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Measuring Non-Standard Neutrino Interactions (NSI) of Solar Neutrinos with Existing and Future Neutrino and Dark Matter Experiments

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Neutrinos can change flavor content on their way from their point of origin to the detector via a phenomenon known as neutrino oscillations. Neutrino oscillations have been confirmed over the past two decades in a wide range of experiments, and their measured parameters are now relatively consistent with the modified standard model (SM). However, there are hints that small deviations from SM neutrino oscillations could be caused by non-standard neutrino interactions (NSI). NSI could marginally (yet significantly) contribute to neutrino oscillations as neutrinos pass through a high-density medium. A convenient source of neutrinos that provides a high-density environment is our Sun. At its core, a high flux of neutrinos is emitted, stemming from fusion reactions, and, as these neutrinos travel to the Sun's surface, they experience a very dense matter profile that modifies their oscillation patterns. Here we study how existing and future neutrino experiments like Super-K, DUNE, Hyper-K, and a proposed low-background module for DUNE as well as dark matter experiments like LZ and XENONnT could observe effects of NSI with new precision measurements of solar neutrino oscillations. We show if and when these experiments could tap into unprobed phase space of NSI couplings, potentially discovering that the so-called 'solar neutrino anomaly' is real and caused by NSI.

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