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Bulk quantities in nuclear collisions from Color Glass Condensate and hybrid hydrodynamic simulations

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Starting from a running-coupling improved k_T-factorized formula of the Color Glass Condensate (CGC) framework, we calculate bulk observables in several heavy-ion collision systems. This is done in two ways: first the particle distribution is calculated directly as implied from the CGC model, and then it is compared to the case where it is instead used as initial conditions for a hybrid hydrodynamic simulation. In this way, it it possible to assess the effects of hydrodynamic and hadronic evolution by quantifying how much they change the results from a pure initial state approach and, therefore, to what extent initial condition models can be directly compared to experimental data. We find that although entropy production in subsequent hydrodynamic evolution can increase multiplicity by as much as 50%, the centrality, energy, and system size dependence of charged hadron multiplicity is only affected at the $\sim$5% level (disregarding a single overall - energy and system size independent - normalization) when compared to the pure initial state case. The parameter-free prediction for these dependencies then gives reasonable agreement with experimental data whether or not hydrodynamic evolution is included. On the other hand, our results are not compatible with the hypothesis that hydrodynamic evolution is present in large systems, but not small systems like p-Pb. Moreover, we find that hydrodynamic evolution significantly changes the distribution of momentum, so that observables such as mean transverse momentum are very different from the initial particle production, and much closer to measured data. Lastly, we point out that the onset of a hydrodynamic phase in heavy-ion collisions, along with viscous effects, could, perhaps, be further investigated by studying the centrality dependence of ratio of the mean p_T across different collision systems with similar collision energy.

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