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LMA-Dark: Large New Physics Effects in Neutrino Oscillations

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In neutrino oscillation physics numerous exact degeneracies exist under the name LMA-Dark. These degeneracies make it impossible to determine the sign of Δm_{31}^2 known as the atmospheric mass ordering with oscillation experiments alone in the presence of new neutrino interactions. The combination of different measurements including multiple oscillation channels and neutrino scattering experiments lifts some aspects of these degeneracies. In fact, previous measurements of coherent elastic neutrino nucleus scattering (CEvNS) by COHERENT already ruled out the LMA-Dark solution for new physics with mediators heavier than $M_{Z'} \sim 50$ MeV while cosmological considerations disfavor these scenarios for mediators lighter than $M_{Z'} \sim 3$ MeV. Here we leverage new reactor data which provides the strongest bounds on CEvNS with light mediators to date. We show that this data completely removes the degeneracies in the ν_e sector for mediators down to the MeV scale at which point constraints from the early universe take over. While the LMA-Dark degeneracy is lifted in the ν_e sector, it can still be restored in the ν_μ and ν_τ sector or with very specific couplings to up and down quarks, and we speculate on a path forward.

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