Yrast Spectroscopy of ^{77}As

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The odd mass nuclei in A $\approx$ 80 mass region exhibit a variety of nuclear structure phenomena such as large signature splitting, signature inversion, band crossing associated with quasiparticle alignment, shape coexistence, high-lying negative parity band based on stapler mechanism *etc* [1]. We are reporting here the effects of quasiparticle alignments in the $g_{9/2}$ yrast positive parity band. The observed results have been interpreted following the total Routhian surface (TRS) and particle-rotor model (PRM) calculations.

The excited states of ^{77}As were populated in the ^{76}Ge$(\alpha, p2n)$ fusion-evaporation reaction at a beam energy of 40 MeV. The beam was delivered by the K-130 Cyclotron machine at the Variable Energy Cyclotron Centre (VECC), Kolkata. The 94% enriched ^{76}Ge target was prepared at the target laboratory of VECC through centrifuge process by depositing enriched ^{76}Ge powder on mylar backing. The thickness of each target was about 2 mg/cm^2 and two such targets were stacked together and used during the experiment.

The de-exciting γ-rays from the excited states of the residual nuclei were detected using the Indian National Gamma Array (INGA). The array was comprised of six Compton-suppressed high resolution HPGe Clover detectors and one Low Energy Photon Spectrometer (LEPS). The details of the experimental set up can be found in Ref. [1].

A part of the level scheme of ^{77}As as obtained from the present work is shown in Fig. 1. The previous level scheme [2] has been extended by placing 18 new transitions and 12 new levels. We have been able to extend the level scheme upto $E_x \approx 7.5$ MeV and $J = 33/2$ $\hbar$. As can be seen in Fig. 1, the presented level scheme has been grouped under two heads: 1a ($\alpha = +1/2$) and 1b ($\alpha = -1/2$). The rotational frequency ($\hbar\omega$) dependent variation of kinematic moment of inertia, $J^{(1)}$, dynamic moment of inertia, $J^{(2)}$, and aligned angular momentum, i_x have been shown in Fig. 2. The relevant experimental data for the yrast positive parity band of ^{79}Br are also plotted for the sake of comparison. It can be seen from Fig. 2 (b) that a large enhancement in $J^{(2)}$ value occurs for ^{79}Br at $\hbar\omega$~0.60 MeV, whereas such a large enhancement is not seen

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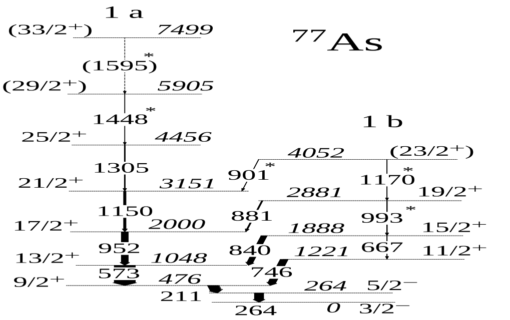

FIG. 1: Partial level scheme of ^{77}As as obtained in the present work. The newly observed transitions have been marked with $*$.

for ^{77}As at the respective band crossing regime of $\hbar\omega$∼0.65 MeV. The large enhancement in $J^{(2)}$ value for ^{79}Br has been interpreted as due to a pair of $\nu g_{9/2}$ alignment with a weaker interaction between the crossing bands [3]. The relatively smaller gain in $J^{(2)}$ value for ^{77}As is possibly due to the similar type of $\nu g_{9/2}$ alignment, but with a moderate interaction between the crossing bands above the 4456 keV, $25/2^+$ state.

Further, the possible evolution of shapes before and after the band crossing is investigated by the total Routhian surface (TRS) calculations. The calculations predict a triaxial shape with $\beta_2 \approx 0.29$ and $\gamma \approx 31°$ at $\hbar\omega = 0.30$ MeV, prior to the band crossing regime. After the first band crossing, the predicted values of the shape driving parameters are found to be $\beta_2 \approx 0.25$ and $\gamma \approx$ -38° at $\hbar\omega = 0.65$ MeV. Thus, the predicted results from the TRS calculations suggest for the persistence of triaxial shape before and after the band crossing.

The signature splitting pattern for the extended band structures has also been investigated in the present work. As can be seen from Fig. 3, large amount of signature splitting occurs between the two partner bands, 1a and 1b. The experimentally observed staggering has been compared with the predicted results from the Particle-Rotor Model (PRM) calculations incorporating Variable Moment of Inertia (VMI) formalism [4]. The Nilsson parameters μ and κ are chosen as 0.43 and 0.067, respectively. The Coriolis attenuation factor has been considered to be 0.7. As can be seen from Fig. 3, the staggering in the energy levels are reasonably well reproduced for the lower spin-states. But deviations between the experimental and theoretical results are observed for the higher spin states. This can possibly be due to the presence of triaxiality in the core nucleus (^{76}Ge) which is not considered in the present set of PRM calculations. The calculations have been carried out using the deformation parameters, β_2 = 0.18 and γ = 0° for the core nucleus. Further calculations in this context are in progress.

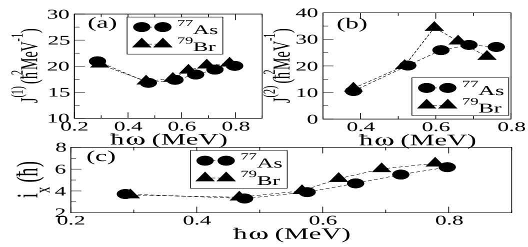

FIG. 2: The variation of (a) kinematic moment of inertia $J^{(1)}$, (b) dynamic moment of inertia $J^{(2)}$, (c) nucleon alignments as a function of rotational frequency, $\hbar\omega$ for the yrast positive parity states of ^{77}As and ^{79}Br.

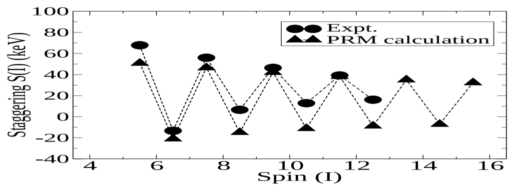

FIG. 3: Comparison between the experimentally observed and theoretically predicted energy staggering of bands, 1a and 1b of ^{77}As.

Acknowledgments

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