Strangeness Production In Nucleus-Nucleus Collisions

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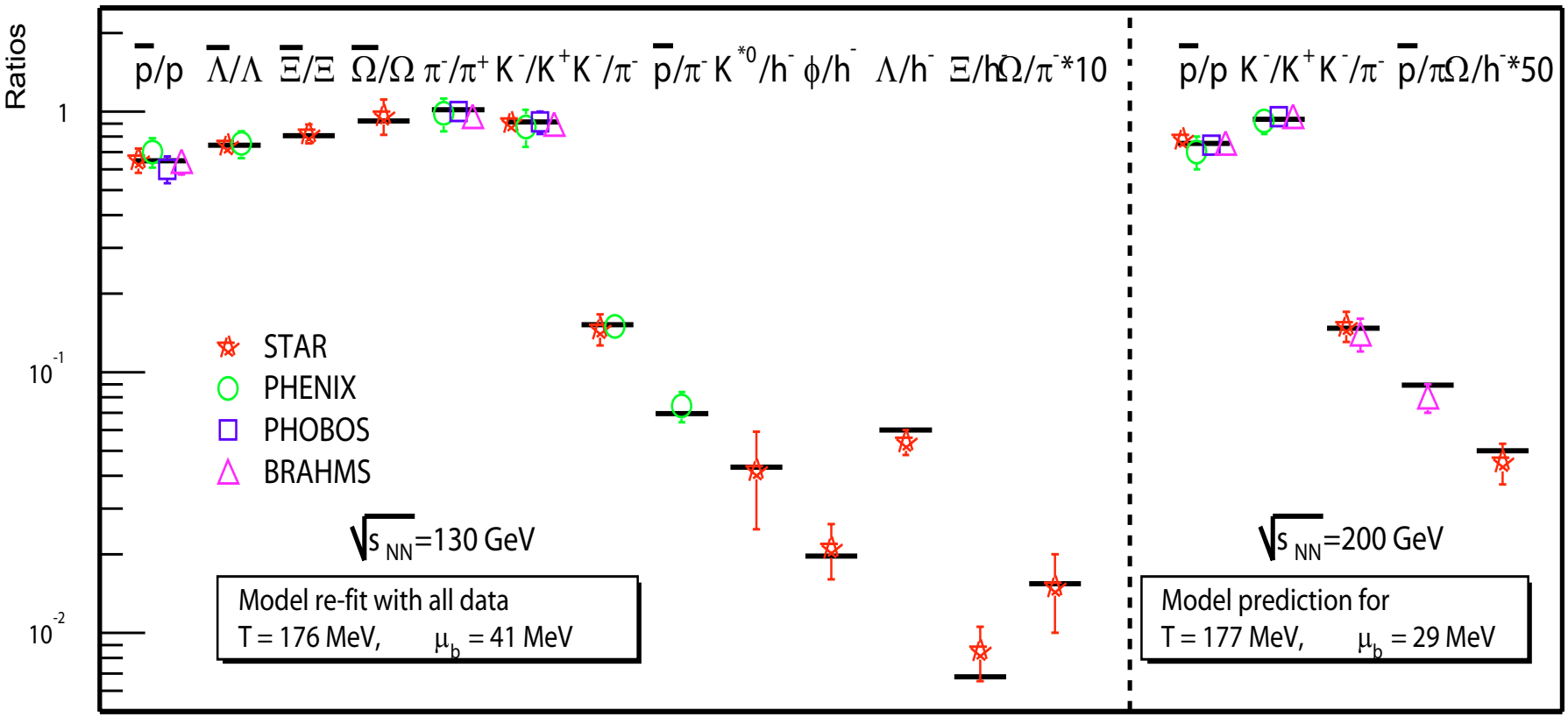
Outline

statistical model in canonical formulation

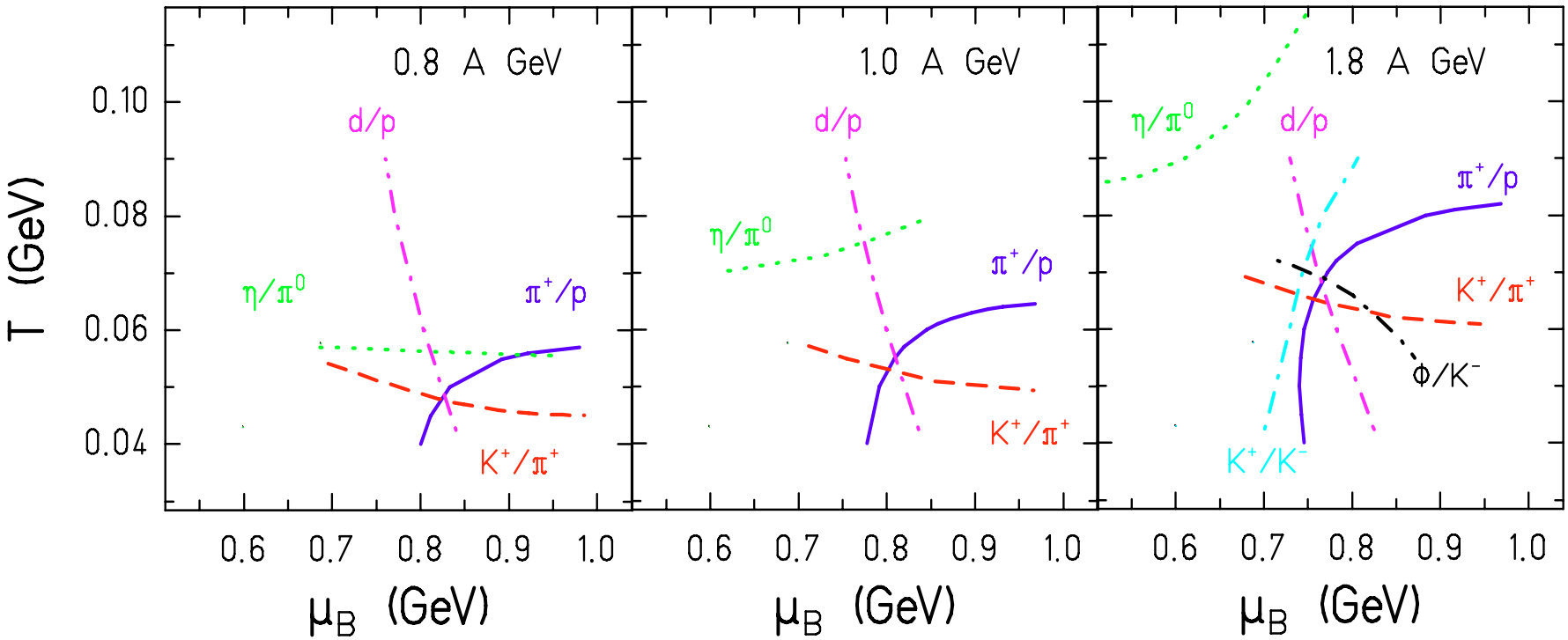
- Strangeness enhancement at SPS
- K^- K^+ in AA versus pp at SIS
- SIS -> AGS
- Xi at 6 AGeV
- Maximum in K^+/π^+ around 30 AGeV

Statistical Model

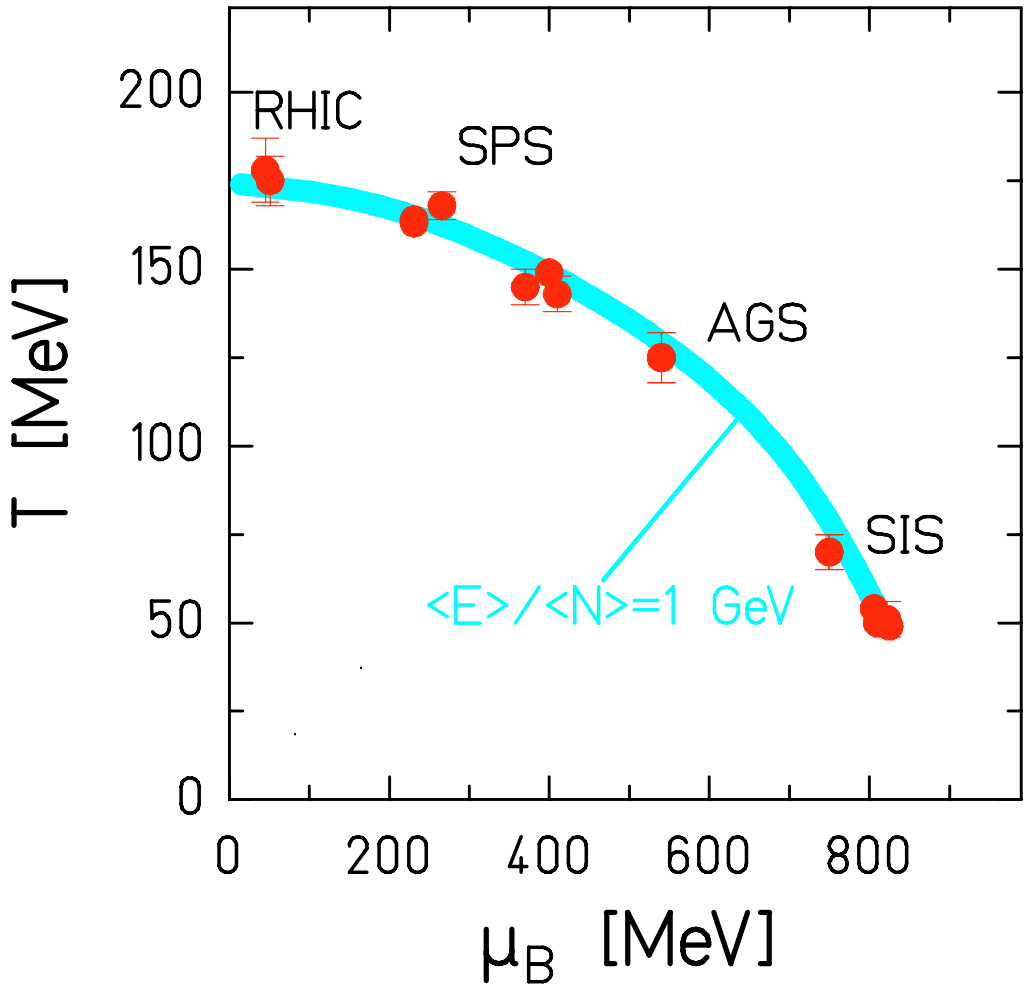


P. Braun-Munzinger, D. Magestro, K. Redlich, J. Stachel, PL B518 (2001) updated

Statistical Model for SIS



Chemical Freeze Out



J. Cleymans and K. Redlich, PRL 81 (1998) 5284

Statistical Model for Rare Processes

Pion density

$n(\pi) = exp(-E_\pi/T)$

Strangeness is conserved!

