

Special Relativity Leads to a Trans-Planckian Crisis that Is Solved by Haug's Maximum Velocity for Matter

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Abstract

In gravity theory, there is a well-known trans-Planckian problem, which is that general relativity theory leads to a shorter than Planck length and shorter than Planck time in relation to so-called black holes. However, there has been little focus on the fact that special relativity also leads to a trans-Planckian problem, something we will demonstrate here. According to special relativity, an object with mass must move slower than light, but special relativity has no limits on how close to the speed of light something with mass can move. This leads to a scenario where objects can undergo so much length contraction that they will become shorter than the Planck length as measured from another frame, and we can also have shorter time intervals than the Planck time.

The trans-Planckian problem is easily solved by a small modification that assumes Haug's maximum velocity for matter is the ultimate speed limit for something with mass. This speed limit depends on the Planck length, which can be measured without any knowledge of Newton's gravitational constant or the Planck constant. After a long period of slow progress in theoretical physics, we are now in a Klondike "gold rush" period where many of the essential pieces are falling in place.

Key words: Special relativity theory, length contraction, Planck length, Planck time, trans-Planck.

1 Introduction: Is There A Quantum and Minimum Length?

One of the open question in physics is whether there is a minimum length or not, and also how to interpret such a thing precisely. The Planck length is considered by many physicists to be the minimum length. According to the National Institute of Standards in the US (NIST CODATA 2014), it is only about 1.616229×10^{-35} meter. This is incredibly small. Looking to the history behind this unit, Max Planck first suggested the Planck length as a component of what he called the natural units [1, 2]. He assumed that there were three essential universal constants, namely the speed of light, c , Newton's gravitational constant G , and the Planck constant \hbar . Using only these three constants and dimensional analysis, he calculated what he thought were the fundamental length, time, mass, and temperature for matter; today these are known as the Planck length, the Planck time, the Planck mass, and the Planck temperature. The Planck length was given as

$$l_p = \sqrt{\frac{G\hbar}{c^3}} \quad (1)$$

In 1883, George Johnstone Stoney [3] suggested a set of natural units that were not too different from those given by Planck. The Stoney length was given as about 1.38×10^{-34} meter. However, the natural units of Planck are generally considered essential today, even though there are some disagreements on their importance. Some physicists would claim they are just mathematical artifacts with no implications for physics whatsoever, while others think there could be a unit smaller than the Planck length, and still others maintain that there should be no minimum length at all – that zero is the minimum. Nevertheless, the majority of physicists seem to agree that there is a minimum length and it is the Planck length. Later in this paper, we will point out recent progress in physics strongly indicating that the Planck length is indeed truly essential, and something that we can observe without relying on the Planck length formula. However, first we will turn to special relativity and the notion of the speed limit and how it leads to a trans-Planckian problem.

4 Recent Break-Through in Relation to the Planck Length

Since the time Max Planck introduced the Planck units, it has been assumed that G , c , and \hbar are truly fundamental universal constants, while the Planck length, Planck time, and Planck mass are just derived constants. Over time, a number of physicists have questioned if the Planck length, the Planck time, and the Planck mass are anything more than mathematical artifacts. However, we have recently shown that the Planck length can be found totally independent of both Newton's gravitational constant and the Planck constant. Based on simple gravity observations, we can find the Planck length and given the speed of light, we can complete just about any gravity predictions that may be needed [15], see also [11, 16, 17]. We only need G when we want to find the weight of an object from gravity observations (and even then we can do without G), which is why Cavendish is considered to be the first one to indirectly measure G by weighing the Earth.

One cannot keep special relativity unmodified and at the same time uphold a minimum distance and minimum time. It is therefore useful to examine other theories. The maximum velocity of matter seems to solve a series of infinity challenges in relativity theory. It also provides insight on a series of "mystical" effects such as entanglement, which can suddenly be understood from a different perspective, see [14].

5 Conclusion

We have clearly demonstrated that special relativity predicts that any particle or object can undergo so much length contraction that the contracted object, as observed from the other frame, will be shorter than the Planck length. That is, special relativity leads to a trans-Planckian crisis. One either has to accept that there is no minimum length or time, or one needs to modify special relativity theory. Our suggested formula for the maximum velocity of matter solves the trans-Planckian special relativity problem in an elegant and compelling way.

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