Evidence for enhanced collectivity in ^{58}Fe examined through Coulomb excitation

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Abstract

In the region of neutron-rich nuclei below the nickel isotopes (Z=28), the appearance of a new island of deformation, similar to the one around ^{32}Mg, has been suggested [1–4]. The shell closure manifested for the N=40, Z=28 system ^{68}Ni [5] seems to completely disappear when protons are added to, or removed from, the $1f_{7/2}$ orbital. For this reason, this area of the Segrè chart offers the opportunity to test the quality of nuclear models, deepening our knowledge on the evolution of the shell-model orbitals. In this regard, the study of the electromagnetic properties of low-lying excited states in neutron-rich Fe and Cr isotopes is key. ^{58}Fe is the heavier stable iron isotope and transition probabilities can be measured by using the well-established multi-step safe-Coulomb excitation method. In particular, by Coulomb exciting ^{58}Fe it is possible to measure the reduced transition probability B(E2; $4_1^+ \rightarrow 2_1^+$) and the electric quadrupole moment $Q_s(2_1^+)$. Previous results on the $Q_s(2_1^+)$ are contradictory and the adopted B(E2; $4_1^+ \rightarrow 2_1^+$) value is not reproduced either by recent large scale shell model calculations and mean-field based models, rising the question if there is physics beyond what is included in the models at play for this state.

The Coulomb excitation experiment to study ^{58}Fe has been successfully performed at ALTO-IJCLab, in March 2023 and preliminary results will be presented with this contribution. A beam of iron with a high enrichment of ^{58}Fe at 220 MeV energy was provided by the Tandem accelerator and scattered on a ^{208}Pb target. The γ-rays depopulating the excited states in ^{58}Fe have been detected with the γ-ray spectrometer nuBall2, composed by 24 clusters of HPGe detectros, in coincidence with the back-scattered ^{58}Fe ions, detected with the DSSD from HIL-Warsaw.

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