Neutral kaon femtoscopy in Au+Au collisions measured at STAR experiment

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Abstract

The **Solenoidal Tracker at RHIC** (STAR) enables the possibility of exploring the properties of strongly interacting nuclear matter using the method of femtoscopy. By studying the quantum statistical effects and final state interactions between two particles, one can extract emission source parameters, which describe geometrical and dynamical properties of the homeogenity region. We use the high statistics data of Au+Au collisions recorded by the STAR experiment to study the correlations between strange particles. The lightest strange particles are kaons. Kaons are less affected by resonances decays and provide a cleaner signal of two-particle correlations. Neutral kaons, K^0_s, can be measured through their decay products to the pair of charged pions.

The Solenoidal Tracker at RHIC

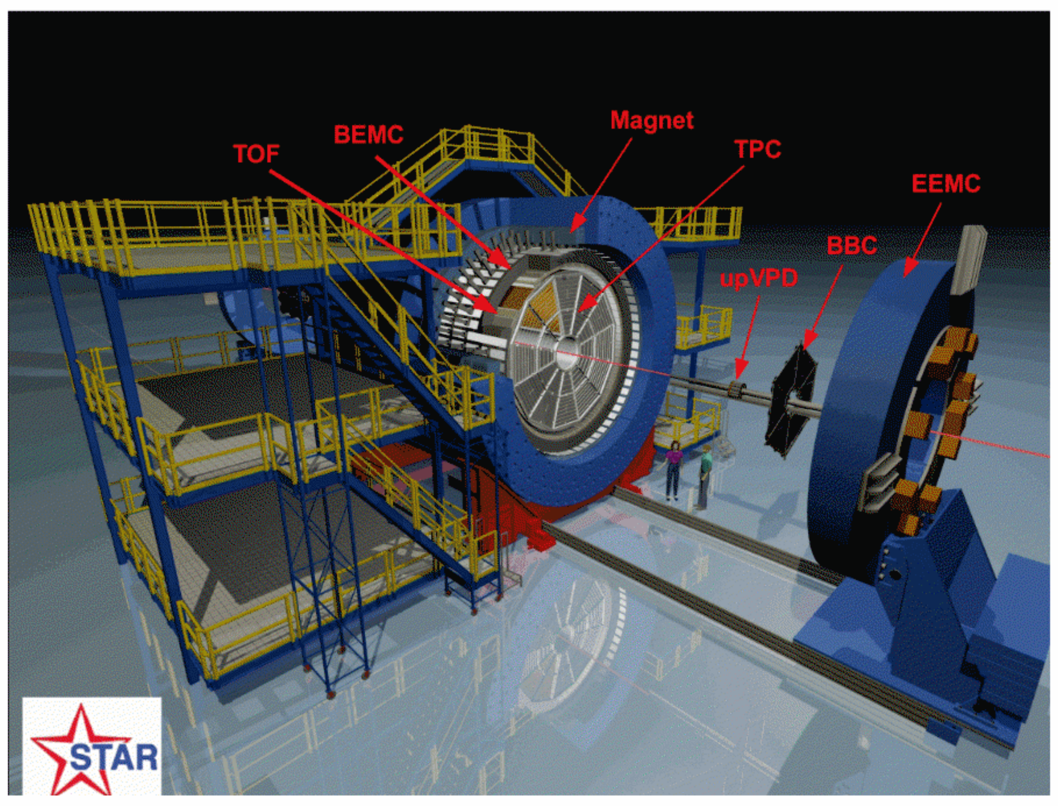

Fig. 1. Diagram of the STAR detector [1].

Kaon identification was performed using information from two detectors:

- **Time Projection Chamber (TPC)** – identification was done via specific ionization energy loss (dE/dx);
- **Time-Of-Flight (TOF)** – measurement of velocity of a particle based on its time of passage through the length of the detector.

Femtoscopy

Femtoscopy – a method to examine **the particle emitting source sizes** (of the order of 10^{-15} m) by measurements of relative momentum characteristics [2].

