

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

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Introduction

The transitional region with $A \sim 120$ 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 $g_{9/2}$ intruder 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 $\Delta I = 1$ collective bands with the same parity and a small energy difference.

A particularly interesting feature of transitional region with $A \sim 120$ region is the observation of highly deformed rotational bands extending into the $I \approx 50$ 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 $^{112}\text{Cd}(^{11}\text{B},3n)^{120}\text{I}$ 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/cm² was prepared onto a ~ 8 mg/cm² 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 acquisition system based on Pixie-16 modules of XIA LLC [10].

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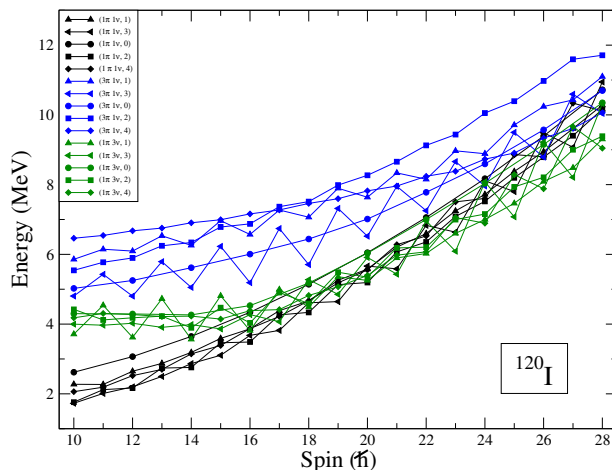


FIG. 1: (Color online) TPSM projected energies, before band mixing, of positive parity states for ^{120}I . Bands are labelled by $(K, \#)$ that designate the states with K quantum number and $\#$ the number of quasiparticles. For instance, $(1,1n1p)$, $(2,1n1p)$, $(3,1n1p)$, $(4,1n1p)$ correspond to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

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