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What oscillations can't see: probing NSI with neutral currents channels in accelerators

Neutrino oscillation experiments probe matter effects induced by non-standard interactions (NSI), but the sensitivity is confined to specific combinations of the underlying operators —leaving orthogonal directions in parameter space completely unconstrained. We show that neutral-current (NC) event rates at long-baseline experiments offer a direct handle on these blind directions, since the same operators that modify the matter potential also shift the NC cross section on nuclear targets. Using existing NOvA data and projections for DUNE, we demonstrate that the joint analysis of charged-current and neutral-current samples breaks degeneracies among correlated NSI parameters for the first time in a terrestrial experiment. This complementarity provides coverage of regions in the NSI parameter space that remain degenerate in oscillation-only analyses and that coherent elastic neutrino–nucleus scattering (CEνNS) measurements cannot yet resolve.

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