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Davydov A S & Filippov G F. Rotational states in even atomic nuclei.
Nucl. Phys. 8:237-49, 1958.
[Moscow State University, USSR]

A theory of the energy states and the electromagnetic transitions between them is developed for nuclei that do not possess axial symmetry. It is shown that violation of axial symmetry does not significantly change the rotational states of axial nuclei and leads to the appearance of new energy states. The reduced probabilities for E2 transitions between various rotational states are computed. [The *SCI*® indicates that this paper has been cited in over 490 publications since 1958.]

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In 1956-1957 one of us (G.F.F.) was doing scientific research on collective excitations of nonspheric atomic nuclei that was led by the other (A.S.D.). The work of A. Bohr and B. Mottelson,[1] who suggested the axial rotator model, had been acknowledged, and physicists had gradually become accustomed to treating the ratios between the energies of different rotation band states as a direct verification of axial symmetry of nonspheric nuclei. But we argued it was really not so, since simple correlations typical for the axial rotator were violated in rotational excitations of some nonspheric nuclei. Therefore, we decided to check whether a hypothesis concerning nonaxiality of the shape of nonspheric atomic nuclei is consistent with experimental data.

We soon arrived at the conclusion that even significant nonaxiality produces no change in the properties of low states of the main rotation band of an axial rotator model and introduces corrections noticeable only for rotational excitations with large angular momenta. These corrections excuse to some extent the deviations of the results of an axial rotator model from experimental ones. Besides, it was nonaxiality that immediately proved the existence of the other rotational bands (except the main one), which are termed the anomalous bands. The nonaxial rotator model summed up our research. It was first published in the Soviet *Journal of Experimental and Theoretical Physics*[2] and then in *Nuclear Physics*.

The nonaxial rotator model was opposed by theorists who debated mainly the existence of a stable nonaxial shape for atomic nuclei. The essence of the answer was as follows: nonaxiality of many nuclei may not be static but dynamic—it originates from zero vibrations of the nucleus relative to the axial symmetry equilibrium shape.[3] However, at that time we couldn't give an exhaustive answer to our opponents based on correct theoretical research. To this end, we extended the framework of phenomenologic models and employed more fundamental microscopic approaches. The corresponding analysis, carried out many years later by Filippov, showed that nonaxiality is the property of atomic nuclei as usual for them as nonsphericity.[4] Experimental verification of the model at the time we proposed it could not be sufficiently completed. The tables of rotational states of atomic nuclei that are now available were not at the disposal of experimenters in those years; therefore, a thorough comparison of model and experiment was delayed for many years. Nevertheless, it has just been elucidated that the model successfully reproduced the properties of rotational excitations of isotopes of many nuclei (in particular, osmium and tungsten). (See, for example, reference 5.) It describes quite satisfactorily the probabilities of electromagnetic transition (measured experimentally) between rotational excitations of many nuclei.

We think that this paper has been frequently cited because the phenomenologic model elaborated in it manages to display the important and the most general regularities of excitation spectra of atomic nuclei. The nonaxial rotator model is also well known because of its extreme simplicity and clearness, and this allows one to employ it when there is no need for the description of a great number of details that, in the long run, only conceal the principal features of the considered phenomenon.

1. **Bohr A & Mottelson B.** Collective and individual aspects of nuclear structure. (Whole issue.) *Mat. Fys. Medd. Dan. Vid. Selsk.* 27(16). 1953. 174 p. (Cited 1,790 times since 1955.)
2. **Davydov A S & Filippov G F.** Rotational states of nonaxial nuclei. *Sov. Phys. JETP* 35:303-8, 1959. (Translated from *Zh. Eksp. Teor. Fiz.* 35:440-7, 1958.) (Cited 110 times.)
3. **Davydov A S.** *Excitation states of atomic nuclei.* Moscow: Atomizdat, 1967. 264 p.
4. **Filippov G F, Ovcharenko V I & Smirnov I F.** *Microscopic theory of collective excitations of atomic nuclei.* Kiev: Naukova Dumka, 1981. 368 p.
5. **Gupta K K, Varshney V P & Gupta D K.** Experimental evidence in support of triaxial shape of $^{150,152,154}Sm$ nuclei. *Phys. Rev. C—Nucl. Phys.* 26:685-96, 1982.

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