

次世代地球ニュートリノ観測によるLLSVP化学組成の測定可能性評価

Evaluating the measurability of LLSVP chemical composition by future geoneutrino detection

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Geophysical studies indicate that the Earth's interior is highly heterogeneous, containing large-scale structures. One of the most prominent features is the Large Low Shear Velocity Provinces (LLSVPs), imaged by seismic tomography as regions with anomalously slow S-wave velocities relative to the surrounding mantle beneath the Pacific Ocean and Africa. The origin of these structures remains debated. One hypothesis suggests LLSVPs result from anomalous chemical compositions enriched in U, Th, and other elements (thermochemical piles), while an alternative hypothesis proposes they are purely thermal features without distinct chemical signatures.

Geoneutrino detection provides a promising approach to address this issue. Geoneutrinos, generated by the beta decay of radioisotopes inside the Earth, traverse the planet with little interaction and can be detected at the surface. However, previous measurements lack angular resolution, preventing the identification of specific source regions. Recent technological advances, such as gadolinium-doped liquid scintillators for enhanced neutron tagging and segmented detector designs, may enable geoneutrino observations with directional sensitivity.

In this study, we present a feasibility study on future geoneutrino detectors equipped with angular resolution. Specifically, we evaluate the sensitivity to mantle heterogeneities and the abundance of heat-producing elements within LLSVPs. Our results suggest that the optimal location for such a detector is near Hawaii, directly above the central Pacific LLSVP. This finding highlights the significant potential of the Ocean Bottom Detector (OBD) project to unravel the chemical nature of the deep Earth.

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