The correlation function (CF) – the ratio of probability of observing two particles with specific momenta $\mathbf{p_1}$ and $\mathbf{p_2}$ at the same place and time (P_2) to the product of probabilities to find them separately (P_1) [3]:

$$CF(\vec{p}_1, \vec{p}_2) = \frac{P_2(\vec{p}_1, \vec{p}_2)}{P_1(\vec{p}_1) P_1(\vec{p}_2)}$$

The experimental correlation function:

$$CF(q_{inv}) = \frac{A(q_{inv})}{B(q_{inv})}$$

$A(q_{inv})$ – the signal distribution,

$B(q_{inv})$ – the background distribution,

$$q_{inv} = \sqrt{(\vec{p}_1 - \vec{p}_2)^2 - (E_1 - E_2)^2}$$

Parametrization

Gaussian density distribution (includes only QS effects):

$$CF(q_{inv}) = 1 + \lambda \exp(-R_{inv} q_{inv})$$

λ – the correlation strength

R_{inv} – the size of the particle-emitting source

Lednicky and Lyuboshitz model includes strong FSI was used to fit the K^0K^0 correlation functions [4].

Armenteros – Podolanski plot

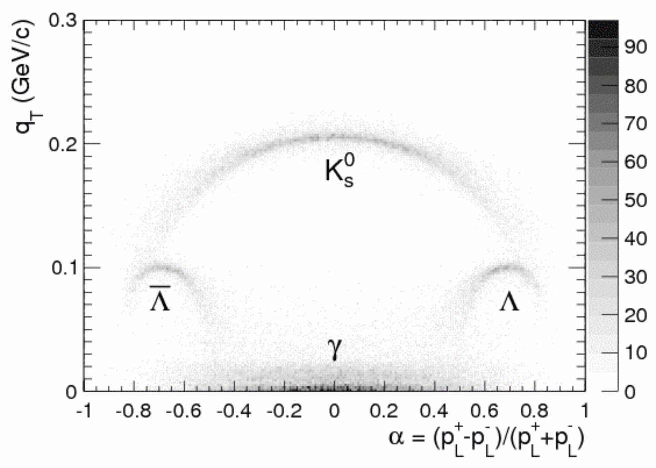

Fig. 2. Armenteros – Podolanski plot [5].

The kinematic properties of the V^0 candidates:

$$K^0_S \rightarrow \pi^+ + \pi^-$$

π^+ and π^- have the same mass and their momenta are distributed symmetrically on average.

Summary

- Kaon femtoscopy – a complementary method to pion femtoscopy
- Allows one to learn about the final state interaction
- Neutral kaon source size ~5 fm for the minimum bias collisions
- Purity correction slightly reduces the extracted size of the particle-emitting source

Neutral kaon results

p_T [GeV/c]	0.2-1.5	DCA of daughter [cm]	< 0.3
|η|	< 0.5	decay length [cm]	> 2
DCA V^0 to the PV [cm]	< 0.3	mass range [GeV/c²]	0.488 – 0.51

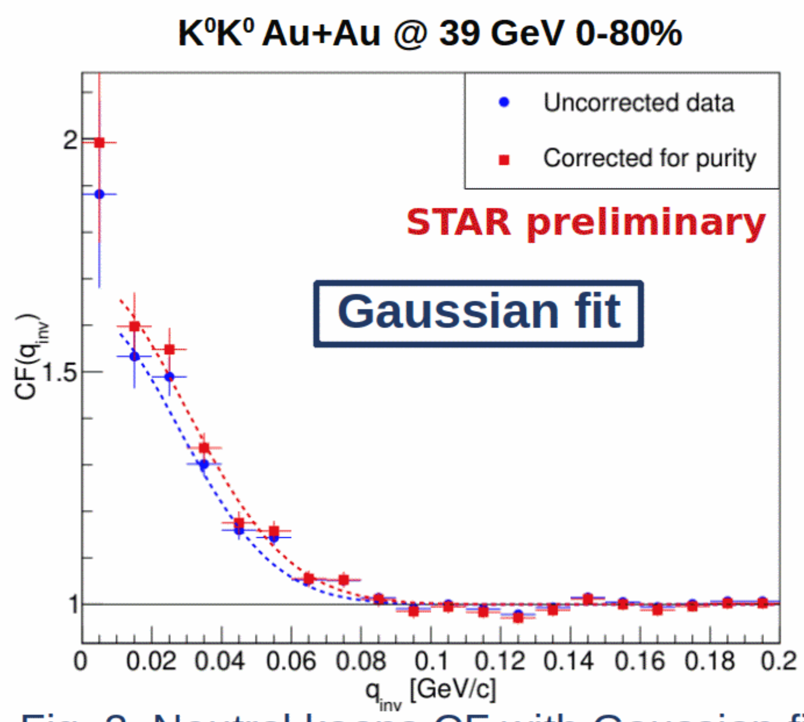

Fig. 3. Neutral kaons CF with Gaussian fit.

