Lifetime and transition strength measurements of ^{73}Br

S. Bhattacharya[1], T. Trivedi[1],* R. Palit[2], D. Negi[3], S. Nag[4], A. Dhal[5], M. K. Raju[6], V. V. Parkar[7], S. Kumar[8], D. Choudhury[9], G. Mahanto[3], R. Kumar[3], R. P. Singh[3], S. Muralithar[3], A. K. Jain[9], S. C. Pancholi[3], and R. K. Bhowmik[3]

[1]*Depatment of Pure & Applied Physics, Guru Ghasidas Vishwavidyalaya,Koni,Bilaspur - 495009, INDIA*

[2]*Deptartment of Nuclear and Atomic Physics, Tata Institute of Fundamental Research, Mumbai - 400005, INDIA*

[3]*Inter University Accelerator Centre, Aruna Asaf Ali Marg, New Delhi - 110067, INDIA*

[4]*Dept. of Physics, National Institute of Technology Raipur, Raipur (CG)- 492010, INDIA*

[5]*Department of Physics, Banaras Hindu University, Varanasi 221005, INDIA*

[6]*Department of Nuclear Physics, Andhra University, Visakhapatnam 530003, INDIA*

[7]*Nuclear Physics Division, Bhabha Atomic Research Centre, Mumbai - 400085, INDIA*

[8]*Department of Physics and Astrophysics, University of Delhi, Delhi 110007, INDIA and*

[9]*Department of Physics, IIT Roorkee, Roorkee 247667, INDIA*

Introduction

Complex quantum many-body system describes the spatial distribution in atomic nucleus which produces different interaction between nucleons, resulting in various exotic nuclear phenomena like shape coexistence, shape evolution, super deformation, magnetic rotation, band termination etc. The studies of these phenomena under extreme of excitation energy and angular momentum is now possible due to advancement in γ- detection technology and through improved theoretical models. Experimentally, terminating bands were observed first in ^{158}Er and subsequently in the A$\sim$110 as well as in A=70 mass region. Terminating states are generated when all the valence particles are aligned along the rotational axis. As a result, rotating nuclei at intermediate spin, gradually loses its collectivity and the band terminates to a non collective state. The particle alignments in odd-A Bromine isotopes show a variety of effects. In ^{75}Br alignment is produced due to interaction of $\pi g_{9/2}$ and $\nu g_{9/2}$ orbitals. However, in ^{77}Br decrease in signature splitting has been observed due change in triaxiality from $\gamma \sim +30^{\circ}$ to $\gamma \sim -30^{\circ}$. Further, it will be interesting to study the shape evoluation induced by the neutron and/or proton interaction in odd-even ^{73}Br nucleus which is predicted as a candidate of terminating band by cranked Nilsson Strutinsky model calculations[1]. The previous lifetime measurements in ^{73}Br nuclei have been carried out by Heese et al.,[2] using few HPGe detectors. However, high-spin states are well established by the work of Plettner et al.,[1]. In present study, we have extracted more precise lifetimes compared to previous work along with the lifetime of some more states of positive and negative parity bands of ^{73}Br with high efficient data.

Experimental Details

The experiment was performed with Indian National Gamma Array (INGA) at Inter University Accelerator Center (IUAC), New Delhi, using ^{50}Cr(^{28}Si,αpγ)^{73}Br reaction. The ^{28}Si beam of 90-MeV energy was bombarded on ^{50}Cr target of thickness 550 μg/cm^2 backed with 12 mg/cm^2 Au [3]. The de-exciting γ rays were detected using 17 Compton-suppressed clover detectors during the experiment. The detectors were placed at five different angles 32°, 57°, 90°, 123°, and 148°. After gain matching of individual crystals, add-back spectra were generated for all the clovers and the coincidence data were

