MASTER

**SOME QUESTIONS ON THE CORIOLIS FORCE,
THE STRUCTURE OF ROTATIONAL STATES AND THE IBM**

by
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The charge to panel members of the Round Table Discussion was to make editorial comments on what transpired during the conference. In response, I would like to raise a few questions which I feel were not addressed during the meeting. Among these are: what is the relationship between the nucleon-nucleon interaction and the Coriolis force, and what is the microscopic origin of rotational and vibrational states? In addition, I shall make a few remarks concerning the interacting boson model.

ON THE CORIOLIS FORCE IN ROTATING NUCLEI

In the past few years, we have recognized the pervasive role which the Coriolis force plays¹⁾ in determining the structure of nuclear states — as has been amply pointed out at this conference. If one adopts the attitude that all nuclear phenomena can ultimately be attributed to the nucleon-nucleon interaction, one could then ask what the relationship is between this interaction and the Coriolis force. One might also try to identify the connection between the Coriolis force and particle-vibration (or fermion-boson) coupling. Understanding this connection will probably elucidate the nature of the transition from spherical to deformed shapes. On one hand the particle-vibration coupling plays an important role as one departs from sphericity; on the other, the Coriolis interaction has an increasingly dominant role as the deformation decreases towards sphericity.

ON THE MICROSCOPIC ORIGIN OF ROTATIONAL STATES

The occurrence of rotational states in nuclei has been accepted for a long time, but the microscopic structure of these states has yet to be fully understood. While the rotational and also vibrational bosons are evidently formed by combinations of pairs of fermions, it is not clear — at least to me — what singles out from the whole fermion space that subset which constitutes the vibrational and rotational excitations. The evolution from vibrational to rotational bosons is also still an open problem.

A related, but more specific, question concerns the structure of collective states built on high- K ($K \gtrsim 10$) states with either prolate or oblate cores. The aligned particle spin in this case has large projection, K , along the symmetry axis, whereas the rotational vector points perpendicular to this axis. Thus there can be significant components of angular momentum along two principal axes. How can this fact be incorporated in the present calculations²⁾ of high spin states which treat angular momentum along only one principal axis? One might also ask about the role of vibrational structures built on high- K states since at high spin, and in particular for oblate shapes, the $\Delta I = 2$ spacing could be comparable for rotational and vibrational structures.

ON THE INTERACTING BOSON MODEL (IBM)

At this meeting, we have learned about the many recent advances of the IBM. A question often asked is whether there is any new physics introduced by the IBM regarding nuclear structure. In the sense that the IBM describes the same physical observables as other phenomenological models, one could say that there is no new physics and that it represents a different mathematical approach. It is more than that in my opinion. In one way, it is more fundamental: starting from boson energies and boson-boson interactions (which, however, have so far been fitted as parameters rather than calculated a priori), it can describe collective aspects of all nuclei – spherical, transitional or deformed – in one uniform framework. This unified approach may hopefully also lead to new insights into the structure of vibrational and rotational bosons, in particular the evolution from one to the other.

Since nuclear structure is governed not only by collective degrees of freedom (bosons) but to a large extent by fermion degrees as well, the recent development of the interacting boson-fermion model (IBFM)³⁾ is an important unifying step. I am particularly impressed by the ability of the model – through the interplay between quadrupole and exchange terms – to reproduce features normally attributed to the Coriolis force in the rotational model. Perhaps this development will shed light on the questions concerning the Coriolis interaction mentioned above.

With the inclusion of both fermion and boson excitations, a natural test of the model will be its ability to predict when one degree of freedom plays a more important role than the other. For example, it will be of interest to use the IBFM to examine how far one needs to go from closed shells before boson excitations dominate the structure of even nuclei.

In a large class of nuclei, there is an evolution with increasing spin along the yrast line from boson to fermion excitations. Examples are the transitions from rotational to decoupled states in backbenders or from vibrational to aligned particle states just outside closed shells. It will be a stringent test of the IBFM to describe this changing character. In nuclei near closed shells, I suspect that the single particle structures may again give way to collective structures along the yrast line at very high spins. What are the IBFM predictions concerning this point?

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- 1) F. S. Stephens, Rev. Mod. Phys. 47 (1975) 43.
- 2) I. Ragnarsson, Talk presented at this conference.
- 3) F. Iachello and O. Schotén, Phys. Rev. Lett. 43 (1979) 679; F. Iachello, Talk presented at this conference.