Chiral Structures in doubly odd nucleus ^{102}Ag

V. Singh[1], S. Sihotra[1],* G.H. Bhat[2], S. Kumar[1], K. Singh[1], N. Singh[1], J. Goswamy[1], J. Sethi[3], S. Saha[3], R. Palit[3], J.A. Sheikh[2], and D. Mehta[1]
[1]Department of Physics, Panjab University, Chandigarh-160014
[2]Department of Physics, University of Kashmir, Srinagar-190 006 and
[3]Department of Nuclear and Atomic Physics, TIFR, Mumbai-400005

Introduction

The level strutures of nuclei approaching the neutron and proton major shell closures at N=Z=50 are complex due the interplay between the single-particle and collective degrees of freedom. Various new deformation generating mechanisms have been identified in theoretical interpretation of the observed level structures. Investigations have revealed diversity in level structures resulting from coupling of the $g_{9/2}$, $d_{5/2}$, $g_{7/2}$, and $h_{11/2}$ valence nucleons and the core-excited configurations. The relevant intringuing triaxiality based phenomena such as magnetic rotation [1] and degenrate twin bands have been reported in this mass region [2]. The twin degenerate dipole bands with similar energy staggering and electromagnetic strengths have been explained with aplanar tilted rotation of the triaxial core along with the valence neutrons and protons aligned along the two extreme axes of the core. Recently, Relativistic Mean Field (RMF) calculations predicted multiple chiral bands in some of the odd odd isotopes of Ag, Rh and In, owing to their triaxial shape. The truncated shell model calculations prescribe an alternative angular momentum coupling scheme, namely, the chopstick model to explain these bands.

Several theoretical approaches have been used to probe the chiral doublet band structures observed in odd odd nuclei. In most of the studies, particle-rotor and three-dimensional cranking approaches have been employed to interpret the observed chiral band structures. Although, these models have been quite successful to provide some basic understanding of the doublet bands, they have also exhibited some deficiencies. In the present work, we shall provide a detailed investigation of ^{102}Ag using the microscopic triaxial projected shell model (TPSM) approach [3]. The doubly odd nucleus ^{102}Ag can provide information on different modes of coupling mechanisms between the odd proton and the odd neutron outside the ^{100}Sn core. By the powerfull detector array the above mentioned features can be studied.

Experimental details

Excited states in the ^{102}Ag nucleus were populated in the ^{75}As(^{31}P, p3n)^{102}Ag fusion-evaporation reaction at E_{lab}= 125 MeV. The de-excitations were investigated through in-beam gamma-ray spectroscopic techniques. The ^{31}P beam was provided by the Pelletron-LINAC facility at TIFR, Mumbai. The ^{75}As target of thickness 2.8 mg/cm^2 was prepared by vacuum evaporation and rolled onto a 10 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 21 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_γ-E_γ matrices and E_γ-E_γ-E_γ cubes compatible with Radware format.These data were used to develop the level scheme.

*Electronic address: ssihotra@pu.ac.in

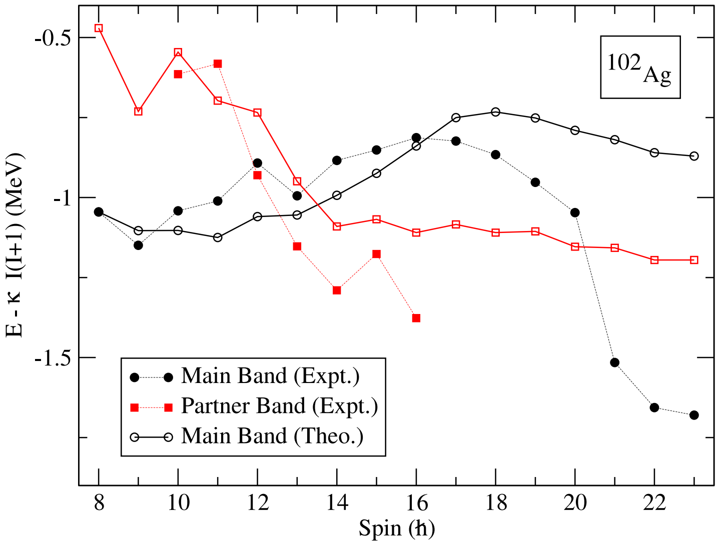

FIG. 1: Comparison of the measured energy levels of negative parity yrast and excited bands for ^{102}Ag with those from TPSM calculation.

Discussion

The present level scheme of ^{102}Ag is built on the I = 5^+ ground state. The level scheme has been extended substantially with addition of about fifty new transitions to the earlier reported ones [5, 6]. The level scheme is established up to $\sim$ 10 MeV excitation energy. The present level scheme preserves major features of the previously observed bands by S. Rastikerdar [5] and V. Ravi Kumar et al.[6]. Previously reported level at 2378 keV having $\triangle\ \tau$ <4ns has not been observed in the present work. A new band consisting of 261-, 275-, 237-, and 267- keV transitions has been observed. The states of this band decay to yrast band by various gamma rays that have been observed in the present work. The projected basis are employed to diagonalize the shell model Hamiltonian consisting of pairing plus quadrupole -quadrupole interaction terms. The projected energies, obtained after shell model diagonalization, for the doublet bands in doubly odd nucleus ^{102}Ag are depicted and compared with the corresponding experimental data in Fig. 1.

Acknowledgments

Authors acknowledge the joint effort of IUAC, New Delhi, TIFR, Mumbai, and IUC-DAEF and SINP, Kolkata, in establishing the INGA clover array. Financial support from IUAC, New Delhi, under the Centre of Advanced Study Funds, and UGC, New Delhi, is duly acknowledged.

References

[1] D. G. Jenkins et al., Phys. Lett. B **428**, 23 (1998).
[2] P. Joshi et al., Phys. Rev. Lett. **98**, 102501 (2007).
[3] Y. Sun, J.A. Sheikh, G.-L. Long, Phys. Lett. **B 533**, 253(2002)
[4] R. palit et al., Nucl. Instrum. Methods A **90**, 680 (2012).
[5] S. Rastikerdar, Physics of Atomic Nuclei, **64**, 1210(2001).
[6] V. Ravi. Kumar et al., Z. Phys. A **351**, 249 (1995).