Collision-space-time: Unified quantum gravity

Espen Gaarder Haug
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Collision-space-time: Unified quantum gravity

Espen Gaarder Haug[a)]
Norwegian University of Life Sciences, Chr. Magnus Falsens vei 18, 1430 Ås, Norway

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Abstract: For about hundred years, modern physics has not been able to build a bridge between quantum mechanics (QM) and gravity. However, a solution may be found here. We present our quantum gravity theory, which is rooted in indivisible particles where matter and gravity are related to collisions and can be described by collision-space-time. In this paper, we also show that we can formulate a quantum wave equation rooted in collision-space-time, which is equivalent to mass and energy. The beauty of our theory is that most of the main equations that currently exist in physics are, in general, not changed in terms of predictions and what we could call structural form, except at the Planck scale. The Planck scale is directly linked to gravity, which has obviously already been detected, and gravity is actually a Lorentz symmetry as well as a form of Heisenberg uncertainty break down at the Planck scale. Our theory gives a dramatic simplification of many physics formulas without altering the output predictions, except at the Planck scale, and this new formulation gives us a unified theory. The relativistic wave equation, the relativistic energy momentum relation, and Minkowski space can all be represented by simpler equations when we understand mass at a deeper level. This is not attained at a cost, but rather a reflection of the benefit in having gravity and QM unified under the same theory. © *2020 Physics Essays Publication.* [http://dx.doi.org/10.4006/0836-1398-33.1.46]

Résumé: Depuis une centaine d'années, la physique moderne n'a pas été en mesure de jeter un pont entre la mécanique quantique et la gravité. Cependant, une solution peut être trouvée ici. Nous présentons notre théorie de la gravité quantique, qui est enracinée dans des particules indivisibles où la matière et la gravité sont liées aux collisions et peuvent être décrites par l'espace-temps de collision. Dans cet article, nous montrons également que nous pouvons formuler une équation d'onde quantique enracinée dans l'espace-temps de collision, qui est équivalente à la masse et à l'énergie. La beauté de notre théorie est que la plupart des principales équations qui existent actuellement en physique ne sont, en général, pas modifiées en termes de prédictions et de ce que nous pourrions appeler la forme structurelle, sauf à l'échelle de Planck. L'échelle de Planck est directement liée à la gravité, qui a évidemment déjà été détectée, et la gravité est en fait une symétrie de Lorentz ainsi qu'une forme d'incertitude de Heisenberg se décomposant à l'échelle de Planck. Notre théorie donne une simplification spectaculaire de nombreuses formules de physique sans altérer les prédictions résultantes, sauf à l'échelle de Planck, et cette nouvelle formulation nous donne une théorie unifiée. L'équation d'onde relativiste, la relation relativiste énergie-quantité de mouvement, et l'espace de Minkowski peuvent tous être représentés par des équations plus simples lorsque nous comprenons la masse à un niveau plus profond. Ceci n'est pas atteint à un coût, mais plutôt une réflexion de l'avantage d'avoir la gravité et la mécanique quantique unifiées sous la même théorie.

Key words: Quantum Gravity; Indivisible Particles; Planck Scale; Unified Theory; Lorentz Symmetry Break Down at the Planck Scale; Heisenberg Uncertainty Break Down at the Planck Scale; Gravity and Lorentz Symmetry Break Down; Gravity Constant; Compton Wave; de Broglie Wave.

I. SHORT INTRODUCTION TO THE INCOMPLETE MASS DEFINITION IN MODERN PHYSICS AND WHAT IT TRULY REPRESENTS

Modern physics texts talk about mass in terms of kg, which are linked to the Planck constant. This became especially clear after the kg was redefined in terms of the Planck constant in 2019, based on the Watt balance.[1–3] Modern physics can explain quite a bit about how energy relates to mass; however, we will claim that an important aspect of mass is missing, and we will elaborate on that observation in this paper. All rest-masses in terms of kg, including elementary particles, can be described by the following formula:

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

where $\bar{\lambda}$ is the reduced Compton wavelength; the formula is simply found by solving the Compton[4] wavelength formula $\bar{\lambda} = \hbar/(mc)$ with respect to the mass.

Less known is that this formula also holds for composite masses, such as one kg because even if a kg or other

[a)]espenhaug@mac.com

composite mass consists of several Compton wavelengths (because they consist of many particles), they are additive and the mathematical Compton wavelength of the composite mass will give the correct Compton frequency of the composite mass. Any composite mass can be written as

$$m = \sum_{i}^{N} \frac{\hbar}{\bar{\lambda}_i}\frac{1}{c} = \frac{\hbar}{c}\sum_{i}^{N}\frac{1}{\bar{\lambda}_i},$$
$$m = \frac{\hbar}{\frac{1}{\sum_{i}^{N}\frac{1}{\bar{\lambda}_i}}}\frac{1}{c},$$
$$m = \frac{\hbar}{\bar{\lambda}}\frac{1}{c}, \tag{2}$$

where

$$\bar{\lambda} = \frac{\hbar}{\sum_{i}^{N} m_i c} = \frac{1}{\sum_{i}^{N}\frac{1}{\bar{\lambda}_i}}. \tag{3}$$

A standard mass, such as a kg, we will claim at a deeper level is simply a collision ratio. One kg has the following number of internal collisions per second (the Compton frequency):

$$f_{1,\mathrm{kg}} = \frac{c}{\bar{\lambda}_{1,\mathrm{kg}}} = \frac{c}{\frac{\hbar}{1\times c}} = \frac{1\times c^2}{\hbar}$$
$$= 8.52\times 10^{50}\,\mathrm{collisions/s}. \tag{4}$$

For example, an electron will have the following number of internal collisions per second (Compton frequency):

$$f_e = \frac{c}{\bar{\lambda}_e} \approx 7.76\times 10^{20}\ \mathrm{collisions/s}. \tag{5}$$

The mass of an electron in terms of kg is the number of collisions in one electron relative to the number of collisions in one kg. That is to say, a kg is a collision ratio and for an electron, this collision ratio is

$$m = \frac{f_e}{f_{1,\mathrm{kg}}} = \frac{7.76\times 10^{20}}{8.52\times 10^{50}} \approx 9.1\times 10^{-31}\ \mathrm{kg}, \tag{6}$$

which is the known mass in kg of an electron. The same holds for a proton or any other mass. Interestingly, the reduced Compton frequency is only a deeper aspect of mass that has recently been more or less confirmed by experimental research, see Refs. 5 and 6.

This means the minimum size a mass that one can observe is one collision. In terms of kg, that is

$$m_g = \frac{1}{8.52\times 10^{50}} = \frac{1}{\frac{1\times c^2}{\hbar}} = \frac{\hbar}{c^2} \approx 1.17\times 10^{-51}\ \mathrm{kg}. \tag{7}$$

This confirms that the Planck constant is linked to quantized energy and mass. However, the Planck constant is linked to a collision ratio definition of mass/energy that is not optimal, as it completely ignores an important aspect of any mass, namely, the duration of each collision; this is a subject that we will return to soon.

The number of collisions in one kg is observational time dependent. If the number of collisions is observed in one kg over half a second rather than one full second, then the number of collisions is cut in half. However, then the number of collisions in an electron will also be cut in half, which means that the mass in kg is typically observational window time independent. However, this only holds true for observational time windows considerably above the Compton time, $t = \bar{\lambda}/c$, of the particle in question. If an electron is observed in a time window equal to half its Compton time, then the mass of the electron is, in our view, probabilistic and the predicted mass inside this time window is half of its known mass due to this probabilistic effect. This will be explained in detail later on.

The mass-gap (one collision) is, on the other hand, in terms of kg always observational time window dependent because in order to observe the smallest mass possible we need to observe one collision no matter what the time window is. If the number of collisions is below one, we have not observed any mass, as collisions come in discrete units. However, as the numbers of collisions decrease in one kg, the shorter the time window then the collision ratio of the mass-gap will be observational time dependent. In the shortest possible time window, the mass of the mass-gap must be

$$m_g = \frac{1}{8.52\times 10^{50}\frac{l_p}{c}} = \frac{c}{8.52\times 10^{50} l_p},$$
$$= \frac{c\hbar}{c^2 l_p} = \frac{\hbar}{l_p}\frac{1}{c} = m_p. \tag{8}$$

Here, we are assuming for a moment that the shortest possible time window is the Planck time. That is to say, when observed in the shortest possible time interval, then the mass-gap is the Planck mass. This is an enormous mass compared to observed particle masses. However, if the same mass-gap is observed inside an observation window of one second, it has a mass in kg of only 1.17×10^{-51} kg. This is close to the photon mass predicted by several researchers.[7,8] However, there is a difference in that the various other photon mass approaches are not observational window time dependent. It is first when one understands that the mass-gap in kg, which we will claim is directly linked to the photon mass, is observational time dependent that one sees that the mass-gap (i.e., the photon mass) is both the Planck mass: $m_p \approx 2.17\times 10^{-8}$ kg, as observed over one Planck second, and 1.17×10^{-51} kg, as observed over one second, and it is even smaller if observed in longer time windows. The photon in our model is massless when moving, and it is always moving at the speed of light c, with one exception: When it is colliding with another photon. As we will soon see, it is the collision between two photons that is the mass of the photon, and in our model, this is the pure mass that makes up all other masses. This photon mass (the collision point between two photons) only exists for one Planck second and is directly and surprisingly linked to gravity.

Since our mass-gap is directly linked to the photon mass (when colliding), we could also have gone to the mass-gap from the standard energy formulation. Since the original discovery by Max Planck, we have known that light energy (electromagnetism) is quantized in relation to the Planck constant in the form

$$E = \hbar f, \tag{9}$$

where f is the frequency per second.[b)]

In our view, one cannot observe an energy frequency below one ($f = 1$), except zero (which corresponds to no energy), in a given observational time window. Assume we observe a photon with a frequency of one in one second; this gives an energy of $E = \hbar f = \hbar \times 1 =$ Joule. Joules (on the SI base) are linked to a time interval, namely, the second, as a Joule is kg·m^2/s^2. As mass is related to energy, we can say, the hypothetical mass of a one frequency photon must be $m_\gamma = \hbar \times 1/c^2 = 1.17 \times 10^{-51}$ kg. Since $f = c/\lambda$ (or alternatively $f = c/\bar{\lambda}$ since we use the reduced Planck constant $\hbar$, rather than the Planck constant h here, as we have $hc/\lambda = \hbar c/\bar{\lambda}$), this would mean the wavelength of the photon has to be equal to the distance light travels in one second, if our observational window is one second. A second is, of course, not something fundamental in nature; it is an arbitrary chosen time window used to standardize our communications in physics and other scientific fields, as well as for daily tasks. To obtain a frequency of one in a half-second observational window, the wavelength of the photon has to be $\frac{1}{2} \times 299792458$ m. Assume we observe such a photon in half a second. Its mass in a half-second would then be $m_\gamma = \hbar \times 1/c^2 = 1.17 \times 10^{-51}$ kg per half second. However, the photon mass, as observed in one second, would now be $m_\gamma = \hbar \times 2/c^2 = 2 \times 1.17 \times 10^{-51}$ kg. But in the one-second observational window, we now have a frequency of two, and this indicates that it is not the smallest energy (mass-gap). If we stick to the idea that the smallest energy must be linked to a frequency of one, then an important question arises: Does there exist a shortest possible time window? Because this would define the shortest possible wavelength of light. The question also concerns whether time comes in discrete units, or if it is continuously divisible. We will soon see that time must come in discrete units equal to the Planck time. This is also closely linked to gravity and means that the smallest possible mass is $\hbar \times 1/c^2$ per Planck second. That is, we have $(\hbar \times 1/c^2)/t_p = \hbar/l_p \times 1/c$, which is the Planck mass, but now in an observational time window of one Planck second. Converted to the observational time window of one second, it corresponds to only $m_\gamma = \hbar \times 1/c^2 = 1.17 \times 10^{-51}$ kg.

In other words, the mass-gap is in some sense both super light and super heavy, all depending on the observational time window. However, we will claim the mass-gap, which is the photon mass, has a limit equal to the Planck mass, as we will show it is not possible to have a shorter time interval than the Planck time. It is important to understand that the photon particle actually has zero mass when behaving as light (when it is moving). It only has mass when it is colliding with another light particle, not because it magically gains any mass, but because mass is the very collision point between photons, in our view.

[b)]We could analyze whether we should use the Planck constant h here, rather than the reduced Planck constant, but this is beyond the scope of this discussion and will not affect any of the main points of conclusions of this paper.

II. INTRODUCTION TO OUR NEW THEORY

Our theory is rooted in the assumption that there is ultimately only one particle, namely, an indivisible particle. Newton was one of the last physicists who held this view. In the *Principia*,[9] he states

> "*Since every particle of space is always and every indivisible moment of duration is everywhere … then 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*." —Isaac Newton

Newton is also very clear on the concept that the ultimate particle is indivisible and fully hard in his book *Opticks*.[10] In our theory, we have made the following assumptions: Everything (energy and matter) consists of two elements

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

This means we have an indivisible particle with a diameter larger than zero. This diameter is unknown, but we will see that when our theory is calibrated to experimental data, it gives a value equal to the Planck length. We are saying that the colliding indivisible particles stand still relative to moving indivisible particles. The question is how long they stand still, and we will see this is one Planck time (Planck second). Further, we will see that the velocity of the indivisible particle is the speed of light. This is not something we assume; this is something we find by calibrating our theory to experiments. Under our theory, there only exists one pure mass, which is the collision between two indivisible particles. Non-colliding indivisible particles have no rest-mass and are moving at the speed of light.

The idea of an indivisible particle goes back to ancient Greek atomism, see Refs. 11–15, for example. Newton made a substantial number of references to atomism[16,17] and was clearly inspired by it; whether this inspiration led to some of his discoveries we will leave to others for consideration. A series of modern physicists including Schrödinger[18] also spent time studying ancient atomism, but it is not clear what, if anything, came out of it. Still, we think that modern physics gave up on atomism before investigating it adequately. Sudden discoveries also involve a certain degree of luck—to understand how a number of pieces fit together. In this paper, we will see how the idea of an indivisible particle falls into place with other theories and helps us unite key discoveries in modern physics into a simple unified quantum gravity theory.

Under this model, an electron will be in a pure mass state at its Compton periodicity. The electron is in a Planck mass state $c/\bar{\lambda}_e \approx 7.76 \times 10^{20}$ times per second. This is somewhat similar to Schrödinger's[19] hypothesis in 1930 of a trembling motion (Zitterbewegung) in the electron that he indicated was approximately $2mc^2/\hbar = 2c/\bar{\lambda}_e \approx 1.55 \times 10^{21}$ times per second. Each of these Planck mass events only lasts for one Planck second, so the mass of the electron in terms of kg will be

$$\begin{aligned} m &= \frac{c}{\bar{\lambda}_e} m_p t_p = \frac{c}{\bar{\lambda}_e} \frac{\hbar}{l_p} \frac{1}{c} \frac{l_p}{c}, \\ &= \frac{\hbar}{\bar{\lambda}_e} \frac{1}{c} \approx 9.1 \times 10^{31}\ \text{kg}. \end{aligned} \tag{10}$$

This standard mass measure still misses an important part of the aspect of mass: How long each collision lasts gets lost in the equation. This is because the Planck length cancels out and we are obtaining the mass as a collision frequency. This is no surprise, since mass as kg is a collision ratio that tells nothing about the collision-duration.

III. THE MISSING PIECE IN THE STANDARD MASS DEFINITION

We have seen that mass in terms of kg is a collision ratio. However, our current mass measure says nothing about the duration of each collision or the duration of all collisions aggregated. That is, mass consists of two important aspects: The number of collisions and the length of time these collisions last (the duration). Standard physics only notes the number of collisions in the form of a collision ratio and has not incorporated collision-time into the mass model. In addition, modern physics does not seem to note that the current mass definition is actually a collision ratio.

A. Mass definition: Mass as collision-time

In our new theory, mass is defined as collision-time over the shortest possible time interval and can be shown as

$$\bar{m} = t_p \frac{l_p}{\bar{\lambda}} = \frac{l_p}{c} \frac{l_p}{\bar{\lambda}}, \tag{11}$$

where t_p is the Planck time. We are not hypothesizing that this is the Planck time; it could be an unknown time x/c, but when our mass model is calibrated to gravity (based on our own quantum gravity model), we find that the shortest time is the Planck time and the shortest length is the Planck length. The factor

$$\frac{l_p}{\lambda} = \frac{t_p}{\frac{\lambda}{c}} \tag{12}$$

is the percentage of time a given particle is in the collision state. Thus, all masses are collisions between indivisibles, and the essential factor for gravity is how long this collision lasts. For a Planck mass particle, this collision lasts for one Planck second per Planck second, $\bar{m} = t_p\ l_p/l_p = t_p$. Every observable elementary particle goes in and out of the Planck mass state at the Compton frequency and therefore has a collision-time per random chosen Planck second of less than a Planck second per Planck second.

We can easily convert a mass in collision-time back to the mass in kg, simply by multiplying it by $\hbar/l_p^2$. That is, we have $m = \bar{m}\hbar/l_p^2$, and $\bar{m} = ml_p^2/\hbar$. However, when converting the mass definition to kg, then the mass definition loses information regarding the duration of each collision. The collision-time mass definition contains more information about the mass; in fact, it has direct information about the collision-duration and indirect information about the number of collisions. We simply obtain the number of collisions (per Planck second) by dividing the collision-time by the Planck time. Since the Planck time is already embedded in the collision-time, we do not need any new information here; it is all contained in the collision-time mass definition. The standard mass (kg) only contains information about the number of collisions relative to the number of collisions in an arbitrary amount of mass, but has no information about the duration of those collisions. We can say, the collision-time definition of mass contains more essential information about what mass really is at a fundamental level, while the standard mass (kg) contains less information at that level, but naturally holds more information about an arbitrary (human) chosen clump of matter (the kg).

The collision-time mass is additive just as the standard kg mass is. To better see the connection and differences between kg and collision-time, we can look at the collision-time ratio rather than the collision-time. The collision-time of one kg is 2.48×10^{-36} s. The collision-time of an electron is 2.26×10^{-66} s. However, the collision-time of one electron divided by the collision-time of one kg is

$$\frac{\bar{m}_e}{\bar{m}_{1\text{kg}}} \approx \frac{2.26 \times 10^{-66}}{2.48 \times 10^{-36}} \approx 9.1 \times 10^{-31}. \tag{13}$$

We advise that this is the same number as the electron mass in kg. Actually, the collision-time ratio will always give the same number output as kg. This supports our suggestion that the kg is a mass related to a ratio. But let us look closer at what happens when we divide two collision-times with each other, to get a mass that is a collision-time ratio, rather than just collision-time. We must then have

$$\frac{\bar{m}_1}{\bar{m}_2} = \frac{\frac{l_p}{c}\frac{l_p}{\bar{\lambda}_1}}{\frac{l_p}{c}\frac{l_p}{\bar{\lambda}_2}} = \frac{\bar{\lambda}_2}{\bar{\lambda}_1}, \tag{14}$$

we can see now that the Planck length has canceled out from the collision-time ratio. Later, we will see that gravity is directly linked to the collision-time duration, and therefore, any mass definition that is a ratio of two masses (such as kg or the collision-time ratio) cannot be used to find gravity without adding the Planck length back to the mass, something that is done indirectly in standard physics by having a gravity constant. This is not clear now, but will become clear through the rest of this paper.

B. Energy definition: Energy as collision-length

Energy at the deepest level is collision-length per shortest time interval

$$\bar{E} = l_p \frac{l_p}{\bar{\lambda}}, \tag{15}$$

and we have

$$\bar{E} = \bar{m}c, \tag{16}$$

and naturally

$$\bar{m} = \frac{\bar{E}}{c}. \tag{17}$$

This simply means that mass is collision-time, energy is collision-length, and the speed of light is collision-length, divided by collision-time. The speed of light is space-time; it is collision-length divided by collision-time

$$\frac{\bar{E}}{\bar{m}} = c = \frac{\bar{L}}{\bar{T}}. \tag{18}$$

Some physicists may assume that this is wrong because we do not have c^2 as a conversion factor between mass and energy. However, we will show that c^2 is not needed. This does not imply that Einstein's $E = mc^2$ is wrong; it simply means that it can be simplified further when one understands mass from this alternative and deeper perspective.

