Study of magnetic rotation in ^{198}Bi

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Introduction

Magnetic rotation (MR) is a well established mode of nuclear excitation. MR bands, consisting of long regular sequences of strong ΔI = 1 M1 transitions with very weak ΔI = 2 E2 crossovers, were discovered in many near spherical nuclei [1, 2]. These bands are formed by the coupling of particles and holes in high-j orbitals. Angular momenta are generated, in an MR band, by shears mechanism with step-by-step alignment of the particle and hole spins into the direction of the total angular momentum which resembles the closing of the blades of a pair of shears. It is thus important to know the particle-hole configuration of an MR band. In mass region A ~ 190 such bands were found in several Pb and Bi isotopes [3-6]. In many cases, however, the excitation energies and definite spin-parities (J^{π}) could not be assigned. So, the configurations could not be established.

In this work, we have studied the high-spin spectroscopy of ^{198}Bi in details with an aim to confirm the proposed MR bands in this nucleus [6] which were not connected to the low lying states [7] and to search for other MR bands.

Experimental Details

Excited states in ^{198}Bi were populated via the fusion-evaporation reactions ^{nat}Re(^{16}O,xn) at 112.5 MeV using ^{16}O beam from the 15-UD Pelletron at IUAC, New Delhi. The γ-rays were detected in INGA [8]. Specific details of the experiment have already been given in ref. [9]. The level scheme was constructed from the analysis of γ–γ matrix and γ–γ–γ cubes. The sum gated spectra with gates put on known transitions of ^{198}Bi are shown in Fig. 1. The J^{π} assignment of states has been done from the type (E/M) and multipolarity of the emitted γ-rays deduced from the DCO and polarization data.

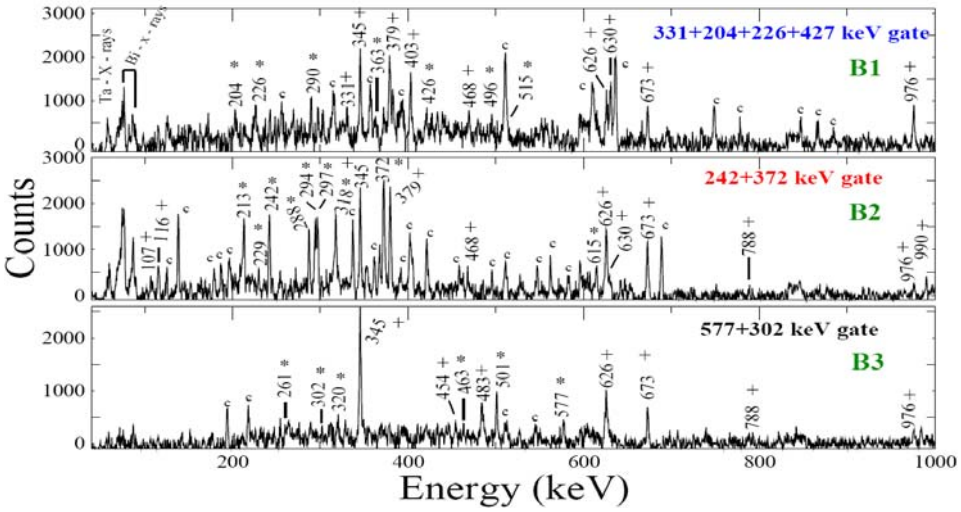

Fig. 1: *Gated γ-ray spectra of ^{198}Bi. Several gates on in-band transitions are summed.*

Results and Discussion

The preliminary level scheme of ^{198}Bi established from the present work is shown in Fig. 2. The previously known [6] three MR bands (namely B1, B2 and B3) have been firmly assigned to ^{198}Bi from coincidence analysis.

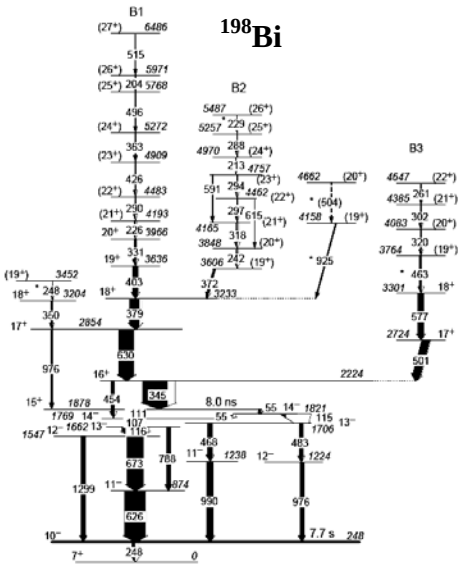

Fig. 2: *Preliminary level scheme of ^{198}Bi obtained from the present work. The * indicates the new γ-rays.*

The γ-rays from these bands are observed clearly in Fig. 1 in coincidence with the known low-lying γ-rays. The peaks marked by * and + belong to the MR bands and the previously known lower-lying states in ^{198}Bi respectively. Contaminated γ rays are indicated by c. From the intensity balance some of the levels have been reordered. The band head spins (with tentative parity assignment) are proposed for the MR bands as 20^+, 18^+ and 16^+ for B1, B2 and B3 respectively from the measured DCO ratios.

The $h_{9/2,}$ $i_{13/2}$ and $s_{1/2}$ orbitals for protons while $i_{13/2}$, $f_{5/2}$ and $p_{3/2}$ orbitals for neutrons are available near the Fermi surface. The I vs. ħω plots, shown in Fig. 3, indicate the similarities between the MR bands in ^{198}Bi with the odd-A neighbors ^{197}Pb and ^{197}Bi. By comparison, the configurations of the MR bands in ^{198}Bi are tentatively assigned as $\pi(h_{9/2}i_{13/2}s^{-1}{}_{1/2})\otimes\nu(i^{-2}{}_{13/2}f_{5/2})$ for B1, $\pi(i_{13/2}h^2{}_{9/2})\otimes\nu(i_{13/2}f^2{}_{5/2})$ for B2 and $(h_{9/2}i_{13/2}s^{-1}{}_{1/2})\otimes\nu(i^{-2}{}_{13/2}p_{3/2})$ for B3. The parity of the bands (from the polarization ratios) are needed to confirm this. This work is in progress.

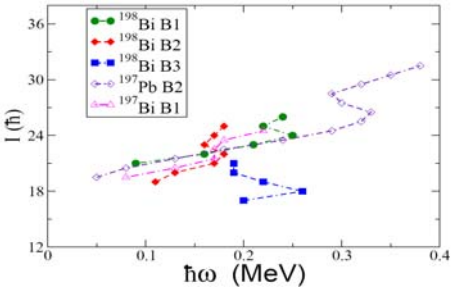

Fig. 3: *I (spin) vs. ħω (rotational frequency) plot for the MR bands in ^{197,198}Bi and ^{197}Pb.*

Summary

In summary, we have investigated the level scheme of ^{198}Bi using the INGA detector array. The excitation energies and J^π assignments have been established for the proposed MR bands in this nucleus, for the first time. On the basis of the systematics we have also assigned tentative configurations for the three MR bands.

Acknowledgement

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