Further Development on Collision Space-Time: Unified Quantum Gravity

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Abstract

We will here show that there is one more relativistic wave equation rooted in the relativistic energy Compton moment relation, which should not be confused with the standard relativistic energy momentum relation. The standard momentum is, from a quantum perspective, rooted in the de Broglie wave. The de Broglie wave is not mathematically defined for rest-mass particles and has strange properties such as converging to infinity when the particle is almost at rest. As mentioned in the previous paper, the de Broglie wave is likely just a mathematical derivative of the true matter wave, which we have good reasons to think is the Compton wave. A wave equation that satisfies the relativistic energy Compton momentum relation will, in addition automatically satisfy the standard relativistic energy momentum relation, so there is no conflict between these two relations. The new one related to Compton is just the deeper reality and help explain why it gives simpler and more elegant relativistic wave equations, which are likely easier to interpret in terms of the physical reality.

Key Words: quantum mechanics, de Broglie wavelength, Compton wavelength, collision space-time

1 One More Relativistic Wave Equation for Collision Space-Time

We have, in the previous paper, argued that from a quantum perspective the standard momentum is directly linked to the de Broglie wave. The de Broglie wavelength [2, 3] is given by

$$\lambda_b = h/(mv\gamma) \tag{1}$$

where $\gamma = 1/\sqrt{1-\frac{v^2}{c^2}}$. First of all, this means the de Broglie wave is not mathematically defined for a rest-mass particle. This because when $v = 0$, we are dividing by zero, which in general is not considered acceptable in mathematics. Based on the Heisenberg uncertainty principle [4, 5], we could try to claim that the particle can never stand still, so that $v = 0$ is irrelevant, but then $E = mc^2$ would only be an approximation, or it would not be valid, as then no particle can stand still. Second, even if we just let v be close to zero, but not exactly zero, then the de Broglie wave converges to infinity, which can lead to absurd predictions, i.e., that the electron is everywhere, or extends everywhere in the universe until observed, even if we observed it one second ago. An infinite or close to infinite matter wavelength, in our view, is simply absurd.

Still, let us take the de Broglie wave for granted for a moment. Now if we solve the de Broglie wave equation with respect to $mv\gamma$, the relativistic momentum, we get

$$p = mv\gamma = \frac{h}{\lambda_b} \tag{2}$$

That is, from a quantum perspective, the standard momentum is always linked to the de Broglie wave. Some readers might protest here, as the relativistic momentum was published long before the de Broglie wave, and they might claim that only the de Broglie wave can be derived from the momentum, as this came first. Such argumentation we will claim is flawed. The fact that something was discovered first does not make it more fundamental. On the contrary, physics is mostly developed from the top down. Most discoveries in physics have been achieved by first observing macroscopic everyday objects and coming up with mathematical models of their behavior. Then, typically later on, we have been able to tie these models to the quantum world. So, when we first have an insight in the quantum world, we can just as well derive from it. And if this means that the de Broglie wave actually represents something fundamental about the quantum world, then we can just as well derive a momentum from it, as we have done here.

That the de Broglie wave not is defined for a rest-mass particle, also means that the standard momentum does not exist for a rest-mass particle. In other words, it is not just that the standard momentum is zero for a rest-mass particle, instead, the standard momentum is not mathematically defined for a rest-mass particle.

Around the same time that de Broglie introduced his matter wave hypothesis, Compton [6] published a formula for a wavelength linked to matter that today is known as the Compton wave

$$\lambda = \frac{h}{mc} \tag{3}$$

Actually, the original Compton wave formula published in 1923 is only valid for a rest-mass particle; the relativistic version of it is

$$\lambda = \frac{h}{mc\gamma} \tag{4}$$

Unlike the de Broglie wavelength, the Compton wavelength is also well-defined mathematically when $v = 0$. Further, when v is close to zero, the Compton wave is still at the size of the quantum realm (sub-microscopic), while the de Broglie wave absurdly converges to infinity. Similar to that, we solved the de Broglie wavelength formula for momentum, and here we can derive another type of relativistic momentum given by $p_t = mc\gamma$, this gives