Energy in standard physics is a frequency per second times the Planck constant. The collision-length can be converted to frequency by dividing it by the shortest length, the Planck length. This gives the frequency per Planck second, so we have to multiply this by the number of Planck times per second to get the frequency per second, that is, $f = \bar{E}/l_p \times 1/t_p = c/\bar{\lambda}$, and this again has to be multiplied by the Planck constant, to get the standard energy definition. The point is, we can always go back to the standard energy definition from our new energy definition. We have $E = \bar{E}\hbar c/l_p^2$, and $\bar{E} = El_p^2/(\hbar c)$. Because $\hbar c/l_p^2$ is then just a constant to convert from one energy unit to another one. We will claim that the collision-length is the more fundamental one, which is directly linked to what is going on at the deepest level. The collision ratio is linked to an arbitrary amount of mass, which we have named kg. The standard energy and mass definitions are much less intuitive than the new definitions, although this can be hard to grasp at first. Even so, the strength of our new concept is that it leads to unified quantum gravity theory.

C. Mass is collision-time and energy is collision-length

Remarkably, all mass can be described as collision-time and all energy as collision-length. Further, collision-length divided by collision-time is the speed of light. This theory also defines the speed of light, which is simply how far an indivisible particle that is not colliding with another particle can move while two other indivisible particles are colliding. The question is: Whether the indivisible particle travels one diameter or more or less than one diameter of an indivisible particle. We will see the answer is that it travels one diameter during the time in which two other indivisible particles are in collision. In other words, the speed of the indivisible particle, using its own diameter as a unit, is one.

Since all is built from indivisible particles, nothing can travel faster than an indivisible particle, so it is no surprise that its speed is the speed of light. Bear in mind that the collision itself is mass, so noncolliding indivisible particles have zero mass when they are moving. That is, the indivisible particles are very similar to the Newtonian concept of light particles. Here, they are mass-less when moving and they are the one and only pure mass when they are colliding. This does not exclude the idea that light also has wavelike properties. In our model, the Compton wave is simply the distance between the indivisible particles. So, it has a kind of "particle-wave" duality, but in a way quite different than the one in standard physics (not mathematically, but in terms of interpretation).

IV. MORE BACKGROUND ON WHY WE CAN USE $\bar{E} = \bar{m}c$ INSTEAD OF $E = mc^2$

To understand how we can go from $E = mc^2$ to claiming we simply need $E = mc$, we must return to the history of scientific thought in relation to energy and mass. Gottfried Leibniz,[20] as early as 1686 (one year before the publication of the *Principia*), was likely the first to suggest that kinetic energy (*vis viva* as he called it: Living force) is proportional to squared velocity. In other words, $E = mv^2$. The Dutch philosopher and professor of mathematics, Willem Gravesande derived the same formula based on experiments. By dropping a brass ball from a height that is four times greater than that of another brass ball, the speed will be about double. If the energy of the mass was linearly proportional to its speed, then the brass ball with twice the velocity should leave an indentation in the clay about twice as deep as the brass ball moving at half the velocity. What Gravesande discovered was that doubling the velocity left an indentation approximately four times as deep. A brass ball with three times the velocity would leave a mark approximately nine times as deep. In short, the energy of a moving object was related to the square of its speed. Gravesande published the results from such experiments in 1720 in a book entitled, *Mathematical Elements of Physicks, prov'd by Experiments: Being an Introduction to Sir Isaac Newton's Philosophy*.[21] In 1732, Pierre Louis Maupertuis[22] claimed that "almost all mathematicians (géomètres) agree that the quantity of uniform effects produced by bodies in motion is proportional to the product of their mass by the square of their velocity…." However, the idea that kinetic energy was a function of v^2 rather than v was far from obvious and there was a long dispute on this, where Émilie du Châtelet also played a central part; du Châtelet was informed by Gravesande about his experiments and was also familiar with Leibniz' work on *vis viva* (kinetic energy) and also communicated with Maupertuis. She[23] concluded, by 1740, that kinetic energy was a function of v^2. See also Refs. 24 and 25 for a historical overview of the debate on kinetic energy in that era.

Einstein's much more famous equation, $E=mc^2$, looks remarkably similar to the Leibniz formula $E=mv^2$. If the speed of light was the limit on how fast something could go, then v could be seen as c in the limit, and the Leibniz formula would be identical to the Einstein equation when setting $v=c$, something suggested by Pretto[26] in 1903. However, this was not completely correct, since the kinetic energy formula, as it is known today, has a factor of $\frac{1}{2}$ in front of it. The half multiplier was actually first suggested by Bernoulli,[27] as he published an article with the formula $\frac{1}{2}mvv$ in 1741. The half multiplier for kinetic energy was discussed in more detail and made popular by Coriolis[28] and Poncelet[29] in the early 19th century.

Einstein,[30] in 1905, was likely the first to derive $E=mc^2$ in a mathematically sound way. We will not contest Einstein's formula; it is, in our view, fully correct and can also be derived from mathematical atomism,[13] see also Khodhabakhsh,[31] who discusses the derivation of mass-energy equivalence using Newtonian mechanics. Still, if c is a constant, then if we divide both sides by c, this gives

$$\begin{aligned}\frac{E}{c} &= \frac{mc^2}{c},\\ \frac{E}{c} &= mc.\end{aligned} \tag{19}$$

We could now define a new energy measure as $\bar{E}=\bar{m}c$, this naturally corresponds to the equation above. It is just that we look at energy in a new way, as described in Sections I–III, which greatly simplifies physics. However, this new approach must naturally be consistent with observations, including the observation that the kinetic energy is somehow related to v^2 and not v. Now the kinetic energy must be

$$\bar{E}_k = \frac{\bar{m}c}{\sqrt{1-\frac{v^2}{c^2}}} - \bar{m}c. \tag{20}$$

When $v \ll c$, this can be approximated by the first term of a Taylor series expansion to be

$$\bar{E}_k \approx \frac{\bar{m}v^2}{2c}. \tag{21}$$

That is, our reformulation is fully consistent with observations that kinetic energy is a function of v^2 and not simply v, as it naturally must be, since all we have done is divided energy by a constant and thereby created a new energy definition. It is first when we understand what mass is at the deepest level that this is truly useful. As we have seen when rest-mass is defined as $\bar{m}=l_p/c \times l_p/\bar{\lambda}$, then mass is collision-time, and pure energy is collision-length.

The formula $\bar{E}=\bar{m}c$ is fully consistent with observations; it is just that we have redefined the units of the energy. As we will see going forward, this makes everything easier conceptually and simplifies many equations, but more importantly, it gives a much simpler deeper logic.

It is important to be aware that moving from $E=mc^2$ to $E=mc$ is not critical or even needed to arrive at our unified theory, which we are describing in this paper. However, it makes the framework much simpler and easier to understand. If we do not take this path, then we will end up with an energy unit defined as a collision-length times the speed of light, and nothing physical corresponds directly to that. Such an energy definition is a mathematical derivative of the deeper reality that we claim consists of collision-length and collision-time. Interested readers can ascertain that we reach basically the same unified theory even when we hold on to $E=mc^2$ by looking at our working paper that is directly related to this paper.[32]

A. Relativistic extension

The diameter of an indivisible particle cannot undergo any length contraction and will be invariant. However, the Compton wavelength, which is the average distance between indivisible particles, can undergo standard length contraction. This means the relativistic energy is given by

$$\bar{E} = \frac{\bar{m}c}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{\frac{l_p^2}{\bar{\lambda}}\frac{1}{c}c}{\sqrt{1-\frac{v^2}{c^2}}} = l_p\frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}. \tag{22}$$

This is not that different from Einstein's special relativity theory (SR), where we have

$$E = \frac{mc^2}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{\frac{\hbar}{\bar{\lambda}}\frac{1}{c}c^2}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{\hbar c}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}. \tag{23}$$

But there is a major difference, as SR theory has not incorporated the diameter of the indivisible particle and therefore has not incorporated the Planck scale.

Further, the relativistic kinetic energy is given by

$$\bar{E}_k = \frac{\bar{m}c}{\sqrt{1-\frac{v^2}{c^2}}} - \bar{m}c = l_p\frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}} - l_p\frac{l_p}{\bar{\lambda}}. \tag{24}$$

In the case $v \ll c$, the formula above can be approximated by the first series of a Taylor series expansion, which gives

$$\bar{E}_k \approx \frac{1}{2}\bar{m}\frac{v^2}{c} = \frac{1}{2}\frac{l_p^2}{\bar{\lambda}}\frac{v^2}{c^2}. \tag{25}$$

As the indivisible particles cannot contract, but the distances between them can, namely, $\bar{\lambda}$, this means the maximum length contraction is in effect until the Compton wavelength reaches the Planck length. This means we must have

$$l_p \le \bar{\lambda}\sqrt{1-\frac{v^2}{c^2}} \tag{26}$$

and solved with respect to v, this gives

$$v \le c\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}}. \tag{27}$$

This is the same maximum velocity of matter that has been suggested by Haug.[33–35] For any observed elementary particle, such as the electron, this predicts a maximum velocity considerably higher than what one can achieve at the Large Hadron Collider, for example, but it is still below the speed of light. The formula gives an interesting special case for the Planck mass particle. For a Planck mass particle, the reduced Compton wavelength is equal to the Planck length, and this gives a maximum velocity of

$$v_{\max} = c\sqrt{1 - \frac{l_p^2}{l_p^2}} = 0. \tag{28}$$

That is, the maximum velocity of a Planck mass particle is zero. This seems absurd at first, until one realizes that the Planck mass particle is the collision point between two indivisible particles. The Planck mass particle is a photon-photon collision, and even from standard physics it is well known that this can create mass, or it is mass, see Refs. 36 and 37. However, the collision only lasts for one Planck second, before it dissolves into energy again. We will see how this actually can be measured from gravity experiments.

It is worth mentioning that the SR theory is not consistent with any minimum length, such as the Planck length. In SR, one can take any length L and simply move it at a speed close enough to c so that its contracted length is shorter than the Planck length, see Ref. 38 for a detailed discussion. As we will see, this means that SR cannot be consistent with quantum gravity, and therefore under SR one needs a separate theory for gravity.

The natural units of Max Planck are generally considered essential today, even though there are disagreements on their importance. Some physicists would claim they are just mathematical artifacts with no implications for physics whatsoever, while others[39,40] think indirectly there could be a unit smaller than the Planck length. Still others maintain that there should be no minimum length at all—that zero is the minimum. For example, if one argues that SR holds without modifications, then one indirectly claims the minimum length limit must simply be $L > 0$; in other words, it is incompatible with the Planck length as a minimum length. Nevertheless, many if not the majority physicists[41–45] seem to agree that there is a minimum length and that it is likely the Planck length.

B. Gravity theory

In a weak field, we have a nonrelativistic formula that gives the same numerical predictions as Newton, but it has a more intuitive gravitational constant, namely, c^3 rather than G. That is, we have

$$\tilde{F} = c^3 \frac{\tilde{M}\tilde{m}}{R^2}. \tag{29}$$

This can be written as

$$\bar{F} = c^3 \frac{\frac{l_p}{c}\frac{l_p}{\bar{\lambda}_M}\frac{l_p}{c}\frac{l_p}{\bar{\lambda}_m}}{R^2}. \tag{30}$$

This model offers all the same observable predictions as Newton's theory of gravity; see Table I, except that it also gives the correct bending of light.[32] We will soon show how to calibrate the gravity formula, and this gives us l_p as the Planck length with no knowledge of G or $\hbar$ required.

V. FINDING THE DIAMETER OF THE INDIVISIBLE PARTICLE

Our rest-mass definition is

$$\bar{m} = \frac{l_p}{c}\frac{l_p}{\bar{\lambda}}. \tag{31}$$

As the diameter of the indivisible particle is important for the collision-time (and we will claim that gravity is rooted in collision-time), we need to find l_p from gravity observations. That it is actually the Planck length is more than a hypothesis, because we can just as well say, it has an unknown value x and then use gravity observations to find what its length is. We find it to be the Planck length and we describe the process in this section.

In addition, we need to find $\bar{\lambda}$ without knowing the traditional mass. Even if we are working with a proton, in order to do this, we will first measure the Compton length of an electron by Compton scattering and find it is $\bar{\lambda}_e \approx 3.86 \times 10^{-13}$ m. We are not going to measure gravity on an electron only, but this helps us find the reduced Compton wavelength for large masses. The cyclotron frequency is linearly proportional to the reduced Compton frequency. Conducting a cyclotron experiment, one can find the reduced Compton frequency ratio between the proton and the electron. For example, Van-Dyck *et al.*[46] measured it to be about (see also Ref. 47)

$$\frac{\frac{c}{\bar{\lambda}_P}}{\frac{c}{\bar{\lambda}_e}} = \frac{f_P}{f_e} = 1836.152470(76). \tag{32}$$

In fact, they measured the proton-electron mass ratio this way and not the mass in kg. Theoretically, it is no surprise that $f_P/f_e = m_P/m_e$. This also holds true in our mass definition

$$\begin{aligned} \frac{f_P}{f_e} &= \frac{\bar{m}_P}{\bar{m}_e}, \\ \frac{f_P}{f_e} &= \frac{\frac{l_p^2}{\bar{\lambda}_P}\frac{1}{c}}{\frac{l_p^2}{\bar{\lambda}_e}\frac{1}{c}} = \frac{\bar{\lambda}_e}{\bar{\lambda}_P}. \end{aligned} \tag{33}$$

That is, we can find the Compton length of an electron and a proton without any knowledge of $\hbar$, or traditional mass measures such as kg. Now, to find the Compton frequency and the reduced Compton length in larger amounts of matter, we just need to count the numbers of protons and electrons in them. Twice the mass will have twice the Compton frequency.

We will claim that the diameter of the indivisible particle is directly linked to the time it takes for collisions and

TABLE I. The table shows the Newton gravitational force in addition to our new quantum gravity theory.

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

that the collision-space-time is what we call gravity. We must therefore perform a gravity measure to calibrate our model and find this diameter. After we have calibrated the model once, it should give us the one and unknown diameter of the indivisible particle x. We should then be able to predict all other known gravity phenomena based on the model.

To calibrate the model, we will use a Cavendish apparatus first developed by Henry Cavendish.[48] Assume we count 3×10^{26} number of protons and add them in a clump of matter. This clump of matter we will divide in two and use as two large balls in the Cavendish apparatus. We now know that the Compton frequency in the large balls in the Cavendish apparatus is approximately $1836.15\times c/\bar{\lambda}_e\times1.5\times10^{26}=2.13\times10^{50}$ per second. The reduced Compton length of this clump of matter must then be $\bar{\lambda}=c/f=c/(2.13\times10^{50})\approx1.4\times10^{-42}$ m. This Compton wavelength is even smaller than the Planck length, something that we soon will understand is physically impossible. But it is important to be aware we are working with a composite mass consisting of many elementary particles. Even though a composite mass does not have one physical Compton wavelength (it has many), such masses can mathematically be aggregated in the following way

$$\bar{\lambda}=\frac{\hbar}{\sum_{i=1}^{n}m_ic}=\frac{1}{\frac{1}{\bar{\lambda}_i}+\frac{1}{\bar{\lambda}_{i+1}}+\cdots+\frac{1}{\bar{\lambda}_n}}. \tag{34}$$

So, we can find the reduced Compton length of any mass by direct measurements of elementary particles and then counting the number of such particles in a larger mass. The same addition rule for Compton waves holds independent of whether we are working with the kg mass definition or the collision-time mass definition. However, there is still an unknown parameter, namely, the diameter of our suggested indivisible particles. Combining our new theory of matter and gravity with a torsion balance (Cavendish apparatus), we can measure the unknown diameter of the indivisible particle. We have that

$$\kappa\theta, \tag{35}$$

Where κ is the torsion coefficient of the suspending wire and θ is the deflection angle of the balance. We then have the following well-known relationship:

$$\kappa\theta=LF, \tag{36}$$

where L is the length between the two small balls in the Cavendish apparatus. Further, F can be set equal to our gravity force formula, but with a Compton view of matter and therefore no need for Newton's gravitational constant, this is important to help us bypass the need for the Planck constant as well.

Our Newton-equivalent gravity formula is equal to

$$F=c^3\frac{\bar{M}\bar{m}}{R^2}=c^3\frac{\frac{x^2}{\bar{\lambda}_M}\frac{1}{c}\frac{x^2}{\bar{\lambda}_m}\frac{1}{c}}{R^2}, \tag{37}$$

where x is unknown. This means we must have

$$\kappa\theta=Lc^3\frac{\bar{M}\bar{m}}{R^2}. \tag{38}$$

We also have that the natural resonant oscillation period of a torsion balance is given by

$$T = 2\pi\sqrt{\frac{I}{\kappa}}. \tag{39}$$

Further, the moment of inertia I of the balance is given by

$$I = \bar{m}\left(\frac{L}{2}\right)^2 + \bar{m}\left(\frac{L}{2}\right)^2 = 2\bar{m}\left(\frac{L}{2}\right)^2 = \frac{\bar{m}L^2}{2}. \tag{40}$$

This means we have

$$T = 2\pi\sqrt{\frac{\bar{m}L^2}{2\kappa}} \tag{41}$$

and when solved with respect to κ, this gives

$$\begin{aligned} \frac{T^2}{2^2\pi^2} &= \frac{\bar{m}L^2}{2\kappa}, \\ \kappa &= \frac{\bar{m}L^2}{2\frac{T^2}{2^2\pi^2}}, \\ \kappa &= \frac{\bar{m}L^2 2\pi^2}{T^2}. \end{aligned} \tag{42}$$

Next, in Eq. (38), we replace κ with this expression

$$\begin{aligned} \frac{\bar{m}L^2 2\pi^2}{T^2}\theta &= Lc^3\frac{\bar{M}_t\bar{m}}{R^2}, \\ \frac{L^2 2\pi^2}{T^2}\theta &= Lc^3\frac{\bar{M}}{R^2}. \end{aligned} \tag{43}$$

Next remember our mass definition is

$$\bar{M} = \frac{x}{\bar{\lambda}}\frac{x}{c}, \tag{44}$$

which we now replace in the equation above and solving with respect to the unknown diameter of the particle, we get

$$\begin{aligned} \frac{L^2 2\pi^2}{T^2}\theta &= Lc^3\frac{\frac{x}{\bar{\lambda}}\frac{x}{c}}{R^2}, \\ \frac{L^2 2\pi^2}{T^2}\theta &= Lx^2\frac{\frac{c^2}{\bar{\lambda}}}{R^2}, \\ \frac{L2\pi^2R^2}{T^2\frac{c^2}{\bar{\lambda}}}\theta &= x^2, \\ x &= \sqrt{\frac{L2\pi^2R^2}{T^2c^2/\bar{\lambda}}\theta}, \\ x &= \sqrt{\frac{L2\pi^2R^2\theta}{T^2 f_c c}}, \end{aligned} \tag{45}$$

where f_c is the reduced Compton frequency of the mass in question, which we have shown how to find previously. Experimentally, one will find that x must be the Planck length and that the standard error in measurements is half of that of the standard error in the Newtonian gravity constant in combination with Cavendish. Today, we have access to small Cavendish apparatuses with built-in fine electronics that can be used to perform fairly accurate measurements of x, and it is clear that x is close to the Planck length.

A. Escape velocity

Remember that

$$\bar{E}_k = \frac{\bar{m}c}{\sqrt{1-\frac{v^2}{c^2}}} - \bar{m}c \tag{46}$$

can be approximated by a Taylor expansion $\bar{E}_k \approx 1/2\,\bar{m}v^2/c$; this means the escape velocity must be

$$\begin{aligned} \bar{E}_k c - c^3\frac{\bar{M}\bar{m}}{R} &= 0, \\ \frac{1}{2}\bar{m}v^2 - c^3\frac{\bar{M}\bar{m}}{R} &= 0, \\ v &= \sqrt{2c^3\frac{\bar{M}}{R}}, \\ v &= \sqrt{2c^3\frac{\frac{l_p}{\bar{\lambda}}\frac{l_p}{c}}{R}}, \\ v &= c\sqrt{2\frac{l_p}{R}\frac{l_p}{\bar{\lambda}}}. \end{aligned} \tag{47}$$

Further, orbital velocity is given by $v_o = c\sqrt{l_p^2/(R\bar{\lambda})}$. This is actually exactly the same escape and orbital velocity we get from standard gravity theory, but then we are dependent on G and knowing the traditional mass measure.

More accurate calculations can be obtained by taking into account relativistic effects; the escape velocity is then

$$v_e = c\sqrt{2\frac{l_p^2}{\bar{\lambda}R} - \frac{l_p^4}{\bar{\lambda}^2R^2}}. \tag{48}$$

Our relativistic escape velocity basically gives an indistinguishable prediction in weak gravity fields compared to the standard escape velocity,[49] but is significant in a very strong gravitational field, see also Section XXI.

