An Inconsistency in Modern Physics and a Simple Solution

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

November 5, 2019

Abstract

In this paper, we will point out an important inconsistency in modern physics. When relativistic momentum and relativistic energy are combined with key concepts around Planck momentum and Planck energy, we find an inconsistency that has not been shown before. The inconsistency seems to be rooted in the fact that momentum, as defined today, is linked to the de Broglie wavelength. By rewriting the momentum equation in the form of the Compton wavelength instead, we get a consistent theory. This has a series of implications for physics and cosmology.

Key words: Special relativity theory, length contraction, Planck length, Planck time, trans-Planck.

1 Introduction

In 1899, Max Planck [1, 2] assumed there were three essential and universal constants: the Planck constant, the speed of light, and the gravitational constant. By using dimensional analysis, he then derived what he considered to be some very fundamental units, namely, length, time, mass, and energy. Today these are known as the Planck units.

The Planck mass is given by

$$m_p = \sqrt{\frac{\hbar c}{G}} \tag{1}$$

The Planck mass can also be found independent of any knowledge of Newton's gravitational constant, as shown in other work [3, 4]. Max Planck himself was not completely clear about the nature of the Planck mass. This mass is very large compared to the rest-mass of any observed elementary particle and has generated consideration speculation over the years. Lloyd Motz was likely the first to suggest there could be a Planck mass particle, see [5–7]. He thought that the Planck mass particle was truly essential, but he was also well aware that the Planck mass (about 10^{-8} kg) was substantially larger than any observed fundamental particle. Therefore, he suggested the Planck mass particle had existed just after the Big Bang and then disintegrated into all of the much smaller particles observed today. Others, like Hawking, have suggested that the Planck mass particle is linked to micro black holes, see [8–10]. We will return to this later and show that there is a much simpler solution for the missing Planck mass particle, but first we will evaluate Planck energy and Planck momentum.

The Planck energy is given by

$$E_p = m_p c^2 \tag{2}$$

and the Planck momentum [11] is given by

$$p_p = m_p c \tag{3}$$

Einstein's theory of special relativity plays a role here, and the relativistic momentum in modern physics is given by

$$p = \frac{mv}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{4}$$

and, finally, the relativistic total energy is given by

$$E = \frac{mc^2}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{5}$$

2 The Inconsistency

Assume we have an elementary mass, m, that after acceleration has a total relativistic energy equal to the Planck energy

$$m_p c^2 = \frac{mc^2}{\sqrt{1-\frac{v^2}{c^2}}} \tag{6}$$

Next we solve this with respect to v and we get

$$v = c\sqrt{1-\frac{m^2}{m_p^2}} < c \tag{7}$$

This velocity is always smaller than the speed of light in a vacuum and this is the same velocity that we have described in a series of papers as an exact upper maximum velocity for elementary particles, see [3, 12, 13].

However, whether this is a new maximum velocity or not is worth further study, although that is not the main point here. However, a very interesting feature of this velocity formula is that if $m = m_p$, then in order to have Planck mass energy, the velocity of the Planck mass particle must be zero. This is no surprise, as $m_p c^2$ can indeed be seen as the rest-mass energy. Moving to the Planck momentum, we find that $p_p = m_p c$, and we can set up the following relation

$$m_p c = \frac{mv}{\sqrt{1-\frac{v^2}{c^2}}} \tag{8}$$

solved with respect to v, this gives

$$v = \frac{c}{\sqrt{1+\frac{m^2}{m_p^2}}} \tag{9}$$

We naturally see this is different than the velocity formula 7. Assume that the mass m is a Planck mass particle with mass m_p. It must move at the following velocity to have Planck mass momentum

$$v = \frac{c}{\sqrt{1+\frac{m_p^2}{m_p^2}}} = \frac{c}{\sqrt{2}} \tag{10}$$

Now this is beginning to sound a bit strange, or we could say inconsistent. On one hand, the Planck mass particle must be standing still in order to have the Planck energy. This seems logical enough as $m_p c^2$ does look like a rest-mass in terms of special relativity. But this also means that a Planck mass particle that has Planck energy cannot have Planck momentum at the same time. Further, why would an almost magical speed of $\frac{c}{\sqrt{2}}$ be required for the Planck mass particle to reach Planck momentum? This indicates that the Planck mass momentum is not a special momentum for the Planck mass particle, because what strange mechanism would limit such a particle to staying below $\frac{c}{\sqrt{2}} \approx 0.7c$? We have not heard of any such mechanism, but it could be an open question.

