Heisenberg Quantum Probabilities
God Does Not Throw Dice at the Planck Scale, but Below!

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Abstract

In this paper we suggest that working with the Planck mass and its link to other particles in a simple way it possible to "convert" the Heisenberg uncertainty principle into a very simple quantum probabilistic model. We further combine this with key elements from special relativity theory and get an interesting quantum relativistic probability theory. Some of the key points presented here could help to eliminate negative (pseudo) probabilities that often are used in standard quantum mechanics. These fake probabilities may be rooted in a failure to understand the Heisenberg principle fully in relation to the Planck mass. When properly understood, the Heisenberg principle seems to give a probabilistic range of quantum probabilities that are sound. There are no instantaneous probabilities and the maximum probability is always unity. In our formulation, the Planck mass particle is always related to a probability of one. Thus, we have certainty at the Planck scale for the Planck mass particle or for particles accelerated to reach Planck energy, but only for one Planck second.

Key words: Heisenberg's uncertainty principle, quantum probabilities, relativistic probabilities, from uncertainty to certainty.

1 From Heisenberg's Uncertainty Principle to Quantum Probabilities

Heisenberg's uncertainty principle [1] is given by

$$\Delta p \Delta x \geq \hbar \tag{1}$$

assume now that p is the Planck momentum, $p = m_p c$. This is actually the only momentum that is directly linked to the speed c. For all non-Planck mass elementary particles, we have a momentum related to a velocity $v < c$. The velocity v is not certain and can take a large range of values so the momentum cannot be certain for non-Planck mass particles. Inputting the Planck momentum in the equation for Heisenberg's uncertainty principle, we get

$$m_p c \Delta x \geq \hbar \tag{2}$$

Since the Planck momentum always is $m_p c$, we will claim that the inequality should be exchanged for an equality in this special case. If so, we must have $\Delta x = l_p$, where l_p is the Planck length first introduced by Max Planck in 1899 [2, 3]. In other words, we claim there is a certainty principle for the Planck mass

$$m_p c l_p = \hbar \tag{3}$$

This we can also write as

$$m_p = \frac{\hbar}{l_p}\frac{1}{c} \tag{4}$$

which is a known expression for the Planck mass. We also have

$$\begin{aligned} \Delta p c \Delta x &\geq \hbar c \\ \Delta p c \frac{\Delta x}{c} &\geq \hbar \\ \Delta E \frac{\Delta x}{c} &\geq \hbar \end{aligned} \tag{5}$$

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Again, in the special case of the Planck mass we have a momentum of $p = m_p c$, so we will claim there is no uncertainty in the Planck momentum and therefore we have

$$m_p c^2 \frac{\Delta x}{c} = \hbar \tag{6}$$

Since $m_p = \frac{\hbar}{l_p}\frac{1}{c}$, the relationship above can only hold true if $\Delta x = l_p$, and $\frac{l_p}{c}$ is the Planck time. The fact that this is related to the Planck time is significant. However, this certainty in the Planck mass, the Planck momentum, and even the Planck mass particle only exists for one Planck second. In other words, we offer a hypothesis that there is a certainty principle that lasts for one Planck second, which is related to the Planck mass particle, the Planck momentum, and the Planck energy. We will see how this plays an important role in taking us from uncertainty in momentum and position in Heisenberg's uncertainty principle for all non-Planck masses towards a simple probabilistic quantum theory.

It is well-known that any subatomic mass can be written as

$$m = \frac{\hbar}{\bar{\lambda}}\frac{1}{c} \tag{7}$$

where $\bar{\lambda}$ is the reduced Compton wavelength of the particle in question. For example, for an electron we have

$$m_e = \frac{\hbar}{\bar{\lambda}_e}\frac{1}{c} \approx 9.10938 \times 10^{-31} \text{ kg} \tag{8}$$

We also show that the mass of any particle can be described as a function of the Planck mass by the following formula

$$m = m_p \frac{l_p}{\bar{\lambda}} \tag{9}$$

this simple relationship was possibly first pointed out by Hoyle, Burbidge, and Narlikar in 1994; see [4]. Based on this, the electron mass can also be written as

$$m_e = \frac{\hbar}{l_p}\frac{1}{c}\frac{l_p}{\bar{\lambda}_e} = m_p \frac{l_p}{\bar{\lambda}_e} \tag{10}$$

