

Extension of the N=40 island of inversion to neutron-rich Cr and Fe isotopes[†]

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The N = 40 island of inversion has been further explored towards the N = 50 shell closure. The 2_1^+ and 4_1^+ states in the ^{66}Cr and $^{70,72}\text{Fe}$ neutron-rich isotopes have been measured from in-beam γ spectroscopy at the RIBF. The measurements were part of the first campaign of the SEASTAR program¹⁾. The SEASTAR setup is composed of the DALI2 high-efficiency gamma spectrometer²⁾ and the MINOS device³⁾ composed of a 100-mm thick liquid hydrogen target and a vertex tracker. Low-energy states in ^{66}Cr and $^{70,72}\text{Fe}$ were populated via $(p, 2p)$ reactions induced by ^{67}Mn and $^{71,73}\text{Co}$.

A ^{238}U beam was accelerated to 345 MeV/nucleon and impinged on a 3-mm thick ^9Be primary target at the entrance of the BigRIPS separator with a mean intensity of 12 pnA. Two beam settings were tuned for ^{67}Mn and $^{71,73}\text{Co}$, respectively. The identification of beam particles and secondary residues were performed event by event from the BigRIPS and ZeroDegree spectrometers, respectively. The incident energies at the entrance (exit) of the secondary target were ~ 260 (~ 200) MeV/nucleon for ^{67}Mn and $^{71,73}\text{Co}$. Their intensities were measured to be 12 s^{-1} , 45 s^{-1} and 6 s^{-1} , respectively. The total beam intensity on target for the two settings was about 6 kHz.

A plateau in the 2^+ and 4^+ energy systematics is observed for Cr and Fe isotopes beyond N=38 and N=40, respectively. Fig. 1 shows the spectrum of ^{66}Cr (top) and the systematics of the first 2^+ and 4^+ states for Cr isotopes (bottom). The data are well reproduced by state-of-the-art shell model calculations with a modified version of the LNPS interaction⁴⁾. This plateau was interpreted within the shell model as an extension of the N=40 island of inversion towards N=50. Whereas quadrupole collectivity is maximum at N=40, the evolution of pairing correlations slightly shifts the minimum of 2_1^+ and 4_1^+ energies.

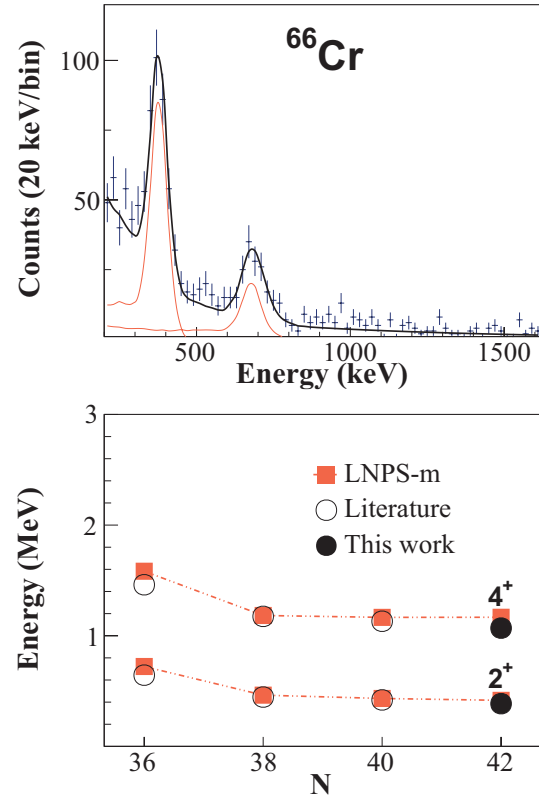


Fig. 1. (Top) Spectrum of ^{66}Cr . (Bottom) Systematics of low-lying 2_1^+ and 4_1^+ states in Cr isotopes.

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