If we shift the analysis from Planck mass particles and look only at observed particles, then there still cannot be a single type of particle that, when accelerated to any velocity $v < c$, will have Planck energy at the same time at which it has Planck momentum. We can see this by trying to solve the following relation with respect to v

$$\frac{E}{c} = p \tag{11}$$

$$\frac{mc^2}{c\sqrt{1-\frac{v^2}{c^2}}} = \frac{mv}{\sqrt{1-\frac{v^2}{c^2}}} \tag{12}$$

The only solution to this is when $v = c$, but then we would have infinite relativistic mass, which is impossible. One could naturally argue that Planck mass particles do not exist at all, and in fact, we have never observed any elementary particles with a mass anywhere close to the Planck mass.

This would also mean that if a Planck mass particle existed, then there cannot be a limit on momentum for elementary particles equal to the Planck mass momentum. Some physicists agree with this, as special relativity technically allows the relativistic momentum of even the smallest elementary particle to approach but never reach infinity. This is because the only restriction is $v < c$ for anything with mass within SR. However, this is absurd, as it would lead theoretically to electrons that have a relativistic mass larger than the rest-mass of the Sun or even the entire Milky Way, see [14].

Again, we revisit the question posed earlier: Why should a Planck mass particle (if it exists) have a magical velocity equal to $\frac{c}{\sqrt{2}}$ in order to have Planck mass momentum? If this prediction on the need for such a velocity is correct (in theory) then it is very likely that the Planck mass particle does not actually exist. However, there is a much simpler solution to this puzzle.

3 The de Broglie Wave Length versus the Compton Wave

Around 1923, Louis de Broglie [15, 16] suggested that matter had wave-like properties. It has also been shown that the wavelength of a photon could be found using the following formula

$$\lambda = \frac{h}{p} \tag{13}$$

where p is the photon's momentum. A photon's momentum is therefore given by

$$p = \frac{\hbar}{\lambda} \tag{14}$$

Further, the energy of a photon is given by

$$E = \frac{\hbar}{\lambda} c \tag{15}$$

Even if modern physics cannot agree on whether a photon has mass or not, at least we can calculate its equivalent mass simply by dividing the energy by c^2. Thus the momentum of a photon can be written as

$$p = E/c^2 \times c = mc = \frac{\hbar}{\lambda} \tag{16}$$

However, for non-photons the momentum is given by the formula

$$p = \frac{mv}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{17}$$

When $v << c$, this can be approximated by the first term of a Taylor series expansion as the well-known $p \approx mv$.

There are several interesting things to notice here. The momentum formula for something with rest-mass is different than the momentum formula for photons. In other words, we appear to have different theories for photons and for matter. The fact that we use separate formulas for photons and matter indicates, in our view, that modern physics has not been completely successful at unifying matter and energy. Although we do have Einstein's $E = mc^2$, which gives a relation between rest-mass and energy.

In about the same year as de Broglie suggested his matter wave, Arthur Compton measured a wavelength from electron scattering; this was later known as the Compton wave, see [17]. While the previously mentioned de Broglie wave has never been measured, the Compton wavelength has been measured in a long series of experiments. The de Broglie wavelength is given by

$$\lambda_b = \frac{h}{\frac{mv}{\sqrt{1-\frac{v^2}{c^2}}}} \tag{18}$$

and from the formula we can see that the de Broglie wavelength is infinite if the particle stands still. Naturally, one could argue the particle cannot stand still. However, there are many interpretations in the modern physics literature with regard to the electron being everywhere in the universe until observed, based on this property of the de Broglie wavelength. Such interpretations do not seem to make much sense though and may actually be based on a failure to understand what the de Broglie length truly represents.

