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Quadrupole moments of neutron-deficient gold isotopes: investigating nuclear deformation

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The neutron-deficient lead region is considered as having a large manifestation of deformation [1-3]. Within this region, neutron-deficient gold isotopes ($Z = 79$) exhibit unique phenomena: charge radii revealed a plateau of strong deformation around $N = 101\sim 107$ region, known as “island of deformation”[4]; remarkable growth in deformation was also observed at ^{187}Au as well as the large isomeric shift [5]; $11/2^-$ spin states display parabolic trends in both magnetic and quadrupole moments of gold and other nearby isotopic chains, reflecting the effects of core-polarization and collectivity [6].

The basic properties of atomic nuclei, including masses, spins, electromagnetic moments, and radii serve as effective means for studying exotic nuclear structure. Laser spectroscopy enables precise extraction of the basic properties of atomic nuclei by measuring the hyperfine structure and isotope shifts of atoms, ions, and molecules [7]. The above phenomena have been extensively investigated by in source laser spectroscopy [8] which extracted the nuclear magnetic moments and charge radii of Au isotopes by measuring their atomic hyperfine structure. Nevertheless, to further understand the physics mechanism of the deformation in neutron-deficient gold, measurement of the quadrupole moment, another basic property of atomic nucleus and sensitive observable to nuclear deformation and shapes is essential, which however requires high-resolution laser spectroscopy technique.

Recently, by utilizing Collinear Resonance Ionization Spectroscopy (CRIS) experiment [9] at ISOLDE-CERN, we have measured the high-resolution hyperfine structure spectra of ground and long-lived isomeric states of $^{180}\text{--}^{197}\text{Au}$. Quadrupole moments of $^{181}\text{--}^{183}, ^{187}\text{--}^{190}\text{Au}$ have been extracted for the first time. This presentation will highlight the newly-measured properties of $^{181}\text{--}^{183}, ^{187}\text{--}^{190}\text{Au}$ states, which will offer new insights into the underlying mechanism of “island of deformation” along the gold isotopic chain, and the shape coexistence in $^{187\text{m}}\text{Au}$.

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