High spin spectroscopy of nuclei in the mass A $\sim$ 110 region

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INTRODUCTION

Nuclei in this mass region lie in the close proximity to $Z = N = 50$ shell closure and therefore their low spin states are dominated by single particle excitations. In the last decade, considerable attention has been given to the study of high spin states in this region. This is primarily due to the discovery of novel phenomena like 'magnetic rotation' and 'smooth band termination'. These phenomenon of magnetic rotation provides an alternative mechanism to collective rotation and single particle excitations in the generation of angular momentum.

The nuclei with neutron number N > 58 have sufficient deformation ($\beta > 0.1$) to have collective rotation along with the magnetic rotation. With the increase in deformation due to the increase in neutron number, the relative contribution of collective rotation increases. It is still not clear at what neutron number the magnetic rotation is completely overtaken by the collective rotation. On the other hand, approaching close to N = 50 the phenomenon of magnetic rotation is competed by single particle excitations. Studies carried out by Jenkins *et.al.* [1] in Cd isotopes and Deo *et.al.* [2] in Ag isotopes indicate that the lower boundary for the appearance of 'magnetic rotation' is expected at N=56. For N < 56 neutron number no regular $M1$ transitions are observed in these isotopes. However, in low mass odd-Indium isotopes, *i.e.* ^{103,105,107}In, several ΔI =1, $M1$ sequences have been identified by Kownacki *et.al.* [3]. It will be fruitful to investigate these sequences for the existence of magnetic rotation. This will help in elucidating the lower limit of the existence of this phenomenon in In isotopes.

In the present work, ^{107}In and ^{109}In nuclei have been investigated. The results of these investigation are presented and discussed in the framework of tilted axis cranking (TAC) and semi-classical models.

Experimental Details.

Two experiments were performed with the Indian National Gamma Array (INGA) at Inter University Accelerator University (IUAC), New Delhi, using ion beams from the 15 UD Pelletron accelerator. In the first experiment high spin states of ^{107}In were populated using the reaction ^{94}Mo(^{16}O, $p2n$)^{107}In at a beam energy of 70 MeV. The target thickness was 0.9 mg/cm^2 with a 6.5 mg/cm^2 thick ^{197}Au backing. For ^{109}In, the reaction ^{96}Zr(^{19}F, $6n$)^{109}In at a beam energy of 105 MeV was used. In this case, the target thickness was 1.0 mg/cm^2 with a 20 mg/cm^2 thick natural Pb backing. Collection of data was done in the list mode format using a CAMAC based multi-crate synchronization mode in Linux platform. The data were sorted using the INGASORT program.

Results and Discussion

^{107}In. In this work, the level scheme of ^{107}In nucleus has been considerably extended. Four new ΔI=1 sequences and one ΔI=2 sequence have been established [4]. In one of the known ΔI=1 sequence, referred to as band 1, shears mechanism has been established as a main source of contribution towards the angular momentum generation in the sequence. Lifetime measurements by DSAM of the levels in the band confirmed the decreasing trend of the $B(M1)$ transition strengths with increase in spin both before and after the alignment (Fig. 1). The tilted axis cranking (TAC) calculations performed for the sequence with the configuration $\pi(\mathrm{g}_{9/2})^{-1}\otimes\nu[\mathrm{h}_{11/2}(\mathrm{d}_{5/2}/\mathrm{g}_{7/2})]$ before the alignment and $\pi(\mathrm{g}_{9/2})^{-1}\otimes\nu[\mathrm{h}_{11/2}(\mathrm{d}_{5/2}/\mathrm{g}_{7/2})^3]$ after the

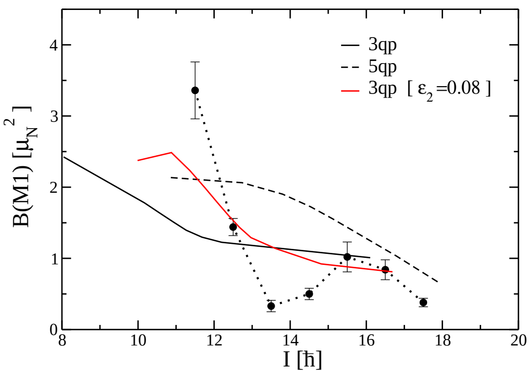

FIG. 1: Comparison of the TAC calculations with the experimental $B(M1)$ strengths as a function of spin for band 1 in ^{107}In.

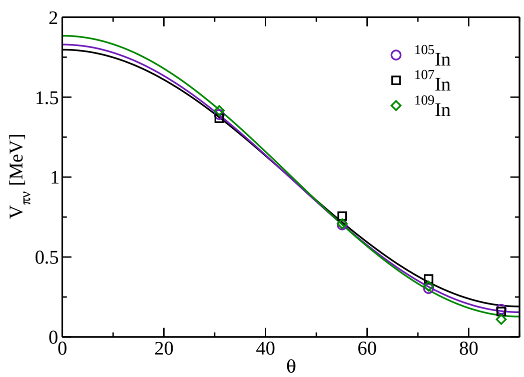

FIG. 2: Semiclassical calculations of interaction energy between the 'shears blades' as a function of shears angle of band 1 in ^{105}In, ^{107}In and ^{109}In.

alignment, were in good agreement with the experimental data. A noteworthy result was the sharp rate of decrease of the $B(M1)$ strengths before the alignment, indicating a low deformation of the core for these multiquasiparticle configurations than that obtained from the minimization procedure. In conclusion, the sequence, especially before the alignment, exhibit one of the pure magnetic rotation in this mass region.

^{109}**In**. The level scheme of ^{109}In nucleus has been considerably modified. Three new ΔI=1 sequences have been established [5]. One of the sequence, referred as band 1 [5], have been identified as the case of magnetic rotation. Based on systematics, the $\pi(g_{9/2})^{-1}\otimes\nu[h_{11/2}(d_{5/2}/g_{7/2})]$ configuration has been assigned to the band before the alignment. The TAC calculations show that the major contribution towards the angular momentum generation comes from the shears mechanism. The semi-classical calculations [6] for this 3-quasiparticle configuration in the band 1 in ^{105}In, ^{107}In and ^{109}In shows that these bands have a very similar behaviour (Fig. 2). This result, therefore, imply no significant change in the relative contribution of core towards the angular momentum generation with the change in neutron number from N =56 to 60 for the above mentioned 3 quasiparticle configuration.

The details of the above mentioned works will be discussed in the presentation.

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