

Phase transitions in the configuration mixed IBM

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Shape coexistence is a widespread phenomenon throughout the nuclear chart and can, from a microscopic point of view, be related to particle-hole (p-h) excitations across closed (sub)shells. In specific regions, these p-h excitations descend very low in energy mainly due to the strong proton-neutron interaction. Hence, the regular and the p-h configurations get considerably mixed up, such that -macroscopically- a coexistence of different shapes may be established.

These different configurations can be treated within the framework of the Interacting Boson Model with configuration mixing (IBM-CM)[1] which approximates nucleon pairs as s- and d-bosons and handles particles and holes equally on the basis of intruder spin symmetry. Starting from the microscopic IBM, a potential energy surface (PES) in the collective variables β and γ can be constructed by calculating the classical limit of the IBM Hamiltonian [2, 3]. In extension, a PES for configuration mixed systems can be calculated [4] and will be used to study ground state energy phase transitions [5]. These may occur when the control parameters of the system - in casu the parameters occurring in the IBM-CM Hamiltonian - are varied. Utilising the machinery of catastrophe theory [6], the locus of degenerate critical points can be calculated, marking out the regions with different behaviour of the PES and thus determining the phase diagram. The evolution of this phase diagram with varying excitation energy of the intruder configuration is studied for U(5)-O(6), U(5)-SU(3), O(6)-SU(3), and SU₋(3)-SU₊(3) mixing. In all cases, regions with a single minimum as well as regions with two coexisting minima are found. Furthermore, members of appropriate isotopic chains can be positioned in the diagram. This allows us to check whether a discontinuity in the experimental separation energies, indicative of first order phase transitions [5], corresponds to the crossing of a critical line in the phase diagram. Phase diagrams for the different IBM-CM limits and applications will be presented.

References

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