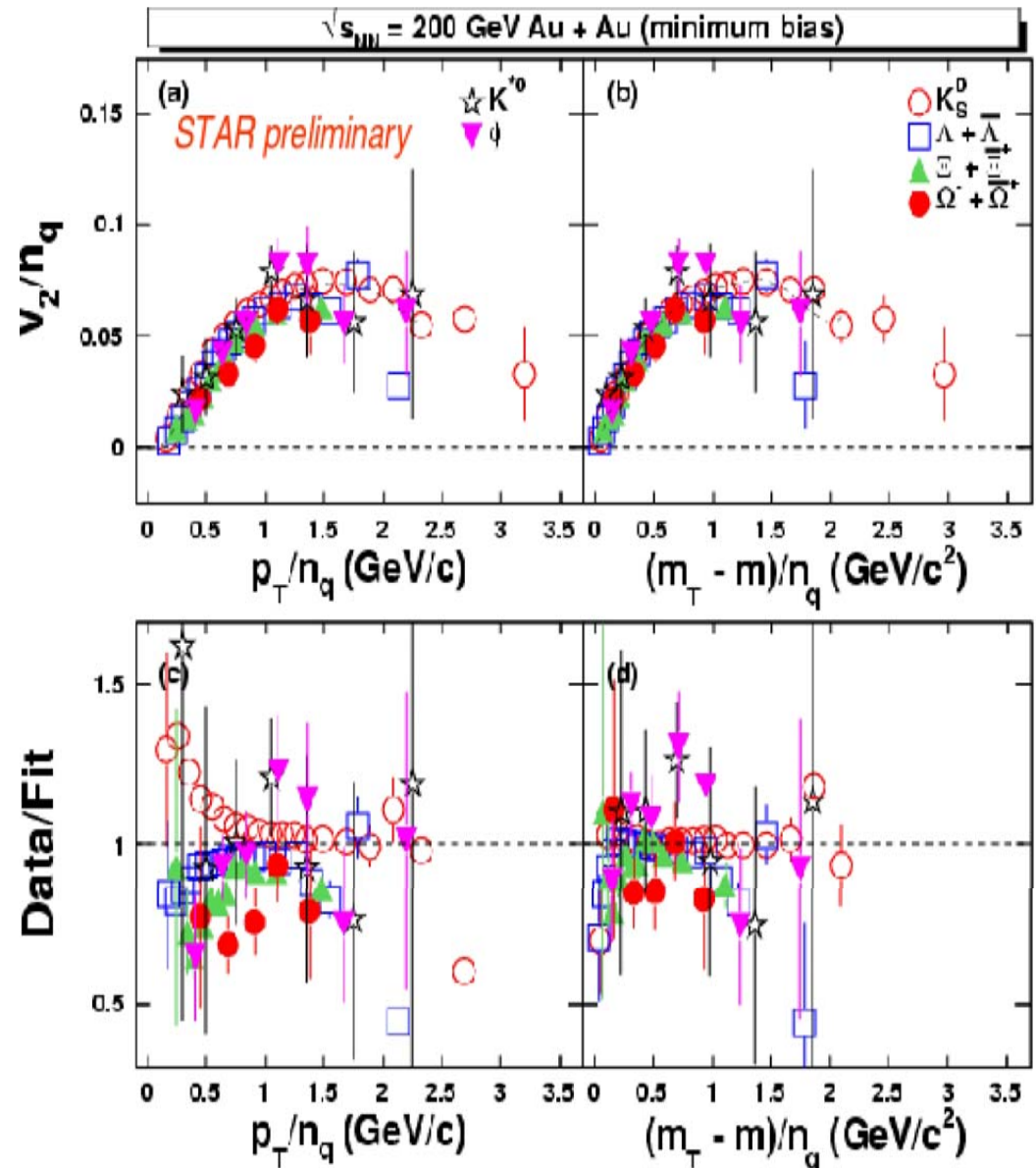


Strange hadron yields in the intermediate p_T region in heavy-ion collisions

**G.Hamar (RMKI/ELTE),
P.Csizmadia (RMKI),
P.Lévai (RMKI)**

Introduction to strangeness prod.

- SPS energy \rightarrow
 dN/dy , $dN/p_T dp_T$
[$p_T < 3$ GeV]
- RHIC energy \rightarrow
 dN/dy , $dN/p_T dp_T$
[$p_T < 7$ GeV]
- $V_2 \rightarrow$
quark coalescence



What about the production rates and spectra?

Quark coalescence model

- Fast rehadronization,
faster than hydrodynamics
- Scaling with the number of valence quarks
(dN/dy , v_2)
- **ALCOR** (Bíró, Lévai, Zimányi 1995)
 - good agreement with data
from SPS to RHIC
 - Only dN/dy and hadronic ratios
- **MICOR** (Csizmadia, Lévai 1999) \rightarrow p_T spectra
- **Parton coalescence/recombination models**
(Hwa, Yang 2002; Greco, Ko, Lévai 2003;
Fries, Müller, Bass 2003; Voloshin, Molnár 2003; ...)

