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Multiplicity density at mid-rapidity in AA collisions: effect of meson cloud

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The understanding of the initial entropy/energy distribution is crucial for hydrodynamical simulation of the evolution of the hot quark-gluon plasma in high-energy AA collisions. A rigorous determination of the initial conditions for the plasma fireball in AA collisions is presently impossible. One of the popular methods in use for this purpose is the wounded nucleon Glauber model. In this phenomenological scheme the entropy density in AA collisions contains the contributions from soft and hard interactions. At mid-rapidity ($\eta = 0$) in the c.m. (center mass) frame the charged particle multiplicity density (which is proportional to the initial entropy density) in AA collisions reads

$$\frac{dN_{ch}(AA)}{d\eta} = \frac{dN_{ch}(pp)}{d\eta}\left[\frac{(1-\alpha)}{2}N_{\rm part} + \alpha N_{\rm coll}\right],$$

where $dN_{ch}(pp)/d\eta$ is the multiplicity density in pp collisions, $N_{\rm part}$ is the number of participants in both the colliding nuclei, $N_{\rm coll}$ is the number of the binary collisions, and α characterizes the magnitude of hard processes to multiparticle production. In the Glauber model model $N_{\rm part}$ and $N_{\rm coll}$ can be expressed via the inelastic pp cross section and the nuclear density. Fitting the data on the centrality dependence of the charged particle multiplicity in Au + Au collisions at $\sqrt{s} = 0.2$ TeV and in Pb + Pb collisions at 2.76 TeV gives $\alpha \approx 0.13{-}0.15$. For such a value of α the hard contribution to the particle production in AA collisions turns out to be rather large ($\sim$40–50 % for central collisions). It is important that the two component Glauber model allows the Monte-Carlo formulation. The Monte-Carlo–Glauber (MCG) model has proved to be a useful tool for analysis of the event-by-event fluctuations of observables in AA collisions.

In the original formulation the MCG model ignores the internal nucleon structure. We study the influence of the meson cloud of the nucleon on predictions of the MCG model for the charged particle multiplicity density at mid-rapidity in AA collisions. Due to the growth of the fraction of the wounded constituents in each nucleon in AA collisions as compared to that in pp collisions in this formulation of the MCG model the multiplicity in AA collisions should be larger. The total weight of the meson-baryon Fock states in the nucleon may be as large as ~ 40 % (with the dominant contribution from the πN component). We use the infinite momentum frame picture for the meson-baryon Fock states. From a formal point of view our calculations correspond to accounting for the effect of the inelastic Gribov rescatterings, since the two Fock components in the nucleon with different inelastic cross sections lead naturally to appearance of the nucleon diffractive excitation. We find that for central AA collisions the meson cloud can increase the multiplicity density by $\sim$16–18 %. The meson-baryon Fock component reduces the required fraction of the binary collisions by a factor of ~ 2 for Au + Au collisions at $\sqrt{s} = 0.2$ TeV and ~ 1.5 for Pb + Pb collisions at $\sqrt{s} = 2.76$ TeV.

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