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Re-thinking the foundation of physics and its relation to quantum gravity and quantum probabilities: Unification of Gravity and Quantum Mechanics

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Abstract

In this paper we will show that standard physics to a large degree consists of derivatives of a deeper reality. This means standard physics is both overly complex and also incomplete. Modern physics has typically started from working with first understanding the surface of the world, that is typically the macroscopic world, and then forming theories about the atomic and subatomic world. And we did not have much of a choice, as the subatomic world is very hard to observe directly, if not impossible to observe directly at the deepest level. Despite the enormous success of modern physics, it is therefore no big surprise that we at some point have possibly taken a step in the wrong direction. We will claim that one such step came when one thought that the de Broglie wavelength represented a real matter wavelength. We will claim that the Compton wavelength is the real matter wavelength. Based on such a view we will see that many equations in modern physics are only derivatives of much simpler relations. Second, we will claim that in today's physics one uses two different mass definitions, one mass definition that is complete or at least more complete, embedded in gravity equations without being aware of it, as it is concealed in GM, and the standard, but incomplete, kg mass definition in non-gravitational physics. First, when this is understood, and one uses the more complete mass definition that is embedded in gravity physics, not only in gravity physics, but in all of physics, then one has a chance to unify gravity and quantum mechanics. Our new theory shows that most physical phenomena when observed over a very short timescale are probabilistic for masses smaller than a Planck mass and dominated by determinism at or above Planck mass size.

Our findings have many implications. For example, we show that the Heisenberg uncertainty principle is rooted in a foundation not valid for rest-mass particles, so the Heisenberg uncertainty principle can say nothing about rest-masses. When re-formulated based on a foundation compatible with a new momentum that is also compatible with rest-masses, we obtain a re-defined Heisenberg principle that seems to become a certainty principle in the special case of a Planck mass particle. Furthermore, we show that the Planck mass particle is linked to gravity and that we can easily detect the Planck scale from gravity observations. The Planck mass particle is unique as it only lasts the Planck time, and in that very short time period it can only be observed directly from itself, and it therefore closely linked to absolute rest.

Keywords: quantum mechanics, quantum probability, de Broglie wavelength, Compton wavelength, gravity, quantum gravity.

1 Introduction

First of all, since we use a series of variables and parameters in this paper and also some newly defined symbols, we will start by providing a list of symbols (Table 1), as a preface to our paper, in order that the reader, at any point in the article, can check what the notation means.

The beginnings of our understanding of the physical world started a long time ago. As technical instruments with high precision were not well developed at the early stage, it was natural that such a theory mainly started from top-down principles. That is to say, by observing macroscopic easily observable phenomena and how they behaved, and then based on this attempting to come up with models and theories that could also describe the deeper and not directly observable reality. Still, even in ancient times bottom-up theories also existed. Ancient atomism [1–3] was such a theory – it assumed everything consisted of indivisible particles and empty space (void). Based on such a simple theory the ancient atomist was extremely successful at predicting a series of things. For example, Democritus [4, 5] predicted around 500 BC, based on atomism, that there had to be binary suns (stars) and a large number of planets, some with life, some without life. This was naturally just a theory

Symbol	Represents (standard notation)
h	Planck constant.
$\hbar$	reduced Planck constant.
r_s	Schwarzschild radius.
g	gravity acceleration.
G	Newton's gravity constant.
δ	Deflection off light angle (light bending angle in a gravitational field).
ω	frequency, used for cyclotron frequency, but also for Compton frequency in wave equation.
f	frequency, used for reduced Compton frequency.
q	charge.
B	uniform magnetic field.
c	speed of light.
v	velocity.
λ_γ	Photon wavelength.
λ	Compton wavelength.
$\bar{\lambda}$	Reduced Compton wavelength.
λ	de Broglie wavelength.
$\bar{\lambda}_b$	Reduced de Broglie wavelength.
λ_e	Compton wavelength electron.
$\bar{\lambda}_e$	Reduced Compton wavelength electron.
m	Rest mass in kg.
$\bar{\lambda}_M$	reduced Compton wavelength of the large mass in the Newton formula.
m_e	rest mass of electron in kg.
m_P	rest mass of proton in kg.
m_p	Planck mass in kg.
l_p	Planck length.
t_p	Planck time.
$\gamma = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$	Lorentz factor
$p = mv\gamma$	Standard momentum (de Broglie momentum).
E	energy, used for both rest-mass energy and total energy.
E_k	kinetic energy.
ψ	wave function
New definitions:	
$p_t = mc\gamma$	total Compton momentum based on kg mass.
$p_r = mc$	rest-mass Compton momentum based on kg mass.
$p_k = mc\gamma - mc$	kinetic Compton momentum based on kg mass.
$\bar{m} = \frac{l_p}{c}\frac{l_p}{\bar{\lambda}}$	rest mass defined as collision time.
$\bar{m}_e = \frac{l_p}{c}\frac{l_p}{\bar{\lambda}_e}$	rest mass electron defined as collision time.
$\bar{m}_P = \frac{l_p}{c}\frac{l_p}{\bar{\lambda}_e}$	rest mass proton defined as collision time.
$\bar{m}\gamma = \frac{l_p}{c}\frac{l_p}{\bar{\lambda}}\gamma$	relativistic collision time mass.
$p_t = \bar{m}c\gamma$	total Compton momentum based on collision time mass.
$p_r = \bar{m}c$	rest-mass Compton momentum based on collision time mass.
$p_k = \bar{m}c\gamma - mc$	kinetic Compton momentum based on collision time mass.
$\bar{E} = \bar{m}c$	rest mass energy defined as collision length.
$\bar{E} = \bar{m}c\gamma = l_p\frac{l_p}{\bar{\lambda}}\gamma$	energy defined as collision length, symbol used for both rest-mass energy and total energy.
$\bar{E}_k = \bar{m}c\gamma - \bar{m}c$	kinetic energy defined as collision length.
$P_c = \frac{l_p}{\bar{\lambda}}\gamma$	collision state probability.
$P_n = 1 - \frac{l_p}{\bar{\lambda}}\gamma$	no-collision probability.
$\hat{\bar{p}}_t = il_p^2\nabla$	Total Compton momentum operator with respect to space x.
$\hat{\bar{E}} = il_p\nabla_t$	Total collision time energy operator with respect to time t.
$v_{max} = c\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}}$	maximum velocity for elementary particles.

Table 1: Symbol list.

and we can discuss up and down how sound it was, for example Aristotle was a notable critic of atomism [6]. In modern times, based on his writings, Schrödinger [7] was clearly interested in atomism, but it is unclear if it inspired him in any of his discoveries, we would say probably not. However, in recent times it is clear that Democritus at least was correct in his prediction that the universe contained many planets [8] as well as binary stars. Whether Democritus was right based on lucky speculations or deep thinking we leave up to others to consider, but we will indeed return to atomism later in this paper.

Still, it was the top-down approach that, at least until the development of atomic physics and quantum mechanics, that has been the dominant approach. And even the quantum mechanics foundation, as we will see, is based on findings and a foundation laid out by top-down principles, and some top-down principles that we will look at are not necessarily all rooted in experiments, but can principally be considered an untested hypothesis. When working from top-down principles, then the smallest misunderstanding about the macroscopic world could have massive implications for our theories about the subatomic world. In this paper we will argue that it has been basically two steps in the wrong direction that have stopped us from being able to unify quantum mechanics with gravity. We will surprisingly claim that one of these two erroneous steps was how one has held on to the old hypothesis of momentum: $p = mv$. One of the core principles of scientific physics is that, for something predicted from theory, one should be able to observe, or at least test out indirectly if this is the case. One has to be careful here with such statements, as much of the subatomic world is too small for us to glimpse in

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any foreseeable future and perhaps forever to be observed directly, even by the best technical instruments of the far-fetched advanced future. Still, theories about the subatomic world should lead to predictions about the observable world that we can then test out and observe. However, the concept of momentum was originally suggested for macroscopic observable objects, so it should be easily observable and test out if: $p = mv$ is a good description of a moving object. Concepts and derivations around momentum are today so very well established and incorporated in all areas of physics, that hardly anyone in physics would even think about questioning our momentum definition. After all, has momentum not been observed over and over again for hundreds of years, is this not one of the best tested cornerstones of physics? Well, we will ask if anyone can show us how to observe mv. We can observe the kg mass (or pound or similar) of an object m by putting it on a weight (as mass is proportional to weight in a given gravity field), and we can measure the velocity of the same object when it moves. Velocity is simply how far something moves in a given period of time. However, we will claim we cannot measure mv, we will claim it is a pure mathematical construct, which we, in this paper, will prove is never needed. Even if I can observe an apple and a banana, that does not mean an "apple-banana" exists. From this mathematically non-observable construct – the momentum for anything with mass – de Broglie [9, 10] around 1924 derived what is today known as the de Broglie wavelength, or the matter wavelength. Furthermore, the standard momentum and the de Broglie wavelength are both part of the foundation of quantum mechanics.

Quantum mechanics has been incredibly successful in many testable predictions, so such a theory cannot be that wrong – there must naturally be something to it. Still, today's quantum mechanics we will claim is shrouded in several what we would could call almost mystical interpretations. We will in this paper try to show that there is another way. There is an alternative and real momentum that can easily be observed, it is the momentum we can derive from the Compton wavelength relation and also observe directly from moving macroscopic objects. The standard momentum and the de Broglie wavelength are both just derivatives (functions) of this real momentum and real matter wavelength. When one understands this, then everything becomes much simpler. Based on this we will also show that much of today's physics is just mathematical functions (derivatives) of a much simpler, and we will claim much more elegant, theory.

The second incorrect path we will see was to ignore Newton's original gravity formula and his claim about what matter entailed. Newton's original gravity formula was $F = \frac{Mm}{r^2}$ and not the modern version $F = G\frac{Mm}{r^2}$. If one had held on to his original formula, then we will see one had likely long ago understood that today's mass definition in non-gravitational physics is incomplete and not the same mass as we find embedded in gravity equations, but, as we will show, unknowingly so also concealed in GM. The only way to get Newton's original mass formula to work is to use a mass definition that gives us a theory that makes quantum mechanics and gravity consistent. Naturally, Newton knew nothing about this. We will see how the gravity constant G, that Newton neither invented nor used, is simply a way to transform the incomplete kg mass definition into a complete mass definition. First, when one understands this in combination with the idea that the Compton wavelength is the real matter wavelength and that the de Broglie wavelength is a derivative, that is a function of the Compton wavelength, then one gets a much simpler theory, which also appears able to let us unify key concepts in gravity with quantum mechanics. As we will see, the world is dominated by probability for masses much smaller than the Planck mass and is dominated by determinism when we get close to the Planck mass and above. Moreover, we will show there is a Planck mass particle that is actually the building block of all matter that again consists of the collision between two light particles. This is a new way to look at physics so we naturally do not ask the reader to take any of this for granted, but we think our theory is rigorous at the same time that it simplifies and makes physics easier to understand. Based on this we think it deserves to at least be considered and discussed, in order to find out if this is on the right path to a unified theory, or just another step into the desert.

2 Mass, Momentum and Energy

Newton, in Principia [11], published in 1686, defined mass as the quantity of matter ("quantities material"). But then, what is matter? Newton also had a clear idea about this – he stated in the third part of his book Principia, which predominately concerned gravity, that behind all his philosophy was the idea about indivisible particles, and that they also had extension in space, and were movable. This was an idea he had probably got from the ancient atomists. One could claim Newton's idea about indivisible particles was speculative as there seems to have been no way Newton could prove this, at least not in his time. If mass is the quantity of matter, and matter ultimately consists of indivisible particles, then these indivisible particles must be incredibly small. Newton held on to this view in his later years, as he also repeated this view on the matter in his book, Opticks [12], published in 1704.

Newton also repeatedly pointed out that mass was proportional to weight for bodies measured in the same gravity field, that were at the same distance from a large massive object, such as the Earth – something we know fits experiments to this day. In gravity theory today we have not necessarily travelled much further in our understanding of mass. Mass is today defined as kg (or we could use pounds), and since mass is proportional to weight this works well for many purposes. We come back to the 2019 kilogram definition that is linked to the Planck constant later on. In quantum mechanics we have gone deeper in our understanding on matter, where it

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is assumed and partly observed that matter has a form of wave-particle duality, as likely first suggested by de Broglie. Still, we have not been able to build a bridge between quantum mechanics and gravity. Prof. Jammer [13] in his work on mass states: "*mass is a mess*" – his point is that we still do not really understand what mass is. And Feynman, putting it a little on the edge with a touch of humor said "*It is important to realize that in physics today, we have no knowledge what energy is.*" Despite Feynman's humorous tone, there is also something to this – here we are about hundred years after the introduction of general relativity theory and quantum mechanics, and we have still not been able to unite the "forces" of the macroscopic and the subatomic world, and we likely do not fully understand what energy and mass is at the deepest level, but maybe there is still hope.

Here we will show that, embedded in Newton's gravity theory, after calibrated to a gravity observation, one basically has an embedded mass definition without being aware of it, which is very close to Newton's original idea that matter ultimately consisted of indivisible particles, and that there even existed indivisible moments of time (as Newton called it). Furthermore, it will be clear that these indivisible particles have a physical extension in space, as Newton also mentioned, and that they were movable. We naturally do not mean that Newton was hiding such things in his gravity formula on purpose. But as we will see, the gravity constant G can be seen as just a parameter for what is missing in the model when one uses a certain mass definition such as the kg definition. When calibrating the model to observable gravity phenomena, we are able to indirectly get several things into the model that are missing from its assumptions. This is naturally on the condition that these missing elements are already embedded in observable gravity phenomena, something we soon will demonstrate is the case. And in non-gravitational physics we are using a different mass definition, the standard kg mass definition, that we will show is incomplete. So indirectly in modern physics one is using a complete mass definition that is embedded and hidden in gravitational theory (after calibration), and an incomplete mass definition in non-gravitational theory. When one can fully understand this one can build a bridge between quantum mechanics and gravity, something we will try to attempt here, but without claiming we have a complete theory, simply that that we are on a new and interesting path that likely deserves more attention among researchers.

Let us first go back to today's mass definition. Often, we are only interested in how many kilograms a mass has, that is to say we are often just operating with the kg definition of mass. The kg definition of mass is originally an arbitrary clump of matter (quantity of matter) likely chosen to be the standard for weight, and since mass is proportional to weight, then kg is also a measure for mass. In many if not most physical formulas that are related to mass, it is the amount of kg this mass has that one needs as input in the formula to perform calculations and thereby offer predictions that can be compared to observations. The kilogram most likely partly originated from trade. In business it is very important to have a standardized measure of weight. The mass size of the kg was likely chosen so it was not so light that the weight was inaccurately based on the weighing equipment used at that time. Also, it could not be so heavy that it could not easily be transported. Well, enough on this topic, one could write a whole book about the history of the kg definition. The Planck constant h that was introduced by Max Planck has output units $kg \cdot m^2 \cdot s^{-2}$, thus the Planck constant contains kg. From 2019 the kg was re-defined on the basis of the Planck constant by using a watt balance, see, for example, [14–16]. This led us to the important question: "*how is kg linked to the quantum world?*". The Planck constant is after all considered to be linked to quantization of energy. We will claim the simplest way to express the rest-mass in terms of kg in terms of constants and parameters linked to the quantum world is by the following formula

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

where h and $\hbar$ are respectively the Planck constant and the reduced Planck constant, and λ and $\bar{\lambda}$ are respectively the Compton wavelength and the reduced Compton wavelength, and c is the speed of light. This mass formula is simply obtained by solving the Compton [17] 1923 wavelength formula, $\lambda = \frac{h}{mc}$, with respect to m. This formula we can say both incorporates a wavelength, and thereby could be linked to the wavelike-property of matter, as well as quantization of matter, as the Planck constant, $\hbar$, is linked to quantization (normally for energy). We will later come back to exactly how we think the Planck constant is linked to quantization – it is far from clear until understood from a deeper perspective. In addition, perhaps to some readers' surprise, we have the speed of light there in the formula to describe a rest-mass, and we will soon understand why.

It is traditionally the de Broglie wavelength that is linked to matter wavelengths and not the Compton wavelength. However, one cannot express a rest-mass in terms of the de Broglie wavelength; this because the de Broglie wavelength [10, 18] is given by $\lambda_b = \frac{h}{mv}$, and since it is not mathematically defined to divide by zero, then the de Broglie wavelength simply does not exist for rest-mass particles. We could argue, based on the Heisenberg uncertainty principle, that a particle never stands still, and that when v approaches zero, then the de Broglie wavelength simply approaches infinity. This may be why several physicists have claimed that the de Broglie wavelength is infinite for rest-mass particles, see for example [19]. Still, an electron almost at rest with an infinite wavelength seems absurd in our view. An infinite or close to infinite wavelength has naturally never been observed, even if one could always claim one has observed it indirectly. And we think several of the interpretations of the de Broglie wavelength for rest or close to rest-mass particles are just "absurd", such as

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> "*The de Broglie wave has infinite extent in space*" – A. I. Lvovsky[1]. [20]

and there is no clear agreement on how to interpret the infinite de Broglie wavelength, as seen, for example, by reading the well-known book by Max Born [21] :

> "*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

On the other hand, the Compton wavelength has indirectly been measured many times, and, for example, the reduced Compton wavelength of an electron with velocity $v << c$ is in the order of approximately 3.86×10^{-13} m, which is indeed a distance not so far from other quantum distances we are aware of, such as, for example, the radius of the proton (approximately 10^{-15} m). The formula for the Compton wavelength and the de Broglie wavelength given above are non-relativistic. The relativistic formulas for the de Broglie wavelength and the Compton wavelength are given by

$$\lambda_{b,r} = \frac{h}{p} = \frac{h}{mv\gamma}, \qquad \lambda_r = \frac{h}{mc\gamma} \tag{2}$$

where $\lambda_{b,r}$ is the relativistic de Broglie wavelength, and λ_r is the relativistic Compton wavelength, and $\gamma = 1/\sqrt{1 - v^2/c^2}$, is the standard Lorentz factor.

The relativistic de Broglie wavelength was introduced by de Broglie himself. To our surprise we have not found a single paper on deriving a full relativistic Compton wavelength[2], even if it is trivial to extend the non-relativistic Compton wavelength to a relativistic one. So we wrote a short paper on the derivation of the relativistic Compton wavelength ourselves [22]. The original Compton wavelength formula assumes the electron is initially at rest. Overall, the de Broglie wavelength seems to have received much more attention than the Compton wavelength. For example, the wave function in the Schrödinger and the Klein Gordon equation is directly linked to the de Broglie wavelength, based on how the wave function is typically set up based on momentum[3], see for example [23].

After Einstein's [24] explanation of the photoelectronic effect it was clear that light had both particle and wavelike properties. Furthermore it was clear that the photon wavelength was related to the photon momentum by the formula $\lambda_\gamma = \frac{h}{p_\gamma}$, where p_γ is the photon momentum, and λ_γ is the photon wavelength. In his PhD thesis, de Broglie was likely to have been inspired by Einstein's relation between photon momentum and the photon wavelength, and speculated that matter also likely had wave-like properties. The natural best guess was then to assume the matter wavelength was also linked to the momentum, as it was assumed to be the case for the photon, and he suggested that the matter wavelength was given by $\lambda_b = \frac{h}{p}$, where p was the momentum of the mass in question. De Broglie's PhD supervisor sent his thesis to Einstein, to obtain his views on it. Einstein liked the idea and basically endorsed this hypothesis. In 1927 it was experimentally confirmed that electrons had wavelike properties, see [25, 26]. These experiments are claimed to have confirmed the de Broglie hypothesis. However, all that was shown in these experiments was that matter also had wavelike properties, as indeed first suggested by de Broglie. It was however not necessarily a measurement or detection of the de Broglie wavelength. It is easily forgotten that Arthur Compton at almost the same time suggested and indirectly measured a wavelength linked to the electron that is today known as the Compton wavelength, from so-called Compton scattering. Compton's paper was however much more experimentally focused, while de Broglie paper more heavily involved deeper (mathematical) philosophy about the possible properties of matter. We think the idea from de Broglie that matter had wave-like properties and a wavelength was brilliant, but we will see that the wavelength formula he suggested as understood from a deeper perspective is likely to be just a mathematical derivative (function) of the real matter wavelength that we will claim is the Compton wavelength.

From the two formulas above (see 2), we can see that the de Broglie wave is always equal to the Compton wavelength multiplied by $\frac{c}{v}$. One can then ask, why are there two wavelengths connected to matter and not only one? Photons do not have two different wavelengths, in particular not one that is short at the same time as the other one is close to infinite. We agree that de Broglie was correct in his hypothesis that matter had wavelike properties, but we will claim his theoretical wavelength is just a mathematical derivative of the real matter wavelengths that we will claim is the Compton wavelength. Why would there be such a simple relation between them, $\lambda_b = \lambda \frac{c}{v}$ if they not were directly related? We have already seen that the Compton wavelength also holds for rest-mass particles, while the de Broglie wavelength is not defined in that case. We will argue that the hypothesis that the de Broglie wave is a real matter wavelength and not only a derivative of the Compton wavelength has led modern physics to develop a whole theory that is just a mathematical derivative of a simpler and more robust theory. But this actually goes all the way back to the definition of momentum, something we will return to soon.

That the de Broglie wavelength is not valid for rest-mass particles we will show is part of the reason why nobody has been able to unify gravity with quantum mechanics. But back to the kg mass first. It is clear that

[1] In an otherwise excellent book.
[2] Not that we know every paper published in physics.
[3] At least the Plane wave solution.

