Band structures in doubly odd ^{120}I and their microscopic description

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Introduction

The transitional region with A∼120 has gained considerable attention in high spin spectroscopic studies mainly because of the softness [1, 2] of the nuclei towards γ deformation resulting from the number of valence nucleons outside the closed shell [3]. Both the valence protons and neutrons are expected to have strong and specific shape driving force on the core when occupying the high-j orbitals that are close to Fermi surface. The proton Fermi surface lies just below the $h_{11/2}$ subshell, while the neutron Fermi surface lies in the $h_{11/2}$ midshell. The active proton orbitals in this mass region are $g_{7/2}, d_{5/2}$, the $g_{9/2}$ extruder and the unique parity $h_{11/2}$ intruder. In the chiral mechanism as described by Frauendorf and collaborators [4–6], high-j particles of one kind of nucleon and high-j holes of the other kind are combined with the triaxial deformed potential in these odd-odd nuclei. One of experimental signatures of the chirality is the observation of a pair of ΔI = 1 collective bands with the same parity and a small energy difference.

A particularly interesting feature of transitional region with A∼120 region is the observation of highly deformed rotational bands extending into the I ≈ 50 region. Their configurations involve neutron and proton excitations across the N = 82 and Z = 50 shell gaps, respectively.

Experimental details

Excited states in the ^{120}I nucleus (Z=53, N=67) were populated in the ^{112}Cd(^{11}B,3n)^{120}I fusion-evaporation reaction at E_{lab}= 50 MeV. The de-excitations were investigated through in-beam γ-ray spectroscopic techniques. The ^{11}B beam was provided by the Pelletron-LINAC facility at TIFR, Mumbai. The ^{112}Cd target of thickness ∼3 mg/cm^2 was prepared onto a ∼ 8 mg/cm^2 thick Pb backing. The recoiling nuclei in the excited states were stopped within the target and the de-exciting γ-rays were detected using the Indian National Gamma Array (INGA) consisting of 16 Compton suppressed clover detectors. Two and higher fold clover coincidence events were recorded in a fast digital data aquisition system based on Pixie-16 modules of XIA LLC [10].

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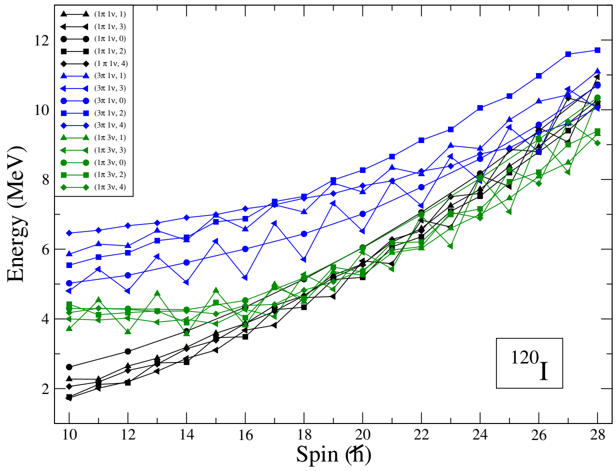

FIG. 1: (Color online) TPSM projected energies, before band mixing, of positive parity states for ^{120}I. Bands are labelled by $(K, \#)$ that designate the states with K quantum number and # the number of quasiparticles. For instance, (1,1n1p), (2,1n1p) (3,1n1p), (4,1n1p) correspond to the $K = 1, 2, 3, 4$ one-neutron coupled to one-proton quasiparticle state.

Discussion

The present level scheme of doubly-odd ^{120}I is built on the I$^{\pi}$ = 2^{-} ground state (T$_{1/2}$ = 81 min) [7–9]. The level scheme has been extended substantially with addition of about fifty new transitions and one new band to the earlier reported ones [7–9]. The level scheme is established up to $\sim$ 8 MeV excitation energy and level in B1-B10 band structures. The previous reported low-lying band structure is confirmed [9]. Present level scheme differ from the previous reported work [8] in the positive-parity band structures and at lower spin. In previous in-beam studies,[7] the decay of band B1 is followed down to an isomeric state with T$_{1/2}$ = 53 min. Band B1 is previously established up to the (16^{-}) state [7]. The triaxial projected shell model (TPSM) approach has been applied to reproduce the properties of various band structure in this nucleus [Fig.1]. The results of data analysis in framework of TPSM will be presented in symposium. Authors acknowledge the joint effort of IUAC, New Delhi, TIFR, Mumbai, and IUC-DAEF and SINP, Kolkata, in establishing the INGA clover array.

References

[1] I. Regnarsson *et al.*, Nucl. Phys. A **233**, 329 (1974).
[2] Y. S. Chen *et al.*, Phys. Rev. C **28**, 2437 (1983).
[3] G. Andresson *et al.*, Nucl. Phys. A **268**, 205 (1976).
[4] S. Frauendorf, Rev. Mod. Phys. **73**, 463 (2001).
[5] V.I. Dimitrov *et al.*, Phys. Rev. Lett. **84**, 5732 (2000).
[6] S. Frauendorf, J. Mend, Nucl. Phys. A **617**, 131 (1997).
[7] H. Kaur *et al.*, Phys. Rev. C **55**, 512 (1997).
[8] L. I. Li *et al.*, Chin. Phys. Lett. **30**, 062301 (2013).
[9] C. B. Moon, J. Korean Phys. Soc. **59**, 1525 (2011).
[10] R. Palit *et al.*, Nucl. Instrum. Methods A **90**, 680 (2012).