Rapidity and centrality dependence of the $K/\pi$ ratios in Au+Au collisions at 62.4 GeV

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Outline

• Experimental setup and analysis issues
• Models employed for comparison
• Rapidity dependence of yields and ratios in central Au+Au collisions at 62.4 GeV
• Results from non-central collisions
• Discussions
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BRAHMS setup

Colliding systems studied:
- Au+Au
- d+Au
- p+p
- Cu+Cu

Energies:
- 200, 130, 62.4 GeV

Physical observables of interest:
- $R_{AA}$, $R_{cp}$, yields, $v_2$, particle ratios

Most important:
The rapidity dependence of these observables

The time of flight detectors at mid-rapidity ensure good pion/kaon/proton separation up to ~3 GeV/c. RICH at forward rapidity separates pions and kaons up to ~25 GeV and protons up to ~30 GeV.
Models employed for comparison with the data

  - *(A Multiphase Transport model)* includes both partonic and hadronic interactions
  - Initial space-time information for partons and strings → HIJING
  - Minijet parton scattering using the parton cascade model ZPC
  - String fragmentation → Lund model
  - The hadronic cascade treated via ART

- **UrQMD v2.3** S.A.Bass et al. (1998), M.Bleicher et al. (1999)
  - *(Ultra relativistic Quantum Molecular Dynamics)* is a microscopic transport model
  - The main mechanism is color strings excitation and their subsequent fragmentation into hadrons followed by a hadronic cascade
  - In the latest version UrQMD includes PYTHIA for high pt generation.
Centrality selection in the models

The Multiplicity Array (MA) response for the simulated events.

We simulate the number of hits in our centrality detector for every event generated by the models and apply the same cuts on multiplicity as for the experimental data.
The invariant spectra and fitting

The pion spectra was fitted best with power law functions, while the kaons were fitted with $mT$ exponential functions. The yields were extracted as parameters from the fit functions.
Rapidity dependence of integrated yields in 0-10% central Au+Au collisions at 62.4 GeV

\(<pt> \text{ and effective temperatures drop at forward rapidity}

anti-p/p = 0.47 at y=0
anti-p/p = 0.023 at y=3.0
Models seem not to explain the absolute value of $K^+$/pi+ ratio at forward rapidity. However, UrQMD seems to qualitatively reproduce the trend of the data.
Relative abundancies dependence on baryo-chemical potential

The model calculations in the left figure are made only at 62.4 GeV. The effective temperatures are extracted using $m_t$ exponentials.
Centrality dependence of yields at mid-rapidity

STAR points are from hep-ex/0808.2041

For comparison we use here the same set of npart obtained trough a MC Glauber model (see STAR paper)
Centrality dependence of yields at mid-rapidity

\[ \sqrt{s_{NN}} = 62.4 \text{ GeV} \]
\[ y = 0 \]

STAR points are from hep-ex/0808.2041

For comparison we use here the same set of npart obtained through a MC Glauber model (see STAR paper)
Centrality dependence of yields at mid-rapidity

\[ \sqrt{s_{NN}} = 62.4 \text{ GeV} \]
\[ y = 0 \]

STAR points are from hep-ex/0808.2041

For comparison we use here the same set of npart obtained through a MC Glauber model (see STAR paper)
Centrality dependence of yields at $y \sim 3$

We observe an increase of pions and protons in the more peripheral bins.
Net-protons versus rapidity and centrality

The fragmentation peak is shifting towards higher rapidities in less central collisions.
Average $\langle pt \rangle$ dependence on centrality and rapidity

Stronger decrease in $\langle pt \rangle$ for heavier particles

No visible $\langle pt \rangle$ dependence on centrality at forward rapidity.
Pion effective temperatures are obtained by fitting the spectra below 1 GeV/c with $m_t$ exponentials.
Anti-particle/particle ratios dependence on centrality

\[ \sqrt{s_{NN}} = 62.4 \text{ GeV} \]
\[ y \approx 3 \]

Graphs showing the ratio of anti-particles to particles in different collisions (p+p, Cu+Cu, Au+Au) as a function of event multiplicity (npart). The graphs compare experimental data with simulations from AMPTv1.11 and UrQMDv2.3.
K/π ratios drop as the system becomes smaller.
K/πi ratios $y=2.7$

K/πi ratio seems to drop also at forward rapidity.
Explanations

Chemical non-equilibrium, canonical suppression

Core-corona models:
J. Manninen, F. Becattini (2005)
Summary

- We measured rapidity and centrality dependent yields of identified particles in Au+Au, Cu+Cu and p+p collisions at 62.4 GeV.

- The K/pi and K-/K+ ratios measured at forward rapidity in Au+Au collisions at 62.4 GeV seem to have a common dependence, on the anti-p/p ratio, with the same ratios measured at SPS energies at mid-rapidity.

- The K/pi ratios at mid-rapidity were found to decrease with decreasing system size. This feature is possibly explained by chemical non-equilibrium and core-corona type of models.