Researchers at IceCube detect record energy neutrinos

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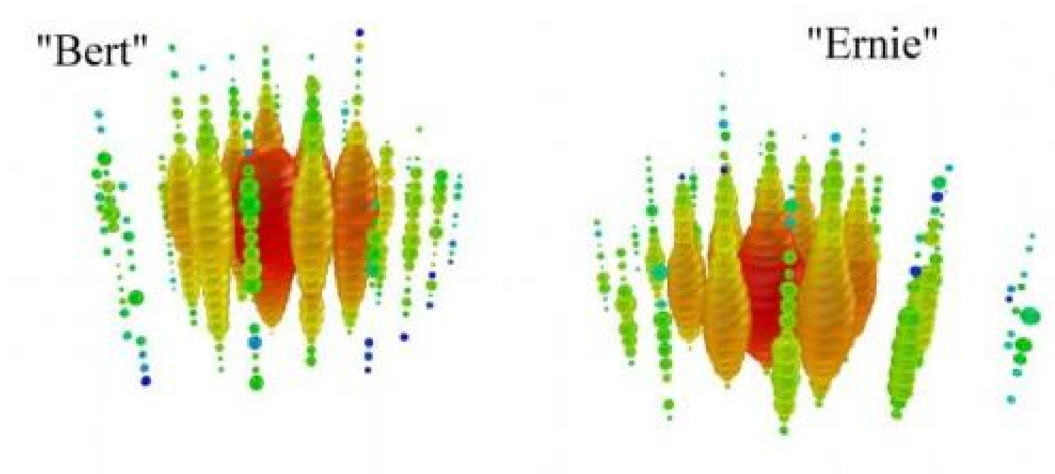

The two observed events from August 2011 (left panel) and January 2012 (right panel). Each sphere represents a DOM (digital optical module). Colors represent the arrival times of the photons where red indicates early and blue late times. The size of the spheres is a measure for the recorded number of photoelectrons. Credit: arXiv:1304.5356 [astro-ph.HE]

(Phys.org) —Researchers at the Antarctic research station IceCube are reporting that they've detected the highest ever energy neutrinos ever observed. In their paper they've uploaded to the preprint server *arXiv*, the team describes how in analyzing sensor data over the period 2010 to 2012 they found evidence of two neutrino induced events that were on an order of ten times the energy of any previous event.

Neutrinos are of particular importance to researchers because they have no charge and very little mass. This means they are free to travel through space without having their paths changed due to gravitational or magnetic forces, a trait that makes them very valuable for one day locating their source. The two neutrinos recorded at IceCube (dubbed Bert and Ernie) are of particular relevance because the odds are very good that they came from the far reaches of space, rather than as a by-product of a collision between cosmic rays and Earth's atmosphere—the researchers give it a confidence level of 2.8 sigma—meaning that the two neutrinos are very likely the first detected from outside the solar system since 1987, when detectors recorded neutrinos believed to have come from a supernova in the Large Magellanic Cloud.

The IceCube research station records collisions between neutrinos and ice particles via an array of optical sensors tied together with strings beneath the ice—such collisions are recorded roughly every six minutes—they can be observed because the collisions release enough Cherenkov radiation to be measurable for an area as large as 6 city blocks. Generally such collisions register energies in the 100 tera-electronvolt range—Bert and Ernie in contrast came in at approximately 1000 tera-electronvolts.

Researchers at the IceCube station and elsewhere are hoping that finding neutrinos that originate from outside the solar system will help explain where high energy cosmic rays that reach our planet come from—their source has baffled scientists for nearly a century. If researchers can eventually trace neutrinos back to their source, they might find that doing so also reveals the source of the cosmic rays.

Because all data from IceCube is recorded, the researchers are able to go back and take a closer look at neutrino collision events over time using different criteria. Because of this new find, that's exactly what they plan to do next, using a lower threshold to determine if other similar events might have been recorded, but missed due to preconceived notions of what they were supposed to be looking for.

More information: First observation of PeV-energy neutrinos with IceCube, arXiv:1304.5356 [astro-ph.HE] arxiv.org/abs/1304.5356

Abstract
We report on the observation of two neutrino-induced events which have an estimated deposited energy in the IceCube detector of $1.04 pm 0.16$ and $1.14 pm 0.17$,PeV, respectively, the highest neutrino energies observed so far. These events are consistent with fully contained particle showers induced by neutral-current $nu_{e,mu,tau}$ ($barnu_{e,mu,tau}$) or charged-current nu_{e} ($barnu_{e}$) interactions within the IceCube detector. The events were discovered in a search for ultra-high energy neutrinos using data corresponding to 615.9 days effective livetime. The two neutrino events are observed over an expected atmospheric background of $0.082 pm 0.004 text{(stat)}^{+0.041}_{-0.057} text{(syst)}$. The resulting p-value for the background-only hypothesis is $2.9times10^{-3}$ ($2.8sigma$) taking into account the uncertainty on the expected number of background events. Though the two events could be a first indication of an astrophysical neutrino flux, the moderate significance and the uncertainties on the expected atmospheric background from neutrinos produced in the decay of charmed mesons do not allow for a firm conclusion at this point.