Λ*(1520)

as a new potential source of K⁻ meson emission in heavy-ion collisions around kaon threshold.

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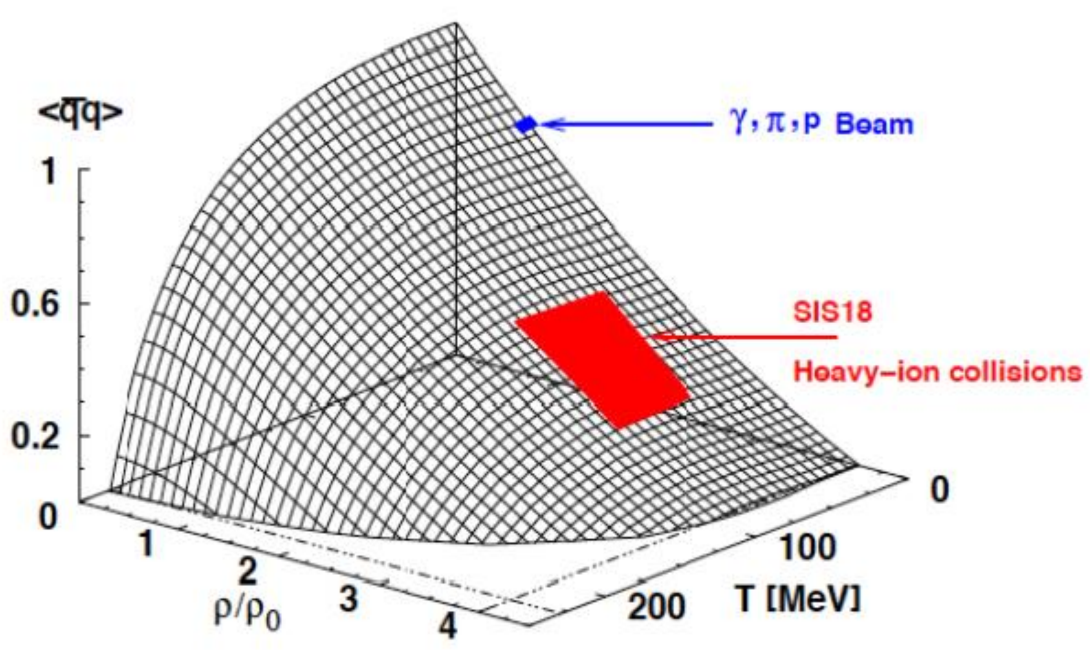
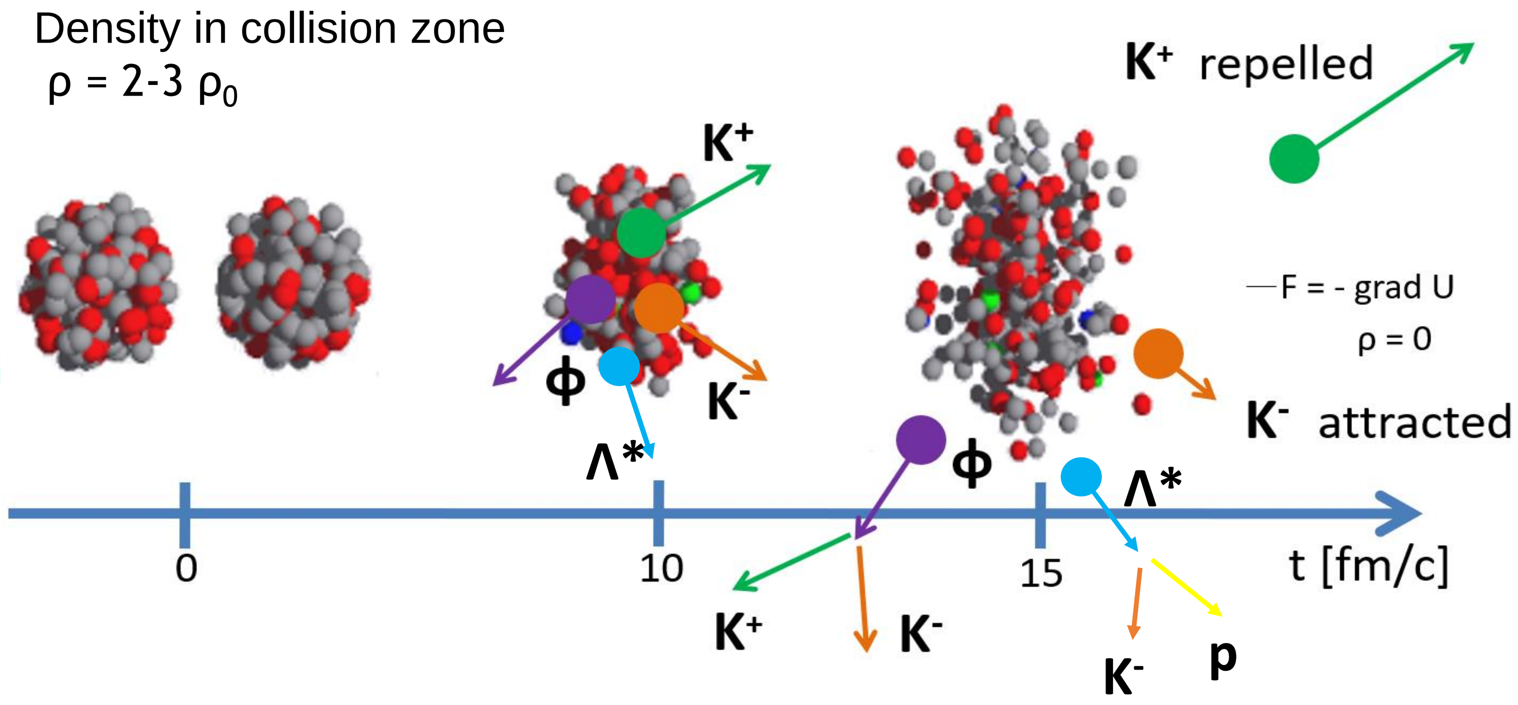
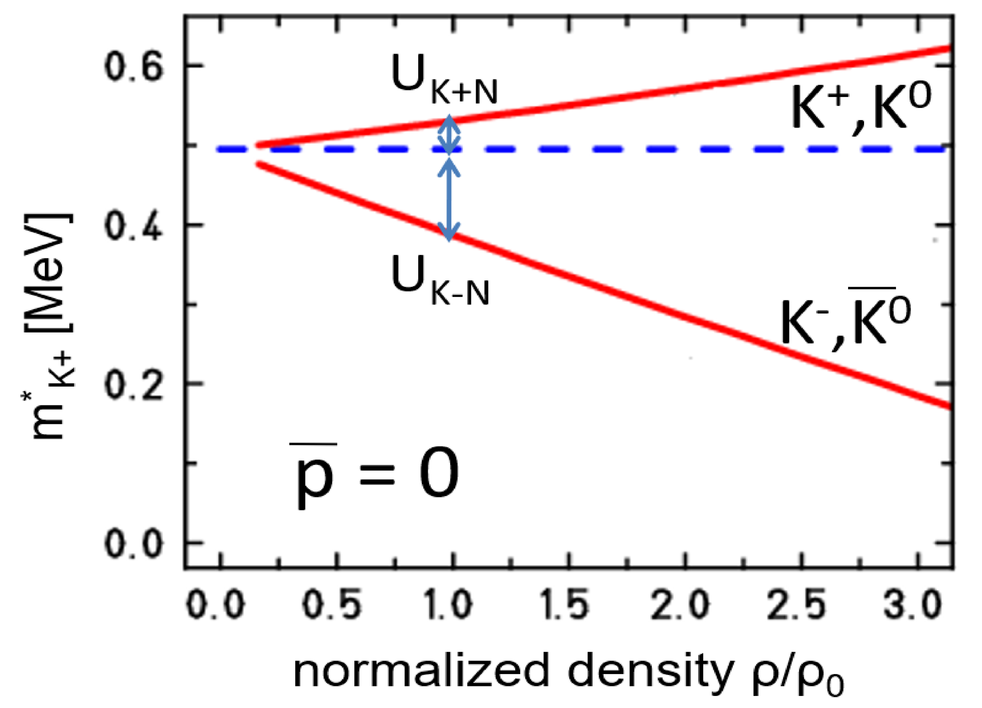
Physics Motivation