Next the Compton wavelength of a rest-mass particle is given by

$$\lambda_c \approx \frac{\hbar}{mc} \tag{19}$$

notice that this would be identical to how one finds the wavelength of a photon, because the momentum of a photon is given by $mc = \frac{\hbar}{\lambda}$. The relativistic version of the Compton wavelength must be

$$\lambda_c = \frac{\hbar}{\frac{mc}{\sqrt{1-\frac{v^2}{c^2}}}} \tag{20}$$

This means the de Broglie wavelength is always directly linked to the Compton wavelength through the following relation

$$\lambda_b = \lambda_c \frac{c}{v} \tag{21}$$

That is to say, the unobserved de Broglie wavelength is always a derivative of the observed Compton wavelength. One can also ask why we need two matter waves. Photons only have one photon wavelength, not one that is very long while the other is short. We think the de Broglie wavelength is simply a mathematical artifact that is not necessary and has actually caused a series of very strange and illogical interpretations. As a promising alternative, a full theory of quantum mechanics can be developed from the Compton wave rather than the de Broglie wave, see [18, 19].

4 Compton Momentum

The rest-mass of any mass can be found by the following formula

$$m = \frac{h}{\lambda_c}\frac{1}{c} \tag{22}$$

It has been shown experimentally that one can find the rest-mass of electrons by finding the Compton wavelength of the electron first. The same cannot be done from the de Broglie wavelength; the rest-mass formula from the de Broglie wavelength would be

$$m = \frac{h}{\lambda_c}\frac{1}{c} = \frac{h}{\lambda_b \frac{v}{c}}\frac{1}{c} = \frac{h}{\lambda_b}\frac{1}{v} \tag{23}$$

but again this leads to an inconsistency when $v = 0$, because we cannot divide by zero. For $v > 0$ and at the same time $v << c$, the formula above gives correct answers for masses of particles. However, formula 22 always gives the correct answer when $v << c$, and we can easily extend it to a relativistic mass as well.

$$\frac{m}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{\frac{h}{\lambda_c}\frac{1}{c}}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{h}{\lambda_c\sqrt{1-\frac{v^2}{c^2}}}\frac{1}{c} = \frac{h}{\lambda_c\sqrt{c^2-v^2}} \tag{24}$$

The interpretation should be that when a mass is moving, the only thing that can undergo length contraction is the Compton wavelength. Similarly, if written in terms of the de Broglie wavelength, this would be

$$\frac{m}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{\frac{h}{\lambda_b}\frac{1}{v}}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{h}{\lambda_b\sqrt{1-\frac{v^2}{c^2}}}\frac{1}{v} = \frac{h}{\lambda_b\sqrt{v^2-\frac{v^4}{c^2}}} \tag{25}$$

This formula works well as long as v not is equal to zero. However, when $v = 0$ the formula is not valid.

5 The Compton Momentum versus de Broglie Momentum

We have shown in the section above that the de Broglie wavelength (which has never been observed) is simply the observed Compton wavelength multiplied by $\frac{c}{v}$. We have also introduced a new momentum, namely what we will call the Compton momentum. The total Compton momentum is given by

$$p_c = \frac{mc}{\sqrt{1-\frac{v^2}{c^2}}} \tag{26}$$

while the de Broglie momentum, which is the standard momentum, is given by

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

We see that the relation between these two momentums is identical to the relation between the de Broglie wavelength and the Compton wavelength. We have that

$$p_b = p_c\frac{c}{v}, \qquad \text{and} \qquad \lambda_b = \lambda_c\frac{c}{v} \tag{28}$$

Notice that when $v = 0$, we have no standard momentum (de Broglie momentum), while we still have Compton momentum. The Compton momentum is mathematically identical to a photon's momentum when $v = 0$. That is to say, we suddenly have a rest-mass momentum in addition to moving momentum. We will claim that there are three types of momentum: rest-mass momentum, kinetic momentum, and total momentum, just as there are three types of energy (rest mass energy, kinetic energy and total energy). The rest-mass momentum is given by

$$p_{c,r} = \frac{mc}{\sqrt{1-\frac{0^2}{c^2}}} = mc \tag{29}$$

The kinetic momentum is given by

$$p_{c,k} = \frac{mc}{\sqrt{1-\frac{v^2}{c^2}}} - mc \tag{30}$$

which, when $v << c$, is approximately equal to $p_{c,k} \approx \frac{1}{2}m\frac{v^2}{c}$. And the total momentum is given by

