Odd nuclei and shape phase transitions: the role of the unpaired fermion

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Shape phase transitions in even as well as odd systems are reviewed within the frameworks of the Interacting Boson Model(IBM) and the Interacting Boson Fermion Model(IBFM) respectively and compared with geometric models when available. We discuss in particular the case of an odd $j = 3/2$ particle coupled to an even-even boson core that undergoes a transition from the spherical limit $U(5)$ to the γ-unstable limit $O(6)$. Energy spectrum and electromagnetic transitions, in correspondence of the critical point, display behaviors qualitatively similar to those of the even core and they agree qualitatively with the model based on the E(5/4) boson-fermion symmetry. We describe then the $U^{BF}(5)$ to $SU^{BF}(3)$ transition when a fermion is allowed to occupy the orbits $j = 1/2, 3/2, 5/2$. The additional particle characterizes the properties at the critical points in finite quantum systems. The formalism of the intrinsic or coherent states is used to describe in details the ground state as well as the excited $\beta-$ and $\gamma-$bands and the potential energy surfaces obtained from model hamiltonians are put in correspondence with the corresponding cases proposed within the geometric collective model based on the Bohr hamiltonian.