Nuclear physics inputs needed for geo-neutrino studies

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Abstract.

Geo-neutrino studies are based on theoretical estimates of geo-neutrino spectra. We propose a method for a direct measurement of the energy distribution of antineutrinos from decays of long lived radioactive isotopes and present preliminary results on ^{214}Bi decay.

All geo-neutrino experiments, either running or in preparation, use the well tagged inverse beta decay on free protons as the reaction for geo-neutrino detection. The specific signal is estimated from the IB cross section and from the decay spectra of geo-neutrinos; whereas the first is determined with an accuracy of half percent, these latter are determined from rather indirect measurements, are based on questionable theoretical assumptions (e.g., the "universal shape" hypothesis), and are affected by an unknown error.

The goal of this work is to provide a framework for a direct measurement of the geo-neutrino spectrum, so that the accuracy of the specific signal can be established. In particular, we propose to exploit the potential of the Counting Test Facility (CTF), which is operational in the underground Gran Sasso Laboratory. For each β or (β,γ) decay event , CTF can measure the sum of the energies deposited by betas and gammas, so that the energy of the antineutrino can be reconstructed by energy conservation.

We also present preliminary results concerning geo-neutrinos from ^{238}U decay chain. We recall that the most important contribution to the geo-neutrino signal arises from ^{214}Bi decay; effective geo-neutrinos (i.e. those above threshold for IB on free protons) are produced only from decays to the ground state and to the first excited state of ^{214}Po. By using data from ^{222}Rn dissolved in the full volume of CTF, we selected about 10^5 candidate decays of ^{214}Bi, tagged by the subsequent ^{214}Po decay, within a sphere of 60 cm around the CTF center. We have used these data in order to determine the feeding probabilities for the ground and first excited state of ^{214}Po and to constrain the possible deformation of the spectrum with respect to the "universal shape".