Probing Collective Dynamics in Ultra-relativistic $^{197}Au +^{197} Au$ collisions at $\sqrt{s_{NN}} = 200$ GeV

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The study of collective expansion plays a key role in understanding the dynamics of nuclear collisions. Initially, there is approximately no motion in transverse direction with respect to the initial direction of the colliding nuclei. All transverse motion must have been created in the collision. The observed strength of the collective motion is accumulated during both the partonic stage when quarks and gluons are the relevant degrees of freedom and through hadronic re-scattering.

In order to quantify the collective expansion in transverse radial direction, we fit transverse momnentum distributions of identified particles within a simple model [1] motivated by hydrodynamics. This model assumes a particle emitting thermal source descibed by a temperature T_{fo} and incorporates transverse radial expansion by a collective velocity parameter β_T. Figure 1 shows results from fits which simultaneously describe experimental spectra of charged pions, kaons, protons and antiprotons [2] for central collisions (1) to peripheral collisions (9). The 1–σ and 2–σ confidence interval are displayed by solid and dashed lines respectively. With increasing centrality, the temperature T_{fo} at the systems kinetic freeze-out is decreasing indicating a longer expansion time which leads to a stronger cooling. Further, the collective velocity parameter β_T is increasing with centrality and then saturates at $\beta_T = (0.60 \pm 0.08)c$. This value of β_T is the largest ever observed in nuclear collisions. It is interesting to note, that results from $p + p$ collisions (single dashed line) at $\sqrt{s_{NN}} = 200$ GeV are best described by fits with $\beta_T \approx 0.2c$. Also shown are fit results for the multi-strange ϕ and Ω from most central collisions [3]. These particles freeze out at a higher temperature close to the predicted phase boundary of hadronic matter [4]. Hence, these mutli-strange particles seem to interact less at the hadronic stage and might give direct insight into the earlier possibly partonic stage with quarks and gluons as the relevant degrees of freedom. The measurement of particles with charm content, i.e. $D^0, D^{\pm}, D_s^{\pm}$ and Λ_c^+ would be of fundamental interest.

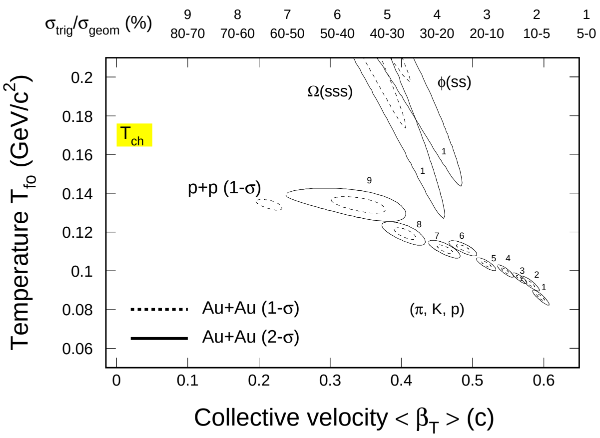

FIG. 1: The 1–σ (solid lines) and 2–σ (dashed lines) confidence intervals of the thermal fits parameters T_{fo} and β_T for π, K, p and $\overline{p}$ from most central (1) to most peripheral (9) $^{197}Au +^{197} Au$ collisions at $\sqrt{s_{NN}} = 200$ GeV. Also shown are results for multi-strange particles ϕ and Ω from central $^{197}Au +^{197} Au$ collisions. Results for π, K, p and $\overline{p}$ from $p + p$ collisions are shown by the single dashed line.

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