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Exploring the properties of deconfined nuclear matter with collective phenomena in ultra-relativistic heavy-ion collisions at the LHC

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In collisions of heavy ions at ultra-relativistic energies at the Large Hadron Collider the deconfined state of nuclear matter, dubbed quark-gluon plasma (QGP), is produced.

Measurements of collective anisotropic flow have extensively contributed to the foundation of a perfect liquid paradigm about QGP properties, according to which QGP is the state of matter with the smallest specific shear viscosity ever discovered.

This talk presents new experimental methods and observables for anisotropic flow analyses developed recently, which can further constrain the QGP properties and other stages of nuclear matter produced in heavy-ion collisions. In particular, new multi-harmonic flow observables, Symmetric Cumulants (SC) and Asymmetric Cumulants (AC) of flow amplitudes are introduced, and their advantages over traditional flow observables are discussed. Theoretically, it is demonstrated that only SC and AC observables satisfy all fundamental properties of multivariate cumulants in a strict mathematical sense. Experimentally, it is found that these new flow observables can reveal for the first time the details of the differential temperature dependence of QGP's specific shear viscosity.

The talk concludes by presenting the latest measurements of multi-harmonic flow observables in heavy-ion collisions. A comparison with predictions from state-of-the-art theoretical models is made.

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