Kaon density

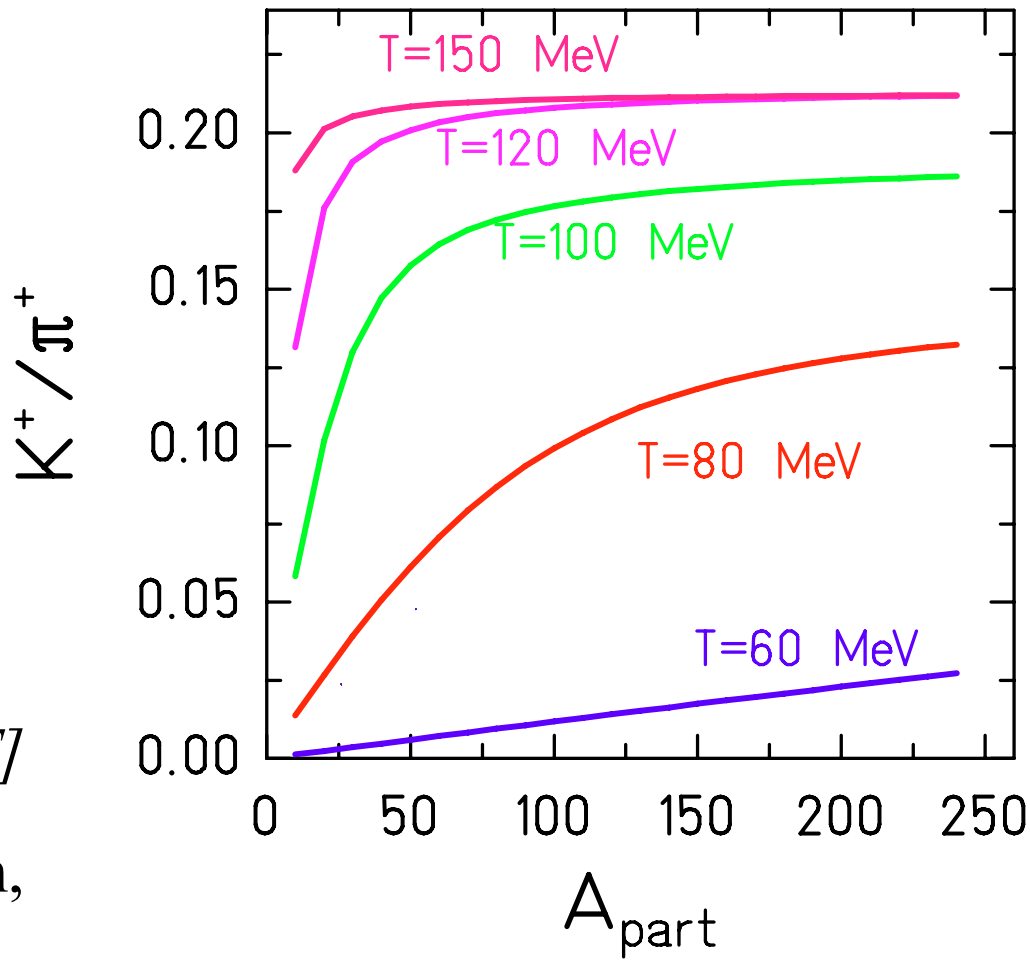
$NN \leftrightarrows N\,\Lambda\,K^+$

$n(K) = exp(-E_K/T)$

$[g\,V \int ... exp[-(E_\Lambda - \mu_B)/T]$

J. Cleymans, HO, K. Redlich,

PRC 60 (1999)



Statistical Model for low T

KaoS Data: M. Mang et al.

Pions/A_{part} constant

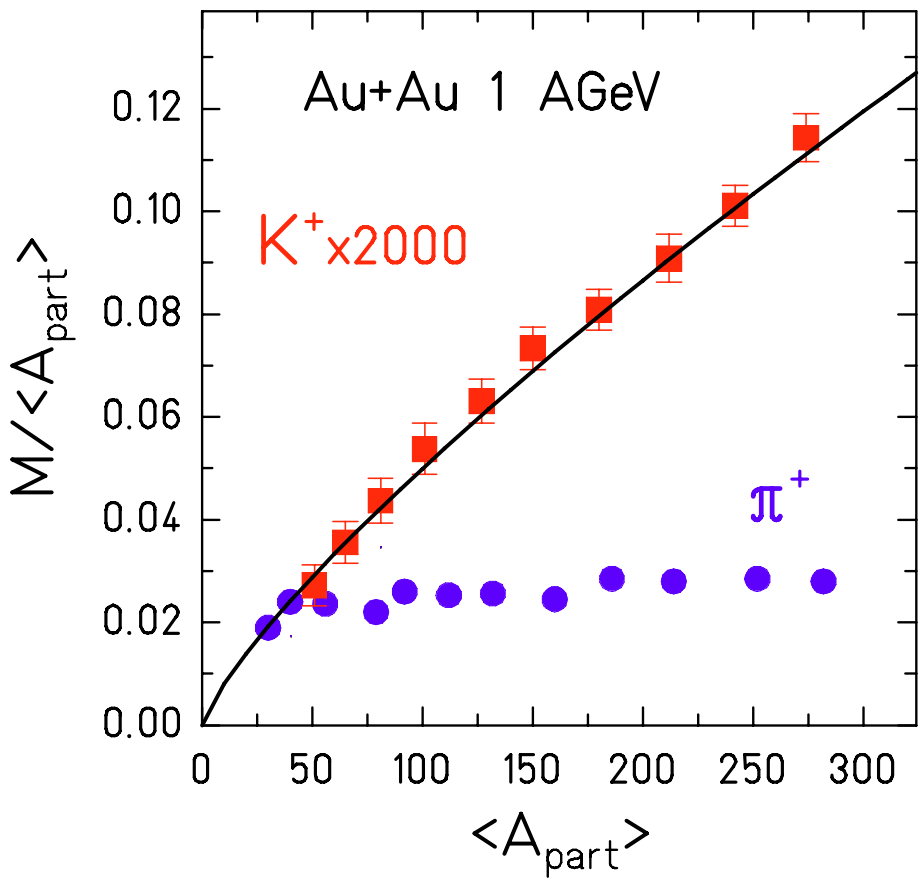
grand-canonical!

Kaons/A_{part} rising

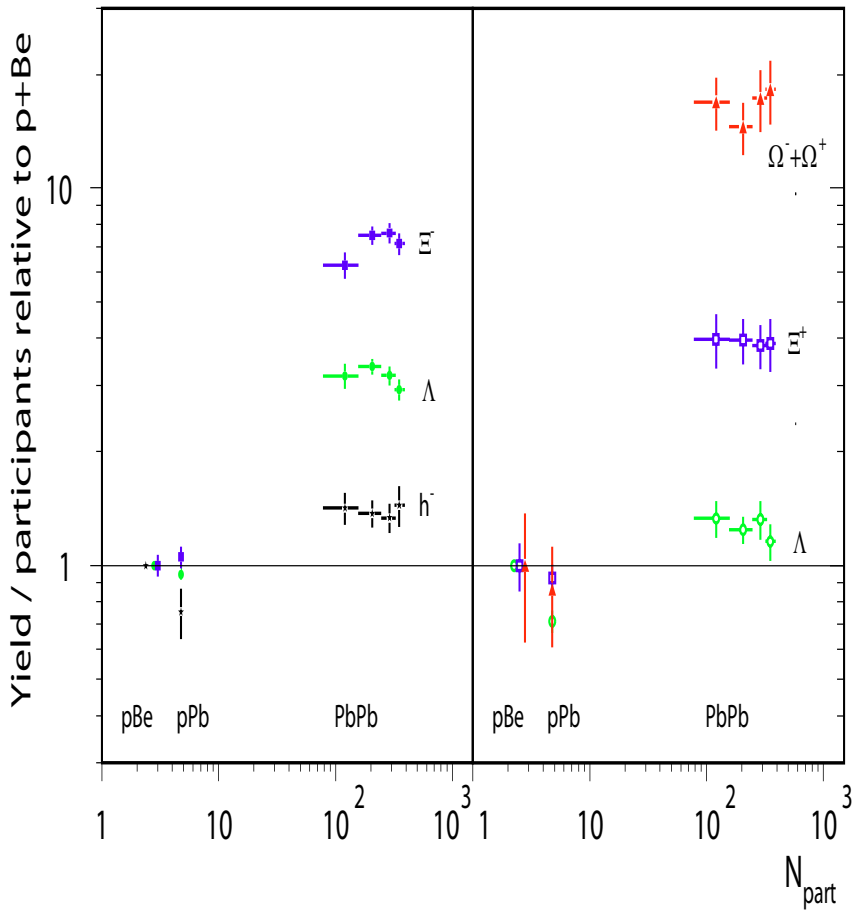
- canonical!