*Electronic address: ttrivedi1@gmail.com

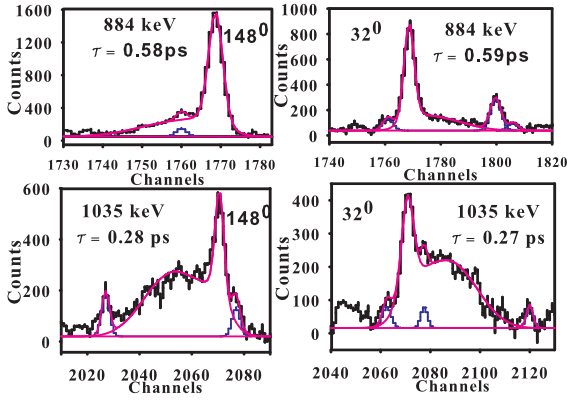

FIG. 1: Least-squares fits of line shapes of some representative transitions (884 and 1035 keV) of ^{73}Br.

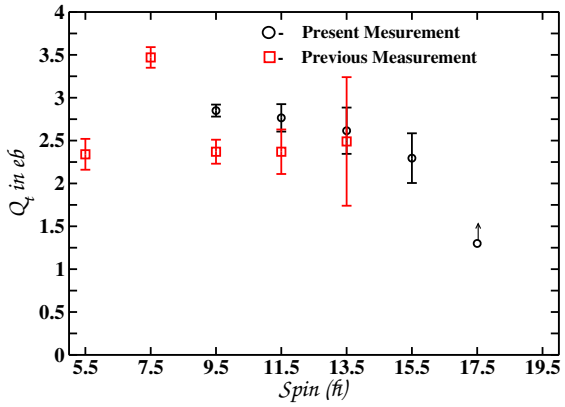

FIG. 2: Transition quadrupole moment for yrast band with signature coefficient $\alpha = -\frac{1}{2}$.

stored in the γ -γ matrix. For the application of the Doppler-shift attenuation method, line shapes were obtained from the background-subtracted spectra projected from matrices consisting of events in the 148° or 32° detector along one axis and all other detectors along the second axis.

Data Analysis and Results

The transitions reported in the level scheme established by Pletnner et al.,[1] were identified and used as reference for present measurement. We have measured the lifetimes of 16 levels in the positive and negative-parity bands of ^{73}Br using LINESHAPE code [4]. The topmost level in the cascade was fitted first by assuming a prompt feed to this level; for the rest of the transitions we have used a rotational cascade side-feeding model of five transitions. The side-feeding intensities were extracted using intensity balance for each level of the cascade from the intensity of transition, measured from present data. In the fitting procedure, χ^2 & QFN minimization technique is used to get the transition quadrupole moment Q_t and lifetimes τ of maximum possible transitions (804, 994, 1166, 1317 and 1466 keV for band-A; 884, 1035, 1181, 1312 and 1471 keV for band-B; 851, 953, 1072, 1216,1347 and 1463 keV for band-C) in positive and negative parity bands. The experimental and fitted line shapes for some of the representative transitions at 148° and 32° for yrast band of ^{73}Br are shown in Fig. 1. Reduced electric quadrupole transition probability B(E2) were also extracted from the measured lifetimes. Fig. 2 shows the variation of transition quadrupole moment for yrast band as a function of spin from the present data along with previous measurements [2]. The transition quadrupole moment decreases from 2.85 eb at spin $19/2^-$ to 1.30 eb at spin $35/2^-$, showing loss of collectivity with spin. A similar behavior have been observed for other positive and negative parity bands also.

Acknowledgments

We thank the staff members of the Pelletron facility and target laboratory of IUAC. Financial support by IUAC (UFR-55313) is gratefully acknowledged.

References

[1] C. Plettner et al., Phys. Rev. C **62**, 014313 (2000).
[2] J. Hesse et al., Phys. Rev. C **36**, 2409(1987).
[3] T. Trivedi et al., Phys. Rev. C **80**, 047302 (2009).
[4] J.C. Wells and N.R. Jhonson, Report ORNL-6689, 44 (1991).