MICOR

- Microscopic rehadronization
- Based on quantummechanics

$$g_{gh} = V_g \frac{-M_{h,Q'}}{2\pi} \int d^3\vec{x}_1 d^3\vec{x}_2 \cdot \tilde{\Psi}^*(\vec{x}_1, \vec{x}_2) V(\vec{x}_1 - \vec{x}_2) \phi_1(\vec{x}_1) \phi_2(\vec{x}_2)$$

- Production rate, phase-space average of σv

$$\langle \sigma^h v \rangle = \frac{\int d^3\vec{p}_1 d^3\vec{p}_2 \cdot f_q(m_1, \vec{p}_1) f_q(m_2, \vec{p}_2) (\sigma(k) v_{12})}{\int d^3\vec{p}_1 d^3\vec{p}_2 \cdot f_q(m_1, \vec{p}_1) f_q(m_2, \vec{p}_2)}$$

- Quark momentum distribution !
- Prehadrons \rightarrow hadrons
- Decaying of the resonances

Mesons, baryons

- Coalescence describes $2 \rightarrow 1$ process
- Baryons:
 - quark + quark \rightarrow diquark
 - diquark + quark \rightarrow prebaryon
- Baryon production depends on diquark's productions

$$\langle \sigma^h v \rangle_{123} \propto \frac{1}{3} \langle \sigma^h v \rangle_{12+3} \cdot \langle \sigma^h v \rangle_{1+2} + \frac{1}{3} \langle \sigma^h v \rangle_{13+2} \cdot \langle \sigma^h v \rangle_{1+3} + \\ + \frac{1}{3} \langle \sigma^h v \rangle_{23+1} \cdot \langle \sigma^h v \rangle_{2+3}$$

Questions in focus

- Production rate
- Production rate ratios
- Hadron yield ratios applying different wave functions
- Hadron spectra
- How these results depend on
 - Wave function model
 - QGP parameters: temperature, effective gluon mass
 - Quark momentum distributions

Wave functions

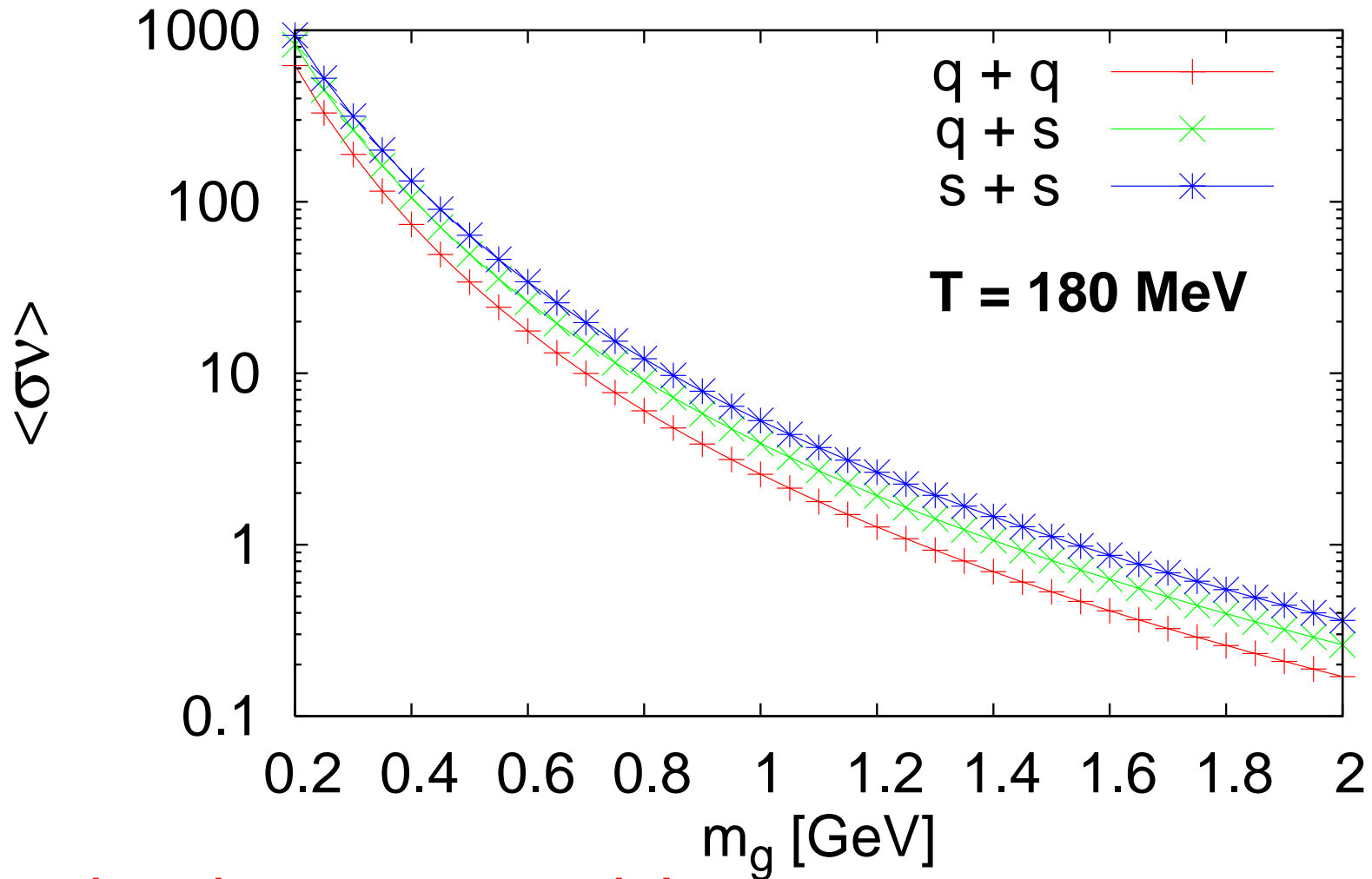
- In quantummechanics wave functions are important
- Incoming quark wave functions :
 - Plane wave + Plane wave
 - Plane wave + Gaussian
 - Gaussian + Gaussian
- Outgoing prehadron wave functions :
 - Plane wave
 - Exponential (hydrogen like)
 - Gaussian

