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A Search for Lorentz Violation using the T2K Near Detectors

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Lorentz symmetry violation (LV) arises when the behavior of a particle depends on its direction or boost velocity. This fundamental symmetry violation is expected to occur at the Planck scale (~10^19 GeV). The Standard Model Extension (SME) is a general theoretical framework that includes both General Relativity and the Standard Model while also allowing for the spontaneous breaking of Lorentz symmetry through a set of controlling coefficients. As predicted by the SME, neutrinos couple to a background tensor feld that is fixed in space and time. As a neutrino beam experiment on Earth rotates with the Earth's sidereal frequency, a neutrino beam experiment will exhibit a sidereal time dependence in the neutrino oscillation probabilities. At baselines shorter than the neutrino oscillation length, oscillation probabilities are calculated in the SME which are entirely due to LV effects. A search for LV at the T2K near detectors with baselines of 280 m is presented. The protons-on-target normalized neutrino event rate at the T2K near detectors is used to search for LV using a shape-only analysis via Fast Fourier Transform (FFT) analysis and a binned log-likelihood fit. No indication of LV is observed with either method in the T2K near detector data. The FFT analysis was used to study the four Fourier modes relevant in the oscillation probability and the binned log-likelihood fit was used to set upper limits on the amplitudes associated with each sidereal time harmonic.

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