The Incompatibility of the Planck Acceleration and Modern Physics? And a New Acceleration Limit for Anything with Mass after Acceleration

Espen Gaarder Haug*
Norwegian University of Life Sciences

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Abstract

The Planck second is likely the shortest relevant time interval. If the Planck acceleration lasts for one Planck second, one will reach the speed of light. Yet, according to Einstein, no particle with rest-mass can travel at the speed of light because this would require an infinite amount of energy. Modern physics is incompatible with the Planck acceleration in many ways. However, in atomism we see that the Planck acceleration happens for the building blocks of the Planck mass and that the Planck mass is dissolved into energy within one Planck second. Further, the Planck mass stands absolutely still as observed from any reference frame. Atomism is fully consistent with the Planck acceleration. The relativistic Planck acceleration is unique among accelerations because it can only happen from absolute rest; it is therefore the same as the Planck acceleration. In other words, atomism predicts breaks in Lorentz invariance at the Planck scale, something several quantum gravity theories address as well. Atomism seems to solve a number of challenges in modern physics and this paper is one of a series in pointing this out.

Key words: Planck acceleration, relativistic Planck acceleration, Planck mass, mass gap, atomism.

Planck Acceleration

The Planck acceleration is known to be

$$a_p = \frac{m_p c^3}{\hbar} = \frac{c}{t_p} = \frac{c^2}{l_p} \approx 5.5609210^{51} \tag{1}$$

where l_p is the Planck length and t_p is the Planck second, see [1]. In 1984, Scarpetta had already predicted this as the maximum acceleration possible, [2], something also suggested by [3]:

> *"the 'Planck acceleration' is both the maximum acceleration for an elementary particle in free space and also the surface gravity of a black hole with minimum mass m_p" – Falla and Landsberg 1994*

However, as pointed out by [4], for example, this enormous acceleration means that one will reach the speed of light after one Planck second, $a_p t_p = c$. Modern physicists do not really know exactly what the Planck length, the Planck mass, or the Planck second represent. They also do not know precisely how to incorporate them into the framework of modern physics. However, many physicists assume that the Planck second must be the shortest time interval possible. This lead to an interesting paradox. Nothing with rest-mass can undergo Planck acceleration, even for one Planck second. This because no object with rest- mass can travel at the speed of light, since this would require an infinite amount of energy, as first pointed out by Einstein, see [5]. So does this mean the Planck acceleration is meaningless, or merely fiction?

This is where mathematical atomism comes in. Here, when two indivisible particles are colliding they are the very foundation of mass; they become the Planck mass, see [6, 7]. This mass only lasts for one Planck second before the two colliding particles leave each other and turn into pure energy (light) once again. The indivisible particles have no rest-mass when they are not colliding; then they are massless. However, they have what we can call potential mass – this mass show up as rest-mass in the Planck second of collision, a moment when they are at absolute rest.

The smallest building blocks of the universe have a rest-mass equal to half of the Planck mass. Whenever we are working with rest-mass, we are always working with two indivisible particles. Thus the smallest rest-mass

*e-mail espenhaug@mac.com.

is the Planck mass, which lasts for one Planck second. As applied to standard particles in modern physics, it is more correct to claim that the rest-mass of an indivisible particle is 5.86685×10^{-52} kg (when colliding).

The atomism model is fully consistent with Planck acceleration and holds that we can go from a velocity of zero to the speed of light in one Planck second, as hypothetically measured with Einstein-Poincaré synchronized clocks. In contrast, no particle in the modern physics model can ever undergo Planck acceleration, even for one Planck second. So one has three choices: 1) introduce a shorter time interval than the Planck second, 2) claim that the Planck acceleration is not relevant for anything with rest-mass (so it is a purely fictitious acceleration), or 3) come up with yet another mathematical trick (fudge) to save the model. Naturally, one could claim that the Planck mass spontaneously radiates into energy within a Planck second. This is basically correct, but modern physics has no model for what would trigger this event. In fact, we (modern physics) do not even have a clear explanation for what energy actually is, as stated by Richard Feynman:

It is important to realize that in physics today, we have no knowledge what energy is.

Relativistic Planck Acceleration

Assume a rocket (or particle) is accelerating with acceleration a, as measured from the rocket (the proper acceleration). The well-known relativistic acceleration is given by (see for example [8] and [9])

$$\alpha = \frac{a}{\left(1 - \frac{v^2}{c^2}\right)^{\frac{3}{2}}} \tag{2}$$

Assume now that the acceleration as observed from the rest frame is the Planck acceleration, $a = a_p$. If one assumes that $v > 0$, then this will lead to a relativistic acceleration greater than then Planck acceleration. According to atomism, the Planck acceleration can only start to happen from a Planck mass (remember the Planck mass only lasts for one Planck second in this model), and the maximum velocity of any fundamental particle is (as described by Haug in a series of working papers as well as published papers [10, 11, 12, 13, 14]

$$v_{max} = \sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}} \tag{3}$$

for a Planck mass we have $\bar{\lambda} = l_p$, which leads to

$$v_{max} = \sqrt{1 - \frac{l_p^2}{l_p^2}} = 0 \tag{4}$$

In other words, the Planck mass is at rest, as observed from any reference frame. The Planck length, the Planck mass, and the Planck time are invariant as observed from any reference frame, in strong contrast to special relativity theory. This also means that the relativistic Planck acceleration is equal to the Planck acceleration

$$\alpha = \frac{a_p}{\left(1 - \frac{v_{max}^2}{c^2}\right)^{\frac{3}{2}}} = a_p \tag{5}$$

Actually, all Planck units are invariant across all reference frames. That is to say, Lorentz symmetry is broken at the very moment we reach Planck energy (the Planck scale). This is consistent with what is predicted by several quantum gravity theories, see for example [15]. In other words, we need a modification of Einstein's special relativity theory. All of Einstein's formulas are valid when using Einstein-Poincaré synchronized clocks, but atomism leads to the incorporation of key mathematical concepts introduced by Max Planck that are intuitive and very easy to understand.

