3 - 2 New Isotope ^{207}Th and Odd-Even Staggering in α-Decay Energies for Nuclei with $Z > 82$ and $N < 126$*

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The new thorium isotope ^{207}Th has been produced in the $5n$ evaporation channel of the fusion reaction ^{36}Ar+^{176}Hf. The 197 ∼ 199 MeV ^{36}Ar^{11+} beam with a typical intensity of ∼0.4 pμA was delivered by the Sector Focusing Cyclotron of the Heavy Ion Research Facility in Lanzhou (HIRFL), China. Isotopically enriched (84.6%) ^{176}Hf targets with thickness of 116 ∼ 360 μg/cm^2 were mounted on a rocking frame which moves horizontally and periodically from side to side during irradiation. The evaporation residues (ERs) were collected and separated by the SHANS, and then implanted into three 300-μm-thick position-sensitive silicon strip detectors (PSSDs) surrounded by eight non-position-sensitive silicon detectors (side detectors). As shown in Fig. 1, an α-decay

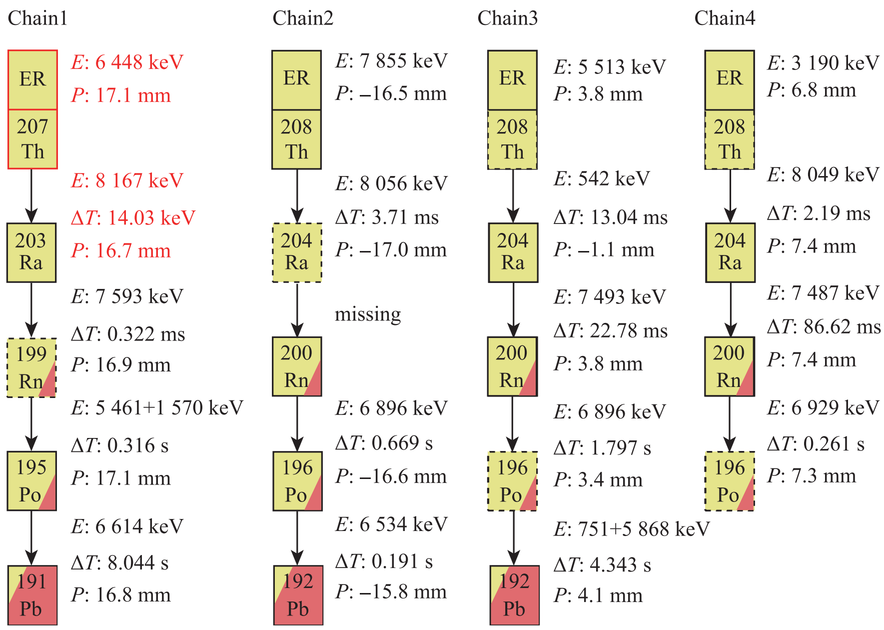

Fig. 1 (color online) The observed α-decay chains assigned to ^{207}Th and ^{208}Th. The annotations are the measured energy (E), decay time (ΔT) and vertical position (P) for each event within the chains. Escaped α decays are marked by rectangles with dashed frames.

chain (chain1) assigned to the new isotope ^{207}Th was found. The probability of random correlations, calculated on the basis of average counting rates in the detectors, was estimated to be less than 1.0×10^{-12}. The α decay of ^{207}Th, measured with an α-particle energy of 8167(21) keV and a half-life of $9.7^{+46.6}_{-4.4}$ ms, is assigned to originate from ground state. In addition, three α-decay chains of the known isotope ^{208}Th were also observed in this experiment. On the basis of these events, an α-particle energy of 8053(18) keV and a half-life of $4.4^{+6.0}_{-1.6}$ ms were deduced for ^{208}Th, which agree with the previously reported data of $E_\alpha = 8044(30)$ keV and $T_{1/2} = 1.7^{+1.7}_{-0.6}$ ms[1].

By combining with the existing data, we find that the α-decay energies of nuclei with $Z > 82$ and $N < 126$ show a regular and distinct odd-even staggering (OES) rather than the commonly-supposed smooth pattern. A theoretical analysis has been performed within relativistic Hartree-Fock-Bogoliubov and large-scale shell model approaches. It is found that the OES originates from both pairing correlations and blocking of particular orbitals by unpaired nucleons. Of particular importance is that pairing correlations result in the OES not only through the contribution of pairing energy to binding energy but also by configuration mixing induced by scattering nucleons to orbitals away from Fermi levels[2].

References

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3 - 3 The Reaction ^{55}Mn + ^{159}Tb: Preparation for the Synthesis of New Elements*

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In recent decades, much experimental progress has been made in the synthesis of SHEs and several attempts have been made. However, none of these experiments provide evidence for the successful synthesis of the new elements. In order to produce the new elements with proton number $Z = 119$ or 120, IMP-CAS (Institute of Modern Physics, Chinese Academy of Sciences) constructed the China Accelerator Facility for superheavy Elements (CAFE2). The beams with medium mass, such as ^{50}Ti, ^{51}V, ^{54}Cr, ^{55}Mn, and so on, can be used to bombard the radioactive actinide targets, producing superheavy nuclei. As above, the attempts to synthesize the elements $Z = 119$ and 120 with the beams of ^{50}Ti and ^{54}Cr have not been successful. Considering the expansibility of experiments and the accessibility of material, the ^{55}Mn + ^{244}Pu and ^{55}Mn + ^{243}Am reactions might be promising for synthesizing the new elements 119 and 120. To investigate the performance of the ^{55}Mn beam in synthesis experiments, the ^{55}Mn + ^{159}Tb reaction was studied.

The experiment was performed on the gas-filled recoil separator, SHANS2 (Spectrometer for Heavy Atoms and Nuclear Structure-2), at CAFE2 in Lanzhou, China. The ^{55}Mn^{18+} beam was accelerated to 257 MeV by a superconducting linear accelerator. The recoiled evaporation residues (ERs) were separated in-flight from the primary beam particles using the gas-filled recoil separator SHANS2, subsequently implanted into a 300-μm-thick double-sided silicon strip detector (DSSD, model BB-17). Six 500-μm-thick side silicon detectors (SSD, model W4) were mounted perpendicular to the face of the DSSD. Two multi-wire proportional chambers (MWPCs) mounted