Collision Space-Time Unified Quantum Gravity

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May 24, 2019

Abstract

We have recently presented a unified quantum gravity theory [1]. Here we extend on that work and present an even simpler version of that theory. For about hundred years, modern physics has not been able to build a bridge between quantum mechanics 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 not changed (in terms of predictions), except at the Planck scale. The Planck scale is directly linked to gravity and gravity is, surprisingly, 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. 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 not attained at a cost, but rather a reflection of the benefit in having gravity and electromagnetism unified under the same theory.

This is version 1 of the current work and contains several important new equations and insight that builds on some of our previous papers. We expect to put out an enhanced version with more detailed explanations soon. In particular, it is worth noting how incredibly simple our new relativistic wave equation is when rooted in collision space-time. The beauty of such simplicity will be evident for those familiar with previous work on this topic; future work will highlight and augment these observations and analysis.

Key Words: Quantum gravity, granular matter, Lorentz symmetry break down at the Planck scale, Heisenberg uncertainty break down at the Planck scale, indivisible particles, gravity and Lorentz symmetry break down.

1 Short introduction to the incomplete mass definition in modern on physics and what it truly represents

Modern physics texts talks about mass in terms of kg or pounds that are linked to the Planck constant. This is particularly clear after the kg was redefined in terms of the Planck constant in 2019. 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, including elementary particles can be described by the following formula

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

This formula also holds for composite masses, such as one kg because even if a kg or other composite mass consists of several Compton wavelengths, 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

$$
\begin{aligned}
m &= \sum_i^N \frac{\hbar}{\bar{\lambda}_i}\frac{1}{c} = \frac{\hbar}{c}\sum_i^N \frac{1}{\bar{\lambda}_i} \\
m &= \frac{\hbar}{\frac{1}{\sum_i^N \frac{1}{\bar{\lambda}_i}}}\frac{1}{c} \\
m &= \frac{\hbar}{\bar{\bar{\lambda}}}\frac{1}{c} \qquad (2)
\end{aligned}
$$

where

$$\bar{\lambda} = \frac{\hbar}{\sum_i^N m_i c} = \frac{1}{\sum_i^N \frac{1}{\bar{\lambda}_i}} \qquad (3)$$

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

$$f_{1,kg} = \frac{c}{\bar{\lambda}_{1,kg}} = \frac{c}{\frac{\hbar}{1\times c}} = \frac{1\times c^2}{\hbar} = 8.52\times 10^{50} \text{ collisions/second} \qquad (4)$$

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

$$f_e = \frac{c}{\bar{\lambda}_e} \approx 7.76\times 10^{20} \text{ collisions/second} \qquad (5)$$

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

$$m = \frac{f_e}{f_{1,kg}} = \frac{7.76\times 10^{20}}{8.52\times 10^{50}} \approx 9.1\times 10^{31} \text{ kg} \qquad (6)$$

which is the known mass in kg of an electron. The same holds for a proton or any other mass.

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

$$m_g = \frac{1}{8.52\times 10^{50}} = \frac{1}{\frac{c^2}{\hbar}} = \frac{\hbar}{c^2} \qquad (7)$$

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 not is optimal, as it completely ignores an important aspect of any mass.

2 Introduction to Our New Theory

Our theory is rooted in the assumption that there ultimately only is one particle, namely an indivisible particle. Newton was one of the last physicists in modern times who held this view. In our theory, we have made the following assumptions, everything (energy and matter) consists of

- 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.
- 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 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.

3 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 length of each collision or the length of all collisions aggregated. That is, mass consists of two important aspects: the number of collisions and also the length of time these collisions last (the duration). Standard physics only notes the number of collisions in form of a collision ratio and has not incorporated collision time into the mass model. In addition, modern physics is not really aware that current mass definition is actually a collision ratio.

3.1 Mass definition: mass as collision time

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

$$\tilde{m} = t_p \frac{l_p}{\bar{\lambda}} = \frac{l_p}{c} \frac{l_p}{\bar{\lambda}} \tag{8}$$

where t_p is the Planck time. We are not hypothesizing that this is the Planck time; it could be an unknown time $\frac{x}{c}$, 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.

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.

3.2 Energy definition: energy as collision length

Energy is collision length per shortest time interval.

$$\tilde{E} = l_p \frac{l_p}{\bar{\lambda}} \tag{9}$$

and we have

$$\tilde{E} = \tilde{m}c \tag{10}$$

and naturally

$$\tilde{m} = \frac{\tilde{E}}{c} \tag{11}$$

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.

$$\frac{\tilde{E}}{\tilde{m}} = c = \frac{\tilde{L}}{\tilde{T}} \tag{12}$$

Some physicists may assume that this must be wrong because we do not have c^2. However, we will show that in fact 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 truly understands mass from this alternative perspective.

3.3 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 even defines the speed of light. The speed of light 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 than one diameter of an indivisible particle.

3.4 Relativistic extension

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

$$\tilde{E} = \frac{\tilde{m}c}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{\frac{l_p^2}{\bar{\lambda}} \frac{1}{c} c}{\sqrt{1 - \frac{v^2}{c^2}}} = l_p \frac{l_p}{\bar{\lambda}\sqrt{1 - \frac{v^2}{c^2}}} \tag{13}$$

Further, the relativistic kinetic energy is given by

$$\tilde{E}_k = \frac{\tilde{m}c}{\sqrt{1 - \frac{v^2}{c^2}}} - mc = l_p \frac{l_p}{\bar{\lambda}\sqrt{1 - \frac{v^2}{c^2}}} - l_p \frac{l_p}{\bar{\lambda}} \tag{14}$$

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

$$\tilde{E}_k \approx \frac{1}{2}\tilde{m}\frac{v^2}{c} = \frac{1}{2}\frac{l_p^2}{\bar{\lambda}} v^2 \tag{15}$$

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

$$l_p \leq \bar{\lambda}\sqrt{1-\frac{v^2}{c^2}} \tag{16}$$

solved with respect to v this gives

$$v \leq c\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}} \tag{17}$$

This is the same maximum velocity of matter that has been suggested by Haug [2–6]. We basically get the same maximum velocity for escape velocity, however surprising this may be.