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we cannot describe a rest-mass with the de Broglie wavelength, the closest we can come is solving the de Broglie formula with respect to the mass, which gives

$$m = \frac{h}{\lambda_b}\frac{1}{v}\gamma = \frac{h}{\lambda_{b,r}}\frac{1}{v} \tag{3}$$

where $\lambda_{b,r} = \lambda_b/\gamma$. And again, we cannot divide by zero, so this formula can also not be valid for $v = 0$. This formula is not valid for rest-mass particles. However, we can describe all rest masses in terms of kg with formula 1, that is based on the Compton wavelength, and also moving masses in terms of kg by simply solving the relativistic Compton wavelength formula with respect to m, this gives

$$m = \frac{\hbar}{\bar{\lambda}}\frac{1}{c}\gamma = \frac{\hbar}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}\frac{1}{c} \tag{4}$$

That is to say we have established a very simple mathematical link between the kg definition of mass and quantum parameters and constants. Nonetheless, the formula 1 or in relativistic form 4 seems to give limited intuition. However, if we slightly re-write the formula we get

$$\frac{\hbar}{\bar{\lambda}}\frac{1}{c} = \frac{\hbar}{\bar{\lambda}}\frac{1}{c}\frac{c}{c} = \frac{\frac{c}{\bar{\lambda}}}{\frac{c^2}{\hbar}} = \frac{\frac{c}{\bar{\lambda}}}{\frac{c}{\frac{\hbar}{1\times c}}} = \frac{f}{f_{1kg}} \tag{5}$$

That is to say the kg mass formula we obtained from the Compton formula can be interpreted as a frequency ratio. It is the reduced Compton frequency of the mass we are interested in, f, divided by the reduced Compton frequency of one kg, f_{1kg}. Alternatively, we could take the two Compton frequencies instead of the reduced Compton frequencies, as this will give the same ratio and numerical output. So we will claim the quantity of matter is linked to the Compton frequency inside the matter. We will later discuss if macroscopic masses like one kg can actually have a Compton wavelength and thereby Compton frequencies, or only elementary particles; for now we assume all masses can have a Compton frequency. The reduced Compton frequency of one kg is given by

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

and to find the kg mass of any mass, we just need to know its reduced Compton frequency, for an electron it is

$$f_e = \frac{c}{\bar{\lambda}_e} \approx 7.76\times 10^{20} \text{ per second} \tag{7}$$

and we get the electron's mass equal to $m_e = \frac{f_e}{f_{1kg}} \approx \frac{7.76\times 10^{20}}{8.52\times 10^{50}} \approx 9.11\times 10^{-31}\ kg$, which is the well-known electron mass[4]. Also note that a particle with reduced Compton frequency of one has a kg mass of

$$\frac{1}{f_{1kg}} = \frac{1}{8.52\times 10^{50}} \approx 1.17\times 10^{-51} \text{ kg} \tag{8}$$

This is actually identical to the mass equivalent of a photon with a frequency of one per second $\frac{E}{c^2} = \frac{\hbar f}{c^2} = \frac{\hbar\times 1}{c^2} \approx 1.17\times 10^{-51}$ kg. The Planck constant is therefore linked to a reduced Compton frequency of one per second relative to the Compton frequency in one kg per second. However, at this point it is not exactly clear what the interpretation of a frequency of one is, but we will return to this soon – but first we will get back to momentum. What is important at this stage is to understand for a possible deeper understanding of one kg is that it represents the Compton frequency ratio of the mass we are interested in relative to the Compton frequency in one kg.

The concept of momentum goes back long back before Newton, but somewhat diffusely. Newton in Principia introduced "quantity of motion" arising from the velocity and quantity of matter conjointly. Jennings [27] in 1721 specifically defines momentum mathematically as we know it today, namely $p = mv$. Momentum was what we can call an idea or a concept, or simply a hypothesis. An important question is if momentum is directly observable even for macroscopic masses. One can find the kg mass of an object by finding its weight relative to a kg mass. And we can measure the velocity of an object, as velocity is simply the distance an object (or a particle) has moved inside a chosen observational time window. That is to say, we can easily observe m, and we can easily observe v, but to our knowledge we cannot observe mv. The momentum definition is only a mathematical concept (multiplication) of two observable entities. Some will likely protest here and claim that momentum is measured all the time, but again one then has to think if we are actually observing momentum, that is mv, or simply m and v separately. Even if we will claim momentum does not exist physically, if it is a derivative of a more real momentum that can actually be observed, therefore the standard momentum still contains embedded valuable information about reality that can be used in further derivations to get to predictions and other important concepts in physics, albeit, as we will see, at the cost of unnecessary complexity. One of

[4]NIST 2018 gives an electron mass equal to $9.1093837015(28)\times 10^{-31}$ kg.

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the most important concepts where momentum appears is in Einstein's relativistic energy momentum relation, which is the foundation behind much of modern quantum mechanics. The momentum $p = mv$ is actually only an approximation when $v << c$. The more precise momentum formula is the well-known relativistic formula

$$p = mv\gamma \tag{9}$$

This is essentially that one has taken the old momentum that was introduced in the past for granted and made it relativistic, after the discovery of relativity theory. When $v << c$ we can approximate the relativistic momentum very well with the first term of a Taylor series expansion, which gives us the well-known "ancient" momentum formula $p \approx mv$. But again we will claim mv has never been directly observed. The de Broglie wavelength was calculated from the momentum formula – we repeat it again here $\lambda_b = \frac{h}{p\gamma} = \frac{h}{mv\gamma}$. But if momentum is not observable, then maybe standard momentum simply does not exist, except as a mathematical construct. We can also solve the de Broglie formula with respect to p, this gives

$$p = \frac{h}{\lambda_b}\gamma \tag{10}$$

But then no one has observed the de Broglie wavelength, for example for a particle almost at rest. Such a de Broglie wavelength would extend beyond our solar system, and if v is very close to zero it would extend beyond our galaxy and when v is close enough to 0, beyond the assumed diameter of the observable universe. One can naturally argue about the interpretation of the de Broglie wavelength and claim our interpretation here is wrong, see for example [28]. More importantly, again the de Broglie wave is not defined for $v = 0$, so if we then derive the standard momentum from the de Broglie wavelength, or at least require the momentum to always be consistent with the de Broglie wavelength, then it is not that standard momentum is zero when $v = 0$, rather the standard momentum simply does not mathematically exist for rest-mass particles. No surprise there, some will possibly say, because momentum has to do with moving particles, but then things in quantum mechanics derived from the standard momentum can also not say anything about rest-mass particles.

Actually, it is when we derive a new momentum from the Compton wavelength formula that we soon will see something very interesting

$$\lambda = \frac{h}{mc\gamma} \tag{11}$$

Solved similarly to the way we adopted to find standard momentum from the de Broglie wavelength formula, the Compton wavelength formula gives us a new momentum that we will call Compton momentum.

$$p_t = mc\gamma = \frac{h}{\lambda}\gamma \tag{12}$$

This is more precisely the total Compton momentum, and we use notation, p_t, to distinguish it from the standard momentum p. First of all, this new Compton momentum is also valid when $v = 0$, as $v = 0$ simply makes $\gamma = 1$, and in that special case the formula above simplifies to mc. The Compton momentum when $v = 0$ we can call rest-mass momentum, $p_r = mc$. We can then also define a kinetic momentum which must be given by

$$\bar{p}_k = mc\gamma - mc \tag{13}$$

The kinetic momentum is the momentum of the moving particle. When $v = 0$, the kinetic momentum is zero, but it is not that it is non-defined mathematically as with standard momentum. Second, if $v << 0$ we can approximate the kinetic momentum formula very well with the first term of a Taylor series expansion, this gives

$$p_k \approx \frac{1}{2}\frac{mv^2}{c} \tag{14}$$

That is the kinetic momentum for a given rest-mass is a function of v^2 and not v as standard momentum. While mv is non-observable, $\frac{1}{2}mv^2/c$ is observable, as we now will discuss. This brings us all the way back to the discussion on kinetic energy, and as we will see it is linked to the Compton momentum. Historically, we know it was a decades-long debate on the topic of whether kinetic energy was a function of v or v^2. In 1686, one year before Newton published his Principia, Leibniz [29] published that kinetic energy (vis viva as he called it: Living force) was proportional v^2 and not v. However, that kinetic energy was a function of the square of velocity and not just proportional to the velocity was not easily accepted. Nevertheless, in 1720 Gravesande [30] performed and published experiments where he dropped brass balls in clay. If the brass ball had twice the velocity, the indent in the clay was not actually twice as deep, but approximately four times as deep. And a brass ball with three times the velocity would leave a mark approximately nine times as deep. Clay was an excellent medium here, because one needed a medium where a minimum amount of the kinetic energy was used to bounce the ball back. In other words the Gravesande experiment confirmed that kinetic energy was a function of v^2 and not v. Actually, the first kinetic energy formula was $E_k = mv^2$, and the half multiplier we are used to was first suggested by Bernoulli [31] in 1741. The half multiplier for kinetic energy was discussed in more detail and made popular by Coriolis [32] and Poncelet [33] in the early 19th century.

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This brings us back to our Compton momentum – it is proportional to v^2 and not v. It is only different from today's kinetic energy by division by a constant, namely c. To divide or multiply by a constant in general only changes the output units. We will claim the Compton momentum is much more directly observable compared to the standard momentum, which is not observable and only calculatable from two things we can observe, namely m and v. Also the wavelength we can predict from the Compton momentum is indirectly observable, and it, as we have discussed at length, is indeed at the scale of what we would expect at the quantum scale, while the hypothetical de Broglie wavelength linked to standard momentum can stretch out beyond our galaxy.

We noticed earlier that the de Broglie wavelength can always be expressed as a function of the Compton wavelength, or the opposite, that is $\lambda_b = \lambda\frac{c}{v}$. We have a similar relation between the standard momentum (which is linked to the de Broglie wavelength) and the Compton momentum, namely we always have

$$p = p_t\frac{v}{c} \tag{15}$$

We will claim we have an observable momentum, the Compton momentum and an indirectly observable wavelength, the Compton wavelength, and we have a non-observable momentum, the standard momentum, and a unobservable wavelength with properties that basically seem absurd, the de Broglie wavelength. We will claim that the standard momentum and the de Broglie wavelength are nothing more than mathematical functions of the real momentum and the real matter wavelength. If this is the case it has several important implications for such topics such as quantum mechanics, as we will start to look at in the next section. If we have found the deeper reality, a good indication would be that many equations derived from this deeper fundament became simpler and were still able to describe what the existing theory can do, and perhaps that we could also discover something new.

2.1 Implications for quantum mechanics

As we have shown in the section above, the standard momentum that is linked to the de Broglie wavelength is not mathematically valid for rest-mass parties. Second, the standard momentum is likely a derivative of the real momentum, the Compton momentum. This alone has a series of implications for quantum mechanics. A cornerstone of the foundation of quantum mechanics is Einstein's relativistic energy momentum relation, which is given by

$$E^2 = p^2c^2 + m^2c^4 \tag{16}$$

where $p = mv\gamma$, or for a photon $p = \frac{h}{\lambda}$. While the relation between energy and the relativistic Compton momentum is much simpler, namely it must be

$$E = p_tc \tag{17}$$

Since $p_t = mc\gamma$. Does this mean we claim Einstein's relativistic momentum relation is wrong? Not at all, since the standard momentum is a function of the real momentum then it is only unnecessarily complex, and also not necessarily valid for $v = 0$. We can easily demonstrate that the Einstein's relativistic energy momentum relation can be derived from the simpler energy relativistic Compton momentum relation, because we must have (keep in mind that the standard momentum is $p = p_t\frac{v}{c}$, and $p_t = p\frac{c}{v}$):

$$\begin{aligned}
E &= p_k + mc^2 \\
E &= p_tc \\
E &= \frac{pc^2}{v} \\
E &= mc^2\gamma \\
E^2 &= m^2c^4\gamma^2 \\
E^2 &= m^2c^4\gamma^2 - m^2c^4 + m^2c^4 \\
E^2 &= m^2c^4(v^2/c^2 - 1)\gamma^2 + m^2c^4(v^2/c^2)\gamma^2 + m^2c^4 \\
E^2 &= m^2c^4\gamma^2 - m^2c^4\left(1 - \frac{v^2}{c^2}\right)\gamma^2 + m^2c^4 \\
E^2 &= m^2c^4v^2/c^2\gamma^2 + m^2c^4 \\
E^2 &= m^2v^2c^2\gamma^2 + m^2c^4 \\
E^2 &= p_0^2c^2\gamma^2 + m^2c^4 \\
E^2 &= p^2c^2 + m^2c^4
\end{aligned} \tag{18}$$

In other words, the standard relativistic energy momentum relation is unnecessarily complex, because it is a derivative (function) of the real and simpler relativistic energy Compton momentum relation. If correct this also

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means quantum mechanics is unnecessarily complex, as the relativistic energy momentum relation is one of its cornerstones. For example, the Klein Gordon equation, which was the first derived relativistic wave equation, is directly linked to the Einstein relativistic energy momentum relation by replacing the energy with the energy operator $i\hbar\frac{\partial}{\partial t}$, and the momentum with the momentum operator, $i\hbar\nabla$, we get the following wave equation

$$\begin{aligned} i^2\hbar^2\frac{\partial^2\psi}{\partial t^2} - i^2\hbar^2c^2\nabla^2\psi - m^2c^4\psi &= 0 \\ -\hbar^2\frac{\partial^2\psi}{\partial t^2} + \hbar^2c^2\nabla^2\psi - m^2c^4\psi &= 0 \\ \frac{1}{c^2}\frac{\partial^2\psi}{\partial t^2} - \nabla^2\psi + \frac{m^2c^2}{\hbar^2}\psi &= 0 \end{aligned} \tag{19}$$

The last line is how the Klein–Gordon equation is most often presented. Already by this stage we can instead start to think, what if we can instead start out with the relativistic energy Compton momentum relation as it is fully consistent and we can even claim the deeper physical foundation of the Einstein relativistic energy momentum relation, and then "speculate" how we can get a new and simpler wave equation? We will leave this for a later stage in our paper as there are also other aspects of the foundation of physics we first need to look closely at. But let us also quickly look at the Schrödinger [34] equation in its relation to the standard momentum. The foundation of the Schrödinger equation is the following relation

$$E = E_k + mc^2 \tag{20}$$

where we can approximate $E_k \approx \frac{p^2}{2m} = \frac{m^2v^2}{2m} = \frac{1}{2}mv^2$, which is the kinetic energy approximation when $v << c$. That is to say, the Schrödinger equation must be non-relativistic as is well known, so it is only valid for $v << c$. However, as we have shown earlier, the standard momentum is likely not mathematically valid, at least if we want it to be consistent with the de Broglie wavelength, when $v = 0$. So the Schrödinger equation and all that comes out from it we will claim is not valid for rest-mass particles, and, as we later will see, the rest is likely to be the very essence of gravity. In addition, the Schrödinger equation has somewhat "strange" properties, such as it has terms of a first order partial derivative with respect to the time dimension and a second order derivative with respect to the space dimension.

2.2 The Heisenberg uncertainty principle and the momentum

We will also now briefly comment on the Heisenberg's [35] uncertainty principle, which was originally given by

$$\Delta p\Delta x \geq \hbar \tag{21}$$

Kennard [36] in the same year published a paper showing we are likely to have $\Delta p\Delta x \geq \frac{\hbar}{2}$, but the half factor is outside of our interest here. What is important to pay attention to at this stage is that the Heisenberg uncertainty principle also relies on the momentum – this is even more clear when one derives the Heisenberg uncertainty principle from scratch, as we will do later on. If the standard momentum is not mathematically valid for a rest-mass particle, then Heisenberg's uncertainty principle also cannot be valid to include rest-mass particles, or at least it must be incomplete. According to Heisenberg's uncertainty principle a particle can potentially never stand completely still, but then Heisenberg's uncertainty principle is, in our view, in the first place derived from a foundation, namely standard momentum (actually a momentum operator that is linked to the standard momentum), that is not valid for a rest-mass particle. Heisenberg's uncertainty principle in its known form can therefore probably not say anything about rest-mass particles as its foundation is not even compatible with it. We will later show how we can modify the foundation of it, and then also show what we get in the special case of rest-mass particles, $v = 0$.

We will demonstrate that to truly understand rest-mass at the deepest level is the very essence of understanding quantum gravity at a deeper level and to also have a chance to unify quantum mechanics with gravity. We will therefore now first return to gravity before we return to quantum mechanics and how we can possibly obtain simpler quantum mechanics that are consistent with quantum gravity.

3 Gravity and the hidden mass definition that is the key to the Planck scale and the speed of gravity

One of the biggest challenges in physics for the last hundred years or so has been that there seems to be no link between gravity and quantum mechanics. Gravity theory has been extremely accurate in predicting heavenly objects. Furthermore, it seems, at least from the mathematical surface, that gravity theory as it is today – I am thinking of Newton's gravitational theory as well as Einstein's general relativity theory – contains no information about the atomic, or subatomic, world and therefore no information about the quantum world.

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Quantum mechanics, on the other hand, has been extremely successful at predicting observable phenomena related to the atomic and subatomic world. We will show that even Newtonian gravity indirectly contains much more information about the quantum world than is commonly thought. Later on, we will understand that gravity is directly linked to what we could call the ultimate rest mass particle, namely the Planck mass particle. We have in the previous section argued that today's quantum mechanics is built on a foundation that is not defined for $v = 0$, and soon we will understand that gravity is closely linked to the case where we, in the subatomic world, have $v = 0$. But before we begin to understand this we need to go back to the history of gravity. Therefore, we will start with a short history of Newtonian gravity, because we will claim modern physics has a very limited understanding of Newtonian gravity and even the wrong assumptions about it.

The Newton gravitational force formula is likely the second most commonly known formula in physics after Einstein's $E = mc^2$, and is today known as

$$F = G\frac{Mm}{R^2} \tag{22}$$

There is no scientific device I can use to measure the gravitational force directly. Perhaps this is not that unexpected as a force is something acting on something, for example on a mass. One can however, on the basis of this formula combined with other formulas, derive predictions for things such as orbital velocity, orbital time and gravitational acceleration. We can naturally easily observe such things as the orbital time of the Moon around the Earth, or the orbital time of the Earth around the Sun, we can also easily find the distance to these objects with parallax. Then one can naturally check the predictions from a gravitational formula (theory) with observations. Table 3 provides an overview of many Newtonian gravitational observations that have been observed and also things that have not been observed, such as the gravity force itself. That they have not been observed can mean they do not actually exist physically and can never be observed, or it can mean they are difficult to observe, or can only be observed indirectly. However, we can only be "sure" on what we have observed at least indirectly, and the observations are very close to predictions we get by inputting values for M, R and G into the formulas, so at least we know the Newton formula is a very good approximation for these phenomena.

Non-Observable, contains GMm	**Formula:**
Gravity force	$F = G\frac{Mm}{R^2}$
Observable Predictions, all contains GM not GMm:	**Formula:**
Gravity acceleration	$g = \frac{GM}{R^2}$
Orbital velocity	$v_o = \sqrt{\frac{GM}{R}}$
Orbital time	$T = \frac{2\pi R}{\sqrt{\frac{GM}{R}}}$
Velocity ball Newton cradle[a]	$v_{out} \approx \sqrt{2\frac{GM}{R^2}H}$
Frequency Newton spring	$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}} = \frac{1}{2\pi R}\sqrt{\frac{GM}{x}}$
Periodicity pendulum (clock)[b]	$T \approx 2\pi\sqrt{\frac{L}{g}} = 2\pi R\sqrt{\frac{L}{GM}}$
Predictions that not have been observed:	**Formula:**
Escape velocity	$v_e = \sqrt{\frac{2GM}{R}}$

Table 2: The table shows a series of gravity effects that can be predicted from Newton's formula. As expected, the speed of light (gravity) does not appear in any of the formulas.

[a] H is the height of the ball drop. This is a very good approximation when $v << c$.
[b] This was actually derived by Huygens [37] some years before Newton. L is the length of the pendulum.

In Table 3 we show observable gravity phenomena that are not considered to be predictable from Newton theory, but from general relativity theory.

In all observable gravity phenomena in the two tables above, we only see GM and never GMm, in observable gravity phenomena, i.e. the small mass m in Newton's gravitational formula always cancels out in derivations to predict directly observable gravity phenomena. All these phenomena described above are basically one gravity body prediction. The small mass m has an insignificant gravitational effect relative to the large mass M. It is still a two-body problem somehow, but it is only how one large mass affects the smaller mass, and only the gravitational force from the large body is relevant. This is why here one always has GM and not GMm in all such observable gravity phenomena. In two real body problems where m is significantly large relative to M, we also need to take into account the gravitational effect from both masses on each other. Then the gravity parameter is changed from $\mu = GM$ to $\mu_2 = G(M_1 + M_2) = GM_1 + GM_2$, in other words here we also have GM_1 and GM_2 and never GM_1M_2. Of course I could invent something, for example gravitational bending multiplied by the small mass and come up with a new term and coin it the 'Ikonok' effect, this would have the formula

Observable predictions (from GR), contains only GM and not GMm	
Advance of perihelion	$\sigma = \frac{6\pi GM}{a(1-e^2)c^2}$
Gravitational red-shift	$z = \frac{\sqrt{1-\frac{2GM}{R_1c^2}}}{\sqrt{1-\frac{2GM}{R_2c^2}}} - 1$
Time dilation	$T_R = T_f\sqrt{1-\sqrt{\frac{2GM}{R}}^2/c^2}$
Gravitational deflection (GR)	$\delta = \frac{4GM}{c^2R} = \frac{4}{R}\frac{l_p^2}{\bar{\lambda}_M}$

Table 3: The table shows a series of gravity effects that can be predicted from Newton's formula.

$\frac{4GMm}{c^2R}$, and indeed it contains GMm, but that does not make it directly observable – it is a mathematical construct, a composite of two things that we can observe, namely the gravitational bending of light from mass M plus the kg mass of the small mass m, that we then multiply by each other, but that does not make it real and observable.

An important question then is, if all the predictable gravity phenomena that we actually can directly observe only contain GM and not GMm, does this imply anything special or significant? Yes, we will soon see this is a key to understanding what is missing in the standard kg definition of mass. To understand this let us first go back to the history of gravity. Newton never invented nor used a gravity constant. In Principia [11] Newton stated the gravitational force in words, and his formula is equivalent to

$$F = \frac{\bar{M}\bar{m}}{R^2} \tag{23}$$

We are deliberately using a different notation for the two masses here, as we will see the original Newton formula leads to a different mass definition than the modern kg mass definition used explicitly in the Newtonian gravitational force formula. Even the historians seem in general to have ignored the fact that Newton introduces a gravitational force formula without any gravity constant, see for example [39] and [40][5]. Therefore, we encourage readers to go back and study Principia itself.

Even without any gravity constant Newton was able to perform a long series of gravity predictions, for example he could find the relative mass between planets in our solar system and the Sun. We can find the relative mass between two masses just by observing the orbital time for one satellite around each of the masses we want to compare, the formula is

$$\frac{M_1}{M_2} = \frac{R_1^3T_2^2}{R_2^3T_1^2} \tag{24}$$

where T_2 and T_1 are the orbital times of, for example, the Moon around the Earth, and the Earth around the Sun, R_2 is the distance from the center of the Earth to the Moon, and R_1 is the distance from the center of the Sun to the Earth[6]. Newton used a similar approach, see Principia and also [41]. Newton was also able to calculate the density of the Earth relative to the Sun very accurately, as he knew their relative mass only from orbital velocities, and could find their relative density by knowing the approximate diameters of the objects and thereby their relative volumes. What Newton was not able to do in his time, but that he clearly tried to do, was to find the relative density of the Earth (or any other heavy object) relative to a known uniform substance, such as water, lead or gold. To perform this somewhat accurately we had to wait for Cavendish in 1798. In the Cavendish apparatus the large gravity object, M, is the large ball in the apparatus. Unlike a planet or a moon, one can have full control of the substance one is making these balls from. From this Cavendish could find the density of the Earth relative to lead, and, as one can easily find the density of a series of uniform materials relative to lead just by using simple old-fashioned weights and their volumes, one therefore had gained additional insight. Still, Cavendish used no gravitational constant to do this, something historians and physics books also often get wrong. What is true is that one can use a Cavendish apparatus to also find the gravity constant.

