LNGS SEMINARS

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A new approach to detect of rare nuclear decay using an ultra-low-background HPGe detector

Abstract

Nowadays, a significant progress in registration of rare alpha decays could be noticed. It is triggered by applying of new experimental approaches for the low rate events registration (namely, cryogenics scintillating bolometers), as well as ultimate improvement of well-known detection technique (crystal scintillator detectors, proportional chamber). In such way was detected the alpha decay of 209Bi (T1/2 = 1.9×1019 y), 180W (1.8×1018 y), 151Eu (4.6×1018 y) and 148Sm (4.6×1015 y). The ultra-low-background gamma spectroscopy with HP Ge detectors was applied to search for 190Pt alpha decay to first excited state with T1/2 = 2.3×1014 y.

Summarizing the listed above results, one can say that in order to detect rare decays with T1/2 > 1014 y, or in other words, with specific counting rate is about of few events per day, one should focus on detector, which possesses of lowest internal background in region of interest, flexibility with respect to investigation of different isotope of interest, possibility to utilize the sample of large mass, detector stability for the long period of data taking, good energy resolution, and high detection efficiency.

However, in case of decays to low-lying excited states (E < 250 keV) the conventional gamma spectroscopy cannot satisfy strict demands on the experimental technique, mainly because of abruptly reduction of the detection efficiency.

A new approach to detect such low-energy gammas, which occur in rare decays to low-lying excited states, is presented. The main feature of our concept is the ultra-nearest disposition of sample in certain simple geometry with respect to Ge detector. That eliminates of gammas absorption in the detector's holding materials and minimizes self-absorption in the sample, as well as simplifies calculation of the detection efficiency. The precise detection of 190Pt alpha decay to the first excited state of daughter nuclide with T1/2 = 4.6×1014 y is first example of applicability of this technique. Future possible targets are under discussion.

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