A Transport Model for Heavy Ion Collisions at RHIC

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To study heavy ion collisions at energies to be available from the Relativistic Heavy Ion Collider (RHIC), we have developed a transport model that includes both initial partonic and final hadronic interactions. Specifically, the parton cascade model ZPC [1] is extended to include the quark-gluon to hadronic matter transition and also final-state hadronic interactions based on the ART model [2].

At present, the ZPC model includes only gluon-gluon elastic scatterings with its cross section taken to be the leading divergent cross section regulated by a medium generated screening mass that is related to the phase space density of produced partons. The initial input of the parton phase space distribution to the ZPC model is obtained from the HIJING model [3], which includes both hard scatterings via the PYTHIA routines with the nuclear shadowing effect and soft interactions using the Lund soft momentum transfer model. Partons are produced from these scatterigns with a formation time determined according to a Lorentzian distribution with a half width given by the ratio of its energy to the square of its transverse mass. The positions of formed partons are then calculated by using straight line propagation from their parent nucleon positions.

Once partons stop interacting, they are converted into hadrons using the HIJING fragmentation scheme after a proper time of approximate 1.2 fm. We consider both the default fragmentation scheme of treating a diquark as a single entity and a modified one which allows the formation of diquark-antidiquark pairs, that fragment into both $BM\bar{B}$ and $B\bar{B}$ with probabilities of 80% and 20%, respectively.

For hadron evolution, we have used the ART model that includes both elastic and elastic hadron scatterings. Multiparticle production is modeled in this model through the formation of resonances. Since the inverse double resonance channels have smaller cross sections than those calculated directly from the detailed balance relation, we have adjusted the double resonance absorption cross sections to improve the model.

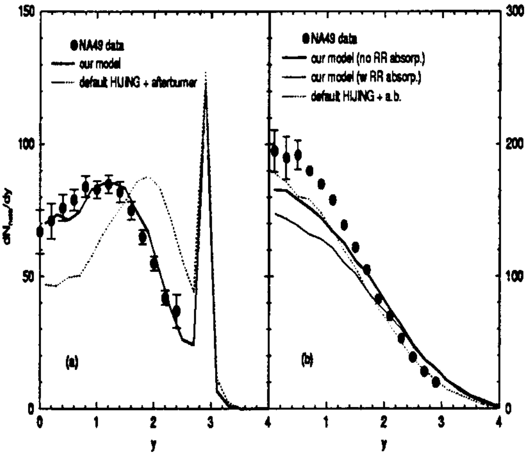

Figure 1: Comparisons between our model calculation and the NA49 data for (a) the net baryon rapidity distribution and (b) the negative hadron rapidity distribution.

Fig.1(a) shows a comparison of the net baryon rapidity distribution between our model results and the NA49 data [4] for 5% central Pb+Pb collisions at 150

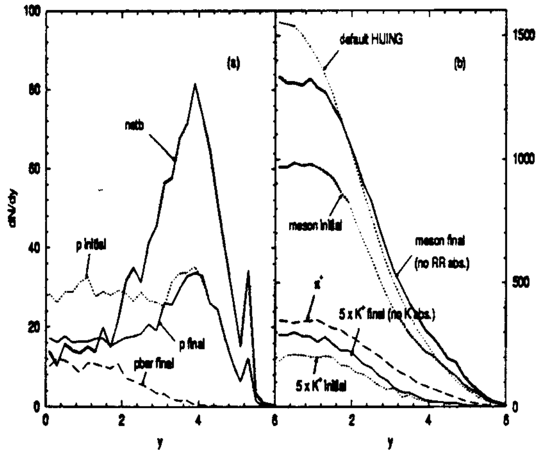

Figure 2: Predictions of (a) baryon and (b) meson rapidity distributions for RHIC Au+Au central (b=0) collisions.

MeV/nucleon. The dotted curve gives the results using the default HIJING fragmentation scheme with afterburner. It shows a visible smaller rapidity shift than that obtained using the modified HIJING fragmentation scheme with afterburner, shown by the solid curve. The latter is seen to give a satisfactory description of the data. Fig.1(b) shows the negative hadron distribution. We see that the modification to HIJING fragmentation scheme increases the rapidity width due to the exchange of meson and baryon positions. If one neglects double resonance cross sections in the ART model, the central rapidity density increases to a value that is comparable to the NA49 data [4]. An enhancement of strange particles is also obtained but the magnitude is very sensitive to their formation time.

We show our predictions for RHIC Au+Au central (b=0) collisions in Fig.2. Many antiprotons are seen to survive after absorption in the hadronic matter, leading to a value of about 10 at central rapidities. The final meson central rapidity height is much larger than the one at the initial time when many rho mesons exist. Results using the default HIJING show a similar distribution except that the central rapidity density is higher. Including the afterburner but without double resonances induced pion absorption also gives a similar meson distribution. Also shown in the figure is the distribution of kaons produced from both string fragmentation and hadronic production. The latter enhances kaon production significantly.

Work is in progress to include in the model the parton inelastic scatterings, dynamical screening, improved treatment of hadronization, etc.

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