3.5 Gravity Theory

In a weak field, we have a formula that gives the same numerical predictions as Newton, but it is much simpler

$$\tilde{F} = c^3\frac{\tilde{M}\tilde{m}}{r^2} \tag{18}$$

This can be written as

$$\tilde{F} = c^3\frac{\frac{l_p^2}{\bar{\lambda}_M}\frac{l_p^2}{\bar{\lambda}_m}}{r^2} \tag{19}$$

This model offers all the same predictions as Newton gravity theory, except it also gives the correct bending of light, see [1].

In the appendix (that is taken from our previous unified quantum gravity paper) we show how to calibrate the gravity formula, and this gives us l_p is the Planck length with no knowledge of G or $\hbar$.

3.6 Escape velocity

Remember that $E_k = \frac{mc}{\sqrt{1-\frac{v^2}{c^2}}} - mc$ can be approximated by a Taylor expansion $E_k \approx \frac{1}{2}\frac{mv^2}{c}$; this means the escape velocity must be

$$\begin{aligned}
\frac{1}{2}\frac{\tilde{m}v^2}{c} - c^3\frac{\tilde{M}\tilde{m}}{r} &= 0 \\
v &= \sqrt{2c^3\frac{\tilde{M}}{r}} \\
v &= \sqrt{2c^3\frac{\frac{l_p}{\bar{\lambda}}\frac{l_p}{c}}{r}} \\
v &= c\sqrt{2\frac{l_p}{r}\frac{l_p}{\bar{\lambda}}}
\end{aligned} \tag{20}$$

Further, orbital velocity is given by $v_o = \sqrt{\frac{l_p}{r}\frac{l_p}{\bar{\lambda}}}$

Strong field

$$v = c\sqrt{2\frac{l_p}{\bar{\lambda}r} - \frac{lp^4}{\bar{\lambda}^2 tr}} \tag{21}$$

3.7 Gravitational acceleration

$$\begin{aligned}
ma &= c^3\frac{\tilde{M}\tilde{m}}{r^2} \\
a &= c^3\frac{\tilde{M}}{r^2} \\
a &= l_p\frac{c^2}{r^2}\frac{l_p}{\bar{\lambda}}
\end{aligned} \tag{22}$$

3.8 Gravity theory strong field

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

$$F = c^2 \frac{\tilde{M}\frac{\tilde{m}}{\sqrt{1-\frac{v_m^2}{c^2}}}}{r^2} \tag{23}$$

Or in terms of quantum entities

$$F = c^2 \frac{\frac{l_p^2}{\bar{\lambda}_M}\frac{l_p^2}{\bar{\lambda}_m\sqrt{1-\frac{v^2}{c^2}}}}{r^2} \tag{24}$$

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 perihelion of Mercury.

$$F = c^2 \frac{\frac{\tilde{M}}{\sqrt{1-\frac{v_M^2}{c^2}}}\frac{\tilde{m}}{\sqrt{1-\frac{v_m^2}{c^2}}}}{r^2\left(1-\frac{v_M^2}{c^2}\right)} = c^2 \frac{\frac{\tilde{M}}{\sqrt{1-\frac{v_M^2}{c^2}}}\frac{\tilde{m}}{\sqrt{1-\frac{v_m^2}{c^2}}}}{r^2\left(1-\frac{v_M^2}{c^2}\right)^{3/2}} \tag{25}$$

Table 1 summarizes how our newly defined momentum brings logic and simplicity back into physics.
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4 Gravity Quantum Mechanics

Here we will introduce a new quantum wave equation that also gives gravity without understanding the importance of collision time and also taking into account that one ultimately has a collision time.

The Klein–Gordon equation is often better known in the form (dividing by $\hbar^2$ and c^2 on both sides):

$$\frac{1}{c^2}\frac{\partial^2}{\partial t^2}\Psi - \nabla^2\Psi + \frac{m^2c^2}{\hbar^2}\Psi = 0 \tag{26}$$

The Klein–Gordon equation has strange properties, such as energy squared, which is one of several reasons that Schröedinger did not like it that much. We have argued previously that one should make a wave equation from the Compton wavelength rather than the de Broglie wavelength [7, 8]. Today, matter has two wavelengths, the de Broglie version, which is a hypothetical wavelength and the Compton wavelength. The Compton wavelength has been measured in many experiments and we can find the traditional kg mass from that plus the Planck length and the speed of light. We cannot find the rest-mass from the de Broglie wavelength, as this length is infinite for a rest-mass. The relation between these two waves, even in a relativistic model, is simply $\bar{\lambda}_B = \bar{\lambda}_c \frac{c}{v}$. To switch from de Broglie to Compton leads to a new momentum definition, where we have rest-mass momentum, kinetic momentum, and total momentum. The traditional relativistic momentum definition is rooted in the de Broglie wavelength (actually the de Broglie wavelength is rooted in an old, non-optimal definition of momentum), that is

$$p = \frac{mv}{\sqrt{1-\frac{v^2}{c^2}}} \tag{27}$$

while our momentum rooted in the measured Compton wavelength is given by

$$p_t = \tilde{E} = \frac{mc}{\sqrt{1-\frac{v^2}{c^2}}} \tag{28}$$

and the rest-mass momentum is given by $p_r = mc$ and the kinetic momentum by

$$p_k = \tilde{E}_K = \frac{mc}{\sqrt{1-\frac{v^2}{c^2}}} - mc \tag{29}$$

This gives us a new and simpler relativistic energy momentum relation, that both gives the same correct output, but one is much simpler mathematically, which is key to obtaining a simpler and fully correct wave equation. The old energy momentum relation rooted in de Broglie wavelength is given by

$$E = \sqrt{p^2c^2 - m^2c^4} \tag{30}$$

while our new energy momentum relation is given by

$$\tilde{E} = \tilde{p}_k - \tilde{m}c \tag{31}$$

that also can be written as

$$\tilde{E} = \tilde{E}_k - \tilde{m}c = \frac{mc}{\sqrt{1-\frac{v^2}{c^2}}} \tag{32}$$

The main difference is that standard physics goes through the de Broglie wavelength (i.e., a nonexistent wavelength that is a derivative of the physical Compton wavelength). The math, therefore, gets unnecessarily complex and lacks intuition, which has led to many different interpretations in standard QM of the same equations. Our theory is much more straightforward and is fully consistent with our gravity theory.

