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Probing alternating-parity bands in even–even nuclei within an axial quadrupole octupole hexadecapole collective model

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Abstract. An analytic quadrupole octupole hexadecapole (QOH) axially symmetric model is used to provide a coherent framework for describing both octupole vibrations and octupole deformations in even-even nuclei. The model offers analytical solutions for the energy spectra and electric E1, E2 and E3 transition probabilities. The spectroscopic features are governed by three physically meaningful parameters: the stiffness constant c_2, the hexadecapole deformation parameter ϕ_{02}, and the sextic potential parameter α, directly linked to ϕ_{01}^{π} which represents the interplay between the quadrupole and octupole deformations for both even and odd angular momentum states. The model is applied across a broad range of nuclei including Ra, Th, Sm, Ba, U, Gd, Nd, Rn, Pu, Xe, and Ce isotopes, effectively capturing the characteristic properties of alternating parity bands. Detailed calculations of E1, E2, and E3 transition matrix elements have been performed for ^{220,222}Rn, ^{222,224,228}Ra, and ^{144,146}Ba yielding results in good agreement with available experimental data.