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Searches for Exotic Oscillations in Atmospheric Neutrinos

We use 4,438 live-days of atmospheric data from the Super-Kamiokande experiment to search for modifications of standard three-flavor neutrino oscillations due to sterile neutrino mixing and Lorentz violation. For the sterile neutrino analysis, we search for fast oscillations driven by an eV^2 -scale mass splitting and oscillations into sterile neutrinos instead of tau neutrinos at the atmospheric mass splitting. No evidence of sterile oscillations is seen and we set limits on $|U_{\mu 4}|^2$ and $|U_{\tau 4}|^2$. The nature of the experiment makes these limits independent of the number of additional sterile neutrinos and the precise value of the mass splitting. For the Lorentz violation analysis, the non-perturbative Standard Model Extension is used in addition to standard three-flavor oscillations, allowing the use of the full range of neutrino path lengths, ranging from 15 to 12,800 km, and energies ranging from 100 MeV to more than 100 TeV in the search. No significant evidence of Lorentz violation was observed, so limits are set on the renormalizable isotropic SME coefficients, improving the existing limits by up to seven orders of magnitude in the e - μ and e - τ sectors, and setting limits for the first time in the μ - τ sector.

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