Production rate

Quark-quark potential : Yukawa with thermal gluon mass (m_g)

PW : Plane wave

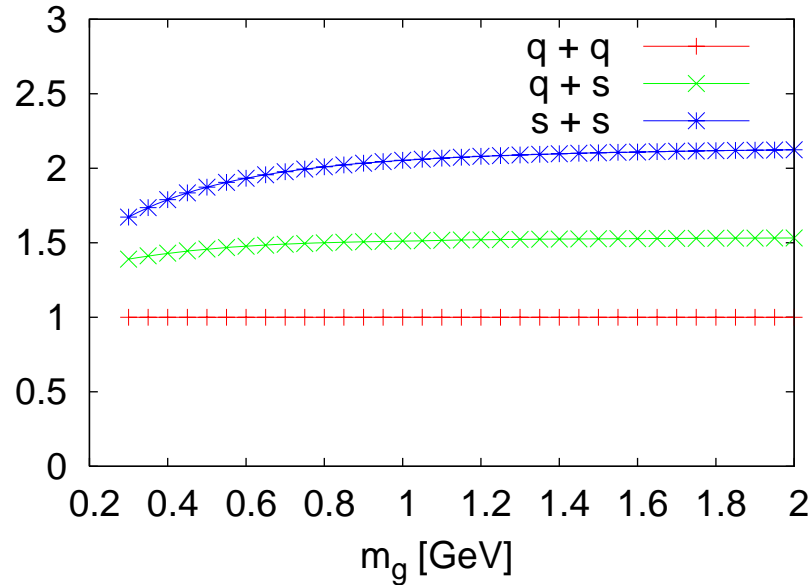
PW+PW \rightarrow PW model



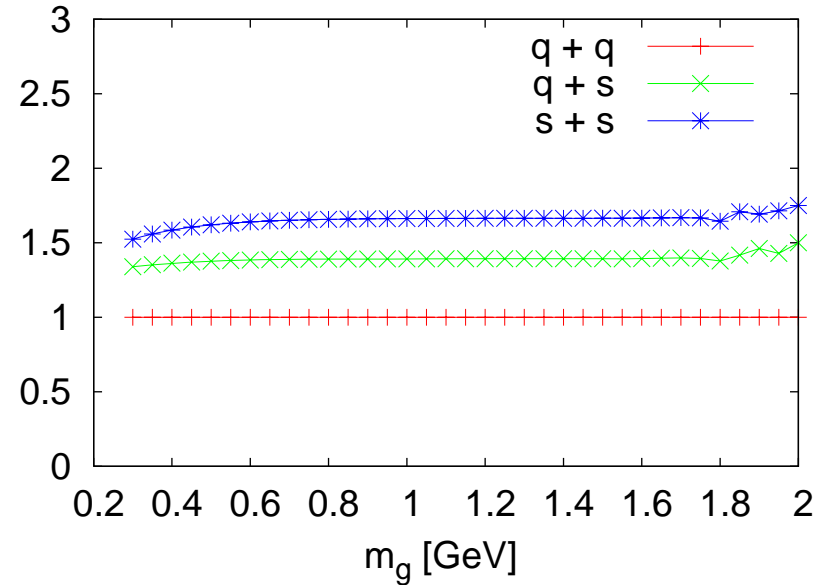
The rate depends on m_g very strongly !

