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Three proton hole structure in ^{106}Ag

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The negative parity non-yrast band of ^{106}Ag has been studied to investigate the falling trend in magnetic dipole transition rates. In this context, the level lifetimes of the excited levels of this band have been measured using the Doppler shift attenuation method. The comparison of the experimental Routhian and the transition rates with the numerical results of the shears mechanism with the principal axis cranking calculation indicates that this band is generated due to the shears mechanism involving the three proton hole configuration.

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I. INTRODUCTION

The shears mechanism is an important mode of angular momentum generation in weakly and moderately deformed nuclei. This mechanism requires a specific single-particle configuration, commonly known as a shears structure, which is formed by the angular momentum vectors of the deformation ($\vec{j}_1$) and the rotation ($\vec{j}_2$) aligned valence particles. The interaction between these two angular momentum vectors leads to the shears band which is characterized by a sequence of magnetic-dipole ($M1$) transitions with falling $B(M1)$ rates as a function of spin. In the semi-classical geometric model by Clark and Macchiavelli [1], the high angular momentum states of the band are attributed to the closing of the two angular momentum vectors which are coupled perpendicularly at the band head and fully aligned at the highest spin ($\vec{I} = \vec{j}_1 + \vec{j}_2$). The angular momentum vectors close around the total angular momentum which remains tilted with respect to the principal axes. In this situation the π-rotational symmetry is lost and the signature is not a good quantum number. The shears mechanism was first observed in the Pb region [2] where the nuclei are nearly spherical and the total angular momentum is almost completely generated by the valence proton and neutron angular momenta. The situation is different for the shears bands of mass-100 and mass-140 regions where the shears configuration is associated with a moderately deformed core. In this scenario, the total angular momentum is generated through an interplay of the shears mechanism and collective rotation. For the nuclei of the mass-140 region, the collective contribution is around 30% and a semi-classical model, shears with principal axis cranking (SPAC) [3,4], has been employed to describe this interplay. In the commonly used version of this model, the rotation aligned vector $\vec{j}_2$ does not change its orientation, while the deformation aligned vector $\vec{j}_1$ closes towards the rotation axis. Thus, the tilt angle of the total angular momentum with respect to the deformation axis changes continuously, while in the geometric model [1], it remains constant. In the mass-100 region, the rotational contribution has been reported to be small and the shears bands can be described by the geometric model where the rotational angular momentum is uniformly distributed over the band [5].

Among the nuclei of the mass-100 region, the effects of the shears mechanism in the Ag isotopes have been studied extensively. In particular, the observation of negative parity doublet bands (the ground state band and its partner) in ^{106}Ag has induced several experimental investigations to understand their origin. The studies by Niyaz *et al.* [6] and Lieder *et al.* [7] have ruled out the possibility of static chirality in this nucleus. In addition to the doublet bands, Lieder *et al.* [7] have reported another negative parity band (band 3) which has been proposed to originate from a four quasiparticle configuration based on the observed value of the quasiparticle alignment and comparison with the particle rotor model calculations. The experimental Routhians have been well reproduced by the calculations but the calculated transition rates fail to describe both the magnitude and the variation of the transition rates as a function of spin. Thus, in the present work, the band 3 of ^{106}Ag has been revisited to understand the single-particle configuration as well as the underlying excitation mechanism.

II. EXPERIMENT

The high spin states of ^{106}Ag were populated using the 68 MeV ^{14}N beam from the 14-UD Pelletron at the Tata Institute of Fundamental Research (TIFR) through the ^{96}Zr(^{14}N,4n) reaction. The 1 mg/cm^2 thick enriched ^{96}Zr target was used which had a ^{206}Pb backing of 9 mg/cm^2. The γ rays were detected in the Indian National Gamma Array (INGA) [8], which consisted of 20 Compton suppressed clover detectors. These were arranged at seven angles with two detectors at 23° and 115°, three each at 40°, 65°, 140°, and 157°, and four detectors at 90° with respect to the beam direction. The target to detector distance was 25 cm. The two- and higher-fold

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