Where Standard Physics Runs into Infinite Challenges, Atomism Predicts Exact Limits

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Abstract

Where standard physics runs into infinite challenges, atomism predicts exact limits. We summarize the mathematical results briefly in a table in this note and also revisit the energy-momentum relationship based on this view.

Key words: Rest-mass energy, rest-mass, relativistic energy, relativistic mass, proper velocity, momentum, kinetic energy, acceleration, rapidity, temperature.

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1 Mathematical Summary of Upper Limits Predicted by Atomism

These are some of the main findings in a series of papers I have posted on this topic (see [1, 2, 3, 4, 5, 7, 8, 9, 10]). This is first draft, and I will update this paper later on. Comments are welcome.

	For non-Planck mass particles	**For a Planck mass particle**
Rest-mass	m	m_p (lasts one Planck second)
Rest-mass energy	$E = mc^2$	$E = m_p c^2$
Maximum relativistic energy	$E = m_p c^2$	$E = m_p c^2$
Maximum relativistic mass	m_p then becomes light	m_p (last one Planck second)
Maximum velocity	$v_{max} = c\sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}}$	$v_{max} = 0$ (and c when dissolved)
Maximum proper velocity	$W_{max} = c\frac{\bar{\lambda}}{l_p}\sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}}$	$W_{max} = 0$
Velocity addition[a]	$V_{max} = \frac{2c\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}}}{2-\frac{l_p^2}{\bar{\lambda}^2}} < c$	$V_{max} = 0$
Velocity addition light/particle[b]	$V_{max} = c$	$V_{max} = c$
Maximum mutual velocity[c]	$2c\sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}}$	0
Maximum Lorentz factor	$\gamma_{max} = \frac{1}{\sqrt{1-\frac{v_{max}^2}{c^2}}} = \frac{\bar{\lambda}}{l_p}$	$\gamma_{max} = \frac{1}{\sqrt{1-\frac{v_{max}^2}{c^2}}} = 1$
Maximum speed ratio	$\beta_{max} = \frac{v_{max}}{c} = \sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}}$	$\beta_{max} = \frac{v_{max}}{c} = 0$
Maximum momentum	$p_{max} = \hbar\sqrt{\frac{1}{l_p^2} - \frac{1}{\bar{\lambda}^2}}$	$p_{max} = 0$
Maximum kinetic energy	$E_{k,max} = \hbar c\left(\frac{1}{l_p} - \frac{1}{\bar{\lambda}}\right)$	$E_{k,max} = 0$ (at rest)
Maximum acceleration	$a_{max} = \left(\frac{c^2}{l_p} - \frac{c^2}{\bar{\lambda}}\right)\sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}}$	0 and $a_p = \frac{c^2}{l_p}$ becomes light
Maximum force	$F_{max} = \left(\frac{\hbar c}{l_p^2} - \frac{\hbar c}{\bar{\lambda} l_p}\right)\sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}}$	$F_{max} = \frac{\hbar c}{l_p^2}$ (One Planck second)
Maximum power	$P_{max} = \hbar c^2\left(\frac{1}{l_p^2} - \frac{1}{\bar{\lambda} l_p}\right)$	$\frac{\hbar c^2}{l_p^2}$ (One Planck second)
Maximum rapidity	$w_{max} = \sqrt{\frac{1+\frac{v_{max}}{c}}{1-\frac{v_{max}}{c}}} \approx \ln\left(2\frac{\bar{\lambda}}{l_p}\right)$	$w_{max} = 0$ (at rest)
Maximum Doppler shift	$f_2 = f_1\sqrt{\frac{4-\frac{l_p^2}{\bar{\lambda}^2}}{\frac{l_p^2}{\bar{\lambda}^2}}} \approx 2\frac{c}{l_p}$	None (at rest)
Maximum length contraction	$\bar{\lambda}\sqrt{1 - \frac{v_{max}^2}{c^2}} = l_p$	l_p (at rest, no contraction) Reduced Compton wavelength Planck particle
Maximum time dilation	$\frac{\bar{\lambda}}{c}\sqrt{1 - \frac{v_{max}^2}{c^2}} = \frac{l_p}{c}$ (Planck time) $\frac{\frac{\bar{\lambda}}{c}}{\sqrt{1-\frac{v_{max}^2}{c^2}}} = \frac{\bar{\lambda}^2}{l_p c}$	0 (at rest, no time dilation)
Maximum temperature	$T_{max} = \frac{\hbar c\left(\frac{1}{l_p} - \frac{1}{\bar{\lambda}}\right)}{k_b}$	$T_p = \frac{m_p c^2}{k_b} = \frac{\hbar c}{l_p k_b}$ (for one Planck second)
Fuel needed for maximum velocity for each fundamental particle.	$\geq 2m_p$	0 (Planck mass particle at rest)

Table 1: The table shows a series of new boundary conditions that are given by atomism.

[a]This formula is for two fundamental particles of the same type – two electrons, for example.

[b]This is velocity addition of the speed of light versus a fundamental particle as measured with Einstein-Poincaré synchronized clocks.

[c]This formula is for two fundamental particles of the same type – two electrons, for example.

In standard physics there is no limit below infinity for kinetic energy, for momentum, for relativistic mass, for relativistic energy, for temperature, or for proper velocity. Further, there is no good explanation for what the Planck acceleration truly represents. Many physicists assume that Planck time is the shortest possible unit of time, but in fact, no rest-mass in standard theory can be accelerated for even one Planck second, as this would mean that the mass was traveling at the speed of light and had infinite kinetic energy.

