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Observing the shape of nuclei at high-energy colliders

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High-energy nuclear collisions are conducted in the world's largest accelerator facilities to characterize the hot and dense phase of strong-interaction matter, the quark-gluon plasma (QGP). Production of QGP droplets began with 197Au+197 collisions at the BNL RHIC in the early 2000's, and was followed in 2010 by 208Pb+208Pb collisions at the CERN LHC.

Thanks to data recently collected in collisions of additional systems, namely, 238U, 129Xe, 96Ru, 96Zr, it has been realized that the final states of heavy-ion collisions are strongly impacted by the collective structure (deformations and radial profiles) of the colliding ions. Nuclear structure manifests, in particular, in the azimuthal momentum anisotropy of the observed particle distributions, which, by virtue of the fluid-like nature of the QGP, directly reflects the deformed shape of the colliding ions at the time of interaction.

I present recent activities that have established high-energy nuclear experiments as a new probe of nuclear structure. I discuss signatures of quadrupole, octupole, and triaxial deformations of nuclei in heavy-ion collisions. I argue that these experiments provide an information about nuclear structure that is fully complementary to that obtained in traditional low-energy experiments, while opening a unique window onto the role played by QCD, i.e., by quarks and gluons, in shaping the collective properties of atomic nuclei.

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