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

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December 11, 2017

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, 8, 7, 9, 10, 11]). 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	$E = mc^2$	$E = m_pc^2$
Maximum relativistic energy	$E = m_pc^2$	$E = m_pc^2$
Maximum relativistic mass	m_p then becomes light	m_p (lasts 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) $\frac{\frac{\bar{\lambda}}{c}}{\sqrt{1-\frac{v_{max}^2}{c^2}}} = \frac{\bar{\lambda}^2}{l_pc}$	0 (at rest, no time dilation)
Maximum temperature	$T_{max} = \frac{\hbar c\left(\frac{1}{l_p} - \frac{1}{\bar{\lambda}}\right)}{k_b}$	$T_p = \frac{m_pc^2}{k_b} = \frac{\hbar c}{l_pk_b}$ (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.

Table 2 compares predictions from modern physics with atomism. While atomism gives exact limits, modern physics has a series of infinity limits. Infinity limits lead to several absurdities, see [8].

	Atomism for particles	**Modern Physics limit for particles**
Rest-mass	m_p	$< \infty$ (or Planck mass ?)
Maximum rest-mass energy	$E = m_p c^2$	$< \infty$ (or Planck energy ?)
Maximum relativistic energy	$E = m_p c^2$	$< \infty$
Maximum relativistic mass	m_p then becomes light	$< \infty$
Maximum velocity	$v_{max} = c\sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}}$	$< c$
Maximum proper velocity	$W_{max} = c\frac{\bar{\lambda}}{l_p}\sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}}$	$< \infty$
Velocity addition[a]	$V_{max} = \frac{2c\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}}}{2-\frac{l_p^2}{\bar{\lambda}^2}}$	$< c$
Velocity addition light/particle[b]	c	c
Maximum mutual velocity[c]	$2c\sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}}$	$< 2c$
Maximum Lorentz factor	$\gamma_{max} = \frac{1}{\sqrt{1-\frac{v_{max}^2}{c^2}}} = \frac{\bar{\lambda}}{l_p}$	$< \infty$
Maximum speed ratio	$\beta_{max} = \frac{v_{max}}{c} = \sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}}$	< 1
Maximum momentum	$p_{max} = \hbar\sqrt{\frac{1}{l_p^2} - \frac{1}{\bar{\lambda}^2}}$	$< \infty$
Maximum kinetic energy	$E_{k,max} = \hbar c\left(\frac{1}{l_p} - \frac{1}{\bar{\lambda}}\right)$	$< \infty$
Maximum acceleration	$a_{max} = \left(\frac{c^2}{l_p} - \frac{c^2}{\bar{\lambda}}\right)\sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}}$	$< \infty$ (Possibly $\frac{c^2}{l_p}$?)
Maximum force	$F_{max} = \left(\frac{\hbar c}{l_p^2} - \frac{\hbar c}{\bar{\lambda} l_p}\right)\sqrt{1 - \frac{l_p^2}{\bar{\lambda}^2}}$	$< \infty$
Maximum power	$P_{max} = \hbar c^2\left(\frac{1}{l_p^2} - \frac{1}{\bar{\lambda} l_p}\right)$	$< \infty$
Maximum rapidity	$w_{max} = \sqrt{\frac{1+\frac{v_{max}}{c}}{1-\frac{v_{max}}{c}}} \approx \ln\left(2\frac{\bar{\lambda}}{l_p}\right)$	$< \infty$
Maximum Doppler shift	$f_2 = f_1\sqrt{\frac{4-\frac{l_p^2}{\bar{\lambda}^2}}{\frac{l_p^2}{\bar{\lambda}^2}}} \approx 2\frac{c}{l_p}$	$< \infty$ (Planck frequency?)
Maximum length contraction	$\bar{\lambda}\sqrt{1 - \frac{v_{max}^2}{c^2}} = l_p$	0 Point particle hypothesis (or l_p?)
Maximum time dilation	$\frac{\bar{\lambda}}{c}\sqrt{1 - \frac{v_{max}^2}{c^2}} = \frac{l_p}{c}$ $\frac{\frac{\bar{\lambda}}{c}}{\sqrt{1-\frac{v_{max}^2}{c^2}}} = \frac{\bar{\lambda}^2}{l_p c}$	> 0 (possibly $\frac{l_p}{c}$?) $< \infty$
Maximum temperature	$T_{max} = \frac{\hbar c\left(\frac{1}{l_p} - \frac{1}{\bar{\lambda}}\right)}{k_b}$	$< \infty$
Fuel needed for maximum velocity for each fundamental particle.	$\geq 2m_p$	$< \infty$
Life expectancy Planck particle	$\frac{l_p}{c}$	?

Table 2: The table compares modern Physics with 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.

Atomism gets rid of a long series of infinity limits and some zero limits and it also offers a simple explanation of why we must have these limits. Modern physics, on the other hand, simply has infinity as the limit because the formulas blow up. In addition, under modern physics one speculates that the Planck length, Planck frequency, and Planck mass can have some limits, but there is no simple explanation of why that is the case. In atomism there is only one truly fundamental particle that has diameter equal to the Planck-length. Pure mass (the Planck mass particle) is simply collisions between indivisible particles and pure energy is freely moving indivisible particles. The indivisible particles themselves cannot undergo length contraction or time dilation. Only the distance between the indivisible particles can undergo length contraction, getting shorter (or longer). Remarkably, this leads to a maximum velocity (for anything with rest-mass) that is directly linked to the diameter of the indivisible particle and the reduced Compton wavelength. Under atomism, the reduced Compton wavelength is directly linked to the distance between indivisible particles. This is not explained in much more detail in [1] and [2].[1]

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 [12].

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

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

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

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

[1] Since I wrote my book before I knew that the diameter of the indivisible particle likely had to be the Planck length, the notation and the way I write in my book can be challenging if read too quickly. However, given enough time for reflection, everything stated is quite straight forward, logical, and simple.

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 can also calculate 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 $\frac{\hbar c^2}{l_p^2}$.

References

I will add more references later and for those interested there are naturally many further references within some of the papers I am already citing. This paper is mostly a summary of my own work, that builds on thousands of years of discoveries, going back to Democritus and Leupicus (at least), who are among the first known sources that introduced the concept of indivisible particles.

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[10] E. G. Haug. The incompatibility of the Planck acceleration and modern physics? *http://vixra.org/abs/1710.0340*, 2017.

[11] E. G. Haug. A maximum limit on proper velocity. *http://viXra:1702.0230*, 2017.

[12] M. Planck. *The Theory of Radiation*. Dover 1959 translation, 1906.

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.