac{\hbar}{c^2} \approx 1.17 \times 10^{-51}$ kg. This is very close to the photon mass suggested by several authors, see [11, 12].

3 Our New Mass Measure

In our new mass definition, we will assume there is an indivisible particle that must be incorporated into the mass definition. As we have suggested, the indivisible particle itself is massless and always moves at the speed of light except when it is colliding. The collision between two indivisible particles itself is mass. But how does one describe a collision? We have already claimed the kg mass is a collision ratio. The collision ratio indirectly reflects how many collisions there are within a given time interval. However, it does not tell about the duration of these collisions. Here, we will use a mass definition that says how long the collision lasts for any particle or chosen quantity of matter. Our mass formula is

$$\tilde{m} = \frac{l_p}{c} \frac{l_p}{\bar{\lambda}} \tag{10}$$

we use the notation $\tilde{m}$ for our collision-time mass to distinguish it from the kg mass. The first part of this is $\frac{l_p}{c}$, which is the Planck time. Each collision lasts for one Planck second; this is not an assumption, but what we obtain from measurements, as we will demonstrate soon. The last part, $\frac{l_p}{\bar{\lambda}}$, gives the number of Planck masses in the mass of question. When $\bar{\lambda} \leq l_p$, this can be seen as the frequency probability of a collision for the given mass in one Planck second. For masses where $\bar{\lambda} < l_p$, then $\frac{l_p}{\bar{\lambda}}$ can be seen as the number of collisions in that mass. The remaining part above the integer value is a probability. We claim the collision-duration time is what is lacking in the mass definition of standard physics, which only has the number of collisions in terms of a collision ratio relative to an arbitrarily chosen clump of matter (the kg) in the mass definition.

Another possible mass definition would be to take the collision-time ratio instead of the collision-time itself. The reduced Compton wave of one kg is $\bar{\lambda}_{1,kg} = \frac{\hbar}{1_{kg} \times c} = \frac{\hbar}{c} \approx 3.52 \times 10^{-43}$ m. Assume we want to express masses as a collision-time ratio relative to the collision-time of one kg. Then the collision-time ratio for an electron is

$$\frac{\tilde{m}_e}{\tilde{m}_{1kg}} = \frac{\frac{l_p}{c}\frac{l_p}{\bar{\lambda}_e}}{\frac{l_p}{c}\frac{l_p}{\bar{\lambda}_{1kg}}} \approx 9.1 \times 10^{-31}$$

. We can see that the number value here is identical to the kg mass of an electron. The collision-time ratio, when using the collision time for one kg as a base, is always identical to the standard kg mass. However, the collision-time ratio has some of the same problems as the kg definition of mass. The collision time ratio is given by

$$\frac{\tilde{m}_e}{\tilde{m}_{kg}} = \frac{\frac{l_p}{c}\frac{l_p}{\bar{\lambda}_1}}{\frac{l_p}{c}\frac{l_p}{\bar{\lambda}_2}} = \frac{\bar{\lambda}_2}{\bar{\lambda}_1} \tag{11}$$

and, as we can see, the Planck length cancels out. So, the collision time ratio (end product), like the kg mass, contains no information about the Planck length, or the duration of collisions. The duration of collisions is what is important for gravity, as we have demonstrated in a previous paper and will further demonstrate here.

4 Gravity

As described earlier in this paper, the Newton gravity formula has been modified from the original Newton formula, and we have

$$F = G\frac{Mm}{R^2} \tag{12}$$

where G is the so -called Newton gravity constant, that Newton himself did not invent, mention, or use in his work. In this formula, M and m are the kg masses of the two masses. However, the Newton gravity force has never been measured; only the effects from gravity have been measured. The small mass, m, is only used in derivations to arrive at predictions related to gravity that can be observed. Actually, m always cancels out before one comes to things we can observe.

In our gravity theory, using masses rooted in Newton's philosophy, which was based on atomism, we have the following gravity formula

$$F = c^3\frac{\tilde{M}\tilde{m}}{R^2} \tag{13}$$

We have the speed of light here cubed instead of the gravity constant G, and our masses are collision-time. If we switch to measuring both distances as long as light has moved inside our chosen time unit (something often done in standard physics), then $c = 1$ and we have the original Newton formula

$$F = c^3\frac{\tilde{M}\tilde{m}}{R^2} = 1^3\frac{\tilde{M}\tilde{m}}{R^2} = \frac{\tilde{M}\tilde{m}}{R^2} \tag{14}$$

All standard gravity predictions can be predicted from this formula. However, since we are used to working in meters and seconds, we will keep $c = 299792458\ m/s$, and will work with formula 13, even if the original Newton formula would work just as well.

Table 1 shows that our formula and the modified Newton formula of modern physics give the same output, and can also be applied to units for anything that can be observed.

However, for the gravity force, which cannot be observed itself, we have different outputs. We will claim that standard physics actually uses two different mass definitions in the Newton formula. If we take $\frac{G}{c^3}M$, this is equal to the collision-time of that mass. In other words, we have

$$\frac{G}{c^3}M = \frac{l_p^2}{\hbar}\frac{\hbar}{\bar{\lambda}}\frac{1}{c} = \frac{l_p}{c}\frac{\hbar}{\bar{\lambda}} = \tilde{M} \tag{15}$$