This in turn leads to a simpler relativistic energy momentum relation than the standard one and also to a new wave equation, see [9] for details. In fact, this gives the same wave equation that we have derived before, but now we show that the Heisenberg collapse at the Planck scale that we found before is directly linked to gravity.

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

$$\begin{aligned}\tilde{E} &= \mathbf{p}_k + \tilde{m}c \\ \tilde{E} &= \left(\frac{\tilde{m}c}{\sqrt{1-\frac{\mathbf{v}^2}{c^2}}} - \tilde{m}c\right) + \tilde{m}c \\ \tilde{E} &= \frac{\tilde{m}c}{\sqrt{1-\frac{\mathbf{v}^2}{c^2}}} \\ \tilde{E} &= \frac{l_p^2}{\bar{\lambda}\sqrt{1-\frac{\mathbf{v}^2}{c^2}}}\end{aligned} \tag{33}$$

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

$$\begin{aligned}\tilde{E} &= \mathbf{p}_k + \tilde{m}c \\ r_e &= \tilde{m}\mathbf{c}\end{aligned} \tag{34}$$

Based on this we get the following relativistic wave equation

$$-l_p^2\frac{\partial\Psi}{\partial t} = -l_p^2\nabla\cdot(\Psi\mathbf{c}) \tag{35}$$

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 (since the velocity of light is constant and incompressible)

$$\nabla\cdot\mathbf{c} = 0 \tag{36}$$

that is[1]. The light velocity field is a solenoidal, which means we can rewrite our wave equation as

$$\frac{\partial\Psi}{\partial t} - \mathbf{c}\cdot\nabla\Psi = 0 \tag{37}$$

So, in the expanded form, we have

$$\frac{\partial\Psi}{\partial t} - c_x\frac{\partial\Psi}{\partial x} - c_y\frac{\partial\Psi}{\partial y} - c_z\frac{\partial\Psi}{\partial z} = 0 \tag{38}$$

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

$$\psi = e^{i(kt-\omega x)} \tag{39}$$

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

$$k = \frac{r_e}{l_p^2} = \frac{\frac{r_e}{\sqrt{1-\frac{v^2}{c^2}}}}{l_p^2} = \frac{2\pi}{\lambda_c} \tag{40}$$

So, we can also write the plane wave function as

$$e^{i\left(\frac{\tilde{L}}{l_p^2}t - \frac{\tilde{T}}{l_p^2}x\right)} = e^{i\left(\frac{\tilde{E}}{l_p^2}t - \frac{\tilde{m}}{l_p^2}x\right)} = e^{i\left(\frac{r_e}{l_p^2}t - \frac{\tilde{m}}{l_p^2}x\right)} \tag{41}$$

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) must be

$$\frac{\partial\psi}{\partial t} = \frac{ir_e}{l_p^2}e^{i\left(\frac{r_e}{l_p^2}t - \frac{\tilde{m}}{l_p^2}x\right)} \tag{42}$$

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

and this gives us a time operator of

$$r_e = -il_p^2 \frac{\partial}{\partial t} \tag{43}$$

And for mass we have

$$\frac{\partial \psi}{\partial x} = \frac{-i\tilde{m}}{l_p^2} e^{i\left(\frac{r_e}{l_p^2}t - \frac{\tilde{m}}{l_p^2}x\right)} \tag{44}$$

and this gives us a mass operator of

$$\tilde{m} = -il_p^2 \nabla \tag{45}$$

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

$$k = \frac{r_e}{l_p^2} = \frac{r_e}{l_p^2} = \frac{2\pi}{\lambda_c} \tag{46}$$

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

5 Written with deeper insight on the collision space-time form only

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

$$\tilde{L} = \tilde{T}\mathbf{c} \tag{47}$$

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

$$-l_p^2 \frac{\partial \Psi}{\partial t} = -l_p^2 \nabla \cdot (\Psi \mathbf{c}) \tag{48}$$

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

$$-\frac{\partial \Psi}{\partial t} = -\nabla \cdot (\Psi \mathbf{c}) \tag{49}$$

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

$$\nabla \cdot \mathbf{c} = 0 \tag{50}$$

that is[2]. The light velocity field is a solenoidal, which means we can rewrite our wave equation as

$$\frac{\partial \Psi}{\partial t} - \mathbf{c} \cdot \nabla \Psi = 0 \tag{51}$$

So, in the expanded form, we have

$$\frac{\partial \Psi}{\partial t} - c_x \frac{\partial \Psi}{\partial x} - c_y \frac{\partial \Psi}{\partial y} - c_z \frac{\partial \Psi}{\partial z} = 0 \tag{52}$$

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

$$\psi = e^{i(kt - \omega x)} \tag{53}$$

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

$$k = \frac{\tilde{L}}{l_p^2} = \frac{\frac{l_p^2}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}}{l_p^2} = \frac{2\pi}{\lambda_{c,R}} \tag{54}$$

So, we can also write the plane wave solution as

$$e^{i\left(\frac{\tilde{L}}{l_p^2}t - \frac{\tilde{T}}{l_p^2}x\right)} \tag{55}$$

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

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

$$\frac{\partial\psi}{\partial x} = \frac{i\tilde{T}}{l_p^2} e^{i\left(\frac{\tilde{L}}{l_p^2}t - \frac{\tilde{T}}{l_p^2}x\right)} \tag{56}$$

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

$$\tilde{T} = -il_p^2\nabla \tag{57}$$

and for collision space (energy) we have

$$\frac{\partial\psi}{\partial t} = \frac{-i\tilde{L}}{l_p^2} e^{i\left(\frac{\tilde{L}}{l_p^2}t - \frac{\tilde{T}}{l_p^2}x\right)} \tag{58}$$

and this gives us a collision-space time operator of

$$\hat{L} = -il_p^2\frac{\partial}{\partial t} \tag{59}$$

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

$$k = \frac{p_t}{l_p^2} = \frac{\tilde{L}}{l_p^2} = \frac{2\pi}{\lambda_c} \tag{60}$$

