A Maximum Limit on Proper Velocity

Espen Gaarder Haug*
Norwegian University of Life Sciences

February 17, 2017

Abstract

Here we examine maximum proper velocity (sometimes referred to as celerity), based on the recently suggested maximum velocity for anything with rest mass, as given by Haug. Proper velocity, $W = \frac{v}{\sqrt{1-v^2/c^2}}$, is a quantity that has been suggested for use in a series of calculations in relativity theory. Current standard theory imposes no limit on how close to infinity the proper velocity for an object with mass can be. Under our extended theory, by contrast, there is a strict upper limit on the proper velocity for anything with rest mass, which again is directly related to our newly suggested maximum velocity for anything with rest mass.

Key words: Proper velocity, celerity, maximum momentum per unit of rest mass.

1 Maximum Proper Velocity

The less known proper velocity was probably first introduced by Sears and Brehme in 1968 as a suggested useful quantity in addition to the well-known standard relative velocity (familiar coordinate velocity), see [1]. Proper velocity has later been used in a series of relativistic calculations (see for example [2, 3, 4, 5]) including also relativistic rocket science [6]. Proper velocity is defined as taking the distance, as measured from the observer frame, divided by the time traveled as measured in the rocket frame (moving frame). Mathematically the proper velocity is defined as

$$W = \frac{v}{\sqrt{1-\frac{v^2}{c^2}}} \tag{1}$$

Proper velocity is very close to standard velocity (familiar coordinate velocity) when we are traveling at low velocities, $v << c$. But at high velocities the difference between standard and proper velocity can become enormous. Standard physics assumes that the velocity of objects with rest mass can be as close to c as we want. In standard theory, moreover, proper velocity for objects with rest mass has no upper boundary; it has no limit on its proximity to infinity, something that is directly expressed by, for example, Fraundorf [5]:

> *It shows that momentum like proper velocity has no upper limit,....*

We agree that the proper velocity for a beam of light must be equal to infinity, thereby having no upper limit.[1] However, based on recent research, [7, 8, 9], we have reason to believe that the maximum velocity for anything with mass has an exact boundary below the speed of light, which is likely given by

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

where l_p is the Planck length [10] and $\bar{\lambda}$ is the reduced Compton wavelength of the particle in question. This again leads to a maximum proper velocity for anything with rest mass:

*e-mail espenhaug@mac.com. Thanks to Richard Whitehead for helping me edit this manuscript.

[1] This basically simply because time stands still when traveling at the speed of light, and a distance divided by a zero time interval gives infinity.

$$\begin{aligned}
W_{max} &= \frac{v_{max}}{\sqrt{1-\frac{v_{max}^2}{c^2}}} \\
W_{max} &= \frac{c\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}}}{\sqrt{1-\frac{\left(c\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}}\right)^2}{c^2}}} \\
W_{max} &= \frac{c\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}}}{\sqrt{1-\left(1-\frac{l_p^2}{\bar{\lambda}^2}\right)}} \\
W_{max} &= \frac{c\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}}}{\frac{l_p}{\bar{\lambda}}} \\
W_{max} &= c\frac{\bar{\lambda}}{l_p}\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}}.
\end{aligned} \tag{3}$$

For experimentally known particles, we have $\bar{\lambda} >> l_p$, which allows for a very good approximation by using the first-term series expansion: $\sqrt{1-\frac{l_p^2}{\bar{\lambda}^2}} \approx 1-\frac{1}{2}\frac{l_p^2}{\bar{\lambda}^2}$. This leads to

$$W_{max} \approx c\frac{\bar{\lambda}}{l_p}\left(1-\frac{1}{2}\frac{l_p^2}{\bar{\lambda}^2}\right). \tag{4}$$

When $\bar{\lambda} >> l_p$ we have

$$W_{max} \approx c\frac{\bar{\lambda}}{l_p}. \tag{5}$$

This means, for example, that the maximum proper velocity for an electron is likely to be

$$W_{max} \approx c\frac{\bar{\lambda}_e}{l_p} \approx c\frac{3.861593\times 10^{-13}}{1.616199\times 10^{-35}} \approx 7.162957\times 10^{30} \text{ m/s}. \tag{6}$$

Of importance here is the presence of an upper boundary on the proper velocity. Proper velocity is also known as momentum per unit of rest mass. In this case we obtain the maximum momentum for a particle per rest mass of the particle of interest. When $\bar{\lambda} >> l_p$ we have

$$W_{max} \approx c\frac{\bar{\lambda}_e}{l_p} = \frac{m_p c}{m}, \tag{7}$$

where m_p is the Planck mass and m is the mass of the particle of interest. For example, an electron yields $W_{max} \approx \frac{m_p c}{m_e} \approx 7.162957\times 10^{30}$ m/s, which is the same maximum proper velocity as given by the calculation above. Again, proper velocity should not be confused with the familiar coordinate velocity.

Interesting too is that

$$\operatorname{arcsin}\left(\frac{7.162957\times 10^{30}}{c}\right) = 52.22102184,$$

which is the maximum rapidity for an electron, as given by [11].

In the special case of a Planck mass particle, we cannot use the approximation given by equation 4. Rather, we are compelled to use the exact formula given by equation 3. For a Planck particle, the reduced Compton wavelength is equal to the Planck length, yielding a maximum proper velocity of

$$W_{max} = c\frac{l_p}{l_p}\sqrt{1-\frac{l_p^2}{l_p^2}} = 0. \tag{8}$$

This is no surprise, as [7] has shown that a Planck mass is probably the very collision point of two photons. At this particular collision point the light particles are changing directions (backscattering) yet standing still for an instant. The Planck mass and the Planck length are invariant under this theory; this again can only happen if the Planck mass particle only lasts for an instant, as discussed in more detail by [7].

2 Conclusion

Haug's recently suggested maximum velocity for anything with rest mass constitutes the basis for suggesting a maximum proper velocity. This is in contrast to current standard theories, which impose no limitations on how close proper velocity can be to infinity.

References

[1] F. W. Sears and R. W. Brehme. *Introduction to the Theory of Relativity.* Addison-Wesley, NY, 1968.

[2] W. Baylis. *Clifford (Geometric) Algebras – With Applications to Physics.* Springer Verlag, 1996.

[3] A. A. Ungar. Thomas precession: Its underlying gyrogroup axioms and their use in hyperbolic geometry and relativistic physics. *Foundations of Physics*, 27(6):881–951, 1997.

[4] D. Hestenes. Spacetime physics with geometric algebra. *American Journal of Physics*, 71(7):691–714, 2003.

[5] P. Fraundorf. A one-map two-clock approach to teaching relativity in introductory physics. *Working paper: Department of Physics Astronomy University of Missouri-StL, arXiv:physics/9611011*, 2011.

[6] R. F. Tinder. *Relativistic Flight Mechanics and Space Travel.* Morgan & Claypool Publishers, 2007.

[7] E. G. Haug. The Planck mass particle finally discovered! Good bye to the point particle hypothesis! *http://vixra.org/abs/1607.0496*, 2016.

[8] E. G. Haug. The gravitational constant and the Planck units. A simplification of the quantum realm. *Physics Essays Vol 29, No 4*, 2016.

[9] E. G. Haug. A new solution to Einstein's relativistic mass challenge based on maximum frequency. *http://vixra.org/abs/1609.0083*, 2016.

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

[11] E. G. Haug. The Lorentz transformation at the maximum velocity for a mass. *http://vixra.org/abs/1609.0151*, 2016.