	Modern "Newton"	Quantum Gravity
Mass seen as	Compton frequency relative to Compton frequency kg	Collision-time per shortest time interval
Mass mathematically	$M = \frac{\hbar}{\bar{\lambda}}\frac{1}{c}$	$\tilde{M}_t = \frac{l_p}{c}\frac{l_p}{\bar{\lambda}}$
Energy	$E = Mc^2 = \frac{\hbar}{\bar{\lambda}}c$	$\tilde{E} = \tilde{M}_t c = l_p\frac{l_p}{\bar{\lambda}}$
Gravity constant	$G = \frac{l_p^2 c^3}{\hbar}$	c^3
Non "observable" predictions:		
Gravity force	$F = G\frac{Mm}{R^2} = \frac{\hbar c}{R^2}\frac{l_p}{\bar{\lambda}_M}\frac{l_p}{\bar{\lambda}_m}$	$\tilde{F} = c^3\frac{\tilde{M}\tilde{m}}{R^2} = \frac{c}{R^2}\frac{l_p^2}{\bar{\lambda}_M}\frac{l_p^2}{\bar{\lambda}_m}$
Observable predictions:		
Gravity acceleration	$g = \frac{GM}{R^2} = c^2\frac{l_p}{R^2}\frac{l_p}{\bar{\lambda}}$	$g = c^3\frac{\tilde{M}}{R^2} = c^2\frac{l_p}{R^2}\frac{l_p}{\bar{\lambda}}$
Orbital velocity	$v_o = \sqrt{\frac{GM}{R}} = c\sqrt{\frac{l_p}{R}\frac{l_p}{\bar{\lambda}}}$	$v_o = \sqrt{\frac{c^3\tilde{M}}{R}} = c\sqrt{\frac{l_p}{R}\frac{l_p}{\bar{\lambda}}}$
Escape velocity	$v_e = \sqrt{\frac{2GM}{R}} = c\sqrt{2\frac{l_p}{R}\frac{l_p}{\bar{\lambda}}}$	$v_e = \sqrt{\frac{2c^3\tilde{M}}{R}} = c\sqrt{2\frac{l_p}{R}\frac{l_p}{\bar{\lambda}}}$
Time dilation	$T_r = T_f\sqrt{1 - \frac{\sqrt{\frac{2GM}{R}}^2}{c^2}} = T_f\sqrt{1 - 2\frac{l_p}{R}\frac{l_p}{\bar{\lambda}}}$	$T_r = T_f\sqrt{1 - \frac{\sqrt{\frac{2c^3\tilde{M}}{r}}^2}{c^2}} = T_f\sqrt{1 - 2\frac{l_p}{R}\frac{l_p}{\bar{\lambda}}}$
Gravitational red-shift	$z(r) \approx \frac{GM}{c^2R} = \frac{l_p}{R}\frac{l_p}{\bar{\lambda}}$	$z(R) \approx \frac{c^3\tilde{M}}{c^2 r} = \frac{l_p}{R}\frac{l_p}{\bar{\lambda}}$
Schwarzschild radius	$r_s = \frac{2GM}{c^3} = 2l_p\frac{l_p}{\bar{\lambda}}$	$r_s = \frac{2c^3\tilde{M}}{c^2} = 2\tilde{E} = 2l_p\frac{l_p}{\bar{\lambda}}$

Table 1: The table shows the Newton gravitational force in addition to our new quantum gravity theory.

In our view, this means that standard physics is using collision-time mass in all gravity predictions, since all observable gravity phenomena contains GM. The other mass, m, is a kg mass, and it cannot be used to predict gravity. It is an incomplete mass, but since we are also using another small kg mass in all derivations to calculate something observable (such as the escape velocity that is input in gravitational time dilation), then the small masses cancel out.

We can conclude that standard physics indirectly uses two different mass definitions in the so-called Newton gravity formula and use a gravity constant to fix this issue. Thus, in all predictions for observable phenomena, the correct mass is being used, that is collision-time type mass. However, in other branches of physics such as special relativity theory and quantum mechanics, a kg mass measure that is not multiplied by the gravity constant is being used. This means that there is no way to unify quantum mechanics or special relativity theory with gravity without addressing this issue. One either has to use collision-time mass everywhere directly in physics, as shown by Haug. The alternative is to retain G and incorporate it in all masses, not merely the mass used for gravity predictions. In that case, we would have to rewrite all kg masses by multiplying them by $\frac{G}{c^3}$. This will give an ugly notation that does not lend itself well to direct intuition, even though its output is identical to our collision space-time unified gravity theory.

5 The Compton Wave and the de Broglie Wave

In another paper, we discussed how the Compton wave is the true matter wave and how the de Broglie wave is just a mathematical derivative of the Compton wave [19, 20]. The de Broglie wave [21, 22] is derived from the standard momentum

$$\lambda_b = \frac{h}{\frac{mv}{\sqrt{1-\frac{v^2}{c^2}}}} \tag{16}$$

this means indirectly that the standard momentum is linked to the de Broglie wave at the quantum level. The de Broglie wave has a series of strange properties, such as an infinite wave length when a particle is at rest. This has led to a series of absurd predictions, I.e., an electron exists everywhere in the universe at the same time until it is observed.

We claim the true matter wave is the Compton wave, which is given by

$$\lambda_c = \frac{h}{\frac{mc}{\sqrt{1-\frac{v^2}{c^2}}}} \tag{17}$$

Unlike the de Broglie wave, the Compton wave can be measured even for rest-mass particles. It would indeed be strange if matter had two types of matter waves. One that is very short when a particle stands still and another that is infinite when the particle stands still.

The de Broglie wave is linked to the Compton wave by the simple function $\lambda_b = \lambda_c \frac{c}{v}$. We can also define a new momentum based on the Compton wave. In our previous paper, we have defined a rest mass momentum as

$$\tilde{p}_r = \tilde{m}c \tag{18}$$

Further, we have defined a kinetic momentum

$$\tilde{p}_k = \frac{\tilde{m}c}{\sqrt{1-\frac{v^2}{c^2}}} - \tilde{m}c \tag{19}$$

and a total momentum

$$\tilde{p}_t = \tilde{p}_k + \tilde{p}_r = \frac{\tilde{m}c}{\sqrt{1-\frac{v^2}{c^2}}} - \tilde{m}c + \tilde{m}c = \frac{\tilde{m}c}{\sqrt{1-\frac{v^2}{c^2}}} \tag{20}$$

We have also shown in the last paper that this corresponds to a new way to see energy. In our new theory, there is actually no need for as distinction between momentum and energy as they are ultimately the same.