One should be aware that the reason we used a Cavendish apparatus in Section V to find the diameter of the indivisible particle, x, which is experimentally the Planck length, is simply for practical reasons. All we need to find the Planck length is a large gravitational mass acting on a much smaller mass; what we need is to know is the Compton frequency in the gravitational mass, i.e., in the mass that is much larger than the other mass. Hypothetically, we could just as well have found the Planck length directly from the Earth and the Moon. We would start by counting the number of protons in the Earth, which is approximately 3.57×10^{51}. Then we could find the Compton wavelength of an electron by Compton scattering, and use a cyclotron frequency to find that the Compton frequency in a proton is about 1836.15 times that of the electron, as described previously. Next, we would find the Planck length from the orbital velocity of the Moon. In a weak gravitational field, we have

$$v_o \approx \sqrt{c^3 \frac{\bar{M}}{R}} = \sqrt{c^3 \frac{\frac{l_p}{c}\frac{l_p}{\bar{\lambda}_E}}{R}}, \tag{49}$$

where $\bar{\lambda}_E$ is the reduced Compton wavelength of the Earth. Solved with respect to x, this gives

$$l_p = \frac{v_o}{c}\sqrt{\bar{\lambda}_E R} \approx 1.61 \times 10^{-35} \text{ m}. \tag{50}$$

This is naturally impossible in practice, simply because we would have to count all the protons in the Earth (without relying on methods using the Planck constant or G). The point is that we could do this in principle and then we would need no knowledge of G or the Planck constant to find the Planck length; it is the Compton frequency and the speed of light that are essential for finding it. The Planck length is the essence that can be extracted from gravity. This also explains why the Cavendish apparatus is so useful. That we use a Cavendish apparatus to find the Planck length has nothing to do with the gravitational constant. The Cavendish apparatus has to do with the fact that we have full control of the gravitational mass, and know what element it is made of, such as lead.

B. Gravitational acceleration

The gravitational acceleration in a weak gravitational field is given by

$$\begin{aligned} ma &= c^3 \frac{\bar{M}\bar{m}}{R^2}, \\ a &= c^3 \frac{\bar{M}}{R^2}, \\ a &= l_p \frac{c^2}{R^2}\frac{l_p}{\bar{\lambda}}. \end{aligned} \tag{51}$$

Similarly, we can derive all standard gravity formulas. As we will see in a weak field, we get the same results as Newton.

VI. SUMMARY GRAVITY FORMULAS

Table I summarizes the gravity formulas in our theory and in a standard Newtonian theory. The outputs of observable gravity phenomena are identical. The output for the gravity force itself is different between the two methods, but this is not observable. The details are discussed in greater depth in Section XVIII.

Note that our energy definition is closely linked to the Schwarzschild radius. This is no coincidence. However, we will claim that the Schwarzschild radius is grossly misunderstood in standard physics. It is said to represent the radius of a black hole, but it actually represents the twice the collision-time multiplied by the speed of light. In other words, it is twice the collision-length. The Schwarzschild radius is a key component of mass and gravity; it is the essence of all mass, and even if the collision point has mathematical properties identical to a black hole, it has little to do with the standard interpretation of black holes, as will be discussed in more detail in Section XXI. If our theory is right, then the Schwarzschild radius should easily be extracted by observing gravity with no knowledge of G and the Planck constant. We will return to this idea later.

A. Relativistic gravity theory, weak and strong field

The strong field (relativistic version), when observing everything from the gravitational mass $\bar{M}$, is

$$F = c^3 \frac{\bar{M}\frac{\bar{m}}{\sqrt{1-\frac{v^2}{c^2}}}}{R^2}. \tag{52}$$

Or, in terms of quantum entities

$$\begin{aligned} F &= c^3 \frac{\frac{l_p}{c}\frac{l_p}{\bar{\lambda}_M}\frac{l_p}{c}\frac{l_p}{\bar{\lambda}_m\sqrt{1-\frac{v^2}{c^2}}}}{R^2}, \\ &= c\frac{\frac{l_p^2}{\bar{\lambda}_M}\frac{l_p^2}{\bar{\lambda}_m\sqrt{1-\frac{v^2}{c^2}}}}{R^2}. \end{aligned} \tag{53}$$

In case we are observing two gravity objects from a third frame, we expect to have the equation below, since this seems to give the correct prediction of the perihelion of Mercury

$$F = c^3 \frac{\frac{\bar{M}}{\sqrt{1-\frac{v_M^2}{c^2}}}\frac{\bar{m}}{\sqrt{1-\frac{v_m^2}{c^2}}}}{R^2\left(1-\frac{v_M^2}{c^2}\right)} = c^3\frac{\bar{M}\frac{\bar{m}}{\sqrt{1-\frac{v_m^2}{c^2}}}}{R^2\left(1-\frac{v_M^2}{c^2}\right)^{3/2}}. \tag{54}$$

A similar Newton equivalent formula to Eq. (52) was suggested in 1981 and 1986 by Bagge[50] and Phillips.[51] This formula was soon forgotten, as it only predicted half of Mercury's precession, see also Refs. 52–57. However, the formula, in our view, can only hold in a two reference frame system, such as observing the Moon from the Earth, or the Earth from the Moon, but not when observing the Sun and Mercury from Earth, for example. When we are observing the precession of Mercury from Earth, we have to handle three reference frames, and we suggest that one must use Eq. (54).

Even if not fully investigated yet, it seems that our model has the same challenges in explaining the rotation of galaxy arms as the standard gravity models of Newton and Einstein.[58] It is an open question if we will need dark matter in our model. It is interesting in this respect that several "new" Newtonian-like gravity models exist that fit galaxy rotations without dark matter, see Refs. 59 and 60, for example. It is also worth noting that our two postulates seem to lead to two sets of space-time transformations, namely, the Lorentz transformation when using Einstein synchronized clocks, but also a type of absolute transformation.[14]

However, the latter one requires that one is able to measure not only the round-trip speed of light, but also the one-way speed of light without relying on clock synchronization. Whether this is possible or not is still an actively debated question, see Refs. 61–63, for example, this could also have potential implications on cosmology.[64] However, it is outside the scope of this paper to discuss it further; here we will stay inside the standard assumptions of Einstein synchronized clocks.

VII. MOMENTUM, DE BROGLIE, AND COMPTON

Momentum, close to the sense in which the term is used in modern physics, was possibly first described mathematically by Jennings[65] in 1721. Jennings said that momentum is the quantity of matter multiplied by the velocity, which is the standard: $p = mv$, that we know today. However, we should keep in mind that momentum was defined before relativity theory had been developed and the scientists of the era also knew very little about the quantum world. The existing momentum was modified to be relativistic by Einstein

$$p = \frac{mv}{\sqrt{1 - \frac{v^2}{c^2}}}. \tag{55}$$

At the quantum level, we will see that standard momentum is linked to the de Broglie wavelength. In his Ph.D. thesis in 1924, de Broglie[66,67] hypothesized that there was a matter wave of the form

$$\lambda_b = \frac{h}{mv} \tag{56}$$

that in the relativistic form, is given by the well-known formula

$$\lambda_b = \frac{\frac{h}{mv}}{\sqrt{1 - \frac{v^2}{c^2}}}. \tag{57}$$

It is worth mentioning that Einstein received a copy of de Broglie's Ph.D. thesis (even before it was accepted) on matter waves and thought it was brilliant work. We are not claiming otherwise, as de Broglie was possibly the first to hypothesize that matter had both a particle and a wavelike nature. In addition, his paper was published in a very prestigious journal, namely, *Nature*. The de Broglie wave was quickly accepted as the correct predicted matter wave, likely because Einstein had been so positive about it, the fact that it was published in *Nature*, and because de Broglie had suggested it was a matter wave directly; it was confirmed a few years later in two independent experiments that matter had also wavelike properties, see Ref. 68 and also Ref. 69. One then assumed that the de Broglie hypothesis was confirmed and de Broglie was awarded the Nobel Prize for his work.

However, at about the same time as de Broglie was putting his hypothesis forward, Arthur Holly Compton published a paper on what is known today as Compton scattering.[4] Compton's work was more experimental in nature and even though he did not describe it in words, what is now known as "the Compton wave" was indirectly given from his formulation

$$\lambda = \frac{h}{mc}. \tag{58}$$

In relativistic form, this is given by

$$\lambda_r = \frac{\frac{h}{mc}}{\sqrt{1 - \frac{v^2}{c^2}}}. \tag{59}$$

One can see that the de Broglie wave formula and the Compton wave formula are almost of the same form, but the de Broglie wave differs from the Compton wave by a factor of c/v. That is, we can always go from the Compton wave to the de Broglie wave, or the other way around by multiplying or dividing by c/v. However, in our view, there is a significant difference between the two waves. The Compton wave has been measured indirectly in a long series of experiments and it came out of experimental research. We will claim that the de Broglie wave has never been measured and never can be measured. The de Broglie wave is a mathematical derivative of the true matter wave, namely, the Compton wave, and it contains very important information, as the Compton wave is embedded within it.

The de Broglie wave and the momentum related to it can be used to complete a series of correct derivations and predictions. However, the interpretations will often appear to be almost absurd, since we are working with a mathematical derivative, rather than a fundamental measure of reality. To support our hypothesis, we can look at the de Broglie wave formula. When the particle stands still, the de Broglie wave is infinite

$$\lambda_b = \frac{h}{mv} = \frac{h}{m \times 0} = \infty. \tag{60}$$

An infinite wavelength has naturally never been measured and never can be measured. This has led to a series of strange and even illogical interpretations that are still present in *Physics Today*. Some comments over time include:

> *"The de Broglie wave has infinite extent in space."*—A. I. Lvovsky[70]

> *"De Broglie had an extremely strong and concrete physical justification for the infinite wavelength of matter waves, corresponding to the body at rest. …. Therefore, the infinite wavelength of matter waves, for zero velocity of body, becomes essentially evident."*—H. Chauhan et al.[71]

The interpretation given by Max Born is likely closer to reality

> *"Physically, there is no meaning in regarding this wave as a simple harmonic wave of infinite extent; we must, on the contrary, regard it as a wave packet consisting of a small group of indefinitely*

close wave-numbers, that is, of great extent in space."—M. Born[72]

Again, we will argue that there cannot be two matter waves. As we have shown earlier, all masses can be expressed both in terms of kg and in the form of collision-time. Again, we will claim the reason the de Broglie wave has such strange properties is simply because it is a derivative, a mathematical artifact of what we will claim is the real and only true matter wave, namely, the Compton wave. One could argue that no particle can ever be at rest due to the Heisenberg uncertainty principle and that the infinite de Broglie wave, when $v = 0$, is actually not an issue. In our view, however, this would be an incorrect interpretation that would make it difficult if not impossible to unify quantum mechanics (QM) with gravity. In Sections VIII–XI, we will move to QM and show how Heisenberg's uncertainty principle likely breaks down at the Planck scale and is replaced by a certainty principle, which is actually linked to a particle standing still.

It is clear that the de Broglie wave is always a function of the Compton wave by the function

$$\lambda_b = \lambda \frac{c}{v}. \tag{61}$$

Further, the de Broglie wave is simply the Planck constant divided by the momentum, something that is well-known. What then is the Compton wave? Is it also linked to a momentum? Consider that we have mc in the denominator of the Compton wave formula (the nonrelativistic), which is basically identical to the momentum for a photon, if we assume the photon mass (as often hypothetically assumed) is

$$m = \frac{hf}{c^2} = \frac{h\frac{c}{\lambda}}{c^2} = \frac{h}{\lambda}\frac{1}{c} = \frac{\hbar}{\bar{\lambda}}\frac{1}{c}, \tag{62}$$

where f is the frequency, and λ is the wavelength of the photon. And the momentum of the photon is

$$p = mc = \frac{hf}{c^2}c = \frac{h\frac{c}{\lambda}}{c^2}c = \frac{h}{\lambda} = \frac{\hbar}{\bar{\lambda}}. \tag{63}$$

The Compton wave is experimentally linked to electrons that clearly are not photons, bearing in mind that in standard physics there are two types of momentum formulas: One for particles with mass, and one for photons. However, if we multiply the standard momentum with c/v, we will get what we would call a new type of momentum, namely,

$$p_t = p\frac{c}{v} = \frac{mv}{\sqrt{1-\frac{v}{c}}}\frac{c}{v} = \frac{mc}{\sqrt{1-\frac{v}{c}}}. \tag{64}$$

This is not the standard momentum, but it is identical to the photon momentum in the special case when $v = 0$. And yet, photons are, according to standard theory, always traveling at c. So, the formula cannot hold for photons, as it would give infinite photon momentum, which is impossible. To resolve this puzzle, we return to our theory; we have already claimed that the building block of the photon, the indivisible particle, stands still for one Planck second when it is in collision. So, in order to find the rest-mass of a photon, we must set $v = 0$. This means we can have a rest-mass momentum of

$$p_t = \frac{mc}{\sqrt{1-\frac{0}{c}}} = mc = \frac{\hbar}{\bar{\lambda}} \tag{65}$$

or when using the collision-time definition of mass, we have

$$\bar{p}_t = \frac{\bar{m}c}{\sqrt{1-\frac{0}{c}}} = \bar{m}c = l_p\frac{l_p}{\bar{\lambda}}. \tag{66}$$

Further, we will have a kinetic momentum

$$p_k = \frac{mc}{\sqrt{1-\frac{v}{c}}} - mc, \tag{67}$$

in the special case where $v \ll c$, this can be approximated with the first term of a Taylor series expansion

$$p_k \approx \frac{1}{2}m\frac{v^2}{c}. \tag{68}$$

Or, in terms of collision-time kinetic momentum,

$$\bar{p}_k \approx \frac{1}{2}\bar{m}\frac{v^2}{c}. \tag{69}$$

Some readers will likely question this, as it means our new momentum does not give $p = mv$, even when $v \ll c$. The standard momentum $p = mv$ can easily be recovered from our new momentum, as the standard (de Broglie) momentum is our total relativistic Compton momentum multiplied by v/c, and then taking the first term of a Taylor series expansion from the de Broglie momentum, in the case when $v \ll c$, this indeed gives $p \approx mv$. In contrast to the impact from energy and our new momentum, the old momentum is, in our view, never measured directly. That kinetic energy must be a function of v^2, when $v \ll c$ can easily be observed. (Our kinetic momentum is the same as our new energy definition.) If one repeats the simple Gravesande experiment (1720) by dropping brass balls on clay, for example, what one observes is kinetic energy (our new momentum), not the old momentum. The standard momentum, as it is normally defined, has $p = mv$, but we will claim it is only indirectly observed by extracting the velocity out of the energy impact observations and then multiplying it by the mass. This can also be accomplished by measuring the velocity through other means and multiplying it by the mass. One does not observe impacts from standard momentum $p = mv$, but one does from something related to $\frac{1}{2}\, mv^2/c$ and that is our new kinetic momentum (when $v \ll c$), which is identical to our new kinetic energy. This does not mean there is anything directly wrong with the standard momentum; it is just that it is a mathematical derivative of the real fundamental Compton momentum, just as the de Broglie wave is a mathematical derivative of the Compton wave. The old momentum contains information from the more fundamental momentum, as a derivative of it, and therefore, it can be used in many calculations and predictions. However, it has several shortcomings, such as not being valid for $v=0$, while our new momentum is always valid and its impact is directly measurable.

In our new formulation, there is no need for momentum and energy; here they are exactly the same. So the rest-mass momentum is identical to our rest-mass energy, kinetic momentum is identical to our kinetic energy, and total momentum is identical to our total energy. We will claim there is no need for both components to predict anything we can observe. More importantly, our reformulation of momentum, from standard momentum to Compton momentum, simplifies the relativistic energy-momentum relation significantly, as we will see in Section VIII.

VIII. THE RELATIVISTIC ENERGY MOMENTUM RELATION

The standard relativistic energy momentum relation is given by

$$E=\sqrt{p^2c^2+m^2c^4}. \tag{70}$$

It plays a central role in obtaining the relativistic wave equation and thereby QM. There is nothing wrong with this relation, but it is unnecessarily complex and we must use two different formulations for the momentum: One for photons $p=mc=h/\lambda$ and one for other masses, namely,

$$p=\frac{mv}{\sqrt{1-\frac{v^2}{c^2}}}. \tag{71}$$

In contrast, the relativistic energy momentum relation when using the Compton momentum can be rewritten as

$$E=p_kc^2+mc^2 \tag{72}$$

that also can be rewritten as

$$E=p_kc+mc^2=\frac{mc}{\sqrt{1-\frac{v^2}{c^2}}}c-mc^2+mc^2=\frac{mc^2}{\sqrt{1-\frac{v^2}{c^2}}}. \tag{73}$$

This can be simplified even further when understanding mass at the deepest level is the collision-time; this gives

$$\bar{E}=\bar{p}_k+\bar{m}c \tag{74}$$

that also can be written as

$$\bar{E}=\bar{p}_k+\bar{m}c=\frac{\bar{m}c}{\sqrt{1-\frac{v^2}{c^2}}}-\bar{m}c+\bar{m}c=\frac{\bar{m}c}{\sqrt{1-\frac{v^2}{c^2}}}. \tag{75}$$

In Section IX, we will derive a new quantum mechanical wave equation from this relation. This is how we will wrap matter, photons, and gravity up together under one theory. This new equation will be our key to unifying QM with gravity.

IX. GRAVITY QM

Here, we will introduce a new quantum wave equation that also is consistent with gravity and takes into account that one ultimately has a collision-time. The Klein–Gordon equation is derived from the standard relativistic energy momentum relation and is given by

$$\frac{1}{c^2}\frac{\partial^2}{\partial t^2}\Psi-\nabla^2\Psi+\frac{m^2c^2}{\hbar^2}\Psi=0. \tag{76}$$

The Klein–Gordon equation has strange properties, such as energy squared, which is one of several reasons that Schrödinger did not like it that much.

If we instead use our new momentum definition and its corresponding relativistic energy–momentum relation, we get

$$\begin{aligned}\bar{E}&=\mathbf{p}_k+\bar{m}c,\\ \bar{E}&=\left(\frac{\bar{m}c}{\sqrt{1-\frac{\mathbf{v}^2}{c^2}}}-\bar{m}c\right)+\bar{m}c,\\ \bar{E}&=\frac{\bar{m}c}{\sqrt{1-\frac{\mathbf{v}^2}{c^2}}},\\ \bar{E}&=\frac{l_p^2}{\bar{\lambda}\sqrt{1-\frac{\mathbf{v}^2}{c^2}}}.\end{aligned} \tag{77}$$

Keep in mind that r_e is half of the relativistic Schwarzschild radius, so we must have

$$r_e=\frac{1}{2}r_s=\frac{l_p^2}{\bar{\lambda}\sqrt{1-\frac{\mathbf{v}^2}{c^2}}}. \tag{78}$$

This means that the relativistic energy momentum relation under our new and deeper understanding of mass can also be written as

$$\begin{aligned}\bar{E}&=\mathbf{p}_k+\bar{m}c,\\ r_e&=\bar{m}_r\mathbf{c},\end{aligned} \tag{79}$$

where $\bar{m}_r=l_p^2/\left(\bar{\lambda}\sqrt{1-\mathbf{v}^2/c^2}\right)$.

Based on this, we get the following relativistic wave equation:

$$-l_p^2\frac{\partial\Psi}{\partial t}=-l_p^2\nabla\cdot(\Psi\mathbf{c}), \tag{80}$$

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.

