Kaon femtoscopic measurements from 200 GeV p+p and Au+Au collisions at STAR

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• Introduction

• Basics of the correlation femtoscopy

• Kaon femtoscopic measurements
  – p+p collisions at $\sqrt{s}=200$ GeV
  – Au+Au collisions at $\sqrt{s_{\text{NN}}}=200$ GeV

• Summary
Charged kaon correlation femtoscopy

• Femtoscopy with *strange particles*
  – Kaon scattering cross-sections are smaller than those for pions, hence *kaons may provide information about a different stage of the collision evolution*
  – Access to the *higher transverse mass* regions compared to pions

• *Clean probe of the emitting source*
  – Smaller contamination from the resonance decays compared with pions
Correlation femtoscopy

- Allows to extract **spatial and temporal parameters of the emitting source** by using particle correlations due to the quantum statistics (QS)

- Two-particle correlation function (CF):
  \[ C(p_1, p_2) = \frac{P_2(p_1, p_2)}{P_1(p_1)P_1(p_2)} \]

- Experimentally:
  \[ C(q_{\text{inv}}) = \frac{A(q_{\text{inv}})}{B(q_{\text{inv}})} \]
  
  \( q_{\text{inv}} \) - relative 4-momentum of the pair
  \( A(q_{\text{inv}}) \) - pair distribution from the same event (contain QS correlations)
  \( B(q_{\text{inv}}) \) - uncorrelated reference sample (event mixing technique)
Fitting procedures

• Correlation functions are fitted by a Bowler-Sinyukov function:
  \[ C(q_{\text{inv}}) = N(1 - \lambda + K(q_{\text{inv}})(1+\exp(-R_{\text{inv}}^2 q_{\text{inv}}^2)))D(q_{\text{inv}}) \]
  - \( N \) - normalization factor
  - \( \lambda \) - correlation strength
  - \( K(q_{\text{inv}}) \) - Coulomb function integrated over a spherical source
  - \( D(q_{\text{inv}}) \) - baseline function, that takes into account non-femtoscopic correlations (important for p+p collisions)

• In order to eliminate possible biases due to the construction of the reference sample in p+p collisions, the measured CFs are corrected on the simulated distributions (contain neither QS correlations nor Final State Interactions) by constructing the double ratio before the fitting:
  \[ C(q_{\text{inv}}) = \frac{\frac{dN_{\text{exp}}^\text{MC}(q_{\text{inv}})/dq_{\text{inv}}}{dN_{\text{ref}}^\text{MC}(q_{\text{inv}})/dq_{\text{inv}}}}{\frac{dN_{\text{exp}}^\text{MC}(q_{\text{inv}})/dq_{\text{inv}}}{dN_{\text{ref}}^\text{MC}(q_{\text{inv}})/dq_{\text{inv}}}} \]

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STAR detectors

- Large acceptance mid-rapidity detector
- Full azimuthal coverage (|η|<1)
- Excellent particle identification
MC generator PYTHIA-6.4.28 with Perugia0 tune is used to describe the non-femtoscopic correlations.

For overlapping $m_T$, the radius parameters for pions and kaons are consistent with each other within uncertainties.
• Source radii for positively and negatively charged kaons are consistent within the uncertainties.
• The emitting source radii increase with centrality (multiplicity) and decrease with pair transverse momentum.
• For the given multiplicity, the kaon source radii are smaller than those for pions → kaons and pions are not emitted from the same space-time position for Au+Au collisions.

Also see Jindřich Lidrych talk.
Conclusions

Like-sign kaon femtoscopy in p+p collisions
• Slight decrease of the charged kaons source radii with increasing $k_T$
• Radius parameters for pions and kaons are consistent with each other within uncertainties for the overlapping $m_T$

Charged kaon correlations in Au+Au collisions
• The source radii of positively and negatively charged kaons are consistent within the uncertainties
• The emitting source radii of charged kaons decrease with increasing pair transverse momentum and increase with the collision centrality
• Kaon source size is smaller compare to pions for the given multiplicity