Production rate ratios

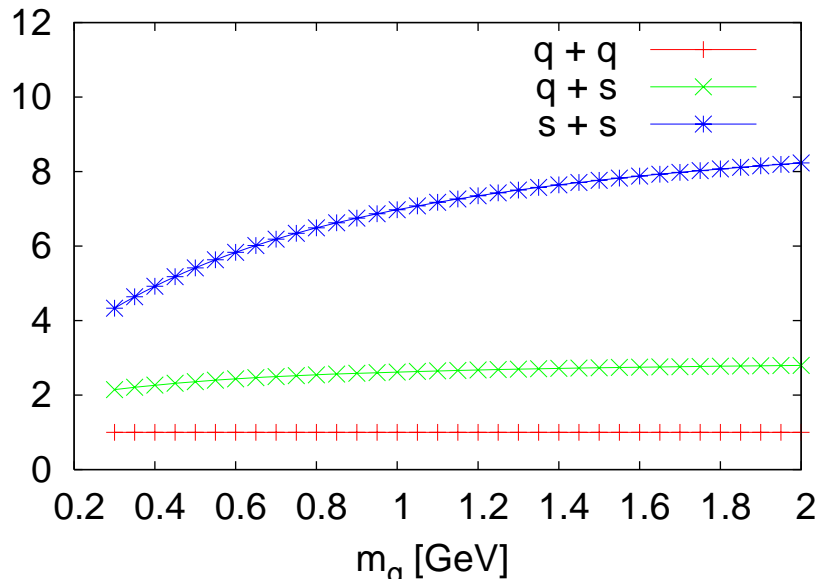
Ratios in PW+PW \rightarrow PW model



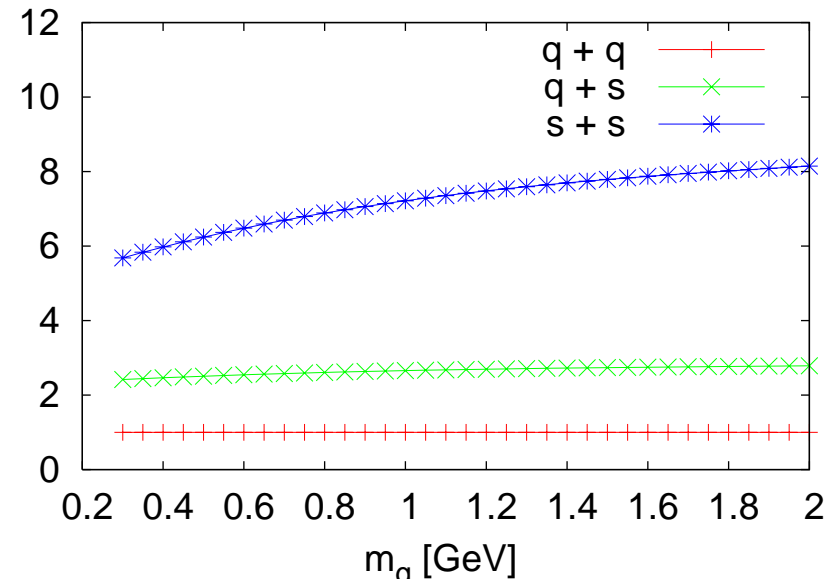
Ratios in G+G \rightarrow G model



Ratios in PW+PW \rightarrow H model



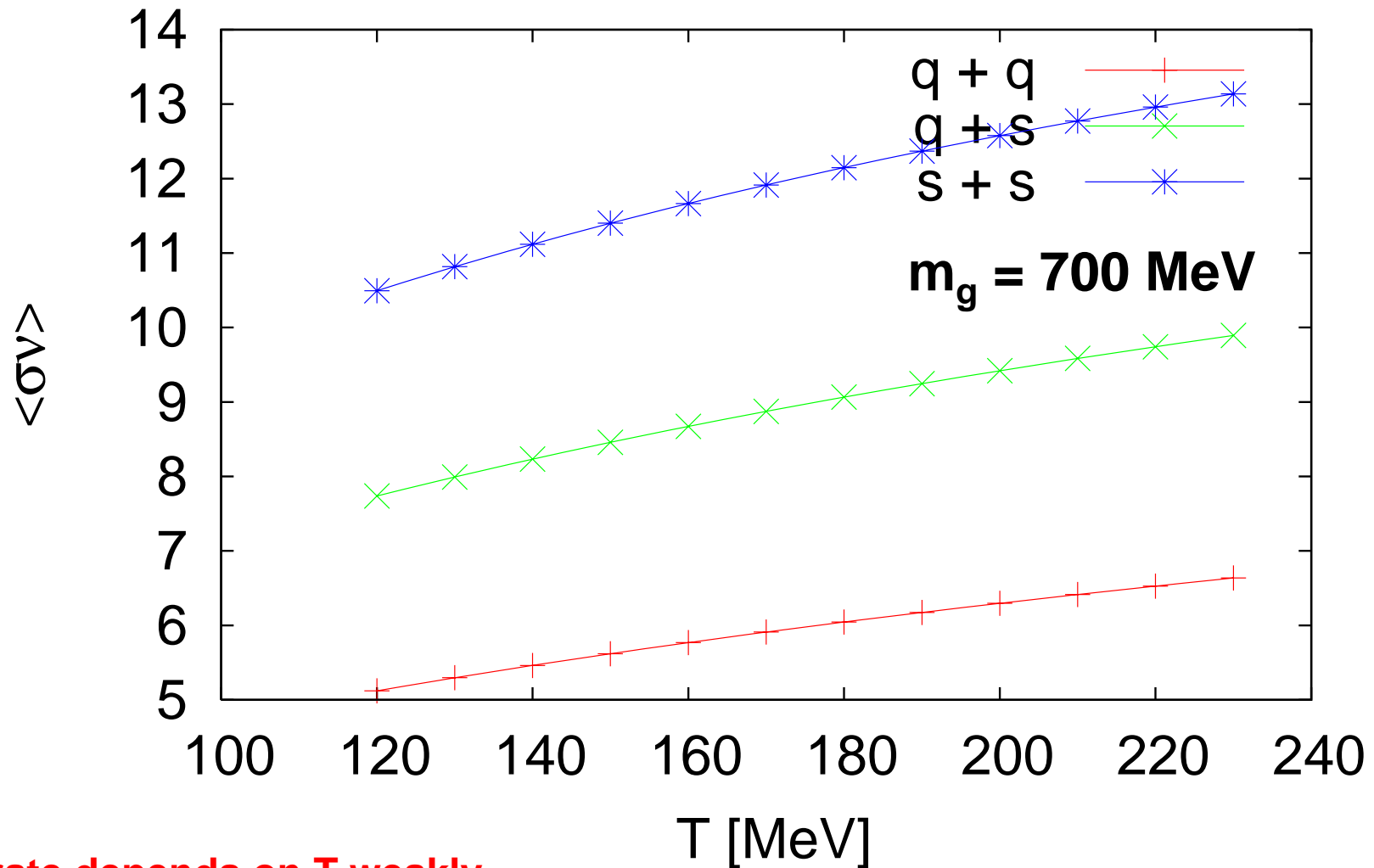
Ratios in G+G \rightarrow H model



