Search for Shears Mechanism in ^{142}Sm

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INTRODUCTION

Generation of angular momentum in weakly deformed nuclei by shears mechanism is a well known phenomenon in nuclear structure physics. During the last two decades, rotational-like bands consisting of dipole transitions have been observed systematically near the spherical region and interpreted as Magnetic Rotor. In this mechanism the total angular momentum along the band is generated by the gradual alignment of the two angular momentum blades and the shears arrangement of the high j orbital give rise to a large transverse magnetic dipole moment [1].

It was also suggested [1] that an Anti Magnetic rotor might be observed in some nuclei. In this case the angular momentum of each proton holes (particles) combines with one of the neutron particles (holes), forming a pair of shears. It is proposed that the holes are moving in time reverse orbit resulting in the cancelation of the perpendicular component of dipole moment depending on the configuration of the valance quasiparticle and holes. This leads to the absence of M1 transitions and enhancement of E2 transition rates and such a band is known as antimagnetic rotational band. The angular momentum is generated by the simultaneous closing of two shears. Since the mean field has Rz symmetry, the rotational bands in Anti Magnetic rotation is expected to manifest itself as a $\Delta I=2$ band of a definite signature.

In the present INGA experiments at TIFR, we studied the level structure of ^{141,142}Sm in order to look for the possible observation of magnetic and anti magnetic rotational bands by measuring the life time of the excited states using DSAM technique.

EXPERIMENTAL DETAILS

The high spin states of ^{142}Sm were populated by the reaction ^{116}Cd (^{31}P, p4n) at beam energy of 148 MeV provided by the Pelletron Linac at TIFR, Mumbai. The target used in the experiment was 2.4 mg/cm^2 ^{116}Cd on 14.5 mg/cm^2 Pb backing. The recoil velocity of the compound nucleus is almost 2% of c. Indian National Gamma Array (INGA) consisting of nineteen Compton suppressed Clover detectors were used to detect de-exciting gamma rays. Two and higher fold gamma-gamma coincidence list mode data were recorded in a fast digital data acquisition system based on Pixie-16 modules of XIA LLC [2]. The data sorting routine MARCOS, developed at TIFR, sorts the time stamped data to generate Eγ – Eγ matrix and Eγ – Eγ – Eγ cube.

RESULTS AND DISCUSSION

The ^{142}Sm nucleus was previously studied by M. Lach et al. [3] using (α, 4n) and (3He, 3n) reaction and reported the level scheme up to 6 MeV, identifying a new isomeric 10^+ state at 3.662 MeV with 480 ± 60 ns lifetime.

The proposed partial level scheme of $^{!42}$Sm, obtained in the present experiment (Fig.1) has been established using the coincidence relationship, relative intensities and R_{DCO} ratios measurements. The energy levels have been extended up to excitation energy ~ 14 MeV and more than seventy new gamma transitions have been placed in the proposed level scheme. From the proposed level scheme it observed that apart from the irregular excitation pattern in the low spin region, the high spin behavior shows some

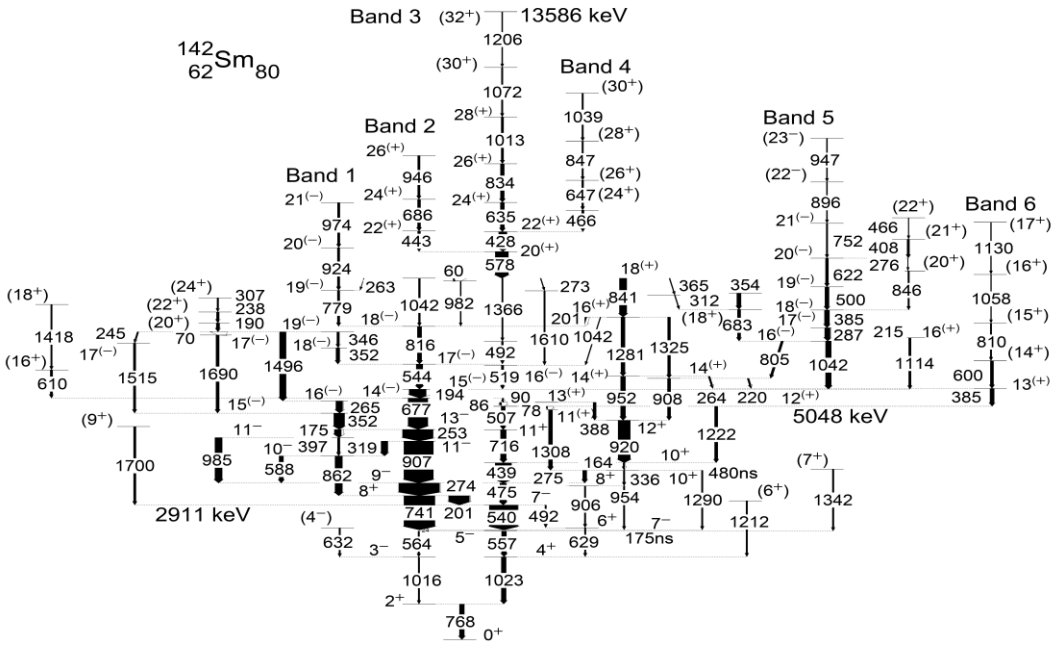

Fig. 1. Level scheme of ^{142}Sm observed in the present experiment.

interesting features. Six bands like structures have been observed in which the band 2 and 3 are found to be quadrupole in nature whereas the bands 1 and 5 are dipole in character. Evaluation of DCO ratio of the bands 4 and 6 and the polarization measurements of the gamma transitions in the bands are in progress. In this paper we concentrate only on Band 3 which consist a cascade of 428, 635, 834, 1013, 1072 and 1206 keV transitions above the 20^+ state at 8.4 MeV. All these transitions are quadrupole in nature and the value of the dynamical moment of inertia remains almost constant with a value of ~ 20 $\hbar^2$ MeV^{-1} (Fig.2). Similar behavior of the constant dynamical moment of inertia has been observed in the case of Anti magnetic rotational band in ^{106}Cd [4]. The sharp increase of dynamical moment of inertia value at a spin of 30ħ may be due to a change in the configuration of the above band. Similar change of dynamical moment of inertia has been observed in ^{143}Sm [5] which was interpreted as an excitation of new pair of protons in the $d_{5/2}$ or $g_{7/2}$ orbital to $h_{11/2}$ state, resulting in a sharp change in the B(M1) values. The life time measurements of the transitions in band 3 will be presented, which would aid in the conclusive interpretation of the nature of this sequence.

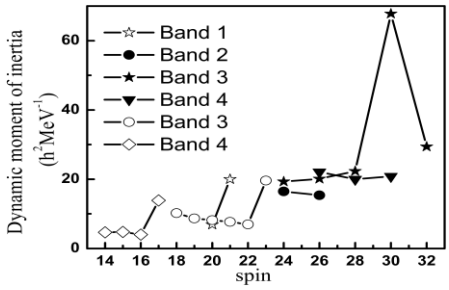

Fig.2. Plot of dynamic moment of inertia for the observed bands in ^{142}Sm.

ACKNOWLEDGMENTS

The authors would like to thank the members of the INGA collaborations as well as the TIFR-BARC Pelletron Linac facility staff.

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