The gravitational constant was actually probably first introduced in 1873 by Cornu and Baille [42], where they introduced the formula $F = f\frac{Mm}{R^2}$. Boys, in 1894, was likely to have been the first to introduce the well-known notation G for the gravity constant that gave us Newton's gravitational force formula with the notation we know it today, namely $F = G\frac{Mm}{R^2}$. Naturally, whether one uses f or G for the constant is merely cosmetic. The important point here is that we worked with Newtonian gravity for almost two hundred years before the

[5]Milstrom [40] correctly highlights that Newton basically only pointed out in written form in Principia that the gravitational force between two masses is proportional to the product of those two masses and inversely proportional to the square of the distance between them, but he then mistakenly claims this corresponds to the equation, $F = G\frac{Mm}{R^2}$. There is not a single word about a gravity constant by Newton, so, from a historical point of view this is wrong, although the book is otherwise excellent.

[6]To find the relative mass between the Sun and the Earth we have $R_1 = 149,600,000$ km, $R_2 = 384,400$ km, $T_1 = 365$ days, and $T_2 = 27.32$ days, so we have $\frac{M_1}{M_2} = \frac{149600000^3\times 27.32^2}{384400000^3\times 365} \approx 330233$, which is very close to the known relative mass of the Sun versus the Earth.

gravity constant was introduced. One of the main reasons for the invention of the gravity constant may have been that, in the mid-1870s, the kg definition of mass became the international standard in much of the world. If one used the kg definition of mass, then one had to add such a constant and calibrate the value of the constant to a gravitational phenomenon to get the formula to work. And G was then clearly a constant, because, if first calibrated to one observable gravity phenomena, for example with the use of a Cavendish apparatus, one did not need re-calibrate the value of G to predict other gravitational phenomena that could easily be checked with observations. Moreover, G did not seem to change over time, so "all" observations and use of the formula indeed point toward G being a constant. However, what does G truly represent? Its output units are $m^3 \cdot kg^{-1} \cdot s^{-2}$. Can anyone imagine anything physical that has such properties; meters cubed divided by kg and seconds squared? I cannot. I can however easily imagine something with length (in meters), for example my shoe, or something with weight (in kg), my shoe, or something that takes time (in seconds), for example moving my shoe from point A to point B. Already from the output dimensions of G, one gets a hint that the so-called Newton gravity constant could be a composite constant, something we will get back to soon. Also one should ask why was it possible to predict a series of gravity phenomena from the Newton gravitational force formula long before the gravity constant even was invented? Does the gravity constant simply relate to the choice of units, or is it embedded to contain a deeper secret about gravity? We will soon understand what the gravity constant truly represents.

Already by 1883, only ten years after the introduction of the gravity constant, Stoney [43] suggested that there were some natural units that could be derived from G, c as well as the elementary charge and the Coulomb constant, today known as the Stoney units. Then, in 1899, Max Planck [44, 45] assumed that there were three universal fundamental constants, G, c and $\hbar$, and then, based on dimensional analysis, derived a fundamental length $l_p = \sqrt{\frac{G\hbar}{c^3}}$, a time $t_p = \sqrt{\frac{G\hbar}{c^5}}$, and a mass $m_p = \sqrt{\frac{\hbar c}{G}}$, today known as the Planck units. The Planck units would, over time, overtake the Stoney units as being considered to be the essential and fundamental natural units, a view held by most to this day. This is also a view we hold, but it is much more than just a view, we will soon show how we can build both gravitational theory and quantum mechanics from these only two constants, namely l_p and c, rather than from G, c and $\hbar$, but first we need a little more history.

Einstein [46] was already by 1916 suggesting that a quantum gravity theory was the next natural step after his general relativity theory, or in his own words

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

Eddington [47] then in 1922 suggested that the Planck length would probably be essential for building a quantum gravity theory. However, as no sign of the Planck units had been detected, others were more skeptical. Prominent physicists like Bridgman [48] (who received the 1946 Nobel Prize in Physics) ridiculed the idea that the Planck units meant anything special, for him it was simply more akin to some mathematical artifacts coming out of dimensional analysis, see also [49]. At the present time, it seems like most physicists involved in the topic think that the Planck length represents the smallest possible length, see for example [50–52], but some seem to think there are lengths and structures below the Planck length, see for example [53]. Nonetheless, there are what we could call a minority group of physicists that still claim, like Bridgman did in 1931, that the Planck units are not useful. For example, Unzicker [54] bases such a claim on his view that "*there is not the remotest chance of testing the validity of the Planck units*". His point we think is – or we should perhaps say seemed like – a valid claim, as it is somewhat similar to Einstein's claim that if we could not detect the ether then why not simply abandon it. If it is not there and does not even have indirect effects we can observe from it, then to include it in our theories will likely only make our theories unnecessarily complex, incomplete or even wrong. However, we will show that the Planck length and thereby the Planck units can be detected, and that they are directly linked to quantum gravity.

There is nothing wrong mathematically in solving the Planck length formula, $l_p = \sqrt{\frac{G\hbar}{c^3}}$, with respect to G, this gives $G = \frac{l_p^2 c^3}{\hbar}$. And we could next, based on this, claim it is the Planck length together with c and $\hbar$ that are the essential constants and that G is simply a composite constant. Some will likely protest here as it is assumed that we need to know G to find the Planck length; therefore, making G a function of l_p just seems to lead us into a unsolvable circular problem. However, we will soon see this is not the case. We will, in other words, claim that G is a composite constant. Haug [55] in 2016 has suggested that G is likely to be such a composite constant as it gives a strong simplification of the many Planck-unit-related formulas that seem to offer better intuition. However, back then we could not see a way to find the Planck length without first knowing G, but this has changed. That G came before l_p does not necessarily make it more fundamental. On the contrary, most things in physics have first consisted of scratching the surface of reality before we have understood something at a deeper level. Before we prove that l_p can easily be found with no knowledge of G, let us also look more closely at the mass M in the gravity formula. This mass is expressed in kg, and we have in section 2 pointed out that the simplest way to express a kg mass from quantum-related parameters and constants is by the following formula

$$M = \frac{\hbar}{\bar{\lambda}_M}\frac{1}{c} \tag{25}$$

we have here added subscript notation M to the reduced Compton wavelength in order not to later confuse it with the reduced Compton wavelength from the smaller mass m in the Newton formula. Therefore, when dealing with both M and m, we will use $\bar{\lambda}_M$ and $\bar{\lambda}$ to distinguish between the reduced Compton wavelength from the large and the small mass. A natural question then, is if non-elementary particles (composite masses like the proton) and even macroscopic masses can have a Compton wavelength? The answer is yes and no. Composite masses do not have a single "physical" Compton wavelength as the electrons likely have – they have many, but we can aggregate the Compton wavelength of the particles making up the composite mass using the following relation

$$\bar{\lambda} = \frac{1}{\sum_{i=1}^{n}\frac{1}{\bar{\lambda}_i}} = \frac{1}{\frac{1}{\bar{\lambda}_1}+\frac{1}{\bar{\lambda}_2}+\frac{1}{\bar{\lambda}_3}+\cdots+\frac{1}{\bar{\lambda}_n}} \tag{26}$$

and in the case the Composite mass only consists of elementary particles with the same Compton wavelength we have

$$\bar{\lambda} = \frac{1}{n\frac{1}{\bar{\lambda}_1}} = \frac{\bar{\lambda}_1}{n} \tag{27}$$

The formulas above are fully consistent with the standard mass addition rule, because we have

$$\begin{aligned} m &= m_1 + m_2 + m_3 \\ \frac{\hbar}{\bar{\lambda}}\frac{1}{c} &= \frac{\hbar}{\bar{\lambda}_1}\frac{1}{c} + \frac{\hbar}{\bar{\lambda}_1}\frac{1}{c} + \frac{\hbar}{\bar{\lambda}_1}\frac{1}{c} \\ \frac{\hbar}{\frac{1}{\frac{1}{\bar{\lambda}_1}+\frac{1}{\bar{\lambda}_2}+\frac{1}{\bar{\lambda}_3}}}\frac{1}{c} &= \frac{\hbar}{\bar{\lambda}_1}\frac{1}{c} + \frac{\hbar}{\bar{\lambda}_2}\frac{1}{c} + \frac{\hbar}{\bar{\lambda}_3}\frac{1}{c} \end{aligned} \tag{28}$$

and in the special case where the composite mass m consists of only one type of elementary particles, we can simplify this to

$$\begin{aligned} m &= n \times m_1 \\ \frac{\hbar}{\bar{\lambda}}\frac{1}{c} &= n\frac{\hbar}{\bar{\lambda}_1}\frac{1}{c} \\ \frac{\hbar}{\frac{1}{n\frac{1}{\bar{\lambda}_1}}}\frac{1}{c} &= n\frac{\hbar}{\bar{\lambda}_1}\frac{1}{c} \\ \frac{\hbar}{\frac{\bar{\lambda}_1}{n}}\frac{1}{c} &= n\frac{\hbar}{\bar{\lambda}_1}\frac{1}{c} \end{aligned} \tag{29}$$

The point is simply that any mass in terms of kg can be described in terms of one variable, the Compton wavelength combined with two constants, $\hbar$ and c; $m = \frac{\hbar}{\bar{\lambda}}\frac{1}{c}$. This even holds for massive objects such as the Earth and the Sun, that is to say for any mass, from the smallest to the largest. However, when we deal with the Compton wavelength of a composite mass we must keep in mind it is not a single physical Compton wavelength, if not it can lead us to the wrong interpretations. Let us now for a moment assume G is a composite constant of the form $G = \frac{l_p^2 c^3}{\hbar}$. Remember again that all observable gravity phenomena contain GM and not GMm, so we have in predictions of all observable gravity phenomena

$$GM = \frac{l_p^2 c^3}{\hbar} \times \frac{\hbar}{\bar{\lambda}_M}\frac{1}{c} = c^2\frac{l_p^2}{\bar{\lambda}_M} \tag{30}$$

Pay close attention to how the Planck constant embedded in G cancels out with the Planck constant in the kg mass definition. We will claim the $\hbar$ embedded in G, not by assumption, but from calibration it is to get the Planck constant out of the kg mass, and to get l_p into the mass. Next take a look at Table 4.

We can from the table see that all Newtonian gravity phenomena are a function of two constants, l_p and c. Furthermore, we can see that all observable gravity phenomena typically only assumed to be possible to predict based on general relativity only contain one constant, namely l_p. And this is more than just some clever re-writing of G, this gives a new and deeper insight into gravity. Because if we are right, and these observable gravity phenomena are also only dependent on c and l_p and some only on l_p, plus some variables, then we should be able to extract l_p from gravity phenomena without any prior knowledge of G – something we will now demonstrate is the case.

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	Modern Newton:
Mass	$M = \frac{\hbar}{\bar{\lambda}_M}\frac{1}{c}$ (kg)
Non observable (contains GMm)	
Gravitational constant	$G, \left(G = \frac{l_p^2 c^3}{\hbar}\right)$
Gravity force	$F = G\frac{Mm}{R^2}$ $(kg \cdot m \cdot s^{-2})$
Observable predictions, identical for the two methods: (contains only GM)	
Gravity acceleration	$g = \frac{GM}{R^2} = \frac{c^2}{R^2}\frac{l_p^2}{\bar{\lambda}_M}$
Orbital velocity	$v_o = \sqrt{\frac{GM}{R}} = cl_p\sqrt{\frac{1}{R\bar{\lambda}_M}}$
Orbital time	$T = \frac{2\pi R}{\sqrt{\frac{GM}{R}}} = \frac{2\pi\sqrt{\bar{\lambda}_M R^3}}{cl_p}$
Velocity ball Newton cradle	$v_{out} = \sqrt{2\frac{GM}{r^2}H} = \frac{cl_p}{R}\sqrt{\frac{2H}{\bar{\lambda}_M}}$
Frequency Newton spring	$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}} = \frac{1}{2\pi R}\sqrt{\frac{GM}{x}} = \frac{cl_p}{2\pi R}\sqrt{\frac{1}{\bar{\lambda}_M x}}$
Periodicity pendulum (clock)	$T = 2\pi\sqrt{\frac{L}{g}} = 2\pi R\sqrt{\frac{L}{GM}} = \frac{2\pi R}{cl_p}\sqrt{L\bar{\lambda}_M}$
Observable predictions (from GR): (contains only GM)	
Advance of perihelion	$\sigma = \frac{6\pi GM}{a(1-e^2)c^2} = \frac{6\pi}{a(1-e^2)}\frac{l_p^2}{\bar{\lambda}_M}$
Gravitational red-shift	$z = \frac{\sqrt{1-\frac{2GM}{R_1c^2}}}{\sqrt{1-\frac{2GM}{R_2c^2}}} - 1 = \frac{\sqrt{1-\frac{2l_p^2}{R_1\bar{\lambda}_M}}}{\sqrt{1-\frac{2l_p^2}{R_2\bar{\lambda}_M}}} - 1$
Time dilation	$T_R = T_f\sqrt{1-\sqrt{\frac{2GM}{R}}^2/c^2} = T_f\sqrt{1-\frac{2l_p^2}{R\bar{\lambda}_M}}$
Deflection	$\delta = \frac{4GM}{c^2R} = \frac{4}{R}\frac{l_p^2}{\bar{\lambda}_M}$
Microlensing	$\theta_E = \frac{2}{R}\sqrt{GM\frac{(d_S-d_L)}{d_Sd_L}} = \frac{2l_p}{R}\sqrt{\frac{d_S-d_L}{\bar{\lambda}_M(d_Sd_L)}}$

Table 4: The table shows that any gravity observations we can make contain GM and not GMm; GM contains and needs less information than is required to find G and M.

Let us consider what we can extract by simply observing the orbital time of the moon around the Earth. The orbital time of the moon is approximately 27.32 days (the sidereal month is the time the Moon takes to complete one full revolution around the Earth with respect to the background stars), that is we have

$$T = \frac{2\pi\sqrt{\bar{\lambda}_M R^3}}{cl_p} \tag{31}$$

solved with respect to l_pc we get

$$l_p = \frac{2\pi\sqrt{\bar{\lambda}_M R^3}}{Tc} \tag{32}$$

That is to say, to find the value for l_p from the orbital time of the moon, we in addition need to know c, which we can find by measuring the speed of light. Moreover, we need to know two variables, namely R and $\bar{\lambda}_M$. The variable R is in this case simply the distance from the center of the Earth to the Moon – this we can for example approximate very well with parallax, it is 384400000 m. Then we also need to find the reduced Compton wavelength of the Earth. Actually, we can find this with no knowledge of G or $\hbar$, but we have to start with an electron. The Compton frequency of an electron is, by the original Compton paper, also given by (based on Compton scattering):

$$\begin{aligned}
\lambda_2 - \lambda_1 &= \frac{h}{mc}(1-\cos\theta) \\
\lambda_2 - \lambda_1 &= \frac{h}{\frac{h}{\lambda_e}\frac{1}{c}c}(1-\cos\theta) \\
\lambda_2 - \lambda_1 &= \lambda_e(1-\cos\theta) \\
\lambda_e &= \frac{\lambda_2-\lambda_1}{1-\cos\theta} \\
\lambda_e &= \frac{\lambda_2-\lambda_1}{1-\cos\theta} \qquad (33)
\end{aligned}$$

Namely, to find the reduced Compton wavelength of the electron we simply need to measure the wavelength of an outgoing photon λ_1 (before hitting the electron) and the wavelength of the reflected photon, λ_2 (after hitting the electron), and the angle between the outgoing and incoming beam, which has been reflected when hitting the electron. Additionally, we have that the cyclotron frequency is given by

$$\omega = \frac{v}{r} = \frac{qB}{m} \tag{34}$$

A proton and an electron have the same charge, so the cyclotron ratio is equal to the mass ratio. This is well known, as one has also used cyclotron frequencies to find the well-known proton electron ratio (≈ 1836.15) by this method, see [56]. Their mass ratio is therefore equal to the Compton wavelength ratio

$$\frac{\omega_P}{\omega_e} = \frac{\frac{qB}{m_P}}{\frac{qB}{m_e}} = \frac{m_e}{m_P} = \frac{\bar{\lambda}_e}{\bar{\lambda}_P} \approx 1836.15 \tag{35}$$

where $\bar{\lambda}_P$ and $\bar{\lambda}_e$ are, respectively, the Compton wavelength of the proton and the electron. That is to say, we now know the reduced Compton length of the proton; it is equal to the reduced Compton frequency we found from the electron divided by the cyclotron ratio, and we have found both of these with no knowledge of the Planck constant $\hbar$. Next, we can find the reduced Compton frequency of the Earth by counting the number of protons in the Earth and divide the Compton wavelength of the proton by this number. There is no physical law that forbids this, but it is practically impossible with our technology and resources – also this would probably destroy our planet, so not so smart. However a way exists that is potentially quite practical using the existing technology. We can first count the number of protons and neutrons that we, for simplicity, assume to have the same mass as the protons, in a handful of uniform matter. This has essentially recently been performed. Silicon (^{28}Si) is very uniform and has crystal structures that basically make it possible to count the number of atoms inside an almost perfect sphere, see [57, 58], and this has also been one of the competing methods for a new kg standard. Other promising methods to count the numbers of atoms also exist – see, for example, [59]. After (or before) we have counted the number of atoms in a silicon sphere, about the size we can hold in our hand, we can measure the gravitational acceleration field created by such a sphere by using it as the large balls in a Cavendish apparatus – it is given by

$$g = \frac{L4\pi^2\theta}{T^2} \tag{36}$$

where T is the oscillation time, θ is the angle of the arm in the apparatus and L is the distance between the two arms. Pay attention to the fact that neither G nor $\hbar$ is needed for this. In addition, we have R_1, which is the distance from the center of the large ball in the Cavendish apparatus to the center of the small ball when the arm in the apparatus is deflected. Figure 1 shows a modern Cavendish apparatus where the angle and oscillation frequency is measured by fine electronics, and then fed directly into a computer.

The relative Compton wavelength between two masses is proportional to their gravitational acceleration in the following way

$$\frac{g_1 R_1^2}{g_2 R^2} = \frac{\frac{GM_1}{R_1^2} R_1^2}{\frac{GM_2}{R^2} R_2^2} = \frac{M_1}{M_2} = \frac{\bar{\lambda}_2}{\bar{\lambda}_1} \tag{37}$$

In this way we know the Compton wavelength of the Earth. First, we found the Compton wavelength of the electron from Compton scattering; it is given by 3.86×10^{-13} m, and from a cyclotron we found the cyclotron frequency ration of a proton versus an electron is 1836.15, and thereby the proton Compton wavelength. Assume we then measure the gravitational acceleration; we measure from our silicon sphere ball (the large balls in the Cavendish) apparatus if $r_1 = 7cm$ is approximately 1.36×10^{-8} m/s^2. The gravitational acceleration in the Earth we can, for example, find by simply by using a pendulum; the gravitational acceleration at the surface of the Earth is given by

$$g = \frac{2\pi L}{T^2} \tag{38}$$

where L is the length of the pendulum. Actually, we can look at the Earth-Moon system as a giant pendulum clock, the orbital time is 27.23 days, the distance to the moon is again 384,400,000 meters. Some will possibly protest as the Huygens [37] formula is often mentioned to only be a good approximation if the angle of the pendulum is small. This is only partly true; the Huygens formula is a good approximation for a small angle, it is inaccurate for a large angle, but it is actually exact for a 360° angle, based on the assumption of a perfect circular orbit, see [38]. So by plugging in the orbital velocity of the moon we get

$$g = \frac{4\pi^2 L}{T^2} \approx \frac{4\pi^2 \times 384400000}{(27.23 \times 24 \times 60 \times 60)^2} \approx 0.00274\ m/s^2 \tag{39}$$

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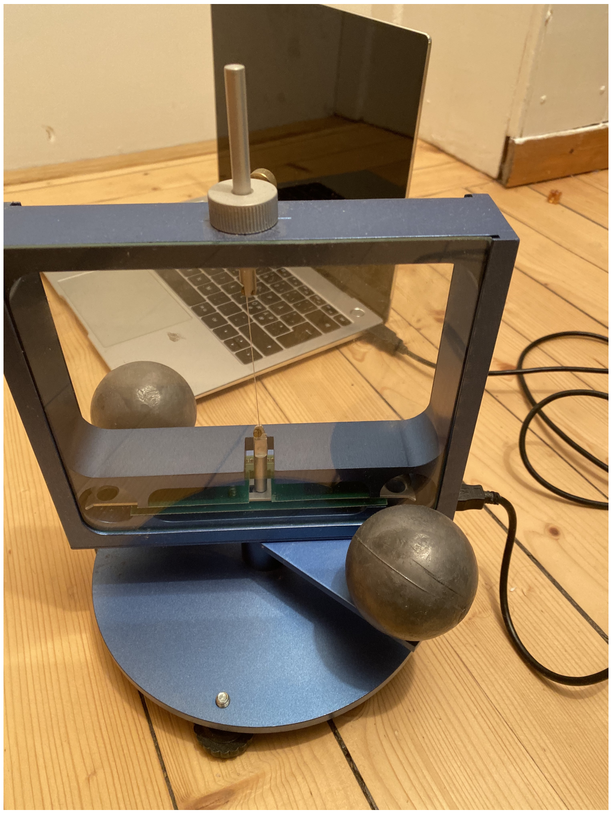

Figure 1: Low-budget modern Cavendish apparatus combining old mechanics with modern electronics that feed directly to your computer through a USB cable. It is remarkable that, in using such an instrument, we can measure the Planck mass with only about 5% error.

This is the gravitational acceleration from the Earth at the distance of the Moon. This means we have all the input to find the reduced Compton wavelength of the Earth, which is equal to

$$\bar{\lambda}_E = \frac{\bar{\lambda}_e/\text{Cyclotron frequency ratio}}{\text{Number of protons in the large Cavendish sphere}} \times \frac{gR^2}{g_E R_E^2} \approx 5.8 \times 10^{-68}\ m \tag{40}$$

where R_E is the distance from the center of the Earth to the center of the Moon. We could naturally have found the reduced Compton wavelength of the Earth by using the known Compton wavelength formula $\bar{\lambda}_E = \frac{\hbar}{M_E c}$; however, this would in general require both knowledge of $\hbar$ and G, as one in this method would need G in general to find the kg mass of the Earth. An important point here is that these two constants are not needed. We now have all we need to find the Planck length from the orbital time of the Moon, we get

$$l_p = \frac{2\pi\sqrt{\bar{\lambda}_M R^3}}{Tc} \approx \frac{2\pi\sqrt{5.8 \times 10^{-68} \times 384400000^3}}{27.322 \times 24 \times 60 \times 60 \times 299792458} \approx 1.61 \times 10^{-35}\ m \tag{41}$$

And, based on knowledge of l_p and c, we do not need any other constant to predict observable gravity phenomena, or at least not any of the well-known phenomena we are looking at here, as clearly demonstrated in Table 4.

