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Evaluation of the Position and Direction Dependence of the Energy Scale Using the Decay of 16N at Super-Kamiokande

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Since the beginning of data taking, the Super-Kamiokande (SK) experiment has been conducting groundbreaking studies of solar neutrinos. All measurements to date, including those from SNO and KamLAND, are consistent with solar neutrino flavor change due to matter enhanced neutrino oscillations. But we are not yet done with solar neutrinos! Two key phenomena are yet to be observed with high significance: the energy dependence in the electron neutrino survival probability, driven by matter effects in the Sun (called the Mikheyev-Smirnov-Wolfenstein effect), and the day-night solar neutrino flux asymmetry, driven by matter effects in the Earth.

Super-Kamiokande measures ^{8}B and hep solar neutrinos via neutrino-electron elastic scattering. These are the highest energy solar neutrinos, but still quite close to SK's lowest energy threshold of 3.5 MeV. As a result, the current systematic uncertainties of the detector's energy scale limit the determination of the solar neutrino flux and energy spectrum with the required precision.

This poster describes the results from energy calibrations performed in three operational phases of SK, including both the pure water and gadolinium-loaded phases. The absolute energy scale of the detector is calibrated by injecting monoenergetic electrons into the tank using a linear accelerator (LINAC). However, these electrons can only be injected in the downward direction and data-taking positions are limited due to the arduous process of handling the LINAC device. To evaluate the systematic uncertainties of the energy scale, ^{16}N atoms produced by a deuterium-tritium (DT) generator are used. ^{16}N atoms decay isotropically, allowing us to measure the direction dependence of the energy scale. Furthermore, the DT device is easier to handle, making it suitable for taking data at many positions in the tank and evaluating the position dependence of the energy scale. These results are presented, along with a discussion of how the energy scale-related systematics can be further reduced to observe the long-sought-after solar neutrino matter effects.

Poster prize

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