The light velocity field should satisfy the following (since the velocity of light is constant and incompressible):

$$\nabla \mathbf{c} = 0, \tag{81}$$

that is,[c)] the light velocity field is a solenoidal, which means we can rewrite our wave equation as

$$\frac{\partial \Psi}{\partial t} - \mathbf{c} \cdot \nabla \Psi = 0. \tag{82}$$

So, in the expanded form, we have

$$\frac{\partial \Psi}{\partial t} - c_x \frac{\partial \Psi}{\partial x} - c_y \frac{\partial \Psi}{\partial y} - c_z \frac{\partial \Psi}{\partial z} = 0. \tag{83}$$

Our new relativistic quantum equation has quite a different plane wave solution than the Klein–Gordon and Schrödinger[73] equations; our plane wave equation is given by

$$\Psi = e^{i(kt - \omega x)}. \tag{84}$$

However, in our theory, $k = 2\pi/\lambda$, where λ is the relativistic Compton wavelength and not the de Broglie wavelength, as in standard wave mechanics. Due to this, we have

$$k = \frac{r_e}{l_p^2} = \frac{\frac{r_e}{\sqrt{1-\frac{v^2}{c^2}}}}{l_p^2} = \frac{2\pi}{\lambda_r}, \tag{85}$$

where $\lambda_r = \bar{\lambda} 2\pi \sqrt{1 - v^2/c^2}$. So, we can also write the plane wave function as

$$e^{i\left(\frac{\bar{L}}{l_p^2}t - \frac{\bar{T}}{l_p^2}x\right)} = e^{i\left(\frac{\bar{E}}{l_p^2}t - \frac{\bar{m}}{l_p^2}x\right)} = e^{i\left(\frac{r_e}{l_p^2}t - \frac{\bar{m}}{l_p^2}x\right)}, \tag{86}$$

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

$$\frac{\partial \Psi}{\partial t} = \frac{i r_e}{l_p^2} e^{i\left(\frac{r_e}{l_p^2}t - \frac{\bar{m}}{l_p^2}x\right)}, \tag{87}$$

and this gives us a time operator of

$$r_e = -i l_p^2 \frac{\partial}{\partial t}. \tag{88}$$

And for mass, we have

$$\frac{\partial \Psi}{\partial x} = \frac{-i\bar{m}}{l_p^2} e^{i\left(\frac{r_e}{l_p^2}t - \frac{\bar{m}}{l_p^2}x\right)}, \tag{89}$$

and this gives us a mass operator of

$$\bar{m} = -i l_p^2 \nabla. \tag{90}$$

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

$$k = \frac{r_e}{l_p^2} = \frac{\frac{l_p^2}{\bar{\lambda}}}{l_p^2} = \frac{2\pi}{\lambda} \tag{91}$$

instead of the relativistic form, where we have

$$r_e = \frac{l_p^2}{\bar{\lambda}\sqrt{1 - \frac{v^2}{c^2}}}. \tag{92}$$

This is because the first term of a Taylor series expansion is $r_e \approx \bar{m}c$ when $v \ll c$.

X. DEEPER INSIGHT ON THE COLLISION-SPACE-TIME FORM ONLY

Since energy is collision-length (space) $\bar{E} = \bar{L}$ and mass is collision-time $\bar{m} = \bar{T}$, we can write the relativistic energy relation as

$$\bar{L} = \bar{T}\mathbf{c}. \tag{93}$$

Now we can substitute $\bar{L}$ and $\bar{T}$ with corresponding collision-space and collision-time operators and get a new relativistic quantum mechanical wave equation

$$-l_p^2 \frac{\partial \Psi}{\partial t} = -l_p^2 \nabla \cdot (\Psi \mathbf{c}), \tag{94}$$

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 l_p^2, we can rewrite this as

$$-\frac{\partial \Psi}{\partial t} = -\nabla \cdot (\Psi \mathbf{c}). \tag{95}$$

The light velocity field should satisfy (since the velocity of light is constant and incompressible)

$$\nabla \cdot \mathbf{c} = 0, \tag{96}$$

that is, the light velocity field is a solenoidal, which means we can rewrite our wave equation as

$$\frac{\partial \Psi}{\partial t} - \mathbf{c} \cdot \nabla \Psi = 0. \tag{97}$$

[c)] For people not familiar or rusty in their vector calculus, we naturally have $\nabla\cdot(\Psi\mathbf{c}) = \Psi\nabla_x c_x + \Psi\nabla_y c_y + \Psi\nabla_z c_z + c_x\nabla_x\Psi + c_y\nabla_y\Psi + c_z\nabla_z\Psi + = \Psi\nabla\cdot\boldsymbol{c} + \boldsymbol{c}\cdot\nabla\Psi$. For an incompressible flow such as we have, the first term is zero because $\Psi\nabla\cdot\mathbf{c} = 0$. In other words, we end up with $\nabla\cdot(\Psi\mathbf{c}) = \boldsymbol{c}\cdot\nabla\Psi$.

So, in the expanded form, we have

$$\frac{\partial \Psi}{\partial t} - c_x \frac{\partial \Psi}{\partial x} - c_y \frac{\partial \Psi}{\partial y} - c_z \frac{\partial \Psi}{\partial z} = 0. \tag{98}$$

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

$$\Psi = e^{i(kt - \omega x)}. \tag{99}$$

In our theory, $k = 2\pi/\lambda_r$, where λ_r is the relativistic Compton wavelength and not the de Broglie wavelength, as in standard wave mechanics. Due to this, we have

$$k = \frac{\bar{L}}{l_p^2} = \frac{\frac{l_p^2}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}}{l_p^2} = \frac{2\pi}{\lambda_r}. \tag{100}$$

So, we can also write the plane wave solution as

$$\Psi = e^{i\left(\frac{\bar{L}}{l_p^2}t - \frac{\bar{T}}{l_p^2}x\right)}. \tag{101}$$

Our quantum wave function is rooted in the Compton wavelength instead of the de Broglie wavelength. For formality's sake, we can look at the collision-space (energy) and collision-time (mass) operators and see that they are correctly specified

$$\frac{\partial \Psi}{\partial x} = \frac{i\bar{T}}{l_p^2} e^{i\left(\frac{\bar{L}}{l_p^2}t - \frac{\bar{T}}{l_p^2}x\right)}. \tag{102}$$

This means the collision-time space operator (mass) must be

$$\bar{T} = -il_p^2 \nabla, \tag{103}$$

and for collision-space (energy), we have

$$\frac{\partial \Psi}{\partial t} = \frac{-i\bar{L}}{l_p^2} e^{i\left(\frac{\bar{L}}{l_p^2}t - \frac{\bar{T}}{l_p^2}x\right)}, \tag{104}$$

and this gives us a collision-space-time operator of

$$\hat{L} = -il_p^2 \frac{\partial}{\partial t}. \tag{105}$$

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

$$k = \frac{p_t}{l_p^2} = \frac{\bar{L}}{l_p^2} = \frac{2\pi}{\lambda_r} \tag{106}$$

instead of the relativistic form

$$\bar{L} = \frac{\bar{m}c}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{l_p^2}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}. \tag{107}$$

This is because the first term of a Taylor series expansion is $\bar{L} \approx \bar{m}c$ when $v \ll c$.

XI. GRAVITY IS BREAKDOWN OF THE HEISENBERG UNCERTAINTY PRINCIPLE AND LORENTZ SYMMETRY AT THE PLANCK SCALE

Earlier in this paper, we have shown that gravity is linked to the Planck scale and that the Lorentz symmetry is broken at the Planck scale. Here, we will see that in addition to the Lorentz symmetry being broken, the Heisenberg[74] uncertainty principle is also broken and it goes from an uncertainty principle to a certainty principle at the Planck scale. We think that this is the most important missing part of modern wave mechanics—that the wave equation breaks down in the only place where the Planck length can enter QM, and it is where both the Heisenberg uncertainty principle and Lorentz symmetry break down.

In the first part of our paper, we have shown that gravity is directly linked to a minimum length, and experimentally this length is the Planck length. The Planck length in relation to mass is essential for the collision-length and collision-time of indivisible particles. So, gravity in a wave equation must be the Planck mass particles in the wave equation, and we can expect that something special should happen at the Planck scale. In our previous analysis, we have claimed that the Planck length, the Planck time, and the Planck mass must be invariant, because it is the only particle that stands absolutely still. We can only observe a Planck mass particle from the Planck mass particle itself. That is, it can only be observed when it is at rest relative to itself. But what does this lead to in our wave equation?

Our plane wave function is given by

$$\Psi = e^{i\left(\frac{\bar{E}}{l_p^2}t - \frac{\bar{m}}{l_p^2}x\right)} = e^{i\left(\frac{r_e}{l_p^2}t - \frac{\bar{m}}{l_p^2}x\right)}. \tag{108}$$

Keep in mind that energy is collision-length (space) and mass is collision-time, so if we call collision-time for $\bar{T}$ and collision-space for $\bar{L}$, then we can write the wave equation as

$$\Psi = e^{i\left(\frac{\bar{L}}{l_p^2}t - \frac{\bar{T}}{l_p^2}x\right)}. \tag{109}$$

However, since we are particular interested in gravity, we can also remember that the collision-length actually is equal to half of the relativistic Schwarzschild radius

$$r_e = \frac{\bar{m}c}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{\frac{l_p^2}{\bar{\lambda}}\frac{1}{c}c}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{l_p^2}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}. \tag{110}$$

Based on this, we can rewrite the wave function as

$$\Psi = e^{i\left(\frac{\frac{l_p^2}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}}{l_p^2}t - \frac{\frac{l_p^2}{c\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}}{l_p^2}x\right)} = e^{i\left(\frac{1}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}t - \frac{1}{c\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}x\right)}. \tag{111}$$

Next we have $v_{\max} = c\sqrt{1 - l_p^2/\bar{\lambda}^2}$, and in the case of a Planck mass particle, we have $v_{\max} = c\sqrt{1 - l_p^2/l_p^2} = 0$. Further, as explained earlier, the Planck mass particle (a photon–photon collision) only lasts for one Planck second, and has a fixed "size" (reduced Compton wavelength) equal to the Planck length. This means that in order to observe a Planck mass particle, we must have $x = l_p$ and $t = l_p/c$. This gives

$$\Psi = e^{i\left(\frac{1}{l_p}\frac{l_p}{c} - \frac{1}{cl_p}l_p\right)} = e^{i\times 0} = 1. \tag{112}$$

That is, the Ψ is always equal to one in the special case of the Planck mass particle, see also Ref. 75. This means if we derive the Heisenberg uncertainty principle from this wave function, in the special case of a Planck mass particle it breaks down and we get a certainty instead of an uncertainty. This certainty lasts the whole of the Planck particle's life time, which is only one Planck second. Keep in mind that all elementary particles can be seen as Planck mass particles coming in and out of existence at their Compton periodicity.

This is fully consistent with our wave equation; when $\Psi=1$, we must have

$$\begin{aligned}\frac{\partial \Psi}{\partial t} &= c\frac{\partial \Psi}{\partial x} + c\frac{\partial \Psi}{\partial y} + c\frac{\partial \Psi}{\partial z}\frac{\partial 1}{\partial t},\\ &= c\frac{\partial 1}{\partial x} + c\frac{\partial 1}{\partial y} + c\frac{\partial 1}{\partial z},\end{aligned} \tag{113}$$

which means there can be no change in the wave equation (in relation to the Planck mass particle), which would also mean no uncertainty. Basically, particle-wave duality breaks down inside the Planck scale. The Planck mass particle is the collision between two photons and it only lasts for one Planck second. While all other particles are vibrating between energy and Planck mass at their Compton frequency, the Planck mass is just Planck mass, it is actually the building block of all other masses. This is a revolutionary view, but a conceptually simpler one that removes a series of strange interpretations in QM, such as spooky action at a distance. This also means the Schwarzschild radius is dominated by probability for masses smaller than a Planck mass and is dominated by determinism for masses larger than a Planck mass.

We can also derive this more formally. Since $\Psi = 1$, for a Planck mass particle we must have

$$\frac{\partial \Psi}{\partial x} = 0. \tag{114}$$

Thus, the Schwarzschild operator (space operator) must be zero for the Planck mass particle. Therefore, we must have

$$\begin{aligned}[\hat{r}_e, \hat{x}]\Psi &= [\hat{r}_e\hat{x} - \hat{x}\hat{r}_e]\Psi,\\ &= \left(-0 \times \frac{\partial}{\partial x}\right)(x)\Psi - (x)\left(-0 \times \frac{\partial}{\partial x}\right)\Psi,\\ &= 0.\end{aligned} \tag{115}$$

That is, $\hat{r}_e$ and $\hat{x}$ commute for the Planck particle (which simply means the Planck mass particle is the collision point between two photons, it is gravity).

We also have

$$\begin{aligned}\left[\hat{\bar{T}}, \hat{x}\right]\Psi &= \left[\hat{\bar{T}}\hat{x} - \hat{x}\hat{\bar{T}}\right]\Psi,\\ &= \left(-0 \times \frac{\partial}{\partial x}\right)(x)\Psi - (x)\left(-0 \times \frac{\partial}{\partial x}\right)\Psi,\\ &= 0.\end{aligned} \tag{116}$$

For formality's sake, the uncertainty in the special case of the Planck particle must be

$$\begin{aligned}\sigma_p\sigma_x &\geq \frac{1}{2}\left|\int \Psi^*[\hat{r}, \hat{x}]\Psi dx\right|,\\ &\geq \frac{1}{2}\left|\int \Psi^*(0)\Psi dx\right|,\\ &\geq \frac{1}{2}\left|-0 \times \int \Psi^*\Psi dx\right|,\\ &= 0.\end{aligned} \tag{117}$$

In the special case of the Planck mass particle, the uncertainty principle collapses to zero. In more technical terms, this implies that the quantum state of a Planck mass particle can simultaneously be a position and a momentum eigenstate. The momentum is equal to the half the Schwarzschild radius; remember we have a probabilistic Schwarzschild radius. That is, for the special case of the Planck mass particle, we have certainty. In addition, the probability amplitude of the Planck mass particle will be one $\Psi_p = e^0 = 1$. However, we have claimed the Planck mass particle only lasts for one Planck second. We think the correct interpretation is that if one observes a Planck mass particle, then we automatically also know its Schwarzschild radius (and therefore also its Compton momentum is certain in that moment), since the particle (according to our maximum velocity formula) must stand still, so it only has rest-mass momentum, which is the Schwarzschild radius. Bear in mind we are talking about energy and momentum in the dimension of collision-length. In other words, for this and only this particle, we know the position and Schwarzschild radius (redefined momentum) at the same time. All particles other than the Planck mass particle will have a wide range of possible velocities for v, which leads to the uncertainty in the uncertainty principle.

Again, the breakdown of the Heisenberg uncertainty principle at the Planck scale is easily to detect, from our analysis in this paper, we know that it must be gravity. However, in modern physics, there is the standard gravity theory, on one hand, and the quantum theory, on the other hand, and the break down at the Planck scale is seen as something special happening outside this system. For 100 years, many have tried to unify QM with gravity, with little success. In our theory, we see that gravity is the break down at the Planck scale. The theory is derived from the Planck scale and combined with key concepts from Newton, Einstein, Compton, and others. This forms the basis for a robust unified theory that can address the various challenges involved.

XII. WHY THE PLANCK SCALE HAS NOT BEEN FOUND EXPERIMENTALLY BEFORE

A series of quantum gravity theories predict break down of Lorentz symmetry at the Planck scale. However, the

Planck scale is normally considered to be related only to extremely high energy levels, even much higher than what can be attained at the Large Hadron Collider. There have been attempts to observe effects at lower energy levels than the Planck energy, but at this time, no signs of Lorentz symmetry break down have been found, as a recent review article Hees *et al*.[76] noted:

> *"In conclusion, though no violation of Lorentz symmetry has been observed so far, an incredible number of opportunities still exist for additional investigations."*

However, modern physics has not incorporated collision-time and space directly into the definitions of mass and energy. Collision-time is pushed into the model through the Newton gravitational constant, but in other aspects of physics (other than gravity), collision-time (duration) is missing and so it becomes impossible to unify these two theories with the existing mass definition. At best, there have been efforts to blend aspects of the theories together, by having separate formulas for photon momentum and momentum for other particles, for example. There have also been efforts through such things as renormalization and other tricks, but these should no longer be needed in a strong unified theory based on a robust and simple model that unify gravity and QM.

Our theoretical discovery that the Heisenberg principle and Lorentz symmetry must be broken at the Planck scale is directly linked to gravity itself. Gravity is Lorentz symmetry and Heisenberg uncertainty break down. When we see that mass consists of collisions and understand that the duration of these collisions is important, we are able to develop a unified theory. This is shockingly simple, while also being cohesive in the sense that the existing main formulas in physics will stand, even if many of them can be rewritten in a simpler form, as we have done in this paper.

XIII. REVISED HEISENBERG UNCERTAINTY PRINCIPLE

Table II summarizes our new uncertainty principle in comparison with the old theory. As we do not need the Planck constant in our theory, but we have claimed the Planck length is the true essence in matter and energy, it is no surprise that the Planck length is seen where the Planck constant normally is observed. Further, everything is related to space and time alone. For example, rest-mass momentum is the same as collision-length, and therefore the same as one of our energy definitions, namely, collision-length, i.e., the space taken up in forms of collision in form of a length.

In our theory, there is only space and time; but specifically, there is collision-time and non-collision-time—there is space with collision and no collisions, which again are only indivisibles in the void, either moving or colliding. Modern physics has only captured the collision frequency at the quantum level, but not the collision-time, or collision-length. Collision-length divided by collision-time is the speed of light, and the speed of light is collision-space-time. We are well aware that the modern version of the Heisenberg uncertainty principle based on Kennard[77] has half of the Planck constant rather than the Planck constant itself. Whether we should use a half in front of the Planck constant or not we will leave for discussion another time, but in any case, this likely does not alter any of our conclusions.

There is collision-time and non-collision-time, and there is collision-length (space) and noncollision (space). The collision-time interval for an elementary particle with reduced Compton wavelength $\bar{\lambda}$ is given by

$$\frac{l_p}{c} \geq \bar{m} \geq \frac{l_p}{\bar{\lambda}}\frac{l_p}{c}. \tag{118}$$

This means that if one plans to observe an electron, for example, in a Planck second observational time window, then either one finds it in collision state, and this collision state lasts for one Planck second, so that is the maximum collision-time in a Planck second. Or, if one does not observe it in a collision state, then the probability for it to be in such a collision state is $l_p/\bar{\lambda}$ and therefore the collision-time is an expected collision-time of $l_p/\mathrm{c} \times l_p/\bar{\lambda}$. This is, however, not an observable collision-time, as it is shorter than the Planck time, and in our theory we can have no length shorter than a Planck length and no time shorter than the Planck time. Further, it is only when the electron (or any other particle) is in its collision state that this is observable gravity. This corresponds to the left side of the inequality above, and it corresponds to the situation where we have Lorentz symmetry and Heisenberg uncertainty break down. The break down in the Heisenberg principle simply means the uncertainty suddenly switches to determinism. But the determinism in an electron only lasts inside one Planck second. This also means things cannot change inside one Planck second, as we have an observation resolution directly linked to the smallest building blocks. We are not necessarily talking about what can be done in the future with the most advanced apparatus, but about the theoretical limits that are linked to reality. But the beauty is that by understanding the smallest building blocks we have a unified consistent quantum gravity theory, where predictions are identical to the gravity phenomena we actually are observing.

It is also clear one can never get a unified theory based on the existing Heisenberg uncertainty fundamentals, which naturally are directly linked to today's QM. Modern physics will not be able to incorporate the Planck scale without modifying Heisenberg's uncertainty principle, something that is clear if one has looked into several extensions of the uncertainty principle in the hope of incorporating gravity, see Refs. 78 and 79. Still, the missing piece seems to entail incorporating collision-time in the mass, which will automatically change the uncertainty principle. This keeps the uncertainty principle unchanged inside a large range, but gives upper and lower bounds.

XIV. IMPLICATIONS FOR QM

That the Heisenberg principle breaks down and becomes a certainty principle at the Planck scale means that Bell's inequality does not necessarily hold any more. This is

TABLE II. The table shows the revisited uncertainty principle and the standard uncertainty principle.

	Revisited uncertainty principle	Standard uncertainty principle
Momentum position uncertainty	$\Delta\bar{E}\Delta x \geq l_p^2$	$\Delta p \Delta x \geq \hbar$
Momentum position uncertainty	$\Delta r_s \Delta x \geq 2l_p^2$	$\Delta p \Delta x \geq \hbar$
Kinetic momentum	$l_p - l_p \frac{l_p}{\bar{\lambda}} \geq p_k \geq 0$	$\Delta p \geq \frac{\hbar}{\Delta x}$ gives $\infty \geq p \geq 0$
Total momentum	$l_p \geq p_t \geq l_p \frac{l_p}{\bar{\lambda}}$	$\Delta p \geq \frac{\hbar}{\Delta x}$ gives $\infty \geq p \geq 0$
Position uncertainty	$\bar{\lambda} \geq x \geq l_p$	$\Delta x \geq \frac{\hbar}{\Delta p}$ gives $0 \leq x \leq \infty$
Energy time uncertainty	$\Delta\bar{E}\Delta t \geq \frac{l_p^2}{c}$ Pauli objection solved	$\Delta E \Delta t \geq \hbar$ Pauli objection not solved
Energy time uncertainty	$\Delta r_s \Delta t \geq 2\frac{l_p^2}{c}$	$\Delta E \Delta t \geq \hbar$
Energy	$l_p \geq \bar{E} \geq l_p \frac{l_p}{\bar{\lambda}}$	$0 \leq E \leq \infty$
Time	$\frac{\bar{\lambda}}{c} \geq t \geq \frac{l_p}{c}$ Time between Planck events	$\Delta t \geq 0$ and $\infty \geq t \geq 0$ Pauli Objection not solved
Kinetic energy	$\left(l_p - \frac{l_p^2}{\bar{\lambda}}\right) \geq \bar{E}_k \geq 0$	Undefind ? $\Delta E \geq \frac{\hbar}{\Delta t}$
Mass as collision-time	$\frac{l_p}{c} \geq \bar{m} \geq \frac{l_p}{c}\frac{l_p}{\bar{\lambda}}$	Missing
Velocity mass	$0 \leq v \leq c\sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}}$	$v < c$
Quantum probability	$1 \geq P \geq \frac{l_p}{\bar{\lambda}}$	Undefined?
Trans-Planckian crisis	No	Yes

because Bell's theorem[80] is rooted in the assumption that the Heisenberg uncertainty principle always holds, see the work by Clover.[81,82] This may again open up new possibilities for local hidden variable techniques, as suggested by Einstein, Podolsky, and Rosen.[83]

As we have shown, the standard energy momentum relation $E = \sqrt{p^2c^2 + m^2c^4}$ can be replaced by $\bar{E} = \bar{p}_k + \bar{m}c = \bar{p}_t$; there is no square root in our energy momentum relation. The square root in the standard energy momentum relation has been interpreted by some researchers to indicate that we may also have negative energy and negative mass. Negative energy and negative mass have been linked to speculative theories about negative probability, see, for example, Refs. 84 and 85. However, negative probabilities seem absurd in many ways. In our new theory, there is less room for such theories.

