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Probing the fp-shell wave-functions with the MED in JYFL

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Studying the nuclei along and near the N=Z line is the best way to find answers to some fundamental questions in nuclear structure, such as charge-dependence of the nuclear interaction or the role of the proton-neutron pairing. Despite our deep understanding of the electromagnetic interaction, the differences in the binding energies in mirror nuclei cannot be reproduced theoretically, thus pointing that the ISB could arise also from the residual nuclear interaction.
Cross-shell particle-hole excitations from the sd to the fp shells in the mid-shell 42≤A≤54 nuclei generate rotational bands of non-natural parity, particularly sensitive to the electromagnetic spin-orbit interaction. In the 43Sc-43Ti mirror pair such positive-parity bands extend up to 27/2+. There is a competition between proton-hole and neutron-hole excitations from the sd orbitals, and the MED are very sensitive to cross-shell single-particle excitations, which can be used to determine the type of nucleons excited across the shell gap. To explore this phenomenon, we performed spectroscopic studies, extending the level scheme of 43Ti up to the 25/2+ state. Excited states of 43Ti were populated in a fusion-evaporation reaction in JYFL, Jyvaskyla. The prompt γ-rays were detected with JUROGAM 3 spectrometer while the evaporation residues were selected with MARA separator. We find that the competition between protons and neutrons promoted from the sd shells yields, at medium-high spin, MED as high as 250 keV. This increase of the MED is interpreted within state-of-the-art large-scale shell model calculations as driven by the competition between the promotion of a proton and of a neutron across the shell gap.

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