$$p_{c,t} = p_{c,r} + p_{c,k} = \frac{mc}{\sqrt{1-\frac{v^2}{c^2}}} \tag{31}$$

Recall that our maximum velocity formula $v = c\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}}$ is equal to zero when $\bar{\lambda} = l_p$. This means the Planck mass particle always has a rest-mass momentum equal to

$$p_{c,r} = \frac{mc}{\sqrt{1-\frac{0^2}{c^2}}} = m_p c \tag{32}$$

So, the rest-mass momentum of a Planck mass particle seems to be linked to the properties of photons. However, the Planck mass particle must always stand still. The interpretation should be that the Planck mass particle is, in fact, the collision point between photons.

In our view, the interpretation is that there only exists one mass, it is the Planck mass, and it is directly linked to photons. In previous work, we have described the case where a Planck mass particle only exists for one Planck second before it dissolves into energy again. An electron, for example, is a Planck mass particle at its Compton frequency, so it is a Planck mass $\frac{c}{\bar{\lambda}}$ times per second, and each of these Planck mass events only lasts for one Planck second. This gives the correct electron mass. This is covered in much more detail in [19].

6 The velocity Inconsistency Discussed and Generalized to a Discrete Wavelength

The velocity $v = \frac{c}{\sqrt{2}}$ is where the standard relativistic momentum of a Planck mass particle predicts a Planck momentum. This is the velocity where the length contracted de Broglie wavelength is identical to the rest-mass Compton wavelength. So, basically

$$\begin{aligned} \lambda_c \times \frac{c}{v}\sqrt{1-v^2/c^2} &= \lambda_{c,r} \\ \lambda_b\sqrt{1-v^2/c^2} &= \lambda_{c,r} \end{aligned} \tag{33}$$

Since $\lambda_b = \lambda_c \frac{c}{v}$, this gives $v = \frac{c}{\sqrt{2}}$. However, in our view this only shows that the standard momentum can be "fudged" to fit a Planck momentum even for a Planck mass particle, but at the cost of having a velocity different than where we will get the Planck energy for a Planck mass particle ($v = 0$). We can see this more clearly by completing the following derivation:

$$\begin{aligned} \frac{m_p v}{\sqrt{1-v^2/c^2}} &= m_p c \\ \frac{m_p \frac{c}{\sqrt{2}}}{\sqrt{\frac{1}{2}}} &= m_p c \end{aligned} \tag{34}$$

Also, we must have

$$\frac{m_p v}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{\frac{\hbar}{l_p}\frac{1}{c}v}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{\hbar}{l_p\frac{c}{v}\sqrt{1-\frac{v^2}{c^2}}}\frac{1}{v} = \frac{\hbar}{\lambda_b\sqrt{1-\frac{v^2}{c^2}}}\frac{1}{v} \tag{35}$$

This means that the length contracted de Broglie length for a Planck mass particle will be below the Planck length when the Planck mass particle is moving at a velocity greater than $\frac{c}{\sqrt{2}}$. The relativistic length contracted reduced Compton wavelength length is naturally shorter than the Planck length for any velocity if the rest Compton length is the Planck length (a Planck mass particle). However, even if the de Broglie wavelength is infinite for a particle at rest, its contracted length is shorter than the Planck length for a Planck mass particle when the particle passes a velocity of $\frac{c}{\sqrt{2}}$. Again, it seems not to make sense from a logical perspective. The de Broglie wave is a mathematical derivative of the real matter wave, which is the Compton wavelength. The Planck mass particle can, in our view, only exist when it stand still relative to the observer. It only exists in one Planck second and the observer must be the Planck mass particle itself in order to observe it. It is the collision point of two light particles. A photon-photon collision is, even by standard physics, theoretically considered to be “The simplest mechanism by which pure light can be transformed into matter?” [20], see also [21]. However, even if the speed of light is considered to be c, we have not seen any discussion of what the photon speed is just at the moment of collision with another photon. In our Compton momentum model, it is zero because something cannot still be moving at speed c when it is in a collision point.

