Physical Review C 2020 vol.102 N3

Description of the low-lying collective states of Zr 96 based on the collective Bohr Hamiltonian including the triaxiality degree of freedom

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Abstract

© 2020 American Physical Society. Background: Several collective low-lying states are observed in Zr96 whose properties, which include excitation energies and E2, E0, and M1 transition probabilities, indicate that some of them belong to the spherical state and the other to deformed states. A consideration of these data in the full framework of the geometrical collective Model with both intrinsic shape variables, β and γ, and rotational degrees of freedom is necessary for Zr96. Purpose: We investigate the properties of the low-lying collective states of Zr96 based on the five-dimensional geometrical collective model including triaxiality as an active degree of freedom. Method: The quadrupole-collective Bohr Hamiltonian, depending on both β and γ shape variables with a potential having spherical and deformed minima, is applied. The relative depth of two minima, height and width of the barrier, and rigidity of the potential near both minima are determined so as to achieve a satisfactory description of the observed properties of the low-lying collective quadrupole states of Zr96. Results: It is shown that the low-energy structure of Zr96 can be described in a satisfactory way within the geometrical collective model with a potential function supporting shape coexistence without other restrictions on its shape. It is shown that a correct determination of the β dependence of the collective potential from the experimental data requires a consideration in the framework of the full Bohr collective Hamiltonian. It is shown also that the excitation energy of the 22+ state can be reproduced only if the rotation inertia coefficient is taken to be four times smaller than the vibrational one in the region of the deformed well. It is shown also that shell effects are important for the description of the B(M1;22+→21+) and B(M1;31+→21+) transition probabilities. An indication of the influence of the pairing vibrational mode on the 02+→01+ transition is confirmed, in agreement with the previous result. Conclusion: Qualitative agreement with the experimental data on the excitation energies and B(E2) and B(M1;22+→21+) reduced transition probabilities is obtained.

http://dx.doi.org/10.1103/PhysRevC.102.034308

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