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

6 Gravity is Breakdown of the Heisenberg Uncertainty Principle at the Planck Scale

This is the most important missing part of modern wave mechanic – that the wave equation breaks down is the only place where the Planck length can enter quantum mechanics, and it is where the Heisenberg uncertainty principle breaks down and also where Lorentz symmetry breaks down. As we have shown earlier in this paper, gravity is directly linked to the Planck length, which is the collision space-time of mass. This means gravity is the Heisenberg break down and the 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. So, then something special should happen at the Planck scale. We have already, from our previous analysis, 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

$$\Psi = e^{i\left(\frac{\tilde{E}}{l_p^2}t - \frac{\tilde{m}}{l_p^2}x\right)} = e^{i\left(\frac{r_e}{l_p^2}t - \frac{\tilde{m}}{l_p^2}x\right)} \tag{61}$$

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

$$\Psi = e^{i\left(\frac{\tilde{L}}{l_p^2}t - \frac{\tilde{T}}{l_p^2}x\right)} \tag{62}$$

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

$$r_e = \frac{\tilde{m}c}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{\frac{l_p^2}{\bar{\lambda}}\frac{1}{c}c}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{l_p^2}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}} \tag{63}$$

Based on this, we can rewrite the wave function as

$$\Psi = e^{i\left(\frac{\frac{l_p^2}{\lambda\sqrt{1-\frac{v^2}{c^2}}}}{l_p^2}t - \frac{\frac{l_p^2}{c\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}}{l_p^2}x\right)} = e^{i\left(\frac{1}{\lambda\sqrt{1-\frac{v^2}{c^2}}}t - \frac{1}{c\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}t\right)} \tag{64}$$

Next we have $v_{max} = c\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}}$, and in the case of a Planck mass particle, we have $v_{max} = c\sqrt{1-\frac{l_p^2}{l_p^2}} = 0$. 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 $t = \frac{l_p}{c}$. This gives

$$\Psi = e^{i\left(\frac{1}{l_p}\frac{l_p}{c} - \frac{1}{cl_p}l_p\right)} = e^{i\times 0} = 1 \tag{65}$$

That is, the Ψ is always equal to one in the special case of the Planck mass particle, see also [10]. 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.

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

$$\begin{aligned} \frac{\partial \Psi}{\partial t} &= c\frac{\partial \Psi}{\partial x} + c\frac{\partial \Psi}{\partial y} + c\frac{\partial \Psi}{\partial z} \\ \frac{\partial 1}{\partial t} &= c\frac{\partial 1}{\partial x} + c\frac{\partial 1}{\partial y} + c\frac{\partial 1}{\partial z} \end{aligned} \tag{66}$$

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 quantum mechanics, 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

$$\frac{\partial \Psi}{\partial x} = 0 \tag{67}$$

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

$$\begin{aligned} [\hat{r}_e, \hat{x}]\Psi &= [\hat{r}_e\hat{x} - \hat{x}\hat{r}_e]\Psi \\ &= \left(-0 \times \frac{\partial}{\partial x}\right)(x)\Psi - (x)\left(-0 \times \frac{\partial}{\partial x}\right)\Psi \\ &= 0 \end{aligned} \tag{68}$$

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), but do not commute for any other particle.

we also have

$$\begin{aligned} [\hat{\hat{T}}, \hat{x}]\Psi &= [\hat{\hat{T}}\hat{x} - \hat{x}\hat{\hat{T}}]\Psi \\ &= \left(-0 \times \frac{\partial}{\partial x}\right)(x)\Psi - (x)\left(-0 \times \frac{\partial}{\partial x}\right)\Psi \\ &= 0 \end{aligned} \tag{69}$$

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

$$\begin{aligned} \sigma_p\sigma_x &\geq \frac{1}{2}|\int \Psi^*[\hat{r}, \hat{x}]\Psi dx| \\ &\geq \frac{1}{2}|\int \Psi^*(0)\Psi dx| \\ &\geq \frac{1}{2}| - 0 \times \int \Psi^*\Psi dx| = 0 \end{aligned} \tag{70}$$

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 one automatically also knows its Schwarzschild radius (and therefore also its 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. In other words, for this and only this particle, one knows the position and Schwarzschild radius (re-defined 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 analyses in this paper we know that it must be gravity. Modern physics have totally missed out of this. There is the standard gravity theory on one hand, and quantum theory on the other hand, and the idea is that the break down at the Planck scale is something special happening outside this system. For 100 years many have tried to unify QM with gravity, but with basically no success. In our theory, we see that gravity is the break down at the Planck scale. We have derived this theory from the Planck scale, and naturally combined the analysis with key concepts from Newton, Einstein, Compton, and others. Possibly, for the first time in history, we have developed a unified theory that can address the challenges involved.

7 Revised Heisenberg Uncertainty Principle

Table 2 summarize our new uncertainty principle compared to the old one. 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, we can see how everything is related to only space and time. For example, rest-mass momentum is the same as collision length, and therefore the same as one of our energy definitions, namely collision length. That is, the space taken up in forms of collision in form of a length.

There is only length and time in our uncertainty principle. This is the beauty of it. In our theory, there is only space and time, but there is collision time and non-collision time – there is space with collision and no collisions, which again are only indivisible in the void, either moving or colliding. Modern physics has only at the quantum level captured the collision frequency, 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.

There is collision time and no collision time, and there is collision length (space) and non-collision (space). The collision time interval for an elementary particle with reduced Compton wavelength $\bar{\lambda}$ is given by

$$\frac{l_p}{c} \geq \tilde{m}_t \geq \frac{l_p}{\bar{\lambda}} \frac{l_p}{c} \tag{71}$$

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. If one does not observe it in a collision state, then the probability for it to be in such a collision state is $\frac{l_p}{\bar{\lambda}}$, and therefore the collision time is an expected collision time of $\frac{l_p}{\bar{\lambda}} \frac{l_p}{c}$. 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, that naturally are directly linked to today's quantum mechanics. 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, for example [11, 12]. 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.