Interestingly, there cannot exist a de Broglie wave with length equal to the Planck length that does not have a Compton wave shorter than the Planck length. This because a de Broglie wave shorter than infinity means the particle must be moving, and since the Compton wave always is the de Broglie wave times $\frac{v}{c}$, it must be shorter than the de Broglie wave. And if the de Broglie wave is now the Planck length, then the Compton wave must be shorter than the Planck length. Actually the Compton wavelength and the de Broglie wave are the same in the special case when $v = c$, which again is not possible for any particle that has rest-mass, as it would mean infinite relativistic mass. Current standard theory would indicate that if one assumes a minimum length, there must be two minimum length limits at the same time, one for the Compton wave, which must be different than the de Broglie wave. This is absurd, and not necessary. All we need to do is to understand that de Broglie is a pure derivative of the Compton wave. So, the minimum length applies to the Compton wave, not the de Broglie wave.

Discrete waves

Next we can extend this to the assumption that the Compton wave can only come in discrete length units of $\bar{\lambda} = Nl_p$. The shortest possible reduced Compton wave is then $\bar{\lambda} = 1 \times l_p = l_p$, that is the Planck length. If we also assume the shortest relativistic length contracted Compton length is the Planck length, then a particle with reduced Compton wavelength $N \times l_p$ have a maximum velocity given by

$$l_p = Nl_p\sqrt{1 - \frac{v^2}{c^2}} \tag{36}$$

solved with respect to v gives

$$v = c\sqrt{1 - \frac{1}{N^2}} \tag{37}$$

For a very large N, this speed limit is very close to that of light. However, for $N = 1$ we see the maximum velocity is zero. This is what we found before in our formula $v = c\sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}}$, when $\bar{\lambda} = l_p$. There is a close connection between these formulas. If we assume, for example, the Compton wavelength of an electron $\bar{\lambda}_e = Nl_p$, then $N = \frac{\bar{\lambda}_e}{l_p}$ and we see the two formulas are essentially the same, based on the assumption that the reduced Compton wavelength of the electron is exactly N number of Planck length.

$$v = c\sqrt{1 - \frac{1}{N^2}} = c\sqrt{1 - \frac{1}{\left(\frac{\bar{\lambda}}{l_p}\right)^2}} = c\sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}} \tag{38}$$

The reduced Compton wavelength of an electron is enormous compared to the Planck length, and the Planck length is very short, so it is not possible to detect directly whether or not the Compton length comes in discrete units from electrons. The main point here is that it is compatible with a discrete version and this is inconsistent with the de Broglie approach if we also assume the Planck length is the minimum length.

Next assume a rest-mass particle with reduced Compton wavelength $\bar{\lambda} = Nl_p$. How fast can the particle move for the length contracted de Broglie wavelength to be greater than the Planck length? We need to solve the following equation

$$Nl_p\frac{c}{v}\sqrt{1 - v^2/c^2} > l_p \tag{39}$$

solved with respect to v, this gives

$$\begin{aligned} v &< c\frac{N}{\sqrt{N^2+1}} \\ v &< c\frac{1}{\sqrt{1+\frac{1}{N^2}}} \end{aligned} \tag{40}$$

Now, let us compare the two maximum velocity formulas that prevent the relativistic Compton wavelength and the relativistic de Broglie wavelength to go below the minimum length.

$$c\frac{1}{\sqrt{1+\frac{1}{N^2}}} > c\sqrt{1 - \frac{1}{N^2}} \tag{41}$$

as we see, the maximum velocity is larger for the de Broglie wavelength. This means in standard physics, there cannot be a Planck length (or any length) limit that applies to both the Compton wave and the de Broglie wave; we can only have a limit on one of them, or else we must have two different limits. Let us look at the Taylor series expansion for these two maximum velocity predictions

$$\sqrt{1-\frac{1}{N^2}} \approx 1-\frac{1}{2}\frac{1}{N^2}-\frac{1}{8}\frac{1}{N^4}-\frac{1}{16}\frac{1}{N^6} \tag{42}$$

and

$$\frac{1}{\sqrt{1+\frac{1}{N^2}}} \approx 1-\frac{1}{2}\frac{1}{N^2}+\frac{3}{8}\frac{1}{N^4}-\frac{5}{16}\frac{1}{N^6} \tag{43}$$

