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Pseudorapidity Density Distribution of Charged Particles and System Size in Heavy-Ion Collision

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In heavy-ion collisions, the pseudorapidity density distribution of charged particles is a fundamental observable that encodes important information about the collision dynamics. In this study, we analyze the pseudorapidity distributions of charged particles from Au+Au collisions at center-of-mass energies ranging from $\sqrt{s_{NN}} = 19.6$ GeV to 200 GeV (RHIC energies), and Pb+Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV and 5.02 TeV (LHC energies). To better capture the asymmetries and energy-dependent shape evolution in the pseudorapidity distributions, we propose a fitting function that extends the traditional Gaussian form by incorporating an error function modulation. This function consists of a sum of two symmetric Gaussians, each modified by an energy-dependent error function characterized by the parameter λ. The λ parameter shows a scaling behaviour with collision energy that resembles the inverse of the baryon chemical potential $(1/\mu_B)$, suggesting a connection with baryon stopping. We interpret the overlap of these modified Gaussians in pseudorapidity space as an indicator of source overlap and use it to estimate the effective system size. This overlap area exhibits an energy dependence similar to that of the baryon chemical potential μ_B. The estimated size shows good agreement with values obtained from femtoscopic analyses and hydrodynamic model predictions.

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