Finding faster-than-light particles by weighing them

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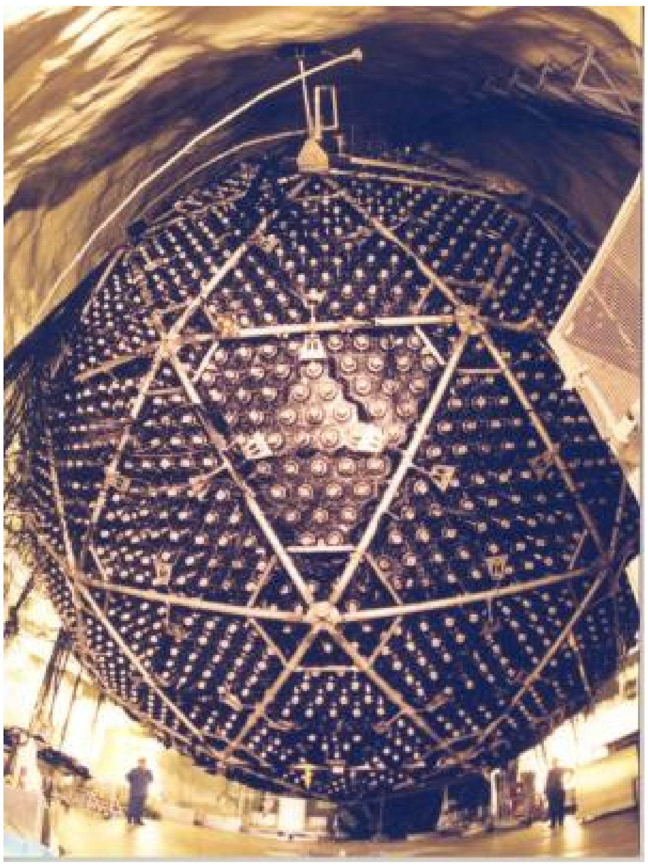

The Sudbury Neutrino Detector. Credit: A. B. McDonald (Queen's University) et al., The Sudbury Neutrino Observatory Institute

In a new paper accepted by the journal Astroparticle Physics, Robert Ehrlich, a recently retired physicist from George Mason University, claims that the neutrino is very likely a tachyon or faster-than-light particle. There have been many such claims, the last being in 2011 when the "OPERA" experiment measured the speed of neutrinos and claimed they travelled a tiny amount faster than light. However, when their speed was measured again the original result was found to be in error – the result of a loose cable no less.

Ehrlich's new claim of faster-than-light neutrinos is based on a much more sensitive method than measuring their speed, namely by finding their mass. The result relies on tachyons having an imaginary mass, or a negative mass squared. Imaginary mass particles have the weird property that they speed up as they lose energy – the value of their imaginary mass being defined by the rate at which this occurs. According to Ehrlich, the magnitude of the neutrino's imaginary mass is 0.33 electronvolts, or 2/3 of a millionth that of an electron. He deduces this value by showing that six different observations from cosmic rays, cosmology, and particle physics all yield this same value within their margin of error. One observation, for example, involves the tiny variations in cosmic background radiation left over from the big bang, while another involves the shape of the cosmic ray spectrum.

Skeptics of tachyons often cite conflicts with relativity theory. In fact, the idea of faster-than light tachyons was first suggested in a 1962 article by George Sudarshan and colleagues Bilaniuk and Deshpande as a kind of loophole in relativity. Einstein had shown that it is impossible for particles (or space ships) to be accelerated up to or beyond the speed of light because of the infinite energy required. Sudarshan and his colleagues suggested, however, that if particles were created initially with faster-than-light speed in particle collisions no acceleration or infinite energy would be necessary – something not possible for space ships unfortunately!

Several decades after tachyons were first proposed, and after many fruitless searches for them, three theorists Chodos, Hauser, and

Kostelecky suggested in 1985 that they might be hiding in plain sight – specifically that neutrinos are tachyons. This idea led them to propose that protons should beta decay when they travel at sufficiently high speed towards us. Normally, this process is forbidden because it could not conserve energy, but that changes if neutrinos are tachyons, energy can be negative in certain reference frames – in effect negative energy tachyons travel backwards in time. The Chodos-Hauser-Kostelecky proposal is what first led Ehrlich to take up the hunt in 1999 when he claimed support for neutrinos being tachyons based on several cosmic ray studies. His new result, however, relies on data from four other areas besides cosmic rays, and is therefore more robust.

In addition, unlike the initial erroneous result in the OPERA experiment his claim cannot be dismissed because of the absence of some phenomena that should be observed and is not assuming the claim is correct. One check on Ehrlich's claim could come from the experiment known as KATRIN, which should start taking data in 2015. In this experiment the mass of the neutrino could be revealed by looking at the shape of the spectrum in the beta decay of tritium, the heaviest isotope of hydrogen. Another test based on high energy cosmic rays could even be made using existing data. Of course, before you try designing a "tachyon telephone" to send messages back in time to your earlier self it might be prudent to see if Ehrlich's claim is corroborated by others.

More information: Six observations consistent with the electron neutrino being a tachyon with mass: $m^2_{\nu e}=-0.11\pm0.016eV^2$, arXiv:1408.2804 [physics.gen-ph] arxiv.org/abs/1408.2804

Provided by George Mason University