^{185}Pt のインビームガンマ線分光
In-Beam Gamma Spectroscopy of ^{185}Pt

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Abstract: High-spin states in ^{185}Pt have been populated via the ^{173}Yb(^{16}O,4n)^{185}Pt reaction at a beam energy of 90 MeV. Level scheme of ^{185}Pt is extended and revised significantly, and evidence is presented for a $\pi h_{9/2}$ alignment at very low frequency in the $\nu 9/2^{+}$[624] and $7/2^{-}$[503] bands. The proton nature of the band crossing is strongly suggested by comparing the measured $B(M1;I\rightarrow I\text{-}1)/B(E2;I\rightarrow I\text{-}2)$ ratios with the theoretical values from the semi-classical Donau and Frauendof approach.

Keywords: in-beam γ-spectroscopy, rotational bands, band crossing

1. Purpose

For the Ir-Pt-Au nuclei with neutron number N=106-108, there exists a very interesting phenomenon concerning the nature of the band crossing [1-3]. The first band crossing for the neutron-deficient prolate Ir-Pt-Au nuclei with neutron number less than 106 clearly results from the alignment of a pair of $i_{13/2}$ quasi-neutrons. However, there has been much debate about the nature of the first crossing at N=106-108. In these isotopes, the rotational bands, not involving $i_{13/2}$ neutrons or $h_{9/2}$ protons, show at least one but in certain cases two distinguishable band crossings below $\hbar\omega \approx 0.35$ MeV [1]. These bands have been observed experimentally up to very high frequencies and the alignment gain after the band crossing approaches 10.0 ħ. The observed band crossings and alignment gains have been explained successfully using two very different scenarios. In the first scenario, it is assumed that all the bands have similar deformations, and therefore standard blocking arguments were used [1-3]. The conclusion is that the alignment of $h_{9/2}$ protons plays a crucial role at frequencies below 0.35 MeV. In the second scenario, the band crossings have been interpreted to be deformation dependent. The cranked shell model calculations show that a given band crossing might appear at very different frequency depending on the deformation of the considered configuration. Thus, nearly all band crossings are explained as the alignment of $i_{13/2}$ neutrons, and the alignment of $h_{9/2}$ protons is only responsible for exceptional cases [1-3]. In order to settle this dispute, detailed experimental information concerning the band properties is needed. As well known, the ratios of reduced transition probabilities $B(M1;I\rightarrow I\text{-}1)/B(E2;I\rightarrow I\text{-}2)$ are sensitive to the quasi-particle configurations below and above the band crossing. Because of the opposite signs of the proton versus neutron g factors, the proton alignment in a band based on neutron configuration usually results in an increase in the $B(M1)$ value, while a neutron alignment has the opposite effect. The converse is also true for a band associated with proton configuration. With the modern powerful γ detector array, we can obtain very high statistic data from which precise *B(M1;I→I-1)/B(E2;I→I-2)* ratios can be extracted. This could help us to classify the nature of the low-frequency band crossings in the Ir-Pt-Au nuclei with neutron number around 108.

2. Methods

The experiments have been performed in the Japan Atomic Energy Agency (JAEA). The $^{173}Yb(^{16}O,4n)^{185}Pt$ reaction was used to populate the high-spin states of ^{185}Pt with the ^{16}O beam of about 1 pnA provided by the tandem accelerator in JAEA. The γ-ray detector array GEMINI composed of 12 Compton suppressed Ge detectors at the time of the present experiment was used. A total of 1.8×10^8 γ-γ coincidence events was accumulated. These coincidence events were sorted into a symmetric and a non-symmetric (DCO sorting) matrices for off-line analysis.

3. Results

In comparison with the previous studies [2], the level scheme of ^{185}Pt has been extended and modified significantly. The rotational band based on the $\nu 9/2^+[624]$ configuration has been confirmed. The inter-band M1 transitions in the $7/2^-[503]$ band has been observed, and this enable us to extract the *B(M1;I→I-1)/B(E2;I→I-2)* ratios. The $1/2^-[521]$ band was extended to very high-spin states, and two band-crossings have been identified.

4. Discussions

The *B(M1)/B(E2)* ratios for a coupled band have been proven to be quite useful in characterizing the specific intrinsic orbit and the quasi-particles associated with band crossing. Information concerning the quasi-particle makeup of the $7/2^-[503]$ band can be obtained by comparing theoretical *B(M1)/B(E2)* values with experimental ones. The experimental *B(M1)/B(E2)* ratios have been deduced from the measured transition intensities, and theoretical estimates were obtained from semi classical formulae [2]. The experimental *B(M1)/B(E2)* ratios for the $7/2^-[503]$ band show a pronounced increase in the band crossing region. In the mass region of the present interest, the $i_{13/2}$ neutrons and $h_{9/2}$ protons should be responsible for the band crossing. Due to the opposite signs of the proton versus neutron *g* factors, the $h_{9/2}$ proton alignment in the $\nu 7/2^-[503]$ band should lead to an increase in the B(M1) value, while the $i_{13/2}$ neutron alignment has the opposite effect. Therefore, the experimentally observed increase in the *B(M1)/B(E2)* ratios strongly suggest that the band crossing in the $\nu 7/2^-[503]$ band is due to the $h_{9/2}$ proton alignment. The two band-crossings in the $1/2^-[521]$ band might be caused by the alignments of $i_{13/2}$ neutrons and $h_{9/2}$ protons.

In order to have a deeper understanding of the band structures in ^{185}Pt, we will perform cranked-shell-model (CSM) calculations by means of Total-Routhian-Surface (TRS) method in the three-dimensional deformation β_2, β_4, and γ space. The data analysis and theoretical calculations are in good progress.

5. References

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