Search for hydrogen in the Earth's core and lower mantle using neutrino oscillations

*Akimichi Taketa[1], Carsten Rott[2]

1. Earthquake Research Institute, University of Tokyo, 2. SungKungKwan University

According to recent reports, lower mantle can preserve more water than previous assumption. Hydrogen is gathering attention as the light element of the outer core. But hydrogen content in the deep Earth cannot be measured directory with the present technology.
We have been studying the composition measurement of the outer core using neutrinos produced in the Earth’ s atmosphere. This method can be applied to water content measurement of the lower mantle. Also, we found the neutrino produced in the Sun can improve the sensitivity of this measurement.
Neutrinos have unique property not found in other elementary particles, called as neutrino oscillation. Neutrino oscillation refers to the phenomenon that the specie of neutrino changes to another specie of neutrino over time. For example, a neutrino produced as a muon neutrino could be detected as an electron neutrino. Probability of changing its specie depends on the mixing angle of neutrino, the masses of three species, its energy, time of flight, violation of charge conjugation parity symmetry, and the electron density of the media which is passed through by the neutrino. The other parameters than the electron density can be measured by other experiments, so neutrino oscillation can be used as the unique prove to measure the electron density of the object.
Therefore, by measuring the neutrinos, which are produced in the Earth’ s atmosphere or in the Sun and passed through the Earth, it becomes possible to measure the electron density distribution of the deep Earth. The matter density distribution is already measured by seismic wave propagation and free oscillation of the Earth. The ratio of the electron density to the matter density is equal to the ratio of the atomic number to the atomic mass (Z/A ratio), so the average chemical composition distribution of the Earth. The Z/A ratio of the standard rock is approximately 0.5, and that of iron is approximately 0.47, whereas The Z/A ratio of hydrogen is 1. So neutrino oscillation is especially sensitive to hydrogen. By using this property, hydrogen search in the deep Earth becomes possible.
We report the possibility of the hydrogen search using solar neutrino oscillations and atmospheric neutrino oscillations.

Keywords: chemical composition, lower mantle, outer core, neutrino