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Geo-neutrinos for advanced earth studies

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Neutrinoes generated in Earth (geo-neutrinos) gives us information about the distribution of Uranium (U), thorium (Th), and pottasium (K) inside Earth. Beta-decays of radionuclides U/Th/K inside Earth produce low energy anti-electron neutrinos (U and Th produces 7.41x10^7 neutrinos $kg^{-1}s^{-1}$ and 1.62x10^7 neutrinos $kg^{-1}s^{-1}$ respectively (without considering neutrino oscillation)) that traverse through Earth without being disturbed due to their extremely small interaction cross section with matter. Recent geo-neutrino observations have produced results that have a potential to support and clarify the current concerns of earth science: estimating the amount of contribution to the surface heat flux; constraining existing Earth's compositional estimates; and clarifying the origin of low shear velocity regions found at the core mantle boundary (CMB). Today, there are two detectors capable of measuring geoneutrinos: KamLAND, in Japan, and Borexino, in Italy. The KamLAND research team has found 116+/-28, 27 geoneutrino candidate events (generated through the decay processes of 238U and 232Th) during 2,991 days of geoneutrino observation (Gando et al. 2013). The contribution from geonuclear reactions to the heat flow, estimated from examination of the geoneutrino flux, reached 11.2+/-7.9, 5.1 TW. Although the volume of the Borexino detector (280 t) is much smaller than that of KamLAND (1,000 t), the background from reactor neutrinos is much lower than that for KamLAND because there are no nuclear power plants in Italy. Borexino detected 14.3±4.4 geoneutrino candidates over 1353 days of observation. Both measuremet results are consistent each other, and also reject the fullly radiogrenic model, which assumes that the total Earth's surface heat flux is completely originated from radiogenic heat from U, Th and K. The upperlimit on the fully radiogenic heat flux hypothesis (Herndon 1996) was set to be 4.5 TW at 95% confidence level (Bellini et al. 2013).

Gando A, Gando Y, Hanakago H, Ikeda H, Inoue K, et al. 2013. Reactor on-off antineutrino measurement with KamLAND. Phys. Rev. D 88:033001.

Herndon JM. 1996. Substructure of the inner core of the Earth. Proc. Natl. Acad. Sci. USA 93:646-48.

Bellini, G., Ianni, A., Ludhova, L., Mantovani, F., McDonough, W.F. 2013. Geo-neutrinos, Prog.Part.Nucl.Phys. 73:1-34

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