Next we will take the difference between them

$$\frac{1}{\sqrt{1+\frac{1}{N^2}}}-\sqrt{1-\frac{1}{N^2}} \approx \frac{1}{2}\frac{1}{N^4} \tag{44}$$

We can easily see that when N is very large, then they are almost the same. The difference using the first three terms in the Taylor series expansion is only $\frac{1}{2}\frac{1}{N^4}$. For an electron, this would mean a speed difference of $c\frac{1}{2}\frac{1}{N^4}=c\frac{1}{2}\frac{1}{\left(\frac{\bar{\lambda}}{l_p}\right)^4}=c\frac{1}{2}\frac{l_p^4}{\bar{\lambda}_e^4}\approx 4.62\times 10^{-82}\ m/s$. This would be impossible to observe. Yet, the main point is that the de Broglie wave (and the standard momentum) seems consistent with Compton (and Compton momentum) derivations from an experimental point of view, as long as we are working with particles much lighter than the Planck mass.

For a Planck mass particle, we have $N=1$, and then we get a maximum velocity for the particle (for its Compton wavelength) to not fall below the Planck length to be $v=c\sqrt{1-\frac{1}{1^2}}=0$, while the de Broglie maximum velocity tells us the particle cannot move faster than $v=c\frac{1}{\sqrt{1+\frac{1}{1^2}}}=c\frac{1}{\sqrt{2}}$. Here the difference in speed is massive and should be easy to detect. Clearly, we have not observed a particle with maximum velocity $c\frac{1}{\sqrt{2}}$, and also there is no known mechanism around this velocity. On the other hand, for our maximum velocity of $v=0$ there is a very simple and logical mechanism and explanation why this likely exists, but is hard to observe. This is the point of a photon-photon collision, also internally in all matter. This collision is a Planck mass that lasts for one Planck second, as it stands still. Still, as we actually need to be the particle itself to observe it, as it only lasts for one Planck second and has a Compton length equal to the Planck length. This view can even provide a unification between quantum mechanics and gravity, see [19].

7 A Short History of Momentum

It is useful to see this topic in a historic perspective. Momentum, close to the sense in which the term is used in modern physics, was possibly first described mathematically by John Jennings in 1721. Jennings says that momentum is the quantity of matter multiplied by the velocity, which is the standard: $p=mv$ that we know today. However, we should keep in mind that momentum was defined before relativity theory had been developed and the scientists of the era also knew very little about the quantum world. Taking a fresh approach and redefining the momentum the way we have done above, e.g., the so-called Compton momentum, simplifies calculations and interpretations. The standard momentum is, as we have shown, rooted in the de Broglie wavelength, and we can also see the standard momentum as a derivative of the Compton momentum, where we have the standard momentum as the Compton momentum times v/c.

8 Summary of Key Findings

- The unobserved de Broglie wavelength is simply a mathematical derivative of the observable Compton wavelength. We always have the relation $\lambda_b=\lambda_c\frac{c}{v}$.
- It is impossible to have a Planck length (or any length) as a minimum length for both the Compton and the de Broglie wave at the same time. One must choose one of them, and as we have shown it is the Compton wave that is the true matter wave, not the de Broglie wave.
- The de Broglie wavelength is infinite for rest-mass particles. This is absurd and has been misinterpreted by modern physics. The solution is to switch to the Compton wavelength, which is the true matter wave.
- The momentum derived from the de Broglie wavelength, which is the standard momentum, will be zero for a rest-mass particle. On the other hand, the rest-mass momentum derived from the Compton wavelength

is $p = mc$, which is the same as for photons. This indicates a relation between mass and photons, just like the rest-mass energy relation of Einstein: $E = mc^2$.