6 The Beauty and The Beast

Table 2 shows how standard physics formulas must be altered if one wants to hold on to the gravity constant G and the kg definition of mass, and at the same time get a unified theory. On the other hand, if one truly understands what G represents, then this is not needed, and one can then write the unified theory with much nicer notation that offers beauty and simplicity. Both approaches give exactly the same results and are one and the same theory at the deepest level. We can call the two approaches the Beauty and the Beast. The Beauty is the theory derived from truly understanding what mass is and why G was added to the Newton formula, while eliminating that constant. The Beast is how we can get to the same unified theory by holding on to G and the kg definition of mass.

The last table shows the deepest level, which is identical for the two notations of a unified quantum gravity theory.

7 Gravity Quantum Mechanics the Beautiful Way

In standard physics we have a relativistic wave equation that one get from the standard relativistic energy momentum relation, this is the Klein–Gordon equation that is given by

$$\frac{1}{c^2}\frac{\partial^2}{\partial t^2}\Psi - \nabla^2\Psi + \frac{m^2c^2}{\hbar^2}\Psi = 0 \tag{21}$$

The Klein–Gordon equation has strange properties, such as energy squared. If we instead use our new momentum definition and its corresponding relativistic energy–momentum relation, we get

$$\begin{aligned}
\tilde{E} &= \mathbf{p}_k + \tilde{m}c \\
\tilde{E} &= \left(\frac{\tilde{m}c}{\sqrt{1-\frac{\mathbf{v}^2}{c^2}}} - \tilde{m}c\right) + \tilde{m}c \\
\tilde{E} &= \frac{\tilde{m}c}{\sqrt{1-\frac{\mathbf{v}^2}{c^2}}} \\
\tilde{E} &= \frac{l_p^2}{\bar{\lambda}\sqrt{1-\frac{\mathbf{v}^2}{c^2}}}
\end{aligned} \tag{22}$$

The r_e is half of the relativistic Schwarzschild radius, so we must have $r_e = \frac{1}{2}r_s = \frac{l_p^2}{\bar{\lambda}\sqrt{1-\frac{\mathbf{v}^2}{c^2}}}$. This means that the relativistic energy momentum relation under our new and deeper understanding of mass can also be written as

$$\begin{aligned}
\tilde{E} &= \mathbf{p}_k + \tilde{m}c \\
r_e &= \tilde{m}\mathbf{c}
\end{aligned} \tag{23}$$

From this, we get the following relativistic wave equation

$$-l_p^2\frac{\partial\Psi}{\partial t}=-l_p^2\nabla\cdot(\Psi\mathbf{c}) \tag{24}$$

where $\mathbf{c}=(c_x,c_y,c_z)$ would be the light velocity field. Since the velocity of light is constant and incompressible then what we can call the light velocity field must satisfy the following

$$\nabla\cdot\mathbf{c}=0 \tag{25}$$

Tis means the light velocity field is a solenoidal, which again means we can rewrite the wave equation above as

$$\frac{\partial\Psi}{\partial t}-\mathbf{c}\cdot\nabla\Psi=0 \tag{26}$$

Our new relativistic quantum wave equation has quite a different plane wave solution than the Klein–Gordon and Schrödinger [23] equations; our plane wave equation is given by

$$\psi=e^{i(kt-\omega x)} \tag{27}$$

However, in our theory $k=\frac{2\pi}{\lambda_c}$, where λ_c is the relativistic Compton wavelength and not the de Broglie wavelength, as in standard wave mechanics. Due to this, we have

$$k=\frac{r_e}{l_p^2}=\frac{\frac{r_e}{\sqrt{1-\frac{v^2}{c^2}}}}{l_p^2}=\frac{2\pi}{\lambda_c} \tag{28}$$

So, we can also write the plane wave function as

$$e^{i\left(\frac{\bar{L}}{l_p^2}t-\frac{\bar{T}}{l_p^2}x\right)}=e^{i\left(\frac{\bar{E}}{l_p^2}t-\frac{\tilde{m}}{l_p^2}x\right)}=e^{i\left(\frac{r_e}{l_p^2}t-\frac{\tilde{m}}{l_p^2}x\right)} \tag{29}$$

where r_e is half the relativistic Schwarzschild radius as defined earlier. Our quantum wave function is rooted in the Compton wavelength instead of the de Broglie wavelength and it incorporates collision-time that does not exist in modern physics, except, as we will see indirectly, through gravity. For formality's sake, we can look at the Schwarzschild radius operator and mass operators and see that they are correctly specified.

This means the Schwarzschild operator (space with respect to time) must be

$$\frac{\partial\psi}{\partial t}=\frac{ir_e}{l_p^2}e^{i\left(\frac{r_e}{l_p^2}t-\frac{\tilde{m}}{l_p^2}x\right)} \tag{30}$$

and this gives us a time operator of

$$r_e=-il_p^2\frac{\partial}{\partial t} \tag{31}$$

And for mass we have

$$\frac{\partial\psi}{\partial x}=\frac{-i\tilde{m}}{l_p^2}e^{i\left(\frac{r_e}{l_p^2}t-\frac{\tilde{m}}{l_p^2}x\right)} \tag{32}$$

and this gives us a mass operator of

$$\tilde{m}=-il_p^2\nabla \tag{33}$$

The only difference between the non-relativistic and relativistic wave equations is that in a non-relativistic equation we can use

$$k=\frac{r_e}{l_p^2}=\frac{r_e}{l_p^2}=\frac{2\pi}{\lambda_c} \tag{34}$$

instead of the relativistic form $r_e=\frac{l_p^2}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}$. This is because the first term of a Taylor series expansion is $r_e\approx\tilde{m}c$ when $v<<c$.