Production rate

Temperature dependence of the meson production rate

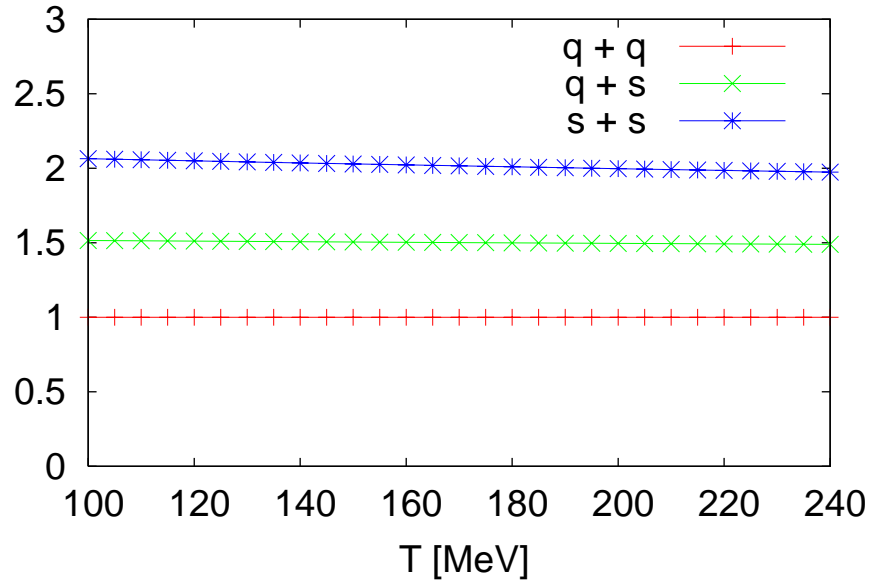
PW+PW --> PW modell



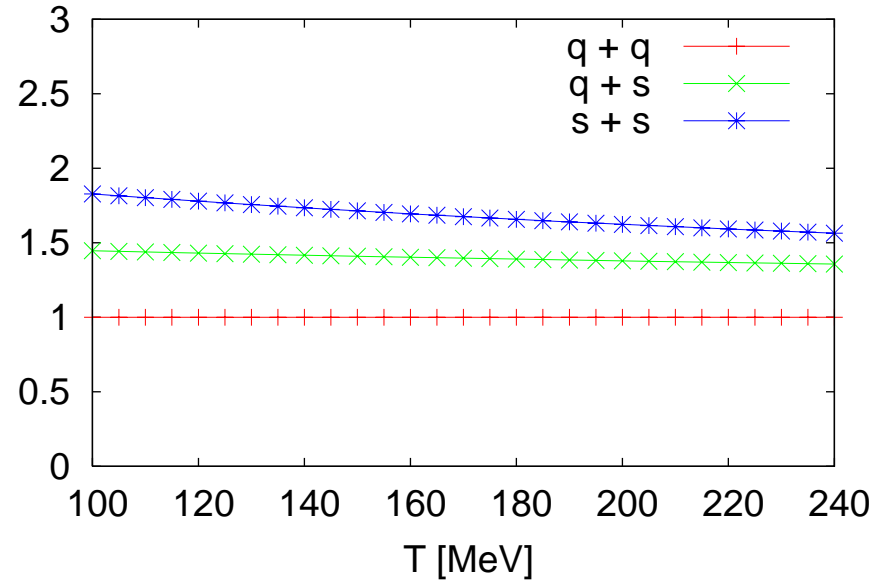
The rate depends on T weakly

Production rate ratios

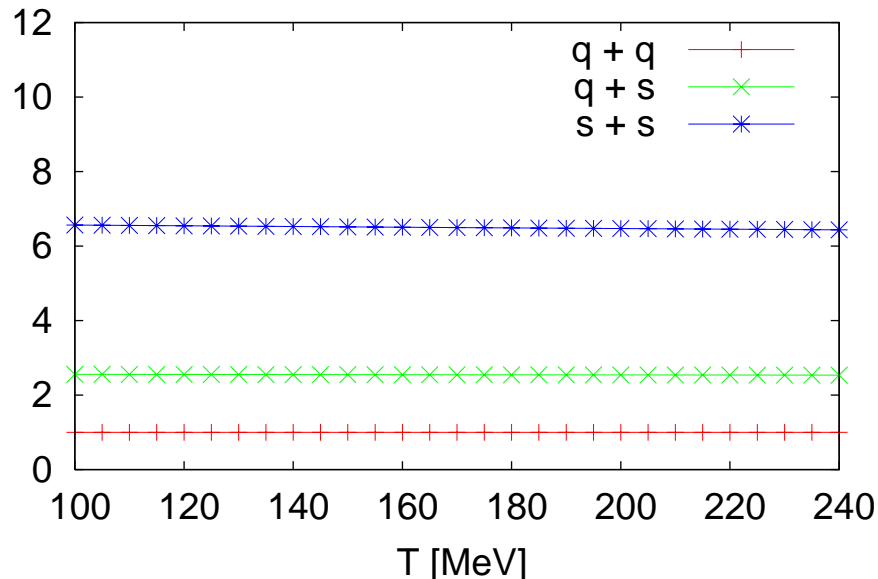