8 Implications of the Breakdown of the Heisenberg Uncertainty Principle at the Planck Scale

That the Heisenberg uncertainty principle breaks down at the Planck scale could have multitude of implications of interpretations of quantum mechanics. For example, Bell?s [13] theorem and the evidence running contrary to the idea that local hidden variable theories [14] cannot exist are based on the assumption that Heisenberg's uncertainty principle always holds, see [15, 16]. Further, our theory means wave-particle duality breaks down at the Planck scale. Also, such things as negative energies, negative mass, and negative probabilities seem to be totally forbidden in our new theory.

De Broglie, with his theory of matter waves that was essential for developing the standard quantum theory, shared Einstein's skepticism towards 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

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: $P = \frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}$, of a Planck 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 $v_{max} = c\sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}}$. This gives a maximum probability is unity for any elementary particle,

$$
\begin{aligned}
P &= \frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v_{max}^2}{c^2}}} \\
P &= \frac{l_p}{\bar{\lambda}\sqrt{1-\frac{\left(c\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}}\right)^2}{c^2}}} \\
P &= \frac{l_p}{\bar{\lambda}\sqrt{1-\frac{c^2\left(1-\frac{l_p^2}{\bar{\lambda}^2}\right)}{c^2}}} \\
P &= \frac{l_p}{l_p} = 1
\end{aligned}
\tag{72}
$$

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 masses, it is different, here as shown previously, before the Compton frequency inside one Planck second can become higher than 1. That is, $\frac{l_p}{\bar{\lambda}}$ 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, 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, Table 3 summarizes some of the many formulas we have discussed in this paper.

This fits perfectly with our uncertainty principle. Again the $\frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}$ 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 $\frac{l_p}{\bar{\lambda}\sqrt{1-\frac{0^2}{c^2}}} = \frac{l_p}{\bar{\lambda}}$. And for a mass moving at its maximum velocity $\frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v_{max}^2}{c^2}}} = 1$. 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 collision state. When it is not in 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.

9 Minkowski Space-Time Is Unnecessarily Complex at the Quantum Level

Our 4-dimensional wave equation is invariant. It should be consistent with relativity theory, since it is a relativistic wave equation. As pointed out by Unruh [17], for example, time in standard quantum mechanics plays a role in the interpretation distinct from space, in contrast with the apparent unity of space and time encapsulated in Minkowski space-time [18]. 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

$$dt^2c^2 - dx^2 - dy^2 - dz^2 = ds^2 \tag{73}$$

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

$$dt^2c^2 - dx^2 = ds^2 \tag{74}$$

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

$$t'^2c^2 - x'^2 = \left(\frac{t-\frac{L}{c^2}v}{\sqrt{1-\frac{v^2}{c^2}}}\right)^2 c^2 - \left(\frac{L-tv}{\sqrt{1-\frac{v^2}{c^2}}}\right)^2 = s^2 \tag{75}$$

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 $t = \frac{L}{v_2}$. 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

$$t'^2c^2 - x'^2 = \left(\frac{\frac{L}{v_2}-\frac{L}{c^2}v}{\sqrt{1-\frac{v^2}{c^2}}}\right)^2 c^2 - \left(\frac{L-\frac{L}{v_2}v}{\sqrt{1-\frac{v^2}{c^2}}}\right)^2 \tag{76}$$

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

$$\begin{aligned} t'^2c^2 - x'^2 &= \left(\frac{\frac{L}{v_2} - \frac{L}{c^2}v}{\sqrt{1-\frac{v^2}{c^2}}}\right)^2 c^2 - \left(\frac{L - \frac{L}{v_2}v}{\sqrt{1-\frac{v^2}{c^2}}}\right)^2 \\ & \left(\frac{L\frac{c}{v_2} - L\frac{v}{c}}{\sqrt{1-\frac{v^2}{c^2}}}\right)^2 - \left(\frac{L - L\frac{v}{v_2}}{\sqrt{1-\frac{v^2}{c^2}}}\right)^2 \\ & \frac{L^2 - 2L^2\frac{v}{v_2} + L^2\frac{v^2}{v_2^2}}{1-\frac{v^2}{c^2}} - \frac{L^2\frac{c^2}{v_2^2} - 2L^2\frac{v}{v_2} + L^2\frac{v^2}{c^2}}{1-\frac{v^2}{c^2}} \\ & \frac{L^2 + L^2\frac{v^2}{v_2^2} - L^2\frac{c^2}{v_2^2} - L^2\frac{v^2}{c^2}}{1-\frac{v^2}{c^2}} \\ & \frac{L^2\left(1 - \frac{v^2}{c^2} + \frac{v^2}{v_2^2} - \frac{c^2}{v_2^2}\right)}{1-\frac{v^2}{c^2}} \\ & \frac{L^2\left(1 - \frac{v^2}{c^2}\right)\left(1 - \frac{c^2}{v_2^2}\right)}{1-\frac{v^2}{c^2}} \\ & L^2\left(1 - \frac{c^2}{v_2^2}\right) \end{aligned} \tag{77}$$

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

$$\begin{aligned} t'c - x' &= \left(\frac{\frac{L}{v_2} - \frac{L}{c^2}v}{\sqrt{1-\frac{v^2}{c^2}}}\right) c - \left(\frac{L - \frac{L}{v_2}v}{\sqrt{1-\frac{v^2}{c^2}}}\right) \\ &= \frac{L\frac{c}{v_2} - L\frac{v}{c}}{\sqrt{1-\frac{v^2}{c^2}}} - \frac{L - L\frac{v}{v_2}}{\sqrt{1-\frac{v^2}{c^2}}} \\ &= \frac{L\frac{c}{v_2} - L\frac{v}{c} - L + L\frac{v}{v_2}}{\sqrt{1-\frac{v^2}{c^2}}} \end{aligned} \tag{78}$$