So how can it be that G plays such an important role in modern gravitational theory if we do not need it? We think the reason is that G is needed to turn an incomplete mass definition, the kg, into a mass definition that is complete, or at least more complete. We have

$$GM = \frac{l_p^2 c^3}{\hbar} \frac{\hbar}{\bar{\lambda}_M} \frac{1}{c} = c^3 \times \frac{l_p}{c} \frac{l_p}{\bar{\lambda}_M} \tag{42}$$

We have shown this before in this paper, but it is a reason we here write it as c^3 multiplied by the Planck time, $t_p = \frac{l_p}{c}$, that is multiplied again with $\frac{l_p}{\bar{\lambda}_M}$, we will suggest that GM at a deeper level indeed represents c^3 multiplied by a complete or at least more complete mass definition. This new rest mass definition will be

$$\bar{M} = \frac{l_p}{c} \frac{l_p}{\bar{\lambda}_M} = t_p \frac{l_p}{\bar{\lambda}_M} \tag{43}$$

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We will claim that standard physics is using two different mass definitions, and that this has been one of two main reasons why nobody has been able to unify gravity with quantum mechanics. This new mass definition is already embedded in standard gravity theory, but unknowingly so. In non-gravitational physics, one does not multiply the kg mass with G and thereby indirectly use a different mass definition in gravity physics and non-gravity physics. This new mass definition has output dimensions of time and we have previously [60] called this mass definition collision time. We will soon discuss the interpretation of this mass definition. We naturally do not mean Newton or his precursors in any way knew this and were hiding c and the Planck length in their formula. But G can simply be seen as something missing in the formula, that we get in the formula after first calibration to a gravity phenomenon. The gravity constant also depends on the mass definition. The kg mass definition contains no information about the Planck length, and by getting the Planck length into the kg mass formula by multiplying it with G, one is also getting the Planck constant out, as it has nothing to do with gravity.

Frequency, how long is the ding?

We showed in section 2 that the kg mass can be seen as a Compton frequency ratio. To observe a frequency, we will claim one must observe something changing. Assume a clock making beeping every hour. The clock has a frequency of one beep per hour, and 24 in a day-and-night period. Assume there were no silent periods between the beeps, then it would just be one long beep, then there could not be a frequency. At the other extreme, if the beep had zero duration, then we would just have silence, and again no frequency. Therefore, a frequency means we must have at minimum two distinguishable states, and not only that, each state must have a duration in time, if not we cannot have a frequency. A frequency ratio that is linked to the Compton frequency, which is what the kg definition is, says nothing about the duration of the "beep", it has no change of state, so then it cannot be a frequency, or more precisely it must be an incomplete description of a frequency. However, by multiplying G with M we keep the frequency, but, as we will see, we then in addition know how long the two different states in the frequency last. We will propose a new theory of matter which, in our view, is already embedded in today's gravity theory through GM, but by understanding what GM truly represents at a deeper level, we will get a simpler gravity theory that will also be a quantum gravity theory, that then again can potentially be unified with quantum mechanics.

Back to the indivisible particles of Newton and the ancient Greeks

Newton claimed in Principia, part 3, which was mostly about gravity, that indivisible particles were behind all his philosophy, and in the same chapter he also mentioned indivisible moments of time, in other words we will claim quantized time. Few of today's physicists seem to be aware of this. Very similar to Newton and the ancient Greek atomists, we will base our theory on two postulates,

- Everything ultimately consists of indivisible particles that move at a constant speed, except when they collide with another indivisible particle.
- and empty space that the indivisible particles can move in.

Assume the diameter of such an indivisible particle is the unknown x, but we will see when calibrated to gravity it is l_p. No observable diameter can naturally be smaller than this, as all mass and energy are assumed to be built from this particle (and empty space). When not colliding this particle moves at a constant unknown speed y, that we will see is c. The duration of the collision between two such particles we will assume is $\frac{x}{y}$, which we will see is $\frac{l_p}{c}$. This time interval is directly linked to how far an indivisible particle moves during the period two indivisible particles are colliding. In elementary particles such as the electron we assume we have collisions at a Compton periodicity; that is to say, at every reduced Compton time there is an internal collision inside the elementary particle between two indivisible particles. So $\frac{\frac{x}{y}}{\frac{\bar{\lambda}}{c}} = \frac{x}{\bar{\lambda}}$, will be the percentage of a time window the particle is in collision state.

The indivisible particle itself is massless, and it moves at speed c. The distance between two indivisible particles moving after each other corresponds to the wavelength of a photon. In this model a monochrome light beam simply consists of a "train" of indivisible particles moving after each other. This is very similar to Newton's corpuscular theory of light, which was perhaps abandoned too early. In elementary particles such as the electron, the indivisible particles are moving back and forth, each over a distance equal to the reduced Compton wavelength at the speed of light, but colliding with each other at the reduced Compton frequency. In other words, as in the kg mass we have a reduced Compton frequency. However, at the end of each Compton time period we have a collision between two indivisible particles. That is to say, our frequency consists of two different states, which is the minimum needed to actually define a real frequency. The collision lasts the Planck time, and the non-collision state lasts the Compton time of the particle minus the Planck time. In other words, pure mass is collisions, and pure energy is non-collisions. A mass that is defined as collision time sounds very different from what we are used to, namely mass in terms of kg, but this new mass definition is much closer to

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the kg mass than one would first think. The kg mass we demonstrated was a Compton frequency ratio. If we find the collision time mass of one kg – and all we need to do this is to know the Compton wavelength of one kg and the Planck length and the speed of light – and in addition divide another mass collision time on the collision time of one kg, then we get (in other words a collision time mass ratio).

$$\frac{\bar{m}}{\bar{m}_{1kg}} = \frac{\frac{l_p}{c}\frac{l_p}{\bar{\lambda}}}{\frac{l_p}{c}\frac{l_p}{\bar{\lambda}_{1kg}}} = \frac{f}{f_{1kg}} = \frac{\frac{c}{\bar{\lambda}}}{\frac{c}{\bar{\lambda}_{1kg}}} \tag{44}$$

This is identical to the kg definition of matter, when the kg definition of matter is understood from a deeper perspective as we looked at in section 2. However, we see when we take the collision time ratio as performed in the formula above, then anything about the Planck length cancels out. That is to say, we are left with a frequency ratio (identical to the frequency ratio in the kg definition of mass), but anything about the Planck length and thereby the Planck time has dropped out of the definition. Namely, the duration and everything about the special event that is needed for a proper frequency has dropped out of the equation. The special event, the second state of the frequency, is simply the collision between two indivisible particles. And it is this collision, and the duration of it, that is the very essence of gravity in our view. Standard physics has built into its kg mass the frequency periodicity, but has no information about the duration of the special event. The duration of the special event inside the Compton frequency, that actually even makes a frequency possible, is missing in the standard mass definition. The standard kg mass definition has an incomplete frequency definition, as it does not have two distinguishable states in each frequency, which are the minimum needed to have a complete frequency definition.

However, standard physics surprisingly gets the collision state and the non-collision state into gravity by multiplying M with G. For the other mass m in the Newton formula it is not important that this mass is missing something essential related to gravity, because the small mass cancels out in derivations to predict anything observable from the formula; remember all observable gravitational phenomena depends on GM and not GMm. Based on this new view we can represent Newtonian gravity with the formula

$$\bar{F} = c^3\frac{\bar{M}\bar{m}}{R^2} \tag{45}$$

This formula has different dimensions from the modern Newton formula, its output unit is m/s. Actually it will be the quantity . However, again the gravity force itself is never observed directly, at least not the modern version of the Newton formula. Even if this formula is different to the modern Newton formula it is, as we will see, close to the original Newton formula. Most important is give all the same predictions for observable gravity phenomena as the modern version of the Newton formula, as demonstrated in Table 5.

Our new simplified gravity formula only needs two constants, l_p and c. From these two constants plus some variables we can predict all observable Newtonian gravitational phenomena. The new theory is now founded on the Planck length, and is therefore directly linked to the Planck scale. We can solve any of the formulas for observable Newton gravity phenomena with respect to l_pc (the unknown x times the unknown y with no knowledge of G. For example, by simply solving the gravitational acceleration field with respect to l_pc (the unknown xy) we get

$$xy = cl_p = R\sqrt{g\bar{\lambda}} \tag{46}$$

Actually, all Newtonian gravitational phenomena contain l_pc. For example, [61] has recently shown how l_pc can be extracted from a Newton gravity force spring without any knowledge of G or $\hbar$. We have already shown how to find the Compton frequency for any mass size. We can easily also extract c from only gravity phenomena without any prior knowledge of the speed of light. We have that

$$c = R\sqrt{g\frac{\bar{\lambda}}{l_p^2}} = R\sqrt{\frac{2g}{r_s}} \tag{47}$$

where r_s is the Schwarzschild radius, $r_s = \frac{2GM}{c^2} = 2l_p\frac{l_p}{\bar{\lambda}}$. The Schwarzschild radius of the Sun we can, for example, find by observing the deflection of light. It is important that we are not predicting the deflection of light, as this in general would require general relativity theory that assumes the speed of gravity is the speed of light, we are only observing the deflection, not predicting it. Also be aware that the Schwarzschild radius is not unique for general relativity theory. Already by 1784 Michell [62] calculated a radius identical to the Schwarzschild radius for a hypotetical object with 500 times the radius of the Sun, but with same density as the Sun. Michell predicted that such an object would be a dark star as the escape velocity at just inside this radius would be larger than the speed of light, somewhat similar to general relativity theory and Schwarzschild's solution that lead to the idea about black holes. What is important here is that we can easily extract a length equal to the Schwarzschild radius indirectly from just "simple" gravity observations of objects in our solar system. From the observed deflection of light δ we have

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	Modern Newton:	Alternative:
Mass	$M = \frac{\hbar}{\lambda_M}\frac{1}{c}$ (kg)	$\bar{M} = \frac{l_p}{c}\frac{l_p}{\lambda_M}$ (collision time, see [60])
Non observable (contains GMm)		
Gravitational constant	$G, \left(G = \frac{l_p^2 c^3}{\hbar}\right)$	c^3
Gravity force	$F = G\frac{Mm}{R^2}$ $(kg \cdot m \cdot s^{-2})$	$F = c^3\frac{\bar{M}\bar{m}}{R^2}$ $(m \cdot s^{-1})$
Observable predictions, identical for the two methods: (contains only GM)		
Gravity acceleration	$g = \frac{GM}{R^2} = \frac{c^2}{R^2}\frac{l_p^2}{\lambda_M}$	$g = \frac{c^3\bar{M}}{R^2} = \frac{c^2}{R^2}\frac{l_p^2}{\lambda_M}$
Orbital velocity	$v_o = \sqrt{\frac{GM}{R}} = cl_p\sqrt{\frac{1}{R\lambda_M}}$	$v_o = \sqrt{\frac{c^3\bar{M}}{R}} = cl_p\sqrt{\frac{l_p^2}{R\lambda_M}}$
Orbital time	$T = \frac{2\pi R}{\sqrt{\frac{GM}{R}}} = \frac{2\pi\sqrt{\bar{\lambda}R^3}}{cl_p}$	$T = \frac{2\pi R}{\sqrt{\frac{c^3\bar{M}}{R}}} = \frac{2\pi\sqrt{\bar{\lambda}R^3}}{cl_p}$
Velocity ball Newton cradle	$v_{out} = \sqrt{2\frac{GM}{R^2}H} = \frac{cl_p}{R}\sqrt{\frac{H}{\bar{\lambda}}}$	$v_{out} = \sqrt{2\frac{c^3\bar{M}}{R^2}H} = \frac{cl_p}{R}\sqrt{\frac{H}{\bar{\lambda}}}$
Periodicity Pendulum (clock)	$T = 2\pi\sqrt{\frac{L}{g}} = 2\pi R\sqrt{\frac{L}{GM}} = \frac{2\pi R}{cl_p}\sqrt{L\bar{\lambda}}$	$T = 2\pi\sqrt{\frac{L}{g}} = T = 2\pi R\sqrt{\frac{L}{c^3\bar{M}}} = \frac{2\pi R}{cl_p}\sqrt{L\bar{\lambda}}$
Frequency Newton spring	$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}} = \frac{1}{2\pi R}\sqrt{\frac{GM}{x}} = \frac{cl_p}{2\pi R}\sqrt{\frac{1}{\bar{\lambda}x}}$	$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}} = \frac{1}{2\pi R}\sqrt{\frac{c^3\bar{M}}{x}} = \frac{cl_p}{2\pi R}\sqrt{\frac{1}{\bar{\lambda}x}}$
Observable predictions (from GR): (contains only GM)		
Gravitational red-shift	$z = \frac{\sqrt{1-\frac{2GM}{R_1c^2}}}{\sqrt{1-\frac{2GM}{R_2c^2}}} - 1 = \frac{\sqrt{1-\frac{2l_p^2}{R_1\lambda_M}}}{\sqrt{1-\frac{2l_p^2}{R_2\lambda_M}}} - 1$	$z = \frac{\sqrt{1-\frac{2c^3\bar{M}}{R_1c^2}}}{\sqrt{1-\frac{2c^3\bar{M}}{R_2c^2}}} - 1 = \frac{\sqrt{1-\frac{2l_p^2}{R_1\lambda_M}}}{\sqrt{1-\frac{2l_p^2}{R_2\lambda_M}}} - 1$
Time dilation	$T_R = T_f\sqrt{1-\sqrt{\frac{2GM}{R}}^2/c^2} = T_f\sqrt{1-\frac{2l_p^2}{R\lambda_M}}$	$T_R = T_f\sqrt{1-\sqrt{\frac{2c^3\bar{M}}{R}}^2/c^2} = T_f\sqrt{1-\frac{2l_p^2}{R\lambda_M}}$
Gravitational deflection (GR)	$\delta = \frac{4GM}{c^2R} = \frac{4}{R}\frac{l_p^2}{\lambda_M}$	$\delta = \frac{4c^3\bar{M}}{c^2R} = \frac{4}{R}\frac{l_p^2}{\lambda_M}$
Advance of perihelion	$\sigma = \frac{6\pi GM}{a(1-e^2)c^2} = \frac{6\pi}{a(1-e^2)}\frac{l_p^2}{\lambda_M}$	$\sigma = \frac{6\pi c^3\bar{M}}{a(1-e^2)c^2} = \frac{6\pi}{a(1-e^2)}\frac{l_p^2}{\lambda_M}$
Indirectly/"hypothetical" observable predictions: (contains only GM)		
Escape velocity	$v_e = \sqrt{\frac{2GM}{R}} = cl_p\sqrt{2\frac{1}{R\lambda_M}}$	$v_e = \sqrt{\frac{2c^3\bar{M}}{R}} = cl_p\sqrt{2\frac{1}{R\lambda_M}}$
Schwarzschild radius	$r_s = \frac{2GM}{c^2} = 2\frac{l_p^2}{\lambda_M}$	$r_s = \frac{2c^3\bar{M}}{c^2} = 2\frac{l_p^2}{\lambda_M}$
Gravitational parameter	$\mu = GM = c^2\frac{l_p^2}{\lambda_M}$	$\mu = c^3\bar{M} = c^2\frac{l_p^2}{\lambda_M}$
Two body problem	$\mu = G(M_1+M_2) = c^2\frac{l_p^2}{\lambda_1} + c^2\frac{l_p^2}{\lambda_1}$	$c^3(\bar{M}_1+\bar{M}_2) = c^2\frac{l_p^2}{\lambda_1} + c^2\frac{l_p^2}{\lambda_2}$
Quantum analysis:		
Constants needed	G, $\hbar$, and c or l_p, $\hbar$, and c	l_p and c, for some phenomena only l_p
Variable needed	one for mass size	one for mass size

Table 5: The table shows that all observable gravity phenomena are linked to the Planck length and the speed of gravity, which is equal to the speed of light. For all observable gravity phenomena, we have GM and not GMm. This means that the embedded Planck constant cancels out, and all observable gravity phenomena are linked to the Planck length and the speed of gravity, that again are identical to the speed of light. When this is understood, one can even rewrite Newton and GR gravity formulas in a simpler form which still gives all of the same results.

$$r_s = \frac{\delta R}{4} \tag{48}$$

Next, we can find the Schwarzschild radius of the Earth as the relative Schwarzschild radius of the Earth relative to the Sun can be found by using the following relations; this is basically the same as equation 24.

$$\frac{r_{s,1}}{r_{s,2}} = \frac{R_1^3 T_2^2}{R_2^3 T_1^2} \tag{49}$$

So, when we have the Schwarzschild radius of the Earth, we can apply it to the formula 47, we now can extract the speed of light (gravity) from the gravitational acceleration field. It is beyond this paper's main topic, but it is assumed that the Newton theory is only compatible with the idea that gravity is infinite. This is because when looking at the Newton formula, if on the surface, it looks like it will only be dependent on the variable R and the mass M, one has failed to understand that the gravity constant and also the mass embedded contains c, not by assumption, but by calibration. Also, the Gauss law of gravity, also known as the Newtonian field equation, that normally (in differential form) is given as $\nabla^2\phi = 4\pi G\rho$, where ρ is the mass density, can when G and M, when understood at a deeper level, be re-written as $\nabla^2\phi = 2\pi c^2\frac{r_s}{V}$. It seems strange to divide the Schwarzschild radius by the volume, to get some type of Schwarzschild radius density; however, soon we will understand that this remarkably corresponds to a gravity energy density. The point is that c now is embedded in the Newtonian gravitational theory, but this is outside the main topics of this paper and has been discussed in great detail in one of our recent paper [63]. We just mention this so the reader understands that we have

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thought much about possible weakness and inconsistencies in our model, and we have not found any so far.

In addition, we do not need the Planck constant $\hbar$ in our model. Standard gravity theory indirectly needs three constants, G, $\hbar$ and c, to predict gravity phenomena, at least if we also want to describe the kg mass with constants and quantum-related variables, such as the matter wavelength of the particle. This is in contrast to our theory where we only need two constants, c and l_p. Actually, superstring theory suggests that the speed of light c and that the Planck length are the two universal fundamental constants, see, for example, [64]. However, superstring theory has not led to a way to find the Planck length independent of G, nor has it led to other testable predictions that distinguish it experimentally from other theories. Our new view gives us an idea that we may have been using two different mass definitions all along without being aware of it, as explained in the section above. When one understands this, one can see that even standard Newton theory at a deeper level is directly linked to the Planck scale, not by assumption, but by calibration to gravity phenomena. All gravity phenomena can be predicted with c and l_p and some only with l_p. To observe something affected by gravity is, from this view, actually to observe or at least detect the Planck scale.

In the special case that we link the time unit to a length unit through the speed of light, as is often also done in standard physics [65], we can set $c = 1$, (this does not imply that we also set $G = 1$ and $\hbar = 1$ as these are not even needed) our new gravity force formula then simplifies to Newton's original formula $F = \frac{\bar{M}\bar{m}}{R^2}$. We can still use this simple formula to predict all Newtonian gravity phenomena, and to also find the Planck length. Instead of calibrating the formula to a constant, it is then directly calibrated to a mass, and when $c = 1$ this mass is $\bar{M} = \frac{l_p}{1}\frac{l_p}{\bar{\lambda}}$, which is also identical to half the Schwarzschild radius.

Newton naturally did not have this in mind with his formula, but, that said, Newton actually knew the approximate speed of light (possibly from as Ole Rømer's 1676 experiment), in Principia, he predicted the time it would take for light to travel from the Sun to the Earth was around 7 to 8 minutes (the modern value is 8 minutes 19 seconds), so he could theoretically have done so. Anyway, if one calibrates his original formula $F = \frac{\bar{M}\bar{m}}{R^2}$ to a gravity observation, this involves only $\bar{M}$ as in this case the small mass, $\bar{m}$, also cancels out in derivations of observable phenomena, then one finds a mass that is fully compatible with Newton's view that mass was the quantity of matter and that the ultimate particles were indivisible and even that there were indivisible units of time.

It is important to be aware that we can always go back and forth between our new mass detection collision time and the modern kg mass definition. The new collision time mass is linked to the kg mass simply by $\bar{m} = \frac{G}{c^3}m = \frac{l_p^2}{\hbar}m$. This means we have

$$\bar{F} = c^3\frac{\bar{M}\bar{m}}{R^2} = c^3\frac{\frac{G}{c^3}M\frac{G}{c^3}m}{R^2} = G\frac{M\frac{G}{c^3}m}{R^2} \tag{50}$$

That is our new gravity force formula, where we have now simply incorporated the new mass definition in both masses in the force formula. To get a unified theory this new mass definition must not only be incorporated in gravity theory, but in all areas of physics. In gravity we strictly only need to do it with one mass in the Newton type formula, as the other mass cancels out to get a predictable phenomenon that we can observe. It is in other areas of physics where we need to do it for all masses. One could achieve this by, for everywhere one has a mass, replacing the mass m with $\frac{G}{c^3}m$; however, this would give a very ugly notation that contained information that is not needed; remember that $G = \frac{l_p^2c^3}{\hbar}$ and $m = \frac{\hbar}{\bar{\lambda}}\frac{1}{c}$ contains more information than the finished product $GM = c^3\frac{l_p}{c}\frac{l_p}{\bar{\lambda}}$, because the $\hbar$ always cancels out. It is first when we understand that

$$\frac{G}{c^3}m = \frac{\frac{l_p^2c^3}{\hbar}}{c^3} \times \frac{\hbar}{\bar{\lambda}}\frac{1}{c} = \frac{l_p}{c}\frac{l_p}{\bar{\lambda}} = \bar{m}, \tag{51}$$

that we can get a simple and elegant theory with nice notation that also unifies gravity with quantum mechanics.

4 Quantum probability embedded in the mass definition

Our new mass definition is collision time

$$\bar{m} = \frac{l_p}{c}\frac{l_p}{\bar{\lambda}} \tag{52}$$

The first part $\frac{l_p}{c} = t_p$ represents the durations of the collision between two indivisible particles. In an elementary particle that has a "physical" Compton wavelength such a collision happens at the reduced Compton periodicity. This is because, in our model, the indivisible particles making up the particle move back and forth, each over a distance equal to the reduced Compton wavelength at the speed of light, to then to collide when they meet. This journey takes the reduced Compton time, $t_c = \frac{\bar{\lambda}}{c}$, while the collision itself lasts the Planck time, $t_p = \frac{l_p}{c}$. This means the percentage of the observational time window the particle has been in collision state is $\frac{t_p}{t_c} = \frac{l_p}{c}/\left(\frac{\bar{\lambda}}{c}\right) = \frac{l_p}{\bar{\lambda}}$, and the percentage of time it has not been in collision state is $1 - \frac{l_p}{\bar{\lambda}}$. If we observe an electron for one second it has been in collision state in only $\frac{l_p}{\bar{\lambda}_e} \approx 4.18 \times 10^{-23}$ seconds. This is a very small fraction of the total time, but still this means it has been in collision states $4.18 \times 10^{-23}/t_p \approx 7.76 \times 10^{20}$ times per second. Assume next that we use an observational time window equal to the Planck time. Now the last term in our mass definition represent a probability

$$P_c = \frac{l_p}{\bar{\lambda}} \tag{53}$$

This is because we only have one collision per Compton time period. Therefore, this is now the probability for an elementary particle to be in a collision state for this Planck time observational time window. Until we actually observe this Planck time observational time window we cannot know if the electron is in a collision state or not in that time window. So we could even try to claim it is both in a collision state and in a non-collision state at the same time until observed, and that we can only say something about the probability of these two states before we actually look to see if the particle is in a collision state or not in this time window. Such an interpretation however, we think would be somewhat incorrect. It is not that the electron at any time can be both in a collision state and at the same time in a non-collision state inside a Planck time window, it can only be in one of the two states, it is simply that we do not know before we observe it. If we kept track of every Planck time, and knew when it was in collision state last time, then this was no longer a probability, but then just the percentage of time the particle is in a collision state. It could even be more complicated than that, as a real observation could disturb the system, but the observation effect, where the observer disturbs the system is outside the topic of this paper.

