Superluminal Mass-Energy Equation and Superluminal Lorentz Transformation

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Abstract

In response to the recent Neutrino Anomaly (arXiv:1109.4897), a Superluminal Mass-Energy Equation and a Superluminal Lorentz Transformation are postulated.

1 Special Relativity

According to Einstein's theory of Special Relativity:

- No objects can travel faster than the speed of light.
- Mass and energy are related through Einstein's famous equation $E^2 = p^2c^2 + m^2c^4$, where E is the total energy of the object, p is the magnitude of the momentum vector of the object, m is the mass of the object at rest, and c is the speed of light.

2 Neutrino Anomaly

However, a sequence of latest experiments in Europe, which involve hundreds of physicists, showed some astonishing anomaly that neutrinos, some tiny neutral non-zero-mass particles, can travel faster than the speed of light (arXiv:1109.4897). As a matter of fact, similar reports were publicized before (arXiv:0706.0437; Phys. Rev. D 76, 072005), but with much less confidence.

If the latest anomaly is confirmed, the theory should be modified; otherwise, the causality could be violated. One approach might be: Einstein's mass-energy equation is maintained and the mass is extended to imaginary. Unfortunately, an imaginary quantity is not physically observable and has no ordering (we cannot say one imaginary number is bigger than another).

3 Superluminal Mass-Energy Equation and Superluminal Lorentz Transformation

As a second approach, we may postulate

$$\begin{aligned} E^2 &= p^2c^2 + m^2c^4 && \text{for subluminal particles} \\ E^2 &= p^2c^2 - m^2c^4 && \text{for superluminal particles,} \end{aligned}$$

where "subluminal" means "travelling slower than light" (subluminal) and "superluminal" means "travelling faster than light" (superluminal). For photons, both the subluminal equation, which is exactly the original Einstein's equation, and the superluminal equation reduce to

$$E^2 = p^2c^2.$$

Likewise, the original Lorentz Transformation is extended to

$$\begin{aligned} \gamma &= \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} && \text{for subluminal particles} \\ \gamma &= \frac{1}{\sqrt{\frac{v^2}{c^2}-1}} && \text{for superluminal particles.} \end{aligned}$$

An extensive verification of superluminal mass-energy equation and superluminal lorentz transformation has to be conducted. For example, we may replace the subluminal mass-energy equation in quantum electrodynamics and weak interaction by the superluminal counterpart, to see if it predicts, while consistency is maintained, some particles able to travelling faster than the speed of light. As a second example, the superluminal postulate must not incur causality violation. It would be interesting to see, with the extended luminal mass-energy equations and extended lorentz transformations, whether or not the Standard Model can take neutrinos into full account and whether or not the neutrino mass can be better determined – two currently unresolved issues.