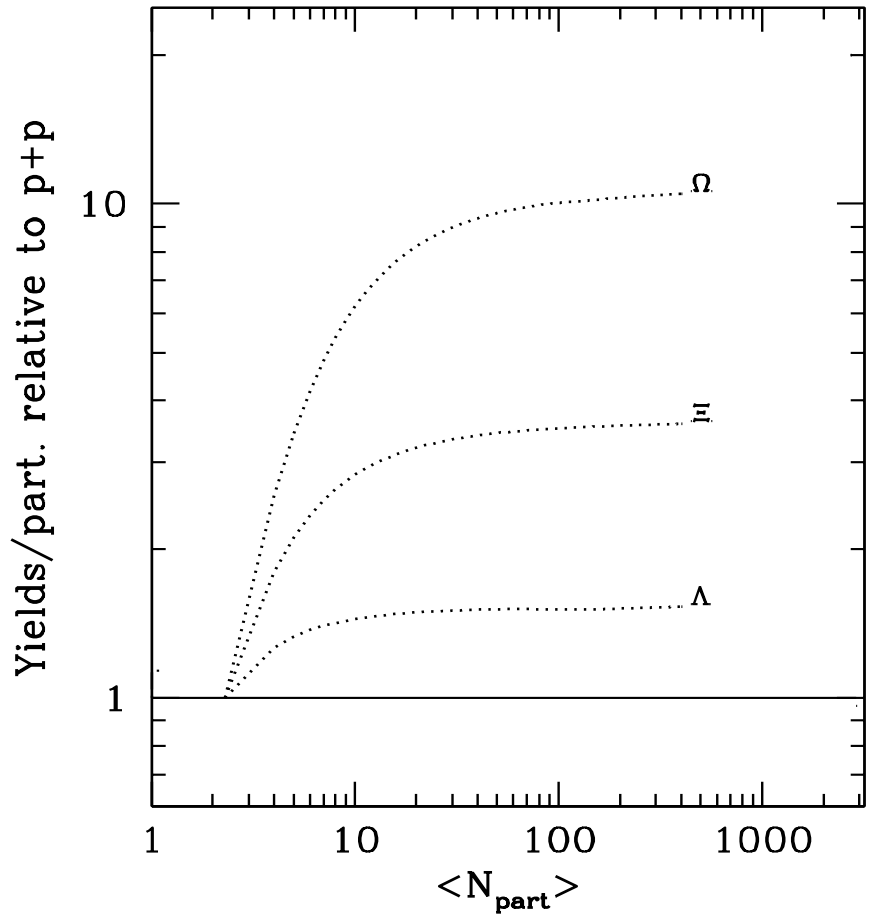
J. Cleymans, HO, K. Redlich,

PRC 60 (1999)



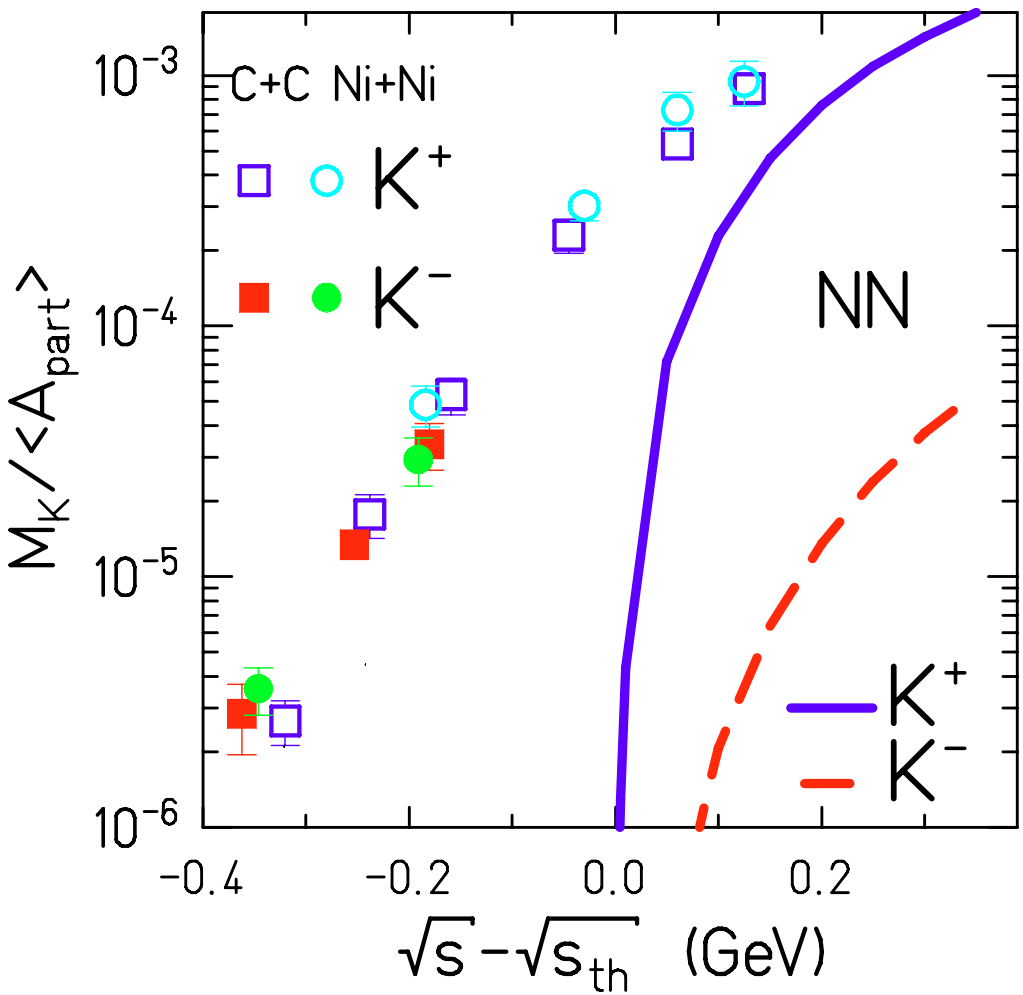
Statistical Model for Small Systems





Data: WA97 New: NA57 Theory: S. Hamieh, K. Redlich A. Tounsi, PL B486 (2000) 61

K^+ and K^- Production at SIS Energies



KaoS Collaboration

F. Laue, C. Sturm, et al.

PRL 82 (1999), updated

NN: parametrization

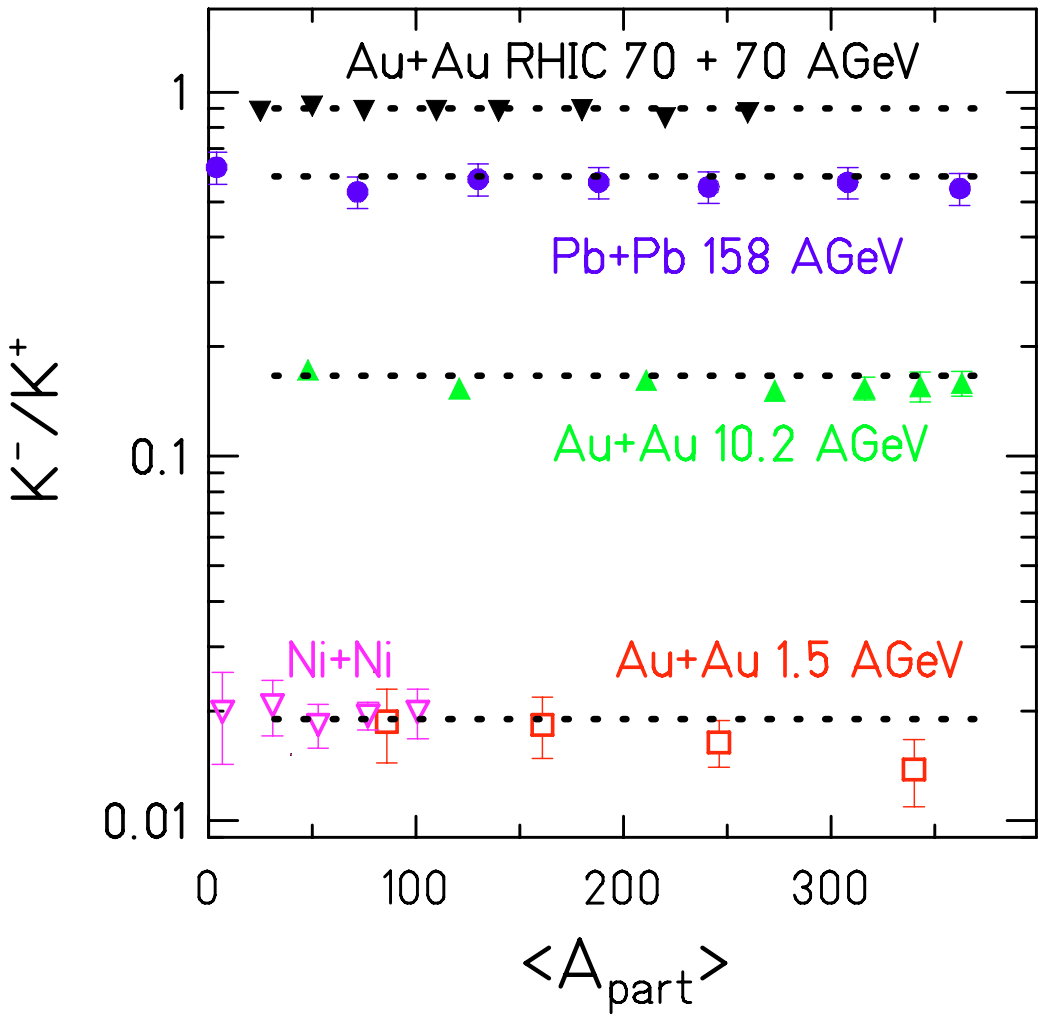
A. Sibirtsev,

PLB 359 (1995)

$$n_{K+} \sim \exp\left(-\frac{E_{K+}}{T}\right)\left[g_{\Lambda}V\int\frac{d^3p}{(2\pi)^3}\exp\left(-\frac{(E_{\Lambda}-\mu_B)}{T}\right)\right]$$

$$n_{K-} \sim \exp\left(-\frac{E_{K-}}{T}\right)\left[g_{K+}V\int\frac{d^3p}{(2\pi)^3}\exp\left(-\frac{(E_{K+})}{T}\right)\right]$$

