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Neutrino oscillations in Earth: a unique tool to probe dark matter inside the Core

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The information about the Earth's interior structure comes from seismic studies and gravitational measurements. The Preliminary Reference Earth Model (PREM) of the density of the Earth is obtained by measuring the travel time of seismic waves. Here, the density distribution inside the Earth is estimated from the model-dependent empirical relations having assumptions based on temperature, pressure, composition, and elastic properties of the Earth, which give rise to uncertainties in the PREM profile.
Neutrinos may be used in a way complementary to seismic studies and gravitational measurements, thus starting an era of "multimessenger tomography" of Earth. Since neutrinos can peek into the deepest layers of Earth with their weak interactions, they can be used to sense the amount of baryonic matter present inside the core. If the baryonic matter observed by neutrinos is found to be less than the expected mass from gravitational measurement, we can attribute the difference to the presence of dark matter inside the core. Atmospheric neutrinos offer the possibility of probing dark matter inside the core of the Earth in a unique way through Earth matter effects in neutrino oscillations. We demonstrate that while the dark matter profile will be hard to identify, the baryonic matter profile inside the core can be probed in a manner complementary to the seismic measurements.

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