Contribution ID: **11** Type: **Oral**

Estimates of the structure of yrast band states via the phenomenology of Harris and IBM

Saturday 5 July 2025 17:10 (30 minutes)

Representing the energies of collective states in terms of effective moments of inertia has the advantage of revealing subtle energy changes in the bands as the spin increases. This is convenient not only for the crossing of bands analysis, manifested through backbending, but in almost all cases. If the crossing of bands in the IBM approximation is described only through the expansion of the latter, by introducing high-spin bosons [1], then the parabolic increase in the moment of inertia with an increase in the rotation frequency or spin of the collective state is also reproduced in the traditional IBM phenomenology. IBM has a group-theoretical justification. The most important basis for which is the assumption of the closedness of the algebra of phonon operators and their commutators. When mapping these operators onto ideal bosons while maintaining the closedness condition of already boson operators, a condition arises for the finiteness of the maximum number of quadrupole bosons Ω and the presence of roots, which are conveniently represented through s-bosons. In the IBM, called IBM phenomenology, the model parameters are selected based only on the best agreement between the calculated and experimental data. The IBM phenomenology, but not in the case of the $SU(3)$ limit, reproduces the fact that even in nuclei with rigid deformation the energies of states grow more slowly than the dependence $I(I+1)$ gives. It is reflected in the nature of the function describing the dependence of the moment of inertia on the square of the rotation frequency (linear or parabolic [2]). Moreover, the nature of this function depends on the parameters of the IBM Hamiltonian. The parabolic case can lead to upbending. Also, upbending can be a specific manifestation of the bands crossing. Moreover, as was shown for ^{222}Th, the bands crossing can occur without this being clearly manifested in the moments of inertia [3]. From comparing the experimental data with the moments of inertia obtained in the Harris scheme, within the framework of expanded by high-spin modes IBM, it is possible to determine from which spins the main component of the wave function ceases to be collective or defined only by d-bosons.

There is one more phenomenon that cannot be reproduced in the Harris model. This is some additional growth of energies of collective states. For moments of inertia, this corresponds to the cessation of growth of the moment of inertia from the rotation frequency or a strong weakening of its growth. In heavy nuclei, if this is realized, then starting from the spin $I \geq 28^+$. It would seem that this is rather strange and the exact opposite was expected due to the growing influence of high-spin modes on collective states with increasing spin. It turned out that this effect is associated with the dynamics of collective states and manifests itself depending on the choice of the maximum number of Ω and is stronger the smaller this number. Thus, this effect, which we called downbending, is a strong criterion for determining the Ω. So for ^{234}U, where states before spin $I = 30^+$ are observed the optimal one turned out to be $\Omega = 22$ and for for ^{238}U, where states before the spin $I = 34^+$ are observed, $\Omega = 25$ turned out to be optimal. The described method of comparing experimental energies with the indicated phenomenological approaches, on the one hand, reveals a number of effects, and on the other, is an extremely useful aid in carrying out microscopic calculations of the structure of the states of yrast bands.

1. A.D. Efimov, I.N. Izosimov, Phys. At. Nucl. 8, 333 (2023).
2. A.D. Efimov et al., JINR Preprint E4-2024-61 (JINR, Dubna, 2024).
3. A.D. Efimov, I.N. Izosimov, JINR Preprint E4-2024-27 (JINR, Dubna, 2024).
4. S. M. Harris, Phys. Rev. B **138**, 509 (1965).

Primary author: EFIMOV, Alexander (Admiral Makarov State University of Maritime and Inland Shipping, St. Petersburg, Russia; Ioffe Physical-Technical Institute, Russian Academy of Sciences, St. Petersburg, Russia.)

Co-authors: Prof. IZOSIMOV, Igor (Joint Institute for Nuclear Research, Dubna, Russia. E-mail: izosimov@jinr.ru); Ms KOVAL, Ilona (1Admiral Makarov State University of Maritime and Inland Shipping, St. Petersburg, Russia)

Presenter: EFIMOV, Alexander (Admiral Makarov State University of Maritime and Inland Shipping, St. Petersburg, Russia; Ioffe Physical-Technical Institute, Russian Academy of Sciences, St. Petersburg, Russia.)

Session Classification: 1. Experimental and theoretical studies of nuclei

Track Classification: Section 1. Experimental and theoretical studies of nuclei.