K^-/K^+ Ratio from SIS up to RHIC

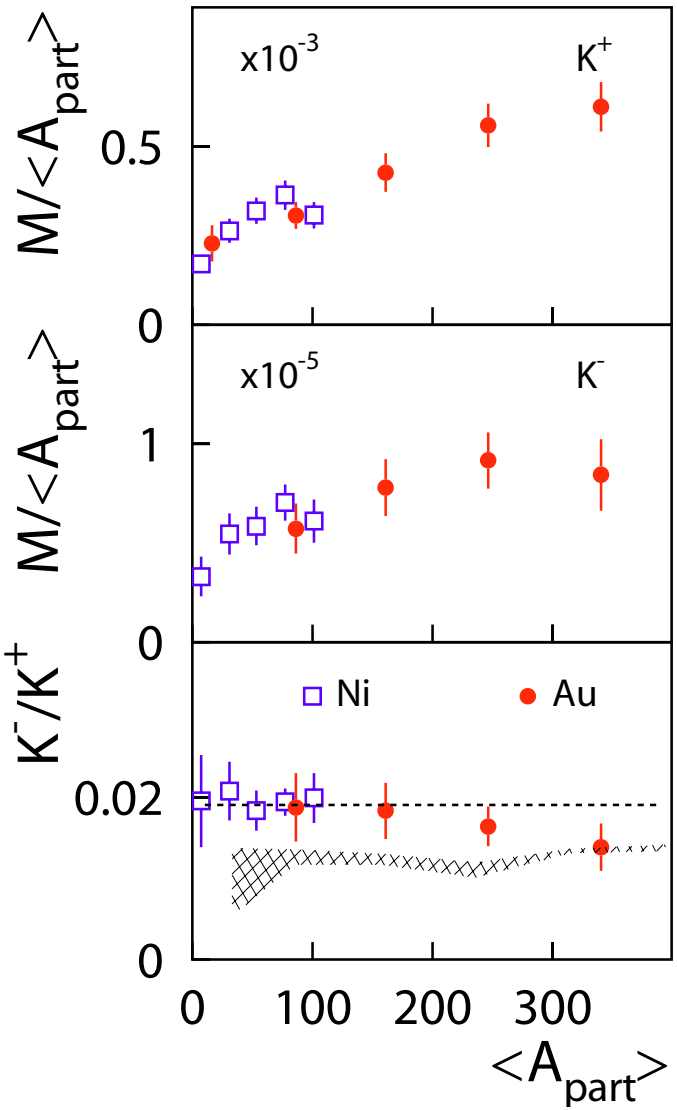


K^- and K^+ are linked

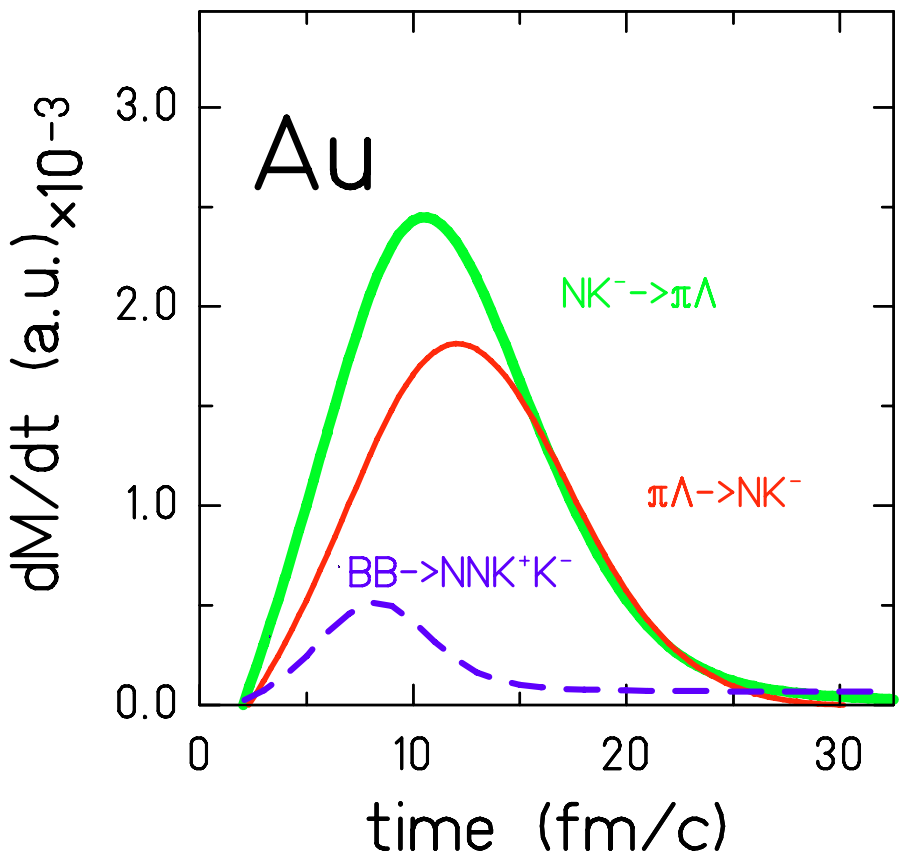
Au+Au 1.5 AGeV

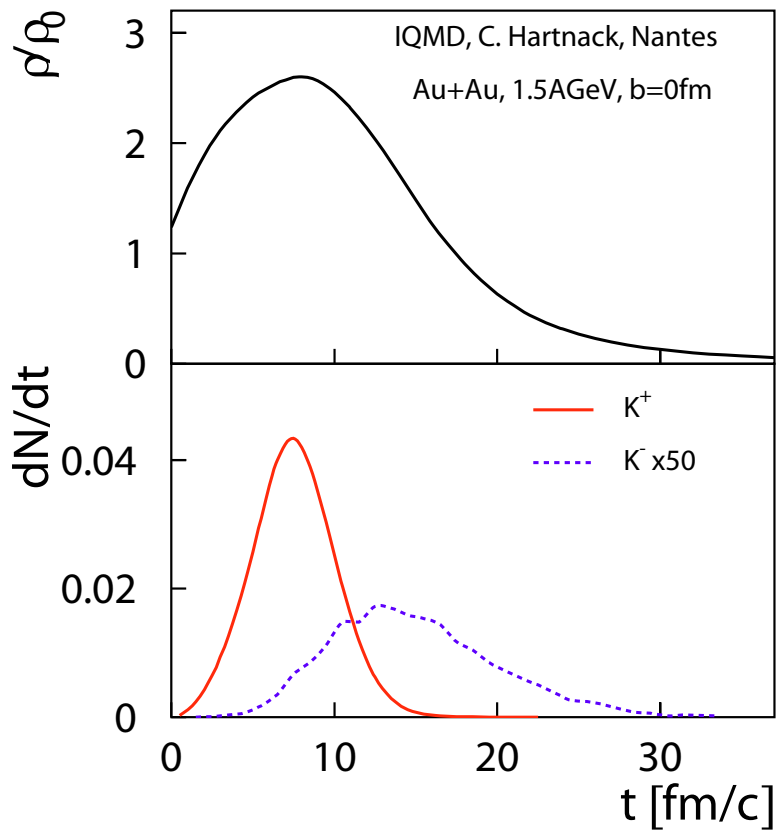
KaoS: A. Förster et al.,

PRL accepted



Time Evolution of K^+ and K^- Production





Strangeness exchange dominates!

Only 20% of all K^- survive!

