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Earth screens out the noise

The AMANDA detector is a camera screen of ice with the whole earth as a filter, says S.Ananthanaryanan

AMANDA is the acronym for Antarctic muon and neutrino detector array, a massive experimental set-up located around the Antarctic ice.

What are neutrinos?

These are the lightest material particles known, lighter than the electron. Unlike the electron, they are without charge. Electrons, though small, give themselves away by interacting with things, because they are charged and get attracted or repelled by other charges. But neutrinos, because they are neutral, do not interact in the normal course and they can pass through whole planets and suns or millions of light years of space without getting absorbed.

That neutrinos should exist at all was a conjecture of the physicist, Wolfgang Pauli to explain the way the energy accounts of beta decay did not seem to balance. It was just theoretically proposed, that 'there must be a small, neutral particle there' and nothing was detected for many years. It was in 1956, using an ingenious method to detect the 'antineutrino' (the 'antiparticle' of the neutrino), that the validity of the conjecture was established.

Statistics

The detector of the antineutrino made use of a nuclear reactor, known to be an exceedingly copious source of antineutrinos. With an idea of how many of the elusive particles there were, the number, exceedingly small, actually detected, reveals the efficacy of the detector. When neutrinos from other sources, like streaming in from space, are detected, the same ratio can be applied to the number detected, to estimate how many neutrinos are streaming in.

This estimate shows that that neutrinos are some of the most abundant particles in the universe. As neutrinos are great survivors, these may be of very great antiquity, even dating back to the beginning of the universe. The processes soon after the 'big bang,' or the beginning of the universe are considered to have generated neutrinos in huge numbers. This tallies with the vast supply that is observed at present.

Neutrinos are thus of great interest to scientists.

Detecting Neutrinos

But how to detect these elusive scepters, if they do not interact at all? Well they do interact, just a bit, with protons, though it is the rarest of rare events. The antineutrino reacts with protons to give off a neutron and a positron (antiparticle of the electron). The positron soon meets an electron and the two annihilate and give of gamma rays, which is what we detect. In 1956, Rennes and Cowan used the beam from the Savanah reactor as a source of antineutrinos and showed that gamma rays did arise.

The AMANDA experiments do it another way. They let the neutrinos pass through ice slabs several kilometers thick. The speed of neutrinos or products of their rare interactions with other particles is faster, in the ice, that the speed of light in ice. In air, all disturbances travel at the speed of sound in air. But if an object moves faster in air than the speed of sound, then a shock wave, the sonic boom of supersonic aircraft, is set up. The same thing happens when neutrinos or other particles move faster than light in ice. The ‘boom’ is a flash of light, which to spot, there is an array of detectors placed all round..

To make sure it is neutrinos we are detecting and not some other particle, the detectors look for neutrinos coming through the ice from the ground below. The whole mass of the earth below keeps out all but the neutrinos and so the experiment stays reliable.

AMANDA II, now operational, hopes to detect point sources of neutrinos in space. If these correspond to supernovae or collisions of black holes or events like that, finding that neutrinos arise at such places would be significant.