Spinning Einstein

Source unknown

Summary

Nobel prize winner Sheldon Glashow and colleague Andrew Cohen, of Boston University in Massachusetts, have suggested that Einstein's Special Theory of relativity needs to be updated to account for the behavior of neutrinos.

Neutrinos are the most abundant particle in the universe; in fact the universe has been described as a vast sea of neutrinos, punctuated by other particles. Recent experiments have shown that neutrinos have mass, even though our current best theory of matter, the Standard Model, says they should be massless. While formulating their "Very Special Relativity," they discovered that a neutrino's mass may be a clue to an irregularity in space time.

From the results of the MM experiments Einstein concluded the speed of light is constant for all observers, regardless of their motion. He also assumed the laws of physics are the same for all observers moving at constant speed. From these two postulates, He derived SR.

If these two postulates are true, then time must have certain symmetries, which form the Lorentz symmetry group, which concerns rotations and changes in velocity. The lorentz symmetry group, with the symmetry of space time translations, are revealed by SR. SR implies that the velocity of light is constant for all observers (is this a postulate?) time slows and distances contract at near light speeds, energy and mass are interchangeable, and two events that appear simultaneous to one observer do not to another observer.

Today scientists are wondering if Lorentz symmetry might be broken at small distances or high energies. They are motivated by a search for the TOE. String theory and loop quantum gravity suggest that Lorentz symmetry might be broken at the Plank scale, 10-35 meters, where both QM and gravity come into play. Non-commutative geometry explicitly calls for Lorentz symmetry breaking at the Plank scale.

Dozens of experiments have unsuccessfully tried to reveal evidence of a break in Lorentz symmetry.

Glashow and Cohen found a way to modify SR to reduce the amount of Lorentz symmetry. This modification they call Very Special Relativity (VSR). In this new version, Lorentz symmetry is prominent enough to maintain the traditional features of SR, such as constancy of speed of light, but full rotational symmetry of space-time is lost. "Not all directions are the same in VSR" says Glashow. … there is a preferred direction in space." On earth, the preferred direction is down. That's because the mass of the planet breaks the symmetry of space time and gravity selects a unique direction. G and C suggest that even in the absence of a *mass, space-time itself treats some directions differently. But don’t the underlying laws of physics see every direction as equal? (Lorentz symmetry). The break in rotational symmetry should be very small, and so unnoticeable at the mid scales of earth. No break in rotational symmetry has yet been documented. Cohen says that if you give up rotational space time symmetry, other possibilities look very nearly rotationally invariant.*

At how small a scale would we find VSR’s Lorentz symmetry violation?

The answer lies in the neutrinos. Neutrinos interact with matter only through gravity and the weak force. They are the least understood of the particles in the Standard Model.

New explanations of the strange qualities of neutrinos may be paving the way for a deeper comprehension of the universe than the standard model affords.

In 1998, the Super-Kamiokande, a Neutrio observatory in Japan found that neutrinos in their sample spontaneously morphed into their three “flavors”. The laws of QM dictate that only particles with mass can change flavors, so the neutrinos must have mass, which “seems” to be 100,000 million times lighter than a proton. Physicists still have no idea how neutrinos can have mass.

The neutrino spin is also puzzling. Researchers have discovered that some particles can spin either to the “left” or “right”, while others can spin only in one direction. Only massless particles can have one directional spin, and only massless particles can travel at the speed of light. Every neutrino ever observed has had left handed spin, so the neutrino should travel at light speed and be massless. How can a neutrino have left handed spin and have mass? VSR appears to provide an answer. VSR’s lorentz violation occurs at the scale of the neutrino’s size, so it can have mass. If it has mass, it cannot travel at the speed of light.

VSR makes some predictions that may be testable some day. It should limit tritium’s momentum as it decays, releasing an electron and an antineutrino. Another possibility is that it could effect electron dipole moment.

Neither of these predictions is currently testable.

Many scientists do not put much stock in VSR, because even very small changes in SR translate into big problems for GR. So although VSR might solve some problems, it might create even bigger ones.