C.Hartnack, H.O., J. Aichelin, PRL 90(2003)

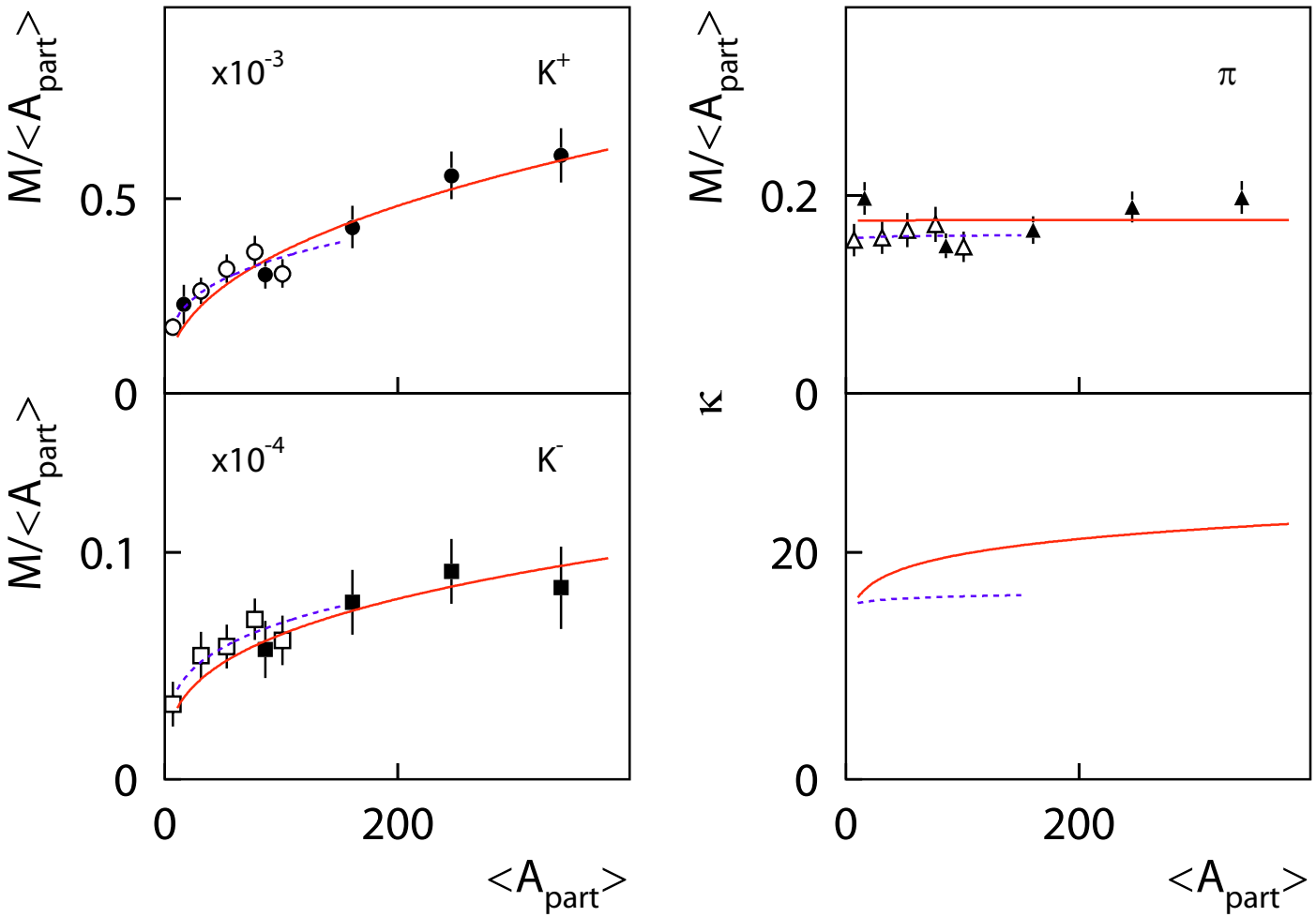
Strangeness Exchange

If equilibrium, then K^- yield just proportional to the density of Λ and the density of pions!

K^+ proportional to Λ! (associate production!)

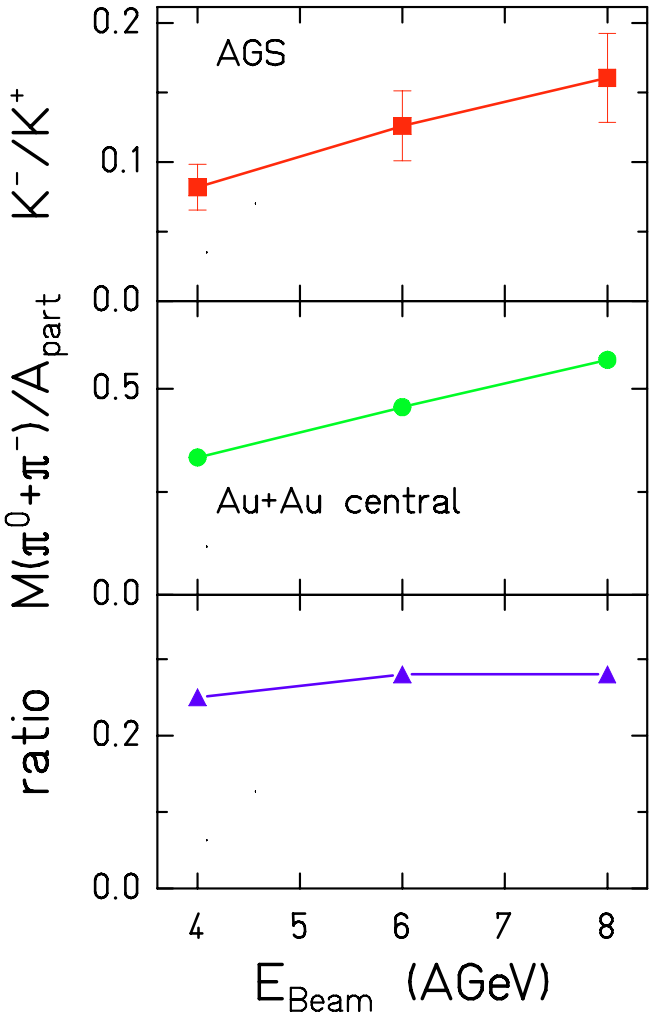
Hence: $K^-/K^+ \sim$ pion density!

