THERMODYNAMICAL EVOLUTION OF HOT AND DENSE HADRONIC MATTER FROM INTRANUCLEAR CASCADE SIMULATION

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We investigate the role of higher baryonic resonances on the thermal evolution of hot and dense hadronic matter at AGS energy region. The inclusion of higher resonances is shown to prevent the temperature from going beyond 200 MeV.

Exploration of various phases of hadronic matter is one of the main goals of heavy-ion physics. At AGS and JHP energies, hot and dense hadronic matter is of primary interest, and significant effort has been devoted to understand its properties by using microscopic simulation models such as RQMD [1], ARC [2], and ART [3]. All of these models have succeeded in reproducing the particle momentum spectra, although the proposed hadronic thermal properties are different. For example, all the observed baryonic resonances up to 2 GeV are explicitly treated in RQMD, while a limited number of them (N, $\Delta(1232)$, $N^*(1440)$ and $N^*(1535)$) are included in ARC/ART and direct multi-pion productions are incorporated instead. Then, the thermal evolution during AA collision will be different, even if the hadronic final distributions are similar: From a statistical consideration, the temperature will be smaller when more degrees of freedom (DOF) are incorporated at the same energy density.

We study the thermal evolution during AA collision at AGS energy, and investigate the role of baryon resonances on this evolution. It has been already recognized that $\Delta(1232)$ is quite important to understand the dynamics of AA collisions at AGS energy. For example, the low transverse momentum component of pions is dominated by Δ decay. The importance of some other resonances ($N^*(1440)$,$N^*(1535)$) has been recognized, too. Therefore, we calculate Au($11.6A$GeV/c)+Au collision with and without higher resonances by cascade simulation: Namely, baryonic resonances up to 2 GeV are explicitly propagated in phase space (case-1), and only 3 types of baryon resonances ($\Delta(1232)$, $N^*(1440)$,$N^*(1535)$) are included (case-2).

First, in the left panel of fig. 1, we show the charged particle rapidity distributions with experimental data [4, 5] using the calculation in case-1. It can be seen that the results well agree with the data, and the results of case-2 are similar to those of case-1.

Next, we compare the thermodynamical evolution of hot and dense hadronic matter. We define the temperature by the ratio of the pressure to the number density in the local rest frame, assuming that the local thermal equilibrium is always achieved for transverse motion. In the right panel of fig. 1, we show the time evolution of energy densities and temperature of the hadronic matter. The energy density of case-1 is approximately equal to case-2, while the temperature of case-1 is much lower than case-2. Thus the effects of DOF of the baryonic resonance on the temperature can be clearly seen. We conclude that although both models can reproduce final hadron spectra, the thermal evolution is different, and we expect that it is possible to elucidate how many DOF are necessary by comparing the calculated results of other observables than those of strongly interacting hadrons.

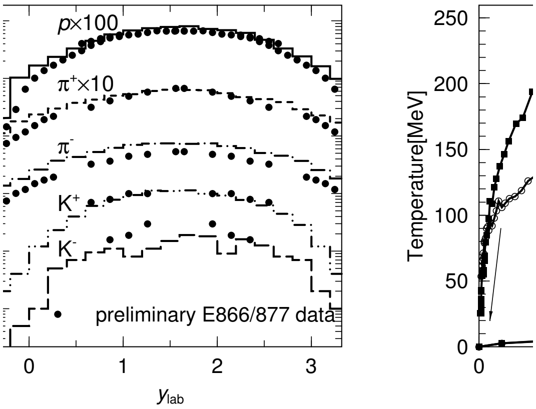

Figure 1: Left:Multiplicity of charged particles in Au(11.6AGeV/c) +Au with experimental data(dots). Right:Comparison of time evolution of hadronic matter between two models from 0fm/c to 25fm/c by 0.5fm/c step

References

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