Application of top-on-top model to $11/2^-$ band in ^{135}Pr[†]

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We have proved that a transverse wobbling mode does not exist in the particle-rotor model with hydrodynamical moment of inertia (MoI).1) Consequently, stable rotation around the middle MoI does not exist in the particle-rotor model as well as in the pure rotor case. Then, a question arises as to how the experimental data of the $11/2^-$ band in ^{135}Pr2) can be explained. This yrast $11/2^-$ band starts near the ground state and shows backbending thrice,3) and the levels discussed in Ref. 2 are concerned with those before the first backbending. Thus, the pairing effect is essentially important in such low-excitation states. We have proposed an analytic formula for the angular-momentum (I) dependence of MoI originating from the Coriolis anti-pairing effect (CAP).4) This formula is derived from the second-order perturbation to the Coriolis term in the self-consistent HFB equation under I and nucleon-number constraints. The I dependence of the MoI is related to the rigid MoI with a functional dependence of the pairing gap together with the blocking effect. We have also achieved good success with the top-on-top model, i.e., the particle-rotor model with the I-dependent rigid MoI, for the high spin and highly excited levels in Lu isotopes in describing not only the energy scheme but also the electromagnetic transitions $B(E2)$ and $B(M1)$.5–7) Similarly, we apply the top-on-top model for the $11/2^-$ band in ^{135}Pr. In reference to the I-dependence curve as displayed in Fig. 9 in Ref. 4, we assume a simplified functional form for the I dependence of MoI for those low-excitation levels,

$$\frac{\mathcal{J}_0}{1+\exp(-(I-b)/a)}. \tag{1}$$

We choose two parameters $a = 7.5$ and $b = 15.5$. The asymptotic value of the MoI in the limit of $I \to \infty$ is assumed to be $\mathcal{J}_0 = 25\ \mathrm{MeV}^{-1}$, and the deformation parameters $\beta_2 = 0.18$ and $\gamma = 18°$.

In Fig. 1, we compare $E(I) - 0.02I(I+1)$ as functions of I between theoretical values and experimental ones2). The theoretical value is normalized at $I = 11/2$ in Band 1 where $I - j$ is even, while Bands 2 and 4 have odd values of $I - j$. For the backbending curve of Band 1, we choose a larger $\mathcal{J}_0 = 35\ \mathrm{MeV}^{-1}$, which reproduces the experimental data from I=35/2 up to 57/2, indicating the CAP effect is well simulated by two common parameters a and b. The energies of $E(I) - 0.02I(I+1)$ are not sensitive to γ, but $\gamma = 18°$ seems to be favorable mainly from the electromagnetic transitions. It also gives good fit to the experimental data2) not only in the electomagnetic transition rates but also in the mixing ratio δ.

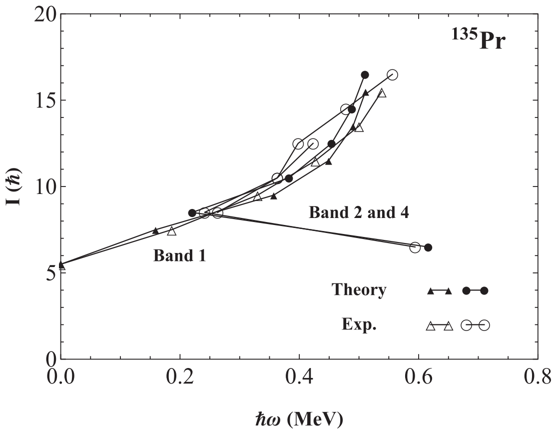

Fig. 1. Comparison of $E(I)-0.02I(I+1)$ between theoretical results and experimental data in Ref.2). Theoretical values are shown by filled triangles for Band 1 and filled circles for Bands 2 and 4, while experimental data are shown for Band 1 by open triangles and for Bands 2 and 4 by open circles. Band 2 is from I=13/2 to 25/2, while Band 4 is from I=17/2 to 33/2.

In conclusion, the experimental data of the $11/2^-$ band in ^{135}Pr2) is interpreted as the normal wobbling band influenced by the CAP effect, rather than the transverse wobbling mode. We point out a possibility of the violation of Bohr symmetry to a small extent, which explains the existence of Band 2, i.e., the signature partner band.

References

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