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New physics studies with reactor antineutrinos and a deuterated liquid scintillator

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The existence of a sterile neutrino is one of the foremost topics of research in the area of neutrino physics. There are several short-baseline anomalies which hint towards the existence of sterile neutrinos [1]. However, a simplistic theory where oscillation is the only explanation is severely constrained due to null results at other experiments [1, 2]. In this work, we propose to study these $O(1\ \mathrm{eV}^2)$ Δm^2-driven short-baseline oscillations with antineutrinos from reactor neutrino complexes located in India. We propose to study both the charged current (CC) and neutral current (NC) interactions of antineutrinos on a deuterated liquid scintillator (DLS) detector. It should be noted that studying NC interactions of neutrinos in the MeV range is facilitated with the use of deuterium in the detector. India is one of the largest producers of heavy water in the world and using deuterated hydrocarbons as neutrino detectors is quite feasible. Such a detector has been explored for detecting future supernova neutrinos, very recently, in Ref. [3]. It is also possible to have multiple detector locations in the few metres to few kilometres distances from the reactor core; thereby aiding a synergistic study between CC and NC interactions at near and far detectors - possibly eliminating flux and cross-section related uncertainties. Further, a combined study of CC and NC interactions may provide sensitivity to all the new active-sterile oscillation parameters which may be quiescent in only CC interactions, as demonstrated before in Ref. [4].

References:
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