In 1956, Pauli[86] pointed out directly how renormalization can lead to negative probabilities—something he also called ghost probabilities. Feynman,[87] who was one of the key people behind renormalization, was strongly critical to this *ad hoc* method, or in his own words

> *"The shell game that we play – is technically called 'renormalization'. But no matter how clever the word, it is still what I would call a dippy process! Having to resort to such hocus-pocus has prevented us from proving that the theory of quantum electrodynamics is mathematically self-consistent. It's surprising that the theory still hasn't been proved self-consistent one way or the other by now; I suspect that renormalization is not mathematically legitimate."*—R. Feynman, 1985

Our energy cut off at the Planck scale for elementary particles (see also Section XXI) will likely mean that renormalization is not needed in our theory. Naturally, this has to be investigated further before any clear conclusion is drawn, and we will leave it for another time.

De Broglie, with his theory of matter waves, which was essential for developing the standard quantum theory, shared Einstein's skepticism toward the type of probability interpretations used in standard QM. In his own words,

> *"We have to come back to a theory that will be way less profoundly probabilistic. It will introduce probabilities, a bit like it used to be the case for the kinetic theory of gases if you want, but not to an extent that forces us to believe that there is no causality."*—Louis de Broglie, 1967[d)]

This is exactly what our new theory has done. For example, our Schwarzschild radius for masses smaller than a Planck mass particle is now directly linked to a frequency probability given by: $P = l_p/(\bar{\lambda}\sqrt{1 - v^2/c^2})$, of a Planck

d)Live interview with Louis Broglie on youtube: https://www.youtube.com/watch?v=stRrf4DB_3Y.

mass event occurring in any given Planck second. It looks like the probability can go above unity as v approaches c, which does not make sense. However, this is not the case, as we have shown the maximum velocity of any elementary particle is $v_{\max} = c\sqrt{1 - l_p^2/\bar{\lambda}^2}$. This gives a maximum probability is unity for any elementary particle

$$\begin{aligned}
P &= \frac{l_p}{\bar{\lambda}\sqrt{1 - \frac{v_{\max}^2}{c^2}}},\\
P &= \frac{l_p}{\bar{\lambda}\sqrt{1 - \frac{\left(c\sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}}\right)^2}{c^2}}},\\
P &= \frac{l_p}{\bar{\lambda}\sqrt{1 - \frac{c^2\left(1 - \frac{l_p^2}{\bar{\lambda}^2}\right)}{c^2}}},\\
P &= \frac{l_p}{l_p} = 1.
\end{aligned} \tag{119}$$

This is again the frequency probability for observing a Planck mass event for an elementary particle with reduced Compton wavelength of $\bar{\lambda}$ inside one Planck second. For a composite mass, it is different here, as shown previously, before the Compton frequency inside one Planck second can become higher than 1. That is, $l_p/\bar{\lambda}$ for a composite mass can be higher than 1. This simply means that the integer part is the number of certain Planck events and the fraction is a probability. In other words, this is the number of collisions we know must happen plus the probability for one uncertain event to happen. The maximum velocity of a composite mass is limited by the heaviest fundamental particles in the composite mass.

This means our theory for single elementary particles built from minimum two indivisible particles can also be written as a Planck mass event probability theory, and Table III summarizes some of the formulas we have discussed in this paper.

This fits perfectly with our uncertainty principle. Again the $l_p/(\bar{\lambda}\sqrt{1 - v^2/c^2})$ part in the formulas in the table should be seen as a frequency probability of a Planck mass event. This probability is for a rest-mass $l_p/(\bar{\lambda}\sqrt{1 - 0^2/c^2}) = l_p/\bar{\lambda}$. And for a mass moving at its maximum velocity $l_p/(\bar{\lambda}\sqrt{1 - v_{\max}^2/c^2}) = 1$. This defines a range of values for all elementary particles. And a probability of unity is directly linked to Lorentz symmetry break down and that the Heisenberg uncertainty principle collapses and becomes a certainty principle inside one Planck second. This simply means if one observes a Planck mass particle inside a Planck second, then it is a Planck mass particle in collision state. Unlike all other particles, the Planck mass particle cannot be in and out of a collision state. When it is not in a collision state, it is energy, but then it is not a Planck mass particle. While all other masses other than the Planck mass particles switch between energy and mass, the Planck mass particle is only mass, but it only lasts for one Planck second. This again is gravity; it is collision-time. Our theory has no mystical probabilities; we are back to frequency probabilities, and everything in our model has logical, simple, and mechanical explanations.

TABLE III. This table shows the standard relativistic mass as well as the probabilistic approach. Be aware of the notation difference between the Planck mass $\bar{m}_p$ and the proton rest-mass $\bar{m}_P$.

Probabilistic approach	Formula
Electron mass as collision-time	$\bar{m}_e = \frac{\bar{m}_e}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{l_p}{c}\frac{l_p}{\bar{\lambda}_e\sqrt{1 - \frac{v^2}{c^2}}}$
Proton mass as collision-time	$\bar{m}_P = \frac{\bar{m}_P}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{l_p}{c}\frac{l_p}{\bar{\lambda}_P\sqrt{1 - \frac{v^2}{c^2}}}$
Planck particle mass as collision-time	$\bar{m}_p = \frac{\bar{m}_p}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{l_p}{c}\frac{l_p}{l_p\sqrt{1 - \frac{0^2}{c^2}}} = \frac{l_p}{c}$
Schwarzschild radius	$\frac{1}{2}r_s = \frac{\bar{m}c}{\sqrt{1 - \frac{v^2}{c^2}}} = l_p\frac{l_p}{\bar{\lambda}\sqrt{1 - \frac{v^2}{c^2}}}$
Schwarzschild radius Planck mass particle	$\frac{1}{2}r_s = \frac{\bar{m}_p c}{\sqrt{1 - \frac{v^2}{c^2}}} = l_p\frac{l_p}{\bar{\lambda}\sqrt{1 - \frac{0^2}{c^2}}} = l_p$

XV. OUR NEW RELATIVISTIC ENERGY MOMENTUM RELATION ALSO GIVES THE SCHRÖDINGER EQUATION WHEN $V \ll C$

Our new energy momentum relation is

$$\bar{E} = \bar{E}_k - \bar{m}c = \frac{\bar{m}c}{\sqrt{1 - \frac{v^2}{c^2}}}. \tag{120}$$

This can be rewritten as

$$\bar{E} = \frac{\bar{m}c}{\sqrt{1 - \frac{v^2}{c^2}}}, \tag{121}$$

and when $v \ll c$, then using the first two terms of a Taylor series approximation, we get

$$\bar{p} = \frac{\bar{m}c}{\sqrt{1 - \frac{v^2}{c^2}}} \approx \bar{m}c + \frac{1}{2}\bar{m}\frac{v^2}{c}. \tag{122}$$

Based on this, we can rewrite Eq. (120) as

$$\begin{aligned}
\tilde{E} &\approx \frac{1}{2c}\bar{m}v^2 + \tilde{m}c,\\
\tilde{E} &\approx \frac{\bar{p}^2}{2\bar{m}c} + \bar{m}c,
\end{aligned} \tag{123}$$

where $\bar{p} = \bar{m}v$, and now replacing $\bar{E}$ with the energy operator $\hat{E} = l_p^2\partial/\partial t$ and $\bar{p}$ with the momentum operator $\hat{p} = l_p^2\nabla$, we get

$$il_p^2\frac{\partial\Psi}{\partial t}\approx\left(\frac{i^2l_p^4}{2\bar{m}c}\nabla^2+\bar{m}c\right)\Psi,$$
$$i\frac{\partial\Psi}{\partial t}\approx\left(\frac{-l_p^2}{2\bar{m}c}\nabla^2+\frac{\bar{m}c}{l_p^2}\right)\Psi, \tag{124}$$
$$i\frac{\partial\Psi}{\partial t}\approx\left(\frac{-\bar{\lambda}}{2}\nabla^2+\frac{1}{\bar{\lambda}}\right)\Psi.$$

This is a close parallel to the Schrödinger equation. The clear connection to the Schrödinger equation is first seen when we use the standard (incomplete) mass measure $m=\hbar/(\bar{\lambda}c)$ then we have

$$E=\frac{mc^2}{\sqrt{1-\frac{v^2}{c^2}}},$$
$$E=\frac{mc^2}{\sqrt{1-\frac{v^2}{c^2}}}-mc^2+mc^2, \tag{125}$$
$$E\approx\frac{1}{2}mv^2+mc^2,$$
$$E\approx\frac{p^2}{2m}+mc^2.$$

Replacing E with the energy operator $i\hbar\,\partial/\partial t$ and p with the momentum operator $i\hbar\nabla$, we get

$$i\hbar\frac{\partial\Psi}{\partial t}\approx\left(\frac{i^2\hbar^2}{2m}\nabla^2+mc^2\right)\Psi,$$
$$i\hbar\frac{\partial\Psi}{\partial t}\approx\left(\frac{-\hbar^2}{2m}\nabla^2+mc^2\right)\Psi,$$
$$i\frac{\partial\Psi}{\partial t}\approx\left(\frac{-\hbar}{2m}\nabla^2+\frac{mc^2}{\hbar}\right)\Psi, \tag{126}$$
$$i\frac{\partial\Psi}{\partial t}\approx\left(\frac{-\bar{\lambda}c}{2}\nabla^2+\frac{c}{\bar{\lambda}}\right)\Psi.$$

The difference between Eq. (126) and Eq. (124) is simply a c due to the standard energy definition is our energy definition multiplied by c, otherwise the equations are identical. This simply means that the Schrödinger equation is consistent with our new framework.

However, our kinetic momentum is zero when $v=0$ and the standard momentum (de Broglie momentum) is not valid when $v=0$, so the Schrödinger equation is likely inconsistent for photon collisions (collisions of indivisible particles), which are central to unifying gravity with QM. The Schrödinger equation is, therefore, simply a good approximation for certain particles, although it is not always valid under all circumstances. This should be investigated further in the light of our new theory.

XVI. MINKOWSKI SPACE-TIME IS UNNECESSARILY COMPLEX AT THE QUANTUM LEVEL

Our four-dimensional wave equation is invariant. It should be consistent with relativity theory, since it is a relativistic wave equation. As pointed out by Unruh,[88] for example, time in standard QM plays a role in the interpretation distinct from space, in contrast with the apparent unity of space and time encapsulated in Minkowski space-time.[89] This has been a challenge in standard QM: Why is it not fully consistent with Minkowski space-time? According to Unruh, whether or not Minkowski space-time is compatible with quantum theory is still an open question. From our new relativistic wave equation, we have good reason to think this may provide the missing bridge to the solution. This is something we will investigate further here.

Minkowski space-time is given by

$$dt^2c^2-dx^2-dy^2-dz^2=ds^2, \tag{127}$$

where the space-time interval ds^2 is invariant. Or, if we are only dealing with one space dimension, we have

$$dt^2c^2-dx^2=ds^2. \tag{128}$$

This is directly linked to the Lorentz transformation (space-time interval) by

$$t'^2c^2-x'^2=\left(\frac{t-\frac{L}{c^2}v}{\sqrt{1-\frac{v^2}{c^2}}}\right)^2c^2-\left(\frac{L-tv}{\sqrt{1-\frac{v^2}{c^2}}}\right)^2=s^2. \tag{129}$$

Assume we are working with only two events that are linked by causality. Each event takes place in each end of a distance L. Then for the events to be linked, a signal must travel between the two events. This signal moves at velocity v_2 relative to the rest frame of L, as observed in the rest frame. This means $t=L/v_2$. In addition, we have the speed v, which is the velocity of the frame where L is at rest with respect to another reference frame. That is, we have

$$t'^2c^2-x'^2=\left(\frac{\frac{L}{v_2}-\frac{L}{c^2}v}{\sqrt{1-\frac{v^2}{c^2}}}\right)^2c^2-\left(\frac{L-\frac{L}{v_2}v}{\sqrt{1-\frac{v^2}{c^2}}}\right). \tag{130}$$

The Minkowski space-time interval is invariant. This means it is the same, no matter what reference frame it is observed from. To look more closely at why this is so, we can do the following calculation:

$$t'^2c^2 - x'^2 = \left(\frac{\frac{L}{v_2} - \frac{L}{c^2}v}{\sqrt{1-\frac{v^2}{c^2}}}\right)^2 c^2 - \left(\frac{L - \frac{L}{v_2}v}{\sqrt{1-\frac{v^2}{c^2}}}\right)^2,$$

$$t'^2c^2 - x'^2 = \left(\frac{L\frac{c}{v_2} - L\frac{v}{c}}{\sqrt{1-\frac{v^2}{c^2}}}\right)^2 - \left(\frac{L - L\frac{v}{v_2}}{\sqrt{1-\frac{v^2}{c^2}}}\right)^2,$$

$$t'^2c^2 - x'^2 = \frac{L^2\frac{c^2}{v_2^2} - 2L^2\frac{v}{v_2} + L^2\frac{v^2}{c^2}}{1-\frac{v^2}{c^2}} - \frac{L^2 - 2L^2\frac{v}{v_2} + L^2\frac{v^2}{v_2^2}}{1-\frac{v^2}{c^2}},$$

$$t'^2c^2 - x'^2 = \frac{L^2\frac{c^2}{v_2^2} + L^2\frac{v^2}{c^2} - L^2 - L^2\frac{v^2}{v_2^2}}{1-\frac{v^2}{c^2}},$$

$$t'^2c^2 - x'^2 = \frac{L^2\left(\frac{c^2}{v_2^2} + \frac{v^2}{c^2} - \frac{v^2}{v_2^2} - 1\right)}{1-\frac{v^2}{c^2}},$$

$$t'^2c^2 - x'^2 = \frac{-L^2\left(1-\frac{v^2}{c^2}\right)\left(1-\frac{c^2}{v_2^2}\right)}{1-\frac{v^2}{c^2}},$$

$$t'^2c^2 - x'^2 = L^2\left(\frac{c^2}{v_2^2} - 1\right). \tag{131}$$

We can clearly see that v is falling out of the equation, and that the Minkowski interval therefore is invariant. For a given signal speed v_2 between two events, the space-time interval is the same from every reference frame. We can also see that it is necessary to square the time and space intervals to get rid of the v and get an invariant interval. If we did not square the time and space intervals, we would get

$$t'c - x' = \left(\frac{\frac{L}{v_2} - \frac{L}{c^2}v}{\sqrt{1-\frac{v^2}{c^2}}}\right)c - \left(\frac{L - \frac{L}{v_2}v}{\sqrt{1-\frac{v^2}{c^2}}}\right),$$

$$= \frac{L\frac{c}{v_2} - L\frac{v}{c}}{\sqrt{1-\frac{v^2}{c^2}}} - \frac{L - L\frac{v}{v_2}}{\sqrt{1-\frac{v^2}{c^2}}},$$

$$= \frac{L\frac{c}{v_2} - L\frac{v}{c} - L + L\frac{v}{v_2}}{\sqrt{1-\frac{v^2}{c^2}}}. \tag{132}$$

The v will not go away if we do not square the time transformation and length transformation. That is $ds = dtc\text{-}dx$ is in general not invariant. However, the squaring is not needed in the special case, where the causality between two events is linked to the speed of light; that is, a signal goes with the speed of light from one side of a distance L to cause an event at the other side of L. In this case, we have

$$t'c - x' = \frac{\frac{L}{c} - \frac{L}{c^2}v}{\sqrt{1-\frac{v^2}{c^2}}}c - \frac{L - \frac{L}{c}v}{\sqrt{1-\frac{v^2}{c^2}}},$$

$$= \frac{L - \frac{L}{c}v}{\sqrt{1-\frac{v^2}{c^2}}} - \frac{L - \frac{L}{c}v}{\sqrt{1-\frac{v^2}{c^2}}} = 0. \tag{133}$$

In other words, we do not need to square the space interval and the time interval to have an invariant space-time interval when the two events follow causality and where the events are caused by signals traveling at the speed of light. We are not talking about the velocity of the reference frames relative each other to be c (which would cause the model to blow up in infinity), but the velocity that causes one event at each side of the distance L to communicate. And in our Compton model of matter, every elementary particle is a Planck mass event that happens at the Compton length distance apart at the Compton time. Each Planck mass event is linked to the speed of light and the Compton wavelength of the elementary particle in question. This means in terms of space-time (only considering one dimension), for elementary particles, we must always have

$$t'c - x' = \frac{\frac{\bar{\lambda}}{c} - \frac{\bar{\lambda}}{c^2}v}{\sqrt{1-\frac{v^2}{c^2}}}c - \frac{\bar{\lambda} - \frac{\bar{\lambda}}{c}v}{\sqrt{1-\frac{v^2}{c^2}}},$$

$$= \frac{\bar{\lambda} - \frac{\bar{\lambda}}{c}v}{\sqrt{1-\frac{v^2}{c^2}}} - \frac{\bar{\lambda} - \frac{\bar{\lambda}}{c}v}{\sqrt{1-\frac{v^2}{c^2}}} = 0. \tag{134}$$

That is, inside elementary particles, there are Planck mass events every Compton time, and these events, we can say, follow causality; they cannot happen at the same time. Two light particles must each travel over a distance equal to the Compton length between each event. The Planck mass events inside an elementary particle follow causality and are linked to the speed of light, which is why we always have $v_2{=}c$ at the deepest quantum level. However, two electrons can, at the same time, travel at velocity $v \le c\sqrt{1 - l_p^2/\bar{\lambda}^2}$ relative to each other.

Or, in three space dimensions (four-dimensional space-time), we should have

$$dtc - dx - dy - dz = 0. \tag{135}$$

The Minkowski space-time is unnecessarily complex for the quantum world. Collision-space-time in the quantum world gives a strongly simplified "special case" of Minkowski space-time, where no squaring is needed and where the space-time interval always is zero. What does this mean? This means simply that an indivisible particle moves its own diameter during the period two other indivisible particles spend in collision. This means length (space) and time are directly liked or actually gives us the speed of light.

In the special case of a Planck mass particle, we have $\bar{\lambda} = l_p$ and also $v = 0$ because $v_{\max}$ for a Planck mass particle is zero. Again, this is simply because two light particles stand absolutely still for one Planck second during their collision, which gives

$$\begin{aligned} t'c - x' &= 0, \\ \frac{\frac{\bar{l}_p}{c} - \frac{l_p}{c^2} \times v}{\sqrt{1 - \frac{v^2}{c^2}}} c - \frac{l_p - \frac{l_p}{c} v}{\sqrt{1 - \frac{v^2}{c^2}}} &= 0, \\ \frac{l_p - \frac{l_p}{c} \times 0}{\sqrt{1 - \frac{0^2}{c^2}}} - \frac{l_p - \frac{l_p}{c} \times 0}{\sqrt{1 - \frac{0^2}{c^2}}} &= 0, \\ t_p c - l_p &= 0. \end{aligned} \tag{136}$$

This means our theory is consistent with the Planck scale. It simply means that time at the most fundamental level is a Planck mass event. As we have claimed before, the Planck mass event has a radius equal to the Planck length and it only lasts for one Planck second.