K^- and K^+ are linked

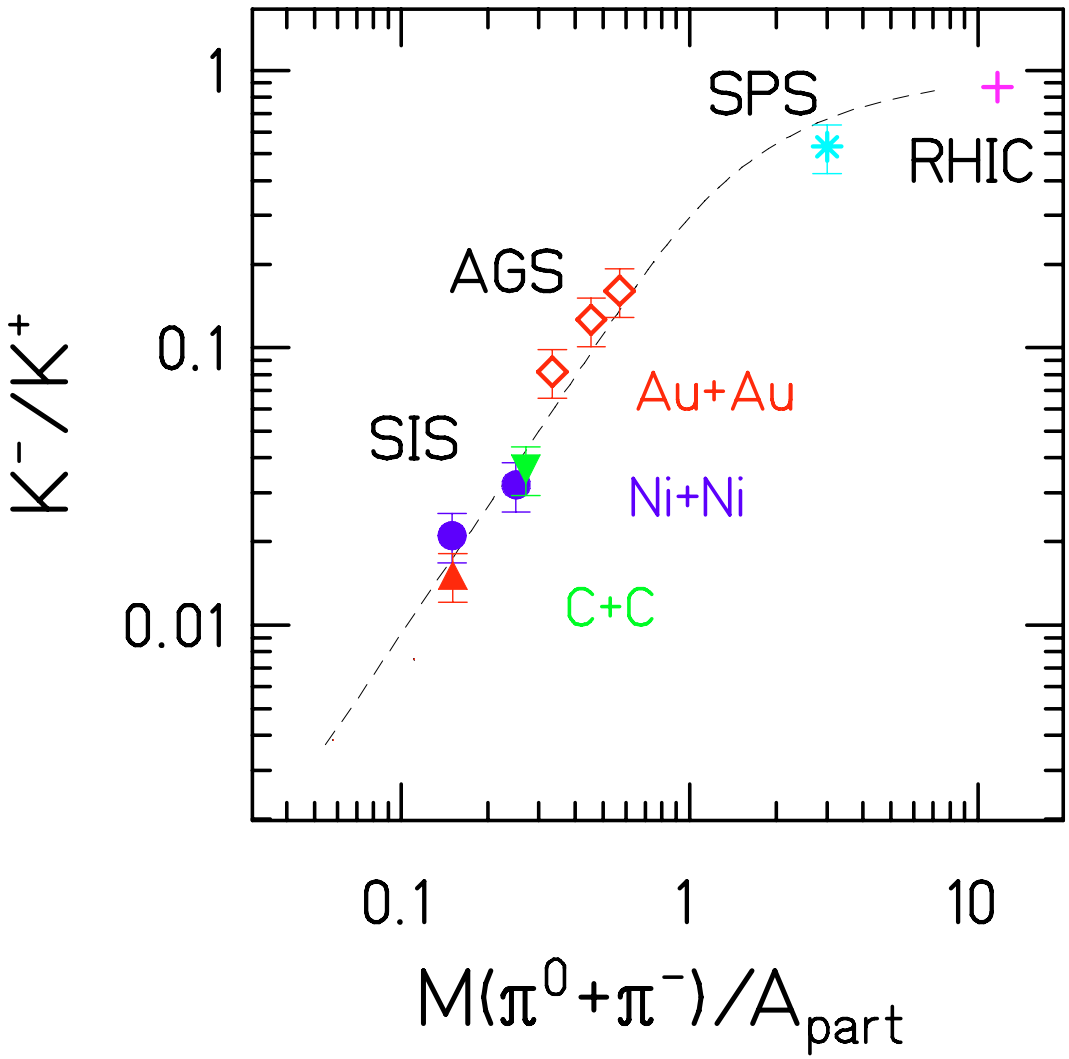


Au+Au 1.5 AGeV Kaos: A. Förster et al., PRL accepted

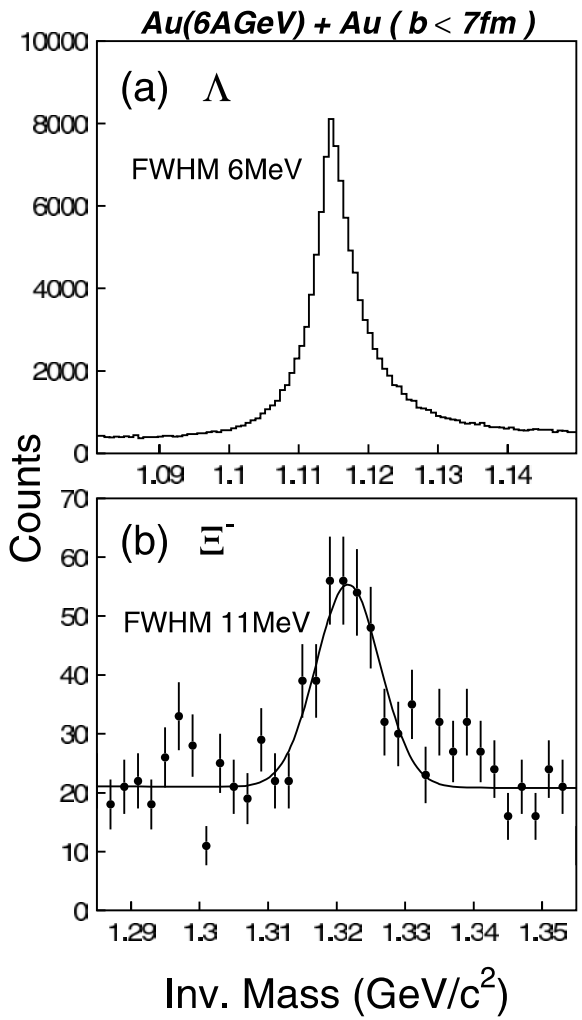
Strangeness Exchange at AGS?



Strangeness exchange up to AGS!



