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Measurement of the Shapes of ^{130,134,136}Ba

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Theoretical calculations[1] have predicted the existence of a prolate to oblate shape transition in the region of the barium nuclei, but have disagreed[2,3] as to the sign of the deformation in the barium isotopes themselves. We have measured the quadrupole moments Q_{2^+} of the first excited states of ^{130,134,136}Ba using the reorientation effect in Coulomb excitation. The basic method has been described elsewhere;[4] a thin target of the separated isotope is Coulomb excited by a beam of heavy ions. Three particle detectors are placed at forward angles where they detect both the inelastically scattered projectile and the recoiling target nuclei in coincidence with de-excitation gamma rays. Thus, the inelastic cross section can be measured simultaneously at six widely separated *CM* angles. In addition, an annular detector was used to detect back scattered projectiles, which are most sensitive to the reorientation effect. All three moments were measured with a beam of 85 MeV ^{40}Ca, corresponding to a minimum separation of 13–14 fm between nuclear surfaces for a head-on collision ($r = 1.25A^{1/3}$fm); the ^{130,134}Ba experiments were also done with beams of 70 and 80 MeV ^{32}S ions, respectively. Calculations done with the de Boer-Winther code were compared to experimental data to determine the Q_{2^+} values. We have obtained moments of $+0.23 \pm 0.18$, 0.06 ± 0.14 and $+0.34 \pm 0.52$ eb for ^{130,134,136}Ba, respectively, ignoring the effects of higher excited states. If matrix elements for the second excited 2^+ state are assumed to be given by the asymmetric rotor values, these moments become $+0.37 \pm 0.18$, $+0.15 \pm 0.14$ and $+0.43 \pm 0.52$ eb, respectively. These values are in marked disagreement with previous values;[5,6] the reason for this discrepancy has not been determined. Inelastic scattering of 10.5 MeV α particle, detected in a magnetic spectrometer at angles of 55° and 65°, was used to measure the BE2 values in ^{130,136}Ba. We obtain $B(\mathrm{E2}; 0_1^+ \rightarrow 2_1^+)$ values of 1.21 ± 0.38 e^2b^2 and 0.504 ± 0.071 e^2b^2 for ^{130}Ba and ^{134}Ba respectively. Values of the quadrupole asymmetry parameter γ calculated with our data are 33°, 32° and 36° for ^{130,134,136}Ba, which agree with γ values calculated from the level positions using the Davydov-Chaban model. This indicates that the Barium nuclei, like the platinum-osmium nuclei are generally oblate in shape, but soft to vibration in the γ coordinate.

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