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THE HALF-LIFE OF 229mTh ISOMERS IN ACID SOLUTION

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The 229mTh isomeric state with an energy of about 8 eV is formed in 2% of the cases of 233U α-decay (see ref. [1] and references therein). For neutral 229mTh atoms, the main decay channel is nonradiative – it is either electronic conversion or decay via an electronic bridge. An estimate of the probability of a decay with photon emission γTh gives a half-life T1/2 ≈ 2 h and is much smaller than the probability of a nonradiative transition. Photons can only be observed for 229mTh ions when the nonradiative channel is closed.
Here we give a detailed analysis of work [2], where γTh photons were observed for 4+ ions of 229mTh in HCl acid solution obtained in an ion exchange column from 0.1 g U (the relative α-activities of 233U and 232U were 99.8% and 0.02%, respectively). In each of several experiments four samples were sequentially prepared with 229mTh in 7M HCl aqueous solution by eluting once an hour fresh Th from U, which was previously purified from Th and its daughters. Sources for
α-spectrometry were prepared from the second and third samples; for each of them the α-activity of Th daughters increased with time. Thus, the α-activity of the samples could not lead to their damped photon emission. The first and fourth liquid samples of 229mTh were placed into thin-layer quartz cuvettes, and t = 60 min after Th elution, the photon counting intensity N(t) from the samples was measured by a photomultiplier with a Sb-Na-K-CS photocathode, the photo efficiency was about 1% in the wavelength range of 300 – 800 nm. The time dependence of N(t) averaged over all experiments was approximated as , where A = 9 ⊠ 3, T1 = 22 ⊠ 3 min, T2 = 290 ⊠ 50 min (errors are one standard deviation). N0 was proportional to the ⊠-activity of 229Th in the samples with an accuracy of 20% and did not correlate with their total ⊠-activity. It can be assumed that for the 229mTh isomer in an HCl solution, T1/2 is in the range of 20 – 400 min. To refine T1/2 and the isomeric transition energy, it is necessary to study the photon spectrum of such samples.

1. B.S. Nickerson, M. Pimon, P.V. Bilous et al.// PRA. 103, 053120 (2021).
2. V.V. Koltsov, T.E. Kuzmina, D.N. Suglobov. Half-life measurement of the 229Th isomer. Proc. Int. Conf. on Nucl, Phys., Moscow, June 16–19, P. 266 (1999).

The speaker is a student or young scientist

No

Section

1. Nuclear structure: theory and experiment

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