Argonne NATIONAL LABORATORY

PHYSICS DIVISION
HEAVY ION DISCUSSION

Probing the wave-functions in the $f_{7/2}$ region via mirror energy differences in cross-shell excitations: the case of A=43 mirror pair

KSENIIA REZYNKINA
INFN Sezione di Padova, Italy

HOST: MARCO SICILIANO

Friday, February 23, 2024
2:30 PM CST

Virtual Meeting - Join Zoom
ID: 160 735 2151 PWD: 009558

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. The differences between the excitation energy of isobaric analogue states (IAS), called mirror energy differences (MED), are signatures of isospin symmetry breaking (ISB) in mirror nuclei. Despite our deep understanding of the electromagnetic interaction, the differences in the experimental 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 which are particularly sensitive to the electromagnetic spin-orbit interaction. In the ^{43}Sc-^{43}Ti 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 which type of nucleons are excited across the shell gap.

To explore this phenomenon, we performed spectroscopic studies, extending the level scheme of ^{43}Ti up to the $25/2^+$ state. Excited states of ^{43}Ti were populated in a fusion-evaporation reaction in JYFL, Jyvaskyla. The prompt γ-rays were detected with JUROGAM3 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. We find that the MED allow to probe the wave-function and identify the type of the nucleon promoted across the N,Z=20 gap to the *fp* shell for this mirror pair, and the $f_{7/2}$ region in general.