8 Gravity Quantum Mechanics: The Ugly Way

Here we retain as much of standard physics as possible: 1) energy must be equal to mass squared, and 2) we keep G and $\hbar$, even though they are not needed if one understands physics at a deeper level. This will still produce a correct quantum mechanics that lets us unify gravity, quantum mechanics, and relativity theory. However, the notation is awkward, as we have to multiply all masses with $\frac{G}{c^3}$,. This also helps to explain why it has been so difficult to unify gravity and quantum mechanics and shows how our collision space-time theory contributes to this understanding.

Our relativistic energy momentum relation is

$$\tilde{E} = \tilde{p}_t \mathbf{c} \tag{35}$$

bearing in mind that we use the Compton momentum rather than the de Broglie momentum. Now we can substitute $\tilde{E}$ and $\tilde{p}_t$ with corresponding energy and momentum operators and get a new relativistic quantum mechanical wave equation

$$-i\hbar\frac{G}{c^3}\frac{\partial\Psi}{\partial t} = -i\hbar\frac{G}{c^3}\nabla\cdot(\Psi\mathbf{c}) \tag{36}$$

where $\mathbf{c} = (c_x, c_y, c_z)$ would be the light velocity field. Interestingly, the equation has the same structural form as the advection equation, but here for quantum wave mechanics. Dividing both sides by $i\hbar\frac{G}{c^3}$, we can rewrite this as

$$-\frac{\partial\Psi}{\partial t} = -\nabla\cdot(\Psi\mathbf{c}) \tag{37}$$

The light velocity field should satisfy

$$\nabla\cdot\mathbf{c} = 0 \tag{38}$$

since the velocity of light is constant and incompressible; that is, the light velocity field is a solenoidal, which means we can rewrite our wave equation as

$$\frac{\partial\Psi}{\partial t} - \mathbf{c}\cdot\nabla\Psi = 0 \tag{39}$$

Even if we call it the ugly way, the result is beautiful and directly linked to our more beautiful way of arriving at this result. However, the derivations are indeed awkward, as the $\frac{G}{c^3}$ factor gives little or no intuition if not understanding the deeper meaning of it, namely that $\frac{G}{c^3} = \frac{l_p^2}{\hbar}$. This factor is used simply to eliminate the Planck constant and put the Planck length into the mass. That is, to get rid of the incomplete kg mass and to replace it with collision-time.

In the expanded form, we have

$$\frac{\partial\Psi}{\partial t} - c_x\frac{\partial\Psi}{\partial x} - c_y\frac{\partial\Psi}{\partial y} - c_z\frac{\partial\Psi}{\partial z} = 0 \tag{40}$$

Our new relativistic quantum equation has quite a different plane wave solution than the Klein–Gordon and Schrödinger equations

$$\psi = e^{i(kx-\omega t)} \tag{41}$$

In our theory, $k = \frac{2\pi}{\lambda_c}$, where λ_c is the relativistic Compton wavelength and not the de Broglie wavelength, as in standard wave mechanics. Due to this, we have

$$k = \frac{p_t}{\hbar\frac{G}{c^3}} = \frac{2\pi}{\lambda_c} \tag{42}$$

So, we can also write the plane wave solution as

$$e^{i\left(\frac{p_t}{\hbar\frac{G}{c^3}}x - \frac{E}{\hbar\frac{G}{c^3}}t\right)} \tag{43}$$

Our quantum wave function is rooted in the Compton wavelength instead of the de Broglie wavelength. Next let us look at the energy and momentum operators and see that they are correctly specified

$$\frac{\partial\psi}{\partial x} = \frac{ip_t}{\hbar\frac{G}{c^3}}e^{i\left(\frac{p_t}{\hbar\frac{G}{c^3}}t - \frac{\tilde{E}}{\hbar\frac{G}{c^3}}x\right)} \tag{44}$$

This means the momentum operator must be

$$\hat{p}_t = -i\hbar\frac{G}{c^3}\nabla \tag{45}$$

and for energy we have

$$\frac{\partial\psi}{\partial t} = \frac{-i\tilde{E}}{\hbar\frac{G}{c^3}}e^{i\left(\frac{p_t}{\hbar\frac{G}{c^3}}t-\frac{\tilde{E}}{\hbar\frac{G}{c^3}}x\right)} \tag{46}$$

and this gives us energy operator of

$$\hat{E} = -i\hbar\frac{G}{c^3}\frac{\partial}{\partial t} \tag{47}$$

The only difference between the non-relativistic and relativistic wave equation is that in a non-relativistic equation we can use

$$k = \frac{p_t}{\hbar\frac{G}{c^3}} = \frac{\frac{m\frac{G}{c^3}c}{\sqrt{1-\frac{v^2}{c^2}}}}{\hbar\frac{G}{c^3}} = \frac{2\pi}{\lambda_c} \tag{48}$$

instead of the relativistic form $\tilde{p}_t = \frac{m\frac{G}{c^3}c}{\sqrt{1-\frac{v^2}{c^2}}}$. This is because the first term of a Taylor series expansion is $p_t \approx m\frac{G}{c^3}c = m\frac{G}{c^2}$ when $v << c$.

