Evolution of proton single-particle states in neutron-rich Sb isotopes beyond $N = 82$[†]

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The chain of Sb isotopes, with a single proton outside the closed $Z = 50$ proton shell, has attracted for many years a special interest since it offers the unique possibility to study the evolution of the proton single-particle states in the $Z = 50$–82 major shell over a wide range of neutron number. Prior to this work, excited-state information was available from the very neutron-deficient isotope ^{105}Sb, close to the presumably doubly-magic ^{100}Sn, up to the neutron-rich isotope ^{135}Sb. Above the $N = 82$ neutron shell gap, when the neutrons start filling the $1f_{7/2}$ orbital, a dramatic decrease of the energy of the $5/2_1^+$ state from 962 keV in ^{133}Sb to 281 keV in ^{135}Sb was observed.[1,2)]

The present work aimed for an extension of the experimental information towards more neutron-rich Sb isotopes. Excited states in ^{136,137,138}Sb, populated in the β decay of the semi-magic Sn isotopes ^{136,137,138}Sn, were studied within the EURICA campaign. The clean ion identification and high γ-ray detection efficiency allowed to observe for the first time the decay of excited states in the $N = 86$ isotope ^{137}Sb, which is considered as one of the key nuclei to pin down the evolution of the single-particle structure beyond $N = 82$. As shown in Fig. 1, the experimental energy of the $5/2_1^+$ state, $E_x = 84$ keV, lies in the middle between the results of shell-model calculations performed using two different realistic effective interactions, labeled Napoli and N3LOP. Together with a similar comparison for ^{136,138}Sb, the new experimental information thus allows to trace the evolution of the single-particle energies above the $N = 82$ shell closure.

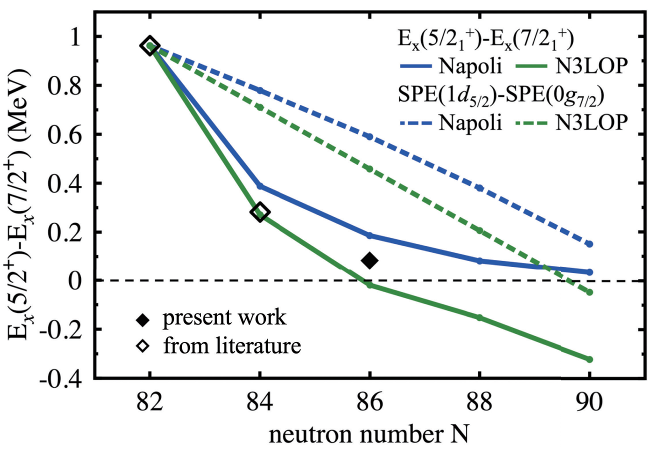

Fig. 1. Excitation energy difference between the $5/2_1^+$ and $7/2_1^+$ states in the odd Sb isotopes. Experimental values are shown as open (literature) and filled (present work) diamonds while solid blue (green) lines represent the results of SM calculations employing the Napoli (N3LOP) interactions. The differences between the effective SPE of the $1d_{5/2}$ and $0g_{7/2}$ orbitals are shown by dashed lines (adopted from Fig. 7 of the original article).

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