Decay spectroscopy of neutron-rich rare-earth isotopes

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The region in the nuclear chart between $50 < Z < 82$ and $82 < N < 126$ is the largest region between traditional nuclear shells and, thus, ideal to study the evolution of collectivity and K isomerism originating from the high-j orbitals around mid-shell. Neglecting any potential sub-shell closures, the nucleus with the largest number of valence particles in this region is ^{170}Dy with proton number $Z = 66$ and neutron number $N = 104$. Accordingly it should be one of the most collective of all nuclei with $A < 208$, in its ground state. From the high degree of axial symmetry and large deformation we expect several long lived, pure K isomers. In particular, we expect a $N = 104$, $K = 6^+$ isomer in ^{170}Dy and a $N = 106$, $K = 8^-$ isomer in ^{172}Dy, similar to the $N = 102$, $K = 6^-$ isomers in ^{166}Gd and ^{164}Sm recently published[1].

A EURICA experiment was carried out in November 2014, where a 345 MeV/u ^{238}U beam impinged on a Be target and the fragments separated and identified in the BigRIPS separator and the ZeroDegree spectrometer and implanted in the WAS^{3}ABi active stopper. The experiment was carried out with two settings, 13.5 hours centering on ^{170}Dy and 45 hours centering on ^{172}Dy. The combined PID is shown in Fig. 1.

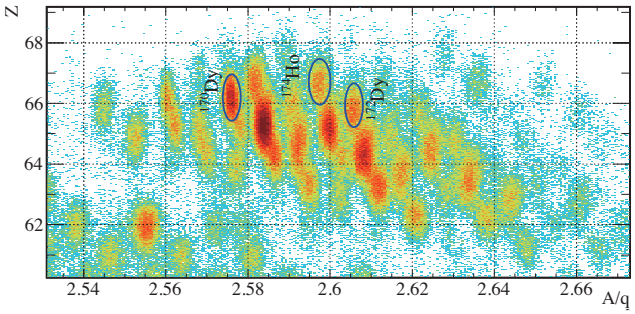

Fig. 1. Combined particle identification obtained during the two settings in the experiments.

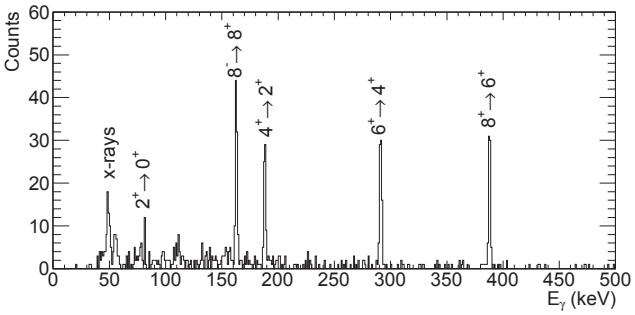

Fig. 2. Combined $\gamma\gamma$-coincidence spectrum gated on the decays from the 8^- isomer in ^{174}Er.

In Fig. 2, the decay of the known $N = 106$, $K = 8^-$ isomer in ^{174}Er[2] is shown. This shows the capabilities to measure very long lived isomers by triggering on conversion electrons in the $4^+ \rightarrow 2^+$ and $2^+ \rightarrow 0^+$ transitions, in this case populated by the β-decay of ^{174}Ho. This is not only the heaviest nucleus that has been measured in EURICA but, with a half life of 4.0 s, it is also the longest lived isomer. Besides the ^{170}Dy, ^{172}Dy, and the previously known ^{174}Er isomers, the experimental data set contains several new isomers, β-delayed γ-rays and new β-decay half-lives. All of these are currently under analysis.

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