9 Gravity Quantum Mechanics: The Ugly Way 2

This is almost the same as above, except that instead of holding on to the idea that energy must be mass squared, we have instead energy just as mass times c. However, we still need to multiply the mass by $\frac{G}{c^3}$ to get a quantum mechanics that is consistent with gravity. Our relativistic energy momentum relation is

$$\tilde{E} = \tilde{p}_t \tag{49}$$

(Remember we are using the Compton momentum rather than the de Broglie momentum). Now we can substitute $\tilde{E}$ and $\tilde{p}_t$ with corresponding energy and momentum operators and get a new relativistic quantum mechanical wave equation

$$-i\hbar\frac{G}{c^3}\frac{\partial\Psi}{\partial t} = -i\hbar\frac{G}{c^3}\nabla\cdot(\Psi) \tag{50}$$

where $\mathbf{c} = (c_x, c_y, c_z)$ would be the light velocity field. Interestingly, the equation has the same structural form as the advection equation, but here for quantum wave mechanics. Dividing both sides by $i\hbar\frac{G}{c^3}$, we can rewrite this as

$$-\frac{\partial\Psi}{\partial t} = -\nabla\cdot(\Psi) \tag{51}$$

Our new relativistic quantum equation has quite a different plane wave solution than the Klein–Gordon and Schrödinger equations

$$\psi = e^{i(kx-\omega t)} \tag{52}$$

In our theory, $k = \frac{2\pi}{\lambda_c}$, where λ_c is the relativistic Compton wavelength and not the de Broglie wavelength, as in standard wave mechanics. Due to this, we have

$$k = \frac{p_t}{\hbar\frac{G}{c^3}} = \frac{2\pi}{\lambda_c} \tag{53}$$

So, we can also write the plane wave solution as

$$e^{i\left(\frac{p_t}{\hbar\frac{G}{c^3}}x-\frac{E}{\hbar\frac{G}{c^3}}t\right)} \tag{54}$$

Our quantum wave function is rooted in the Compton wavelength instead of the de Broglie wavelength. Next let us look at the energy and momentum operators and see that they are correctly specified

$$\frac{\partial\psi}{\partial x} = \frac{ip_t}{\hbar\frac{G}{c^3}}e^{i\left(\frac{p_t}{\hbar\frac{G}{c^3}}t-\frac{\tilde{E}}{\hbar\frac{G}{c^3}}x\right)} \tag{55}$$

This means the momentum operator must be

$$\hat{p}_t = -i\hbar\frac{G}{c^3}\nabla \tag{56}$$

and for energy we have

$$\frac{\partial\psi}{\partial t} = \frac{-i\tilde{E}}{\hbar\frac{G}{c^3}} e^{i\left(\frac{p_t}{\hbar\frac{G}{c^3}}t - \frac{\tilde{E}}{\hbar\frac{G}{c^3}}x\right)} \tag{57}$$

and this gives us energy operator of

$$\hat{E} = -i\hbar\frac{G}{c^3}\frac{\partial}{\partial t} \tag{58}$$

The only difference between the non-relativistic and relativistic wave equation is that in a non-relativistic equation we can use

$$k = \frac{p_t}{\hbar\frac{G}{c^3}} = \frac{\frac{m\frac{G}{c^3}c}{\sqrt{1-\frac{v^2}{c^2}}}}{\hbar\frac{G}{c^3}} = \frac{2\pi}{\lambda_c} \tag{59}$$

instead of the relativistic form $\tilde{p}_t = \frac{m\frac{G}{c^3}c}{\sqrt{1-\frac{v^2}{c^2}}}$. This is because the first term of a Taylor series expansion is $p_t \approx m\frac{G}{c^3}c = m\frac{G}{c^2}$ when $v << c$.

10 Occam'z Razer Means Collision-Time Wins over Standard Physics

We have recently introduced a unified quantum gravity theory [19, 20]. In short, we have replaced the standard mass definition that we claim is incomplete with our new mass definition that is collision-time. We also maintain that all energy can be described as collision length. We no longer need the gravity constant G. Newton himself never described such a constant; his gravity formula was $F = \frac{Mm}{r^2}$, which is the gravity formula we also obtain, and still we generate the same output as standard physics for all observable gravity phenomena. We also do not need the Planck constant; instead, we need the Planck length, which can be found with no knowledge of G or $\hbar$. Our theory needs fewer constants than standard physics and is therefore more compact. Further, we no longer need momentum and energy, as they are the same in our theory. In addtion, we address the definition of mass and energy. In our theory, energy is collision length.

11 Conclusion

In this paper, we have summarized how we can unify quantum gravity with quantum mechanics and relativity theory. We also illustrate the challenges involved in developing a unified theory over the past 100 years. Modern physics has used an incomplete mass measure and in addition has viewed the de Broglie wave is the true matter wave, while in reality the Compton wave is the better choice.

In our new theory, the gravity constant G is no longer needed and in eliminating it, we arrive at a theory that is more consistent with Newton's original theory. Modern physics has, in fact, disregarded an essential element of Newton's philosophy behind his theory, i.e., that mass ultimately consisted of indivisible particles. In this paper, we have shown how one can also reach a unified theory by holding on to G and the Planck constant, although neither of these constants are needed in our theory. Instead, the Planck length plays an important role, and we have shown in previous publications how it can be extracted from gravity observations with no knowledge off G or $\hbar$. If we hold on to G and $\hbar$ as constants and work with the kg definition of mass that is directly linked to these two constants, we can still get a unified theory that is the same as our previous theory. However, this comes with ugly notation that gives minimal intuition and the deeper meaning is hidden because the kg mass definition is incomplete, and also because G is a composite constant. Without understanding what G, the Planck constant $\hbar$, and the kg definition of mass truly represent, it is indeed challenging, if not impossible to reach either form of a unified theory of quantum gravity.

