Radial Flow in Au+Au Collisions at E/A=100 MeV

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Central collisions between two heavy nuclei offer a unique opportunity to generate large baryonic systems at high excitation energies. In symmetric collisions the (not necessarily thermal) excitation energy can be controlled by the incident beam energy whilst keeping the size of the excited system rather constant. Thus, central collisions of symmetric target-projectile combinations are ideally suited to disentangle size and excitation energy effects and explore the evolution from multifragmentation towards a complete vaporization. A particular interesting aspect of these collisions is the large radial flow which is expected to govern the dynamics of the reaction zone. The radial flow may be quantified by analyzing kinetic energy spectra of light and intermediate mass fragments. Here, results for Au+Au collisions obtained by the ALADIN+MINIBALL/-WALL collaboration at E/A=100 MeV are presented. At this incident energy, the maximum mean fragment multiplicity in central collisions is observed [1]. In the present analysis, central collisions corresponding to a reconstructed impact parameter window from 0-3 fm were selected by a cut on the total charged particle multiplicity detected in the MINIBALL/-WALL.

Mean kinetic energies per nucleon in the cm-system as a function of the cm-angle are displayed in Fig. 1. Except for the Z=1 fragments, distortions of the mean kinetic energy due to detector thresholds and the limited angular acceptance are rather small for cm-angles between 45° and 135°. Within this region, a clear increase of the mean kinetic energies along the beam axis is observed.

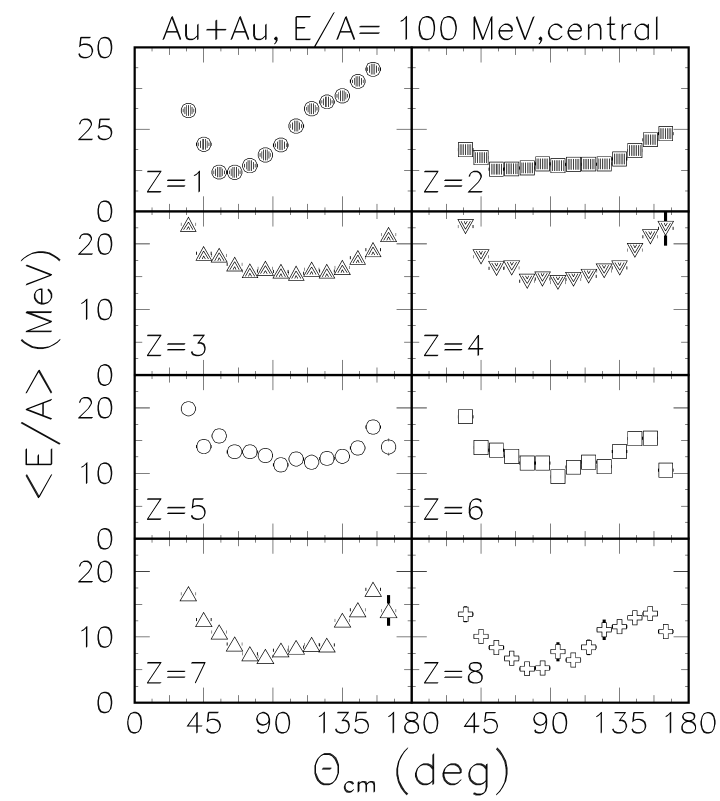

Figure 1: Mean kinetic energy per nucleon in the cm-system as a function of the cm-angle for Au+Au collisions at E/A=100 MeV. Central events corresponding to a reconstructed impact parameter from 0-3 fm were selected. The data are not corrected for the experimental detection efficiency.

Contaminations from non-central collisions as a consequence of an imprecise impact parameter reconstruction may mimic an additional collective flow along the beam axis. Indeed, calculations [2] within the framework of the QMD-model suggest that the observed anisotropy of the mean kinetic energies is caused by an admixture from non-central collisions. We, therefore, focus in the following on kinetic energy spectra of particles emitted to cm-angles close to Θ_{cm}=90°.

Fig. 2 shows the invariant cross section of fragments with element numbers Z=1-8 emitted in the range from Θ_{cm}=80° to 100° as a function of their kinetic energy per nucleon. For clarity, data points for neighboring elements are separated by a factor of 10. For a quantitative analysis of these spectra it was assumed that the kinetic energy distributions are given by a thermal contribution which is superimposed on a self-similar flow-velocity profile [3]. For fragments with charge $Z \in [3, 6]$ the mean collective flow energy per nucleon varies - depending on the value of the assumed thermalized energy - between $\langle E/A \rangle = 7$ and 16 MeV. (For a given temperature the variation of $\langle E/A \rangle$ is only ±3 MeV.) The observed spectra of the heavier fragments with Z=7 and 8 can not be described by these flow values and exclude independent of the choice of the temperature parameter mean flow energies larger than 6 MeV.

The question whether this dependence of the collective flow energy per nucleon on the element number can be traced back to different spatial source distributions is presently being explored by means of microscopic model calculations.

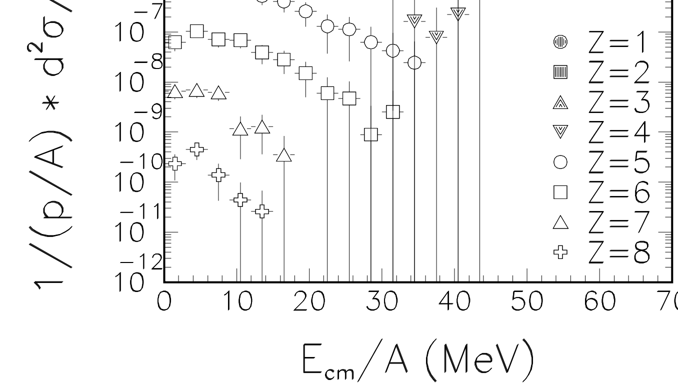

Figure 2: Invariant cross sections of fragments produced in central Au+Au collisions at E/A=100 MeV and emitted at Θ_{cm} = 80-100°.

[1] M.B. Tsang *et al.*, Phys. Rev. Lett. **71**, 1502 (1993).
[2] G.J. Kunde, PhD thesis, Universität Frankfurt (1994).
[3] J.P. Bondorf *et al.*, Nucl. Phys. A**296**, 320 (1978).

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