Researchers at Super-Kamiokande report solar neutrino signal is slightly stronger at night (Update)

March 14 2014, by Bob Yirka

(Phys.org) —Researchers working at the Super-Kamiokande Collaboration in Kamioka, Japan are reporting slightly stronger neutrino detection occurring at night, due they say to changes that occur in flavor as the neutrinos pass through the Earth. In their paper published in *Physical Review Letters*, the researchers describe the results they found when analyzing a year's worth of data from their detector, which showed a flux of solar neutrinos during nighttime that was approximately 3.2 percent greater than what was measured during the day.

Scientists have known for a while that neutrino's change "flavor" as they journey through space—such as when they travel from the sun to our planet. The term "flavor" refers to its characteristics, which can be one of three: electron, muon, and tau. But until now, it wasn't clear if traveling through an object could also cause them to change flavor. In this new effort, the researchers have found that they likely do indeed, which means that sometime in the future, neutrino detectors could be used to learn more about the interior of our planet.

Scientists have found that approximately half of the low energy electron neutrinos emitted by the sun change to a tau or muon flavor before they reach us (which reduces the chances of electron neutrino detectors detecting them). An even smaller number of high energy electron neutrinos find their way here. Now the researches in Tokai are reporting that they've found evidence that because fewer electron neutrinos are detected at night, it's reasonable to conclude that that some of them have changed back to muon or tau flavors as they pass through the Earth (it's not likely the sun produces fewer neutrinos when the detector is on the dark side of the planet) which means that passing through the Earth has caused the neutrinos to revert back to the flavor they started out as.

Perhaps just as exciting is that the measured results agree with theories made by Russian physicists Stanislav Mikheyev and Alexei Smirnov in 1986 who were basing their research on work done previously by Lincoln Wolfenstein back in 1978—they describe what has come to be known as the MSW effect.

Because the work done falls below the 5σ needed for classification as a new discovery, however, more work will have to be done to find additional evidence of changes to neutrino flavors as they pass through a material before what the team has found will be considered as generally accepted by the physics community.

More information: 1. www-sk.icrr.u-tokyo.ac.jp/sk/index-e.html

2. First Indication of Terrestrial Matter Effects on Solar Neutrino Oscillation, *Phys. Rev. Lett.* 112, 091805 – Published 7 March 2014. dx.doi.org/10.1103/PhysRevLett.112.091805 . On Arxiv: arxiv.org/abs/1312.5176

ABSTRACT
We report an indication that the elastic scattering rate of solar B8 neutrinos with electrons in the Super-Kamiokande detector is larger when the neutrinos pass through Earth during nighttime. We determine the day-night asymmetry, defined as the difference of the average day rate and average night rate divided by the average of those two rates, to be [−3.2±1.1(stat)±0.5(syst)]%, which deviates from zero by 2.7σ. Since the elastic scattering process is mostly sensitive to electron-flavored solar

neutrinos, a nonzero day-night asymmetry implies that the flavor oscillations of solar neutrinos are affected by the presence of matter within the neutrinos' flight path. Super-Kamiokande's day-night asymmetry is consistent with neutrino oscillations for 4×10^{-5} $eV^2 \leq \Delta m^2_{21} \leq 7\times10^{-5}$ eV^2 and large mixing values of θ_{12}, at the 68% C.L.

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