Collective Flow in Heavy Ion Collisions

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In heavy ion collisions collective flow observables are derived from the momentum distributions of the final baryons. In particular, the transverse components contain information on the compressional energy and thus on the equation-of-state (EOS) of nuclear matter. Usually the EOS is parametrized in terms of phenomenological non-relativistic (Skyrme-type) or relativistic (Walecka-type) funtionals of the density (and nuclear momentum). On the other hand it is of great interest to investigate whether an EOS, derived from a realistic nucleon-nucleon interaction is also able to describe heavy ion collisions. At present the most successful scheme to describe NN-scattering, nuclear matter and finite nuclei is the (relativistic) Dirac-Brückner-HF approach, which includes two-body correlations. However, different DB models have been developed, which differ, e.g. by the treatment of the negative energy contributions, and which lead to different behaviors with respect to the density and momentum dependence. To apply DB mean fields in heavy ion collisions is a way to test this behavior at higher densities and momenta.=20

However, mean fields for ground state nuclear matter are not directly applicable to heavy ion collisions, since the latter contain essential non-equilibrium effects, i.e. the local momentum distributions do not correspond to sharp Fermi spheres. Since effective interactions depend on the momentum distributions via the Bethe-Salpeter equation, they are affected by non-equilibrium effects. Approximate methods to include these into the effective mean fields in a local phase space configuration approximation were developed in our group earlier [1].

In a recent work [2] we tested in this way two particular DB-models from Groningen (Malfliet, et al.) and Tübingen (Fuchs, et al.). The Tübingen work excludes spurious negative energy contributions and leads to a slightly softer EOS and less repulsive momentum dependence. We have investigated transverse in-plane and out-of-plane flow not only inclusively but also differentially as a function of total transverse momentum. We have studied mainly Au+Au collisions between 250 and 2000 MeV per nucleon and compared to FOPI data.

We find that generally the microscopic mean fields are able to describe experimental data, provided the non-equilibrium features are taken into account. The systematic comparison to the data favours slightly the Tübingen DB-model, particularly at energies above 400 AMeV. The differences are more clearly seen for the more extensive observables. These investigations result in the unified picture that in a relativistic framework microscopic effective interactions are able to describe nuclear systems under very different conditions.

References

[1] T. Gaitanos *et al.*, Phys. Lett. **B478** (200) 79
[2] T. Gaitanos *et al.*, EPJ submitted, nucl.th/0102010.