Hydrodynamic approach to heavy-quark diffusion in the quark-gluon plasma

Federica Capellino
f.capellino@gsi.de

Motivation

J/ψ and D mesons show elliptic flow

Sign of thermalization!

\[ E \frac{d^3N}{d^3p} = E \frac{d^2N}{2\pi p_T dp_T dy} \left( 1 + \sum_{n=1}^{\infty} 2v_n \cos[n(\phi - \psi_{RP})] \right) \]
Heavy-quark diffusion current

\[ N^\mu = n_0 u^\mu + \nu^\mu \]
\[ \partial_\mu N^\mu = 0 \]

Equation of motion for the diffusion current needed!

Starting point: Fokker-Planck equation

\[ k_0 \partial_t f_k + k^i \partial_i f_k = k_0 \frac{\partial}{\partial k^i} \left( A k^i f_k \right) - D g^{ij} \frac{\partial^2}{\partial k^i k^j} f_k \]

the model we deserve..

… maybe also the one we need!
In the non-relativistic limit, our model agrees with transport models (Langevin/Fokker-Planck equation)!

\[ 2\pi D_s T_c = 3.7 \]
Relaxation to hydrodynamics

Compared with a Bjorken-like expansion, our model predicts that charm quarks relax to a **hydrodynamic** behaviour.

**Thermalization is possible for charm quarks!**

... Less likely for bottom.
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Outlook

- Simulate the heavy-quark diffusion in realistic hydrodynamic simulation of the QGP
- Study interaction with other conserved currents

- Develop proper initial conditions for the HQ spatial distribution
- Implement hadronization from the medium

We’re just one hydro simulation away to add a new curve for thermalized charm to the zoo!