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Perspectives for probing the Earth core composition with atmospheric neutrino detectors

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Our knowledge about the Earth's interior is mainly based on seismic measurements, cosmochemical and petrological constraints, and theories of Earth formation. Whereas the matter density profile is determined with a high precision, the chemical composition of the deep Earth can only be estimated indirectly. In particular the amount and nature of light elements in the Core remain controversial.

A new approach comes from the field of particle physics. The oscillation probabilities of neutrinos traversing the Earth are affected by the electron density along their trajectory. In combination with a known matter density profile, their measurement leads to a direct constrain of the proton-to-nucleon (Z/A) ratio along the neutrino path. Since this parameter varies among chemical elements this technique has the potential to provide insights into the chemical composition of the core. From the current knowledge of the Earth's interior, oscillation resonance effects are expected at ~GeV energies, making atmospheric neutrinos excellent candidates for oscillation tomography research

In our study we find that the atmospheric neutrino telescope KM3NeT/ORCA will be able to resolve the Z/A ratio of the Earth's outer core with an uncertainty of <10% at 1σ. We further show that, in order reach resolutions sufficient to constrain the Earth core composition, bigger and denser versions of currently existing detector types are needed.

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