XVII. ALL GRAVITY PHENOMENA CAN BE EASILY PREDICTED WITH NO KNOWLEDGE OF *G*, THE PLANCK CONSTANT, OR EVEN ANY KNOWLEDGE OF THE TRADITIONAL MASS SIZE

Recently, it has been shown by Haug[90,91] that "all" gravity phenomena can be easily predicted with no knowledge of Newton's gravity constant, nor any knowledge of the standard mass size of the object. This can be done by finding the Schwarzschild radius of any astronomical object simply by using the following formula:

$$\frac{1}{2} r_s = g \frac{r^2}{c^2}. \tag{137}$$

The gravitational acceleration field can be measured quite easily without any knowledge of gravity theory; at the surface of Earth it is about $9.8\,\text{m/s}^2$. This we can simply measure by dropping an object through two time-gates. The speed of light we can measure without any knowledge of gravity and the same with the radius of the Earth. Now that we know the Schwarzschild radius of the Earth, we can predict all other gravity phenomena from this, as shown in Table IV.

Since mass is assumed to be the cause of gravity, how can it be that we can predict all gravity phenomena without knowing either the traditional mass of the Earth or the Newton gravitational constant? The reason is simple. Standard physics uses an incomplete mass measure. Half of the Schwarzschild radius is the collision-length of the mass in question; it is the (gravitational) energy of the mass. So, using this approach, we are naturally predicting how gravity affect such things as light. However, since the energy is the collision-length is equal to half the Schwarzschild radius, we do not need to convert an incomplete mass measure (kg) into collision-time by first finding the gravitational constant and then multiplying the mass with this to find the Schwarzschild radius. We already have incorporated this into our mass definition, and that is why our theory is so much simpler, and helps us understand why we can perform all gravitational predictions without knowledge of *G*, or the Planck constant, or the traditional mass size.

TABLE IV. The table shows that the most common gravitational measurements and predictions can be done without any knowledge of Newton's gravitational constant or knowledge of the traditional mass size. The reason is that the Schwarzschild radius actually represents the collision-length, which is the mass in terms of collision-time multiplied by the speed of light.

What to measure/predict	Formula	How
Half Schwarzschild radius	$r_e = \frac{gR^2}{c^2}$	From g (9.8 m/s^2 Earth)
Gravitational acceleration field	$g = \frac{r_e}{R^2} c^2$	Find r_e first
Orbital velocity	$v_o \approx c\sqrt{\frac{r_e}{R}}$	Find r_e first
Escape velocity	$v_e \approx c\sqrt{2\frac{r_e}{R}}$	Find r_e first
Time dilation	$t_2 \approx t_1\sqrt{1 - 2\frac{r_e}{R}}$	Find r_e first
GR bending of light	$\delta = 4\frac{r_e}{R}$	Find r_e first
Gravitational red-shift	$\lim_{R\to+\infty} z(R) = \frac{r_e}{R}$	Find r_e first

XVIII. A CLOSER LOOK AT THE NEWTON GRAVITATIONAL CONSTANT AND WHY IT IS NEEDED ONLY IN STANDARD INCOMPLETE PHYSICS

Actually, Newton himself (*Principia*) never introduced a gravitational constant. His gravity formula was simply $F = Mm/R^2$. That is, the gravity force is proportional to the masses multiplied divided by the square root of the center to center distance. Without the gravitational constant, Newton was able to find the relative mass between planets, and also between the Sun and planets. Other physicists have had similar ideas to Newton, including Robert Hooke. The gravity constant was first indirectly measured in 1798 by Cavendish using a torsion balance apparatus, also known as Cavendish apparatus. Cavendish used this to measure the density of the Earth. Even if Cavendish often is credited as the first one to measure the gravity constant, he mentions no such constant. His focus is on the Earth density relative to a mass of which we know the density. In 1873, the Newton gravity formula, as it is known today, was first formally described by Cornu and Baille[92] using the gravity constant (today known as the Newton gravity constant) in a footnote, namely,

$$F = f\frac{Mm}{R^2}. \tag{138}$$

In 1894, the gravity constant was first coined *G* by Boys,[93] but many physicists still called it *f* in the early

1900s, see, for example, Isaachsen[94] in 1905, and Planck[95] as late as 1928. The gravity constant is, in modern physics, a constant that is found by calibrating the Newton model to fit observations, based on a certain definition of mass. Newton would possibly dislike this re-definition of his formula, as he was clear on the idea that the building blocks for matter and energy consisted of indivisible particles and indivisible time, something that is not incorporated into today's kg definition of mass. Newton had not elaborated on this line of thought fully, but he was on the right track. That is, the gravity constant is heavily dependent on the definition of mass and our understanding (or we could even say, our lack of understanding) of the nature of mass. It is a parameter that captures what one missed, but besides being a parameter needed to calibrate the Newtonian formula (and General Relativity) to fit observational data, the Newton gravity constant gives little intuition. The fact that the constant does not seem to vary naturally indicates it is related to something at a deeper level that is unchangeable. But could it really be something fundamental that exists in nature that is $m^3 \cdot kg^{-1} \cdot s^{-2}$? We doubt so.

In several papers, Haug[28,96,97] has suggested that the Newton gravity constant is a composite constant of the form

$$G = \frac{l_p^2 c^3}{\hbar}. \tag{139}$$

This can be found simply by solving the Planck length formula $l_p = \sqrt{G\hbar/c^3}$ of Max Planck[98,99] with respect to G. It is then easy to think this is just creating a circular problem, as from the Planck formula we need G in order to find the Planck length. We are not alone in suggesting that the gravitational constant G is a composite of the form $G = l_p^2 c^3/\hbar$. McCulloch[100] has suggested similarly that $G = \hbar c/m_p^2$, which basically is the same as $G = l_p^2 c^3/\hbar$, since $m_p = \hbar/(l_p\, c)$. However, McCulloch[101] has incorrectly followed the standard assumption in modern physics and assumed that one needs to know G to find the Planck mass (Planck length), and therefore he arrives at a circular problem that we do not have. In his own words

> *"In the above gravitational derivation, the correct value for the gravitational constant G can only be obtained when it is assumed that the gravitational interaction occurs between whole multiples of the Planck mass, but this last part of the derivation involves some circular reasoning, since the Planck mass is defined using the value for G."*—M. McCulloch, 2016

However, as we have shown, the Planck length plays an essential role in matter and energy, and it can be found without any knowledge of G and also with as shown by Haug,[102] and also without knowledge of the Planck constant as shown in a more profound way in the beginning of this paper, using the Cavendish apparatus, see also Ref. 103.

In our collision-space-time theory, we are avoiding this circular problem. We have basically proven it is the Planck length, which must be the diameter of the indivisible Newton particle that is essential for gravity, as it leads us to the duration of each collision in a mass, and not only the number of collisions (as one has in kg mass). In gravity, we can do without the gravity constant and the Planck constant. The gravity constant is only needed when one uses the incomplete mass definition of kg that only gives us the collision ratio in order to convert it into collision-time, which also contains the collision-duration.

The standard mass definition model is incomplete; the gravity constant that is embedded contains the Planck constant, the Planck length, and the speed of light. The Planck constant is actually needed to eliminate the Planck constant embedded in the standard mass definition of kg to perform gravity calculations, then the Planck length needs to be introduced, as well as the speed of gravity c, which is the speed of the indivisible particle.

This means that GM, in reality, can be seen as a way to convert the standard mass definition into the more essential collision-time mass definition. We have

$$GM = \frac{l_p^2 c^3}{\hbar} \times \frac{\hbar}{\bar{\bar{\lambda}}} \frac{1}{c} = c^3 \times \frac{l_p}{c} \frac{l_p}{\bar{\lambda}} = c^3 \bar{M} = c^2 \bar{E}. \tag{140}$$

The c^2 that we get in addition to the collision-length ($\bar{E} = \bar{L}$) is basically because the Newton gravity formula is linked to gravitational acceleration; the c^2 here has nothing to do with going from mass to energy (in this formula). All observable gravity predictions from the Newton formula is based on the large mass only, see Table V. The smaller mass is only used in derivations where two small masses cancel each other out, in the derivation of escape velocity, for example. What definition is used for the small mass in the Newton formula is therefore of little importance as long as we employ the same mass definition for both of the small masses used in a series of gravitational derivations.

We would go as far as to say, G is needed to turn the standard kg mass back to Newton's strong indication that mass was ultimately linked to indivisible particles and indivisible time, as he claims in *Principia*, is the essence of all his philosophy. That is, GM should be seen as c^3 times the collision-time, and the collision-time is the very essence of mass; it is what truly define mass at its deepest level. Collision-time contains more information than the kg definition of mass. If we know the collision-time of a mass, we can perform gravity calculations (without G or $\hbar$), and find such things as the frequency in energy. As long as we do not handle gravity, we can work with only the number of collisions, which is the deeper reason one does not need G in nongravity physics. Only when we want to compare the essential mass to an arbitrary clump of matter called a kg do we need the Planck constant. The Planck constant is essential if we want to know mass in terms of a collision ratio relative to the arbitrary chosen mass kg. However, if we define mass as only the collision ratio, as kg is, we have no knowledge of the collision-duration, and the collision-duration is the very essence that gives gravity. However, modern physics has been able to do this in an ad-hoc way, by calibrating the kg mass definitions to gravity observations, and by introducing a gravity constant.

TABLE V. The table shows the Newton gravitational force in addition to our new quantum gravity theory. Here, the solution also holds for a strong gravitational field in a two-reference frame system.

Mass seen as	Modern "Newton" Compton frequency relative to Compton frequency kg	New quantum gravity Collision-time per shortest time interval
Mass mathematically	$M=\frac{\hbar}{\bar{\lambda}}\frac{1}{c}$	$\bar{M}=\frac{l_p}{c}\frac{l_p}{\bar{\lambda}}$
Energy		
Gravity constant	$G=\frac{l_p^2c^3}{\hbar}$	c^3
Non "observable" predictions:		
Gravity force	$F=G\frac{Mm}{R^2}$	$\bar{F}=c^3\frac{\bar{M}\frac{\bar{m}}{\sqrt{1-\frac{v^2}{c^2}}}}{R^2}$
	$F=\frac{\hbar c}{R^2}\frac{l_p}{\bar{\lambda}_M}\frac{l_p}{\bar{\lambda}_m}$	$\bar{F}=\frac{c}{R^2}\frac{l_p^2}{\bar{\lambda}_M}\frac{l_p^2}{\bar{\lambda}_m\sqrt{1-\frac{v^2}{c^2}}}$
Observable predictions:		
Gravity acceleration	$g=\frac{GM}{R^2}=c^2\frac{l_p}{R^2}\frac{l_p}{\bar{\lambda}}$	$g=c^3\frac{\bar{M}}{R^2}=c^2\frac{l_p}{R^2}\frac{l_p}{\bar{\lambda}}$
Orbital velocity	$v_o=\sqrt{\frac{GM}{R}}=c\sqrt{\frac{l_p}{R}\frac{l_p}{\bar{\lambda}}}$	$v_o=c\sqrt{\frac{l_p}{\bar{\lambda}}\frac{l_p}{R}-\frac{1}{2}\frac{l_p^4}{\bar{\lambda}^2R^2}}$
Escape velocity	$v_e=\sqrt{\frac{2GM}{R}}=c\sqrt{2\frac{l_p}{R}\frac{l_p}{\bar{\lambda}}}$	$v_e=c\sqrt{2\frac{l_p}{\bar{\lambda}}\frac{l_p}{R}-\frac{l_p^4}{\bar{\lambda}^2R^2}}$
Time dilation	$T_R=T_f\sqrt{1-\frac{\sqrt{\frac{2GM}{R}}^2}{c^2}}=T_f\sqrt{1-2\frac{l_p}{R}\frac{l_p}{\bar{\lambda}}}$	$T_R=T_f\sqrt{1-2\frac{l_p^2}{\bar{\lambda}R}+\frac{l_p^4}{\bar{\lambda}^2R^2}}$
Gravitational red-shift	$z(r)\approx\frac{GM}{c^2R}=\frac{l_p}{R}\frac{l_p}{\bar{\lambda}}$	$z(R)\approx\frac{c^3\tilde{\bar{M}}}{c^2R}=\frac{l_p}{R}\frac{l_p}{\bar{\lambda}}$
Schwarzschild radius	$r_s=\frac{2GM}{c^2}=2l_p\frac{l_p}{\bar{\lambda}}$	$r_s=2l_p\frac{l_p}{\bar{\lambda}}=2\bar{E}$

Actually, if we define a length unit in terms of how long the speed of light moves in our chosen time unit, then $c=1$, something well known to also standard physics.[104] Then we can operate fully (in a weak gravitational field) with Newton's original formula, but only if we use the collision-time definition of mass. That is, the original Newton formula without a gravity constant is fully valid: $F=\bar{M}\bar{m}/R^2$, see Ref. 105.

XIX. COLLISION-TIME THREE-DIMENSIONAL AND THE SAME THREE DIMENSIONS AS COLLISION-SPACE?

Since collision-time and collision-length are so closely connected, one should consider that collision-time is three-dimensional and actually the same three dimensions as the collision-length dimensions. This does not mean one would have six dimensions (three in time and three in space), but only three dimensions in total. The mass-gap in our model consist of two colliding indivisible particles. In terms of QM, one could suggest that the relativistic wave equation should be

$$\nabla_t\Psi-\mathbf{c}\cdot\nabla_x\Psi=0, \tag{141}$$

or in its full form,

$$\frac{\partial\Psi}{\partial t_x}+\frac{\partial\Psi}{\partial t_y}+\frac{\partial\Psi}{\partial t_z}-c\frac{\partial\Psi}{\partial x}-c\frac{\partial\Psi}{\partial y}-c\frac{\partial\Psi}{\partial z}=0. \tag{142}$$

This is naturally no surprise, as the collision-time (at collision) must take up one Planck length (center to center between the two colliding indivisible particles). The constant c is only needed because we tend to use different unit systems for length and time. If we use the same units, that is the speed of light per Planck second rather than per second then $c=1$ or alternatively light seconds for distance, we then have

$$\frac{\partial\Psi}{\partial t_x}+\frac{\partial\Psi}{\partial t_y}+\frac{\partial\Psi}{\partial t_z}-\frac{\partial\Psi}{\partial x}-\frac{\partial\Psi}{\partial y}-\frac{\partial\Psi}{\partial z}=0. \tag{143}$$

This simply means we can have no extension in collision-time without an extension in space, this is because time is colliding indivisible particles. This seems to indicate that collision-time is three dimensional. However, this does not mean that one can go back in time. This simply means the collision-time takes up space and if it is negative then it means it happens to the left of us or below us, rather than to the right of us or above us. This is simply where the collision takes place in space.

For example, the t_x axis would be the same as the x axis, but as long as we do not set $c = 1$, this means we are using different unit systems for length and time, and a conversion factor like c on each axis is needed to go from space coordinates to time coordinates. Naturally by setting $c = 1$, that is one-dimensional diameter per time unit, then they are one and the same, collision-space is collision-time. This does not change the concept that the speed of light is isotropic and the same in every direction. However, it is more correct to say, the speed of light always is one. This simply means we get one collision-time unit for every collision-space unit. This also means a free moving indivisible particle can travel its own diameter in space in the same amount of time two other indivisible particles spend in collision. This simply means we cannot have observable time without taking up space with collisions, and we cannot have collisions taking up space without spending time in collisions.

XX. GOING BACK AND FORTH BETWEEN STANDARD NOTATION/DIMENSIONS AND OUR NEW NOTATION/DIMENSIONS

In the beginning of this paper, we claimed that "*The beauty of our theory is that most of the main equations that currently exist in physics are not changed (in terms of predictions), except at the Planck scale*." And we stand behind this claim. However, since we have changed the dimensions of both mass and energy, from kg and Joule to collision-time and collision-length, as well as going from what we call the de Broglie momentum (standard momentum) to the Compton momentum, it can be difficult to see how close our theory is to standard theory, except at the Planck scale.

It is important to be aware that at any point we can easily return to the established and better-known mass and energy standards. Our mass in terms of collision-time can be turned back into kg mass simply multiplying it by $\hbar/l_p^2$. And we can go from our energy measure to the standard energy measure simply multiplying by $\hbar c/l_p^2$. This causes no issues as long as we do not work with gravity. However, if one turns the mass back to the kg mass when working with gravity, then one must again introduce the gravity constant, or at least its composite form $G = l_p^2 c^3/\hbar$. This is because we cannot do "any" predictions of gravity phenomena without incorporating the collision-time one way or the other because gravity is collision-time. This is linked to the Planck length and therefore the Planck scale; gravity is the Planck scale. One naturally has the choice to do this in the way of standard physics, by having a mystical G in addition to the kg mass, or one can switch to the more intuitive and we would say, correct mass definition of collision-time.

That one indirectly has the Planck length and the collision-time embedded in basic gravity in standard physics, by having $G \times M$, but not having the Planck length incorporated in nongravity physics is the reason one is not able to unify gravity and QM. It is first when one understands that $G \times M$ actually is a way to incorporate the Planck length back into the mass, and that such a mass definition also must be done in other parts of our physics, that one will be able to unify gravity with (modified) SR and QM, as we have done here.

Today, modern physics actually uses a different mass definition for gravity phenomena and nongravity phenomena. This is only understood when we see that $G \times M$ is actually to get the Planck length, and thereby the collision-time back into the mass in gravity, because there it is absolutely needed, as gravity is the Lorentz symmetry and also the Heisenberg break down at the Planck scale. One could try to argue against this by saying, "*But there are two masses in the modern use of the modified Newton formula*." We say, modified as Newton himself never used G in his formula. It is important to be aware that even if there are two masses in the Newton formula $F = GMm/R^2$, one of the masses always cancels out in derivations. For all gravity predictions or gravity observations based on the Newton formula, only one mass (the larger mass) is used, see Table V.

One should also keep in mind one can always go between our new Compton momentum and the de Broglie momentum by multiplying the Compton momentum with v/c. By incorporating the Planck length into the mass definition, we get a unified theory. However, we still have the Heisenberg uncertainty principle, we still have relativity theory, and we still get the same relative outputs. Kinetic energy, for example, is still a function of v^2. It is first at the Planck scale that we see the Heisenberg uncertainty principle breaks down and becomes a certainty principle and where Lorentz symmetry breaks down, this break down is gravity.

Actually, we can obtain the kg mass directly from our collision-time definition of mass without relying on the Planck constant. The important point to have in mind is that the standard mass definition is a mass ratio. It is, for example, a particle mass such as an electron relative to the mass of one kg. And one kg is an arbitrary chosen mass unit. The collision-time of an electron is given by

$$\bar{m}_e = \frac{l_p}{c}\frac{l_p}{\bar{\lambda}_e}. \tag{144}$$

To find the collision-time of one kg without relying on the Planck constant, we have to physically count the number of protons in the clump of matter we have decided to call one kg. The number of protons in one kg is roughly 5.98×10^{26} protons. We also need to know the Compton wavelength of the proton. This we can find, as shown before, by first finding the Compton wave of the electron by Compton scattering, then using a cyclotron to find the Compton wave of the proton relative to the electron. And the Compton wavelength of the one kg mass must be

$$\bar{\lambda}_{1\text{kg}} = \frac{1}{5.98 \times 10^{26} \times \frac{1}{\bar{\lambda}_e/1836.15}} \approx 3.52 \times 10^{-43}\ \text{m}. \tag{145}$$

This means the collision-time of one kg is given by

$$\bar{m}_{1\text{kg}} = \frac{l_p}{c}\frac{l_p}{\bar{\lambda}_{1\text{kg}}}. \tag{146}$$

The collision-time ratio of the electron versus the collision-time of one kg gives a kg mass of the electron of

$$\frac{\bar{m}_e}{\bar{m}_{1\mathrm{kg}}}=\frac{\frac{l_p}{c}\frac{l_p}{\bar{\lambda}_e}}{\frac{l_p}{c}\frac{l_p}{\bar{\lambda}_{1\mathrm{kg}}}}=\frac{\bar{\lambda}_{1\mathrm{kg}}}{\bar{\lambda}_e}\approx 9.1\times 10^{-31}, \tag{147}$$

which is exactly identical to the kg mass of the electron. However, from the collision-time ratio, we can see that the Planck length cancels out, that is, the collision ratio, or the collision-time ratio cannot contain the Planck length (with one exception, the Planck mass). This means the standard mass definition, which is a mass ratio, loses out on the collision-duration in each mass. This makes it impossible to develop a unified theory when using a mass ratio, such as kg. This is because gravity is, in our view, directly linked to the collision-duration, that again is directly linked to the Planck length. If the mass is a collision ratio, or a collision-time ratio, this ends up being the same thing. Such a mass definition lacks information about the duration of each collision, and a unified theory cannot be made from such a theory. However, by instead using the collision-time as a mass measure, we have attained a unified theory.

