Octupole Two Phonon States in Deformed Nuclei ◇

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By means of the (p,t) reaction the excitation spectra of 0^+ states in ^{158}Gd [1], ^{228}Th, ^{230}Th, and ^{232}U have been studied using the Q3D magnetic spectrograph.

The 0^+ transfer angular distributions have very large cross sections at very small reaction angles, a feature that allows to identify these states in otherwise very complicated and dense spectra.

We resolved for each of these nuclei typically 12 excited states with safe 0^+ assignments. The studied excitation energy range is up to 3.1, 2.5, 2.5, and 2.1 MeV, resp.

As for ^{158}Gd [2], we compare the data with *spdf*-IBA calculations. The parameters are chosen to reproduce the low lying spectra, especially the bands of negative parity. These four axially symmetric, statically deformed nuclei differ significantly with respect to the excitation energy of their lowest negative parity state, the sequence is $E_x(1^-, {}^{158}\mathrm{Gd}) = 977.1\,\mathrm{keV}$, $E_x(1^-, {}^{228}\mathrm{Th}) = 328.0\,\mathrm{keV}$, $E_x(1^-, {}^{230}\mathrm{Th}) = 508.1\,\mathrm{keV}$, and $E_x(1^-, {}^{232}\mathrm{U}) = 563.2\,\mathrm{keV}$. For the energy ranges considered the IBA predicts five excited 0^+ states of pure *sd* (quadrupolar) bosonic structure for all these nuclei, but three, six, seven and four excited 0^+ states, resp., which have two bosons in the *pf* boson space. They are related to – or represent – octupole two phonon excitations (OTP).

Accounting in addition for the monopole pairing vibration, collective model descriptions provide nearly quantitatively the number of the observed excited 0^+ states in these actinide nuclei. This is shown in Fig. 1 for ^{232}U, ^{230}Th and ^{228}Th.

References

[1] S.A. Lesher *et al.*, Phys. Rev. **C66** (2000) 051305

[2] N.V. Zamfir, J.-Y. Zhang, R.F. Casten, Phys. Rev. **C66** (2002) 057303

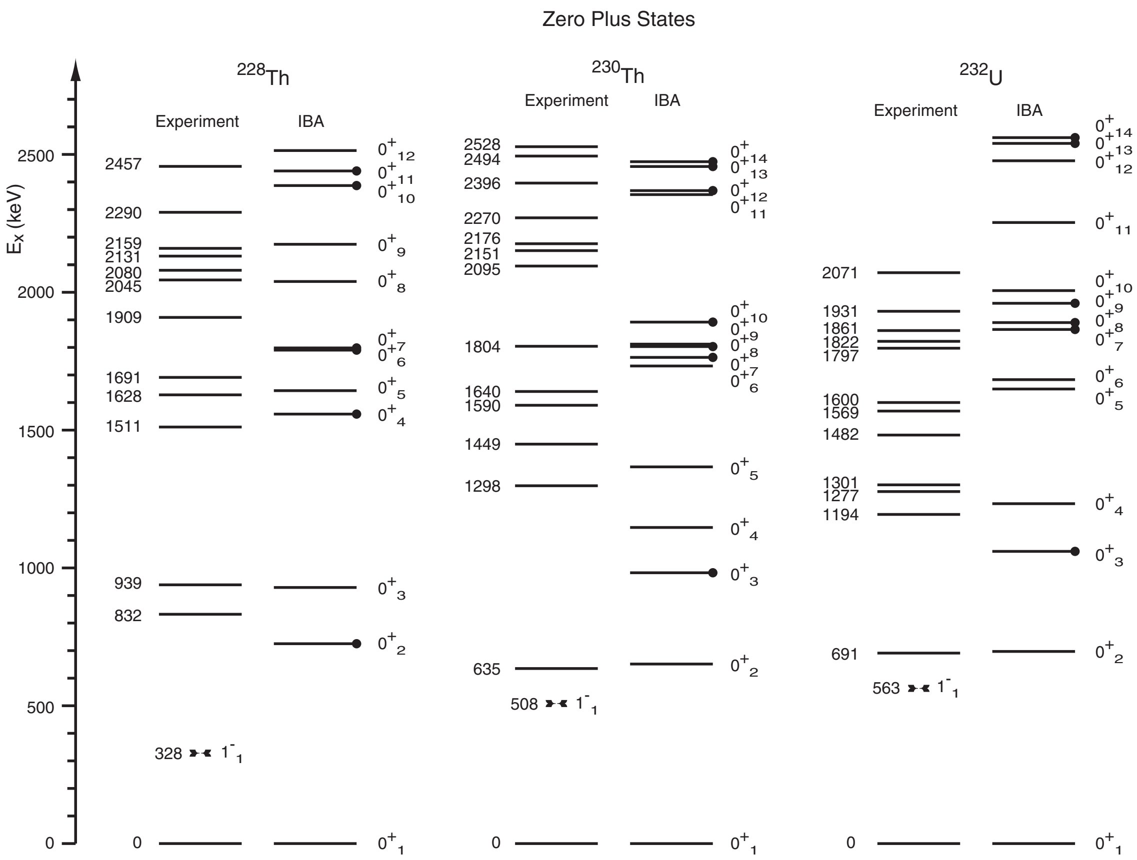

Fig. 1: Excitation energies of all known excited 0^+ states in ^{232}U, ^{230}Th and ^{228}Th, compared with *spdf*-IBA calculations. OTP states are marked by a dot. The excitation energies of the 1^-_1 states are indicated.

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