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β-decay studies of neutron-rich indium isotopes: γ-ray emission from neutron-unbound states in 134Sn and 133Sn

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Simple systems in the proximity of the doubly-magic shell closures constitute the best cases for testing the predictive power of shell-model calculations. In this context, understanding of the nuclear structure in the closest vicinity of the doubly-magic ^{132}Sn is essential before making extrapolations of the nuclear properties towards more neutron-rich nuclei. Recently, it was indicated that in the region southeast of ^{132}Sn nuclear structure effects affect the neutron versus γ ray competition in the decay of neutron-unbound states [1]. β-decay studies of neutron-rich indium isotopes, ^{135}In, ^{134}In and ^{133}In, provide excellent conditions to investigate such effects since their decays are characterized by large energy windows for the population of neutron-unbound states ($Q_{\beta n} > 10$ MeV). Consequently, states in β, βn and even $\beta 2n$ daughters of indium isotopes can be investigated simultaneously. These nuclei and the n-γ competition following their β decay are also relevant in the framework of the astrophysical r-process since ^{135}In is a so-called waiting point [2].

Excited states in ^{135}Sn, ^{134}Sn, ^{133}Sn and ^{132}Sn were investigated via β decay of ^{135}In, ^{134}In and ^{133}In at ISOLDE Decay Station. Isomer-selective ionization using the Resonance Ionization Laser Ion Source enabled the β decays of ^{133g}In (I^{π}=9/2^{+}) and ^{133m}In (I^{π}=1/2^{-}) to be studied independently for the first time [3]. Owing to the large spin difference of those two β-decaying states, it is possible to investigate separately the lower- and higher-spin states in the daughter ^{133}Sn and therefore to probe independently different single-particle transitions relevant in the ^{132}Sn region. States having neutron-hole nature were identified in ^{133}Sn at energies exceeding neutron-separation energy up to 3.7 MeV [3]. Due to centrifugal barrier hindering the neutron from leaving the nucleus ($\ell = 4$ or 5), the contribution of electromagnetic decay of those unbound states was found to be significant. The same phenomenon was identified for a new neutron-unbound state observed in ^{134}Sn. In addition to the previously known transitions following the β decay of ^{134}In [4, 5], we firmly assigned 11 γ transitions to the decay of ^{134}In based on parent half-life and γ-γ coincidences with the known γ rays depopulating states in ^{134}Sn, ^{133}Sn and ^{132}Sn. β and $\beta 2n$ decay branches of ^{134}In have been observed for the first time. Preliminary results of the first β-decay studies of ^{135}In will be presented. A comprehensive description of excited states in ^{134}Sn, ^{133}Sn and ^{132}Sn was obtained from both β and βn decay branches of indium isotopes.

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