XXI. MORE ON IMPLICATIONS

Our theory may only have implications outside standard physics at the Planck scale. We have pointed out that Lorenz symmetry breaks down at the Planck scale and at the same time, a form of Heisenberg uncertainty principle collapses. However, unlike other quantum gravity theories, Planck scale break downs are easily observable indirectly, as this is gravity. Table VI summarizes some of the key differences between our new collision-space-time theory and standard physics.

A. Infinity limits replaced by exact limits linked to the Planck scale

The fact that Lorentz symmetry breaks at the Planck scale also leads to infinity challenges in standard physics being replaced by exact limits for elementary particles, as shown in Table VII. For example, in standard physics, there is no rule that hinders an electron from travelling at a speed very close to c, as long as the speed is below c. If close enough to c, the relativistic mass of an electron could be equal to the entire rest-mass of our solar system, the galaxy or even the mass of the observable universe. Such electrons would have an enormous kinetic energy, and we have a good observer of such electrons, namely, the Earth itself. For billions of years, the Earth has likely not been hit by a single such electron, see Ref. 106 for an in-depth discussion on this. One should not only look for predictions that can be observed when comparing theories, but also "predictions" that have never been observed.

Our speed limit for anything with rest-mass, which comes directly from understanding that mass is linked to indivisible particles at the deepest level, leads to a speed limit of anything with mass to $v_{\max}=c\sqrt{1-l_p^2/\bar{\lambda}^2}$. Table VII is mostly a consequence of this speed limit that comes out of our mass definition combined with relativity theory. We also see that a length limit equal to the Planck length leads to a minimum limit on length contraction that leads to maximum limits on such things as kinetic energy and momentum for elementary particles. A minimum length is directly linked to a maximum kinetic energy and momentum for elementary particles, since the only variable in a mass is the Compton wavelength. As can be seen from the table, we find similar limits if we switch back to the kg definition of mass. There is no such limit in the kg definition of mass itself, it is first when we understand that the kg definition of mass is incomplete and derive the theory from collision-time that we get these limits. But there is nothing wrong with going back to the kg definition of mass when we are not working with gravity. We can work with the kg definition of mass when we need less information about energy and mass, or when we want to compare our results with standard definitions.

B. Implications for Planck mass particles and micro black holes

So called micro black holes and the Planck mass are closely connected. However, in standard physics, there seem to be more questions than answers around micro black holes and the Planck mass. Our theory seems to remove most if not all mysteries around the Planck mass and micro black holes. But before we discuss the implications of our theory, we will take a quick look at the history of the Planck mass and its possible connection to micro black holes.

Max Planck introduced the Planck mass in 1899 and although it was a fundamental important mass, he did not discuss the possible implications of this in great detail. Lloyd Motz[107–109] was likely the first to suggest there could be a Planck mass particle. He thought that the Planck mass particle was truly essential, but he was also well aware that the Planck mass (about 10^{-8} kg) was substantially larger than any observed fundamental particle. Therefore, he suggested the Planck mass particle had existed just after the Big Bang and then disintegrated into all of the much smaller particles observed today. Others, like Hawking, have suggested that the Planck mass particle is linked to micro black holes, see Ref. 110. Others have tried to link Planck mass micro black holes to dark matter, see Ref. 111.

Our theory gives a new fresh view on the Planck mass particle and corresponding micro black holes. In the collision between two photons, we have the Planck mass, if observed over an observational time window of one Planck second, but only a mass of about 1.17×10^{-51} kg as observed over one second. This was discussed in the introduction. It is, in other words, difficult if not impossible to observe directly, but we have shown it is directly linked to gravity and that we can observe it if we observe macroscopic amounts of matter and measure the gravity effects. The collision between two indivisible particles has a Planck mass when observed over the shortest possible time interval and has, as we will see, the mathematical properties of a micro black hole. In our theory, the term "micro black hole" seems to be a misnomer

TABLE VI. Modern/standard physics versus unified quantum gravity theory.

Entity	Standard physics	Unified quantum gravity
Rest-mass	$m = \frac{\hbar}{\bar{\lambda}}\frac{1}{c}$	$\bar{T} = \bar{m} = \frac{l_p}{c}\frac{l_p}{\bar{\lambda}}$ Collision − time
Rest-mass energy	$E = \frac{\hbar}{\bar{\lambda}}c$	$\bar{L} = \bar{E} = l_p\frac{l_p}{\bar{\lambda}}$ Collision length (space)
Relativistic mass	$m = \frac{\hbar}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}\frac{1}{c}$	$\bar{T} = \bar{m} = \frac{l_p}{c}\frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}$ Collision − time
Relativistic energy	$E = \frac{\hbar c}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}$	$\bar{L} = \bar{E} = l_p\frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}$ Collision length
Know how to find the Planck length independent of G and $\hbar$?	No	Yes
Matter wave	Mistakenly using de Broglie wave. The de Broglie wave is a derivative of the physical Compton wave.	Compton wave.
Energy momentum relation	$E = \sqrt{p^2c^2 - m^2c^4}$	$\bar{E} = \bar{p}_t$ or $\bar{L} = \bar{T}c$ (same)
Plane wave	$\Psi = e^{i\left(\frac{p}{\hbar}x - \frac{E}{\hbar}t\right)}$	$\Psi = e^{i\left(\frac{\bar{L}}{l_p^2}t - \frac{\bar{T}}{l_p^2}x\right)}$ or $\Psi = e^{i\left(\frac{\frac{1}{2}rs}{l_p^2}t - \frac{\bar{m}}{l_p^2}x\right)}$ or $\Psi = e^{i\left(\frac{\bar{E}}{l_p^2}t - \frac{\bar{m}}{l_p^2}x\right)}$
Relativistic wave equation	$\frac{1}{c^2}\frac{\partial^2}{\partial t^2}\Psi - \nabla^2\Psi + \frac{m^2c^2}{\hbar^2}\Psi = 0$	$\frac{\partial\Psi}{\partial t} - \mathbf{c}\cdot\nabla\Psi = 0$
Minkowski space-time geometry	$dt^2c^2 - dx^2 - dy^2 - dz^2 = ds^2$ Not agreement if consistent with QM.	$dtc - dx - dy - dz = 0$ Consistent with QM and gravity.
Gravity weak field	$F = G\frac{Mm}{R^2}$	$\bar{F} = c^3\frac{\bar{M}\bar{m}}{R^2}$
QM full of "mystical" interpretations?	Yes	No
Relativity theory consistent with minimum length?	No	Yes
Found the Planck scale?	No	Yes
Unified quantum gravity?	Not even close.	Yes

TABLE VII. The table compares standard physics with our new theory. As we see, a series of infinity limits are replaced by exact limits linked to the Planck scale.

	Our new theory	Modern physics limit (or limit, if assume $v < c$)
Smallest particle	Diameter = Planck length. Spatial dimension.	Point particle. No spatial dimension.
What is mass?	Collisions between indivisibles.	Unclear at best, duality.
Velocity for mass	$v_{\max} = c\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}}$ (m/s)	$v < c$
Proper velocity	$W_{\max} = c\frac{\bar{\lambda}}{l_p}\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}}$ (m/s)	$W < \infty$
Lorentz factor	$\gamma_{\max} = \frac{1}{\sqrt{1-\frac{v_{\max}^2}{c^2}}} = \frac{\bar{\lambda}}{l_p}$	$\gamma < \infty$
Speed ratio	$\beta_{\max} = \frac{v_{\max}}{c} = \sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}}$	$\beta < 1$

TABLE VII. *Continued*

	Our new theory	Modern physics limit (or limit, if assume $v < c$)
Relativistic mass (kg mass)	$m_{\max} = \frac{m_0}{\sqrt{1-\frac{v_{\max}^2}{c^2}}} = m_p = \frac{\hbar}{l_p}\frac{1}{c}$ (kg)	$<\infty$
Maximum kinetic energy (kg mass)	$E_{k,\max} = \frac{mc^2}{\sqrt{1-\frac{v_{\max}^2}{c^2}}} - mc^2 = \hbar c\left(\frac{1}{l_p} - \frac{1}{\bar{\bar{\lambda}}}\right)$ (J)	$<\infty$
de Broglie momentum (kg mass)	$p_{\max} = \frac{m v_{\max}}{\sqrt{1-\frac{v_{\max}^2}{c^2}}} = \hbar\sqrt{\frac{1}{l_p^2} - \frac{1}{\bar{\bar{\lambda}}^2}}$ (J · s)	$<\infty$
Rest Compton momentum (kg mass)	$p_{r,\max} = mc = \frac{\hbar}{\bar{\bar{\lambda}}}$ (J · s)	$<\infty$
Kinetic Compton momentum (kg mass)	$p_{k,\max} = \frac{mc}{\sqrt{1-\frac{v_{\max}^2}{c^2}}} - mc = \frac{\hbar}{l_p} - \frac{\hbar}{\bar{\bar{\lambda}}}$ (J · s)	$<\infty$
Total Compton momentum (kg mass)	$p_{t,\max} = \frac{mc}{\sqrt{1-\frac{v_{\max}^2}{c^2}}} = \frac{\hbar}{l_p}$ (J · s)	$<\infty$
Relativistic mass collision-time	$\bar{m}_{\max} = \frac{\bar{m}_0}{\sqrt{1-\frac{v_{\max}^2}{c^2}}} = \bar{m}_p = \frac{l_p}{c} = t_p$ (s)	>0
de Broglie momentum	$\bar{p}_{\max} = \frac{\bar{m} v_{\max}}{\sqrt{1-\frac{v_{\max}^2}{c^2}}} = l_p\sqrt{1 - \frac{l_p^2}{\bar{\bar{\lambda}}^2}}$ (m)	>0
Rest Compton momentum (collision-length)	$\bar{p}_{r,\max} = \bar{m}c = l_p\frac{l_p}{\bar{\bar{\lambda}}}$ (m)	>0
Kinetic Compton momentum (collision-length)	$\bar{p}_{k,\max} = \frac{\bar{m}c}{\sqrt{1-\frac{v_{\max}^2}{c^2}}} - \bar{m}c = l_p - l_p\frac{l_p}{\bar{\bar{\lambda}}}$ (m)	>0
Maximum acceleration	$a_{\max} = \frac{v_{\max}}{\frac{\bar{\bar{\lambda}}\sqrt{1-\frac{v_{\max}^2}{c^2}}}{c}} = \frac{c^2}{l_p}\sqrt{1 - \frac{l_p^2}{\bar{\bar{\lambda}}^2}}$ (m/s^2)	$<\infty$
Maximum rapidity	$w_{\max} = \sqrt{\frac{1+\frac{v_{\max}}{c}}{1-\frac{v_{\max}}{c}}} \approx \ln\left(2\frac{\bar{\bar{\lambda}}}{l_p}\right)$	$<\infty$
Maximum Doppler shift two sided	$f_2 = f_1\sqrt{\frac{4 - \frac{l_p^2}{\bar{\bar{\lambda}}^2}}{\frac{l_p^2}{\bar{\bar{\lambda}}^2}}} \approx 2\frac{c}{l_p}$	$<\infty$
Maximum length contraction	$\bar{\bar{\lambda}}\sqrt{1-\frac{v_{\max}^2}{c^2}} = l_p$ (m)	Point particle hypothesis Still >0 (?).
Maximum time dilation	$\frac{\bar{\bar{\lambda}}}{c}\sqrt{1-\frac{v_{\max}^2}{c^2}} = \frac{l_p}{c}$ (s)	>0
Maximum time dilation	$\frac{\frac{\bar{\bar{\lambda}}}{c}}{\sqrt{1-\frac{v_{\max}^2}{c^2}}} = \frac{\bar{\bar{\lambda}}^2}{l_p c}$ (s)	$<\infty$
Maximum temperature (kg mass)	$T_{\max} = \frac{\frac{mc^2}{\sqrt{1-\frac{v_{\max}^2}{c^2}}} - mc^2}{k_b} = \frac{\hbar c\left(\frac{1}{l_p} - \frac{1}{\bar{\bar{\lambda}}}\right)}{k_b}$ (k)	$<\infty$

with regard to the description of what it actually is. Still, the collision point of two indivisible particles is not giving off any light during its lifetime, but the lifetime is only one Planck second. After this Planck second, the collision dissolves into light again. So, in this sense it is black for a very short time interval, but it is not a hole. On the contrary, it is a fully solid and it has a spatial dimension directly linked to the reduced Compton wavelength of the Plank mass, that again is the Planck length, that again is the diameter of the indivisible particle. The collision between two indivisible particles will therefore have a radius equal to the Planck length. In 1971, Hawking suggested that the majority of the universe consists of gravity collapsed objects, that is black holes and micro black holes. This also holds true in our model of the universe, but unlike Hawking, we have a simple and unifying theory that answers the question of where these collapsed objects are. The micro black holes are simply the Planck mass, that is a collision between two photons that are coming in and out of existence in all matter; they are the only pure mass that makes up all other masses in the form of internal collisions, and we could naturally also have external collisions (collisions internally, mass, and even free photons colliding with other photons).

Interestingly, the standard escape velocity of a Planck mass is

$$v_e = \sqrt{\frac{2Gm_p}{l_p}} = c\sqrt{2}, \tag{148}$$

at the Planck length radius of a Planck mass. The Planck length is the reduced Compton wavelength of the Planck mass. An escape velocity of $v_e = c\sqrt{2}$ is impossible, as nothing can move faster than light. The Schwarzschild radius of the Planck mass is $r_s = 2Gm_p/c^2 = 2l_p$, and naturally has a corresponding escape velocity of c, as this is this basically is the definition of the Schwarzschild radius. But there is no good explanation for why the Schwarzschild radius of a micro black hole should be exactly twice the reduced Compton wavelength of the Planck mass. Some researchers have suggested other masses for the micro black holes. For example, Motz and Epstein[112] suggested that a micro black hole has a mass of half the Planck mass. This would give a Schwarzschild radius equal to the Planck length, but the reduced Compton wavelength of such a mass would be half the Planck length. This would not seem to be consistent with a minimum length equal to the Planck length.

On the other hand, our new escape velocity

$$v_e = c\sqrt{2\frac{l_p^2}{\bar{\lambda}R} - \frac{l_p^4}{\bar{\lambda}^2 R^2}} \tag{149}$$

gives an escape velocity of c exactly at the Planck length for a Planck mass. This new escape velocity gives an escape velocity of c at the radius $r_e = GM/c^2$ rather than $r_s = 2GM/c^2$ as in standard physics. Our escape velocity is very close to the standard escape velocity in a weak gravitational field, but different close to the Planck scale. There is a logical explanation for this. The Planck mass particle is simply the collision point of two photons. It stands still for one Planck second, and the two indivisible particles than travel away from each other at the speed of light, as indivisible particles when freely moving are light.

If the Planck length is the smallest length, and it is clearly so, according to our theory, then the Planck mass is indeed the smallest mass that has an escape velocity of c at its reduced Compton length. Even an electron is, in our model, a Planck mass $f = c/\bar{\lambda}$ times per second. But these Planck masses only last for one Planck second, and this gives the correct mass of an electron as explained in Section I. In our theory, every elementary particle such as an electron will also have a Schwarzschild type radius (or actually half of that) equal to the Planck length, but the Schwarzschild-type radius of the electron will come in and out of existence $f = c/\bar{\lambda}$ times per second. Half the Schwarzschild radius of an electron is

$$\frac{1}{2}r_s = \frac{GM}{c^2} = \frac{c^3\bar{M}}{c^2} = l_p\frac{l_p}{\bar{\lambda}}. \tag{150}$$

This is much smaller than the Planck length, but the last part of this equation $l_p/\bar{\lambda}$ can be seen as a frequency probability when smaller than one, as described in Section XIV. That is, for masses smaller than the Planck mass, the radius where the escape velocity is c is probabilistic.

In our theory, does a larger black hole exist? This would likely be many Planck mass particles packed together. Each Planck mass particle must stand still, which we know from our maximum velocity formula. For a micro black hole, this simply means we can only observe the Planck mass, the collision between two indivisible particles by being part of this particle itself. This is because it would take one Planck second to send light out from the Planck mass particle, and in the same time, it is being dissolved. But during the time it stands still, an indivisible particle that is not colliding can move the diameter of one indivisible. So, the collision point is standing still relative to the speed of light, which must be isotropic in this unique reference frame. Further, the speed of a free moving indivisible particle must be c relative to it, as shown in our derivations of our gravity theory.

However, this means that all black holes must be at rest relative to each other. Black holes create a preferred reference frame. This would mean the Earth moves at the same velocity relative to all so-called black holes. This also means black holes all must have the same velocity time dilation relative to our solar system. This is consistent with experiments. A large study by Hawkings[43,44] of high redshift (high Z) quasars has shown no velocity time dilation. Attempts to explain the lack of velocity time dilation in high Z quasars include speculative ideas such as high Z quasars are black holes expanding exactly at a rate to contradict the lacking velocity time dilation. This is not needed in our theory.

In Table VIII, we summarize many particularities of the Planck mass particle. At the deepest level, we can say, our theory is binary. All elementary particles with mass less than the Planck mass are simply the Planck mass coming in and out of existence at the Compton frequency of that particle, and this Planck mass particle (collision) lasts for one Planck

TABLE VIII. The table shows a series of new boundary conditions that are given by atomism, where we have said (kg) this simply means the mass here is kg.

	Planck mass particle	Comment
Duality		Goes from mass to photon in one Planck second
Rest-mass in kg	$m_p = \frac{\hbar}{l_p}\frac{1}{c}$	Lasts one Planck second. One collision over number of collisions in one kg
Rest-mass collision-time	$\bar{m}_p = \frac{l_p}{c}$	The Planck mass particle lasts one Planck second, this is the collision-time
Rest-mass energy (kg mass)	$E = m_p c^2 = \frac{\hbar}{l_p} c$ (J)	
Rest-mass energy collision-length	$\bar{E} = \bar{m}_p c = l_p$	
Maximum relativistic mass	$\frac{\bar{m}_p}{\sqrt{1-\frac{0^2}{c^2}}} = m_p = \frac{l_p}{c}$	m_p: Lasts one Planck second then becomes light
Velocity	$v \le c\sqrt{1-\frac{l_p^2}{l_p^2}} = 0$ and c	Stands still, can only be observed from itself, then moves at speed c when dissolved into light
Proper velocity	$W \le \frac{l_p}{l_p}\sqrt{1-\frac{l_p^2}{l_p^2}} = 0$	
Lorentz factor	$\gamma = \frac{1}{\sqrt{1-\frac{0^2}{c^2}}} = \frac{l_p}{l_p} = 1$	v is always 0 for Planck mass particle
de Broglie momentum (kg mass)	$p = \frac{m_p v}{\sqrt{1-\frac{v^2}{c^2}}} = 0$	v is always 0 for Planck mass particle
de Broglie momentum	$\bar{p} = \frac{\bar{m}_p v}{\sqrt{1-\frac{v^2}{c^2}}} = 0$	v is always 0 for Planck mass particle
Compton rest momentum (kg mass)	$\bar{p}_r = \bar{m}_p c = \frac{\hbar}{l_p}$ (J·s)	
Compton rest momentum (Same as rest-mass energy)	$\bar{p}_r = \bar{m}_p c = l_p$	Collision-length
Compton kinetic momentum (Same as kinetic energy)	$\bar{p}_k = \frac{\bar{m}_p c}{\sqrt{1-\frac{0^2}{c^2}}} - \bar{m}_p c = 0$	Collision-length
Compton total momentum (Same as total energy)	$\bar{p}_t = \frac{\bar{m}_p c}{\sqrt{1-\frac{0^2}{c^2}}} = l_p$	Collision-length
Maximum acceleration	$a = \frac{c^2\sqrt{1-\frac{l_p^2}{l_p^2}}}{l_p} = 0$ and $a_p = \frac{c^2}{l_p}$	From mass to light a_p lasts one Planck second
Maximum length contraction	$l_p\sqrt{1-\frac{v_{\max}^2}{c^2}} = l_p$	at rest, no contraction
Maximum time dilation	$\frac{l_p}{c}\sqrt{1-\frac{0^2}{c^2}} = \frac{l_p}{c}$	at rest, no time dilation
Maximum temperature	$0, T_p = \frac{m_p c^2}{k_b}$	for one Planck second
Escape velocity at $r = l_p$	$v_e = c$	Standard physics $v_e = c\sqrt{2}$

second. In column 2, we have several places two values. For example, for acceleration we have acceleration zero and also the Planck mass acceleration a_p=c^2/l_p. The reason for this duality is that the Planck mass itself is not accelerating, but it is dissolving into energy after one Planck second (at least when not directly surrounded by other Planck mass particles). So, from time zero and up to the Planck time, there is no acceleration, but at the Planck time, the Planck mass is dissolving into energy and the indivisible particles then move at speed c. So, the Planck mass particle itself is not accelerating, but dissolving. We can also say, the Planck mass has a dual velocity, the Planck mass itself stands still, but it is building blocks, two indivisible particles will, when the collision ends, dissolve into free traveling indivisible particles and will now be moving at the speed of light. The Planck mass particle is where light and mass melt.

