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Monte Carlo simulations of neutrino and charged lepton propagation in the Earth with nuPyProp

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An accurate modeling of neutrino flux attenuation and the distribution of leptons they produce in transit through the Earth is an essential component to determine neutrino flux sensitivities of underground, sub-orbital and space-based detectors. Through neutrino oscillations over cosmic distances, astrophysical neutrino sources are expected to produce nearly equal fluxes of electron, muon and tau neutrinos. Of particular interest are tau neutrinos that interact in the Earth at modest slant depths to produce τ-leptons. Some τ-leptons emerge from the Earth and decay in the atmosphere to produce extensive air showers. Future balloon-borne and satellite-based optical Cherenkov neutrino telescopes will be sensitive to upward air showers from tau neutrino induced τ-lepton decays. We present nuPyProp, a python code that is part of the nuSpaceSim package. NuPyProp generates look-up tables for exit probabilities and energy distributions for $\nu_\tau \rightarrow \tau$ and $\nu_\mu \rightarrow \mu$ propagation in the Earth. This flexible code runs with either stochastic or continuous electromagnetic energy losses for the lepton transit through the Earth. Current neutrino cross section models and energy loss models are included along with templates for user input of other models. NuPyProp results are compared with other recent simulation packages for neutrino and charged lepton propagation. Sources of modeling uncertainties are described and quantified.

Keywords

neutrino telescopes; Monte Carlo simulations

Collaboration

other (fill field below)

other Collaboration

nuSpaceSim

Subcategory

Theoretical Methods

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