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Scanning the Earth with solar neutrinos and DUNE

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We explore oscillations of the solar 8B neutrinos in the Earth in detail. The relative excess of night νe events (the Night-Day asymmetry) is computed as function of the neutrino energy and the nadir angle η of its trajectory. The finite energy resolution of the detector causes an important attenuation effect, while the layer-like structure of the Earth density leads to an interesting parametric suppression of the oscillations. Different features of the η− dependence encode information about the structure (such as density jumps) of the Earth density profile; thus measuring the η distribution allows the scanning of the interior of the Earth. We estimate the sensitivity of the DUNE experiment to such measurements. About 75 neutrino events are expected per day in 40 kt. For high values of Δm221 and Eν>11 MeV, the corresponding D-N asymmetry is about 4\% and can be measured with 15% accuracy after 5 years of data taking. The difference of the D-N asymmetry between high and low values of Δm221 can be measured at the 4σ level. The relative excess of the νe signal varies with the nadir angle up to 50\%. DUNE may establish the existence of the dip in the η− distribution at the (2−3)σ level.

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