Is There a Missing Lorentz Shift for Mass?

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Abstract

In special relativity, we operate with length contraction and length transformation; these are not the same thing even though they are related. In addition, we have time dilation and time transformation. However, when it comes to mass, we have only relativistic mass and no mass transformation. We will suggest here, based on a better understanding of mass at the quantum level, that there must also be a Lorentz mass transformation. Recent research strongly indicates that mass is directly linked to the Compton wavelength of the particle in question and since we can operate with both length contraction and length transformation, this means we should have corresponding masses. Length contraction of the Compton wavelength corresponds to what is known today as relativistic mass, while length transformation means we also need mass transformation.

Key words: Length contraction, length transformation, mass transformation.

1 Introduction

Assume we have a rod with rest length L. A rod moving at velocity v will undergo length contraction $L\sqrt{1-v^2/c^2}$, as observed from the laboratory frame. However, we also have Lorentz length transformation

$$L' = \gamma(L - tv) \tag{1}$$

where $\gamma = 1/\sqrt{1-v^2/c^2}$. The length contraction can be calculated from the Lorentz transformation, so they are related. The length contraction has to do with two signals being sent from the front and the back of the rod that reach the laboratory frame simultaneously, as observed from the laboratory frame. In contrast, the Lorentz length transformation has to do with two signals being sent from the front and the back of the rod at time t appart, as measured from the rod frame. If $t = 0$, then the two signals are sent at the same time from the rod frame, but it is not happening simultaneously from the other frame due to the relativity of simultaneity. In the same way, we have time dilation and time transformation.

2 The Missing Lorentz Shift for Mass?

When it comes to mass, we have rest-mass and relativistic mass. The relativistic mass concept was introduced by Einstein [6, 7] and is given by

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

In 1923, Louis de Broglie [1, 2] hypothesized that there had to be a matter wave, today known as the de Broglie wave or simply the matter wave. In the same year, Arthur Compton [3] measured a wave related to electrons that today is known as the Compton wave. Both men received Nobel prizes for their work. It was soon confirmed in other experiments that matter did have wave-like properties. The Davisson and Germer in 1927 experiment [4], for example, observed diffraction patterns using electrons. Still, the de Broglie wavelength has mystical properties such as being infinite when a particle is at rest. This is not the main topic of this article, but we will claim that the de Broglie wavelength is mostly a mathematical artifact and a derivative of the Compton wave, which we have discussed in another paper [8]. The Compton wavelength has, contrary to the de Broglie wavelength, been measured in a series of experiments, and if one knows the Compton wavelength, the Planck constant, and the speed of light, then one can determine the mass of the particle. The rest-mass of any particle is given by

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$$m = \frac{\hbar}{\bar{\lambda}}\frac{1}{c} \tag{3}$$

We can measure the Planck constant from Watt balance experiments [9, 11, 12], and the speed of light can be measured without any knowledge of mass. Both the Planck constant and the speed of light are, in modern physics, assumed to be constants that not are affected by the reference frame, which is something we will also assume here. This means the only element here that can be affected by motion is the Compton wavelength of matter. The Compton wavelength is a length and we therefore assume it can undergo length contraction; this gives us

$$m' = \frac{\hbar}{\bar{\lambda}\sqrt{1-\frac{v^2}{c^2}}}\frac{1}{c} = \frac{\frac{\hbar}{\bar{\lambda}}\frac{1}{c}}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{m}{\sqrt{1-\frac{v^2}{c^2}}} = \gamma m \tag{4}$$

That is, we will claim relativistic mass is directly linked to length contraction in the reduced Compton wavelength off matter. However, since mass is related to length, we should expect that Lorentz length transformation is relevant in this context. This means we must also have Lorentz transformation mass directly linked to Lorentz length transformation

$$m^- = \frac{\hbar}{\gamma(\bar{\lambda} - tv)}\frac{1}{c} \tag{5}$$

we will claim the time t in a elementary particle always must be linked to the Compton time, which is $t_c = \frac{\bar{\lambda}}{c}$. This is supported to some degree by recent research that strongly indicates matter is linked to the Compton clock model [5, 10]. Replacing t with the Compton time we get

$$m^- = \frac{\hbar}{\gamma(\bar{\lambda} - \frac{\bar{\lambda}}{c}v)}\frac{1}{c} = \frac{m}{\gamma\left(1-\frac{v}{c}\right)} \tag{6}$$

and in the opposite direction we have

$$m^+ = \frac{\hbar}{\gamma(\bar{\lambda} + \frac{\bar{\lambda}}{c}v)}\frac{1}{c} = \frac{m}{\gamma\left(1+\frac{v}{c}\right)} \tag{7}$$

We will claim matter at the quantum level is linked to the round-trip speed of light. This matter is composed of photons traveling back and forth over the Compton wavelength of the particle in question and interacting at every Compton time. This means matter, as we see it at time levels higher than the Compton time, is

$$m' = \frac{1}{2}m^- + \frac{1}{2}m^+ = \frac{m}{\gamma\left(1-\frac{v}{c}\right)} + \frac{m}{\gamma\left(1+\frac{v}{c}\right)} = \gamma m \tag{8}$$

Only at the Compton time level (quantum level) will it be easily to confirm that we also have Lorentz-transformed relativistic mass. Whether or not it can also have measurable and predictable effects at time scales considerably above the Compton time of the particle is an open question. We encourage others to examine this further.

The misunderstanding that the de Broglie wave is the matter wave, rather than the Compton wave, may be the reason we do not have a Lorentz transformation of mass at the quantum level.

3 Conclusion

We claim the only aspect that can be altered in moving matter is the Compton wavelength; it can undergo length contraction and length transformation. This means we have Lorentz transformed mass, not only relativistic mass, which means there are two types of relativistic mass: one linked to length contraction (standard relativistic mass) and the other linked to Lorentz length transformation. Our analysis indicates this is only directly detectable at time intervals close to the Compton time. For considerably longer time intervals, the Lorentz-transformed mass cannot be observed "directly," as mass (in our view) is linked to the round-trip speed of photons and their interactions.

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