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Non-gaussian matter distribution inside nucleons and its application to small systems.

The initial geometry of a heavy-ion collision is determined by the spatial distribution and fluctuations of the participating nucleons. In small collision systems, such as p+Pb, O+O and Ne+Ne, these spatial distributions can have a pronounced influence on the geometry of the produced matter and its subsequent hydrodynamic evolution. While hydrodynamic models have successfully described a wide range of observables, the description of the initial state remains a significant source of uncertainty, particularly in small collision systems where fluctuations in the spatial structure of the colliding nucleons can strongly influence the subsequent evolution. Most initial-condition models commonly assume a Gaussian nucleon profile; however, the extent to which the shape of this profile affects the initial collision geometry and the resulting final-state observables remains an important question. This motivates the investigation of more flexible nucleon density profiles and their impact on hydrodynamic predictions. In this work, generalised Gaussian initial conditions are investigated within the \textsc{TRAJECTUM} framework using the TRENTo initial-condition model with nucleon substructure. Constituent hot spots are sampled from a generalised normal distribution characterised by a shape parameter β , which allows the spatial profile of the nucleon substructure to be varied while maintaining a fixed distribution width. The resulting initial conditions are evolved through the pre-hydrodynamic and relativistic hydrodynamic stages before particlisation. The dependence of the initial-state geometry and final-state observables, including anisotropic flow coefficients and mean transverse momentum, on the generalised Gaussian profile is studied for different values of β . Comparisons with conventional Gaussian initial conditions and experimental measurements at LHC energies will be used to assess the sensitivity of these observables to the assumed nucleon shape.

Keywords:

Relativistic heavy-ion collisions; Small collision systems; Generalised Gaussian distribution; Nucleon substructure; TRENTo; TRAJECTUM; Hydrodynamic modelling

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