Gell-Mann-Oakes- Renner relations:

$$m_K^{*\,2} f_K^{*\,2} = -\frac{m_u + m_s}{2} < \bar{u}u + \bar{s}s > + \theta(m_s^2)$$

decay constant

mass

Nucleus – Nucleus collision at beam Energy of 1 – 2A GeV

- Time of collision — t ~ **20 – 30 fm/c** ~ **10^{-22} s**
- Temperature of nuclear matter — T ~ **70 MeV**
- Density of nuclear matter — ρ = **2 – 3 ρ_0** (ρ_0 = 0.17 fm^{-3})
- NN → NK⁺Λ — T_{th_lab} = **1.6** GeV
- NN → NNK⁻K⁺ — T_{th_lab} = **2.5** GeV

Effects induced by in-medium potential:

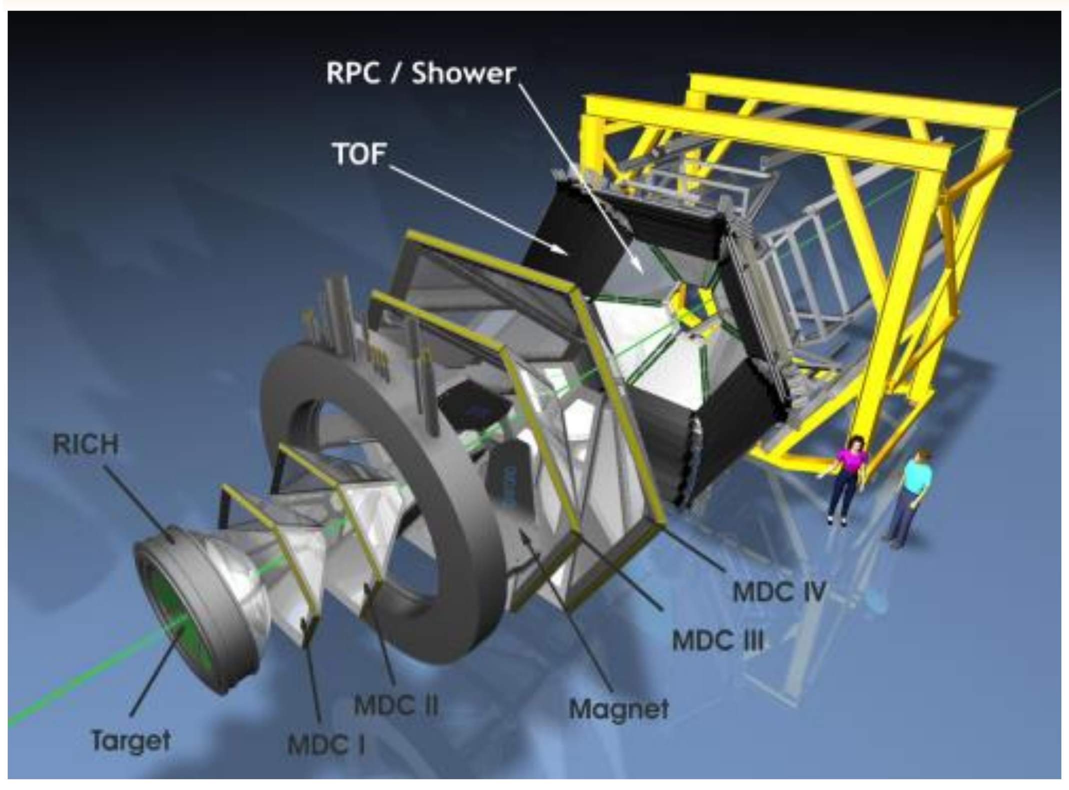
m_{K^+} ↗ K⁺ accelerates (repulsion)

m_{K^-} ↘ K⁻ slows down (attraction)

In such conditions, quantum chromodynamics (QCD) predicts the partial restoration of the chiral symmetry due to dropping value of the quark-antiquark condensate <q̄q>. The collision zone may produce new hadrons including the ones containing the strange quark, like K±, ϕ or Λ*(1520). The basic properties of particles (like mass and decay constant) are expected to be modified with respect to their values in vacuum.

Experimental setups

HADES



SIS-18 (GSI Darmstadt)

