Investigation of the Role of Leading Anharmonicities in Potential Energy Surface for Quadrupole Degree of Freedom

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We concentrate our attention on the properties of the energies and electromagnetic properties of the one- and two-phonon states. We take into account the third-, fourth- and fifth-order terms in the potential energy surface and compare the qualitative predictions arising from the leading processes, with the results of exact calculation obtained by solving the corresponding Bohr collective Hamiltonian. We take the potential energy surface in the form

$$V(\beta,\gamma)=a_2\beta^2+a_3\beta^3\cos 3\gamma+a_4\beta^4+a_5\beta^5\cos 3\gamma ,$$

The solutions of the Bohr Hamiltonian due to incoherence follow the behaviour of the leading-order processes. The importance of the interferent cubic-quartic terms is stressed. The dominant patterns are summarized in a set of rules. However, this should not be interpreted too rigidly, because sizable contributions are to be expected from higher-order terms in kinetic energy.

For illustration, the partial leading order contributions to the $2_2^+ \to 2_1^+$ transition $\sim a_3$ are 3/70, -1/70, and those $\sim a_3 a_4$ are -297/16, -33/8, 11/8, 189/16, -27/2, -1/2, -21/8, 21/4, 3/4, 1/8, 143/48, -35/48, 21/8, 3/8.