This probability can also not be higher than one, because if the reduced Compton wavelength is the distance between two indivisible particles (center to center), then this distance cannot be shorter than l_p. This is because l_p is the diameter of the indivisible particle and if two indivisibles lie side by side (the collision state) they cannot get closer to each other. We will soon study how it is only is a Planck mass particle that has collision probability $P_c = \frac{l_p}{l_p} = 1$. An exception to the rule that $\frac{l_p}{\bar{\lambda}} \leq 1$ is for composite particles (composite mass). For example a one kg mass has a reduced Compton wavelength much shorter than the Planck length, $\bar{\lambda}_{1kg} = \frac{\hbar}{1kg \times c} \approx 3.52 \times 10^{-43}$ m. This will give $\frac{l_p}{\bar{\lambda}_{1kg}} \approx 45994327.12$, this cannot be a probability as it is above one, the integer part here represents the number of collisions in the one kg during one Planck time, and the decimal part 0.12 represents the probability for one more collision. When the Compton wavelength is shorter than the Planck length, then P_c will be a sum of probabilities, and only the decimal part is then what we normally consider a real probability, as the integer parts are the aggregates of 100% probabilities. The case of $\frac{l_p}{\bar{\lambda}} > 1$, can then only happen with composite masses; remember the reduced Compton wavelength of a composite mass consists of the Compton wavelength of many particles and is given by formula 26. So, even if no elementary particles can have a reduced Compton wavelength shorter than the Planck length, a composite mass can have a composite Compton wavelength shorter than the Planck length, but when interpreting it we have to be careful with interpretations, as we have been here.

And for a given particle type the probability of not being in a collision state in a Planck time observational time window is simply

$$P_n = 1 - \frac{l_p}{\bar{\lambda}} \tag{54}$$

This probability is for the Planck mass particle (that we will soon discuss in detail) always zero, as $\bar{\lambda} = l_p$ for a Planck mass particle. This again is consistent with the idea that the Planck mass particle is the collision between two indivisible particles. While all other elementary particles, such as an electron, consist of the Planck mass particles coming in and out of existence at the reduced Compton frequency, in this model there is no other mass in an electron or any particle other than the Planck mass coming in and out of existence. In terms of kg, the Planck mass is much larger than the electron – so is this not contradictory? Well one must multiply the Planck mass by the percentage of time an electron is in a collision state, that is in a Planck mass state, the electron mass in kg is

$$m_e = m_p \frac{l_p}{\bar{\lambda}_e} = f_e m_p t_p \tag{55}$$

where f_e is the reduced Compton frequency. That is to say the electron is a Planck mass coming in and out of existence $f_e = 7.76 \times 10^{20}$ times per second. This is somewhat similar to Schrödinger's [66] 1930 hypothesis of a tremble motion (Zitterbewegung) in the electron that he predicted to have a frequency of $\frac{2m_e c^2}{\hbar} = 2fe$. The Zitterbewegung has never been observed, and this would not be so strange if it is an internal frequency in the electron (and other elementary particles). If the observational time window of the electron is smaller than the Compton time of the electron; well let us assume the observational time window is the Planck time. Then the electron can be seen as a probabilistic Planck mass – this is true for any observational time window shorter than the Compton time, as there is only one collision per reduced Compton time. If working with kg mass the electron is the Planck mass, 2.17×10^{-8} kg multiplied by the probability it is in a collision state (Planck mass state), which is $P_c = \frac{l_p}{\bar{\lambda}_e}$, this gives the well-known kg mass of the electron.

Next let us move to incorporate relativistic effects. The shortest possible reduced Compton wavelength is the distance between two indivisible particles when they collide, and this distance is $\bar{\lambda} = l_p$. This distance can also only be observed from this particle itself. This because the Planck mass particle dissolves after the Planck time, and to observe it from a distance would mean even a light signal could not reach it or leave it before the collision state has dissolved.

Again, the reduced Compton wavelength is the distance between indivisible particles. This length can undergo length contraction until the two indivisible particles making up the fundamental particle lie side by side (collide). To understand this in relation to relativistic effects let us first look at the standard mass broken down in quantum variables and constants, we then have

$$m\gamma = \frac{m}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{\frac{\hbar}{\bar{\lambda}}\frac{1}{c}}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{\hbar}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}\frac{1}{c} \tag{56}$$

This formula will always give the correct kg mass of a particle. This basically means that the reduced Compton wavelength undergoes standard length contraction, and there is no limit on how much it can length-contract as long as $v < c$. This also means there is basically no limit on how big the relativistic mass (and thereby the kinetic energy) even for a single electron can be, as long as it is smaller than infinite. There is considerable room between very large and infinitely large, that the electron kinetic energy then can contain. The mass of the Milky Way is around 10^{12} solar masses. Assume for a moment an electron moves at a velocity equal to $v \approx c\sqrt{1-\frac{m_e^2}{M_m^2}} \approx c \times (1 - 1.04 \times 10^{-145})$. This velocity is still $< c$, so fully valid inside Einstein's [67] special relativity theory. This would mean there is nothing forbidding a single electron to have a kinetic energy basically equal to the rest-mass energy of our galaxy. Even if the Earth was hit by one such electron it would likely pulverize the entire planet. This has clearly not happened in the billions of years the Earth has existed, because the Earth is still here. In a theory one should not only look to see if what it predicts and that has been confirmed by observations, one should also look for what the model predicts that has never been observed even in billions of years. Therefore, either such electrons must be extremely remote or they simply do not exist or cannot exist. One could go into a long discussion on why this has not happened – one possibility is that it is simply absurd that electrons can take such a high kinetic energy, as discussed by [68, 69]. Maybe our new mass definition can give us a better explanation as to why we do not observe such electrons. Our collision time mass in a relativistic settings must be

$$\bar{m}\gamma = \frac{\bar{m}}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{\frac{l_p}{c}\frac{l_p}{\bar{\lambda}}}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{l_p}{c}\frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}} \tag{57}$$

The formula is structurally not that different from the standard formula (it is just multiplying the standard relativistic mass formula with $\frac{l_p^2}{\hbar}$), but here we will claim the Compton wavelength cannot contract to a length smaller than the Planck length, as the Compton wavelength is the distance between two indivisible particles, and they have a diameter of the Planck length. This means we must have that $\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}} \geq l_p$, this means we must also have

$$\begin{aligned}
\bar{m}\gamma &\geq \frac{l_p}{c}\frac{l_p}{l_p} \\
\frac{l_p}{c}\frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}} &\geq \frac{l_p}{c}\frac{l_p}{l_p} \\
v &\leq c\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}}
\end{aligned} \tag{58}$$

That is to say we get a new exact maximum velocity limit for elementary particles, as has been suggested by Haug [55, 70][7]. The maximum speed of the electron would then be approximately $v_{max} \leq c(1-8.78\times10^{-46})\ m/s$, which is below c, but considerably higher than the velocity one can achieve in the Large Hadron Collider. Therefore, at present no experiment exists that has been performed that can prove this hypothesis on maximum velocity of elementary particles wrong. However, if such a maximum speed limit exists for elementary particles, then it would indeed explain why the Earth has not been observed to be hit by, for example, electrons with a kinetic energy equal to the rest-mass energy of our Sun, the Milky Way or even much higher. The maximum kinetic energy of any elementary particle based on our new models seems to be equal to the rest-mass energy of the Planck mass. This is still a lot of energy, but considerably much less energy than we have discussed above. There is a lot of energy between the Planck mass energy and infinity. Our new maximum velocity offers a clear

[7] We actually suggested such a maximum velocity based on a more general formula at a presentation we gave at the Royal Institution in London October 15, 2015.

cut-off at the Planck scale. For a composite mass such as a proton the maximum velocity of the proton will then likely depend on the elementary particle making up the proton with the shortest reduced Compton wavelength, that is to say the most massive fundamental particle embedded in the proton. Haug [70] suggested that the proton will then likely start to dissolve when reaching this speed – this is currently a hard-to-test hypothesis as this speed will be far above what we can observe in LHC for example.

Another important point is that special relativity without incorporating our maximum velocity is not compatible with the idea often used in quantum gravity, that the shortest possible length is the Planck length. One can take any particle or object with length $L > l_p$, then, by moving this object at a speed of $v > c\sqrt{1-\frac{l_p^2}{L^2}} < c$, and then the length contracted observation of L will be below the Planck length. This we have discussed in more detail in [69, 71]. On the other hand, by incorporating our suggested maximum speed limit one will likely ensure that we have a relativity theory that is always compatible with the idea that the shortest possible observable length is l_p. We are here thinking about an ideal observer, that is even an electron, and, as we will see, that even the building blocks of a photon can be an observer – we are not talking about the technical possibilities to observe this directly.

Let us go back to our newly introduced quantum probabilities, for the rest-mass particle we said that $P_c = \frac{l_p}{\bar{\lambda}}$ could be interpreted as the probability for an elementary particle to be in a collision state when using a observational time window of the Planck-time. At the moment we observe it, if we observe a particle in the Planck time observational time window, it will either be in Planck mass state (collision state) or not. For a moving particle, that is for a relativistic mass (particle), we find that this quantum frequency probability is now given by

$$P_c = \frac{l_p}{\bar{\lambda}}\gamma = \frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}} \tag{59}$$

Based on standard physics assumptions, where the only speed limit for a mass is $v < c$, then this probability can become larger than one and can therefore not be a valid probability (inside standard frequency probability theory). However, since we have $v_{max} = c\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}}$ we see that the maximum probability is

$$P_{c,max} = \frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v_{max}^2}{c^2}}} = \frac{l_p}{\bar{\lambda}\sqrt{1-\frac{\left(c\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}}\right)^2}{c^2}}} = \frac{l_p}{l_p} = 1 \tag{60}$$

That is to say, the frequency probability for an elementary particle to be in a collision state (Planck mass particle state) can never be higher than one for any elementary particles. It can be higher for composite particles, but again it can then be seen as an aggregate of probabilities, where the integer part then represents the number of collision events per Planck time, and the decimal part represent the probability for one more event. This means masses with relativistic mass of the Planck mass and upwards will be dominated by determinism and relativistic masses considerably below m_p will be dominated by probability (uncertainty).

5 The Planck mass particle and its unique quantum frequency probability

The Planck mass particle plays an extremely important role in our theory, so we must take a closer look at it. Planck, in 1899, suggested what is today known as the Planck mass, but said little about what it represented except for indicating it was potentially a very important mass. Lloyd Motz, while working at the Rutherford Laboratory, [72–74] was likely the first to suggest there could be an important particle (in 1962) that had a mass equal to the Planck mass. Motz coined this particle the *uniton*, see also Markov [75] that, in 1967, introduced a similar particle that he coined *maximon*. Motz was naturally fully aware that his suggested Planck mass particle (uniton) had an enormous mass compared to the mass of any particles which had been observed. He tried to get around this challenge by suggesting the unitons had radiated most of their energy away:

> *According to this point of view, electrons and nucleons are the lowest bound states of two or more unitons that have collapsed down to the appropriate dimensions gravitationally and radiated away most of their energy in the process.* – Lloyd Motz

Others [76] have similarly suggested that Planck mass particles only existed just after the Big Bang and that most of their mass has radiated away, to become today's known observed particles, such as the electron and the proton. Others, including Motz and Hawking, have suggested that the Planck mass particles could exist today as micro-black holes [77–79]. Planck mass particles have also been suggested as a candidate for cosmological dark matter [80, 81]. Our theory is in many ways much simpler – we have shown that the Planck mass is observational time dependent. It is only if the Planck mass particle, the collision between two indivisible particles, is observed in the Planck time that it has the assumed mass of $m_p \approx 2.17 \times 10^{-8}\ kg$ (per Planck time), and it can only be directly observed in the Planck time window. This is because the Planck mass is one collision, and the kg mass is a collision frequency ratio. The reduced Compton frequency of one kg in a Planck time observational time window is $\frac{c}{\bar{\lambda}_{1kg}}t_p \approx 45994327$. The collision frequency of the Planck mass particle is 1. So we have that the Planck mass particle in kg as observed in the Planck time is $m_p \approx \frac{1}{45994327} \approx 2.17 \times 10^{-8}$ kg (per Planck time), which is the well-known Planck mass. However, it is important to pay attention to the fact that the Planck mass particle can only be directly observed inside a Planck time observational time window, as this is the lifetime of the particle. One has to be part of the Planck mass particle to observe the Planck mass particle. This again is because the maximum speed of a signal is the speed of light. The Planck mass particle has a radius equal to the Planck length, and only lasts the Planck time before dissolving into its two indivisible particles, that again are energy. The Planck mass particle still has many indirect effects outside a timeframe of the Plank time that can be observed. Assume we have a one-second resolution observational time window, the collision frequency inside one kg is now $\frac{c}{\bar{\lambda}_{1kg}} \approx 8.52 \times 10^{50}$, while a single Planck mass particle is still only one collision, because that is the very definition of a Planck mass particle – that it is one collision between two indivisible particles. Its mass in kg is now $\frac{1}{8.52 \times 10^{50}} \approx 1.17 \times 10^{-51}\ kg$. That is a super-small mass, much smaller than the electron mass $\approx 10^{-31}$. This mass is also equal to an energy with frequency one per second, as $\hbar f_p = \hbar \times 1 = 1.05^{-34}\ J$ since this corresponds to a res-mass of $\frac{\hbar f}{c^2} = \frac{\hbar \times 1}{c^2} = \frac{1}{8.52 \times 10^{50}} \approx 1.17 \times 10^{-51}\ kg$. This corresponds closely to the suggested photon mass in several studies, see, for example, the review article by [82]. Furthermore, the Planck mass particles are the building blocks of all masses and all energy. At the observational time windows we tend to operate, such as the second, the Planck mass particle corresponds to an incredibly small mass in terms of kg. This resolves the puzzle of why the Planck mass particle is much larger than any observed particle such as the electron, it is actually a much smaller mass in the observational time window that we observe with our technology. Nonetheless, it is the standard Planck mass size if observed directly in its lifetime of the Planck time.

Back to the maximum velocity of particles, which we gave in the section above as $v_{max} = c\sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}}$. For a Planck mass particle we have $\bar{\lambda} = l_p$, the maximum velocity for a Planck mass particle relative to an observer is

$$v_{max} = c\sqrt{1 - \frac{l_p^2}{l_p^2}} = 0 \tag{61}$$

That means the velocity of a the Planck mass particle must always be zero. This seems to be absurd at first, and in conflict with aspects such as Lorentz symmetry and the relativity principle itself. However, it is fully consistent with the idea that the Planck mass particles are simply a collision between two indivisible particles and that this collision only lasts the Planck time. In the Planck time the speed of a light signal can only move the Planck length, since $ct_p = l_p$. And since l_p is the radius of the Planck mass particle (two indivisibles colliding), then one must be part of the Planck mass particle itself to observe it. In other words, one is at rest with the Planck mass particle in order to observe it directly – again this does not mean we cannot observe a series of indirect effects from this collision from other reference frames, such as gravity. This makes the Planck mass particle unique; it can only be observed from its own frame of reference, and it is therefore invariant, not because it is the same as observed from a series of reference frames, but because it can only be observed (directly) from its own reference frame. We therefore actually have what we can call a legal break with Lorentz symmetry. We have a unique reference frame, because this frame can only be observed from its own rest frame. We already know that light has a unique and constant speed – this also means that light particles have a unique rest-mass frame when colliding. It is a reference frame that only lasts the Planck time. So the Planck time, the Planck length, are invariant, and they are both directly linked to the collision between two indivisible (light) particles, which is then making up the Planck mass particle. In other words, the Planck mass particle is in our view a photon-photon collision, and it is also predicted by standard theory that when two photons collide we get mass, see for example [83].One should ask oneself, if a photon hits another photon and is reflected, then why should this event take zero time? And from our theory it clearly looks like it takes the Planck time.

Also the relativistic collision time mass of the Planck mass particle is given by

$$\bar{m} = \bar{m}_0\gamma = \frac{l_p}{c}\frac{l_p}{l_p\sqrt{1 - \frac{v}{c^2}}} \tag{62}$$

but since the maximum velocity $v_{max} = 0$, then we are left with

$$\bar{m} = \bar{m}_0\gamma = \frac{l_p}{c}\frac{l_p}{l_p\sqrt{1 - \frac{0}{c^2}}} = t_p\frac{l_p}{l_p} = t_p \tag{63}$$

Interestingly, here we see that, as we have mentioned before, the last part $\frac{l_p}{\bar{\lambda}} = \frac{l_p}{l_p} = 1$, is a probability for the particle to be in a collision state inside a Planck time window. That is to say, because the Planck mass particle is always in a collision state (when it exist) in the observational time window an ideal observer can observe it directly, namely the Planck time. This because this is the lifetime of the Planck mass particle, and

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if we observe the Planck mass particle, it is in collision state, as the collision state is the Planck mass particle. All other particles go in and out of the collision state, and known observed particles such as an electron are for the majority of the time not in a collision state, but still in a collision state $\frac{c}{\bar{\lambda}_e}$ times per second. We are here talking about internal collisions in the electron (and any other particle), not external. That the Planck mass particle is the only particle with a collision state probability of always one will be essential to understand the limitations of the Heisenberg uncertainty principle, and to also unify quantum mechanics with gravity.

Still, this is only a hypothesis so long as we cannot observe a consequence linked to the Planck mass particle. The collision time from one collision event is only the duration of the Planck time; this is a time interval far shorter than anything we have instruments to detect today. But what if one has an enormous amount of such collisions, each lasting one Planck time, then we should be able to detect and measure the aggregate of them. And we will claim this is exactly what we can do in gravity observations, and is why we now, unlike before, assumed that it is possible to extract the Planck length independently of knowledge of G. Gravity is directly linked to the Planck scale, and we claim it is easy to detect the Planck scale for large masses, it is any effect observable related to gravity.

6 Energy

The standard energy relation for rest-mass particles is $E = mc^2$. There is nothing wrong with dividing both sides by c, so $\frac{E}{c} = mc$, and we could then re-define the energy to a new energy as $E_n = \frac{E}{c}$, and then simply write $E_n = mc$ – this would simply give a different output dimension of energy than the one used today. We can always multiply existing equations with known constants on both sides, for example we could multiply $E = mc^2$ with $c^{2.5}$ on each side; however, this would just make the equation and the output units more complex. To multiply or divide each side of a known equation by known constants each side must have a purpose, such as simplifying without losing something that is already there. To divide $E = mc^2$ to get $E_n = mc$ does not seem much of a simplification, but perhaps a little, the standard energy is joule, which is $kg \cdot m^2/s^2$ and joule divided by c is $kg \cdot m/s$. Even if the output dimensions are slightly simplified, it does not seem worth doing, and it would also require an explanation as to why we would do something like that. However, when we switch the mass definition to collision time, then we see that if we define $\breve{E} = \bar{m}c^2$, then the energy output dimensions are m^2/s, but if we divide by c on each side, that is redefine the energy to $\bar{E} = \frac{\breve{E}}{c}$ then the output unit for energy is simply meter (m), that is to say we end up with that mass is collision time and energy is collision length. However, we must be very careful that we not are manipulating the energy units/dimensions in ways that make them inconsistent with observations, and be aware that this is still fully consistent with the fact that $E = mc^2$, but it is unnecessarily complex. We can, as described in section 2, easily run experiments showing kinetic energy is a function of v^2 and not v, if we have the following energy mass relation

$$\bar{E} = \bar{m}c\gamma \tag{64}$$

and a kinetic energy as

$$\bar{E}_k = \bar{m}c\gamma - \bar{m}c \tag{65}$$

then the approximation for this when $v << c$ is the first series of a Taylor expansion then we get $\bar{E}_k \approx \frac{1}{2}\bar{m}\frac{v^2}{c}$, that is it is dependent on v^2 for low velocities as has been tested. This is also fully consistent with $E = mc^2\gamma - mc^2$, because we can always multiply our collision time mass $\bar{m}$ with $\frac{\hbar}{l_p^2}$, and multiply both sides of $\bar{E} = \bar{m}c$ with c on both sides. We have performed extensive research on this outside that which we can describe in this paper, and have found no inconsistencies, but readers should naturally not take this for granted, but investigate it further. That is to say our new energy definition is identical to our Compton momentum. That in our new theory there is actually no need for both momentum and energy, all we need is energy and mass (or Compton momentum and mass, which are the same thing). At the deeper level our energy is given by

$$\bar{E} = \bar{m}c\gamma = l_p \frac{l_p}{\bar{\lambda}\sqrt{1 - \frac{v^2}{c^2}}} \tag{66}$$

Namely, energy at the deepest quantum level is a collision length l_p multiplied by a probability of collision state of $\frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}$. In pure energy we have that $v_{max} = 0$, this seems contradictory to the idea that energy moves at speed c. However, to observe energy, a photon, we need to collide it with another light particle (building block of photon and all matter). We need a photon-to-photon collision to observe a photon. Keep in mind that in our model matter is built of light particles, that is to say indivisible particles traveling at speed c when not colliding with another such particle. The photon is then longer a photon as it is colliding with another photon, it is then a Planck mass particle, that lasts one Planck time. Light does not only have an invariant upper speed, c, but also an invariant lower speed $v = 0$, but it is then no longer light, but in a Planck particle mass state. We end up with what we could call a sandwich model, where both the upper and lower speed limit are defined by light particles. Nothing can move faster than these and they move with speed c, and this speed is the same as

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observed from any reference frame (with Einstein-Poincaré synchronized clocks). However, they also define the lowest speed limit which is always $v = 0$, as the collision between two indivisibles can only be observed from the indivisible particle itself. The collision itself can be seen as an observation, by an ideal observer, not directly by our instruments.

