Reply to the Comment on "I = 4 bifurcation in ground bands of even-even nuclei and the Interacting Boson Model"

H. Toki and L. A. Wu
Research Center for Nuclear Physics, Osaka University,
Ibaraki, Osaka 567-0047, Japan
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Kuyucak and Stuchbery (KS) comment on our study on the I = 4 bifurcation phenomena in the ground rotational band \cite{1} from both the experimental and the theoretical sides \cite{2}. Although there exist some interesting systematics in the existing experimental data, which are discussed in detail in our second paper \cite{3}, we have to wait for more precise experiments for the definite evidence of these interesting phenomena.

The main aim of our study \cite{1,3} was to show that there exists the mechanism to provide the I = 4 bifurcation phenomenon in the simplest version of IBA, the IBM-1. The existence of the staggering pattern depends only on the geometrical features of IBM, the boson number N being finite and \( > \frac{1}{2} \). The large value for \( > \frac{1}{2} \) was questioned in the comment \cite{2}. The large value was used, however, by various authors in the literature \cite{4,5,6}. The consequence of the use of the actual value for \( > \frac{1}{2} \) by Toki and Wu \cite{1,3} on the beta and the gamma bands is discussed by Kuy et al. using the quadrupole Hamiltonian \cite{2}. We should, however, be aware of the fact that there exist many Hamiltonians which can give the same value for \( > \frac{1}{2} \), but do not provide the same spectra.

In fact, our Hamiltonian (used in Fig. 6 of \cite{3}) is in very good agreement with the experimental systematics not only for the ground band but also for
the beta and the gamma bands. The reasonable yrast spectra and the suitable amplitude for the staggering are obtained as seen in Fig. 6 of ref. [3]. We have performed the full diagonalization calculations using the computer code (PHINT) also for the beta and the gamma bands. We get very reasonable values for $R$ value, which ranges from 0.76 to 1.53, and $R$ from 1.12 to 1.98 for boson number $N$ changed from 4 to 14. This is almost in perfect agreement with the experimental systematics as seen in Fig. 1 of Ref. [2]. These values are much better than those of the SU(3) limit, which gives $R$ and $R$ approximately 2.5.

Concerning the E2 transitions, we have one more free parameter. We may take smaller in eq. (4) of [2] to reduce the value of $R$ in Ref. [2].

We want to make one comment on the quadrupole Hamiltonian for the case of the large beta deformation. The exact diagonalization (PHINT) provides totally different results than the approximate ones using the $1N$ expansion [3]. The amount of the staggering comes out to be 20 keV instead of 0.5 keV of the experimental data with [3] of Ref. [3]. In order to get the small value for the staggering, one should take a much smaller , which should be 18. However, the bandheads are still higher than the experimental systematics. This was the reason why we did not use the popular quadrupole formalism in our papers [1,3].

References

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