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Longitudinal Nuclear Suppression and Nonadditive Transport in Relativistic Heavy-Ion Collisions

We investigate longitudinal nuclear suppression in relativistic heavy-ion collisions using the observable (R_(dN⁄dy)), defined as the binary-collision-scaled ratio of rapidity distributions in Pb–Pb and p–p interactions. Numerical studies with EPOS, FTFP_BERT, and HIJING reveal notable model dependence: FTFP_BERT and HIJING reproduce the experimentally observed increase in the ratio toward forward and backward rapidities, whereas EPOS predicts qualitatively different behavior. Motivated by this discrepancy, we develop two analytical descriptions based on nonadditive statistics. First, starting from the Tsallis quasi-exponential distribution, we derive a closed analytical expression for the rapidity spectrum in terms of a hypergeometric function. Second, we formulate a transport approach based on the nonadditive Boltzmann equation in the relaxation-time approximation. The latter provides a satisfactory description of negatively charged pion data over the range \sqrt(s_NN)=6.3-17.3 GeV using physically admissible parameters. The extracted evolution of the nonadditivity parameter toward values above unity, together with t⁄τ of order one, indicates relaxation toward a non-Boltzmann power-law stationary state and supports the relevance of anomalous diffusion in the produced medium.

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