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Appendix: Finding the Electron mass from the Compton wavelength of the electron

There are several ways to find the Compton wavelength of the electron, one way is to use Compton scattering. The Compton scattering method has the advantage it need no knowledge of the Planck constant to find the Compton wave. Another method to find the Compton wavelength of the electron is to watch the Hydrogen spectral lines. The Compton wave length of the electron is linked to the spectral lines with the following formula

$$\lambda_e = \lambda \left(\frac{1}{\sqrt{1-\alpha^2}} - \frac{3}{4} - \frac{1}{\sqrt{1-\alpha^2}} \frac{1}{4} \right) \tag{60}$$

This method also requires that we know the fine structure constant, that again likely means one also need to know the Planck constant (?). For hydrogen like atoms with element above $z > 1$ the following formula can be used to find the Compton wavelength

$$\lambda_e = \lambda \left(\frac{1}{\sqrt{1-(z^2\alpha^2)}} \frac{1}{n_1^2} - \frac{1}{n_1^2} - \frac{1}{\sqrt{1-(z^2\alpha^2)}} \frac{1}{n_2^2} + \frac{1}{n_2^2} \right) \tag{61}$$

	Unified with G **If wants to hold on to G and kg** **The Beast**	**Unified the Newton Way** **Mass rooted in atomism** **The Beauty**
Mass	kg mass introduced 1800	Atomism mass: indivisibles Newton's philosophy behind everything Democritus and Leucippus
Time	??	Newton's indivisible time
Mass	$m = \frac{\hbar}{\bar{\lambda}}\frac{1}{c}$ kg	$\tilde{T} = \tilde{m} = \frac{l_p}{c}\frac{l_p}{\bar{\lambda}}$ Collision-time
Energy	$\bar{E} = \left(m\frac{G}{c^3}\right)c^2 = m\frac{G}{c}$ Collision-length times c $\bar{E} = \tilde{E}c$	$\tilde{L} = \tilde{E} = \tilde{m}c = l_p\frac{l_p}{\bar{\lambda}}$ Collision-length
Speed of light	$c = \frac{\bar{E}}{m\frac{G}{c^2}}$	$c = \frac{\tilde{E}}{\tilde{m}} = \frac{\tilde{L}}{\tilde{T}}$
Maximum velocity mass	$v_{max} = c\sqrt{1 - \frac{Gm^2}{\hbar c}}$	$c = c\sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}}$
Relativistic energy	$\bar{E} = \frac{m\frac{G}{c}}{\sqrt{1-\frac{v^2}{c^2}}}$	$\tilde{E} = \frac{\tilde{m}c}{\sqrt{1-\frac{v^2}{c^2}}}$
Kinetic energy	$\bar{E}_k = \frac{m\frac{G}{c}}{\sqrt{1-\frac{v^2}{c}}} - m\frac{G}{c}$	$\tilde{E}_k = \frac{\tilde{m}c}{\sqrt{1-\frac{v^2}{c^2}}} - \tilde{m}c$
Kinetic energy	$\bar{E}_k \approx \frac{1}{2}Gm\frac{v^2}{c^3}$	$\tilde{E}_k \approx \frac{1}{2}\tilde{m}\frac{v^2}{c}$
Relativistic Compton wave	$\bar{\lambda} = \frac{\hbar}{\frac{mc}{\sqrt{1-\frac{v^2}{c^2}}}}$	$\bar{\lambda} = \frac{l_p^2}{\frac{\tilde{m}c}{\sqrt{1-\frac{v^2}{c^2}}}}$
Relativistic de Broglie wave	$\bar{\lambda} = \frac{\hbar}{\frac{mv}{\sqrt{1-\frac{v^2}{c^2}}}}$	$\bar{\lambda} = \frac{l_p^2}{\frac{\tilde{m}v}{\sqrt{1-\frac{v^2}{c^2}}}}$
Rest mass Compton momentum	$\tilde{p}_r = m\frac{G}{c^2}$	$\tilde{p}_r = \tilde{m}c$
Total Compton momentum	$\tilde{p}_t = \frac{m\frac{G}{c^2}}{\sqrt{1-\frac{v^2}{c^2}}}$	$\tilde{p}_t = \frac{\tilde{m}c}{\sqrt{1-\frac{v^2}{c^2}}}$
Kinetic Compton momentum	$\tilde{p}_k = \frac{m\frac{G}{c^2}}{\sqrt{1-\frac{v^2}{c^2}}} - m\frac{G}{c^2}$	$\tilde{p}_k = \frac{\tilde{m}c}{\sqrt{1-\frac{v^2}{c^2}}} - \tilde{m}c$
de Broglie momentum	$\tilde{p}_b = \frac{m\frac{G}{c^3}v}{\sqrt{1-\frac{v^2}{c^2}}}$	$\tilde{p}_b = \frac{\tilde{m}v}{\sqrt{1-\frac{v^2}{c^2}}}$
Gravity	$F = c^3\frac{M\frac{G}{c^3}m\frac{G}{c^3}}{r^2} = G\frac{Mm\frac{G}{c^3}}{r^2}$	$F = c^3\frac{\tilde{M}\tilde{m}}{r^2}$
Orbital velocity	$v_o \approx \sqrt{\frac{GM}{r}}$	$v_o \approx \sqrt{\frac{c^3\tilde{M}}{r}}$
Escape velocity	$v_e = \sqrt{\frac{2GM}{r} - \frac{G^2M^2}{c^2r^2}}$	$v_e = \sqrt{\frac{2c^3\tilde{M}}{r} - \frac{c^4\tilde{M}^2}{r^2}}$
Schwarzschild radius	$r_s = \frac{2GM}{c^2}$	$r_s = 2\tilde{M}c = 2\tilde{E}$
Gravity acceleration	$g = \frac{GM}{r^2}$	$g = \frac{c^3\tilde{M}}{r^2}$
Energy momentum relation	$\bar{E} = \tilde{p}_kc + \tilde{p}_rc$	$\tilde{E} = \tilde{p}_k + \tilde{m}c$
Relativistic wave equation Compact form	$-i\frac{G}{c^3}\hbar\frac{\partial\Psi}{\partial t} + i\hbar\frac{G}{c^3}c\nabla = 0$ $\frac{\partial\Psi}{\partial t} - c\nabla = 0$	$-il_p^2\frac{\partial\Psi}{\partial t} + il_p^2c\nabla = 0$ $\frac{\partial\Psi}{\partial t} - c\nabla = 0$
Wave equation when $v << c$	$i\frac{\partial\Psi}{\partial t} \approx \left(\frac{-\bar{\lambda}}{2}\nabla^2 + \frac{1}{\bar{\lambda}}\right)\Psi$	$i\frac{\partial\Psi}{\partial t} \approx \left(\frac{-\bar{\lambda}}{2}\nabla^2 + \frac{1}{\bar{\lambda}}\right)\Psi$
Lorenz symmetry break down at the Planck scale	Yes	Yes
Heisenberg uncertainty break down at the Planck scale	Yes	Yes
Hidden?	Secrets hidden in G and $\hbar$	Nothing hidden
G	?	$G = \frac{l_p^2c^3}{\hbar}$ No need
$\hbar$	Only partly understood	$\hbar = \frac{1}{f_{c,1kg}}$, No need

