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Precision measurements of ^{144}Ce - ^{144}Pr beta-spectra with Si(Li)-spectrometer

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The discovery of solar and atmospheric neutrino oscillations means that at least two of three neutrino mass states are nonzero. The oscillation parameters and the Planck telescopeconstraints on the sum of light neutrinomasses limit the most severe mass state of the three known types of neutrinos (ν_e, ν_μ, ν_τ) to 70MeV. Heavier sterile neutrinos appear in many SM extensions, they are well-motivated candidates for the role of dark matter particles. This work is devoted to the search for manifestations of massive neutrinos in the β-spectra of $^{144}\text{Ce} - ^{144}\text{Pr}$ nuclei. The $^{144}\text{Ce} - ^{144}\text{Pr}$ electron antineutrino source is one of the most suitable for studying neutrino oscillations into a sterile state with a mass of about 1 eV. The $^{144}\text{Ce} - ^{144}\text{Pr}$ decay schemes allow to test the emission of neutrinos with masses from several keV to 3 MeV. The range of possible investigated masses is determined by the resolution of the β-spectrometer and the end-point energy of $^{144}\text{Pr}\beta$-decay [1].
We used an original β-spectrometer with 4π-geometry [2], consisting of two Si(Li) -detectors with a sensitive volume thickness 8 mm, that exceeds the range of 3 MeV electrons. The $4\pi\beta$ total absorption spectrometer allows direct measurement of β-spectra, which does not require corrections of the response function due to backscattering of electrons from the surface of the crystal. The measured spectrum, containing 1.5×10^9 events, was fitted in the energy range (250 - 3030) keV. The upper limits on the mixing parameter $|U_{eH}|^2$ were determined in a standard way from the profile of the dependence $\chi^2(|U_{eH}|^2)$. As a result, for neutrinos with a mass $m_{\nu H}$ in the range (100–2200) keV, new upper limits were set at the level $|U_{eH}|^2 \leq (0.1{-}3.0) \times 10^{-3}$ for 90% C.L., which are 2-3 times more stringent than those obtained in previous experiments.
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Bibliography

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