We will suggest that the term $\frac{l_p}{\bar{\lambda}_e}$ can also be considered a quantum probability that is linked to a one Planck second observational time window. The electron mass in its probabilistic form for one Planck second is therefore just an expected rest-mass

$$E[m_e] = m_p \frac{l_p}{\bar{\lambda}_e} = m_e \tag{11}$$

The electron mass in a very short observational window is simply an expectation and a function of the Planck mass. The idea is that the Planck mass particle make up all other masses. We suggest that an electron consists of $\frac{c}{\bar{\lambda}_e} \approx 7.76344 \times 10^{20}$ Planck masses per second. However, each Planck mass only lasts for one Planck second, so the mass of the electron must be

$$m_e = \frac{c}{\bar{\lambda}_e} \times 1.17337 \times 10^{-51} \approx 9.10938 \times 10^{-31} \text{ kg} \tag{12}$$

The value 1.17337×10^{-51} is simply a Planck mass in one Planck second. This is somewhat similar to Schrödinger's [5] hypothesis in 1930 of a Zitterbewegung ("trembling motion" in German) in the electron that he indicated was approximately

$$\frac{2mc^2}{\hbar} = \frac{2c}{\bar{\lambda}_e} \approx 1.55269 \times 10^{21} \tag{13}$$

This is exactly twice our assumed Planck mass frequency in the electron per second. We think our number is the more relevant one here, but it is interesting to see that the old Masters where probably not far from similar ideas. In any case, what is important here is that every mass can be expressed as a function of the Planck mass multiplied by its quantum probability. And each particle has a quantum probability equal to

$$P = \frac{l_p}{\bar{\lambda}} \tag{14}$$

For a proton, we will get an expected rest-mass in a Planck second observational time window of

$$E[m_{\mathbf{P}}] = m_p \frac{l_p}{\bar{\lambda}_P} \approx 1.67262 \times 10^{-27} \text{ kg} \tag{15}$$

Next we will move on to take this concept further to relativistic probabilities.

2 Relativistic Quantum Probabilities

We will claim that our introduced quantum probabilities must follow relativistic rules. We will claim every elementary particle must have a relativistic quantum probability that is

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

Many will likely protest here, because if we only rely on combining this with Einstein's special relativity theory [6] it means we can get relativistic probabilities above unity and even close to infinite probabilities. This would be absurd and would not lead to a good theory. However, this problem has actually already indirectly been solved (without the author knowing that this also was related to sound quantum probabilities before now). In recent years, Haug has published a series of papers [7, 8, 9] where he shows strong theoretical evidence in favor of the idea that elementary particles have a maximum velocity of

$$v_{max} = c\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}} \tag{17}$$

For example, for an electron this means the maximum velocity is

$$v_{max} = c\sqrt{1-\frac{l_p^2}{\bar{\lambda}_e^2}} \approx c \times 0.99999999999999999999999999999999999999999999912412 \tag{18}$$

More important here is that at this maximum velocity for each particle, the quantum relativistic probability can take on a maximum value of

$$\begin{aligned}
P &= \frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v_{max}^2}{c^2}}} \\
P &= \frac{l_p}{\bar{\lambda}\sqrt{1-\frac{\left(c\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}}\right)^2}{c^2}}} \\
P &= \frac{l_p}{\bar{\lambda}\sqrt{1-\frac{c^2\left(1-\frac{l_p^2}{\bar{\lambda}^2}\right)}{c^2}}} \\
P &= \frac{l_p}{\bar{\lambda}\sqrt{1-1+\frac{l_p^2}{\bar{\lambda}^2}}} \\
P &= \frac{l_p}{\bar{\lambda}}\frac{\bar{\lambda}}{l_p} = 1
\end{aligned} \tag{19}$$

Thus Haug's maximum velocity very elegantly leads to a maximum quantum probability of one. This means we get a boundary condition on the quantum probability for each elementary particle for each Planck second of

$$\frac{l_p}{\bar{\lambda}} \leq P \leq 1 \tag{20}$$

Still, the relativistic quantum probability range will be different for each elementary particle. The maximum relativistic mass a particle can take is directly linked to its maximum velocity and thereby to its maximum probability of one. The maximum relativistic mass for any particle is the Planck mass multiplied by the maximum relativistic probability, which is one, and not surprisingly we get

$$\text{Expected relativistic maximum mass electron} = m_p\frac{l_p}{\bar{\lambda}_e\sqrt{1-\frac{v_{max}^2}{c^2}}} = m_p \times 1 = m_p \tag{21}$$

How should we interpret this? It means at its maximum velocity any subatomic particle becomes a Planck mass, when relying on quantum probabilities. This also means that the original Heisenberg uncertainty principle collapses and become the certainty principle at the Planck scale. In addition, the Lorentz symmetry is broken at the Planck scale.

