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Precision measurement of 144Ce – 144Pr beta-spectrum

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Beta-decay is a specific decay process that undergoes a reaction with thee-particle product composition that results in continuous spectral shape of electrons or positrons. The shape of the spectrum was described already in 1934 by E. Fermi [1], but such description appeared to be valid only for allowed transitions ($\Delta I = 0,1$ $\Delta\pi = 1$). Involvement of nuclear exchange in other types of transitions complicates such decay description and often makes it necessary to perform experimental evaluation.

Precision beta-spectra measurement always had a great importance in some fundamental physics problems including neutrino physics, e.g. a 144Ce – 144Pr source is one of the most suitable to search for neutrino oscillation into sterile state for sterile neutrino mass around 1 eV. Magnetic and electrostatic spectrometers have high resolution, but at the same time usage of such kinds of equipment involves the size and cost issues. Since electron mean free path at the energy of 3 MeV (which is basically the maximum energy of a beta-transition for the long-lived nuclei) does not exceed 2 g/cm2, electron registration could be effectively performed with the solid state scintillators and semiconductors.

A strong probability of backscattering from detector surface is present in case of semiconductor detectors and is dependent upon the detector material. One possible way of solving this issue is a precise simulation of the spectrometer response function that is quite promising as it could be used in a very simple target-detector setup. Another solution to this problem is usage of 4π geometry [2], that fully covers the radioactive source and is able to register the backscattered electrons.

In this work we present the results of 144Ce – 144Pr spectrum measurement performed with two setups of both types and controlled with the shape of an allowed 0- – 1- transition in 144Pr, having precision that was substantially increased with respect to the previous studies of these beta-spectra. We have obtained parameter values for the paramertrized transition shape factor that is compared with the other experiments and could be used for electron antineutrino spectrum definition.

The speaker is a student or young scientist

No

Section

1. Neutrino physics and nuclear astrophysics

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