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Validating the Earth's Core using Atmospheric Neutrinos with ICAL at INO

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The Iron Calorimeter (ICAL) detector at the proposed India-based Neutrino Observatory (INO) aims to detect atmospheric neutrinos and antineutrinos separately in the multi-GeV range of energies and over a wide range of baselines. By utilizing its charge identification capability, ICAL can efficiently distinguish μ^- and μ^+ events. Atmospheric neutrinos passing long distances through Earth can be detected at ICAL with good resolution in energy and direction, which enables ICAL to see the density-dependent matter oscillations experienced by upward-going neutrinos in the multi-GeV range of energies. In this work, we explore the possibility of utilizing neutrino oscillations in the presence of matter to extract information about the internal structure of Earth complementary to seismic studies. Using good directional resolution, ICAL would be able to observe 331 μ^- and 146 μ^+ core-passing events with 500 kt·yr exposure. With this exposure, we show for the first time that the presence of Earth's core can be independently confirmed at ICAL with a median $\Delta\chi^2$ of 7.45 (4.83) assuming normal (inverted) mass ordering by ruling out the simple two-layered mantle-crust profile in theory while generating the prospective data with the PREM profile. We observe that in the absence of charge identification capability of ICAL, this sensitivity deteriorates significantly to 3.76 (1.59) for normal (inverted) mass ordering.

Attendance type

In-person presentation

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