The Planck mass particle is a particularly interesting case; its reduced Compton wavelength is $\bar{\lambda} = l_p$, which gives a probability range for the Planck mass particle of

$$\begin{aligned}\frac{l_p}{l_p} &\leq P_p \leq 1 \\ 1 &\leq P_p \leq 1 \end{aligned} \tag{22}$$

This can only be true if the Planck particle quantum probability always is $P_p = 1$. This naturally means there is no uncertainty for the Planck mass particle. One could criticize this approach and say this is not so strange, since we have defined the Planck momentum as certain from the beginning. However, there is more to it and this shows that the theory is consistent. As also pointed out by Haug in several earlier papers, the maximum velocity for the Planck mass particle is also very unique; it is

$$v_{max} = c\sqrt{1 - \frac{l_p^2}{l_p^2}} = 0 \tag{23}$$

and this makes the relativistic quantum probability of the Planck mass particle consistent; it is

$$P_p = \frac{l_p}{l_p\sqrt{1 - \frac{v_{max}^2}{c^2}}} = \frac{l_p}{l_p\sqrt{1 - \frac{0^2}{c^2}}} = \frac{l_p}{l_p} = 1 \tag{24}$$

Our interpretation here is that the Planck mass particle is the very collision point of the light particles making up each elementary particle. This also explain why a Planck mass particle can have momentum of $m_p c$. Naturally, the Planck mass particle must follow relativistic rules, so we must have

$$p_p = \frac{mc}{\sqrt{1 - \frac{v^2}{c^2}}} = mc \tag{25}$$

which can only happen if $v = 0$. Our interpretation is that the Planck mass particle bursts into energy within one Planck second and the entire momentum is used internally to achieve that transformation. We also get a hint about the lifetime of a Planck particle from the Planck acceleration, $a_p = \frac{c^2}{l_p} \approx 5.56092 \times 10^{51}\ m/s^2$. The Planck acceleration is assumed to be the maximum possible acceleration by several physicists; see [10, 11], for example. The velocity of a particle that undergoes Planck acceleration will actually reach the speed of light within one Planck second: $a_p t_p = \frac{c^2}{l_p}\frac{l_p}{c} = c$. However, we know that nothing with rest-mass can travel at the speed of light, so no "normal" particle can undergo Planck acceleration if the shortest possible acceleration time interval is the Planck second. The solution is simple. The Planck acceleration is an internal acceleration inside the Planck particle that within one Planck second turns the Planck mass particle into pure energy.

Further, the Planck mass particle is the same from every reference frame across reference frames. It clearly breaks Lorentz symmetry, something that also several quantum gravity theories predict, among them a newly introduced quantum gravity theory that is derived from the Heisenberg principle that relies on the quantum probability approach presented here.

3 Probabilistic Summary

In this short section we will summarize some of our key findings in tables. Table 1 shows the range for the relativistic quantum probability for an electron, a proton, and a Planck mass particle.

	Probability range	**Probability range**
Electron quantum probability	$\frac{l_p}{\bar{\lambda}_e} \leq P_e \leq 1$	$4.18532 \times 10^{-23} \leq P_e \leq 1$
Proton quantum probability	$\frac{l_p}{\bar{\lambda}_P} \leq P_P \leq 1$	$7.6849 \times 10^{-20} \leq P_P \leq 1$
Planck particle quantum probability	$\frac{l_p}{l_p} \leq P_p \leq 1$	$P_p = 1$

Table 1: The table show the range for the relativistic quantum probability for an electron, a proton, and a Planck mass particle. .

Table 2 shows the standard relativistic mass as well as the probabilistic approach; they are consistent. Be aware that there must be a maximum velocity limit on anything with mass; this will be equal to Haug's maximum velocity.

	Standard appproache	**Probabilisitic approach observation in one Planck second**
Electron mass	$m=\frac{m_e}{\sqrt{1-\frac{v^2}{c^2}}}=\frac{\frac{\hbar}{\bar{\lambda}_e}\frac{1}{c}}{\sqrt{1-\frac{v^2}{c^2}}}$	$E[m]=m_pP_e=m_p\frac{l_p}{\bar{\lambda}_e\sqrt{1-\frac{v^2}{c^2}}}\geq m_e$
Proton mass	$m=\frac{m_{\mathbf{P}}}{\sqrt{1-\frac{v^2}{c^2}}}=\frac{\frac{\hbar}{\bar{\lambda}_P}\frac{1}{c}}{\sqrt{1-\frac{v^2}{c^2}}}$	$E[m]=m_pP_P=m_p\frac{l_p}{\bar{\lambda}_P\sqrt{1-\frac{v^2}{c^2}}}\geq m_{\mathbf{P}}$
Planck mass particle	$m_p=\frac{m_p}{\sqrt{1-\frac{0^2}{c^2}}}=m_p$	$E[m]=m_pP_p=m_p\frac{l_p}{l_p\sqrt{1-\frac{0^2}{c^2}}}=m_p$

