New microsecond isomers in ^{189,190}Bi

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New microsecond isomers in the neutron-deficient isotopes ^{189,190}Bi have been identified at the velocity filter SHIP in the p4n and p3n evaporation channels, respectively, of the complete fusion reaction of ^{52}Cr ions with a ^{142}Nd target. After in-flight separation the evaporation residues (EVRs) were implanted into a position-sensitive silicon detector (PSSD), where their subsequent α-decays were measured. Behind the PSSD a four-fold segmented Ge-clover detector was installed for prompt and delayed (up to 5 ms) α-γ and α-X ray coincidence measurements allowing for the investigation of long-lived isomeric states. EVRs were identified by excitation-function measurements and by using the Recoil-Decay-Tagging method on the basis of delayed recoil-γ, recoil-X ray, and recoil-γ-α coincidences. A detailed description of the experimental set-up used and of the results for ^{188,189,190}Po and their daughter products was given in [1].

Fig.1a shows the γ-ray spectrum measured by the clover detector in coincidence with recoils registered in the PSSD. The γ-transition observed at 357(1) keV has an excitation function similar in shape and position to the 6672-keV α-decay of the $9/2^-$ ground state of ^{189}Bi ($T_{1/2}$ = 680 ms) and of the 7298 keV α-decay of the $1/2^+$ isomeric state (^{189m1}Bi) of ^{189}Bi. On this basis we assign this transition to ^{189}Bi. Fig.1b shows the same spectrum as in Fig.1a, but with an additional condition that the EVR-γ pair is correlated within the time interval of 2 s with an α decay of E_α = 6672 keV. The procedure to take into account the background of possible random correlations is described in detail in [2]. In Fig.1b, besides a peak at E_γ = 357(1) keV coincidences with the K-X rays of Bi are also observed. Thus, the excitation function behaviour, coincidence with the Bi K-X rays and the condition of correlation with the α decay of ^{189g}Bi establishes the origin of the 357 keV γ-line as an isomeric state (^{189m2}Bi) built on top of the $9/2^-$ ground state in ^{189}Bi.

By comparing the number of the K-X rays and γ-rays in Fig.1b, corrected for the corresponding efficiencies [1], a conversion coefficient of α_K = 0.9(1) was deduced, which is consistent with the theoretical value of α_K(357 keV, M2) = 0.77. This establishes the spin and the parity of the 357-keV isomeric state ^{189m2}Bi as $13/2^+$. We assume that this state decays by the M2 transition directly to the $9/2^-$ ground state of ^{189}Bi, as in the cases of ^{191,193,195}Bi [3]. Applying a procedure described in [2] , we deduced a lower limit of $T_{1/2}$ > 360(120) ns for the half-life value of the 357-keV transition.

By using the same method as described above for ^{189m2}Bi and by analysing the recoil-γ (Fig.1c) and recoil-γ-α(6450 keV) (Fig.1d) correlations a previously unknown isomeric γ–decay with the energy of E_γ = 273(1) keV and a lower half-life limit of $T_{1/2}$ > 500(100) ns was observed on top of the α-decaying (E_α = 6450 keV) 10^- isomeric state in ^{190}Bi. The detailed discussion of the observed results is given in [2].

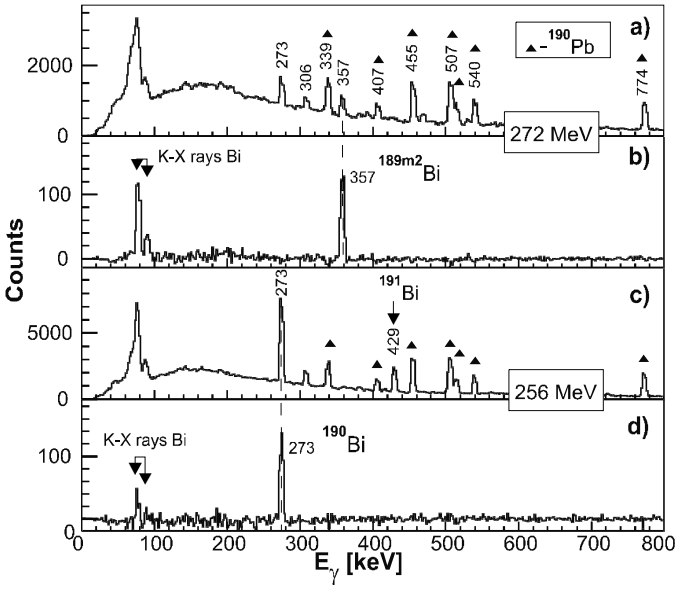

Figure 1. a) Recoil-γ coincidence spectra (time interval ΔT(EVR-γ) < 5 μs and b) background-subtracted recoil-γ-α(6672 keV) spectra for ^{189}Bi collected at the beam energy of 272.0(5) MeV; c) and d) the same as a) and b), but for ^{190}Bi, collected at the beam energy of 256.0(5) MeV. Known γ-decays of the microsecond isomeric states in ^{190}Pb [4] are marked by filled triangles.

References

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