Shape Phase Transition from Octupole Deformation to Octupole Vibrations: The Analytic Quadrupole Octupole Axially Symmetric Model

Dennis Bonatsos[#], D. Lenis[#], N. Minkov[†], D. Petrellis[#], and P. Yotov[†]

[#] Institute of Nuclear Physics, N.C.S.R. "Demokritos"
GR-15310 Aghia Paraskevi, Attiki, Greece

[†] Institute for Nuclear Research and Nuclear Energy, Bulgarian Academy of Sciences
72 Tzarigrad Road, BG-1784 Sofia, Bulgaria

Abstract

An analytic collective model in which the relative presence of the quadrupole and octupole deformations is determined by a parameter (ϕ_0), while axial symmetry is obeyed, is developed [1]. The model [to be called the Analytic Quadrupole Octupole Axially symmetric model (AQOA)] involves an infinite well potential, provides predictions for energy and $B(EL)$ ratios which depend only on ϕ_0, draws the border between the regions of octupole deformation and octupole vibrations in an essentially parameter-independent way, and in the actinide region describes well ^{226}Th and ^{226}Ra, for which experimental energy data are shown to suggest that they lie close to this border. The similarity of the AQOA results with $\phi_0 = 45^{\rm o}$ for ground state band spectra and $B(E2)$ transition rates to the predictions of the X(5) model is pointed out. Analytic solutions are also obtained for Davidson potentials of the form $\beta^2 + \beta_0^4/\beta^2$, leading to the AQOA spectrum through a variational procedure. In the rare earth region it is proved that the N=90 isotones ^{150}Nd, ^{152}Sm, ^{154}Gd, and ^{156}Dy, which are known to provide the best examples of the X(5) critical point symmetry between quadrupole vibrations [U(5)] and axial quadrupole deformation [SU(3)], also lie on the border between the regions of stable axial octupole deformation and octupole vibrations, thus exhibiting a doubly critical character. Spectra and B(EL) transition rates are described in terms of the AQOA model including tunneling effects.

References

[1] D. Bonatsos, D. Lenis, N. Minkov, D. Petrellis, and P. Yotov, Phys. Rev. C (2005) accepted. nucl-th/0505017.