Table 2: This table shows the standard relativistic mass as well as the probabilistic approach. Be aware of the notation difference between the Planck mass m_p and the proton rest mass $m_{\mathbf{P}}$.

	Standard appproache	**Probabilisitic approach observation in one Planck second**
Electron mass	$m=\frac{m_e}{\sqrt{1-\frac{v^2_{max}}{c^2}}}=m_p$	$E[m]=m_pP_e=m_p\frac{l_p}{\bar{\lambda}_e\sqrt{1-\frac{v^2_{max}}{c^2}}}=m_p\times 1=m_p$
Proton mass	$m=\frac{m_{\mathbf{P}}}{\sqrt{1-\frac{v^2_{max}}{c^2}}}=m_p$	$E[m]=m_pP_P=m_p\frac{l_p}{\bar{\lambda}_P\sqrt{1-\frac{v^2_{max}}{c^2}}}=m_p\times 1=m_p$
Planck mass particle	$m_p=\frac{m_p}{\sqrt{1-\frac{v^2_{max}}{c^2}}}=m_p$	$E[m]=m_pP_p=m_p\frac{l_p}{l_p\sqrt{1-\frac{v^2_{max}}{c^2}}}=m_p\times 1=m_p$

Table 3: This table shows the standard relativistic mass as well as the probabilistic approach at the maximum velocity only.

4 Something is Rotten in Standard Probabilistic Quantum Mechanics

We will claim there is something rotten in modern quantum mechanics, despite its extreme success in predicting what we observe in experiments. The Wigner [12] quasi-probability distribution is well-known can take on negative values and values above unity, see also . Even if these negative probabilities never are observed in practice, they play a central role in quantum mechanics to get the math to fit observations. Renormalization is another ad-hoc method that has been used repeatedly for years; over time it has become an acceptable procedure that few physicists are questioning these days.

However, an important critic of renormalization was Feynman [14]. Clearly, he had a central role in the development of quantum electrodynamics, and yet he claimed

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

We strongly suspect that the negative and above unity probabilities, as well as renormalization in standard quantum mechanics, could be related to the fact that modern physics does not have an exact maximum velocity limit on anything with rest-mass. They only have the limit $v<c$, which means that one can get basically as close to infinite kinetic energies and infinite relativistic masses as one wants. No matter how close the speed v is to the speed of light, one can always get a little closer to the speed of light. If the probabilistic approach presented here is correct, this means that standard quantum mechanics likely has embedded within it quantum probabilities above unity ? something that is absurd. The flawed ad-hoc adjustment for this is to add a probability function that allows negative probabilities to get the sum of probabilities in order now to not break other basic probabilistic rules. Two fake probabilities: negative and above unity may give a correct prediction, but it can also lead to spooky interpretations. Further, the assumption of instantaneous probabilities could also lead to fake probabilities. If the shortest possible time interval is one Planck second, then the ultimate quantum probabilities should be linked up to that observational time window as we have done here. The Planck length and the Planck second are closely connected, and so are the probabilistic presented in this paper.

5 Conclusion

In this paper we have suggested that $\frac{l_p}{\bar{\lambda}}$ can be interpreted as quantum probability related to the rest-mass of each particle. Further, we claim the relativistic version of this quantum probability simply is $\frac{l_p}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}$. This can only hold true if elementary particles are limited by Haug's suggested maximum velocity for elementary particles. This speed limit is $v_{max} = c\sqrt{1-\frac{v^2}{c^2}}$, which actually corresponds to a maximum velocity that Haug has recently derived from the Heisenberg principle when simply assuming that the Planck length is the shortest length one can measure. Because standard physics does not have such a speed limit, but simply maintains that $v < c$, we suspect this is the reason for the reliance on fake probabilities such as negative and above-unity quasi-probabilities. By studying this paper and other recent and related papers by Haug, it is possible that we may be able to solve some of the big challenges in quantum mechanics in a new and more elegant way, which also reduces the amount of spooky interpretations that exist in today's quantum mechanics.

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