In-Beam Gamma Spectroscopy of ^{168}Ta and ^{173}W

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Abstract: High-spin states in ^{168}Ta and ^{173}W have been populated via the ^{145}Nd(^{27}Al,4n)^{168}Ta and ^{150}Nd(^{28}Si,5n)^{173}W reactions. Level schemes of ^{168}T and ^{173}W are extended and modified significantly, and signature inversion is observed in the $\nu 5/2^-[512]$ band of ^{173}W.

Keywords: high-spin states, in-beam γ-spectroscopy, rotational bands, signature inversion

1. Purpose

Present investigations are continuous efforts to study the band structures of odd-odd nuclei in the mass-170 region using the γ detector array in JAEA. Prior to this work, only limited high-spin data exist in ^{168}Ta [1]. A previous study for ^{174}Re [2] has led to identification of a new band in ^{174}Re. This band is most probably built on the $\pi 1/2^-[541]\otimes\nu 5/2^-[512]$ configuration, and it shows characterestics of low-spin signature. In order to understand the inversion phenomenon in this new configuration, it is needed to know the signature splitting behavior of the $\nu 5/2^-[512]$ quasi-neutron bands in the neighboring nuclei. With this in mind, we have carried out experiments to study the high-spin band structures in ^{168}Ta and ^{173}W.

2. Methods

The experiments have been performed in the Japan Atomic Energy Agency (JAEA). The ^{145}Nd(^{27}Al,4n)^{168}Ta and ^{150}Nd(^{28}Si,5n)^{173}W reactions were used to populate the high-spin states of ^{168}Ta with the ^{27}Al and ^{28}Si beams of 1 pnA provided by the tandem accelerator in JAEA. The γ-ray detector array GEMINI composed of 12~19 Compton suppressed Ge detectors was used. A total of 1.7×10^8 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 [1,3], the level schemes of ^{168}Ta and ^{173}W have been extended and modified significantly. In particular, low-spin signature inversion has been observed in the $\nu 5/2^-[512]$ band of ^{173}W. This indicates that the low-spin signature inversion in the $\pi 1/2^-[541]\otimes\nu 5/2^-[512]$ band may be a consequence of anomalous signature splitting of the $\nu 5/2^-[512]$ band. The $\pi 1/2^-[541]\otimes\nu i_{13/2}$ semi-decoupled band in ^{168}Ta has not been found in the present datum-set. We therefore conclude that this band should be far off the yrast line.

4. Discussions

An important issue from present investigations may be the observation of low-spin signature inversion in the $\nu 5/2^-[512]$ band of ^{173}W. As is well known, the low-spin signature inversion has been observed in a number of two-quasiparticle bands of odd-odd nuclei in this mass region. Several theoretical attempts have been made suggesting that the nuclear triaxiality, proton-neutron residual interactions, band crossings, band mixing, quadrupole pairing, and the combined effects could be possible reasons for the inversion phenomenon. However, no conclusive explanation has been made so far. The inversion phenomenon has also been observed in some odd-Z nuclei, but in these cases, signature inversion occurs at higher rotational frequencies beyond bandcrossing.

The present result provides an interesting testing ground for different theoretical approaches. For instance, one may disregard the effects of proton-neutron residual interactions in such a one-quasiparticle band. Furthermore, the nuclear triaxiality should be of less importance for the inversion phenomenon since the $\nu i_{13/2}$ band in the same nucleus has normal signature splitting. Given the fact that the $\nu 5/2^-[512]$ and $\nu 5/2^-[523]$ Nilsson orbitals have strong interactions, the configuration mixing may play an important role for the low-spin signature inversion in the $\nu 5/2^-[512]$ band of ^{173}W. This is in need of further theoretical investigations

5. References

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