Under mathematical atomism (based on just two postulates), we get all the equations of special relativity when using Einstein-Poincaré synchronized clocks, and we also get a series of new predictions. We obtain the exact upper boundary conditions on a series of relativistic formulas that are linked to the entities found by Max Planck in 1906 [11].

Atomism leads to a quantized relativity theory that helps us to understand the Planck mass in a new way. The Planck mass is the very key to understanding physics, and in our view it can only be grasped fully through atomism. Still, atomism leads to breaks in Lorentz symmetry at the Planck scale; this is consistent with what is predicted by several quantum gravity theories.

2 Energy-Momentum Relationship

Here we show that the energy-momentum relationship has a limit equal to the rest- mass energy of the Planck mass for any fundamental particle

$$
\begin{aligned}
E_{max}^2 &= p_{max}^2c^2 + m^2c^4 \\
E_{max} &= \sqrt{p_{max}^2c^2 + m^2c^4} \\
E_{max} &= \sqrt{\left(\hbar\sqrt{\frac{1}{l_p^2} - \frac{1}{\bar{\lambda}^2}}\right)^2 c^2 + \left(\frac{\hbar}{\bar{\lambda}}\frac{1}{c}\right)^2 c^4} \\
E_{max} &= \sqrt{\hbar^2\left(\frac{1}{l_p^2} - \frac{1}{\bar{\lambda}^2}\right)c^2 + \frac{\hbar^2}{\bar{\lambda}^2}\frac{1}{c^2}c^4} \\
E_{max} &= \hbar c\sqrt{\frac{1}{l_p^2} - \frac{1}{\bar{\lambda}^2} + \frac{1}{\bar{\lambda}^2}} \\
E_{max} &= \frac{\hbar}{l_p}c = m_pc^2 \qquad (1)
\end{aligned}
$$

In the special case of a Planck mass particle (see also [6]), we have that $\bar{\lambda} = l_p$ and this gives

$$
\begin{aligned}
E_{max} &= \sqrt{\left(\hbar\sqrt{\frac{1}{l_p^2} - \frac{1}{l_p^2}}\right)^2 c^2 + \left(\frac{\hbar}{l_p}\frac{1}{c}\right)^2 c^4} \\
E_{max} &= \sqrt{\hbar^2\left(\frac{1}{l_p^2} - \frac{1}{l_p^2}\right)c^2 + \frac{\hbar^2}{l_p^2}\frac{1}{c^2}c^4} \\
E_{max} &= \hbar c\sqrt{\frac{1}{l_p^2} - \frac{1}{l_p^2} + \frac{1}{l_p^2}} \\
E_{max} &= \frac{\hbar}{l_p}c = m_pc^2 \qquad (2)
\end{aligned}
$$

That is the same end result as for any other particle. Note, however, that the momentum for a Planck mass particle is zero. This is because a Planck mass particle can only exist when it is at absolute rest. The Planck mass particle is the same as observed across reference frames; the same is true for the Planck length and Planck time. Other particles have less rest-mass, but the maximum momentum ensures that they have total maximal energy equal to the Planck mass particle.

3 Maximum Acceleration Force

I have not calculated the maximum acceleration force before in any of my papers. The maximum relativistic acceleration force is given by (see also Appendix A)

$$\begin{aligned}
F_{max} &= \frac{m}{\sqrt{1-\frac{v_{max}^2}{c^2}}} a_{max} \\
F_{max} &= m_p \left(\frac{c^2}{l_p} - \frac{c^2}{\bar{\lambda}} \right) \sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}} \\
F_{max} &= \frac{\hbar}{l_p} \frac{1}{c} \left(\frac{c^2}{l_p} - \frac{c^2}{\bar{\lambda}} \right) \sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}} \\
F_{max} &= \left(\frac{\hbar c}{l_p^2} - \frac{\hbar c}{\bar{\lambda} l_p} \right) \sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}} \qquad (3)
\end{aligned}$$

For a Planck particle it is

$$F_{max} = m_p a_p = \frac{\hbar}{l_p} \frac{1}{c} \frac{c^2}{l_p} = \frac{\hbar c}{l_p^2} \qquad (4)$$

Again, the Planck mass particle is very unique.

4 Maximum Power

We are also calculating the maximum power for something with rest-mass

$$\begin{aligned}
P_{max} &= \frac{E_{k,max}}{\frac{\bar{\lambda}}{c}\sqrt{1-\frac{v_{max}^2}{c^2}}} \\
P_{max} &= \frac{\hbar c \left(\frac{1}{l_p} - \frac{1}{\bar{\lambda}} \right)}{\frac{l_p}{c}} \\
P_{max} &= \frac{\hbar c^2 \left(\frac{1}{l_p} - \frac{1}{\bar{\lambda}} \right)}{l_p} \\
P_{max} &= \hbar c^2 \left(\frac{1}{l_p^2} - \frac{1}{\bar{\lambda} l_p} \right) \qquad (5)
\end{aligned}$$

This is slightly below the Planck power $\frac{\hbar c^2}{l_p^2}$.

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5 Appendix A

One could mistakenly forget to take the relativistic mass; this gives

$$\begin{aligned}
F_{max} &= m a_{max} \\
F_{max} &= m\left(\frac{c^2}{l_p}-\frac{c^2}{\bar{\lambda}}\right)\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}} \\
F_{max} &= \frac{\hbar}{\bar{\lambda}}\frac{1}{c}\left(\frac{c^2}{l_p}-\frac{c^2}{\bar{\lambda}}\right)\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}} \\
F_{max} &= \left(\frac{\hbar c}{l_p\bar{\lambda}}-\frac{\hbar c}{\bar{\lambda}^2}\right)\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}} \qquad (6)
\end{aligned}$$

We clearly think this is not the correct approach.