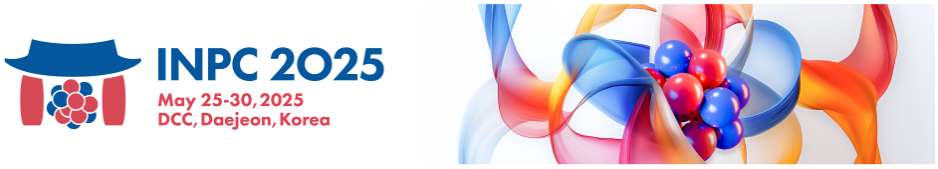

Contribution ID: **259** Type: **Contributed Oral Presentation**

Heavy quark mass and potential in quark-gluon plasma

Friday, 30 May 2025 08:55 (15 minutes)

We study the thermal production of charm quarks in relativistic heavy-ion collisions as at RHIC and LHC energies. Our study is based on the off-shell parton-hadron-string dynamics (PHSD) transport approach, which describes the full-time evolution of heavy-ion collisions on a microscopic basis with hadronic and partonic degrees of freedom. The sQGP is realized within the effective dynamical quasi-particle model (DQPM), which is adapted to reproduce lattice QCD results for the thermodynamic observables of the sQGP. Based on the success of the DQPM in describing the spatial diffusion coefficients D_s from lQCD, we evaluate the production of charm quark pairs by rotating the Feynman diagrams so that the incoming charm quark and the outgoing light parton are swapped in elastic scattering diagrams. Charm quark annihilation is realized by detailed balance. We find that the number of thermally produced charm quark pairs strongly depends on the charm quark mass in the QGP. While for the heavy charm quarks of mass $m_c = 1.8$ GeV it is subdominant compared to the primary charm production by binary nucleon-nucleon collisions, the numbers of primary and thermal charm quarks become comparable for a smaller (bare) $m_c = 1.2$ GeV. Compared to the experimental data on the $R_{\rm AA}$ of D mesons in heavy ion collisions at RHIC and LHC energies, it is more favorable for charm quarks in the QGP to gain additional mass due to thermal effects than to have a low bare mass [1].

Assuming that the number densities of the heavy flavor in the hadron gas and in the QGP are the same at T_c, since the phase transition is crossover at low μ_B, we obtain the effective mass of the heavy quark at T_c from the comparison with the hadron resonance gas model, which well describes the particle yield in heavy-ion collisions.
We find that the charm quark mass at vanishing baryon chemical potential is about 1.8 GeV [2], which is in agreement with our results from thermal charm production in heavy ion collisions. The mass increases slightly with increasing baryon chemical potential and then decreases.
On the other hand, the anticharm quark mass decreases steadily with increasing baryon chemical potential.

The heavy quark mass in QGP is related to the heavy quark potential at a large distance. We test three different heavy quark potentials, namely the free and internal energies of the heavy quark pair in QGP, and the unscreened potential recently proposed by the HotQCD Collaboration [3] through the thermal production of charm quarks in heavy ion collisions. We find that the free energy potential overestimates the charm production in heavy-ion collisions at the LHC, while the unscreened potential produces results closest to the experimental data from the ALICE collaboration among the three potentials [4].

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Session Classification: Parallel Session

Track Classification: Hot and Dense Nuclear Matter