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Collectivity and vibrational-octupole instability in ^{220}Rn and ^{226}Ra

The vibration and rotation modes shed light on collective properties of nuclei. The rotational level patterns in ^{220}Rn and ^{226}Ra nuclei have been obtain in a collective quadrupole+octupole approach with microscopic mass tensor and moments of inertia dependent on deformation and pairing degrees of freedom. However, the main objective is to quantitatively confirm the known experimental facts that the Rn nucleus passes from octupole vibrational to octupole deformed with external rotation, while the Ra nucleus is hardly affected by rotation, being octupole deformed from the beginning.

The collective potential calculated in a nine-dimensional collective coordinate space is determined using the macroscopic-microscopic method with Strutinsky shell correction and the BCS method with particle number projection. The corresponding Hamiltonian is diagonalized based on the projected solutions of the harmonic oscillators coupled with the corresponding Wigner functions. Such an orthogonalised basis is additionally symmetrised with respect to the so-called internal symmetry group, specifically dedicated to the collective space used, to ensure the uniqueness of the solutions of the Hamiltonian with respect to the laboratory frame.

The response of the pairing and deformation degrees of freedom to external rotation is discussed in the variational approach (the total energy is minimised by the pairing and deformation variables). As the nuclear spin increases, the pairing gaps of protons and neutrons decrease from equilibrium values to zero (no superfluid solution). Consequently, the corresponding microscopic moments of inertia increase with increasing collective spin (Coriolis antiparity effect), resulting in effectively lower rotational energy levels Iπ with respect to pure rigid-rotor solution I(I+1) pattern. The overall comparison of experimental and theoretical rotational energy level schemes, dipole, quadrupole and octupole transition probabilities of BE(λ) in ^{220}Rn and ^{226}Ra is satisfactory.

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