Strange and charm quark production in hot QCD

Valeriya Mykhaylova

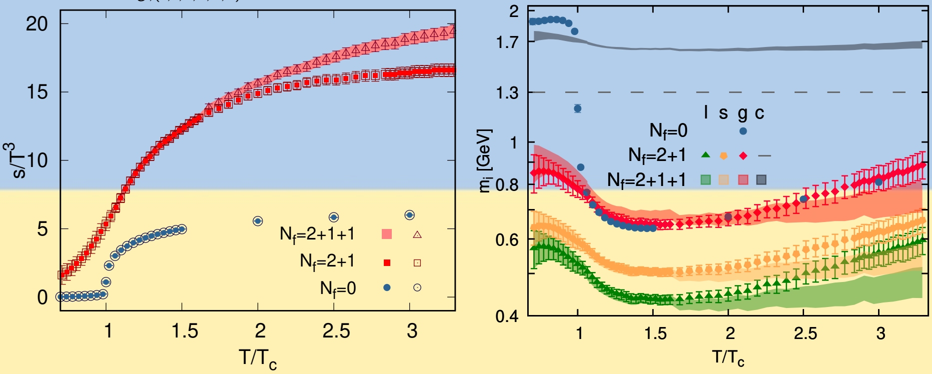
Institute of Theoretical Physics
University of Wrocław

V. M., C. Sasaki, Phys.Rev.D 103 (2021) [arXiv:2007.06846]
V. M., M. Bluhm, C. Sasaki, K. Redlich, Phys.Rev.D 100 (2019) [arXiv:1906.01697]

Quasiparticle Model Setup

QGP = weakly-interacting system of massive, dressed quarks and gluons

$$s = \sum_{i=g,(l,\bar{l},s,\bar{s},c,\bar{c})} \frac{d_i}{\pi^2} \int dp\, 2p^2 \, \frac{\frac{4}{3}p^2 + m_i^2[G(T),T]}{E_i(T)\,T} f_i^0 \Longrightarrow G(T) \Longrightarrow m_i[G(T),T]$$



Full bullets - in quasiparticle model (QPM), open bullets - original lattice data

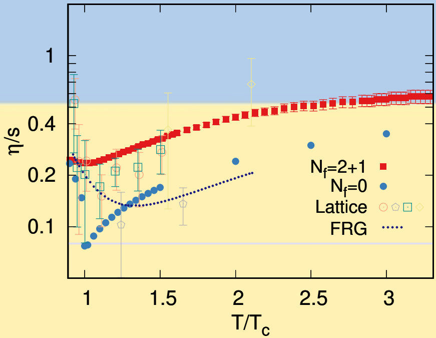
Interactions are encoded in dynamically generated masses m_i through effective coupling $G(T)$ deduced from lQCD EoS (s/T^3).

[V.M, M. Bluhm, C. Sasaki, K. Redlich, PRD 100 (2019) and preliminary; lQCD: Wuppertal-Budapest]

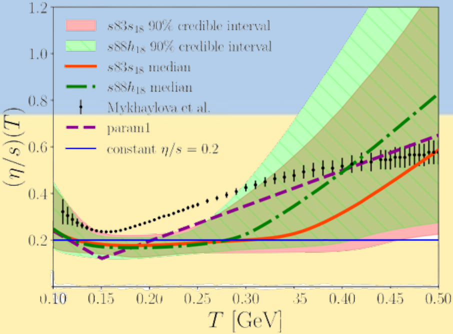
Specific Shear Viscosity

Computed in kinetic theory with relaxation time approximation, $\tau_i \simeq \left(\sum n_i \bar{\sigma}_{12\to 34}\right)^{-1}$

$$\eta = \frac{1}{15T} \sum_{i=l,\bar{l},s,\bar{s},g} \int \frac{d^3p}{(2\pi)^3} \frac{p^4}{E_i^2} d_i \tau_i f_i^0 (1 \pm f_i^0) \,.$$



[V.M, M. Bluhm, C. Sasaki, K. Redlich, PRD 100 (2019)]



[J. Auvinen et al., Phys.Rev.C 102 (2020)]

Full bullets - QPM result. Red curve on LHS = black on RHS.

