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Exact analytical treatment of nuclear shape phase transitions in terms of the sextic oscillator

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The sextic oscillator V(r) = Arˆ2 + Brˆ4 +Crˆ6 + D/rˆ2 offers a flexible shape that can be used in the Bohr Hamiltonian to model transition between spherical and deformed shape phases in the r=beta variable. The general form of the sextic oscillator is not solvable, however, the A, B and C coefficients can be parametrized in terms of two independent parameters (a, b) such that the problem reduces to a quasi-exactly (QES) form. This means that the lowest few energy eigenvalues and the wave functions can be determined in closed form, and the B(E2) values can also be calculated analytically [1,2]. The model has been applied to describe the transition between the spherical and gamma-unstable shape phases [1,2] for even-even nuclei near the Z=50 shell closure, and it has been shown that the two phases are separated by a parabola in the (a,b) phase space. Later the model has been generalised to discuss further types of phase transitions too (see e.g. [3]). Here we report on the extension of the model that allows the treatment of 22 energy levels instead of the original 10, while all the calculations remain analytically solvable [4]. The model is applied to the Ru, Pd, Pt and Os isotope chains, and the trajectory obtained in the (a,b) phase space is analysed for each chain.

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