

Strength of octupole correlations in the actinides *

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Octupole correlations have attracted much attention over the years, and the actinide nuclei remain an interesting source of information because they offer the possibility to investigate the interplay between collective rotation and octupole degrees of freedom. In previous work by I. Wiedenhöever *et al.* [1], it was suggested that, in the lightest Pu isotopes, strong octupole correlations lead to the absence (239, 240) or delay in frequency (238) of the strong proton alignment observed in the heavier (241, 242, 243, 244) Pu isotopes. More evidence supporting this suggestion has emerged from recent detailed studies in U and Pu nuclei with Gammasphere.

A series of so-called "unsafe" Coulomb excitation experiments has been carried out with Gammasphere at ATLAS. Ground state bands and octupole band structures have been identified in ^{237–239}U and ^{236–244}Pu. In contrast to its isotone ²³⁷U, the energy differences in ²³⁹Pu between states of same spin and opposite parity are getting smaller at high spin, and become almost degenerate at spin 53/2 [2]. In addition, in ^{238–240}Pu the staggering factor, which is proportional to the energy difference between states of positive and negative parity (and, hence, measures the extent to which the two bands can be viewed as one), are getting smaller and comparable to those seen in nuclei with octupole deformation at high spin, while in their U isotones the staggering factors stay constant (above 200 keV). Furthermore, the (I+1)⁺→I⁻ E1 linking transitions were observed at high spin in ²⁴⁰Pu, in addition to the I⁻→(I-1)⁺ linking γ rays. This can be viewed as further evidence for an octupole rotor. Moreover, the estimation of the D_0 moments from the branching ratios between the inter- and in-band transitions, also supports the conclusion of stable octupole deformation present at high spins in the three lightest Pu isotopes. Additional indication of stronger octupole correlations in ²³⁹Pu comes from the small difference between the decoupling parameters extracted for the $K = 1/2^+$ and $K = 1/2^-$ sequences. This is in contrast with the situation in ²³⁷U, where the differences are much larger.

It has been shown that strong octupole correlations or stable octupole deformation impact the magnitude of the alignment gain i_x and its evolution with rotational frequency [3]. The ^{238–240}Pu isotopes are strikingly different from the other nuclei in the neighboring region. At $\hbar\omega \sim 0.25$ MeV, the noticeable rise of alignment in other nuclei is absent in these three isotopes. All the data available today indicate that strong octupole correlations in these three Pu isotopes have a considerable impact on their structure and that a transition from an octupole vibration to stable octupole deformation occurs at high spin.

[1] I. Wiedenhöever *et al.*, Phys. Rev. Lett. 83, 2143 (1999).

[2] S. Zhu *et al.*, Phys. Lett. B 618, 51 (2005).

[3] S. Frauendorf, V.V. Pashkevich, Phys. Lett. B 141, 23 (1984).

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