Symmetry and Phase Transitions in Nuclei

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Phase transitions in nuclei have received considerable attention in recent years, especially after the discovery that, contrary to expectations, systems at the critical point of a phase transition display a simple structure.
In this talk, quantum phase transitions (QPT), i.e. phase transitions that occur as a function of a coupling constant that appears in the quantum Hamiltonian, H, describing the system, will be reviewed and experimental evidence for their occurrence in nuclei will be presented. The phase transitions discussed in the talk will be shape phase transitions. Different shapes have different symmetries, classified by the dynamic symmetries of the Interacting Boson Model, U(5), SU(3) and SO(6).
Very recently, the concept of Quantum Phase Transitions has been extended to Excited State Quantum Phase Transitions (ESQPT). This extension will be discussed and some evidence for incipient ESQPT in nuclei will be presented.
Systems at the critical point of a phase transition are called “critical systems”. Approximate analytic formulas for energy spectra and other properties of “critical nuclei”, in particular for nuclei at the critical point of the second order U(5)-SO(6) transition, called E(5), and along the line of first order U(5)-SU(3) transitions, called X(5), will be presented. Experimental evidence for “critical nuclei” will be also shown.
Finally, the microscopic derivation of shape phase transitions in nuclei within the framework of density functional methods will be briefly discussed.