Landau Model for RHIC Rapidity Distribution - The Role of Viscosity

G.S. Denicol, **Ph. Mota**, **T. Koide** and **T. Kodama**

Instituto de Fisica, Universidade Federal do Rio de Janeiro,
Rio de Janeiro, RJ, Brasil

It has been pointed out that the rapidity distribution of mesons for the central collisions of relativistic heavy ions can well be fitted by Gaussian distributions, and the energy dependence of the width seems to be in accordance with the simple Landau picture [1]. It is interesting to see if this fact really indicates certain validity of the Landau model in RHIC. However, a simple-minded Landau hydro-model with reasonable initial condition and freeze-out temperature does not correspond to this picture. To obtain the experimental rapidity distribution, the initial energy density should be very large, and when the system cools down to the expected freeze-out temperature, the flow profile approximates the Bjorken scaling solution in the sense that the final rapidity distribution presents a plateau rather than a Gaussian form near the central rapidity. As a matter of fact, even considering the transverse dynamics, it is not easy to reproduce the required rapidity width without forming a plateau within the framework of ideal hydrodynamics. In this work, we examine the effect of viscosity in relativistic hydrodynamics [2] and its consequence on the rapidity distribution. We found that the inclusion of the viscosity can transform the central plateau in the rapidity distribution into a Gaussian type, reproducing well the observed data for mesons. This might be a first indication of the importance of viscosity (non-equlibrium effects) in hydro scenario of relativistic heavy ion collisions. We also found that, even under the presence of viscosity, a relatively large relaxation time makes the fluid motion as if ideal while the velocity gradient is small. These results suggest a possible alternative scenario for the hydrodynamic motion of the colletive flow. It may well be possible that the apparent ideal fluid behavior in transverse motion is due to a relatively large relaxation time. A larger effective relaxation time may be understood due to the presence of non-equilibrium effects such as eddy turbulences.

References

[1] G. Bearden et al (BRAHMS collaboration), Phys. Rev. Lett. 94, 162301, H. Petersen, M. Bleicher nucl-th/0611001 and see references therein.
[2] T. Koide, G.S. Denicol, Ph. Mota, T. Kodama, Phys.Rev.C75:034909, 2007.