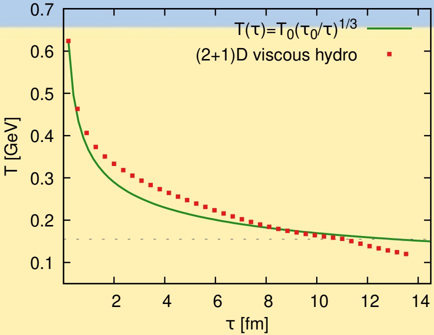
Time evolution of the QGP

For boost-invariant medium we juxtapose:

1. Bjorken scaling (1D expansion): [J. D. Bjorken, PRD 27 (1983)]

$$T(\tau) = T_0\left(\frac{\tau_0}{\tau}\right)^{1/3}$$

2. (2+1)D 2^{nd} order viscous hydro with η/s from QPM [J. Auvinen et al., Phys.Rev.C 102 (2020)]



⋆ Same initial conditions for both: $\tau_0 = 0.2$ fm, $T_0 = 0.624$ GeV

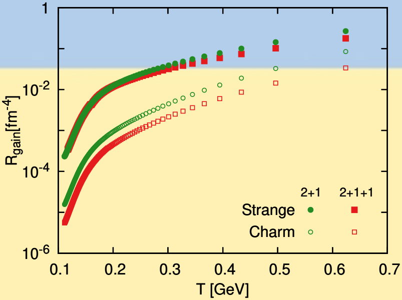
Production rate of strange and charm quarks

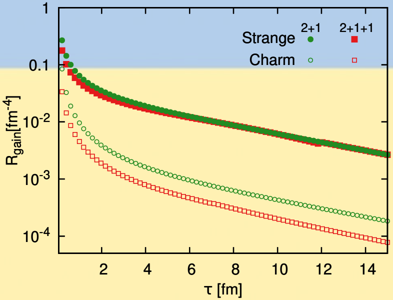
Cross-sections depend on effective masses of the quasiparticles

$$R_s^{gain} = \frac{1}{2}\,\bar{\sigma}_{gg\to s\bar{s}}\,n_g^2 + \bar{\sigma}_{q\bar{q}\to s\bar{s}}\,n_q^2 + \bar{\sigma}_{c\bar{c}\to s\bar{s}}\,n_c^2$$

$$R_c^{gain} = \frac{1}{2}\,\bar{\sigma}_{gg\to c\bar{c}}\,n_g^2 + \bar{\sigma}_{q\bar{q}\to c\bar{c}}\,n_q^2 + \bar{\sigma}_{s\bar{s}\to c\bar{c}}\,n_s^2$$

[T.S. Biro et al., PRC 48 (1993); J. Rafelski et al., Acta Phys.Polon.B 27 (1996); B.-W. Zhang et al., Phys.Rev.C 77 (2008)]



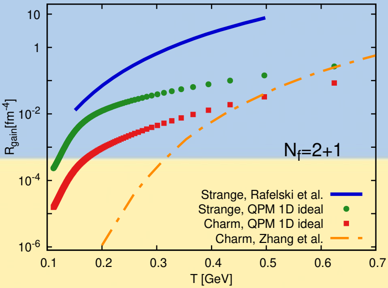


Preliminary

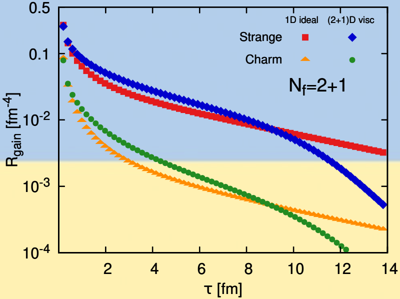
Production rates for $N_f = 2+1+1$ are suppressed by larger effective m_s and m_c.

Production rate of strange and charm quarks

$N_f = 2 + 1$, comparison to models with different setup



Differences up to few OOM arise due to different particle masses, couplings, EoS...



$T_0 \simeq 0.6$ GeV $\rightarrow T_c$ at $\tau =$11-13 fm

Preliminary

[J. Rafelski et al., Acta Phys.Polon.B 27 (1996); B.-W. Zhang et al., Phys.Rev.C 77 (2008)] https://events.ift.uni.wroc.pl/event/70/