Table 2: The table shows two unified theories of physics; the only difference is notation. If one wants to hold on to G and the kg definition of mass, then one gets an ugly notation where the deeper logic is hard to see (hidden inside G and the kg definition of mass). If, on the other hand, one switches to a mass definition rooted in atomism and in Newton's philosophy, then one gets a beautiful notation and simplicity.

	Unified with G **If wants to hold on to G and kg** **The Beast**	**Unified the Newton Way** **Mass rooted in atomism** **The Beauty**
Mass	kg mass introduced 1800	Atomism mass: indivisibles Newton's philosophy behind everything Democritus and Leucippus
Time	??	Newton's indivisible time
Mass	$m=\frac{\hbar}{\bar{\lambda}}\frac{1}{c}$ kg	$\tilde{T}=\tilde{m}=\frac{l_p}{c}\frac{l_p}{\bar{\lambda}}$ Collision-time
Energy	$\tilde{E}=m\frac{G}{c^3}c=m\frac{G}{c^2}$ Collision-length	$\tilde{L}=\tilde{E}=\tilde{m}c=l_p\frac{l_p}{\bar{\lambda}}$ Collision-length
Speed of light	$c=\frac{\tilde{E}}{m\frac{G}{c^3}}$	$c=\frac{\tilde{E}}{\tilde{m}}=\frac{\tilde{L}}{\tilde{T}}$
Maximum velocity mass	$v_{max}=c\sqrt{1-\frac{Gm^2}{\hbar c}}$	$c=c\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}}$
Relativistic energy	$\tilde{E}=\frac{m\frac{G}{c^2}}{\sqrt{1-\frac{v^2}{c^2}}}$	$\tilde{E}=\frac{\tilde{m}c}{\sqrt{1-\frac{v^2}{c^2}}}$
Kinetic energy	$\tilde{E}_k=\frac{m\frac{G}{c^2}}{\sqrt{1-\frac{v^2}{c^2}}}-m\frac{G}{c^2}$	$\tilde{E}_k=\frac{\tilde{m}c}{\sqrt{1-\frac{v^2}{c^2}}}-\tilde{m}c$
Kinetic energy	$\tilde{E}_k\approx\frac{1}{2}Gm\frac{v^2}{c^4}$	$\tilde{E}_k\approx\frac{1}{2}\tilde{m}\frac{v^2}{c}$
Relativistic Compton wave	$\bar{\lambda}=\frac{\frac{\hbar}{mc}}{\sqrt{1-\frac{v^2}{c^2}}}$	$\bar{\lambda}=\frac{\frac{l_p^2}{\tilde{m}c}}{\sqrt{1-\frac{v^2}{c^2}}}$
Relativistic de Broglie wave	$\bar{\lambda}=\frac{\frac{\hbar}{mv}}{\sqrt{1-\frac{v^2}{c^2}}}$	$\bar{\lambda}=\frac{\frac{l_p^2}{\tilde{m}v}}{\sqrt{1-\frac{v^2}{c^2}}}$
Rest mass Compton momentum	$\tilde{p}_r=m\frac{G}{c^2}$	$\tilde{p}_r=\tilde{m}c$
Total Compton momentum	$\tilde{p}_t=\frac{m\frac{G}{c^2}}{\sqrt{1-\frac{v^2}{c^2}}}$	$\tilde{p}_t=\frac{\tilde{m}c}{\sqrt{1-\frac{v^2}{c^2}}}$
Kinetic Compton momentum	$\tilde{p}_k=\frac{m\frac{G}{c^2}}{\sqrt{1-\frac{v^2}{c^2}}}-m\frac{G}{c^2}$	$\tilde{p}_k=\frac{\tilde{m}c}{\sqrt{1-\frac{v^2}{c^2}}}-\tilde{m}c$
de Broglie momentum	$\tilde{p}_b=\frac{m\frac{G}{c^3}v}{\sqrt{1-\frac{v^2}{c^2}}}$	$\tilde{p}_b=\frac{\tilde{m}v}{\sqrt{1-\frac{v^2}{c^2}}}$
Gravity	$F=c^3\frac{M\frac{G}{c^3}m\frac{G}{c^3}}{r^2}=G\frac{Mm\frac{G}{c^3}}{r^2}$	$F=c^3\frac{\tilde{M}\tilde{m}}{r^2}$
Orbital velocity	$v_o\approx\sqrt{\frac{GM}{r}}$	$v_o\approx\sqrt{\frac{c^3\tilde{M}}{r}}$
Escape velocity	$v_e=\sqrt{\frac{2GM}{r}-\frac{G^2M^2}{c^2r^2}}$	$v_e=\sqrt{\frac{2c^3\tilde{M}}{r}-\frac{c^4\tilde{M}^2}{r^2}}$
Schwarzschild radius	$r_s=\frac{2GM}{c^2}$	$r_s=2\tilde{M}c=2\tilde{E}$
Gravity acceleration	$g=\frac{GM}{r^2}$	$g=\frac{c^3\tilde{M}}{r^2}$
Energy momentum relation	$\tilde{E}=\tilde{p}_k+\tilde{p}_r$	$\tilde{E}=\tilde{p}_k+\tilde{m}c$
Relativistic wave equation Compact form	$-i\frac{G}{c^3}\hbar\frac{\partial\Psi}{\partial t}+i\hbar\frac{G}{c^3}\nabla=0$ $\frac{\partial\Psi}{\partial t}-\nabla=0$	$-il_p^2\frac{\partial\Psi}{\partial t}+il_p^2c\nabla=0$ $\frac{\partial\Psi}{\partial t}-c\nabla=0$
Wave equation when $v << c$	$i\frac{\partial\Psi}{\partial t}\approx\left(\frac{-\bar{\lambda}}{2}\nabla^2+\frac{1}{\bar{\lambda}}\right)\Psi$	$i\frac{\partial\Psi}{\partial t}\approx\left(\frac{-\bar{\lambda}}{2}\nabla^2+\frac{1}{\bar{\lambda}}\right)\Psi$
Lorenz symmetry break down at the Planck scale	Yes	Yes
Heisenberg uncertainty break down at the Planck scale	Yes	Yes
Hidden?	Secrets hidden in G and $\hbar$	Nothing hidden
G	?	$G=\frac{l_p^2c^3}{\hbar}$ No need
$\hbar$	Only partly understood	$\hbar=\frac{1}{f_{c,1kg}}$, No need