The v will not go away if we do not square the time transformation and length transformation. That is $ds = dtc - dx$ 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

$$\begin{aligned} t'c - x' &= \frac{\frac{L}{c} - \frac{L}{c^2}v}{\sqrt{1-\frac{v^2}{c^2}}} c - \frac{L - \frac{L}{c}v}{\sqrt{1-\frac{v^2}{c^2}}} \\ &= \frac{L - \frac{L}{c}v}{\sqrt{1-\frac{v^2}{c^2}}} - \frac{L - \frac{L}{c}v}{\sqrt{1-\frac{v^2}{c^2}}} = 0 \end{aligned} \tag{79}$$

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

$$\begin{aligned} t'c - x' &= \frac{\frac{\bar{\lambda}}{c} - \frac{\bar{\lambda}}{c^2}v}{\sqrt{1-\frac{v^2}{c^2}}} c - \frac{\bar{\lambda} - \frac{\bar{\lambda}}{c}v}{\sqrt{1-\frac{v^2}{c^2}}} \\ &= \frac{\bar{\lambda} - \frac{\bar{\lambda}}{c}v}{\sqrt{1-\frac{v^2}{c^2}}} - \frac{\bar{\lambda} - \frac{\bar{\lambda}}{c}v}{\sqrt{1-\frac{v^2}{c^2}}} = 0 \end{aligned} \tag{80}$$

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 $v \leq c\sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}}$ relative to each other.

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

$$dtc - dx - dy - dz = 0 \tag{81}$$

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

$$\begin{aligned}
t'c - x' &= 0 \\
\frac{\frac{\bar{l_p}}{c} - \frac{l_p}{c^2} \times v}{\sqrt{1 - \frac{v^2}{c^2}}} c - \frac{l_p - \frac{l_p}{c} v}{\sqrt{1 - \frac{v^2}{c^2}}} &= 0 \\
\frac{l_p - \frac{l_p}{c} \times 0}{\sqrt{1 - \frac{0^2}{c^2}}} - \frac{l_p - \frac{l_p}{c} \times 0}{\sqrt{1 - \frac{0^2}{c^2}}} &= 0 \\
t_p c - l_p &= 0
\end{aligned} \tag{82}$$

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.

10 Conclusion

We have unified gravity with quantum mechanics in a new unified relativistic quantum gravity wave equation. This is a first draft version that we soon will update, but the most important mathematical results are here to support a unified quantum gravity theory that is both simple and elegant, paving the way for future work in this domain.

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Table 1 summarizes how our newly defined momentum brings logic and simplicity back into physics.

11 Appendix: Finding the Parameters for our Gravity Model

In our gravity formula described in the last section, we need to find the unknown diameter of the indivisible particle and the reduced Compton wavelength of the small and large masses. To do this, we 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 only on an electron, but this helps us finding the reduced Compton wavelength for large masses. Further, 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, [**?**] measured it to be about (see also [**?**])

$$\frac{\frac{c}{\bar{\lambda}_P}}{\frac{c}{\bar{\lambda}_e}} = \frac{f_P}{f_e} = 1836.152470(76) \tag{83}$$

.

In fact, they measured the proton-electron mass ratio this way and not the mass in *kg*. Interestingly, the reduced Compton frequency is only a deeper aspect of mass that has recently been more or less confirmed by experimental research, see [**? ?**]. Theoretically, it is no surprise that $\frac{f_P}{f_e} = \frac{m_P}{m_e}$. This also holds true in our mass definition

$$\begin{aligned} \frac{f_P}{f_e} &= \frac{\tilde{m}_P}{\tilde{m}_e} \\ \frac{f_P}{f_e} &= \frac{\frac{l_p^2}{\bar{\lambda}_P}\frac{1}{c}}{\frac{l_p^2}{\bar{\lambda}_e}\frac{1}{c}} = \frac{\bar{\lambda}_e}{\bar{\lambda}_P} \end{aligned} \tag{84}$$

That is, we can find the Compton length of an electron and also 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 amounts of protons and electrons in them. Twice the mass has 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 that the collision space-time is what we call gravity. We must therefore perform a gravity measure to calibrate our model. 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, [**?**]. 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 are approximately $1836.15 \times 1.5 \times 10^{26} = 2.13 \times 10^{50}$ per second. The reduced Compton length must then be $\bar{\lambda}_M = \frac{f}{c} = \frac{2.13\times 10^{50}}{c} \approx 1.4 \times 10^{-42}$ 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

$$\bar{\lambda} = \frac{\hbar}{\sum_{i=1}^{N} m_i c} = \frac{1}{\frac{1}{\bar{\lambda}_i} + \frac{1}{\bar{\lambda}_{i+1}} + \frac{1}{\bar{\lambda}_n}} \tag{85}$$

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. 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

$$\kappa\theta \tag{86}$$

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

$$\kappa\theta = LF \tag{87}$$

where L is the length between the two small balls in the 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

$$F = c^3\frac{\tilde{M}_t\tilde{m}_t}{R^2} = c^3\frac{\frac{x^2}{\bar{\lambda}_M}\frac{1}{c}\frac{x^2}{\bar{\lambda}_m}\frac{1}{c}}{R^2} \tag{88}$$

where x is unknown. This means we must have

$$\kappa\theta = Lc^3\frac{\tilde{M}\tilde{m}}{R^2} \tag{89}$$

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

$$T = 2\pi\sqrt{\frac{I}{\kappa}} \tag{90}$$

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

$$I = \tilde{m}\left(\frac{L}{2}\right)^2 + \tilde{m}\left(\frac{L}{2}\right)^2 = 2\tilde{m}\left(\frac{L}{2}\right)^2 = \frac{\tilde{m}L^2}{2} \tag{91}$$

this means we have

$$T = 2\pi\sqrt{\frac{\tilde{m}L^2}{2\kappa}} \tag{92}$$

and when solved with respect to κ, this gives

$$\begin{aligned}
\frac{T^2}{2^2\pi^2} &= \frac{\tilde{m}L^2}{2\kappa} \\
\kappa &= \frac{\tilde{m}L^2}{2\frac{T^2}{2^2\pi^2}} \\
\kappa &= \frac{\tilde{m}L^2 2\pi^2}{T^2}
\end{aligned} \tag{93}$$