Xi at 6 AGeV

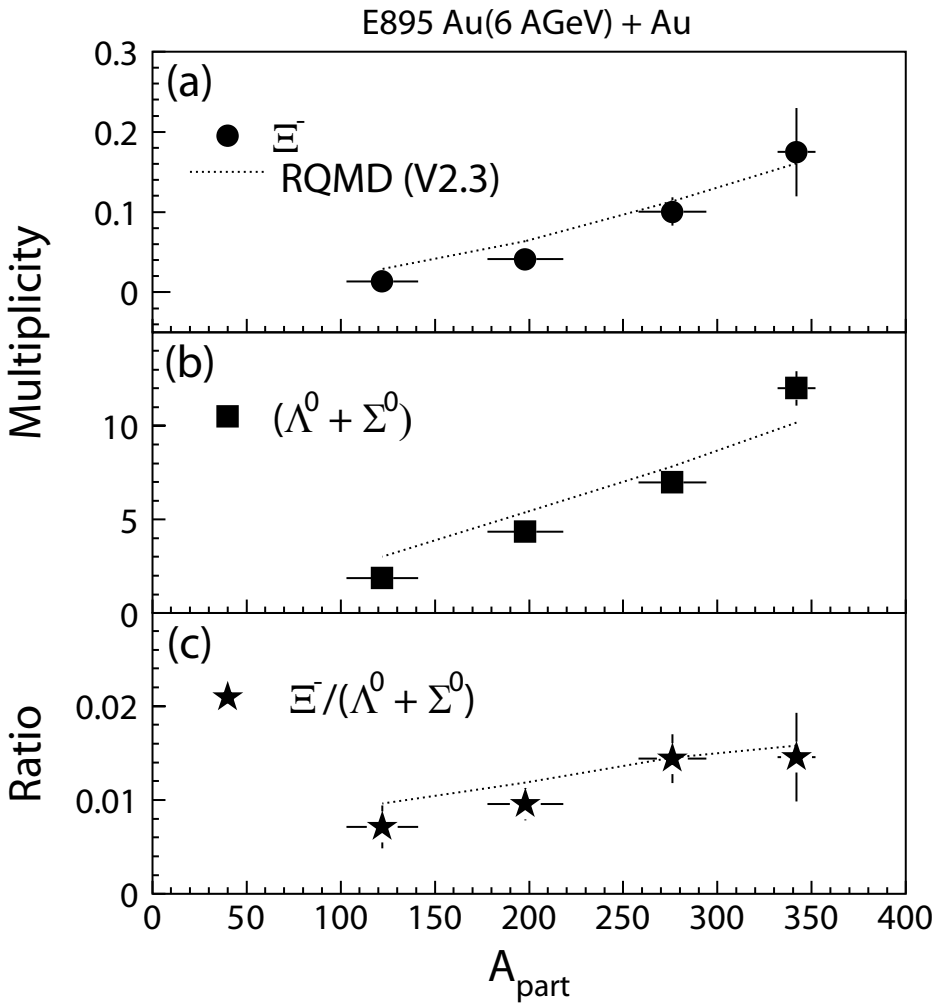


P. Chung et al.,

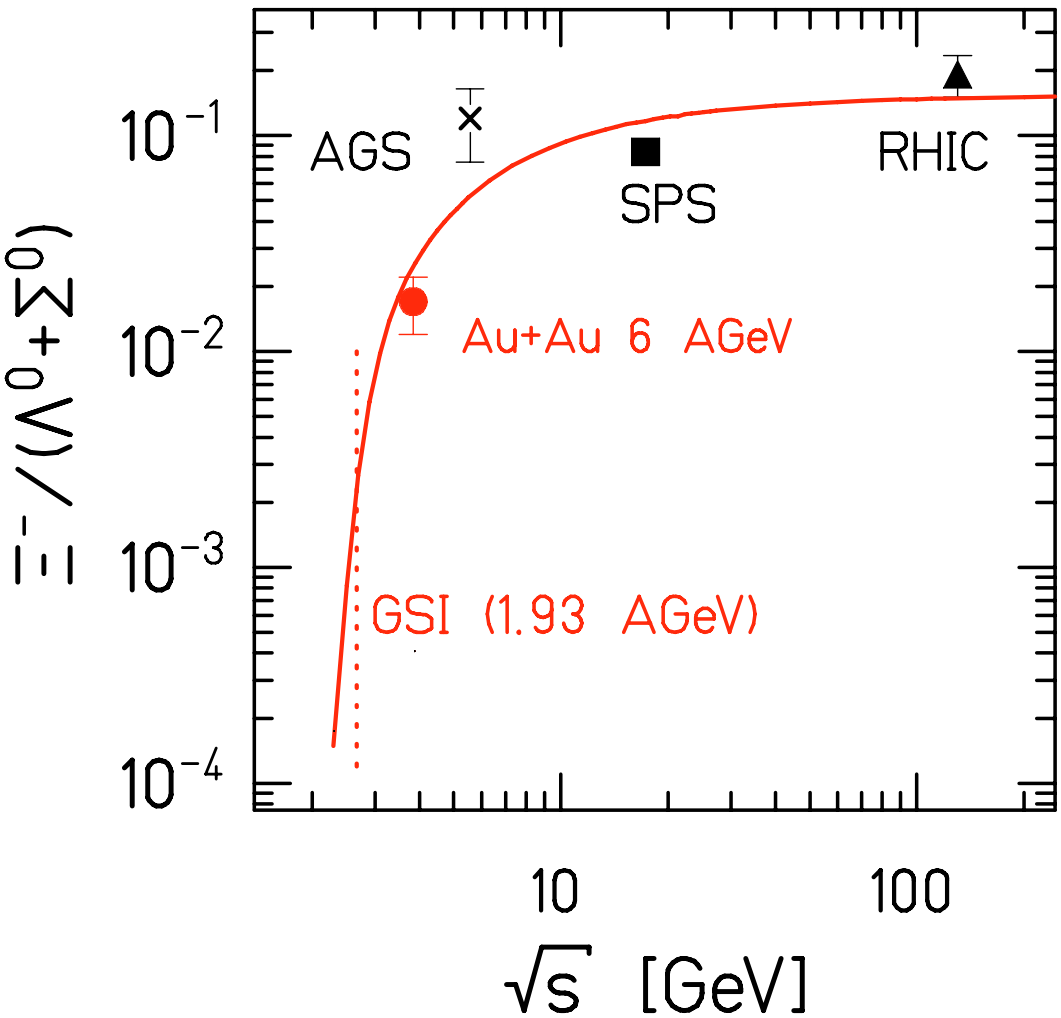
E895 Collaboration

PRL accepted

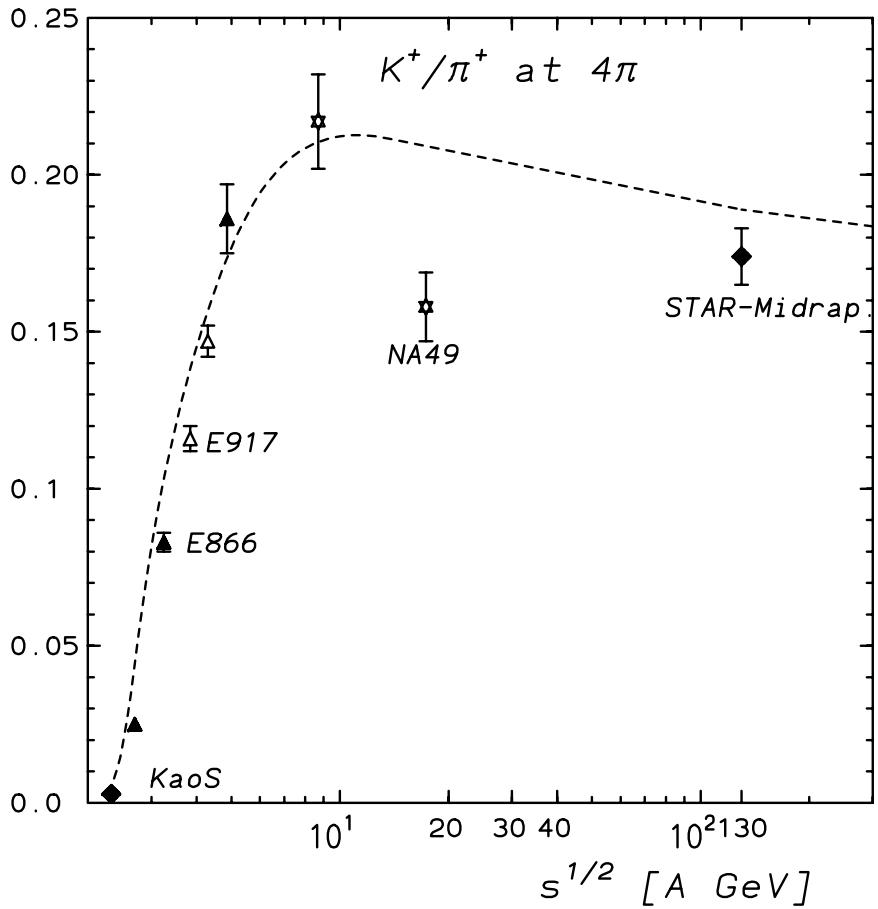
Centrality Dependence of Xi

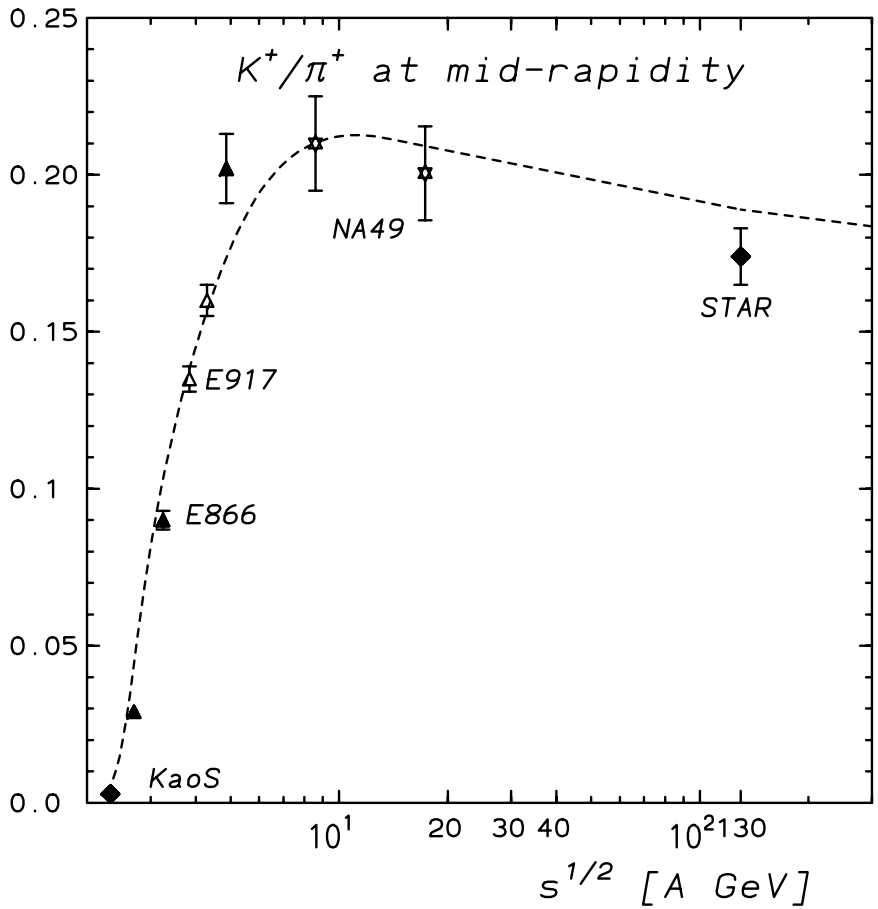


Xi at AGS! and SIS?

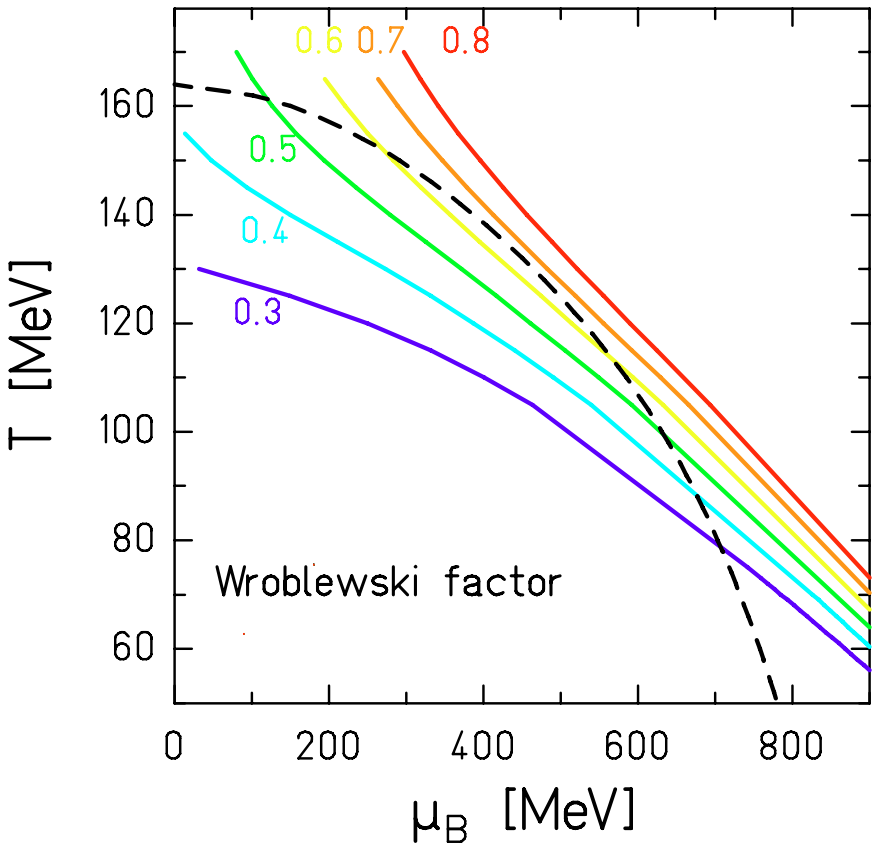


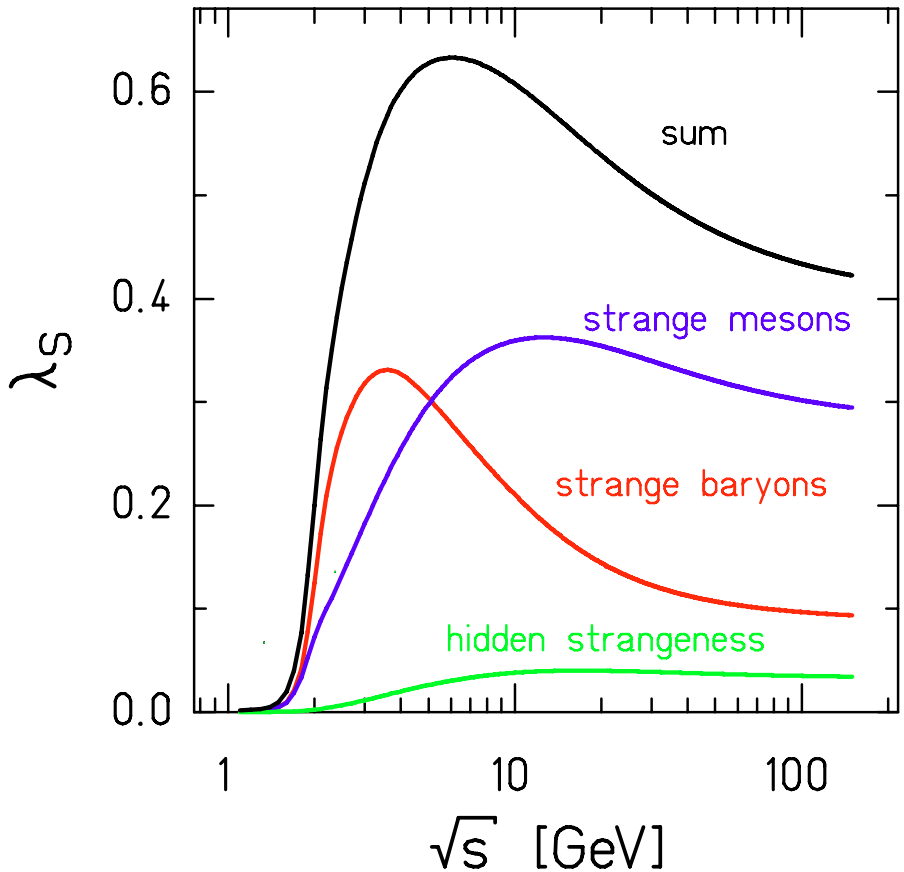
K^+/π^+ Ratio


K+/π+ at 4π
0.25
0.20
0.15
0.1
0.05
0.0
KaoS
E866
E917
NA49
STAR-Midrap
10^1
20
30
40
10^2
130
s^1/2 [A GeV]


K+/π+ at mid-rapidity
0.25
0.20
0.15
0.1
0.05
0.0
KaoS
E866
E917
NA49
STAR
10^1
20
30
40
10^2
130
s^1/2 [A GeV]

