

## Constant and variable matter density effects in Long Baseline Neutrino Experiments

In this paper, the appearance and survival probabilities ( $P(\nu_\mu \rightarrow \nu_e)$  and  $P(\nu_\mu \rightarrow \nu_\mu)$ ) have been studied for neutrinos travelling through matter of constant density to explore the oscillation behaviours among the three known active neutrinos. The **Deep Underground Neutrino Experiment (DUNE)** with a baseline of  $1284.9\text{km}$  (from **FermiLab**, Illinois to **Sanford Laboratory**, South Dakota) with constant matter density of  $2.957\text{gcm}^{-3}$  has been considered in the analysis. Additionally, using Byron Roe's method, neutrino oscillations for a beam of muon neutrinos traversing the variable densities of the earth interior have been explored. Oscillations measured using variable density profile are, then, compared to that of constant density calculations and a qualitative assessment is performed. For the calculations, the three-neutrino fit from the **NuFIT 4.0.**, based on the data available in November, 2018, are considered for the oscillation parameters. Furthermore, the oscillations have been studied considering muon anti-neutrinos ( $\bar{\nu}_\mu \rightarrow \bar{\nu}_e$  and  $\bar{\nu}_\mu \rightarrow \bar{\nu}_\mu$ ) and the asymmetry in neutrino-antineutrino oscillations is measured for both constant and variable density profiles.

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