Collective expansion at RHIC

K. Filimonov, M. Kaneta, and N. Xu

In high-energy nuclear collisions, collective motion has been used as an important tool to understand collision dynamics[1]. Collective motion is driven by pressure gradient which is directly related to the degree of freedom of the system under study. Practically, the information on collectivity is normally extracted from transverse momentum distributions $1/(2\pi p_t)d^2N/dp_t dy$.

Recently, the PHENIX collaboration has published their identified particle spectra[2] up to $p_t \sim 3.5$ GeV/c. The PHENIX results on the negatively charged particle p_t distributions are re-plotted in Figure 1 (a). As one can see, at $p_t \sim 2$ GeV/c, anti-proton yield is almost equal to that of pions. Note that this phenomenon has never been observed before. In e^+e^- collisions[3], the proton yields are always below that of pions up to $p_t \sim 50$ GeV/c.

In order to understand the observation, Vitev and Gyulassy[4] have put forward an argument that high p_t pions (mesons in general) are suppressed and protons (baryons in general) are boosted via collective expansion.

In this short report, we will use both HIJING[5] and RQMD[6] event generators to study particle distributions from collisions at RHIC energy. About 0.5M HIJING and 1.5k RQMD events were used in this study. The resulting distributions are shown in Fig.1 (b) and (c) for HIJING and RQMD, respectively. In the model calculation, we added decayed antiprotons to the primary ones with appropriate branching ratios. It is clear that HIJING model does not reproduce

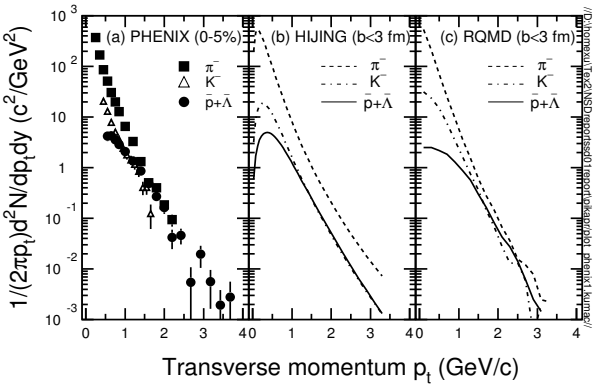

Figure 1: *Transverse momentum distributions of negatively charged pions and kaons, and inclusive antiprotons from central Au+Au collisions at $\sqrt{s_{\rm NN}}$ =130 GeV. The results are from (a) PHENIX measurement; (b) HIJING; and (c) RQMD simulations.*

the observed features (Fig. 1(b)). This is perhaps due to the fact that no rescatterings are implemented in this model. In RQMD, on the other hand, the rescatterings amongst hadrons are allowed, and the RQMD results show a much better agreement with the data (Fig. 1(c)). Due to rescatterings, the RQMD model gives results similar to hydrodynamical model predictions[7].

Note that particles like pions, kaons, and (anti)-protons are copiously produced in the high energy nuclear collisions. They pass through all stages of the collisions. Therefore, from p_t distributions of those particles alone one can not determine whether the collective motion is generated at partonic or hadronic stage. In order to identify the partonic degree of freedom, one needs to study the p_t distributions of particles like Ω, D, and J/ψ whose elastic cross sections are much smaller than those of π, K, p.

Footnotes and References

[1]For example see I. Bearden *et al.* (NA44 Collaboration), Phys. Rev. Lett. **78**, 2080 (1997); H. van Hecke, H. Sorge, and N. Xu, Phys. Rev. Lett. **81**,5764 (1998).

[2]K. Adcox et al, (PHENIX Collaboration), nucl-ex/0112006, Dec. 2001.

[3]SLAC-pub-8687

[4]I. Vite and M. Gyulassy, nucl-th/0104066 Apr. 2001.

[5]X.N. Wang, Phys. Rep. **280**, 287(1997).

[6]H. Sorge, Phys. Rev. **C52**, 3291(1995).

Footnotes and References

[7]D. Teaney, J. Lauret, and E. Shuryak, nucl-th/0011058 Apr. 2001.