# Structure of degenerate bands in $^{120}$I

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## Introduction

The transitional region with A∼120 has gained a substantial preference in high spin spectroscopic studies due to the observance of various dynamical features such as backbending, shape coexistence, high spin phase transition, and signature splitting, octupole collectivity and chirality. These properties arise mainly because of the softness [1, 2] of the nuclei towards $\gamma$ 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 region are $g_{7/2}(d_{5/2})$, the $g_{9/2}$ extruder and the unique parity $h_{11/2}$ intruder. Because of the large nuclear quadrupole deformation included by the occupation of the high j orbital,the intruding $h_{11/2}$ proton orbital displays a large number of alignment properties. The shape driving force of the aligned pair also depends on the position of the neutron Fermi surface within the $h_{11/2}$ subshell. The alignment of neutrons originating from the upper $h_{11/2}$ subshell is expected to polarize the $\gamma$ soft core to $\gamma \sim$ -60$^o$, resulting in a collective oblate nuclear shape, while a prolate shape is favoured for neutrons in the lower $h_{11/2}$ subshell. Terminating configurations have also been identified in various isotopes of $_{52}$Te and $_{53}$I, $_{44}$Ru and $_{45}$Rh, and recently in $^{123}$Cs.

## 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 $\gamma$-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 $\gamma$-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 [4]. The data sorting routine "Multi pARameter time stamped based COincidence Search program (MARCOS)", developed at TIFR, sorts the time stamped data to generate E$_\gamma$-E$_\gamma$ matrices and E$_\gamma$-E$_\gamma$-E$_\gamma$ cubes compatible with Radware format. The DCO ratios has been performed for the $\gamma$ rays. The Integrated Polarization Directional Correlation from Oriented nuclei (IPDCO) analysis was performed using two asymmetric polarization matrices corresponding to the parallel and perpendicular segments (with respect to the emission plane) of the clover

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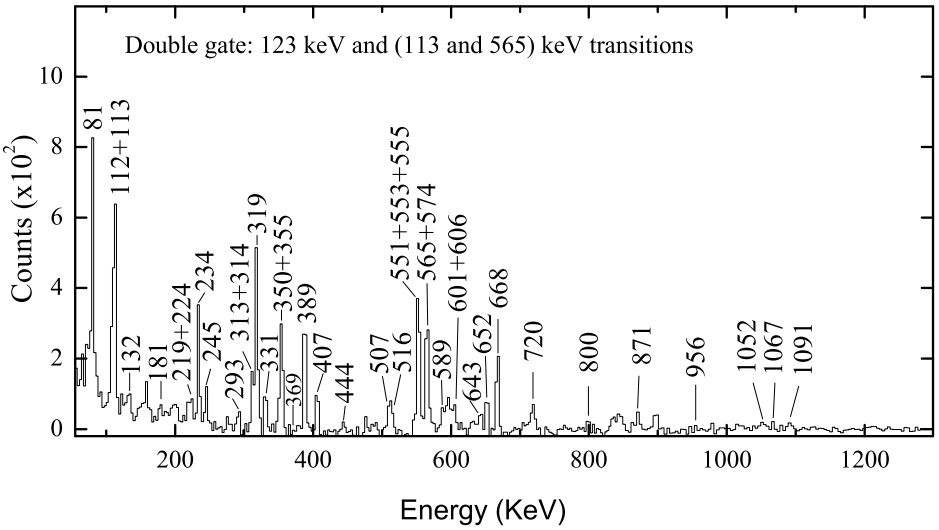


FIG. 1: The double-gated coincidence spectrum for positive parity energy levels of degenerate bands of $^{120}$I.

detector chosen as a Compton polarimeter along one axis and the coincident $\gamma$ rays in all the detectors along the other axis.

## Discussion

The present level scheme of doubly-odd $^{120}$I is built on the $I^{\pi} = 2^{-}$ ground state ($T_{1/2}$ = 81 min) [5–7]. The level scheme has been extended substantially with addition of many new transitions to the earlier reported ones [5–7]. The level scheme is established up to $\sim$ 8 MeV excitation energy. The previous reported low-lying band structure is confirmed [7]. Present level scheme differ from the previous reported work [6] in the positive-parity band structures. The previously reported 357-, 359-, 797-, 798 keV transitions in the excited positive parity band are not confirmed and the band is extended with newly observed 132-, 181-, 285-, and 369 keV dipole transitions (Fig. 1). The placement of these transitions is confirmed by the newly observed 569-, 588-, 501-, 417-, and 466 keV crossover transitions and the decay from excited positive parity band to the lower excited positive-parity band via 268-, 356-, 820-, 876-, and 469 keV transitions. The lower excited positive-parity band is extended at higher spin states with 588-, 726-, and 1172 keV transitions. The positive parity bands are nearly degenrate. The nearly degenerate band structures have been observed in A$\sim$ 100 and A$\sim$ 130 mass region. The results of data analysis will be presented in symposium.

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