Ratios in PW+PW \rightarrow PW model



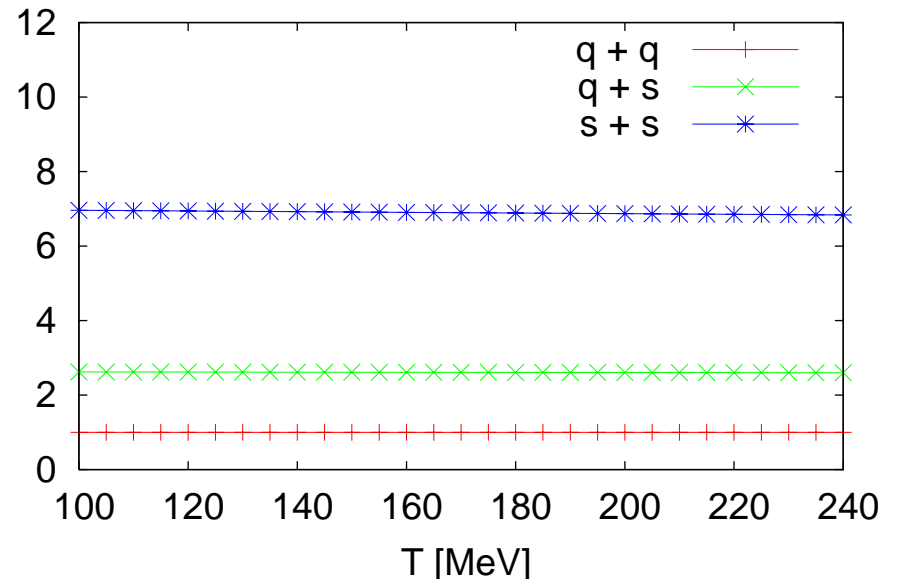
Ratios in G+G \rightarrow G model



Ratios in PW+PW \rightarrow H model



Ratios in G+G \rightarrow H model



Hadron spectra

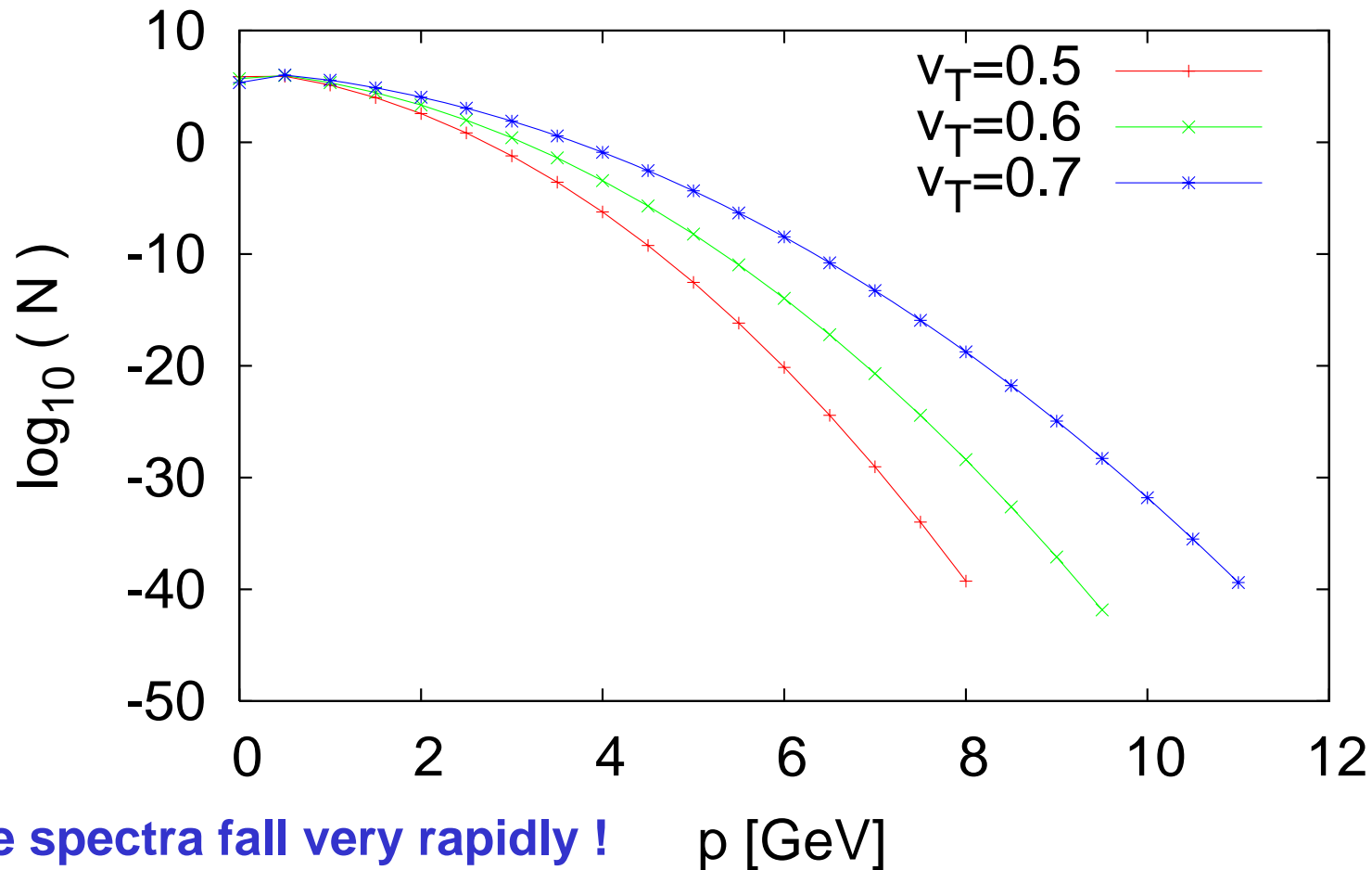
- **Local coalescence !**
- **Prehadron momentum from the quarks momenta**
 - Boltzmann distribution,
 - Jüttner distribution,
 - Tsallis distribution
- **Hadron got the same momentum as it's prehadron**
- **Exploding fireball (v_T)**
- **Boost with the velocity-field (locally)**
 - spherical symmetry,
 - Björken flow,
 - hydro model