Before purity correction:

R = 5.08 ± 0.19 fm
λ = 0.630 ± 0.051

After purity correction:

R = 4.72 ± 0.20 fm
λ = 0.701 ± 0.056

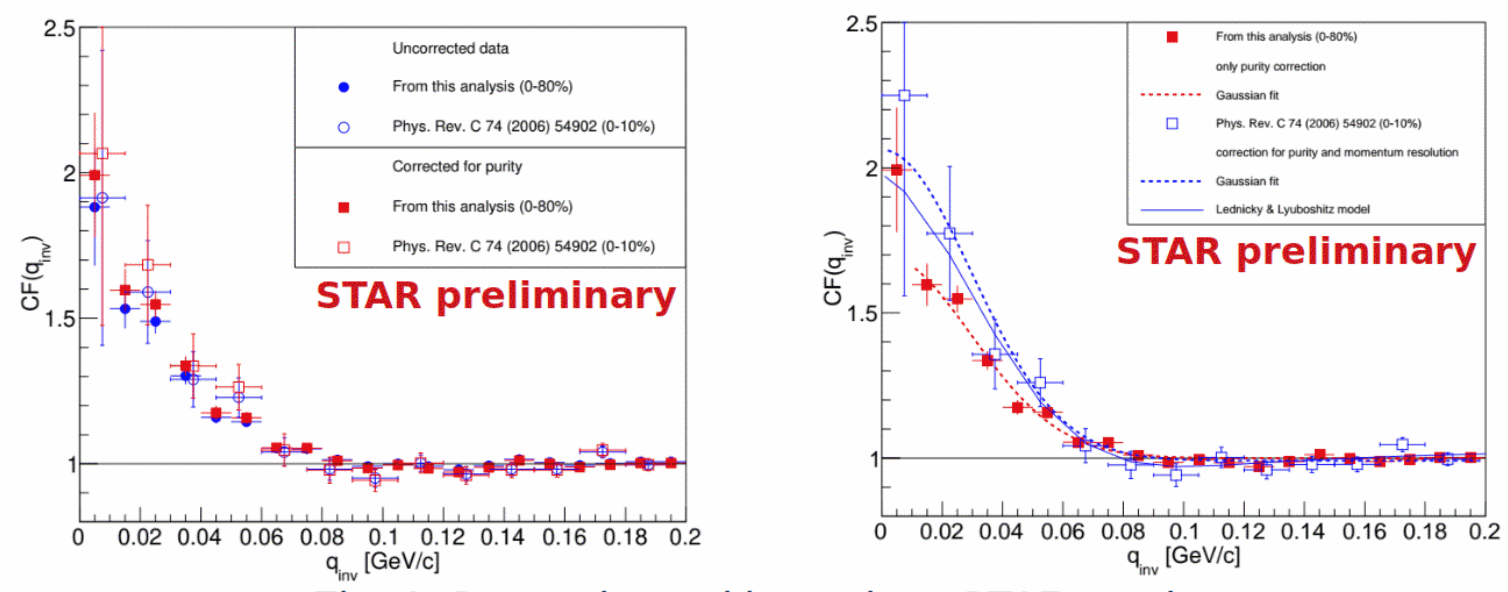

Fig. 4. Comparison with previous STAR result.

References

[1] Maria and Alex Schmah
[2] Hanbury Brown, R. and Twiss, R., Phil. Mag. 45 (1954) 663.
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[4] Lednicky, R. and Lyuboshitz, V., Sov.J.Nucl.Phys. 35 (1982) 770.
[5] Aamodt, K., et al., Eur. Phys. J. C 71 (2011) 1594.

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The STAR Collaboration
drupal.star.bnl.gov/STAR/presentations

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