SIMPLE EXPERIMENT THAT UNEQUIVOCALLY VERIFY RELATIVITY

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Abstract. Although many experiments have been cited as empirical verification of special relativity, they are not experiments that could not have questions raised about their validity as proofs. There is one simple experiment that could be carried out to put to rest, incontrovertibly, the controversies concerning the validity of special relativity - by a direct measurement of the speed of beta particles from beta decay. If special relativity is correct, no electrons would be found to go faster than light speed. If special relativity is invalid, then kinetic energy obeys the old $1/2mv^2$ formula. Some beta particles could be ejected with kinetic energy greater than 1 MeV; such electrons would be detected to travel at about twice the speed of light. Though it is one of the simplest experiment that many laboratories over the world could perform, the experiment has yet to be carried out.

1. Experiment to Measure Speed of Beta Particles

Even after a hundred years since 1905, there are still controversies over the validity of Einstein's theory of special relativity. Though many experiments have been cited as incontrovertible verification of special relativity, all such experiments have never been direct verification; they rely on some underlying physics that, if they were to fail, then the experiments would also be invalidated. Many of the formulas that are used, e.g the Lorentz magnetic force law, have been called into question by some physicists at one time or another. So all the experiments are not without controversy. There is a direct, yet very simple, experiment that could verify special relativity - an experiment that could easily be carried out by most laboratories in the better universities in the world. The experiment will not invoke the least of controversy over the interpretation of the result of the experiment.

The one thing that mark special relativity and make it "special" and easily distinguished from Newtonian physics is the well known relation $E = mc^2$. More accurately, the mass variable m should be the new relativistic mass γm where γ is velocity dependent: $\gamma = 1/\sqrt{1 - v^2/c^2}$; v being the velocity of a particle and c is the speed of light, a universal constant. Prior to special relativity, mass is always assumed to be an invariable constant quantity of matter. But with special relativity, as a particle's speed increases, so does its relativistic mass. From the expression of $\gamma = 1/\sqrt{1 - v^2/c^2}$, it can be seen that v cannot be greater than c, the speed of light, otherwise the mass of a particle becomes indeterminate (square root of a negative value is only imaginary; mass has to be real and positive). In the old Newtonian mechanics, the kinetic energy formula is $KE = 1/2mv^2$. In special

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relativity, the old $1/2mv^2$ is no longer applicable; it has to be replaced by the new formula $KE = (\gamma - 1)mc^2$, m being now the invariable rest mass.

In Newtonian mechanics, particles may travel at any speed, even greater than the speed of light, as there is nothing within its mechanics which prohibits a particle to go at an infinitely high speed. But with special relativity, there is a limit to the maximum speed that a particle may travel in empty space - never exceeding the speed of light c. Indeed, since the invention of the first particle accelerators, particles like electrons, protons have never been observed to travel faster than light. Even with the current most advanced Large Hadron Collider (LHC) of CERN, proton-proton collision with particle energy near 7 TeV still have the protons not able to violate the speed of light as a limiting speed - the prediction of special relativity seems to hold very well. So such experiments that have been carried out routinely over decades give a very strong support that special relativity is empirically validated.

But there are voices questioning whether the speed limit of c is true in nature or it is only observed to be true within our particle accelerators. The accelerators are machines built and designed through our physics - basically electromagnetism. That particles within accelerators cannot surpass the speed of light may not be a rule of nature, but rather electromagnetism has a limit in accelerating charged particles - the forces pushing at the particles become zero when the speed of light is reached; thus through electromagnetic means, particle will never surpass the speed of light even though nature has no limit set as to a maximum speed that elementary particles may travel. A simple experiment exists that could easily settle the question if electrons may, or may not, go faster than light speed. It is an experiment which, though simple to carry out, yet have never been done until now.

Some unstable heavy elements undergo natural radioactive beta decay in which high energy electrons, the so named beta particles, are ejected. It has been determined, even in the 1930's, that such electrons have an energy distribution that may range from 0 to 1.16 MeV. Now, such electrons are energized directly by the internal nuclear binding forces, unlike by the electromagnetic forces within particle accelerators. Such electrons have kinetic energy that either obeys the old $1/2mv^2$ formula or the $(\gamma - 1)mc^2$ of special relativity - but never both! For an electron that have kinetic energy greater than 1 MeV, the old formula will mean it will have a velocity about twice the speed of light. But if special relativity is the only correct physics replacing Newtonian mechanics, no electrons would be found to go faster than light.

2. Conclusion

The above suggested experiment is the simplest experiment that would conclusively settle if matter particles may, or may not, go faster than light. In this manner, special relativity too would be verified.

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