Signature Effects of Three-quasiparticle Band in ^{165}W

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In this paper, we present three-quasiparticle-plus-rotor Coriolis coupling calculations for the explanation of signature effects observed in a three-quasiparticle (3QP) rotational band $\frac{3}{2}[521]_\nu \otimes \frac{3}{2}[651]_\nu \otimes \frac{3}{2}[651]_\nu$ in ^{165}W. We successfully reproduce signature effects which confirm the validity of our model [1-3]. We also highlight the various causes responsible for these signature effects and also discuss various issues involved in these calculations.

In order to explain the observed signature effects in ^{165}W, we have carried out the three-quasiparticle-plus-rotor Coriolis mixing calculations. The single particle (s.p.) wave functions have been obtained by using the Nilsson model with deformation parameters as ε_2=0.158, ε_4=-0.007 [4] and Nilsson model parameters as κ=0.0636, μ=0.393 [5]. We have not tried to fit the whole band except for a reduction of $\left\langle j'm' \middle| J_+ \middle| jm \right\rangle$ matrix elements within meaningful limits and minor variation of the inertia parameter of the bands having major contribution to a given 3QP band. The results are presented in Fig. 1(a-d) for all the four members of the given 3QP configuration. The features we have extracted from the Coriolis calculations for all the four members of a given quadruplet are discussed below:

1. $K^\pi = \frac{9}{2}^- : \frac{3}{2}[521]_\nu \otimes \frac{3}{2}[651]_\nu \otimes \frac{3}{2}[651]_\nu$ band

The staggering pattern for this band is presented in Fig. 1(a). According to our Coriolis calculations, staggering pattern is not very regular over a large spin range.

2. $K^\pi = \frac{3}{2}^- : \frac{3}{2}[521]_\nu \otimes \frac{3}{2}[651]_\nu \otimes \frac{3}{2}[651]_\nu$ band

This member of the 3qp quadruplet has been observed experimentally in the spin range I=25/2$^-$ to 59/2$^-$ [6] and exhibits a signature inversion at I=39/2$^-$. From Fig. 1(b), it is clear that the phase of staggering as well as signature inversion for this band has been successfully reproduced by our model. On the basis of the phase of staggering (Fig. 1(b)), we assign $K^\pi = \left|\frac{3}{2} + \frac{3}{2} - \frac{3}{2}\right| = \frac{3}{2}^-$ band-head spin to this band. Experimental data are shown by the dotted line and the calculated results are shown by the solid line. Our calculations shows the point of inversion at I=35/2$^-$(indicated by solid arrow in Fig. 1(b)), which is two units lower than the experimental point of inversion (I=39/2$^-$; indicated by dotted arrow in Fig. 1(b)). Secondly the magnitude of staggering at higher spin value is large as compared to the experimental observation. These two inconsistencies in the calculations are mainly due to the non-availability of experimental data (band-head energies and inertia parameter) for all the interacting bands. In Fig. 1(e) we have shown the results for this band without any fitting except for a 45% reduction of the $i_{13/2}$ matrix elements and a 10% reduction of other matrix elements. From Fig.1 (e), it is clear that the phase as well as the point of inversion is exactly the same as the experimental observation, which confirms the validity of our model for reproduction of signature splitting as well as signature inversion in 3QP rotational bands. No doubt the magnitude of staggering in these calculations (Fig.1 (e)) is large as compared to the experimental data, but it can be reduced by minor variations of the inertia parameters as shown in Fig. 1(b).

3. $K^\pi = \frac{3}{2}^-, \frac{3}{2}^- : \frac{3}{2}[521]_\nu \otimes \frac{3}{2}[651]_\nu \otimes \frac{3}{2}[651]_\nu$ bands

The staggering patterns for these bands are presented in Fig. 1(c-d). According to the

Coriolis calculations, staggering pattern is regular at higher spin values for these bands.