Statistics: ~**10^9 events**

HADES acceptance

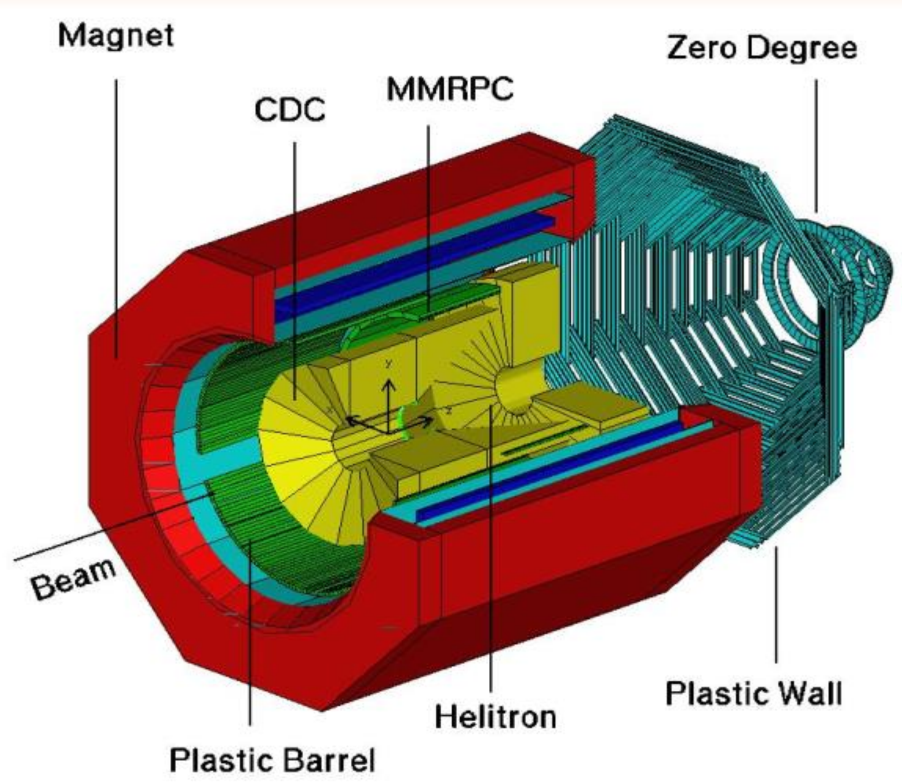
MDC: 18˚ ≤ θ_{lab} ≤ 85˚

RPC : 18˚ ≤ θ_{lab} ≤ 45˚

TOF: 44˚ ≤ θ_{lab} ≤ 88˚

Full azimuth

FOPI



SIS-18 (GSI Darmstadt)

Statistics: ~**10^8 events**

FOPI acceptance

CDC: 27˚ ≤ θ_{lab} ≤ 113˚

MMRPC : 30˚ ≤ θ_{lab} ≤ 53˚

Plastic Barrel: 55˚ ≤ θ_{lab} ≤ 110˚

Full azimuth

Estimation of the Λ*(1520) yield

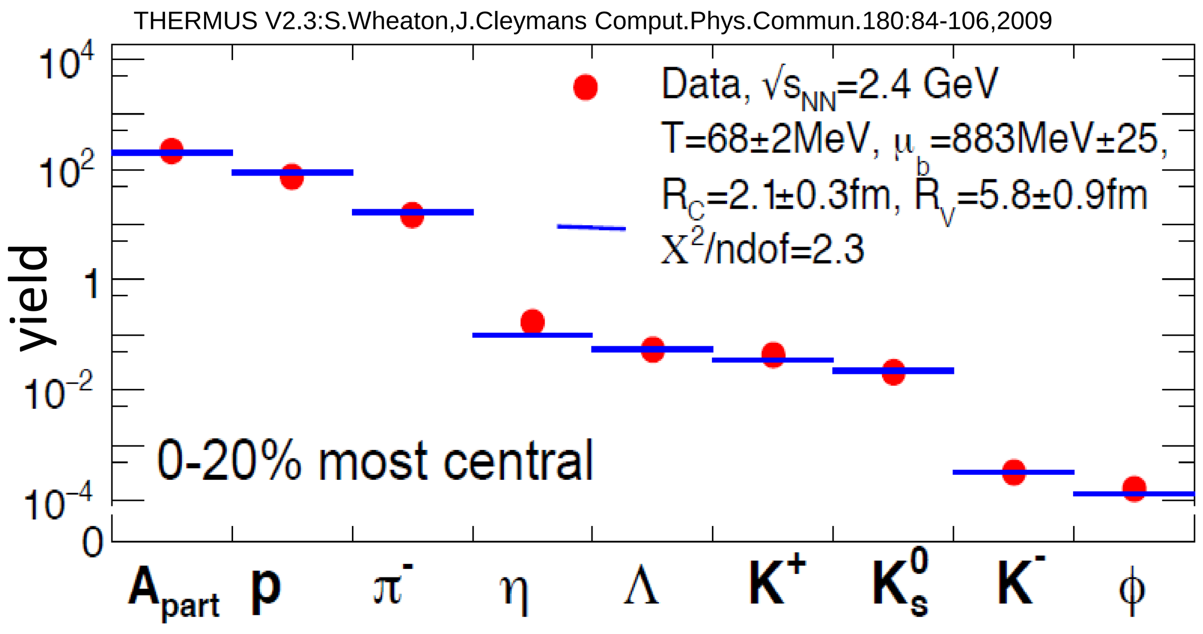
Contribution to the K⁻ spectrum: **Λ*(1520) → pK⁻** (BR≈ 22%) decay channel : **not measured yet** at energies around the kaon threshold!

