New and comprehensive β- and βp-decay spectroscopy results in the vicinity of ^{100}Sn†

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The doubly magic nucleus ^{100}Sn and other nuclei with similar mass and atomic numbers possess various nuclear structure and astrophysical properties of importance.[1] It is one of the few regions in the nuclear chart where experimental observables to be compared to nuclear shell model (SM) and ab-initio theories were scarce, due to the low production cross section. However, a high radioactive isotope beam production rate at RIBF enabled a decay spectroscopy experiment on ^{100}Sn and other $N \approx Z \approx 50$ nuclei, which featured WAS3ABi[2] and EURICA[3] detectors for heavy ion implantation, charged particle decay correlation and γ-ray spectroscopy.

The database on β-decay and βp-decay half-lives ($T_{1/2}$) and branching ratios (b_β, $b_{\beta p}$) of these proton-rich nuclei was greatly expanded, with new or more precise values. Several nuclei and isomers experienced notable revisions on their $T_{1/2}$ and $b_{\beta p}$. β-decay endpoint measurements yielded ground-state to ground-state energy differences for 8 proton-rich nuclei, as well as the excitation energies of 3 isomeric states (see Fig. 1). The results were consistent with AME2016,[4] mass models and SM calculations. Energy spectra of βp decays were produced with new, comparable or higher statistics in relation to the available literature.

From EURICA data, 25 new γ rays were observed and assigned to 10 new states in multiple nuclei, with guidance from empirical SM[5] in the $(p_{1/2}, g_{9/2})$ proton and neutron orbitals above the ^{76}Sr core. One example is the β-decay and βp decay of ^{98m}In, where the first observation of βp-delayed γ rays from this isomer could be assigned to excited states in ^{97}Cd (see Fig. 2). As for ^{97}Cd itself, a new isomer with $J^\pi = (1/2^-)$ was proposed based on a new β-delayed γ ray with $E_\gamma = 1245$ keV, whose associated β-decay half-life was 0.73(7) s.

A systematic evaluation of the assignment of new excited states to tentative spins and parities was carried out by comparing the energies of the corresponding states, between their experimental and theoretical values. The energy discrepancies were less than 300 keV and/or 20% relative to the experimental excitation energy.

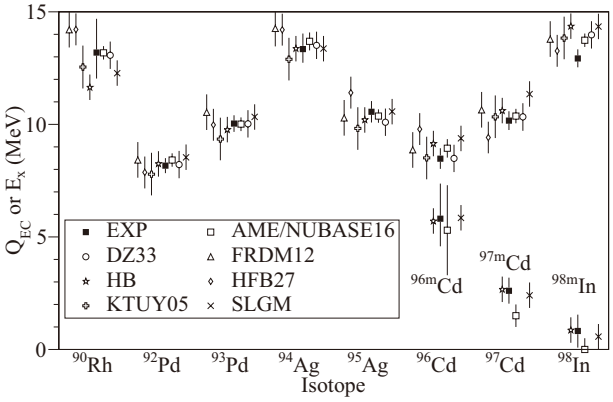

Fig. 1. Ground-state to ground-state energy differences and excitation energies of isomers deduced from β-decay endpoint energy measurements. The reader is advised to refer to the original article for references of the different mass models and SM calculations.

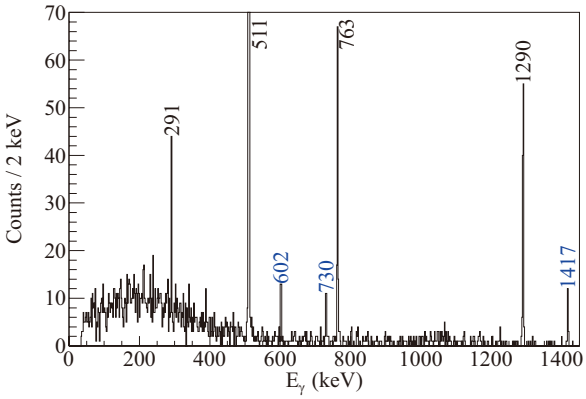

Fig. 2. γ-ray spectrum with EURICA, correlated to the βp decay of ^{98m}In. Except for the 511-keV annihilation γ ray, the peaks labeled in black correspond to known γ rays in ^{97}Cd. Those labeled in blue were assigned as de-excitation transitions from new excited states in the same nucleus.

† Condensed from the article in Phys. Rev. C **99**, 034313 (2019)

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