From the present three-quasiparticle-plus-rotor Coriolis mixing calculations, we conclude that that rotor-particle coupling terms play a major role for the explanation of observed signature effects in a 3QP rotational band of ^{165}W.

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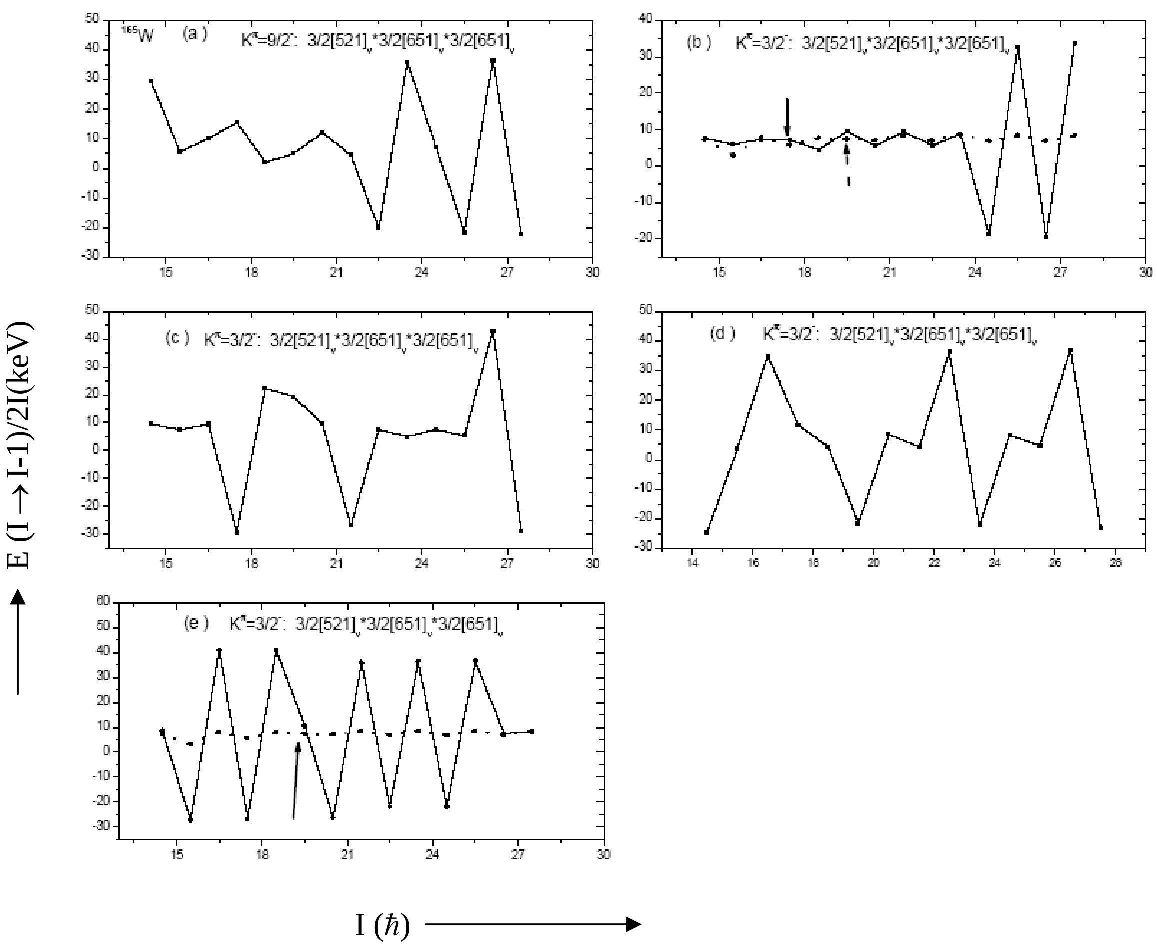

Fig.1(a-e). Results of the three-quasiparticle-plus-rotor Coriolis mixing calculations for ^{165}W. The calculations are represented by the solid lines and the experimental data by the dotted lines. Arrow indicates the point of inversion.