$$p_t = mc\gamma = \frac{h}{\lambda} \tag{5}$$

we have used the notation p_t rather than p to distinguish it from the standard momentum; and we can call p_t the total Compton momentum. It is also well-defined for $v = 0$, unlike the standard momentum. When $v = 0$, we get

$$p_t = \frac{mc}{\sqrt{1 - 0^2/c^2}} = \bar{m}c \tag{6}$$

this we can call the rest-mass Compton momentum and use notation p_r for it. A rest- mass momentum may sound strange, as we are used to thinking that momentum is only related to something that is moving. But it is no more strange than rest-mass energy. If we have a moving particle, we can take its total Compton momentum and subtract the rest-mass Compton momentum and then considering this to be the kinetic Compton momentum, we get

$$p_k = p_t - p_r = \frac{mc}{\sqrt{1 - 0^2/c^2}} - mc \tag{7}$$

From this line of thought, we also have a new relativistic energy Compton momentum relation. This is not taken to exist instead of the standard relativistic energy momentum relation, $E^2 = p^2c^2 + m^2c^4$, but in addition to it. This new relativistic energy Compton momentum relation is given by

$$E = \mathbf{p}_t c \tag{8}$$

that also can be written as

$$E = \mathbf{p}_t c = \mathbf{p}_k c + mc^2 \tag{9}$$

From here we can derive two new relativistic wave equations when using the standard mass definition m and and energy definition, as is used in the relation above. We have done this in a recent working paper, see [7]. Here our main focus is to go beyond this work, as we will do in the next section. In the appendix we prove that the relativistic energy momentum relation is directly linked to the relativistic energy Compton momentum relation.

2 Collision Space-Time

In collision space-time, we need to replace the standard kg mass definition: m ($m = \frac{\hbar}{\lambda}\frac{1}{c}$), with $\bar{m} = \frac{l_p}{c}\frac{l_p}{\lambda}$, which, as we have previously described, is collision-time (internal collision time in any mass, that is the cause of gravity). When we have replaced m with $\bar{m}$, we uses notation $\bar{p}_t$, $\bar{p}_k$, $\bar{p}_r$ instead of p_t, p_k and p_r to make it clear when we are working with Compton momentum based on the standard mass definition, and when the work is based on our new more complete mass definition (that is already embedded in standard gravity indirectly, see [8]).

In our previous paper [1], we have defined energy as collision length, and the relation between energy and mass as

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

this is not in conflict with Einstein?s $E = mc^2$, in fact, it is fully consistent with this, as discussed in our previous paper. The relativistic energy from our new energy definition and its relation to the Compton momentum is

$$\bar{E} = \bar{\mathbf{p}}_t = \bar{\mathbf{p}}_k + \bar{m}c \tag{11}$$

where $\bar{\mathbf{p}}_t = \bar{m}c\gamma$ and $\bar{\mathbf{p}}_k = \bar{m}c\gamma + \bar{m}c$. In [1], we derived a relativistic wave equation by using a momentum operator on the total Compton momentum, $\bar{p}_t$. Here, we present a new relativistic wave equation related to collision space-time, which is derived and based on using a momentum operator on the kinetic Compton momentum instead; this gives a kinetic momentum operator of $\hat{\bar{\mathbf{p}}}_k = -il_p^2\nabla$, an energy operator of $\hat{\bar{E}} = il_p^2\frac{\partial}{\partial t}$, and a relativistic wave equation of

$$il_p^2\frac{\partial}{\partial t}\Psi = \left(-il_p^2\nabla + \bar{m}c\right)\Psi \tag{12}$$

that can be simplified by dividing by il_p^2 on both sides of the equation. This gives

$$i\frac{\partial}{\partial t}\Psi = \left(-i\nabla + \frac{\bar{m}c}{l_p^2}\right)\Psi \tag{13}$$

As $\frac{l_p^2}{\bar{m}c} = \bar{\lambda}$, this can also be written as

$$i\frac{\partial}{\partial t}\Psi = \left(-i\nabla + \frac{1}{\bar{\lambda}}\right)\Psi \tag{14}$$

This is a first order relativistic wave equation that can also be used in quantum gravity because $\bar{E} = \frac{l_p^2}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}} = \frac{1}{2}r_s\gamma$, where r_s is the Schwarzschild radius.

