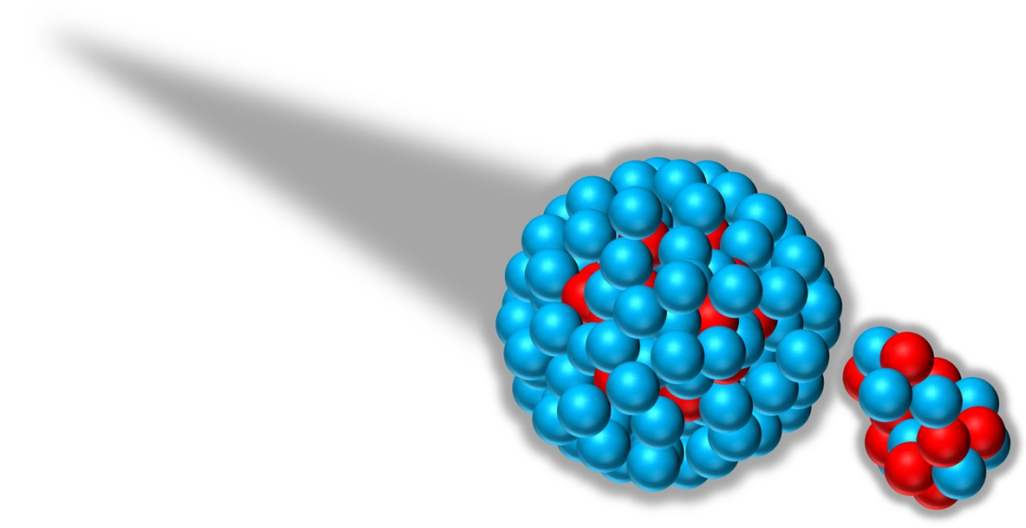
Imaging nuclear shapes with heavy-ion collisions

Objectives

- When heavy ions collide at high speeds, they create an extremely hot and dense state of matter called the quark-gluon plasma (QGP).
- In this work, scientists studied fixed-target collisions between large lead (^{208}Pb) nuclei and smaller neon (^{20}Ne) nuclei. Neon-20 has a stretched, “bowling-pin” nuclear shape.
- The team showed that this unusual shape produces clear patterns in the flowing motion of particles after the collision, called anisotropic flow.



Fixed-target collisions between lead and neon nuclei provide a new way to probe quark-gluon plasma and image the shape of atomic nuclei.

Impact

- This research demonstrates that nuclear shapes can leave a fingerprint in the flow of particles produced in heavy-ion collisions.
- The unusual structure of neon-20 leads to distinctive patterns that can be measured by the LHCb experiment at CERN.
- These findings help scientists test ideas about how nuclear structure connects to the creation of QGP.
- They also show how fixed-target experiments can explore QGP in a new region of beam energies and densities, giving insights into how matter behaved in the early universe.
- This cross-disciplinary approach links nuclear structure theory with high-energy physics and creates a new tool for imaging the shapes of nuclei.

Accomplishments

- “Anisotropic Flow in Fixed-Target ^{208}Pb + ^{20}Ne Collisions as Probe of Quark-Gluon Plasma”, Giacalone et al., Phys. Rev. Lett. 134, 0832301 (2025).