LOW-ENERGY NUCLEAR ELECTRON SPECTROMETRY AND ITS APPLICATION IN THE KATRIN NEUTRINO PROJECT

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The current stage of development of the nuclear electron spectrometry is also connected with the direct determination of the rest mass of the electron antineutrino from the analysis of the tritium beta spectrum near its endpoint (E_0 = 18.6 keV). The aim of the neutrino project KATRIN [1] is to achieve the sensitivity of 0.2 eV/c^2 for this quantity after the full measuring time of 1000 days. One of the conditions for achieving the declared sensitivity is to ensure the stability of the electrostatic retarding potential in the mass-sensitive region of the beta spectrum from $E_0 - 30$ eV to $E_0 + 5$ eV at the level of several tens of mV. It was estimated that the instability of the retarding potential within ±60 mV may create about 40% of the total allowable systematic uncertainty at which the aimed mass sensitivity of 0.2 eV/c^2 is still achievable. One of the ways to control the stability of the retarding potential of the main KATRIN spectrometer is to monitor the position of the reference electron line produced by a natural source with an energy close to E_0 on the same type satellite spectrometer. This source has to ensure the stability of the reference line energy within ±60 meV during the two-month measurement cycle. The use of solid-state radioactive sources for this purpose requires a detailed study of all factors (physical and chemical) affecting the energy of the reference electrons. In the presentation, the results of our extensive studies of the influence of the local physicochemical environment of atoms for different radioisotopes on both the energy of the emitted conversion and Auger electrons and the structure of their energy spectra are given. The narrow K conversion electron line (17824.3(5) eV) of the 32 keV nuclear transition in ^{83m}Kr generated in the ^{83}Rb decay was proposed as the suitable reference line. Our investigations shown that the ^{83m}Kr/^{83}Rb sources prepared by ion implantation into polycrystalline platinum foils meet the requirement of the KATRIN project for the reference line.

1. www.katrin.kit.edu