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Solar neutrinos in Super-Kamiokande

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Recently the concern with the effect of matter on the neutrino oscillation has been growing, because the possibility of mass hierarchy determination by next generation experiments through the matter effect has been recognized.

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. This is the first direct indication that neutrino oscillation probabilities are modified by the presence of matter.

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 $[-3.2 \pm 1.1(\text{stat}) \pm 0.5(\text{syst})]\%$, 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 $4 \times 10^{-5} \text{ eV}^2 \leq \Delta m^2_{21} \leq 7 \times 10^{-5} \text{ eV}^2$ and large mixing values of θ_{12} , at the 68% C.L.

We also report the measured recoil electron spectrum whose shape should reflect the transition between vacuum dominated oscillations (lower energy solar neutrinos) and matter dominated oscillations (higher energy solar neutrinos).

Summary

Primary author(s) : Dr. SEKIYA, Hiroyuki (ICRR, University of Tokyo)

Presenter(s) : Dr. SEKIYA, Hiroyuki (ICRR, University of Tokyo)

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