Kinetic Energy in the Collective Quadrupole Hamiltonian from the Experimental Data

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In description of collective nuclear dynamics the kinetic energy term with its mass coefficient plays as important role as the potential energy. However, considerably larger progress and understanding were achieved in development of the method of calculation of the potential energy. As for expression for kinetic energy, its important ingredient is a mass tensor. It was known from the general expressions obtained within the Generator coordinate method and Adiabatic Time Dependent Hartree Fock method that the mass tensor has a complicated dependence on collective coordinates. Nevertheless, in practice, it was often assumed that the mass coefficient can be considered as a constant in the analysis of properties of the low-lying excited states. Only in description of nuclear fission where parameters of a nuclear shape undergo considerable variations, dependence of mass coefficient on the deformation parameter was taken into account from the beginning.

Some years ago it was shown based on the experimental data for the excitation energies of the low-lying nuclear excited states and E2 transition probabilities and used in the theoretical analysis that the mass parameter in the Bohr Hamiltonian is, in fact, a tensor depending on the shape variables.

The other important feature of the kinetic energy term is its dependence on the collective momentum. It is usually assumed that it is possible to be limited only by the terms quadratic in collective momentum. However, using the Generator coordinate method or the Generalized density matrix method it is possible to show that the exact expression of the collective Hamiltonian contains all degrees of the square of the collective momentum. We usually neglect terms of the order higher than the square assuming adiabaticity of the collective motion with respect to the single particle one. Nevertheless, it is interesting to obtain some information on the importance of the neglected terms basing on the experimental data. It is one of the aims of the present investigation to estimate the effect of the term in the Hamiltonian which is of the fourth order in the collective momentum.