KamLAND : Geo-Neutrino Measurement in Japan

Itaru Shimizu

Research Center for Neutrino Science, Tohoku University, Sendai 980-8578, Japan

Introduction

Geoneutrinos are antineutrinos produced in radioactive isotope decays within Earth's interior. Those antineutrinos are neutral particle and can be detected by weak interaction, however, due to extremely small cross section, there were no feasible experiments for a long time. The observation of geoneutrinos has been finally made using large-size liquid scintillator detectors, KamLAND in Japan and Borexino in Italy.

Geo-Neutrino Measurement in KamLAND

KamLAND (Kamioka Liquid Scintillator Anti-Neutrino Detector) is located in Kamioka mine, Japan, at a depth of 1,000 m. The KamLAND data collected between March 2002 and November 2012 provides a most precise measurement of the geo neutrino flux, 3.4×10^{6} cm⁻²s⁻¹ at the Kamioka site. The observed energy spectra are consistent with the expectation of ²³⁵U and ²³²Th decays in the Earth.

Earth Model Comparison

The measured geoneutrino fluxes can be compared with the Earth model predictions. Based on an appropriate geophysical assumption, the flux can be converted into a radiogenic heat of $11.2^{+7.9}$ -5.1 terawatt (TW), and then composition models of the Earth are constrained from this estimate. It proved that the radiogenic heat is smaller than the heat dispersion rate of 47 ± 2 TW from Earth's surface, indicating secular cooling of the Earth. Multi-site data at different geological locations, *e.g.* Japan and Italy, will be useful to construct a detail map of neutrino sources inside the Earth.