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Measurements of octupole collectivity in ^{144}Ba via Coulomb excitation

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Identifying nuclei that have a stable octupole deformation is crucial to the search for odd mass isotopes with atomic electric-dipole moments. Observation of an atomic electric dipole moment would indicate CP violation due to physics beyond the standard model. Mean-field calculations predict that octupole correlations are enhanced for certain nuclei in the actinide and lanthanide regions of the nuclear chart. The magnitude of octupole correlations can be inferred from the structure of nuclear energy levels and enhanced E1 transition strengths, although shell effects can complicate the interpretation of such data. The E3 moment is the observable that provides the most unambiguous measure of enhanced octupole correlations, being insensitive to single particle effects. Direct measurements of the E3 moments in ^{222,224,226}Ra show they exhibit stable octupole deformation, while ^{228}Ra behaves as an octupole vibrator [1]. Current experimental B(E3) data in the lanthanide region however is scarce. Measurements reported for the B(E3) of ^{144,146}Ba [2,3] are significantly enhanced over theory and are consistent with octupole deformation, but have very large associated uncertainties.

To address this, a Coulomb excitation experiment on ^{144}Ba was conducted at the HIE-ISOLDE facility at CERN in November 2024, with aims to re-measure the B(E3). A beam of ^{144}Ba was produced by bombarding a primary uranium carbide target with a $1\mu A$ proton beam. The ^{144}Ba beam was re-accelerated to 4.52 MeV/u, optimised to maximise the Coulomb excitation cross section while staying within Cline's safe energy criterion, ensuring excitation occurs purely via the electromagnetic interaction. The beam was then focused onto a secondary ^{208}Pb target, with a silicon DSSSD placed downstream to detect the scattered target and projectile. The target was surrounded by the Miniball spectrometer, consisting of seven HPGe clusters used to detect the de-excitation of both the target and projectile. Thanks to the intense beams delivered by ISOLDE the measurement was successful, despite a significant portion of the beam consisting of isobaric contaminants. The multiple Coulomb-excitation code GOSIA will be used to provide a direct measurement of both the E2 and E3 moments. The greater number of statistics observed for the ^{144}Ba ($3^- \longrightarrow 2^+$) transition, compared to the previous measurement [2], suggests that the B(E3) transition strength in ^{144}Ba will likely be determined with improved precision. Analysis of the data is ongoing, and the current status will be presented.

[1] P. A. Butler et al., "Evolution of Octupole Deformation in Radium Nuclei from Coulomb Excitation of Radioactive ^{222}Ra and ^{228}Ra Beams," *Physical Review Letters*, vol. 124, no. 4, p. 042503, Jan. 2020, doi: 10.1103/PhysRevLett.124.042503.
[2] B. Bucher et al., "Direct Evidence of Octupole Deformation in Neutron-Rich ^{144}Ba," *Physical Review Letters*, vol. 116, no. 11, p. 112503, Mar. 2016, doi: 10.1103/PhysRevLett.116.112503.
[3] B. Bucher et al., "Direct Evidence for Octupole Deformation in ^{146}Ba and the Origin of Large \(E1\) Moment Variations in Reflection-Asymmetric Nuclei," *Physical Review Letters*, vol. 118, no. 15, p. 152504, Apr. 2017, doi: 10.1103/PhysRevLett.118.152504.

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