Next, in equation 89 we are replacing κ with this expression

$$\begin{aligned}
\frac{\tilde{m}_t L^2 2\pi^2}{T^2}\theta &= Lc^3\frac{\tilde{M}_t\tilde{m}_t}{R^2} \\
\frac{L^2 2\pi^2}{T^2}\theta &= Lc^3\frac{\tilde{M}_t}{R^2}
\end{aligned} \tag{94}$$

Next remember our mass definition is $\tilde{M}_t = \frac{x^2}{\bar{\lambda}}\frac{1}{c}$, which we now replace in the equation above and solving with respect to the unknown diameter of the particle, we get

$$\begin{aligned}
\frac{L^2 2\pi^2}{T^2}\theta &= Lc^3\frac{\frac{x^2}{\bar{\lambda}}\frac{1}{c}}{R^2} \\
\frac{L^2 2\pi^2}{T^2}\theta &= Lx^2\frac{\frac{c^2}{\bar{\lambda}}}{R^2} \\
\frac{L2\pi^2 R^2}{T^2\frac{c^2}{\bar{\lambda}}}\theta &= x^2 \\
x &= \sqrt{\frac{L2\pi^2 R^2}{T^2\frac{c^2}{\bar{\lambda}}}\theta} \\
x &= \sqrt{\frac{L2\pi^2 R^2\theta}{T^2 f_C c}}
\end{aligned} \tag{95}$$

where f_C is the reduced Compton frequency of the mass in question, that we earlier have shown how to find. Experimentally, one will find that x must be the Planck length and that the standard error in measurements is half of that of using Newtonian theory in combination with Cavendish. Today one have access to small Cavendish apparatuses with built in fine electronics that can be used to do quite accurate measurements of x, and it is clear that x is close to the Planck length.

Entity	Standard physics	New theory
Total momentum mass	$p = \frac{mv}{\sqrt{1-\frac{v^2}{c^2}}}$	$p_t = E_t = \frac{mc}{\sqrt{1-\frac{v^2}{c^2}}}$
Kinetic momentum	$p = \frac{mv}{\sqrt{1-\frac{v^2}{c^2}}}$	$p_k = E_k = \frac{mc}{\sqrt{1-\frac{v^2}{c^2}}} - mc$
Kinetic momentum $v << c$	$p \approx mv$	$p_k = E_k \approx \frac{1}{2}m\frac{v^2}{c}$
Rest-mass momentum	None	$p_r = mc$
Momentum photon	$p = \frac{h}{\lambda} = mc$	$p_t = E = \frac{mc}{\sqrt{1-\frac{v^2}{c^2}}} = mc$ since $v = 0$ photon–photon collision
From momentum to energy	For photons multiply by c, or else complicated	Just multiply by c for photons and standard mass
From energy to momentum	For photons divide by c, or else complicated	Just divide by c for photons and standard mass
Matter wave-1	$\lambda_B = \frac{h}{\frac{mv}{\sqrt{1-\frac{v^2}{c^2}}}}$ Never observed!	λ_B just a derivative of λ_c
Matter wave-2 Compton wave The new momentum used	$\lambda_c = \frac{h}{\frac{mc}{\sqrt{1-\frac{v^2}{c^2}}}}$ Observed Not understood	$\lambda_c = \frac{l_p^2}{\frac{\tilde{m}c}{\sqrt{1-\frac{v^2}{c^2}}}}$ The only matter wave Understood
Mass from Compton	$m = \frac{h}{\lambda_c}\frac{1}{c}$	$\tilde{m} = \frac{l_p^2}{\lambda_c}\frac{1}{c}$
Mass from de Broglie	$m = \frac{h}{\lambda_B}\frac{1}{v}$ Impossible for rest-mass	$\tilde{m} = \frac{l_p^2}{\lambda_B}\frac{1}{v}$ Impossible for rest-mass (artifact)
de Broglie from Compton	$\lambda_B = \lambda_c\frac{c}{v}$	$\lambda_B = \lambda_c\frac{c}{v}$
Compton from de Broglie	$\lambda_c = \lambda_B\frac{v}{c}$	$\lambda_c = \lambda_B\frac{v}{c}$
Phase velocity	$v_p = \frac{E}{p} = \frac{c^2}{v}$ Not understood, cannot carry energy	$v_p = \frac{p}{\tilde{m}} = \frac{E}{\tilde{m}} = c$ Understood, can carry energy
Energy–momentum relation	$E^2 = p^2c^2 + (mc^2)^2$	$E = E_k + mc$
Energy–momentum relation	$E^2 = p^2c^2 + (mc^2)^2$	$E = p_t$ same as above
Momentum from energy	$p = \frac{\sqrt{E^2-m^2c^4}}{c} = \frac{\sqrt{\left(\frac{mc^2}{\sqrt{1-\frac{v^2}{c^2}}}\right)^2 - m^2c^4}}{c}$	$p_k = E - \tilde{m}c = \frac{mc}{\sqrt{1-\frac{v^2}{c^2}}} - \tilde{m}c = E_k$
Momentum from energy	$p = \frac{\sqrt{E^2-m^2c^4}}{c} = \frac{E}{c} = \frac{h\frac{c}{\lambda}}{c} = \frac{h}{\lambda}$ Partly "trickery" derivation, but correct	$p_k = E - mc = \frac{\tilde{m}c}{\sqrt{1-\frac{v^2}{c^2}}} - \tilde{m}c = 0$ photon–photon collision $v = 0$ $p_t = E = \tilde{m}c = l_p\frac{l_p}{\lambda}$
Invariant mass	$m = \frac{\sqrt{\frac{E^2}{c^2} - p^2}}{c}$	$\tilde{m} = \frac{E - p_k}{c}$
Negative: energy, momentum, and mass	Cannot be excluded	Totally excluded
Negative probability	Suggested as solution	Absurd and not needed
Max velocity matter	$v < c$	$v \leq c\sqrt{1 - \frac{l_p^2}{\lambda^2}}$
Trans-Planckian crisis	Yes	No

Table 1: This table summarizes how our newly defined momentum brings logic and simplicity back into physics.