The Planck acceleration, $a_p = c^2/l_p \approx 5.55 \times 10^{51}$ m/s^2 has been suggested by several physicists to be the maximum acceleration. In 1984, Scarpetta[113] had already predicted this as the maximum acceleration possible for any mass; something also suggested by Falla and Landsberg:[114]

> *"the 'Planck acceleration' is both the maximum acceleration for an elementary particle in free space and also the surface gravity of a black hole with minimum mass m_p"*—Falla and Landsberg, 1994

However, there is a problem with this inside standard physics. If the Planck length is the minimum time, as often assumed, then even if a mass undertakes Planck acceleration in this minimum time, it will reach a velocity of the speed of light: $a_p t_p = c^2/l_p \times l_p/c = c$. But no particle with mass can be accelerated to the speed of light, as this would require infinite energy according to the relativistic energy mass reaction that also holds in our theory. So, the Planck acceleration seems incompatible with standard physics. However, in our theory, we have shown that the Planck mass particle is the collision point between the building blocks, (the indivisible particles) of two photons. This collision lasts for one Planck second, this we can even indirectly measure from gravity experiments, for example, using a Cavendish apparatus. Then in one Planck second, the Planck mass (the collision) dissolves as the indivisible particles now travel away from each other. And since the indivisible particles themselves are massless and only the collision is the mass, this is fully consistent with the Planck acceleration taking the mass from 0 to c in one Planck second. It is not that the Planck mass accelerates, it is that it dissolves into its parts that are pure energy (free traveling indivisibles).

Similarly, for the temperature, the Planck mass particle has no kinetic energy and therefore no temperature, but in one Planck second it dissolves into pure energy. So, the shift from having no kinetic energy to dissolving into light is identical to the Planck temperature that we can say, lasts one Planck second. Just like the mass-gap, what we can call the temperature-gap is observational window dependent. If observed over one second, the temperature from a single Planck mass particle event is just 7.6×10^{-12} K.

This also explains why the escape velocity of a Planck mass particle in our theory is c. Again, this indicates nothing more than the collision between two photons dissolves, and the indivisibles (that are the light particles, similar to suggested by Newton) travel away from each other. Our theory seems fully consistent on also a series of points where standard physics seems to have more questions than answers, namely, at the Planck scale.

XXII. POSSIBLE REASONS WHY A UNIFIED QUANTUM GRAVITY THEORY HAS NOT BEEN FORMULATED BEFORE NOW

One of the two main reasons one has not been able to produce a unified theory before now is that one not has incorporated collision-time in the mass; one has only done this indirectly as gravity by using a gravity constant. That is, gravity has been almost a magical force that is related to mass, but has not been embedded in the mass. Modern physics has been incorporating the Planck scale in all gravity indirectly through the Newton gravity constant. The Newton gravity constant should, as we have discussed earlier, be seen as a composite constant. It is first when one understands this and sees that it is actually used to get rid of the Planck constant and to introduce the Planck length and the speed of light into all gravity phenomena that one is closing in on how things are connected at the deepest level. The Newton gravity constant is calibrated to a gravity phenomenon to get the gravity formulas to predict other gravity phenomena. The Newton gravitational constant is indeed a universal and important constant; it is just that it is a composite constant. One can instead reformulate the mass to what it truly is, namely, collisions between indivisible particles that happen at the Compton frequency. One does not need the gravitational constant or the Planck constant to find the Planck length. The Planck length is embedded in any gravity phenomena, as it is directly linked to the very essence of mass. This is also why the Schwarzschild radius is so important.

Second, one has developed a QM rooted in the de Broglie wavelength rather than the Compton wavelength. The de Broglie wavelength is, in our view, simply a mathematical derivative of the true physical matter wave, which is the Compton wave. This leads to several absurd predictions, such as the idea that a particle at rest will have an infinite de Broglie wavelength. This also means that the standard momentum is a derivative of the more fundamental momentum. Modern physics has thereby mostly reached the right predictions, but with the use of unnecessarily complex equations.

It is important to be aware we can always recover the established formulas from our new formulation simply by multiplying the mass by $\hbar/l_p^2$ (which also is c^3/G) and recover the standard momentum by multiplying our momentum with v/c, and recover the standard energy by multiplying our energy with c (after having converted the mass from our mass to kg mass). However, by switching back to the de Broglie wave related momentum one loses the rest-mass momentum, since the standard momentum is infinite when $v = 0$. Standard physics have partly gotten around this by having two momentum formulas, that is a separate formula for photons. This approach is not able to fully tie light and mass together and therefore fails to give a unified theory. Our new theory does not have such issues and is able to unify gravity with QM and relativity theory.

XXIII. CONCLUSION

We have unified QM with gravity and have formulated a simple but powerful unified quantum gravity theory. The key is to take into account collision-time in mass, something that has been missing in standard mass measures. Standard mass measures such as kg have only embedded the number of collisions in a collision ratio, but misses out on the duration of the collisions. Gravity is surprisingly Lorentz symmetry as well as a form of Heisenberg uncertainty break down at the Planck scale. Mass is directly linked to Compton frequency, and elementary particles have strong parallels to clocks in the sense that they tick at the Compton frequency. Each tick is a Planck mass that lasts for one Planck second. The Planck length, which is the diameter of an indivisible particle, can be found without any knowledge of the Newton gravitational constant and there is even no need for the Planck constant. The Planck length and Planck time are essential as the smallest (even theoretically) observable collision-length (energy) and collision-time (mass).

Our theory also gives us a model consistent with a simplified version of Minkowski space-time. The beauty of our theory is that it keeps most major predictions and formulas in modern physics intact. However, with our new mass definition, many equations get significantly simplified. Also, many of the interpretations in QM are simplified and less mystical. Wave-particle duality breaks down at the Planck scale (inside a Planck second) and this is linked to Lorentz symmetry break down that again can be observed, as it is gravity.

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[1]M. Stock, Philos. Trans. R. Soc. **369**, 3936 (2011).
[2]M. M. Thomas, P. P. Espel, D. D. Ziane, P. P. Pinot, P. P. Juncar, F. Santos, S. Merlet, F. Piquemal, and G. Geneves, Metrologia **52**, 433 (2015).
[3]I. A. Robinson and S. Schlamminger, Metrologia **53**, A46 (2016).
[4]A. H. Compton, Phys. Rev. **21**, 483 (1923).
[5]S. Lan, P. Kuan, B. Estey, D. English, J. M. Brown, M. A. Hohensee, and H. Mueller, Science **339**, 554 (2013).
[6]D. Dolce and A. Perali, Eur. Phys. J. **130**, 41 (2015).
[7]G. T. Gillies, J. Luo, and L. C. Tu, Rep. Prog. Phys. **68**, 77 (2005).
[8]J. Quintero, G. T. Gillies, G. Spavieri, and M. Rodriguez, Eur. Phys. J. D **61**(3), 531 (2011).
[9]I. Newton, *Philosophiae Naturalis Principia Mathematica* (Royal Society, London, 1687, and first English version in 1728).
[10]I. Newton, *Opticks: Or, a Treatise of the Reflexions, Refractions, Inflexions and Colours of Light* (Sam Smith and Ben J. Walford, Printers to the Royal Society, London, 1704).
[11]J. C. Gregory, *A Short History of Atomism* (A. & Black, London, 1931).
[12]L. L. Whyte, *Essay on Atomism: From Democritus to 1960* (Wesleyan University Press, Middletown, CT, 1961).
[13]A. Phyle, *Atomism* (Thoemmes Press, Bristol, UK, 1995).
[14]E. G. Haug, *Unified Revolution: New Fundamental Physics* (E.G.H. Publishing, Oslo, Norway, 2014).
[15]C. Grellard and A. Robert, *Atomism in Late Medieval Philosophy and Theology* (Koninklijke Brill, Leiden, The Netherlands, 2009).
[16]R. E. Schofield, Am. J. Phys. **49**, 211 (1981).
[17]A. Chalmers, "Newton's atomism and its fate," in *The Scientist's Atom and the Philosopher's Stone*, Boston Studies in the Philosophy of Science, Vol. 279 (Springer, Dordrecht, The Netherlands, 2009).
[18]E. Schrödinger, *Nature and the Greeks and Science and Humanism* (Cambridge University Press, Cambridge, UK, 1954).
[19]E. Schrödinger, *Uber Die Kräftefreie Bewegung in Der Relativistischen Quantenmechanik. (about the Force-Free Movement in Relativistic Quantum Mechanics)* Sitzungsberichte der Preussischen Akademie der Wissenschaften (Physikalisch-Mathematische Klasse, Berlin, 1930).
[20]G. W. Leibniz, "Brief demonstration of a notable error of Descartes's and others concerning a natural law 1678," in *Philosophical Papers and Letters. The New Synthase Historical Library* (Texts and Studies in the History of Philosophy), edited by L. E. Loemker, Vol. 2 (Springer, Dordrecht, The Netherlands, 1989); "A brief demonstration of a notable error of Descartes and others concerning a natural law," *According to Which God is Said Always to Conserve the Same Quantity of Motion; a Law Which They Also Misuse in Mechanics*.
[21]W. J. Gravesande, *Mathematical Elements of Physicks, Prov'd by Experiments: Being an Introduction to Sir Isaac Newton's Philosophy*, Revis'd and corrected by Dr. John Keill (Printed for G. Strahan, Arth. Bettesworth, W. Lewis, W. Mears, and T. Woodward, London, 1720).
[22]P. L. M. Maupertuis, *Letter from Maupertuis to Bernoulli,* March 10, 1732.
[23]E. du Châtelet, *Institutions de Physique* (Prault, Paris, France, 1740).
[24]M. Terall, Hist. Sci. **42**, 189 (2004).
[25]R. Hagengruber, *Emilie du Châtelet between Leibniz and Newton* (Springer, Dordrecht, The Netherlands, 2012).
[26]O. De Pretto, "Ipotesi dell'etere nella vita dell'universo (Hypothesis of aether in the life of the universe)," R. Venetian Inst. Sci., Lett. Arts. **LXIII** (II), 439–500 (1903).
[27]D. Bernoulli, Commentarii Acad. Sci. Imperialis Petropolitanae **8**, 99 (1741).
[28]G. G. Coriolis, *Du Calcul de l'Effet des Machines* (Carilian-Goeury, Paris, France, 1829).
[29]J. V. Poncelet, *Introduction á la Mécanique Industrielle, Physique ou Expérimentale* (Carilian-Goeury, Paris, France, 1829).
[30]A. Einstein, Ann. Phys. (Berl.) **17**, 891 (1905). English translation by G. B. Jeffery (1923).
[31]C. M. Khodhabakhsh, Phys. Essays **29**, 313 (2016).
[32]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," e-print viXra:1904.0547 (2019).
[33]E. G. Haug, *Presentation at the Royal Institution in London*, October 15, 2015.
[34]E. G. Haug, Phys. Essays **29**, 558 (2016).
[35]E. G. Haug, Acta Astronaut. **136**, 144 (2017).
[36]D. E. Chang, V. Vuletic, and M. D. Lukin, Nat. Photon. **8**, 685 (2014).
[37]O. J. Pike, F. Mackenroth, E. G. Hill, and S. J. Rose, Nat. Photon. **8**, 434 (2014).
[38]E. G. Haug, Appl. Phys. Res. **12**(1), 1 (2020).
[39]H. Okawa, K. Nakao, and M. Shibata, Phys. Rev. D **83**, 121501 (2011).
[40]L. Tomassini and S. Viaggiu, Class. Quantum Grav. **28**, 075001 (2011).
[41]T. Padmanabhan, Gen. Relativ. Gravitation **17**, 215 (1985).
[42]L. J. Garay, Int. J. Mod. Phys. A **10**, 145 (1995).
[43]R. J. Adler, Am. J. Phys. **78**, 925 (2010).
[44]S. Hossenfelder, Class. Quantum Grav. **29**, 115011 (2012).
[45]A. Farag, M. Mohammed, A. Khalil, and E. C. Vagenas, EPL **112**, 20005 (2015).
[46]R. S. Van-Dyck, F. L. Moore, D. L. Farnham, and P. B. Schwinberg, Int. J. Mass Spectrom. **66**, 327 (1985).
[47]G. Graff, H. Kalinowsky, and J. Traut, Z. Phys. A **297**, 35 (1980).
[48]H. Cavendish, Philos. Trans. R. Soc. **88**, XXI (1798).
[49]A. T. Augousti and A. Radosz, Eur. J. Phys. **376**, 331 (2006).
[50]E. R. Bagge, Atomkernenergie-Kerntechnik **39**, 23 (1981).
[51]T. E. Phipps, Am. J. Phys. **54**, 245 (1986).
[52]T. Chow, Eur. J. Phys. **13**, 198 (1992).
[53]P. C. Peters, Am. J. Phys. **55**, 757 (1987).
[54]T. E. Phipps, Am. J. Phys. **55**, 758 (1987).
[55]T. Biswas, Am. J. Phys. **56**, 1032 (1988).
[56]P. C. Peters, Am. J. Phys. **58**, 188 (1990).
[57]S. K. Ghosal and P. Chakraborty, Eur. J. Phys. **12**, 260 (1991).
[58]A. Einstein, "Näherungsweise integration der feldgleichungen der gravitation (approximate integration of the gravitational field equations)," in *Sitzungsberichte der Königlich Preussischen Akademie der Wissenschaften Berlin*, Part 1:(Verlag der Königlichen Preussischen Akademie der Wissenschaften, Berlin, 1916).
[59]M. Milgrom, Astrophys. J. **270**, 365 (1983).
[60]M. E. McCulloch, Astrophys. Space Sci. **362**, 149 (2017).
[61]G. Spavieri, M. Rodriguez, and A. Sanchez, J. Phys. Commun. **2**, 085009 (2018).
[62]G. Spavieri and E. G. Haug, Phys. Essays **32**, 331 (2019).
[63]G. Spavieri, G. Gillies, E. G. Haug, and A. Sanchez, J. Mod. Opt. **66**, 2131 (2019).
[64]E. T. Kipreos, PLoS One **10**, 1 (2014).

[65]J. Jennings, *Miscellanea in Usum Juventutis Academicae (Miscellaneous in Use of the University Youth)* (R. Aikes & G. Dicey, Northampton, UK, 1721).
[66]L. de Broglie, Nature **112**, 540 (1923).
[67]L. de Broglie, "Recherches sur la théorie des quanta (Research on the theory of quanta)," Ph.D. thesis, Migration - Université en Cours d'affectation, Paris (1924); https://tel.archives-ouvertes.fr/tel-00006807/document
[68]G. P. Thomson and A. Reid, Nature **119**, 890 (1927).
[69]C. Davisson and L. H. Germer, Phys. Rev. **30**, 705 (1927).
[70]A. I. Lvovsky, *Quantum Physics: An Introduction Based on Photons* (Springer, Berlin, 2018).
[71]H. Chauhan, S. Rawal, and R. K. Sinha, "Wave-particle duality revitalized: Consequences, applications and relativistic quantum mechanics," e-print arXiv:1110.4263 (2011).
[72]M. Born, *The Restless Universe* (Harper & Brothers, New York, 1936).
[73]E. Schrödinger, Phys. Rev. **28**, 1049 (1926).
[74]W. Heisenberg, Z. Phys. **43**, 172 (1927).
[75]E. G. Haug, "Revisiting the derivation of Heisenberg's uncertainty principle: The collapse of uncertainty at the Planck scale," preprint 10.20944/preprints201805.0258.v1 (2018).
[76]A. Hees, Q. G. Bailey, A. Bourgoin, H. P. Bars, C. Guerlin, and C. L. Poncin-Lafitte, Universe **2**, 30 (2016).
[77]E. H. Kennard, Z. Phys. **44**, 326 (1927).
[78]F. Ahmadi and F. Vali, Phys. Procedia **22**, 537 (2011).
[79]S. Gangopadhyay and A. Dutta, Gen. Relativ. Gravitation **46**, 1661 (2014).
[80]J. S. Bell, Physics **1**, 195 (1964).
[81]M. Clover, "Bell's theorem: A new derivation that preserves Heisenberg and locality," e-print arXiv: quant-ph/0409058 (2004).
[82]M. Clover, "Bell's theorem: A critique," e-print arXiv: /quant-ph/0502016 (2005).
[83]A. Einstein, B. Podolsky, and N. Rosen, Phys. Rev. **47**, 777 (1935).
[84]P. Dirac, Proc. R. Soc. London, A **180**, 980 (1942).
[85]R. P. Feynman, "Negative probability," first published in *Quantum Implications: Essays in Honor of David Bohm*, edited by F. D. Peat and B. Hiley (Routledge & Kegan Paul Ltd., London, 1987).
[86]W. Pauli, Nuovo Cim. **4**(Suppl. 2), 703 (1956).
[87]R. P. Feynman, *QED: The Strange Theory of Light and Matter* (Penguin, London, 1985).
[88]W. G. Unruh, "Chapter: Minkowski space-time and quantum mechanics," in *Minkowski Spacetime: A Hundred Years Later*, edited by V. Petkov (Springer, Berlin, 2009).
[89]H. Minkowski, "Space and time. A translation of an address delivered at the 80th Assembly of German Natural Scientists and Physicians, at Cologne, 21 September," in *The Principle of Relativity* (Dover, Mineola, NY, 1923, 1908).
[90]H. E. G, "Gravity without Newton's gravitational constant and no knowledge of mass size," preprint 10.20944/preprints201808.0220.v1 (2018).
[91]E. G. Haug, "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!," preprint https://vixra.org/abs/1908.0461.
[92]A. Cornu and J. B. Baille, C. R. Acad. Sci. Paris **76**, 954 (1873).
[93]C. V. Boys, Nature **50**, 571 (1894).
[94]D. Isaachsen, *Lærebog i Fysikk* (Det Norske Aktieforlag, Christiania, 1905).
[95]M. Planck, *Einführung in Die Allgemeine Mechanik (Introduction to General Mechanics)* (Verlag von Hirtzel, Leipzig, Germany, 1928).
[96]E. G. Haug, Int. J. Astron. Astrophys. **6**, 205 (2016).
[97]E. G. Haug, Int. J. Astron. Astrophys. **8**, 6 (2018).
[98]M. Planck, *Natuerliche Masseinheiten (Natural Units of Measure)*, Der Koniglich Preussischen Akademie Der Wissenschaften (Verlag der Königlichen Preussischen Akademie der Wissenschaften, Berlin, 1899).
[99]M. Planck, *Vorlesungen Uber Die Theorie der Warmestrahlung (Lectures on the Theory of Heat Radiation)* (J.A. Barth, Leipzig, Germany, 1906). See also *The Theory of Heat Radiation*, English translation (Dover, Mineola, NY, 1952).
[100]M. E. McCulloch, Astrophys. Space Sci. **349**, 957 (2014).
[101]M. E. McCulloch, EPL **115**, 69001 (2016).
[102]E. G. Haug, Appl. Phys. Res. **9**, 58 (2017).
[103]E. G. Haug, "Finding the Planck length independent of Newton's gravitational constant and the Planck constant: The Compton clock model of matter," preprint preprints201809.0396.v1 (2018).
[104]P. Langacker, *Can the Laws of Physics Be Unified*? (Princeton University Press, Princeton, NJ, 2017).
[105]E. G. Haug, "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!," *ResearchGate* (2019).
[106]E. G. Haug, J. Mod. Phys. **9**, 2623 (2018).
[107]L. Motz, Nuovo Cim. **26**, 672 (1962).
[108]L. Motz, Nuovo Cim. A 65, 326, (1970); *previous work at Rutherford Observatory* (Columbia University, New York, 1966).
[109]L. Motz, *The Quantization of Mass* (Rutherford Observatory, Columbia University, New York, 1971).
[110]S. Hawking, Mon. Not. R. Astron. Soc. **152**, 75 (1971).
[111]G. M. Obermair, J. Phys: Conf. Ser. **442**(Conf. 1), 012066 (2013).
[112]L. Motz and J. Epstein, Nuovo Cimento A **51**, 88 (1979).
[113]G. Scarpetta, Lett. Nuovo Cimento **41**, 51 (1984).
[114]D. F. Falla and P. T. Landsberg, Eur. J. Phys. **15**, 204 (1994).