Int. Workshop “Shapes and Dynamics of Atomic Nuclei: Contemporary Aspects”
ed. Nikolay Minkov, Heron Press, Sofia 2017

Intrinsic Vortical Mode and the Rotational Bands of Well-Deformed Nuclei

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Abstract

The well-known quenching effect of global nuclear rotation on pairing correlations [1] may be described in terms of coupling body-frame rotational and counter-rotating intrinsic currents within the so-called Chandrasekhar S-ellipsoid coupling scheme [2]. In particular it has been demonstrated that the results of Routhian-Hartree-Fock-Bogoliubov calculations may be quantitatively very well reproduced by doubly constrained Hartree-Fock calculations where the constraining operators are a component of the angular momentum and of the so-called Kelvin circulation operators [3]. The Lagrange multiplier of the latter is a given function of the angular velocity of the global rotation [4]. In this work, we take stock on these theoretical results to deduce a sixth-order polynomial expression of the energies within a rotational band of well deformed nuclei. Only two experimental quantities are introduced for each isotope: the intrinsic quadrupole moment and the energy of the first 2^+ state. Calculations have been performed for 52 well deformed (such that $E(4^+)/E(2+) > 3$) rare-earth and 31 actinide nuclei. Results are in excellent agreement up to the rather high spins where other phenomena than Coriolis anti-pairing (CAP) effects start to be effective (see as an example the kinematic moments of inertia vs angular velocity of the ^{240}Pu nucleus on the Figure). Our model, of course, fails whenever some other mechanisms are at work as e.g. in back-bending situations (see on the Figure the well-known ^{162}Er case). Beyond validating its theoretical underlying ansatz, our model can serve as a baseline to visualize the appearance upon increasing the spin, of physical effects other than the CAP phenomenon.

References

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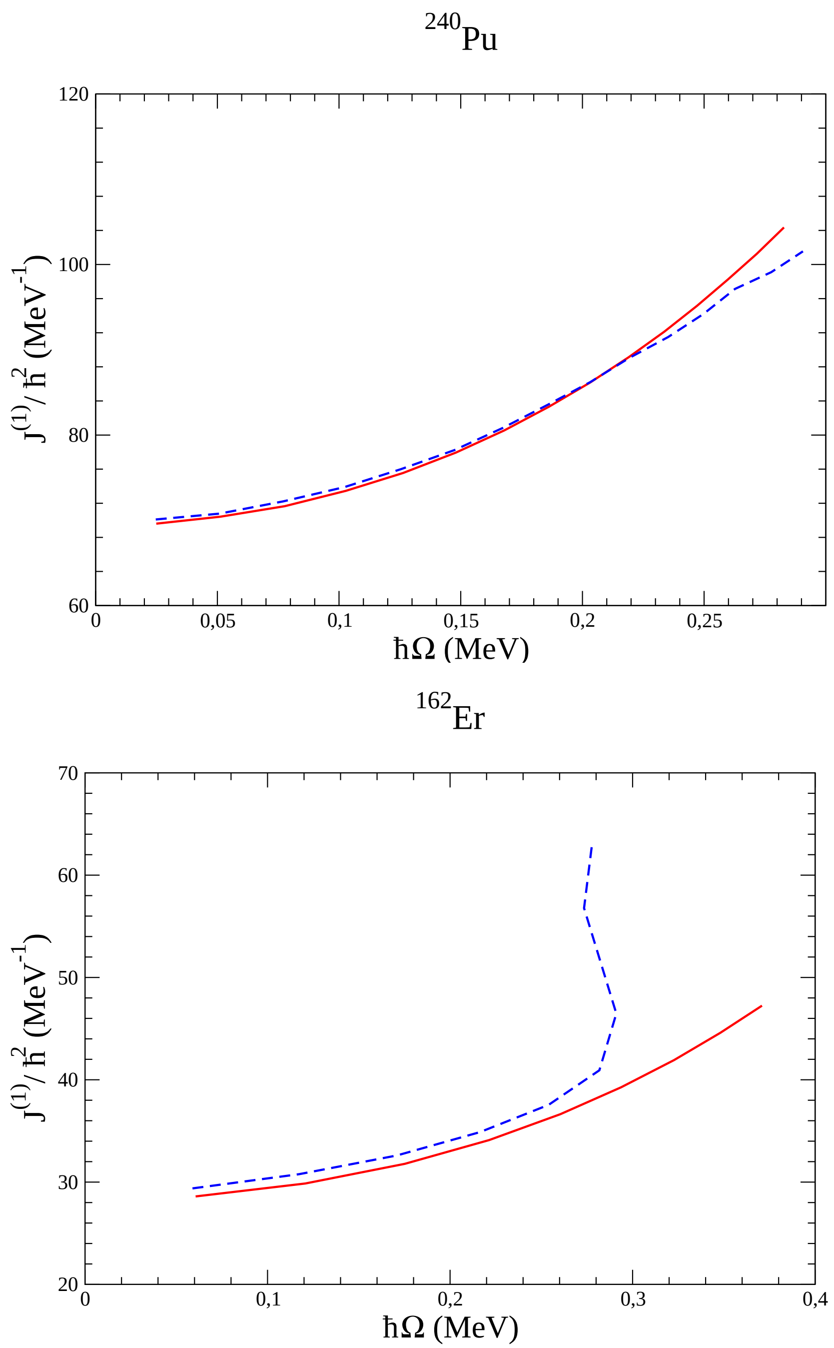

Figure 1. Moment of inertia as a function of the angular velocity (full line: our model, dashed line: experimental data).