Shape coexistence along $N = 40$ studied with isomer and beta decay

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In ^{68}Ni the presence of a high-lying 2^+ state with small transition probability to the ground state is a result of the N = 40 harmonic oscillator shell gap between the fp shell and the $g_{9/2}$ orbital. This shell gap is reduced as protons are removed in Fe and Cr isotopes[1)]. Collective behavior is caused by quadrupole correlations which favour energetically the deformed intruder states involving the neutron $g_{9/2}$ and $d_{5/2}$ orbitals and proton excitations across the Z=28 subshell gap[2)] leading to rather low-lying first 2^+ states and large B(E2) values.

Limited experimental data is still available for the low spin states of the region of deformation that develops south of ^{68}Ni. The trend of the ratio E_{4+}/E_{2+} towards $N = 40$ in Cr isotopes suggests a transition from spherical (at $N = 32$) to deformed shapes, that approach better the gamma-unstable regime than the axially deformed one, while Fe isotopes lie at the O(6) limit from $N = 30$ to $N = 42$[3)]. To better understand the structure of these nuclei, the knowledge of other states at low excitation energy is needed.

The large difference in angular momentum between the $p_{1/2}$, $f_{5/2}$ and $d_{5/2}$, $g_{9/2}$ orbitals around the Fermi surface in $N \approx 40$ nuclei leads to the occurrence of several isomeric states. In the Cr and Ti nuclei with $N = 39$ and $N = 41$ similar configurations should also lead to long-lived states. Observation of isomers at $N = 39$ will allow us to draw conclusions on the location and evolution of intruder orbitals towards ^{60}Ca. Theoretical and experimental investigations show that the collective behavior observed in ^{64}Cr, with its small E(2^+) energy and large B(E2) value, is restored approaching ^{60}Ca[2,4)].

In this report we present some preliminary experimental results. Several new gamma transitions deexciting isomeric states, as well as states populated in the beta decay have been identified for the first time. The determination of beta decay half-lives in this region is of relevance for a better understanding of the r-process nucleosynthesis.

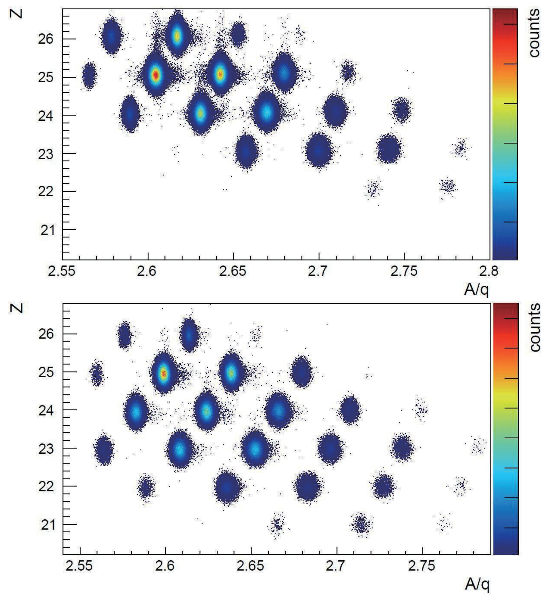

Fig. 1. Ions produced, identified and implanted into the AIDA active stopper for (top) the ^{64}Cr setting, (bottom) the ^{60}Ti setting.

A high intensity ^{238}U beam provided by the RIKEN Nishina Center Accelerator Complex impinging on a Be target was used to produce the nuclides of interest in in-flight fission. In the experiment the EURICA gamma-ray array surrounded the implantation detector AIDA into which the fragments of interest were implanted. The fragments were identified using the BigRIPS separator employing the ΔE-ToF-Bρ method. Figure 1 shows the particle identification plots of the fragments using this technique for the ^{60}Ti and the ^{64}Cr settings. The analysis of the experimental data on the β-decays in ^{64}Cr region and the isomers decay is in progress.

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