For energy we are used to thinking of frequency times the Planck constant. Our new energy definition is a length that we call collision length, that is equal to half the Schwarzschild radius and also the Compton momentum, all of these three are the same. However, we can easily go from collision length to frequency by simply dividing energy by the Planck length. Our new energy is the Planck length multiplied by the collision frequency per Planck time, which is equal to the reduced Compton frequency per Planck time. For example, an electron has a collision frequency per Planck time (which is the reduced Compton frequency per Planck time) of simply

$$f = \frac{\bar{E}}{l_p} = \frac{\bar{m}_e c}{l_p} = \frac{l_p}{\bar{\lambda}_e} = 4.19 \times 10^{-23} \text{ per plank time} \tag{67}$$

Therefore, the frequency is less than one per Planck time – actually all masses smaller than the Planck mass will have such a frequency less than one, so it is an expected frequency. In other words, it is identical to the probability of the electron being in a collision state. To obtain the more familiar reduced Compton frequency per second, we simply have to multiply the above frequency (frequency probability) with the number of Planck times in one second, $\frac{1}{t_p}$, this gives 7.76×10^{20} per second which is identical to $\frac{c}{\bar{\lambda}_e}$. Thus, to convert collision length to joule we simply do the following $\frac{\bar{E}}{l_p}\frac{1}{t_p} \times \frac{1}{8.52 \times 10^{50}} = \bar{E}\frac{\hbar}{l_p^2}c = E$. In other words, standard energy in terms of joule is just collision length multiplied by a composite constant, $\frac{\hbar}{l_p^2}c$, we can at any time go back and forth between standard energy to collision time energy, or from our collision time mass to kg mass. The standard energy and the standard mass are dependent on the same variable, the reduced Compton wavelength. We have to ask ourselves what is easier to understand intuitively, a length (collision length in meter) or joule ($kg \cdot m^2/s^2$)? We clearly think the first. And this is also in our view much more than just a fancy change of output units and dimensions, as the new view gives a significant new insight into the quantum world as it is even compatible with gravity and quantum gravity.

7 The connection between the energy, the Schwarzschild radius and quantum gravity

Half the Schwarzschild radius is given by

$$\frac{1}{2}r_s = \frac{GM}{c^2} = l_p \frac{l_p}{\bar{\lambda}} \tag{68}$$

This is equal to the rest-mass energy in our model $\bar{E} = \bar{m}c = l_p\frac{l_p}{\bar{\lambda}}$. The Schwarzschild radius is therefore what we can call rest-mass energy, or we could even call it gravity energy as it can also be used to predict observable gravity phenomena. Half the Schwarzschild radius is simply our collision length, which is a more complete description of energy than standard energy. For all particles we have observed, such as electrons and also composite particles like protons, then $\bar{\lambda} >> l_p$. This means the Schwarzschild radius of such particles is smaller than the Planck length, which should be impossible in a theory that claims to be consistent with the idea that the Planck length is the shortest possible length. Actually, we will claim all elementary particles have a Schwarzschild radius equal to the Planck length, which is the radius of the collision between two indivisible particles that go in and out in collision state. In fact, particles with mass smaller than the Planck mass do not have a stable Schwarzschild radius, but a Schwarzschild radius equal to the Planck length, that comes in and out of existence with a probability of $\frac{l_p}{\bar{\lambda}}$, in an observational time window of the Planck time. We have not derived general relativity theory from our theory, and we have scarcely investigated general relativity theory in this paper – this we leave for another time. So how can it be that we can now suddenly incorporate the Schwarzschild radius into our theory? It is important to be aware that the Schwarzschild radius is not only unique for general relativity theory. The Schwarzschild radius is simply the radius a mass must be inside where the escape velocity is c for that radius. As we mentioned earlier, an identical radius was also calculated and presented by Michell [62] n 1784 based on Newton mechanics.

Based on formula 68 also means that the Schwarzschild radius, and thereby the gravity, are probabilistic for particles below the Planck mass, as they have $\bar{\lambda} > l_p$, and remember $\frac{l_p}{\bar{\lambda}}$ can be seen as a probability for the particle to be in a collision state if the observation time window is the Planck time. For mass sizes from and above Planck mass particles the Schwarzschild radius is stable, that is so say deterministic. This means for Planck mass size and up the gravity is stable and not probabilistic. Also be aware that the Planck mass particle, the collision between two indivisible particles, surprisingly has many of the same mathematical properties as a micro black hole, but with very different interpretations. The two indivisible particles indeed leave each other at the speed of light, and the calculated escape velocity of a Planck mass with radius equal to the Planck length is the speed of light. For more detailed discussion on this in relation to our theory see [60].

If we know the speed of light (gravity) c, that we, for example, can find from simply measuring the speed of light of a laser beam, then we from any Newton gravitational phenomena can very easily extract the Schwarzschild radius, which is the rest-mass collision length energy. This we can see by looking closely at Table 5. For example we can find the Schwarzschild radius from the Earth by simply observing the gravitational acceleration on the surface of the Earth, if we solve the gravitational acceleration formula in Table 5 with respect to the Schwarzschild radius we get

$$\bar{p}_r = \bar{m}c = \frac{1}{2}r_s = g\frac{R^2}{c^2} \tag{69}$$

Next, we only need the Schwarzschild radius and the speed of light to predict other gravity phenomena, we do not need G or $\hbar$. Moreover, we do not need the Compton wavelength in this case, see Table 6.

What to measure/predict	**Formula**
Schwarzschild radius / rest mass Compton momentum	$\frac{1}{2}r_s = \bar{m}c = \frac{gR^2}{c^2}$
Gravitational acceleration field	$g = \frac{r_s}{2R^2}c^2$
Orbital time	$T = \frac{2\pi}{c}\sqrt{\frac{2R^3}{r_s}}$
Orbital velocity	$v_o = c\sqrt{\frac{r_s}{2R}}$ t
Velocity ball Newton cradle	$v_{out} = \frac{c}{R}\sqrt{\frac{Hr_s}{2}}$
Periodicity Pendulum (clock)	$T = \frac{2\pi R}{c}\sqrt{\frac{2L}{r_s}}$
Advance of perihelion	$\sigma = \frac{3\pi r_s}{a(1-e^2)}$
Time dilation	$t_2 = t_1\sqrt{1 - 2\frac{r_s}{2R}}$
GR bending of light	$\delta = 4\frac{r_s}{2R}$
Gravitational red-shift	$\lim_{R\to+\infty} z(R) = \frac{r_s}{2R}$
Microlensing	$\theta_E = \frac{1}{R}\sqrt{\frac{2(d_S-d_L)r_s}{(d_Sd_L)}}$

Table 6: The table shows how a series of common gravitational measurements and predictions can be done without any knowledge of the traditional mass size or knowledge of G, when we rely on the Schwarzschild radius which is identical to the rest-mass Compton momentum, and in our view actually represents the collision length, which is the collision time mass multiplied by the speed of light.

We are here working with the aggregates of Planck particle events, and extract their rest-mass energy, which is the sum of the collision lengths, $\frac{1}{2}r_s$. To know the Compton wavelength is only needed if we want to separate out how long one single Planck-mass event (collision event is). That we can predict all observable gravity phenomena from the collision length energy (the Schwarzschild radius) and c is quite remarkable from an interpretative point of view. Because if mass is what is causing gravity, and we do not need to find the traditional kg mass and also not G to do so, then it is perhaps because the collision time contains everything about the mass we need to know to predict gravity, and this is exactly what our theory tells us. This also explains why we can re-write the Gaussian law of gravity as $\nabla^2\phi = 4\pi G\rho = 2\pi c^2\frac{r_s}{V} = 4\pi c^2\frac{\bar{E}}{V}$, in other words the so-called Schwarzschild radius represents the collision length energy that is directly linked to gravity. If the Schwarzschild radius only relates to black holes why is it we can then predict all observable gravity phenomena from it combined with only c and some variables such as R? This should perhaps make us re-think what it truly represents.

Table 7 summarizes how mass and energy and also the Schwarzschild radius can be looked at as probabilistic.

8 Partial derivatives with respect to space and time gives us frequency probabilities and a differential equation

It is interesting to note that we have

$$\frac{\partial\bar{m}}{\partial t_p} = \frac{\partial t_p \frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}}{\partial t_p} = \frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}} \tag{70}$$

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	Probabilistic approach
Electron mass as collision time	$\bar{m}_e = \frac{\bar{m}_e}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{l_p}{c}\frac{l_p}{\bar{\lambda}_e\sqrt{1-\frac{v^2}{c^2}}} = \bar{m}_p P_c$
Proton mass as collision time	$\bar{m}_P = \frac{\bar{m}_P}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{l_p}{c}\frac{l_p}{\bar{\lambda}_P\sqrt{1-\frac{v^2}{c^2}}} = \bar{m}_p P_c$
Planck particle mass as collision time	$\bar{m}_p = \frac{\bar{m}_p}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{l_p}{c}\frac{l_p}{l_p\sqrt{1-\frac{0^2}{c^2}}} = \frac{l_p}{c} = \bar{m}_p P_c = m_p \times 1$
Schwarzschild radius as collision length	$\frac{1}{2}r_s = \bar{E} = \frac{\bar{m}c}{\sqrt{1-\frac{v^2}{c^2}}} = l_p\frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}} = l_p P_c$
Schwarzschild radius Planck mass as collision-space	$\frac{1}{2}r_s = \bar{E}_p = \frac{\bar{m}_p c}{\sqrt{1-\frac{v^2}{c^2}}} = l_p\frac{l_p}{l_p\sqrt{1-\frac{0^2}{c^2}}} = l_p P_c = l_p \times 1$
Electron rest mass collision state probability	$P_c = \frac{l_p}{\bar{\lambda}_e} = 4.19 \times 10^{-23}$ in the Planck time
Proton rest mass collision state probability	$P_c = \frac{l_p}{\bar{\lambda}_P} = 7.69 \times 10^{-20}$ in the Planck time
Proton rest mass collision state probability	$P_c = \frac{l_p}{\bar{\lambda}_p} = \frac{l_p}{l_p} = 1$ in the Planck time

Table 7: This table shows the "standard" relativistic collision time mass as well as the probabilistic approach. Be aware of the notation difference between the Planck mass m_p and the proton rest-mass $m_{\mathbf{P}}$. All masses and even such things as the Schwarzschild radius can be expressed as Planck units multiplied by a frequency probability P_c.

and

$$\frac{\partial \bar{E}}{\partial l_p} = \frac{\partial \bar{p}_t}{\partial l_p} = \frac{\partial l_p \frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}}{\partial l_p} = \frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}} \tag{71}$$

This means we can describe the change in energy and gravity (or the Compton momentum, which is the same thing) with respect to change in space: $x = l_p$, and the change in mass with respect to change in time $t = t_p$, with the following simple differential equation

$$\frac{\partial \bar{E}}{\partial l_p} = \frac{\partial \bar{m}}{\partial t_p} \tag{72}$$

which describes the relation between how energy changes as we move in space and how mass changes as we move in time, and the result is we have two identical quantum frequency probabilities $\frac{l_p}{\bar{\lambda}}\gamma = \frac{l_p}{\bar{\lambda}}\gamma$. Furthermore, in the special case of the Planck mass particle, we have

$$\frac{\partial \bar{m}_p}{\partial t_p} = \frac{\partial t_p \frac{l_p}{l_p\sqrt{1-\frac{v^2}{c^2}}}}{\partial t_p} = \frac{l_p}{l_p\sqrt{1-\frac{0^2}{c^2}}} = 1 \tag{73}$$

and

$$\frac{\partial \bar{p}_t}{\partial l_p} = \frac{\partial \bar{E}_p}{\partial l_p} = \frac{\partial l_p \frac{l_p}{l_p\sqrt{1-\frac{v^2}{c^2}}}}{\partial l_p} = \frac{l_p}{l_p\sqrt{1-\frac{0^2}{c^2}}} = 1 \tag{74}$$

Again this simply means the Planck mass particle always has a probability of one for being in a collision state, and the same with the Planck mass Compton momentum. However, one can question if it even makes sense to look at change in time and space with respect to the Planck mass particle, as it will dissolve after the Planck time and the minimum time unit we can move is t_p and the minimum space length we can move is $x = l_p$.

We also have that

$$\begin{aligned} l_p\frac{\partial \bar{E}}{\partial l_p} &= ct_p\frac{\partial \bar{M}}{\partial t_p} \\ \bar{E}_p\frac{\partial \bar{E}}{\partial l_p} &= c\bar{m}_p\frac{\partial \bar{M}}{\partial t_p} \\ \bar{E}_p\frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}} &= c\bar{m}_p\frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}} \end{aligned} \tag{75}$$

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where $\bar{E}_p$ is the Planck mass energy in terms of collision length, and $\bar{m}_p$ is the Planck mass in terms of collision time. That basically means that all elementary particles and even the mass of composite particles can be described as a frequency probability multiplied by the Planck mass. For composite masses this will be an aggregate of probabilities.

Furthermore, since $\bar{E} = \frac{1}{2}r_s$ we also have that

$$\frac{1}{2}\frac{\partial r_s}{\partial l_p} = \frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}} \tag{76}$$

and also

$$\frac{1}{2}\frac{\partial r_s}{\partial l_p} = \frac{\partial \bar{m}}{\partial t_p} \tag{77}$$

that is the change in the Schwarzschild radius with respect to change in space is identical to the change in the mass with respect to change in time.

9 A fresh view on the Heisenberg uncertainty principle

We now return to the Heisenberg uncertainty principle and look at it from a new perspective. Our perspective is controversial, but we ask the reader to try to look at it without prejudice. The Heisenberg uncertainty principle is again given by

$$\Delta p \Delta x \geq \hbar \tag{78}$$

Keep in mind that, in standard physics, we have two momentum formulas, one for photons and one for particles with rest-mass. Let us start with particles with rest mass, the momentum broken down in physical constants and quantum entities such as the de Broglie matter wavelength is in our view given by

$$p = mv\gamma = \frac{mv}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{\frac{\hbar}{\bar{\lambda}_b}\frac{1}{v}v}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{\hbar}{\bar{\lambda}_b\sqrt{1-\frac{v^2}{c^2}}} \tag{79}$$

This is the momentum as well as the kg mass as derived from the de Broglie wavelength – in other words it is the other side of the coin of the de Broglie wavelength relativistic formula, and therefore fully compatible with the de Broglie wavelength. We could call the standard momentum the de Broglie momentum. Since the Planck constant and the speed of light are constants, the only variable is the de Broglie wavelength, well $\bar{\lambda}_b\sqrt{1-\frac{v^2}{c^2}}$ is the relativistic de Broglie wavelength. The de Broglie wavelength is a function of the type of particle and its velocity. Assume we are dealing with a known type of particle, for example an electron. For a given velocity the de Broglie wavelength is then given. The only uncertain variable is therefore the velocity of the particle. We therefore will claim one can re-write the Heisenberg uncertainty principle as

$$\frac{\hbar}{\bar{\lambda}_b\sqrt{1-\frac{(\Delta v)^2}{c^2}}}\Delta x \geq \hbar \tag{80}$$

As the Planck constant is a constant, we will claim there is no fundamental uncertainty around it, except measuring uncertainty, but that is not what the Heisenberg uncertainty principle concerns; it should not be confused with the observer effect. Assume that we have $\Delta x = \bar{\lambda}_b$, this gives

$$\begin{aligned}
\frac{\hbar}{\bar{\lambda}_b\sqrt{1-\frac{(\Delta v)^2}{c^2}}}\bar{\lambda}_b &\geq \hbar \\
\frac{\hbar}{\sqrt{1-\frac{(\Delta v)^2}{c^2}}} &\geq \hbar \\
\frac{1}{\sqrt{1-\frac{(\Delta v)^2}{c^2}}} &\geq 1
\end{aligned} \tag{81}$$

We can only have that $\frac{1}{\sqrt{1-\frac{(\Delta v)^2}{c^2}}} = 1$ if $\Delta v = 0$, but we know we cannot have $v = 0$ as the de Broglie wavelength is not defined for $v = 0$ and also not the standard momentum consistent with a de Broglie wavelength. One could protest here and say that $\Delta v = 0$ does not mean $v = 0$, as we are talking about the uncertainty in the velocity and not in the velocity itself. This we believe would be a misinterpretation, as we will claim only a velocity that is always $v = 0$ has an uncertainty in the velocity of zero, something that will become clear later

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on when we get to the Planck mass particle. But then the standard Heisenberg uncertainty principle is not valid for the Planck mass particle, which is the very essence of gravity. We claim the Heisenberg uncertainty principle is basically nothing more than to say that $v < c$ and that before we have measured the velocity of a particle, then the particle can have any velocity between zero and $v < c$, as this indeed will give

$$\infty > \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} \geq 1 \tag{82}$$

This simply means $v < c$ that again corresponds to a de Broglie wavelength $\bar{\lambda}_b > 0$. However, since the standard momentum is not valid for $v = 0$ we must for the standard Heisenberg uncertainty principle actually have

$$\infty > \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} > 1 \tag{83}$$

and

$$\Delta p \Delta x > \hbar \tag{84}$$

That is to say, we will claim the Heisenberg uncertainty principle, in its current form, linked to the standard momentum, is not valid for $v = 0$, i.e. it can say nothing about rest-mass particles. One could try to interpret this as all particles with mass will always have a velocity $0 < v < c$, and that a particle can therefore never stand still, and that it therefore does not matter that the de Broglie wavelength and thereby the momentum is not valid for $v = 0$, this we think would be a grave mistake. The correct interpretation we believe is to understand that the Heisenberg uncertainty principle is rooted in the standard momentum, which is not mathematically defined for rest-mass particles, so that the Heisenberg uncertainty principle can say nothing about rest-mass particles in its current form.

Let us assume that we try to incorporate a Planck length limit and just speculatively set $\Delta x \geq l_p$. We can then, in the special case, set $\Delta x = l_p$, and this gives

$$\frac{\hbar}{\bar{\lambda}_b\sqrt{1-\frac{(\Delta v)^2}{c^2}}} l_p \quad \geq \quad \hbar \tag{85}$$

Solved with respect to Δv this gives $\Delta v \leq \sqrt{1-\frac{l_p^2}{\bar{\lambda}_b^2}}$, which is different to our previously derived maximum velocity of matter. This maximum velocity does not make much sense as it is a function of the de Broglie wavelength, $\bar{\lambda}_b$, that itself is a function of the velocity, so we get a maximum velocity that again is a function of the velocity of the particle. Secondly, as long as we work with the kg mass definition that contains no information about the Planck length, then setting a Planck length limit is only a speculative hypothesis with no solid foundation as to why this should be the case.

10 Uncertainty principle based on the Compton momentum

Next, let us, instead of using the standard momentum as the foundation for the uncertainty principle, suggest an uncertainty principle based on the Compton momentum, from this we get, if we still work with the kg mass definition, the following

$$\begin{aligned}
\Delta p_t \Delta x &\geq \hbar \\
mc\gamma \Delta x &\geq \hbar \\
\frac{\frac{\hbar}{\bar{\lambda}}\frac{1}{c}c}{\sqrt{1-\frac{(\Delta v)^2}{c^2}}} \Delta x &\geq \hbar \\
\frac{\hbar}{\bar{\lambda}\sqrt{1-\frac{(\Delta v)^2}{c^2}}} \Delta x &\geq \hbar \\
\frac{1}{\bar{\lambda}\sqrt{1-\frac{(\Delta v)^2}{c^2}}} \Delta x &\geq 1
\end{aligned} \tag{86}$$

This modified Heisenberg uncertainty principle based on the Compton momentum is compatible with $\Delta v = 0$ and a particle at absolute rest. We can also here speculatively assume $\Delta x \geq l_p$, and then in the special case where we have $\Delta x = l_p$ and solve with respect to Δv, we get $\Delta v = c\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}}$, which is the maximum velocity formula we have derived before, but here linked to maximum uncertainty in velocity. In this maximum velocity uncertainty formula, we do not have the problematic issue that the maximum velocity formula itself is a function of velocity, that we obtained from the maximum uncertainty in velocity formula, that we again got from the standard Heisenberg uncertainty principle, when we assumed $\Delta x \geq l_p$. However, still there is no clear reason from this uncertainty principle based on the Compton momentum with the kg definition of mass, that we should have a minimum limit on uncertainty in the position equal to the Planck length.

Let us also incorporate our new mass definition in the Compton momentum. We start with the Compton momentum and the kg mass

$$\begin{aligned} \Delta p_t \Delta x &\geq \hbar \\ mc\gamma\Delta x &\geq \hbar \\ \frac{mc}{\sqrt{1-\frac{(\Delta v)^2}{c^2}}}\Delta x &\geq \hbar \end{aligned} \tag{87}$$

Next we turn the kg mass into a collision time mass – remember we have $\bar{m} = m\frac{l_p^2}{\hbar}$. That is to say, we simply need to multiply both sides with $\frac{l_p^2}{\hbar}$ (a more formal derivation based on quantum mechanics is given in section 12), this gives

$$\begin{aligned} \frac{\bar{m}c}{\sqrt{1-\frac{(\Delta v)^2}{c^2}}}\Delta x &\geq l_p^2 \\ \frac{\frac{l_p}{c}\frac{l_p}{\bar{\lambda}}c}{\sqrt{1-\frac{(\Delta v)^2}{c^2}}}\Delta x &\geq l_p^2 \\ \frac{l_p}{\bar{\lambda}\sqrt{1-\frac{(\Delta v)^2}{c^2}}} &\geq \frac{l_p}{\Delta x} \end{aligned} \tag{88}$$

Following this, we can try to investigate the boundary conditions for this new uncertainty principle. We know the minimum uncertainty in Δv cannot be below zero, so we set $\Delta v = 0$, which is the case of a particle we know is at rest, then solved with respect to Δx we get $\Delta x = \bar{\lambda}$. That is the maximum uncertainty in Δx is up to the reduced Compton wavelength of the rest mass of the particle in question, in other words we have $\Delta x \leq \bar{\lambda}$. That is to say, we must have

$$\begin{aligned} \frac{l_p}{\bar{\lambda}\sqrt{1-\frac{(\Delta v)^2}{c^2}}} &\geq \frac{l_p}{\Delta x} \\ \frac{l_p}{\bar{\lambda}\sqrt{1-\frac{(0)^2}{c^2}}} &\geq \frac{l_p}{\bar{\lambda}} \end{aligned} \tag{89}$$

Keep in mind that $\frac{l_p}{\bar{\lambda}\sqrt{1-\frac{(\Delta v)^2}{c^2}}}$ is a frequency probability of the particle being in a collision state as observed in the Planck time observational time window, and it is also the percentage of time in a longer observational time interval that the particle is in collision state. This, in other words, puts a lower limit on this collision state quantum probability for a given particle equal to $P_c \geq \frac{l_p}{\bar{\lambda}}$.

