

Maximum Velocity for Matter in Relation to the Schwarzschild Radius

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Abstract

This is a short note on a new way to describe Haug's newly introduced maximum velocity for matter in relation to the Schwarzschild radius. This leads to a probabilistic Schwarzschild radius for elementary particles with mass smaller than the Planck mass.

Keywords: Schwarzschild radius, maximum velocity of matter, probabilistic Schwarzschild radius.

1 Haug's Maximum Velocity for Matter

Haug's newly introduced maximum velocity for matter has been published in a series of papers and working papers; see, for example [1, 2, 3]. It is given by

$$v_{max} = c\sqrt{1 - \frac{l_p^2}{\lambda^2}} \quad (1)$$

where l_p is the Planck length; see also [4, 5]. Haug has also recently shown that the Planck length is given by

$$l_p = \sqrt{\frac{1}{2}R_s\bar{\lambda}} \quad (2)$$

where R_s is the Schwarzschild radius and $\bar{\lambda}$ is the reduced Compton wavelength of the same mass. An important point is that the Schwarzschild radius and the reduced Compton wavelength can be found independent of any knowledge of Newton's gravitational constant or any knowledge of the Planck constant as shown by [6]. This means the maximum velocity is given by

$$v_{max} = c\sqrt{1 - \frac{l_p^2}{\lambda^2}} = c\sqrt{1 - \frac{\sqrt{\frac{1}{2}R_s\bar{\lambda}}^2}{\lambda^2}} = c\sqrt{1 - \frac{R_s}{2\lambda}} \quad (3)$$

We think this formula only gives meaning for elementary particles; we have suggested in other working papers that all elementary particles have a probabilistic Schwarzschild radius. More precisely, they have a Schwarzschild radius equal to the Planck length with a frequency (probability) of only $\frac{l_p}{\lambda}$. That is to say, the probabilistic Schwarzschild radius for an elementary particle is

$$R_s = 2l_p\frac{l_p}{\lambda} \quad (4)$$

This version of the Schwarzschild radius formula also holds for masses larger than the Planck mass, but then the interpretation is no longer simply probabilistic, as the probabilistic factor (frequency): $\frac{l_p}{\lambda}$ will be higher than one. Integer numbers above one indicate the number of Planck masses, and there is certainty for Planck masses. The fraction above one indicates an additional probabilistic factor for the remaining mass. This means that probabilistic effects dominate below the Planck mass and determinism dominates above; see [7].

Be aware that the Schwarzschild radius of any mass, including the probabilistic Schwarzschild radius of elementary particles such as electrons, can be found independent of any knowledge of G . The Planck length can also be found independent of G and \hbar ; see Haug's recent working papers [8].

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Even if the maximum velocity formula only holds for elementary particles, it can give a good indication of the maximum velocity of composite masses (e.g. particles such as protons). As suggested by [2, 7], the maximum velocity of the composite object will be limited by the heaviest elementary particle in the object. Our theory predicts that the heaviest particle will start to dissolve into energy when it reaches the maximum velocity.

2 Heisenberg Uncertainty Principle Extended to the Schwarzschild Radius

In 1927, Heisenberg [9] published what today is known as the Heisenberg Schwarzschild principle; (see also [10])

$$\Delta p \Delta x \geq \hbar \quad (5)$$

In 1932, during his Nobel lecture Heisenberg himself suggested the existence of a universal least length. Later on (in 1958), he assumed that the least length was the atom nuclei diameter 10^{-15} m; see also [11]. A series of researchers have argued that the Planck length is indeed the shortest length that gives any meaning; see [12, 13], for example. Modern quantum gravity theories are also returning to the idea that the Planck length is the universal least length, even though there is still considerable scientific debate on this.

Here we will assume that the smaller possible uncertainty in the position is the Planck length. We can then replace our expression for the Planck length with $l_p = \sqrt{\frac{1}{2} R_s \bar{\lambda}}$ and see what we get. Further, we will assume that elementary particles must have a momentum smaller than or equal to the Planck mass momentum; the maximum momentum is then $m_p c = \frac{\hbar}{l_p}$. If this is the maximum momentum of an elementary particle (including the Planck mass particle), then this must also be the maximum uncertainty in the momentum for an elementary particle. Based on this we get

$$\begin{aligned} \Delta p \Delta x &\geq \hbar \\ \Delta p l_p &\geq \hbar \\ \Delta p \sqrt{\frac{1}{2} R_s \bar{\lambda}} &\geq \hbar \\ \sqrt{\frac{1}{2} R_s} &\geq \frac{\hbar}{\Delta p \sqrt{\bar{\lambda}}} \\ \sqrt{\frac{1}{2} R_s} &\geq \frac{\hbar}{\Delta m_p c \sqrt{\bar{\lambda}}} \\ \sqrt{\frac{1}{2} R_s} &\geq \frac{\hbar}{\frac{\hbar}{l_p} \frac{1}{c} \sqrt{\bar{\lambda}}} \\ \sqrt{\frac{1}{2} R_s} &\geq \frac{l_p}{\sqrt{\bar{\lambda}}} \\ R_s &\geq 2 \frac{l_p^2}{\bar{\lambda}} = 2 l_p \frac{l_p}{\bar{\lambda}} \end{aligned} \quad (6)$$

The correct interpretation of this is likely that the Schwarzschild radius is probabilistic for elementary particles. All elementary particles have a Schwarzschild radius equal to the Planck length, but they only have this at the Compton periodicity, and the Schwarzschild radius only lasts for one Planck second for each unit of Compton time. That is the Schwarzschild radius is the reduced Compton frequency over the shortest possible time interval multiplied by the shortest possible length. This means the probability inside a Planck second for observing the Schwarzschild radius is $\frac{l_p}{\bar{\lambda}}$. For the Planck mass particle (also known by modern physics as a micro black hole), this probability is one, because we then have $\bar{\lambda} = l_p$. That is why the Planck mass particle is the smallest mass that has a Schwarzschild radius. Smaller particles still have a Schwarzschild radius, but it is then probabilistic.

3 The Planck Constant

A small side note is that we can rewrite the Planck constant as

$$\hbar = \frac{R_s \bar{\lambda} c^3}{2G} \quad (7)$$

This is simply because the Planck constant is embedded in Newton's gravitational constant, as the gravitational constant is simply $G = \frac{l_p^2 c^3}{\hbar}$; see [1], that is

$$\hbar = \frac{R_s \bar{\lambda} c^3}{2G} = \frac{l_p \frac{l_p}{\lambda} \bar{\lambda} c^3}{G} = \frac{l_p^2 c^3}{G} = \frac{l_p^2 c^3}{\frac{l_p^2 c^3}{\hbar}} \quad (8)$$

4 Conclusion

In this paper, we have shown that there is a link between the Schwarzschild radius and our maximum velocity of matter. An important point is that the Schwarzschild radius can be found independent of any knowledge of Newton's gravitational constant or any knowledge of the Planck constant. This again leads to the idea that we can derive a probabilistic Schwarzschild radius for elementary particles using the Heisenberg uncertainty principle.

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