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A microscopic derivation of nuclear collective rotation-vibration model

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We derive a microscopic version of the successful phenomenological hydrodynamic model of Bohr-Davydov-Faessler-Greiner for collective rotation-vibration motion of an axially symmetric deformed nucleus. The derivation is not limited to small oscillation amplitude. The nuclear Schrodinger equation is canonically transformed to collective co-ordinates, which is then linearized using a constrained variational method. The associated constraints are imposed on the wavefunction rather than on the particle co-ordinates. The approach yields three self-consistent, time-reversal invariant, cranking-type Schrodinger equations for the rotation-vibration and intrinsic motions, and a self-consistency equation. For harmonic oscillator mean-field potentials, these equations are solved in closed forms for excitation energy, cut-off angular momentum, and other nuclear properties for the ground-state rotational band in deformed nuclei. The results are compared with measured data.

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