Imaging the collective structure of atomic nuclei in high-energy nuclear collisions from STAR

Chunjian Zhang (for STAR Collaboration)

Recently, high-energy nuclear collisions have been proposed as a powerful tool to image the global structure of heavy atomic nuclei, such as their shapes and radial profiles. We present the first quantitative demonstration of this method by extracting the quadruple deformation β_2 and triaxiality γ for ^{238}U nuclei, known for its large prolate shape. We achieve this by comparing several flow observables in collisions of ^{238}U with collisions of near-spherical ^{197}Au. Though the extracted β_2 of ^{238}U is consistent with low-energy experiments, the measurements indicate a non-zero γ of ^{238}U in its ground state. A similar comparative measurement is carried out in collisions of ^{96}Ru and ^{96}Zr. Large differences are observed in almost all flow observables in the two collision systems, reflecting strong impacts from the structure differences between the pair of isobars. In particular, our measurements suggest an intriguing octupole deformation β_3 in ^{96}Zr which is not predicted by mean field model calculations, as well as a larger neutron skin in ^{96}Zr. The prospect of the imaging method for studying nuclear structure is also discussed.