So, the energy operator is, at the same time, a Schwarzschild radius operator. Total energy (collision length) is the same as a relativistic Schwarzschild radius. However, the interpretation of the Schwarzschild "radius" is very different here than in standard gravity theory, see [1].

We obtain almost the same relativistic wave equation if we decide to work with the standard mass and energy definitions (but still from Compton momentum rather than standard momentum), then we get:

$$i\frac{\partial}{\partial t}\Psi = \left(i\nabla + \frac{mc^2}{\hbar}\right)\Psi \tag{15}$$

That also can be written as

$$i\frac{\partial}{\partial t}\Psi = \left(i\nabla + \frac{c}{\bar{\lambda}}\right)\Psi \tag{16}$$

However, we cannot tie this wave equation to gravity if it is rooted in the standard kg mass definition of modern physics, see also [8].

We plan to complete additional work on these new wave equations and their implications in the near future and welcome comments on the work completed so far.

3 Appendix

There is no conflict between the new relativistic energy Compton momentum relation and the standard energy momentum relation. A wave equation that satisfies the new relativistic energy Compton momentum relation will automatically satisfy the standard energy momentum relation. We will prove here that the relativistic energy momentum relation and the relativistic energy Compton momentum relation are effectively two sides of the same coin, where the the relativistic energy Compton momentum relation is much closer to what is going on at the deepest level of reality, while the standard energy momentum relation is an over complicated way to model quantum mechanics through the de Broglie momentum, p, and therefore indirectly the de Broglie wavelength.

It is useful for the following derivation to use the notation $p = mv\gamma$, $p_0 = mv$, and $p_t = mc\gamma$ so we have

$$
\begin{aligned}
E^2 &= p^2c^2 + m^2c^4 \\
E^2 &= p_0^2c^2\gamma^2 + m^2c^4 \\
E^2 &= m^2v^2c^2\gamma^2 + m^2c^4 \\
E^2 &= m^2c^4v^2/c^2\gamma^2 + m^2c^4 \\
E^2 &= m^2c^4\left(\frac{v^2}{c^2} - 1\right)\gamma^2 + m^2c^4\gamma^2 + m^2c^4 \\
E^2 &= \frac{m^2c^4\left(\frac{v^2}{c^2} - 1\right)}{1 - \frac{v^2}{c^2}} + m^2c^4\gamma^2 + m^2c^4 \\
E^2 &= \frac{-1 \times m^2c^4\left(\frac{v^2}{c^2} - 1\right)}{-1 \times \left(1 - \frac{v^2}{c^2}\right)} + m^2c^4\gamma^2 + m^2c^4 \\
E^2 &= -m^2c^4 + m^2c^4\gamma^2 + m^2c^4 \\
E^2 &= m^2c^4\gamma^2 \\
E &= mc^2\gamma \\
E &= p_tc = p_kc + mc^2 \qquad (17)
\end{aligned}
$$

we are showing it rigorosly line by line as it is of great importance to be aware of that the two relativistic energy momentum relations, one linked to the de Broglie wave, and the other linked to the Compton are two sides of the same coin, a wave equation satisfying the last line, will automatically also satisfy the first line.

and we can naturally go the other way around

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

In other words, there is no conflict between the relativistic energy momentum relation and the relativistic energy and Compton relation; they are two facets of the same relation, where the simpler, yet deeper way to model it is through the relativistic energy Compton relation. This also holds for photons, but in order to understand this, one needs to study our collision space-time paper carefully.

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