1 A suggested new maximum acceleration for any "fundamental" particle with less mass than the Planck mass particle

From Heisenberg's Uncertainty principle we have, see also [16, 17, 18]

$$\left|\frac{dv}{dt}\right| \leq \frac{1}{\hbar}\Delta E \Delta v \tag{6}$$

Here, we are using $\frac{1}{\hbar}$ instead of $\frac{2}{\hbar}$, as we have reasons to think this is the correct version when used in this respect. This is something we likely will comment on in more detail in a future version of this paper. For anything with rest-mass we have

$$v_{max} = c\sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}} \tag{7}$$

Based on this, Haug [6] has shown that the maximum kinetic energy is given by

$$k_{e,max} = \frac{mc^2}{\sqrt{1-\frac{v_{max}^2}{c^2}}} - mc^2 = m_p c^2 - mc^2 = \hbar c\left(\frac{1}{l_p} - \frac{1}{\bar{\lambda}}\right) < m_p c^2 \tag{8}$$

and from this we get

$$\begin{aligned} a_{max} = \left|\frac{dv}{dt}\right| &\leq \frac{1}{\hbar}\hbar c\left(\frac{1}{l_p} - \frac{1}{\bar{\lambda}}\right) c\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}} \\ a_{max} &\leq \left(\frac{c^2}{l_p} - \frac{c^2}{\bar{\lambda}}\right)\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}} < \frac{c^2}{l_p} \end{aligned} \tag{9}$$

This is the maximum acceleration that is very close to the Planck acceleration, but always below the Planck acceleration for any particle, which also has mass after it is accelerated. Only for the Planck mass particle we can have

$$\begin{aligned} \left|\frac{dv}{dt}\right| &\leq \frac{1}{\hbar}\Delta E \Delta v \\ \left|\frac{dv}{dt}\right| &\leq \frac{1}{\hbar}\frac{m_p c^2}{\sqrt{1-\frac{v_{max}^2}{c^2}}} c \\ \left|\frac{dv}{dt}\right| &\leq \frac{1}{\hbar} m_p c^2 c \\ \left|\frac{dv}{dt}\right| &\leq \frac{c^2}{l_p} \end{aligned} \tag{10}$$

The maximum velocity for a Planck mass particle is zero, and it only lasts for one Planck second. The Planck mass is the collision point between two light particles (in our theory these are indivisible particles). We also have that

$$\begin{aligned} \left|\frac{dv}{dt}\right| &\leq \frac{1}{\hbar}\Delta E \Delta v \\ \left|\frac{dv}{dt}\right| &\leq \frac{1}{\hbar}\left(\frac{m_p c^2}{\sqrt{1-\frac{v_{max}^2}{c^2}}} - m_p c\right) c \\ \left|\frac{dv}{dt}\right| &\leq \frac{1}{\hbar}(m_p c^2 - m_p c^2) c \\ \left|\frac{dv}{dt}\right| &\leq 0 \end{aligned} \tag{11}$$

This shows us that a Planck mass particle cannot merely undergo any acceleration to still be a mass. Both results 10 and 11 are correct. This basically shows that the Planck mass only can have rest-mass energy and no kinetic energy, as the Planck mass particle only can exist when it is at absolute rest. In addition, it is the same as observed from any reference frame. Further, after one Planck second, the Planck mass particle is dissolved into pure energy that travels at the speed of light.

To conclude, we are studying an essential paradox: for a Planck mass particle, we have zero acceleration, but after one Planck second it dissolves into light. So, for a Planck mass particle, we have Planck acceleration. However, it is important to understand that the Planck mass particle must dissolve into energy after one Planck second as measured with Einstein-Poincaré synchronized clocks. For any fundamental particle with mass after acceleration, the maximum acceleration is given by

$$a_{max} \leq \left(\frac{c^2}{l_p} - \frac{c^2}{\bar{\lambda}}\right)\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}} \tag{12}$$

Since for any known observed particle the reduced Compton wavelength is $\bar{\lambda} >> l_p$, we can approximate this very well by

$$a_{max} \leq \left(\frac{c^2}{l_p} - \frac{c^2}{\bar{\lambda}}\right)\left(1 - \frac{1}{2}\frac{l_p^2}{\bar{\lambda}^2}\right) \tag{13}$$

If one mistakenly should assume the maximum acceleration is the Planck acceleration when it actually should be the maximum acceleration in formula 12, then one gets an acceleration error of

$$\frac{c^2}{l_p} - \left(\frac{c^2}{l_p} - \frac{c^2}{\bar{\lambda}}\right)\sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}} \approx 2.327 \times 10^{29}$$

This seems like an enormous error, but it is still incredibly small compared to $\frac{c^2}{l_p}$ or $\left(\frac{c^2}{l_p} - \frac{c^2}{\bar{\lambda}}\right)\sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}}$. It is likely the largest error that has not been "detected" for the gigantic numbers of the maximum acceleration, $5.56092 \times 10^{51} - 2.327 \times 10^{29} \approx 5.56092 \times 10^{51}$.

As we have suggested, the relativistic Planck acceleration is unique among accelerations because it can only happen from absolute rest and only for a Planck mass particle that then dissolves into energy after one Planck second. Studying these phenomena from an atomist point of view may shed new light on some of the mysteries and paradoxes of physics.

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