Study of high-*K* bands in ^{111}In

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Introduction

Nuclei in the A=110 mass region contain rich structural information. Although, these nuclei, with the proton number close to the shell-closure (Z=50), are normally expected to be spherical, collective states arising from proton excitations across the shell-gap have been reported. Some of these intruder-type rotational bands have been shown to terminate smoothly at a high spin when all the quasiparticle angular momentum is exhausted [1, 2]. In addition, high-K, $\Delta I = 1$ bands of intense dipole transitions have also been reported in this mass region, involving hole(s) in the same $g_{9/2}$ high-*K* proton orbital. Such bands have been identified in ^{110}Cd and ^{111,113}In [3-5]. The bands have only been observed up to modest spins and drop off quickly in *B(M1)/B(E2)* strength suggesting 'shears' dynamics ('magnetic rotation') related to the perpendicular coupling of high-*K* proton hole(s) to low-*K* neutron orbitals at low spin in a weakly deformed nucleus. The level spacings are somewhat irregular and cross-over *E2* transitions are weak, indicating small *B(E2)* strengths. The objective of the present work is to study such high-K bands in ^{111}In from a direct study of the *B(M1)* rates in order to understand if the shears mechanism is responsible for their structure.

Experiment

Excited states of ^{111}In were populated in the ^{100}Mo(^{19}F, α4n) reaction at *E*=105 MeV using the INGA at the Inter University Accelerator Centre (IUAC), New Delhi. Fifteen Clover HPGe detectors arranged in five rings at 32º, 57º, 90º, 123º, and 148º with respect to the beam direction were used along with standard NIM and CAMAC electronics, including the Clover module developed at the IUAC. Target consisted of 2 mg/cm^2 enriched ^{100}Mo deposited on 8mg/cm^2 gold. Two and higher-fold events with a count rate of 4-5 kcps were recorded using CANDLE and analyzed offline using INGASORT.

Results and discussion

Two high-*K* bands (bands 6 and 8 in Ref. [4]) have been populated up to ($43/2^+$) and ($33/2^+$), respectively. Mean lifetimes of four states in band 8 have been estimated for the first time using the DSA data. Fig. 1 shows the partial level scheme for band 8 and representative DSA spectra along with the lineshapes (using the code LINESHAPE) for the 371.3 and 535.4 keV γ-rays belonging to this band. Table 1 provides the lifetime results and the deduced *B(M1)* and *B(E2)* rates for the four highest transitions in the band. The lifetimes include the effects of both cascade as well as direct feedings to the states. Errors in the lifetime results include the statistical uncertainty in the data and the effect of an assumed 50% uncertainty in the side-feeding times.

Table 1 summarizes the new experimental results. The *B(E2)* for the cross-over 883.7, 1047.6 and 1080.1 keV transitions lie within 3-10 W.u. corresponding to an average quadrupole deformation of 0.05. The small deformation and the limited range of angular momentum for the band suggest that particle-hole excitations are not likely to be involved in their structure. Hence, band 8 is proposed to have the configuration $\pi(g_{9/2})^{-1}(\nu h_{11/2})^{+2}$. The *B(M1)* values are large at low spin ($2.7^{+0.56}_{-0.48}$ μ_N^2 for the $27/2^+ \rightarrow 25/2^+$ transition) and decreases to 0.24±0.04 μ_N^2 for the $(33/2^+) \rightarrow 31/2^+$ γ-ray (see Table 1). These results along with the small quadrupole deformation clearly show that the states arise due to the shears mechanism. The large $J^{(2)}/B(E2)$ = 669 $\hbar^2$MeV^{-1}(eb)$^{-2}$ for the $29/2^+$ state further corroborates this inference. The fraction of total spin attributable to core rotation for this state is found to be 0.19 from a semi-classical interpretation of the shears mechanism, A detailed analysis of the data for band 6 (refer to Ref. [4]) is in progress.

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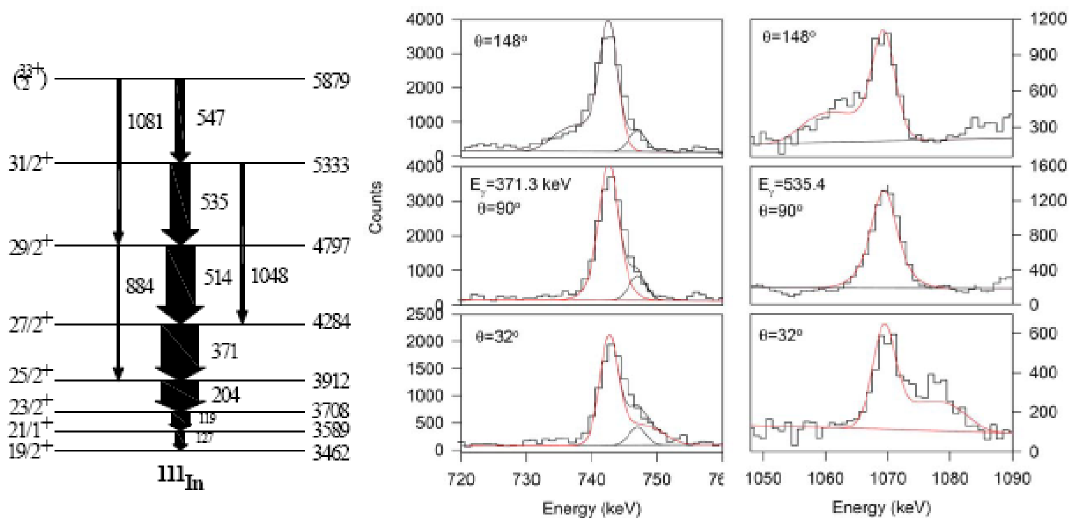

Fig. 1. Partial level scheme of ^{111}In (left) showing only inband transitions and lineshape fits to DSA data for the 371.3 and 535.4 keV transitions.

Table 1. Summary of level lifetimes and the reduced transition probabilities *B(M1)* and *B(E2)* in ^{111}In. The figure on the right shows the plot of *B(M1)* vs. level spin.

E_{ex} (keV)	E_γ (keV)	$J_i^\pi \rightarrow J_f^\pi$	τ (ps)	B(M1) μ_N^2	B(E2) (W.u.)	β_2
4283.5	371.3	$27/2^+ \rightarrow 25/2^+$	$0.41^{+0.09}_{-0.07}$	$2.7^{+0.56}_{-0.48}$	-	
4797.1	513.6	$29/2^+ \rightarrow 27/2^+$	$0.34^{+0.11}_{-0.07}$	1.15±0.29		
	883.7	$29/2^+ \rightarrow 25/2^+$			9.6±2.4	0.07±0.02
5332.5	535.4	$31/2^+ \rightarrow 29/2^+$	$0.86^{+0.20}_{-0.15}$	0.36±0.08		
	1047.6	$31/2^+ \rightarrow 27/2^+$			3.7±0.70	0.04±0.01
5879.2	546.6	$(33/2^+) \rightarrow 31/2^+$	$1.03^{+0.19}_{-0.15}$	0.24±0.04		
	1080.1	$(33/2^+) \rightarrow 29/2^+$			4.8±0.76	0.05±0.01