Next, from our previous analysis we have that $v_{max} = c\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}}$, this mean we also must have $\Delta v \leq c\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}}$. If we now set $\Delta v = c\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}}$, this leads to

$$\begin{aligned} \frac{l_p}{\bar{\lambda}\sqrt{1-\frac{\left(c\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}}\right)^2}{c^2}}}\Delta x &\geq l_p \\ \frac{l_p}{l_p}\Delta x &\geq l_p \\ \Delta x &\geq l_p \end{aligned} \tag{90}$$

This means we must have $l_p \geq \Delta X \leq \bar{\lambda}$ and $0 \geq \Delta v \leq c\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}}$. And, unlike in the standard framework, in our collision time mass theory we also have very good reasons to assume $\Delta x \geq l_p$. In contrast to standard

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theory, here we have a solid foundation to suggest so, as l_p is the diameter of the indivisible particles making up all particles. And because the reduced Compton wavelength is the distance to distance between indivisible particles. If we set $\Delta x = l_p$, we must also have $\Delta v = c\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}}$, and this gives

$$\begin{aligned}
\Delta \bar{p}_t \Delta x &\geq l_p^2 \\
\bar{m}_p c \gamma l_p &\geq l_p^2 \\
l_p \frac{l_p}{\bar{\lambda}\sqrt{1-\frac{(\Delta v)^2}{c^2}}} &\geq l_p^2 \\
l_p \frac{l_p}{\bar{\lambda}\sqrt{1-\frac{(c\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}})^2}{c^2}}} l_p &\geq l_p^2 \\
1 &\geq 1
\end{aligned} \tag{91}$$

We cannot have $1 > 1$, so $\geq$ can be replaced with $=$ sign in the case $\Delta x = l_p$. That is to say our new uncertainty principle gives us a range for the quantum probability of a particle being in a collision state, we end up with

$$\begin{aligned}
\frac{l_p}{\bar{\lambda}} &\leq \frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}} \leq 1 \\
\frac{l_p}{\bar{\lambda}} &\leq P_c \leq 1
\end{aligned} \tag{92}$$

Again, pay attention to the fact that $P_c = \frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}$ is the frequency probability for the particle to be in a collision state as observed in the Planck time. On the other hand, if we mistakenly only incorporate the velocity limit we have in standard theory $v < c$, and thereby also assume $\Delta v < c$, directly or indirectly, then we do not get an upper unit limit on this probability; that is to say, at a deeper level the standard Heisenberg uncertainty principle likely indirectly allows probabilities above unity. We are not going to investigate this further here, but we can speculate that this could potentially be one of the reasons why we sometimes need negative probabilities [84–87] in standard quantum physics, perhaps to compensate for the embedded and we would say concealed, > 1, probabilities in the standard Heisenberg uncertainty principle. In other words, we would think the negative "pseudo" probabilities (or extended probability theories) in parts of quantum physics could potentially be linked to make an incomplete uncertainty principle and its corresponding incomplete quantum mechanics somehow still also work (a type of replacement for the special case of rest mass particles). That one can use negative pseudo probabilities to get a get an incomplete model to still work is known from quantitative finance, see [88] (for example when one work outside the state-space of the model). However, in finance, it is typically easy to find out why the underlying model is incomplete as the models and the assets markets are much easier to understand and observe than the subatomic world. Therefore, negative probabilities have not become popular in finance, as one has instead been able to fix the incomplete model, and thereby have probabilities staying in the interval zero to one. Could it be that we are on to something similar here, that is to discover and then potential fix an incomplete model for uncertainty in the quantum realm?

The special case of the Planck mass particle

In the special case of the Planck mass particle we have

$$\begin{aligned}
\Delta \bar{p}_t \Delta x &\geq l_p^2 \\
\frac{\frac{l_p}{c}\frac{l_p}{l_p}c}{\sqrt{1-\frac{(\Delta v)^2}{c^2}}}\Delta x &\geq l_p^2 \\
\frac{l_p}{l_p\sqrt{1-\frac{(\Delta v)^2}{c^2}}}\Delta x &\geq l_p \\
\frac{\frac{l_p}{c}\frac{l_p}{l_p}c}{\sqrt{1-\frac{(\Delta v)^2}{c^2}}}\Delta x &\geq l_p^2 \\
\frac{1}{\sqrt{1-\frac{(\Delta v)^2}{c^2}}}\Delta x &\geq l_p
\end{aligned} \tag{93}$$

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As the Planck mass particle is always at rest if it is observed, as it must be observed from itself. We have that Δv must be zero for this special case. Well, we have from previous that the maximum uncertainty in $\Delta v = c\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}}$. And since the reduced Compton wavelength of a Planck mass particle is $\bar{\lambda} = l_p$ we get that its maximum uncertainty in velocity is $\Delta v = c\sqrt{1-\frac{l_p^2}{l_p^2}} = 0$, this gives

$$\begin{aligned} \frac{l_p}{l_p\sqrt{1-\frac{0^2}{c^2}}}\Delta x &\geq l_p \\ \Delta x &\geq l_p \end{aligned} \tag{94}$$

Actually we must have $\Delta x = l_p$ for the Planck mass particle as the radius of the particle only is l_p, and it only can be observed inside its own radius before it dissolves, this gives

$$\begin{aligned} \Delta\bar{p}_t l_p &\geq l_p \\ \frac{\frac{l_p}{c}\frac{l_p}{l_p}c}{\sqrt{1-\frac{(\Delta v)^2}{c^2}}} l_p &\geq l_p \\ \frac{1}{\sqrt{1-\frac{0^2}{c^2}}} &\geq 1 \\ 1 &\geq 1 \end{aligned} \tag{95}$$

In other words, the $\geq$ sign should actually be replaced with $=$ for the Planck mass particle, as we know $1 = 1$, and $1 \geq 1$ does not give much meaning. This simply means the quantum probability for a Planck mass particle to be in a collision state must always be one. If it is not in a collision state it simply does not exist. That is to say, for a Planck mass particle we have zero uncertainty. This is because the Planck mass particle dissolves into its indivisible particles after the Planck time. The Planck mass particle only has one state, that is a collision state, while all other particles made up of Planck mass particles going in and out of existence have two different states, collision state and non-collision state. The Planck mass particle is simply two indivisible particles lying next to each other in a collision state, it has a radius equal to the Planck length. A signal cannot travel faster than light, and in the lifetime of the Planck mass particle we therefore have to be part of it to observe it.

Energy time uncertainty principle

Our collision length energy leads to the following energy time uncertainty principle

$$\begin{aligned} \Delta E\Delta t &\geq \frac{l_p^2}{c} \\ \frac{\bar{m}c}{\sqrt{1-\frac{(\Delta v)^2}{c^2}}}\Delta t &\geq \frac{l_p^2}{c} \\ \frac{\frac{l_p}{c}\frac{l_p}{\bar{\lambda}}c}{\sqrt{1-\frac{(\Delta v)^2}{c^2}}}\Delta t &\geq \frac{l_p^2}{c} \\ \frac{l_p}{\bar{\lambda}\sqrt{1-\frac{(\Delta v)^2}{c^2}}} &\geq \frac{l_p}{c\Delta t} \end{aligned} \tag{96}$$

Assume now the minimum uncertainty in time is $\Delta t = t_p = \frac{l_p}{c}$, and we put this into the equation above, this gives

$$\begin{aligned} \frac{l_p}{\bar{\lambda}\sqrt{1-\frac{(\Delta v)^2}{c^2}}} &\geq \frac{l_p}{c\frac{l_p}{c}} \\ \frac{l_p}{\bar{\lambda}\sqrt{1-\frac{(\Delta v)^2}{c^2}}} &\geq 1 \end{aligned} \tag{97}$$

Solved with respect to Δv this gives $\Delta v = c\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}}$, and since for a Planck mass particle $\bar{\lambda} = l_p$ this gives $\Delta v = c\sqrt{1-\frac{l_p^2}{l_p^2}} = 0$. So, this confirms that in the special case of the Planck mass particle, we have zero uncertainty. Namely, for the Planck mass particle. the $\geq$ sign in the uncertainty principle becomes an equal sign.

11 An attempt to make a new and simplified quantum mechanics

So far in our paper we are very confident that we have a mathematically rigorous theory that is consistent with all experiments and observations that have been performed in physics. In the next sections we attempt to develop a new and simplified quantum mechanics. However, we are here breaking into uncharted territory on a rather complex topic, so we are less certain about the completeness and interpretation of the theory we will present here than in the rest of the paper. However, we think it, as a minimum, should be seen as an interesting introduction to a potential new path. First of all, it is important to understand that our theory in general is fully consistent with existing quantum mechanics, as our theory also leads to the standard relativistic energy momentum relationship as shown in section 2. Furthermore, we can always switch back from our collision time mass to the standard kg mass simply by multiplying it by the composite constant $\frac{\hbar}{l_p^2}$; however, this will only lead to a more complex theory. That is to say, the existing standard theory that also without modifications cannot lead to unification of gravity with quantum mechanics.

We already have shown in section 2 the standard relativistic energy momentum relation, $E^2 = p^2c^2 + m^2c^4$, is just a function of the much simpler relativistic energy Compton momentum relation, that is given by

$$E = p_t c = mc^2\gamma \tag{98}$$

If we in addition replace the kg mass with the collision time mass and the energy with collision length we get

$$\bar{E} = \bar{p}_t = \bar{m}c\gamma \tag{99}$$

Before we suggest a relativistic wave equation we also have to know if the collision length energy $\bar{E}$, and the Compton momentum $\bar{p}_t$, and the collision time mass, $\bar{m}$, can best be described as scalars or vectors. This must also be chosen in a way that ensures a consistent mathematical theory, that also makes logical sense with respect to our assumptions about the quantum world. In modern physics mass is considered a scalar, the same is the case with energy, while momentum is a vector. Here, we will try to take a closer look at the assumptions behind this based on our new view on matter and energy and momentum.

Assume the smallest possible particle is a spherical indivisible particle, as shown in Figure 2. It clearly has no direction in space as it is perfectly spherical, so it must be a scalar and not a vector. In standard physics elementary particles are point particles, but they also have wave-particle duality. In standard physics it is assumed that the matter wave that has length equal to the de Broglie wavelength spreads out symmetrically in all directions, this is at least one of several possible interpretation of standard physics (?). So yes, standard physics assume a rest-mass is a scalar.

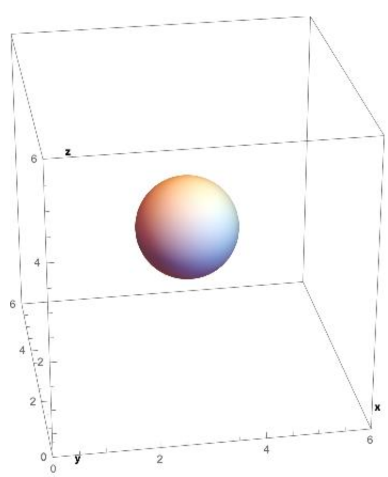

Figure 2: The figure shows one indivisible particle, if it is at rest it is a scalar. However, indivisible particles not colliding are energy that moves at speed c (velocity $\boldsymbol{c}$), since the motion is in a direction they are vectors.

When it comes to macroscopic objects all will likely agree a parked car is standing in a given direction, so it seems like it can better be described by a vector than a scalar (one could naturally come up with a perfectly

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symmetrical car, but that is beyond the point we are making here). However, a ball lying on the ground is symmetrical and is a scalar. Still, we could imagine that if the building blocks of the ball were many oval-shaped particles, then the individual building blocks of the ball would be vectors. What we are interested in is if the most fundamental particles are vectors or scalars. In our model the ultimate particle is indeed indivisible, but this is a particle that always travels at velocity $\boldsymbol{c}$, except when colliding with other particles. This particle makes up both energy and mass. When it moves, and it moves with velocity $\boldsymbol{c}$, then it is what we call energy. So, if the particle in Figure 1 moves relative to the observer in a given direction then it can likely best be described as a vector. That is to say, energy is likely to be a vector at the deepest level, not a scalar. In this model a photon is a series of such particles moving after each other with distance to distance between them equal to the photon wavelength. A mass in our model is two colliding indivisible particles, the Planck mass particle, this is illustrated in Figure 3.

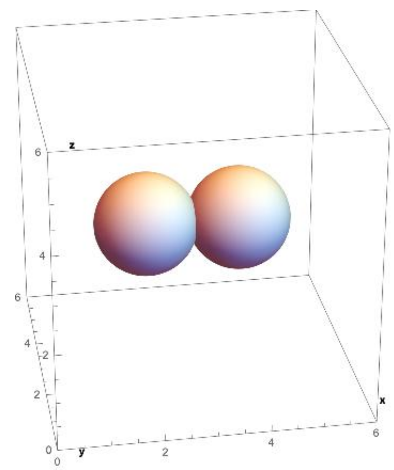

Figure 3: The figure shows two indivisible particles colliding; this structure is what we call mass, it can simplified be described as a vector as the two-sphere structure has direction in space.

The Planck mass particle, consisting of two colliding indivisibles, is not symmetrical, it has a direction in space, so it is a vector. Non-Planck-mass particles in our model consist of indivisible particles, each moving back and forth over a distance equal to the reduced Compton wavelength of that particle and then colliding – this can be illustrated by Figure 4, this is also clearly a vector as such a structure also have a direction in space.

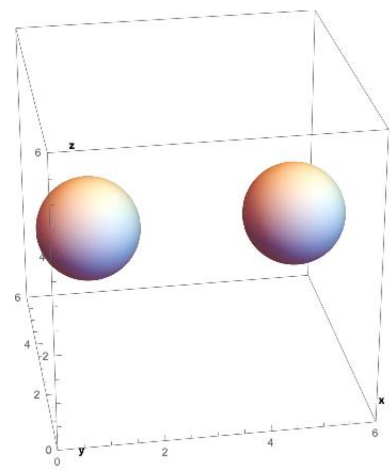

Figure 4: The figure shows two indivisible particles traveling after each other with a distance center to center equal to the Compton wave, this is a vector.

From this perspective we have the kg mass as a vector

$$\boldsymbol{m} = (m_x, m_y, m_z) = \frac{\hbar}{\boldsymbol{\bar{\lambda}}}\frac{1}{c} = \left(\frac{\hbar}{\bar{\lambda}_x}\frac{1}{c}, \frac{\hbar}{\bar{\lambda}_y}\frac{1}{c}, \frac{\hbar}{\bar{\lambda}_z}\frac{1}{c}\right), \tag{100}$$

or in terms of collision time mass

$$\bar{\boldsymbol{m}} = (\bar{m}_x, \bar{m}_y, \bar{m}_z) = \frac{l_p}{c}\frac{l_p}{\bar{\boldsymbol{\lambda}}} = \left(\frac{l_p}{c}\frac{l_p}{\bar{\lambda}_x}, \frac{l_p}{c}\frac{l_p}{\bar{\lambda}_y}, \frac{l_p}{c}\frac{l_p}{\bar{\lambda}_z}\right), \tag{101}$$

that is the reduced Compton wavelength in our model is not spreading out in all directions for elementary particles, but has a direction in space, as illustrated in Figures 3 and 4, where the reduced Compton wavelength is the distance center to center between the indivisible particles. This also means the Compton momentum is a vector, as we have

$$\bar{\boldsymbol{p}}_t = (\bar{p}_x, \bar{p}_y, \bar{p}_z) = \bar{\boldsymbol{m}}c\gamma = (\bar{m}_x c\gamma, \bar{m}_y c\gamma, \bar{m}_z c\gamma) \tag{102}$$

Another alternative to assuming that mass is a vector and that the Compton momentum and also energy for this reason is a vector, is to assume the mass is a scalar, but that the Compton momentum and energy still can be vectors by assuming the velocity of light is a vector velocity-field. This would mean we have $\bar{\boldsymbol{p}} = \bar{m}\boldsymbol{c}\gamma$, and $\bar{\boldsymbol{E}} = \bar{m}\boldsymbol{c}\gamma$. Another way to "turn" the Compton momentum and energy into vectors is to multiply each with a unit velocity vector $\hat{\boldsymbol{v}}$, this gives $\bar{\boldsymbol{p}} = \bar{m}c\gamma\hat{\boldsymbol{v}}$ and $\bar{\boldsymbol{E}} = \bar{m}c\gamma\hat{\boldsymbol{v}}$. That is to say, there are several ways to get our theory mathematically consistent, but each method would likely lead to different interpretations, so it is not sufficient just to have it mathematically consistent. A small side step is the photon mass; the photon mass is in general given by simply $p = \frac{\hbar}{\lambda_\gamma}$. There is no need for velocity in the standard photon momentum. The way standard physics turns photon momentum into a vector is by assuming one has a light velocity field and now writing the momentum as fourth momentum, $\mathbf{P}_\gamma = (p_t, p_x, p_y, p_z) = \left(\frac{E}{c}, \frac{Ev_x}{c^2}, \frac{Ev_y}{c^2}, \frac{Ev_z}{c^2}\right)$, however what if it is the wavelength of the photon that has a direction in space? We could then alternatively obtain a vector from the photon momentum in this way, $\boldsymbol{p}_\gamma = (p_x, p_y, p_z) = \frac{\hbar}{\boldsymbol{\lambda}_\gamma} = \left(\frac{\hbar}{\lambda_{\gamma,x}}, \frac{\hbar}{\lambda_{\gamma,y}}, \frac{\hbar}{\lambda_{\gamma,z}}\right)$, this just to illustrates that perhaps our idea of mass being a vector due to assuming the Compton wavelength having a direction in space is likely to be closer to standard theory than one can initially get the impression of it being.

Anyway, let us assume mass, energy and momentum are vectors. Remember the Compton momentum is identical to our new energy definition. This is unlike standard physics. So we have the following relativistic energy momentum relation

$$\bar{\boldsymbol{E}} = \bar{\boldsymbol{m}}c = \boldsymbol{p}_t \tag{103}$$

We can replace the energy vector with the following energy time operator $\hat{\bar{E}} = il_p\nabla_t = l_p\frac{\partial}{\partial t_x}\boldsymbol{i} + l_p\frac{\partial}{\partial t_y}\boldsymbol{j} + l_p\frac{\partial}{\partial t_z}\boldsymbol{k}$, where $\boldsymbol{i}, \boldsymbol{j}, \boldsymbol{k}$ are the standard unit vectors in the directions of the x, y and z coordinates. Further the Compton momentum space operator with $\hat{\bar{p}}_t = il_p^2\nabla = il_p^2\frac{\partial}{\partial x}\boldsymbol{i} + il_p^2\frac{\partial}{\partial y}\boldsymbol{j} + il_p^2\frac{\partial}{\partial z}\boldsymbol{k}$. This gives the following quantum wave equation[8]

$$il_p\nabla_t\psi = -il_p^2\nabla\psi, \tag{104}$$

that should be consistent with our relativistic energy Compton momentum relation, and therefore indirectly also the standard relativistic energy momentum relation, see section 2. Here ψ is a scalar wave-function. We can divide by il_p on each side and simplify further to

$$\nabla_t\psi + l_p\nabla\psi = 0 \tag{105}$$

That is to say we have three-dimensional time and three-dimensional space, so one could even claim six-dimensional collision space-time (3+3), but it is more like the familiar three dimensions in space are both connected to space and time, this because mass is collision time, and mass also has a physical extension at the deepest subatomic level, collision length (energy) also has extension and direction. Collision time and collision length are two sides of the same coin, we cannot observe space without time, and we cannot observe time without space. In this theory it is not like we can move only along the x-axis and at the same time we can decide to move in any of the three time directions: t_x, t_y, t_z. To move only in the x direction in space means we also can only move in the t_x direction in time, the time direction follows the space direction as they are ultimately two sides of the same coin (subatomic reality). Calling our six-dimensional theory simply '*three dimensional space-time*" would perhaps be a better way to coin our theory than six dimensional, after all three-dimensional space-time is three dimensions in space and three in time. In our theory time just means something was standing still while something was moving relative to it. Time simply means we can move in three dimensions. If we could not

[8] We [55] have performed a very similar attempt before, where we got $\frac{\partial\psi}{\partial t} = \boldsymbol{c}\cdot\nabla\psi$, we now have discovered we had made an error there with respect to the energy operator, and that this wave equation should be corrected to $\frac{\partial\psi}{\partial t} = l_p\boldsymbol{c}\cdot\nabla\psi$. The reason we have *pmbc* there and not in our new wave-equation is due to we worked with a mass operator actually then. Back then we also had some inconsistencies with respect to use of vectors and scalars. This time we have also carefully considered if mass and energy are vectors or scalars and paid attention to getting the math consistent here, which leads us to our new and this time we hope complete and robust quantum wave equation of $\nabla_t\psi = l_p\nabla\psi$. Our previous wave equation could likely not handle gravity, but after the fix it should handle gravity, energy, momentum and mass. Remember in our new theory energy (collision-length) is equal to the Compton momentum, that again is equal to the Schwarzschild "radius", so our wave-equation at the same time modells all these, as they at the deepest level are the same.

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move, then the world would be 100% static, and could not even be observed. To observe space we need to move in space, and to also observe time we need to be able to move in space.

We are not the first to seriously consider the quantum world to have three time dimensions and three space dimensions, see for example [89–99] that also suggested there could be three time dimensions and three space dimensions (3+3). Still, this line of thought does not appear to have gained momentum and was principally discussed in the 1970s to 1980s, and is now partly forgotten. Perhaps we are now much closer to understanding the possibility of three time dimensions in addition to three space dimensions.

Our new relativistic quantum equation has quite a different plane wave solution than the Klein–Gordon and Schrödinger equations, but at first glance it looks exactly the same:

$$\psi = e^{i(kx-\omega t)} \tag{106}$$

In our theory, we should have $k = \frac{2\pi}{\lambda}$, where λ is the relativistic Compton wavelength and not the de Broglie wavelength as it is assumed to be in standard wave mechanics, see for example [23, 100]. We have

$$\bar{p}_t = \bar{m}_t c = \frac{l_p}{c}\frac{l_p 2\pi}{\lambda}c = kl_p^2 \tag{107}$$

and we have the relativistic frequency per Planck time is given by $\frac{\bar{E}}{l_p} = \frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}$, this means if ω is the relativistic frequency per Planck time then we have

$$\bar{E} = \bar{m}_t c\gamma = \frac{l_p}{c}\frac{l_p}{\lambda\sqrt{1-\frac{v^2}{c^2}}}c = l_p\frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}} = l_p\omega \tag{108}$$

One normally thinks of frequency as $\frac{c}{\bar{\lambda}}$ (or in relativistic form $\frac{l_p}{\bar{\lambda}}\gamma$), but this is the frequency per second. The frequency per Planck time is $\frac{c}{\bar{\lambda}}t_p = \frac{l_p}{\bar{\lambda}}$. An important point is that the Planck mass particle only lasts the Planck time, so to operate with frequencies above the Planck time will likely not be able to properly describe the full depth of reality. Therefore, standard physics is working with the de Broglie frequency per second, while we are working with the reduced Compton frequency per Planck time.