Maximum Strangeness around 30 AGeV

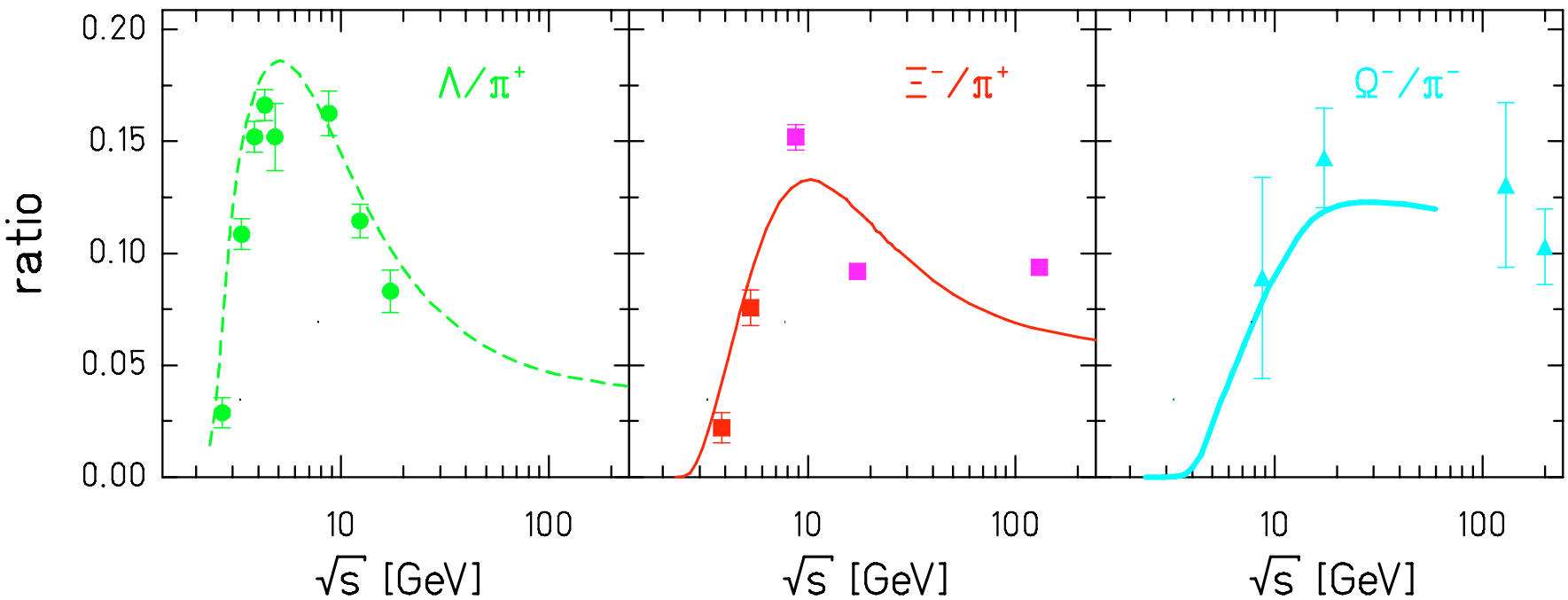




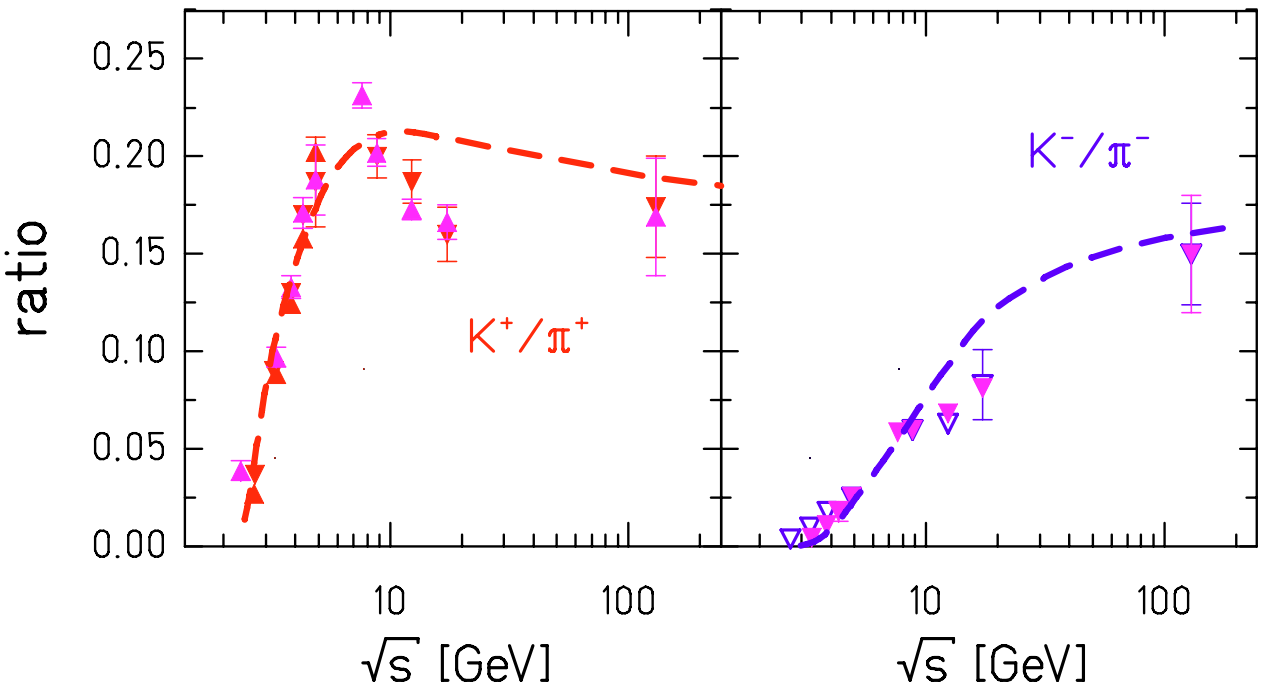
$\lambda_S = 2\ s\hat{s}/(u\bar{u} + d\hat{d})$

P. Braun-Munzinger, J. Cleymans, HO, K. Redlich, NPA 697(2002) 902

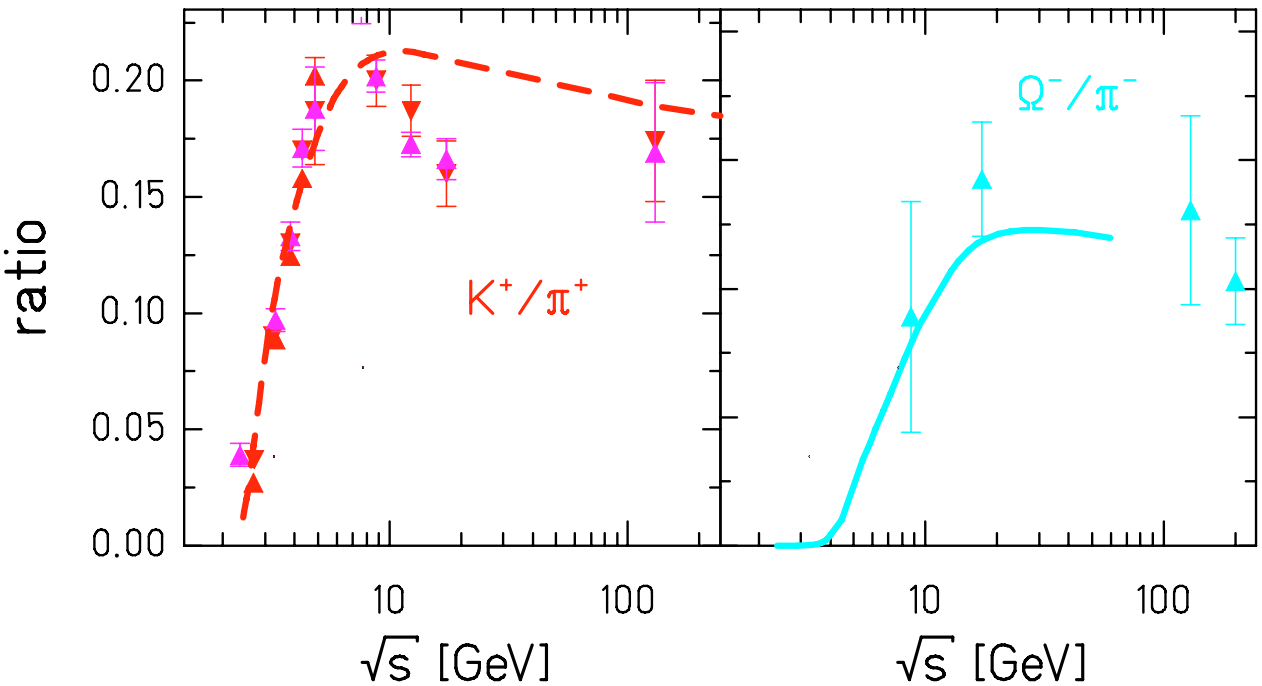
Baryons



Mesons



What about γ_S?



$K^+/\pi^+ \sim \gamma_S \quad \rightarrow \quad \Omega/\pi^- \sim (\gamma_S)^3$

γ_S is highly questionable!

Strangeness content in HG and in QGP

Old idea from Rafelski/ Müller 1981

increase

Marek‘s idea

decrease

Conclusions

Strangeness saturation of hadron gas is observed!

Maximum in strange/non-strange ratio:

balance of T and μ_B OR ?

What is the strangeness content of a QGP?

Strangeness

How to reach strangeness saturation

via hadronic processes?

At SIS/AGS strangeness exchange!

K^-N potential? Difficult in yield!

Azimuthal distribution! Data to come!

K^+: how? K^+N potential EOS!

At SPS/RHIC?

Final conclusion

Problems worthy of attack,

prove their worth by hitting back!