Alpha decay of ^{114}Ba

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In recent years, intense experimental and theoretical research has been devoted to investigate nuclei near the doubly magic nucleus ^{100}Sn (Z=N=50). In this region of the nuclear chart, an island of α emission occurs, covering neutron-deficient isotopes of tellurium (Z=52) through cesium (Z=55). Alpha emission is a rich source of nuclear structure information [1]. The α-particle energy E_α, corrected for the recoil effect, yields the difference between the masses of mother and daughter nucleus. Above ^{100}Sn, this quantity directly relates to the Z=N=50 shell-strength. Moreover, the information on energy, half-life and α-decay branching ratio (b_α) yields the reduced widths for this disintegration mode (W_α). Measurements of W_α values may shed light on the question whether superallowed α decay occurs for nuclei beyond ^{100}Sn, with protons and neutrons occupying identical $d_{5/2}$, $d_{3/2}$ and $g_{7/2}$ orbitals. Moreover, these nuclei, and in particular ^{114}Ba, are predicted to be promising candidates for the observation of cluster (^{12}C) radioactivity. The decay of ^{114}Ba had already been investigated in previous experiments [2-4], but only lower limits for α and ^{12}C partial half-lives could be established [2]. In this contribution we report on preliminary results obtained in a reinvestigation of the α-decay properties of ^{114}Ba.

The experiment was performed at the GSI On-line Mass Separator. ^{114}Ba was produced in fusion-evaporation reactions induced by a 284 MeV ^{58}Ni beam on 2.0-3.8 mg/cm^2 thick ^{58}Ni targets. The reaction products were stopped inside a high-temperature cavity ion source in two tantalum catcher foils, from which most recoils – at the ion source temperature of about 2400 K – are swiftly released as thermalized atoms. Chemical selectivity for barium isotopes was achieved by adding CF_4 and thus using on-line fluorination. The ionization takes place selectively in the fluorination sideband of BaF, all contaminants including CsF being reduced to levels well below 10^{-5} [5]. The BaF^+ ions were accelerated to 55 keV, mass-separated and focused alternately onto two carbon foils, each one being viewed by a ΔE-E silicon telescope.

The search for α emission was performed using the ΔE spectrum registered in anticoincidence with the E detector. Figure 1 shows the corresponding spectrum obtained from both telescopes during a measurement time of 55.6 hours. Three α lines were observed at the energies 3410±40, 3740±30 and 4160±30 keV, containing 38, 21 and 22 events, respectively. We assign the lowest-energy line to the α decay of ^{114}Ba. This assignment is based on the Z and A selectivity that was reached combining the fluorination ion source with mass-separation. The higher-energy members of this triplet are assigned to the known [6] α lines from the decay of ^{110}Xe and ^{106}Te. Taking into account the recoil correction, we obtained a Q_α value of 3540±40 keV for ^{114}Ba. This result, together with the known [6] Q_α values of ^{110}Xe and ^{106}Te, yields a Q value of 19000±60 keV for ^{12}C decay of ^{114}Ba, which is important to obtain experimentally relevant predictions for this decay mode.

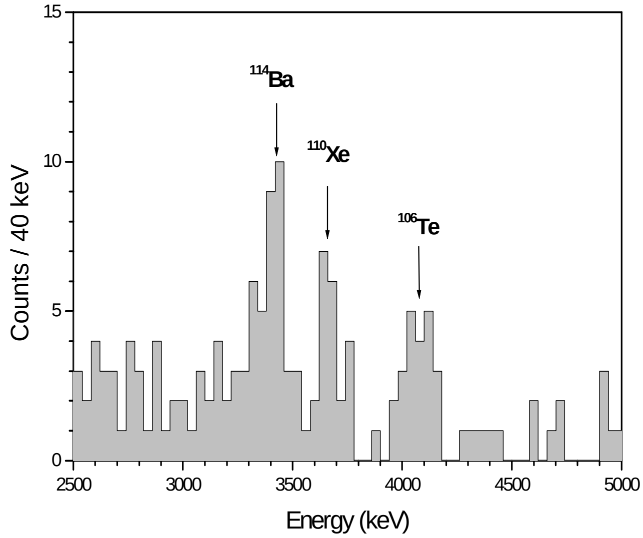

Figure 1. Section of the ΔE spectrum from both telescopes, taken in anticoincidence with the related E detectors.

By comparing the 38 α events observed with the 980 β-delayed protons (βp) detected simultaneously in ΔE-E coincidence, the b_α value of ^{114}Ba was determined to be $(9\pm3)\cdot10^{-3}$. This result takes into account the detection efficiencies of the telescopes and the known βp branching ratios for ^{114}Ba [4] and its daughter ^{114}Cs [7]. The new b_α value is somewhat larger but still compatible with the previously obtained upper limit of $3.7\cdot10^{-3}$ (68% c.l.) [2]. Moreover, the analysis of time correlations will allow us to deduce the half-life of ^{110}Xe and the b_α values for ^{110}Xe and ^{106}Te.

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