Based on the above, we can rewrite the plane wave solution as

$$\psi = e^{i(kx-\omega t)} = e^{i\left(\frac{\bar{p}_t}{l_p^2}l_p - \frac{\bar{E}}{l_p}t_p\right)} \tag{109}$$

where $\bar{p}_t$ is the total Compton momentum as defined earlier. So, our quantum wave function is rooted in the Compton wavelength instead of the de Broglie wavelength, and in the collision-time mass instead of the standard kg mass. For the formality of it, we look at the momentum and energy operators and see that they are correctly specified

$$\frac{\partial\psi}{\partial x} = \frac{i\bar{p}_t}{l_p^2}e^{i\left(\frac{\bar{p}_t}{l_p^2}x - \frac{\bar{E}}{l_p}t\right)} \tag{110}$$

This means the momentum operator must be

$$\hat{\bar{p}}_t = -il_p^2\nabla\cdot \tag{111}$$

and for energy we have

$$\frac{\partial\psi}{\partial t} = -\frac{i\bar{E}}{l_p}e^{i\left(\frac{\bar{p}_t}{l_p^2}x - \frac{\bar{E}}{l_p}t\right)} \tag{112}$$

and this gives us an energy operator of

$$\hat{\bar{E}} = il_p\nabla_t \tag{113}$$

We see that also the momentum and energy operators are not the same as under standard quantum mechanics.

12 Formal re-derivation of Heisenberg uncertainty principle based on collision time mass

Based on our Compton momentum operator $\hat{\bar{p}}_t = il_p^2\nabla$, or in the special case when only dealing with the x axis dimension we have the Compton momentum operator: $\hat{\bar{p}}_t = l_p^2\frac{\partial}{\partial x}\boldsymbol{i}$. We can then check if our Compton momentum operator commute with the space operator $\hat{x}$. We should have

$$
\begin{aligned}
[\hat{\bar{p}}_t, \hat{x}]\psi &= [\hat{\bar{p}}_t\hat{x} - \hat{x}\hat{\bar{p}}_t]\psi \\
&= \hat{\bar{p}}_t\hat{x}\psi - \hat{x}\hat{\bar{p}}_t\psi \\
&= l_p^2 i\frac{\partial}{\partial x}\boldsymbol{i}(\psi x) - x l_p^2 i\frac{\partial}{\partial x}\boldsymbol{i}\psi \\
&= il_p^2\left(x\frac{\partial}{\partial x}\boldsymbol{i}\psi + \psi\frac{\partial}{\partial x}\boldsymbol{i}x - x\frac{\partial}{\partial x}\boldsymbol{i}\psi\right) = il_p^2\psi
\end{aligned} \tag{114}
$$

That is to say, $\hat{\bar{p}}_t$ and $\hat{x}$ as expected do not commute, just as in the case for the standard Heisenberg uncertainty principle, and we must have

$$
\begin{aligned}
\Delta\bar{p}_t\Delta x &\geq |\int \psi^*[\hat{\bar{p}}_t, \hat{x}]\psi dx| \\
\Delta\bar{p}_t\Delta x &\geq |il_p^2\int \psi^*\psi dx| \\
\Delta\bar{p}_t\Delta x &\geq |il_p^2| \\
\Delta\bar{p}_t\Delta x &\geq l_p^2
\end{aligned} \tag{115}
$$

This looks unfamiliar, but is nothing more mysterious than the fact that our new mass definition is the kg mass definition multiplied by $\frac{l_p^2}{\hbar}$, and also that our momentum is different than the standard momentum, so we end up with $\Delta\bar{p}_t\Delta x \geq l_p^2$ instead of $\Delta\bar{p}_t\Delta x > \hbar$. In the special case of the Planck mass particle we will challenge whether the procedure above can be used, or at least how it should be interpreted. The Planck mass particle only has a lifetime equal to the Planck time, and the Planck time is the shortest time interval that can exist in our theory, and the Planck length is the shortest space interval one can observe. And we are not thinking about what we can observe from the most advanced technical instruments here, but an ideal quantum observer, which could even be a single photon, or in this case even a single indivisible particle, that in our theory is the building block of all energy and matter. This particle has a diameter equal to the Planck length. The Planck mass particle is two such indivisible particles standing side by side (in a collision) for the Planck time, to then leave each other again at the speed of light. In other words, we cannot look at change in space or change in time for a Planck mass particle, as it would already have dissolved as we went from t_p to $2t_p$, and t_p is the shortest possible time interval, and l_p the shortest length interval. We have shown that a new type of quantum frequency probability is always one for a Planck mass particle. We think it is likely that the Heisenberg uncertainty principle collapses from an uncertainty principle to a certainty principle for the Planck mass particle. One interpretation is that the $\geq$ sign in the uncertainty principle above then simply switches (or simplifies) to an equal sign, and that we in this special case of the Planck mass particle simply have

$$
\begin{aligned}
\bar{p}_t l_p &\geq l_p^2 \\
m_p c\gamma l_p &\geq l_p^2 \\
\frac{\frac{l_p}{c}\frac{l_p}{l_p}}{\sqrt{1-\frac{(\Delta v)^2}{c^2}}}l_p &\geq l_p^2 \\
\frac{\frac{l_p}{c}\frac{l_p}{l_p}}{\sqrt{1-\frac{0^2}{c^2}}}l_p &\geq l_p^2 \\
l_p l_p &\geq l_p^2 \\
1 &\geq 1
\end{aligned} \tag{116}
$$

And naturally we cannot have $1 \geq 1$, but only $1 = 1$. It is as if in the very limit the principle above goes from $\geq$ to just $=$, and this also means the uncertainty collapses. In terms of uncertainty this would naturally mean that we, for the Planck mass particle, have $\Delta\bar{p}_t\Delta x = 0$.

If we are right, this could potentially have major implications for a series of interpretations in quantum mechanics. For example, we would expect there to be implications for entanglement and Bells theorem [101]. Bells theorem was a response to Einstein, Podolsky, and Rosen's hidden variable theory [102], where it is assumed that Bell proved that Einstein, Podolsky, and Rosen's idea about hidden variable theories was wrong. However, Bells theorem is based on what we could say is the hidden assumption that Heisenberg's uncertainty principle always holds, see for example [103, 104]. If the Heisenberg uncertainty principle, when understood from a deeper perspective, is not an uncertainty principle for the Planck mass particle, but becomes a certainty principle in this very limit (or alternatively is simply not valid for Planck mass particles), then we can no longer exclude

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the possibility of hidden variables. We think this is a path worthy of further investigation. After all, we have clearly shown in the gravity sections in this paper that the Planck length can easily be extracted from Newtonian gravity phenomena and only by knowing one other constant c. The Planck length we have shown is likely to be linked to a Planck mass particle. And we have reason to think the Planck mass particle has been misunderstood in the past. We have been searching for an enormously large particle mass, 10^{-8} kg, that is nowhere to be found. Well, this is the mass of the Planck mass particle, but it only exists for the Planck time, and it is therefore observational time window dependent. In terms of kg and in relation to the time unit of one second it corresponds to only about 10^{-51} kg. Even in an electron we claim the Planck mass particle comes into existence at the reduced Compton frequency of the electron, that is $f_e = \frac{c}{\bar{\lambda}_e} \approx 7.76 \times 10^{20}$ times per second. That is an enormous number of times per second that we have a Heisenberg uncertainty principle potentially break down – by break down we simply mean $\geq$ is limited to $=$ and that the uncertainty then disappears. However, this is very hard to detect as the standard Heisenberg uncertainty principle is valid $1 - \frac{l_p}{\bar{\lambda}_e} \approx 1 - 4.1 \times 10^{-23}$ fraction of the observational time. To detect the Heisenberg uncertainty breakdown in a single electron would likely mean being able to measure observable gravity effects from a single electron. This we are not able to do, but we are able to measure gravity effects from massive amounts of protons, that again consist of elementary particles. So in our view can easily measure the breakdown of the Heisenberg uncertainty principle, it is any observable gravity observation.

13 Three dimensional Space-time geometry $(3 + 3 = 6)$

Our quantum wave equation $\nabla_t \psi = l_p \nabla \psi$, must be inconsistent with Minkowski [105] spacetime as our relativistic quantum wave equation only is consistent with six dimensions (three dimensional space-time, three time dimensions plus three space dimensions). An alternative would be to try to re-formulate it as a four-dimensional space-time theory. Actually it is not even clear if Minkowski space-time is fully consistent with standard quantum mechanics, see for example [106] for a discussion on this.

Minkowski space-time is basically given by

$$dt^2c^2 - dx^2 - dy^2 - dz^2 = ds^2 \tag{117}$$

where the space-time interval ds^2 is invariant. It is a four-dimensional space-time, with three space dimensions and one time dimension. In the case where we deal with the simplified case of one dimension in space and time we have the well-known relation

$$dt^2c^2 - dx^2 = ds^2 \tag{118}$$

This relation is directly linked to the Lorentz transformation, as we have

$$t'^2c^2 - x'^2 = \left(\frac{t - \frac{L}{c^2}v}{\sqrt{1 - \frac{v^2}{c^2}}} \right)^2 c^2 - \left(\frac{L - tv}{\sqrt{1 - \frac{v^2}{c^2}}} \right)^2 = s^2 \tag{119}$$

Next, assume we now are working with two events that are distance L apart which are linked with causality. For the two events to be linked by causality, information needs to be sent between them. This could be, for example, in the form of a bullet coming from event one and hitting event two, or for example a sound signal. The signal moves at speed v_2 as observed from the rest frame of L. This means the time between the cause and effect between the two events is $t = \frac{L}{v_2}$. We also have a speed v, which is the velocity of the frame where L is at rest with respect to another reference frame. From this we have

$$t'^2c^2 - x'^2 = \left(\frac{\frac{L}{v_2} - \frac{L}{c^2}v}{\sqrt{1 - \frac{v^2}{c^2}}} \right)^2 c^2 - \left(\frac{L - \frac{L}{v_2}v}{\sqrt{1 - \frac{v^2}{c^2}}} \right)^2 \tag{120}$$

The Minkowski space-time interval is invariant because $s^2 = t'^2c^2 - x'^2$ is invariant. This naturally means it is observed to be the same, no matter what reference frame it is observed from. One way to understand why this is the case is to look at the following derivation

$$
\begin{aligned}
s^2 = t'^2c^2 - x'^2 &= \left(\frac{\frac{L}{v_2} - \frac{L}{c^2}v}{\sqrt{1-\frac{v^2}{c^2}}}\right)^2 c^2 - \left(\frac{L - \frac{L}{v_2}v}{\sqrt{1-\frac{v^2}{c^2}}}\right)^2 \\
&= \left(\frac{L\frac{c}{v_2} - L\frac{v}{c}}{\sqrt{1-\frac{v^2}{c^2}}}\right)^2 - \left(\frac{L - L\frac{v}{v_2}}{\sqrt{1-\frac{v^2}{c^2}}}\right)^2 \\
&= \frac{L^2 - 2L^2\frac{v}{v_2} + L^2\frac{v^2}{v_2^2}}{1-\frac{v^2}{c^2}} - \frac{L^2\frac{c^2}{v_2^2} - 2L^2\frac{v}{v_2} + L^2\frac{v^2}{c^2}}{1-\frac{v^2}{c^2}} \\
&= \frac{L^2 + L^2\frac{v^2}{v_2^2} - L^2\frac{c^2}{v_2^2} - L^2\frac{v^2}{c^2}}{1-\frac{v^2}{c^2}} \\
&= \frac{L^2\left(1 - \frac{v^2}{c^2} + \frac{v^2}{v_2^2} - \frac{c^2}{v_2^2}\right)}{1-\frac{v^2}{c^2}} \\
&= \frac{L^2\left(1 - \frac{v^2}{c^2}\right)\left(1 - \frac{c^2}{v_2^2}\right)}{1-\frac{v^2}{c^2}} \\
&= L^2\left(1 - \frac{c^2}{v_2^2}\right) \qquad (121)
\end{aligned}
$$

That is to say, v is falling out of the equation, and the Minkowski space-time interval is therefore proven invariant. For a given signal speed v_2 between two events, the space-time interval is the same from every reference frame. In the special case where the signal between the two causal events is always moving at $v_2 = c$, then things simplify considerably. In this special case, we have

$$
\begin{aligned}
s^2 = t'^2c^2 - x'^2 &= \left(\frac{\frac{L}{v_2} - \frac{L}{c^2}v}{\sqrt{1-\frac{v^2}{c^2}}}\right)^2 c^2 - \left(\frac{L - \frac{L}{v_2}v}{\sqrt{1-\frac{v^2}{c^2}}}\right)^2 \\
&= \left(\frac{L\frac{c}{v_2} - L\frac{v}{c}}{\sqrt{1-\frac{v^2}{c^2}}}\right)^2 - \left(\frac{L - L\frac{v}{v_2}}{\sqrt{1-\frac{v^2}{c^2}}}\right)^2 \\
&= \frac{L^2 - 2L^2\frac{v}{c} + L^2\frac{v^2}{c^2}}{1-\frac{v^2}{c^2}} - \frac{L^2\frac{c^2}{c^2} - 2L^2\frac{v}{c} + L^2\frac{v^2}{c^2}}{1-\frac{v^2}{c^2}} \\
&= 0 \qquad (122)
\end{aligned}
$$

Namely, in this case the space-time interval is always zero and naturally also invariant. Already in 1960, Rindler[9] [107] showed that the Minkowski space-time could be simplified from $dt^2c^2 - dx^2 - dy^2 - dz^2 = ds^2$ to $dt^2c^2 - dx^2 - dy^2 - dz^2 = 0$ when dealing with light signals, and also in the moving system $dt'^2c^2 - dx'^2 - dy'^2 - dz'^2 = 0$, see also [108].

Next, let us replace L with the reduced Compton wavelength, as this is the distance indivisible particles travel inside particles at the speed of light and then collide. In other words, internally in matter at the very quantum level we only have causality events linked at the speed of light, this gives

$$
\begin{aligned}
s^2 = t'^2c^2 - x'^2 &= \left(\frac{\frac{\bar{\lambda}}{v_2} - \frac{\bar{\lambda}}{c^2}v}{\sqrt{1-\frac{v^2}{c^2}}}\right)^2 c^2 - \left(\frac{\bar{\lambda} - \frac{L}{v_2}v}{\sqrt{1-\frac{v^2}{c^2}}}\right)^2 \\
&= \frac{\bar{\lambda}^2 - 2\bar{\lambda}^2\frac{v}{c} + L^2\frac{v^2}{c^2}}{1-\frac{v^2}{c^2}} - \frac{L^2\frac{c^2}{c^2} - 2L^2\frac{v}{c} + L^2\frac{v^2}{c^2}}{1-\frac{v^2}{c^2}} \\
&= 0 \qquad (123)
\end{aligned}
$$

In the special case of a Planck mass particle, we have $\bar{\lambda} = l_p$ and further we have $v = 0$ since v_{max} for a Planck mass particle is zero. This gives

[9] And perhaps others had showed the same long before him?

$$s^2 = t'^2c^2 - x'^2 \quad = \quad \left(\frac{\frac{\bar{\lambda}}{c} - \frac{\bar{\lambda}}{c^2}0}{\sqrt{1-\frac{v^2}{c^2}}}\right)^2 c^2 - \left(\frac{\bar{\lambda} - \frac{L}{v_2}0}{\sqrt{1-\frac{v^2}{c^2}}}\right)^2 = 0 \tag{124}$$

Which simply means our theory also on this is consistent with the Planck scale. Again the reason why we always have $v = 0$ for the Planck mass particle is that it can only be observed directly from itself. It lasts one Planck time, and its "radius" is the Planck length, it can only "communicate" with itself and can only be observed from one of the two indivisible particles that are part of the Planck mass particle, and that stand next to each other in a collision. The Planck mass particle is always the same, it is invariant, but due to very special reasons, as we have discussed through this paper.

However, our theory likely need the following space-time geometry at the deepest level of reality (needed to describe collision space-time)

$$dx^2 - dy^2 - dz^2 - c^2dt_x^2 + c^2dt_y^2 + c^2dt_z^2 = 0 \tag{125}$$

An important point mentioned by Cole [89] is that, while x, y and z are observable separately, it is often thought that the quantity $t = \sqrt{t_x^2 + t_y^2 + t_z^2}$, is observable only in one time measurement, t. The drawback of this interpretation, as pointed out by Cole, is that if the transformations for the six co-ordinates x, y, z, t_x, t_y, t_z are linear, then the transformations for the quantities x, y, z and t become nonlinear. In other words it seems to lead to simplification to add two time dimensions.

Our theory is three-dimensional space-time theory, and since space-time consists of space and time, it means we have three time dimensions and three space dimensions that are closely tied together. We cannot observe space without motion, and motion requires time, and time requires motion in space. If we, for example, move only in the y direction, then time also has to move in the y direction. That is to say, y in the space directly linked directly to t_y. Collision-space and collision time are two sides of the same coin, which is why we call it collision space-time. A three dimensional space-time geometry is actually nothing more than space plus motion, as time in our theory always is linked to length divided by the speed of the indivisible particle.

14 Summary

We have claimed that the Compton wavelength is the true matter wavelength and that the de Broglie wavelength is simply a mathematical function of this deeper reality. Furthermore, we claim that the standard momentum is also just a mathematical function of what we have coined the Compton momentum. This has led to an unnecessarily complex theory. In addition, we have shown that the de Broglie wavelength and the standard momentum cannot be mathematically defined for rest-mass particles, $v = 0$, so anything that is built on standard momentum, such as standard quantum mechanics and the Heisenberg uncertainty principle, cannot be valid to say anything about rest-mass particles. We have also shown that the Planck mass particle is the very essence of gravity and that it could be the building block of all other masses, and that it is always at rest in its lifetime, but its lifetime is only the Planck time. We have a quantum mechanical theory and a uncertainty principle that are not compatible with rest-mass particles and rest is the very essence of gravity. Therefore, it is perhaps not so strange that we not have been able to unify gravity with quantum mechanics.

We have also shown that standard physics indirectly used two different mass definitions. There is, in our view, an embedded, more correct, mass definition in gravity theory that one obtains from multiplying the kg mass with G. In all non-gravity parts of physics, one is using an incomplete mass definition, and this also makes it impossible to unify gravity and quantum mechanics, before this is understood and fixed, as we have attempted to start to do in this paper. When this is done it seems that we obtain a deeper and simpler theory, and we can, from this theory, derive "all" the most well-known formulas in physics, and it can then be shown that many of them are unnecessarily complex, and that they often cannot describe rest-mass particles. On the other hand, the new and deeper theory is also fully consistent with rest-mass particles. Rest-mass particles are the essence to understanding gravity from a quantum perspective, as it seems like gravity is directly linked the Planck mass particle where rest ($v = 0$) is essential.

Table 8 summarizes some of our key findings. In column two we show a theory built around the de Broglie wavelength, and in column three a theory built around the Compton wavelength. A theory consistently built around the de Broglie wavelength has a momentum and actually a mass that is not valid for rest $v = 0$. When one then builds a quantum theory based on this, this theory also cannot say anything about rest-masses, and in our theory it is essential to understand rest to be able to unify quantum mechanics with gravity.

15 Conclusion

We have discussed how the Compton wavelength is potentially the real matter wavelength, and how the de Broglie wavelength is likely to be a mathematical function (derivative) of the Compton wavelength. We have

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	"Standard" physics: derivatives of deeper reality, de Broglie wavelength consistent:	**Deeper reality: Compton wavelength consistent:**
Matter wavelength	$\bar{\lambda}_b$ de Broglie	$\bar{\lambda}$ Compton
Relativistic mass	$m = \frac{\hbar}{\bar{\lambda}_b}\frac{1}{v}\gamma$	$\bar{m} = \frac{l_p}{c}\frac{l_p}{\bar{\lambda}}\gamma$
Rest mass	$m = \frac{\hbar}{\bar{\lambda}_b}\frac{1}{v}$ Not valid for $v = 0$ Not valid rest-mass	$\bar{m} = \frac{l_p}{c}\frac{l_p}{\bar{\lambda}}$ valid for $v = 0$
Momentum	$p = mv\gamma$ de Broglie based	$\bar{p}_t = \bar{m}c\gamma$ Compton based
Energy	$E = mc^2\gamma$	$\bar{E} = \bar{m}c\gamma$
Energy momentum relation	$E^2 = p^2c^2 + m^2c^4$	$\bar{E} = \bar{p}_t = \bar{m}c\gamma$
Collision-state probability	not defined (concealed), implicit also above one	$\frac{l_p}{\bar{\lambda}} \leq \frac{l_p}{\bar{\lambda}}\gamma \leq 1$
Maximum velocity mass	$v < c$	$v \leq c\sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}}$
Uncertainty principle	$\Delta p \Delta x > \hbar$	$\Delta p \Delta x \geq l_p^2$
Relativistic wave equation	$\frac{\partial^2\psi}{\partial t^2} = \nabla^2\psi + \frac{m^2c^2}{\hbar^2}\psi$ Klein-Gordon	$\nabla_t\psi = -l_p\nabla\psi$
Space-time geometry	$dtc^2 - dx^2 - dy^2 - dz^2 = ds^2$	$dt_x^2 + dt_y^2 + dt_z^2 = dx^2 + dy^2 + dz^2$
Newtonian type gravity	$F = G\frac{Mm}{R^2}$	$F = c^3\frac{M\bar{m}}{R^2}$
Gauss law of gravity	$\nabla^2\phi = 4\pi G\rho$	$\nabla^2\phi = 2\pi c^2\frac{r_s}{V}$
Number of universal constants	$G, \hbar, c$	l_p, c

Table 8: The table shows a summary of how our theory leads to simplification of series of equations/relationships, and still our theory is compatible with the standard equations, but we have shown that many of the standard equations not are compatible with such things as rest-mass particles.

also shown how the standard momentum must be consistent and can also be derived from the de Broglie wavelength. In contrast to the Compton wavelength, the de Broglie wavelength is not mathematically valid for rest-mass particles. Furthermore, we claim that the standard momentum since it must be consistent with the de Broglie wavelength cannot be valid for rest-mass particles. Quantum mechanics, including the Heisenberg uncertainty principle, has its foundation in the standard momentum and or the de Broglie wavelength. Much of our existing theory can therefore say nothing about rest mass particles. We have however introduced a new momentum that is directly linked to the Compton wavelength and is also fully valid for rest-mass particles.

In addition, we have shown that physics uses two mass definitions without being aware of it. In gravity theory, standard physics is using a more complete mass definition than the standard kg definition, that is embedded in G multiplied by M. This is without being aware of it, while in the rest of physics one is using an incomplete kg mass definition. We must both switch to the Compton wavelength from the de Broglie wavelength and from the kg mass to a new mass definition that is already embedded in existing gravity physics in order to have a chance to unify gravity with quantum mechanics. We have attempted to do so in this paper. This seems to also lead to a simplification of quantum mechanics. We get a quantum mechanical setup that seems to represent a three-dimensional space-time, i.e. three dimensions in space and their correspondent three dimensions in time. Our new and deeper understanding of mass and gravity also makes us able to extract the Planck length and also the speed of gravity directly from observable gravity phenomena without any prior knowledge to other constants. It seems as if the three universal constants, G, $\hbar$ and c can be replaced with only two universal constants, namely l_p and c. All masses can be seen as a Planck mass multiplied by a quantum probability for the particle to be in a collision state, the same with energy. In our theory mass is collision time and energy is collision length.

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