Determination of the Equation of State in Relativistic Heavy Ion Collisions

T. Gaitanos, C. Fuchs [a], and H. H. Wolter
[a] Inst. für Theoretische Physik, Univ. Tübingen

Heavy ion reactions are studied at high energies ($E_{beam} = 100 \cdots 1000\ MeV/A$) to obtain information about the equation of state of nuclear matter. Theoretically this is done with covariant transport equations of the type of a Boltzmann equation (RBUU) [1]. In such calculations the equation-of-state enters through the parametrisation of the nuclear mean field which is often taken from the non-linear Walecka model [2]. However, such mean fields are adjusted to the ground state of nuclear matter and do not take into account the non-equilibrium anisotropic phase space configuration in a heavy ion collision. In continuation of previous work we include such effects in the so-called *Local Phase Space Configuration Approximation* (LCA), which parametrizes locally the momentum space by two Fermi spheres (or ellipsoids) of density and relative velocity which are extracted from the RBUU calculations. Relativistic mean fields for such configurations are not available; therefore we have extrapolated these from Dirac-Brueckner HF (DB) calculations for nuclear matter [3]. Thus the LCA fields contain, besides the non-equilibrium effects, also effects of antisymmetrization and correlations. In a similar way we determine the effective NN cross section in medium from the imaginary part of DB self energies [4].

The influence of different choices of the mean field on the reaction dynamic is assessed by comparing flow observables for different mean fields to experiment [5]. As an example, fig. 1 shows P_x^{dir} depending on the beam energy E_{beam} for different mean fields. The data are from experiments with the FOPI detector at the GSI [6]. Calculations with DB-LCA mean fields are able to reproduce the flow data fairly well while the phenomenological Walecka-model underestimates the data considerably. This results shows that a realistic, non-equilibrium description of the nuclear mean field is important in order to extract information on the equation of state from heavy ion collisions.

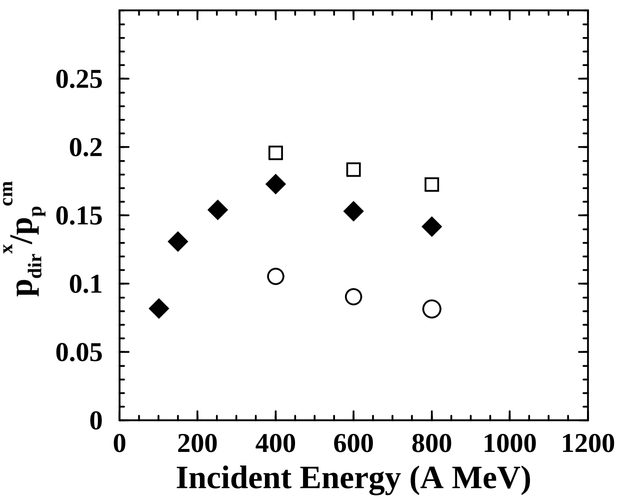

Fig. 1: Mean directed in-plane transverse flow normalized to the centre-of-mass projectile momentum per nucleon for Au on Au and multiplicity-bin ML4 corresponding to semi-central ($3 \leq b \leq 5$) collisions. RBUU-calculations were performed with DB mean fields in LCA (squares) and with the nonlinear Walecka model NL2 (circles). The experimental value (full diamonds) is taken from Ref. [6].

References

[1] C. Fuchs, H. H. Wolter, Nucl. Phys. **A589** (1995) 732
[2] J. Walecka, Ann. Phys. **83** (1994) 497
[3] L. Sehn, H. H. Wolter, Nucl. Phys. **A601** (1996) 473
[4] C. Fuchs, L. Sehn, and H. H. Wolter, Nucl. Phys. **A601** (1996) 505
[5] C. Fuchs, T. Gaitanos, and H. H. Wolter, Phys. Lett. **B381** (1996) 23
[6] A. Gobbi for the FOPI Collaboration, Nucl. Phys. **A583** (1996) 499