- In standard physics, one operates with different formulas for momentum for photons and matter. This is not necessary if one switches to Compton momentum.
- The de Broglie wavelength has, contrary to what many physicists assume, never been observed. On the other hand, the Compton wavelength has been observed very accurately many times. The misunderstanding that the de Broglie wavelength has been confirmed stems from observations showing matter has wave-like properties, but this is not because matter has a de Broglie wave, it is because matter has a Compton wave.
- The rest-mass formula derived from the de Broglie wavelength blows up for a rest-mass particle, because we have division with zero. The rest-mass formula derived from the Compton wavelength gets the correct rest-mass.
- Many of quantum mechanics absurd predictions are rooted in the fact that one has derived the theory from the unobservable de Broglie wavelength rather than the Compton wavelength.
- Only by deriving a theory from the Compton wavelength are we able to get a consistent theory, including a unified quantum gravity theory.

Summary in relation to relation to standard theory and the Planck scale

- If a Planck mass particle exists, then according to standard theory it must stand still to have Planck energy, and it must move at velocity $\frac{c}{\sqrt{2}}$ to have Planck momentum. It is strange that we should have a special velocity of $\frac{c}{\sqrt{2}}$. Under our modified theory, we find that the Planck mass energy and the Planck momentum only exist for Planck mass particles (two colliding light particles) when at rest; the collision point is at rest and only lasts for one Planck second.
- The Planck mass is, according to standard theory, massive compared to any observed elementary particle and even compared to protons. To explain its features, some have theorized that Planck mass particles only existed at the beginning of the Big Bang, or that such particles are hiding in micro black holes or in black holes. We think that this is attributable to problems with the model. In our theory, the Planck mass particle is a observational time window-dependent mass. It is only the Planck mass when observed over one Planck second. If observed over a second, it is about 10^{-51} kg.

9 Conclusion

In this paper, we have explained how there are inconsistencies in modern physics in relation to the Planck scale. Further, we have shown that several inconsistencies and strange interpretations disappear if we use a momentum rooted in the Compton wavelength rather than the de Broglie wavelength.

References

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

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

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

[4] E. G. Haug. Finding the Planck length independent of Newton’s gravitational constant and the Planck constant: The Compton clock model of matter. *https://www.preprints.org/manuscript/201809.0396/v1*, 2018.

[5] L. Motz. Gauge invariance and the structure of charged particles. *Il Nuovo Cimento*, 26(4), 1962.

[6] L. Motz. A gravitational theory of the mu meson and leptons in general. *Rutherford Observatory, Columbia University*, 1966.

[7] L. Motz. The quantization of mass. *Rutherford Observatory, Columbia University*, 1971.

[8] S. Hawking. Gravitationally collapsed objects of very low mass. *Monthly Notices of the Royal Astronomical Society*, 152, 1971.

[9] L. Motz and J. Epstein. The gravitational charge $1/2\sqrt{\hbar c}$ as a unifying principle in physics. *Il Nuovo Cimento*, 51(1), 1979.

[10] G. M. Obermair. Primordial Planck mass black holes (ppmbhs) as candidates for dark matter? *Journal of Physics, Conference Series*, 442, 2013.

[11] A. Casher and S. Nussinov. Is the Planck momentum attainable? *arXiv:hep-th/9709127*, 1997.

[12] E. G. Haug. The gravitational constant and the Planck units. A simplification of the quantum realm. *Physics Essays Vol 29, No 4*, 2016.

[13] E. G. Haug. The ultimate limits of the relativistic rocket equation. The Planck photon rocket. *Acta Astronautica*, 136, 2017.

[14] E. G. Haug. Modern physics incomplete absurd relativistic mass interpretation. and the simple solution that saves Einstein’s formula. *Journal of Modern Physics*, 9(14), 2018.

[15] de. L. Broglie. Waves and quanta. *Nature*, 112(540), 1923.

[16] de. L. Broglie. Recherches sur la thorie des quanta. *PhD Thesis (Paris)*, 1924.

[17] A. H. Compton. A quantum theory of the scattering of x-rays by light elements. *Physical Review. 21 (5):*, 21(5), 1923.

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

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

[20] O. J. Pike, F. Mackenroth, E. G. Hill, and Rose S. J. A photon–photon collider in a vacuum hohlraum. *Nature Photonics*, 8, 2014.

[21] B. King and C. H. Keitel. Photon–photon scattering in collisions of intense laser pulses. *New Journal of Physics*, 14, 2012.