The kinematics of K⁻ mesons produced in decay channel is different than that of kaons emitted directly from the collision zone, hence separation kaons needed.

Two sets of experimentally obtained yields HADES and FOPI experiments → fitted with the **THERMUS** statistical model code.

Based on the obtained parameters, the yields of Λ*(1520) were extracted in each case. This allows to estimate the contribution of Λ*(1520) to the K⁻ yield.

THERMUS V2.3:S.Wheaton,J.Cleymans Comput.Phys.Commun.180:84-106,2009



Au + Au @ 1.23A GeV
HADES

$$\frac{P(\Lambda^*(1520))}{P(K^-)} = 0.74$$

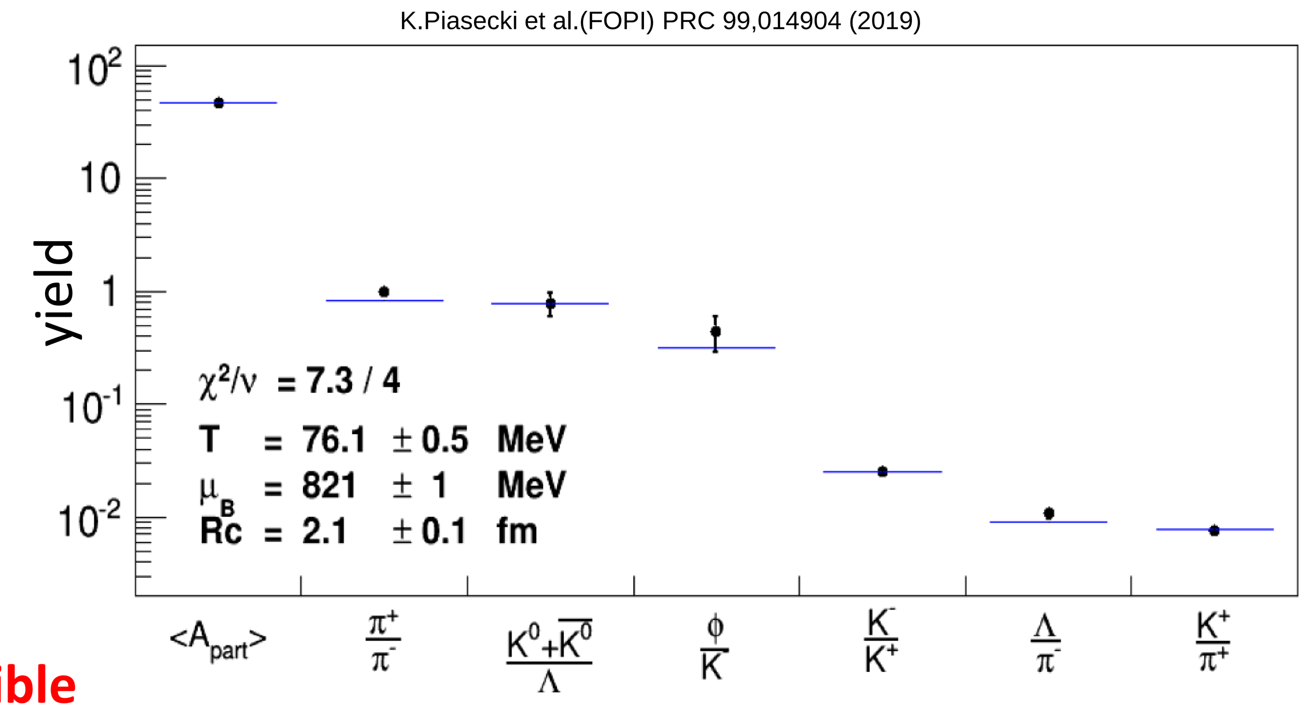
$$\frac{P(\Lambda^*(1520) \to K^-)}{P(K^-)} = 16\%$$

Ni + Ni @ 1.91A GeV
FOPI

$$\frac{P(\Lambda^*(1520))}{P(K^-)} = 0.46$$

$$\frac{P(\Lambda^*(1520) \to K^-)}{P(K^-)} = 10\%$$

K.Piasecki et al.(FOPI) PRC 99,014904 (2019)



The contribution of Λ* to the K⁻ should be **non-negligible**

(March 2019) HADES Collaboration carried out the experiment Ag+Ag at 1.58A GeV

- Very high statistics (**10^{10} events**)
- Good resolution

→ Chance for precise reconstruction of K⁻ and Λ*(1520) signals