Hadron spectra

Applying classical Boltzmann distributon

→ the hadron spectra are independent on the initial wave function

Rho meson spektrum, Boltzmann



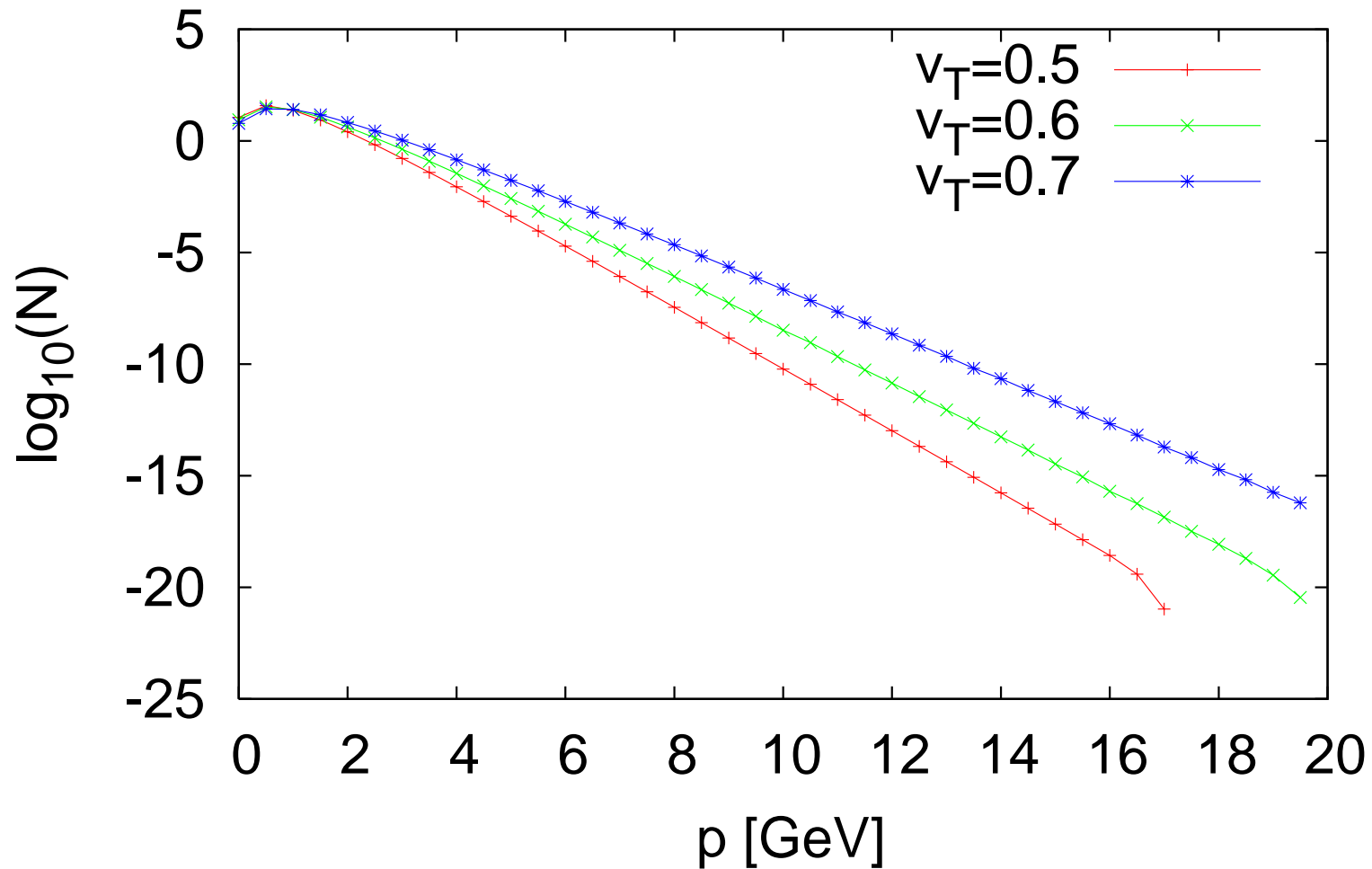
These spectra fall very rapidly !

p [GeV]

Hadron spectra

Applying Jüttner distributon

Rho meson spektrum, relativistic



Hadron ratios

Modell	N_s/N_q	K^*/ρ	ϕ/K^*	Σ^*/Δ	Ξ^*/Σ^*	Ω/Ξ^*
Boltzmann d.						
PW+PW>PW	0.448	0.671	0.600	0.790	0.700	0.644
PW+PW>H	0.235	0.598	0.600	0.848	0.785	0.746
PW+PW>G	0.474	0.686	0.600	0.791	0.690	0.628
G+G>PW	0.441	0.668	0.600	0.790	0.702	0.648
G+G>H	0.227	0.593	0.600	0.849	0.791	0.753
G+G>G	0.503	0.700	0.600	0.791	0.681	0.614
Jüttner d.						
PW+PW>PW	0.401	0.701	0.600	0.857	0.721	0.644
PW+PW>H	0.206	0.624	0.600	0.928	0.815	0.752
PW+PW>G	0.424	0.706	0.600	0.843	0.708	0.631
G+G>PW	0.396	0.701	0.600	0.862	0.724	0.647
G+G>H	0.201	0.620	0.600	0.931	0.819	0.757
G+G>G	0.435	0.712	0.600	0.845	0.706	0.627
ALCOR		0.434	0.391	0.574	0.506	0.442

Conclusion

- **Fast rehadronization by quark coalescence**
- **Quantummechanical description**
- **Robustness in hadron ratios for different**
 - **wave functions**
 - **parameters (temperature, effective gluon mass, ...)**
 - **and quark momenta distributions**
- **Spectra is given by the fireball velocity profile**

Outlook

- **Include resonance decay**
- **Study different fireball velocity-fields**
- **Spectra dependence on fireball density distribution**
- **Periferial collisions**
- **Test further quark momenta distributions**