Table 3: This table is almost the same as Table 2. The last column is the same. In the second column, we use $\tilde{E}$, rather than $\bar{E}$ as in the previous table. The two approaches then have identical outputs. In one way, we hold on to G and the Planck constant, even if they embedded in the theory and cancel out. In the last column, we see what the theory really is, a beautiful simple unified theory.

	Unified deepest level	
Mass	$\tilde{T} = \tilde{m} = \frac{l_p}{c}\frac{l_p}{\bar{\lambda}}$	Collision time
Energy	$\tilde{L} = \tilde{E} = \tilde{m}c = l_p\frac{l_p}{\bar{\lambda}}$	Collision-length
Speed of light	$c = \frac{\tilde{E}}{\tilde{m}} = \frac{\tilde{L}}{\tilde{T}} = \frac{l_p\frac{l_p}{\bar{\lambda}}}{\frac{l_p}{c}\frac{l_p}{\bar{\lambda}}}$	
Max velocity mass	$v_{max} = c\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}}$	
Relativistic energy	$\tilde{E} = \frac{\tilde{m}c}{\sqrt{1-\frac{v^2}{c^2}}} = l_p\frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}$	
Kinetic energy	$\tilde{E} = \frac{\tilde{m}c}{\sqrt{1-\frac{v^2}{c^2}}} - \tilde{m}c = l_p\frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}} - l_p\frac{l_p}{\bar{\lambda}}$	
Kinetic energy	$\tilde{E} = \frac{1}{2}\frac{l_p^2}{\bar{\lambda}}\frac{v^2}{c^2}$	
Relativistic Compton wave	$\bar{\lambda}_r = \bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}$	
Relativistic de Broglie wave	$\bar{\lambda}_{b,r} = \bar{\lambda}_b\sqrt{1-\frac{v^2}{c^2}}$	A derivative of Compton
Relativistic Compton momentum	$\tilde{E} = \tilde{p}_t = \frac{\tilde{m}c}{\sqrt{1-\frac{v^2}{c^2}}} = l_p\frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}$	True momentum
Relativistic kinetic Compton momentum	$\tilde{E}_k = \tilde{p}_k = \frac{\tilde{m}c}{\sqrt{1-\frac{v^2}{c^2}}} - \tilde{m}c = l_p\frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}} - l_p\frac{l_p}{\bar{\lambda}}$	True momentum
Relativistic de Broglie momentum	$\tilde{p}_b = \frac{\tilde{m}v}{\sqrt{1-\frac{v^2}{c^2}}} = l_p\frac{v}{c}\frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}$	Derivative, not needed
Gravity	$F = c^3\frac{\tilde{M}\tilde{m}}{r^2} = \frac{l_p^4 c}{\bar{\lambda}^2 r^2}$	
Orbital velocity	$v_o \approx \sqrt{\frac{c^3\tilde{M}}{r}} = \sqrt{\frac{c^2 l_p^2}{\bar{\lambda} r}}$	
Escape velocity	$v_e = \sqrt{\frac{2c^3\tilde{M}}{r} - \frac{c^4\tilde{M}^2}{r^2}} = \sqrt{\frac{2c^2 l_p^2}{\bar{\lambda} r} - \frac{c^2 l_p^4}{\bar{\lambda}^2 r^2}}$	
Schwarzschild radius	$r_s = 2c\tilde{M} = 2\frac{l_p^2}{\bar{\lambda}}$	
Gravity acceleration	$g = \frac{c^3\tilde{M}}{r^2} = \frac{c^2 l_p^2}{\bar{\lambda} r^2}$	
Energy momentum relation	$\tilde{E} = \frac{l_p^2}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}} - \frac{l_p^2}{\bar{\lambda}^2} + \frac{l_p^2}{\bar{\lambda}^2} = \frac{l_p^2}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}$	
Wave equation	$\frac{\partial\Psi}{\partial t} - c\nabla = 0$	
Lorenz symmetry break down at the Planck scale	Yes	Detected as gravity
Heisenberg uncertainty break down at the Planck scale	Yes	Detected as gravity
G	$G = \frac{l_p^2 c^3}{\hbar}$	G is not needed

Table 4: Here we have just simplified the two unified quantum gravity theories in Table 1 to their deepest level; they are then identical. It is only notation that distinguishes the two theories in Table 1