A Thermal Fireball Description of Heavy-Ion Collisions

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One of the goals of current investigations in heavy-ion collisions is to establish the existence of the quark-gluon plasma (QGP) phase and to study its properties. Several signals have been proposed as indicators for its creation. However, no unambiguous proof has been established so far. A large part of the problem lies in the difficulty to separate effects of the evolution of the hot and dense medium from characteristic changes in the physics of reactions taking place inside this medium. Therefore, it is mandatory to aim at a consistent description of as many observables as possible within a single model of the medium evolution.

In [1], we have proposed a model for the evolution of a fireball assuming local thermal equilibrium and isentropic expansion. In this approach, the evolution is constrained by two major pieces of information: firstly, by measured hadronic momentum spectra and HBT interferometry data which reflect the freeze-out state; secondly, by information on the equation of state obtained in lattice simulations and represented in terms of a quasiparticle picture [2]. We have demonstrated that this evolution scenario is in good agreement with data on dilepton emission [1]. Here, we present *three* additional observables, measured at SPS, and our corresponding model calculations, all evaluated within the same fixed fireball evolution [1].

Figure 1 shows our result on J/ψ suppression [3], compared to data of the NA50 collaboration. Dissociation of the J/ψ into $c\bar{c}$ was taken into account by scattering off thermal gluon quasiparticles in a kinetic framework.

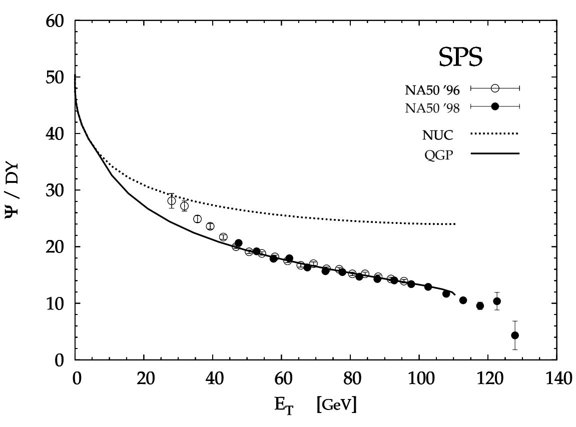

Figure 1: Result at SPS energy for the ratio Ψ/Drell-Yan as function of the transverse energy. The dotted curve includes only nuclear effects, while the full line is the complete result including gluon dissociation.

Figure 2 shows measured hadron ratios, compared to a model of statistical hadronization at the phase transition boundary with subsequent resonance decays [4].

Finally, figure 3 displays the direct photon rate, as measured by WA98, and our model calculation, where we have used the leading order photon emission rate from the QGP, along with estimates of the impact of the quasiparticle picture on this rate [5].

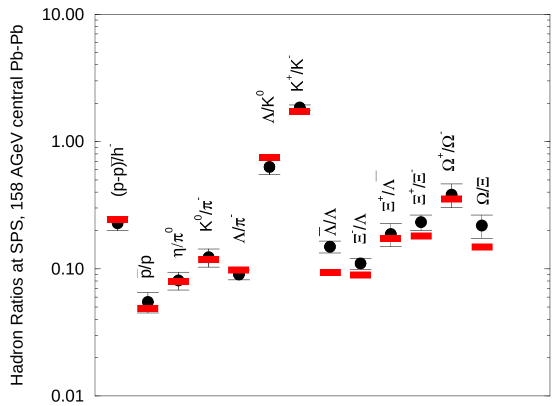

Figure 2: Hadron ratios in the statistical hadronization model (dashed bands) as compared to experimental results (filled circles) for SPS, 158 AGeV central Pb-Pb collisions.

Apparently, the agreement in all three considered cases is good. Since each of the observables probes different stages of the evolution, the overall amount of consistency lends strong support to the thermal fireball scenario.

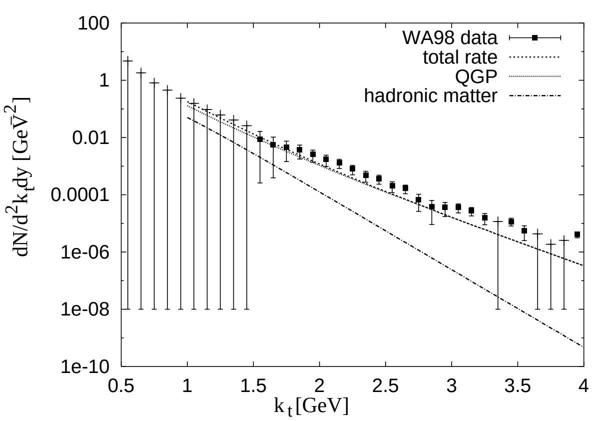

Figure 3: Thermal photon spectrum for 10% most central Pb-Pb collisions at SPS, 158 AGeV Pb-Pb collisions, shown are calculated rate (total, contribution from QGP and hadronic gas) and experimental data

References

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[3] A. Polleri, T. Renk, R. A. Schneider and W. Weise, in preparation.

[4] T. Renk, hep-ph/0210307, subm. to Eur. Phys. J A.

[5] T. Renk, hep-ph/0301133, subm. to Phys. Rev. C.