	Revisited Uncertainty Principle	**Standard Uncertainty Principle**
Momentum position uncertainty	$\Delta \tilde{E}_t \Delta x \geq l_p^2$	$\Delta p \Delta x \geq \hbar$
Momentum position uncertainty	$\Delta \tilde{r}_s \Delta x \geq 2 l_p^2$	$\Delta p \Delta x \geq \hbar$
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	$\Delta \tilde{E} \Delta t \geq \frac{l_p^2}{c}$	$\Delta E \Delta t \geq \hbar$
Energy time uncertainty	$\Delta \tilde{r}_s \Delta t \geq 2 \frac{l_p^2}{c}$	$\Delta E \Delta t \geq \hbar$
Energy	$l_p \geq \tilde{E} \geq l_p \frac{l_p}{\bar{\lambda}}$ Pauli Objection solved	$0 \leq E \leq \infty$ Pauli Objection not solved
Time	$\frac{\bar{\lambda}}{c} \geq t \geq \frac{l_p}{c}$ Time between Planck events	$\Delta t \geq 0$ $\infty \geq t \geq 0$ Pauli Objection not solved
Kinetic energy	$\left(l_p - \frac{l_p^2}{\bar{\lambda}}\right) \geq \tilde{E}_k \geq 0$	Undefined ? $\Delta E \geq \frac{\hbar}{\Delta t}$ Pauli Objection not solved
Mass as collision time	$\frac{l_p}{c} \geq m \geq \frac{l_p}{c} \frac{l_p}{\bar{\lambda}}$ Length of collision time	Missing
Mass as collision length (space)	$l_p \geq m \geq l_p \frac{l_p}{\bar{\lambda}}$ space extension of collision	Missing
Velocity mass	$0 \leq v \leq c\sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}}$	$v < c$
Trans-Planckian crisis	No	Yes

Table 2: The table shows the Revisited Uncertainty Principle and the Standard Uncertainty Principle.

	Revisited Uncertainty Principle	**Standard Uncertainty Principle**
Momentum position uncertainty	$\Delta p_t \Delta x \geq l_p^2$	$\Delta p \Delta x \geq \hbar$
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	$\Delta E \Delta t \geq l_p^2$	$\Delta E \Delta t \geq \hbar$
Energy	$l_p c \geq E \geq l_p c \frac{l_p}{\bar{\lambda}}$ Pauli Objection solved	$0 \leq E \leq \infty$ Pauli Objection not solved
Time	$\frac{\bar{\lambda}}{c} \geq t \geq \frac{l_p}{c}$ Time between Planck events	$\Delta t \geq 0$ $\infty \geq t \geq 0$ Pauli Objection not solved
Kinetic energy	$c\left(l_p - \frac{l_p^2}{\bar{\lambda}}\right) \geq E_k \geq 0$	Undefined ? $\Delta E \geq \frac{\hbar}{\Delta t}$ Pauli Objection not solved
Mass as collision time	$\frac{l_p}{c} \geq \tilde{m}_t \geq \frac{l_p}{\bar{\lambda}} \frac{l_p}{c}$ Length of collision time	Missing
Mass as collision length (space)	$l_p \geq \tilde{m} \geq l_p \frac{l_p}{\bar{\lambda}}$ space extension of collision	Missing
Velocity	$0 \leq v \leq c\sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}}$	$v < c$
Trans-Planckian crisis	No	Yes

Table 3: The table shows the Revisited Uncertainty Principle and the Standard Uncertainty Principle.

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

Table 4: This table shows the standard relativistic mass as well as the probabilistic approach. Be aware of the notation difference between the Planck mass m_p and the proton rest-mass $m_{\mathbf{P}}$.

Entity	**Standard physics**	**Unified Quantum Gravity**
Rest mass	$m = \frac{\hbar}{\bar{\lambda}}\frac{1}{c}$	$\tilde{T} = \tilde{m} = \frac{l_p}{c}\frac{l_p}{\bar{\lambda}}$ Collision time
Rest mass energy	$E = \frac{\hbar}{\bar{\lambda}}c$	$\tilde{L} = \tilde{E} = l_p\frac{l_p}{\bar{\lambda}}$ Collision length (space)
Relativistic mass	$m = \frac{\hbar}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}\frac{1}{c}$	$\tilde{T} = \tilde{m} = \frac{l_p}{c}\frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}$ Collision time
Relativistic energy	$m = \frac{\hbar c}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}$	$\tilde{T} = \tilde{m} = l_p\frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}$ Collision length
Know how to find l_p independent off G and $\hbar$	No	Yes
Matter wave	Mistakenly using de Broglie wave de Broglie wave is a derivative the physical Compton wave	Compton wave
Energy momentum relation	$E = \sqrt{p^2c^2 - m^2c^4}$	$\tilde{E} = \tilde{p}_t$ $\tilde{L} = \tilde{T}c$
Plane wave	$\Psi = e^{i\left(\frac{\tilde{p}}{\hbar}x - \frac{E}{\hbar}t\right)}$	$\Psi = e^{i\left(\frac{\tilde{L}}{l_p^2}t - \frac{\tilde{T}}{l_p^2}x\right)} = e^{i\left(\frac{\frac{1}{2}r_s}{l_p^2}t - \frac{\tilde{m}}{l_p^2}x\right)}$
Relativistic wave equation	$\frac{1}{c^2}\frac{\partial^2}{\partial t^2}\Psi - \nabla^2\Psi + \frac{m^2c^2}{\hbar^2}\Psi = 0$	$\frac{\partial\Psi}{\partial t} - \mathbf{c}\cdot\nabla\Psi = 0$
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
Gravity weak field	$F = G\frac{Mm}{r^2}$	$F = c^3\frac{\tilde{M}\tilde{m}}{r^2}$
QM full of mystical interpretations	Yes	No
Incorporated Planck scale ?	Not even close	Yes
Unified quantum gravity?	Not even close	Yes

Table 5: Modern/standard physics versus Unified Theory.