Probing neutron-rich In and Cd nuclei with isomer spectroscopy

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Some thirty years after it was opened up to observation, the region around doubly magic ^{132}Sn still remains the object of intense interest as the shell structure and effective residual interactions in this part of the nuclidic chart are intimately related to many important issues. The very different predictions obtained by various theoretical approaches, e.g., for the proposed quenching of shell-closures for extremely neutron rich nuclei, is a clear indication that the detailed understanding of neutron-rich systems far from stability is far from complete. To obtain more experimental information about excited states in nuclei "southwest" of ^{132}Sn, we have performed an experiment aimed at searching for relatively long-lived (0.1-100 μs) isomeric states and studying their decay using high-resolution γ-ray spectroscopy. Ref. [1] describes the in-flight fission fragment isomer spectroscopy method in more detail.

The isotopes of interest were produced directly in projectile fission of 732 MeV/nucleon ^{238}U on a ^{208}Pb target, and subsequently separated and identified event-by-event using the fragment separator FRS. At the FRS focal plane, the transmitted ions were slowed down and subsequently implanted in a plastic catcher viewed by six segmented Clover-type detectors, with which delayed γ-rays emitted by the implanted ions were detected. The energy and time of all "first hits" in the Ge detectors within an 80 μs interval following the implantation of an ion were recorded together with the particle identification information for the respective ion. This allowed the construction of heavy ion-gated γ-ray energy-time and energy-energy matrices.

The data presented here were obtained during an effective measurement time of 8 hours with the FRS optimized for the transmission of ^{130}Sn. In the following, we briefly discuss some of the preliminary results obtained so far. In those cases where the observed properties are difficult to explain by systematics alone, on-going realistic shell model calculations will hopefully aid our interpretation.

^{125}*Cd:* Two strong coincident γ-transitions of 720 and 743 keV with similar intensity follow the decay of this previously unknown isomer with a half-life of 14(2) μs. Two much weaker delayed γ-transitions keV, with as of yet undetermined lifetimes, are also observed.Comparing with the A=120-130 tin isotopes, where the lowest-lying excited state is alternately 2^+ or $15/2^-$, a possible interpretation of this decay would be a cascade starting with a hindered M2 transition deexciting a $19/2^+$ isomer via an $15/2^-$ level down to a known $(11/2^-)$ state.

^{127}*Cd:* One significant delayed γ-transition at 820 keV was observed in coincidence with the implanted ^{127}Cd ions. The very low statistics have thus far only allowed placing the limit 1 μs$<T_{1/2}<$10 μs on its half-life. In addition, a number of weaker delayed γ-rays may also be present. The origin of this previously unknown isomer is difficult to interpret, and it is also not known whether the observed γ-ray represents the primary isomeric transition. In analogy to ^{125}Cd, the observed γ-ray could be a hindered M2 $19/2^+$-to-$15/2^-$transition.

^{126}*In:* The decay of this previously unreported isomer exhibits a strong γ-ray at 244 keV, with a half-life of 29(2) μs, as well as two weaker 614 and 865 keV transitions with as of yet undetermined lifetimes. We tentatively interpret this as the primary isomeric M2 (E3) transition connectingthe 1^- member of the $\pi g_{9/2}^{-1}\nu h_{11/2}^{-1}$ multiplet with the 3^+ ground state. Evidence for other members ofthis negative-parity multiplet comes from the proposed $(8^-)\beta$-decaying state that has previously been observed[2].

^{130}*In:* A single delayed γ-transition of 389 keV with a half-life $T_{1/2}<$6 μs was observed in coincidence with the implanted ^{130}In ions, apparently associated with the decay of a previously unreported isomer. The delayed transition we observe could connect a previously unobserved member of the$\pi g_{9/2}\nu h_{11/2}$ multiplet with the 1^- ground state or another level with the same configuration.

References

[1] M.N. Mineva et al., Eur. Phys. J. **A11** (2001) 9.

[2] L. Spanier et al., Nucl.Phys. **A474** (1987) 359.

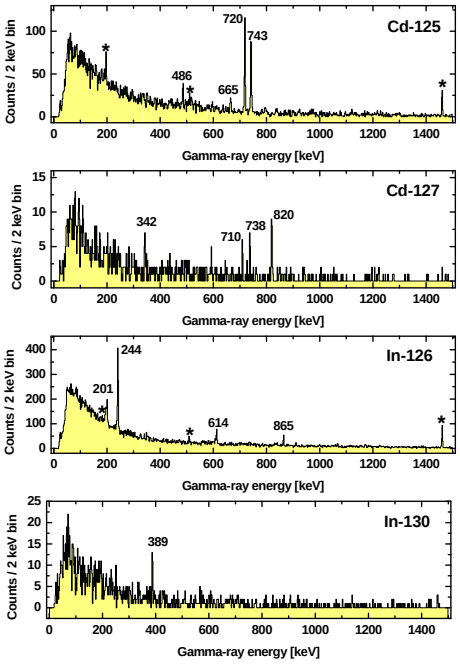

Figure 1: Heavy-ion-gated delayed (1-60 μs after prompt) γ-ray spectra of selected isomers. Asterisks label background activities.