

# Heavy quark dynamics in vacuum and in the quark gluon plasma (QGP)\*

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## Introduction

Heavy quarks (Q) are produced in hard binary initial collisions between the incoming nucleons in relativistic heavy-ion reactions. They provide an important independent observable that can probe some properties of the quark-gluon plasma (QGP) produced in these collisions. To this aim, we study the heavy quarks dynamics from their production until hadronization and freeze-out.

## Heavy quark scattering

Our study of the heavy quark propagation is realized within the microscopic Parton-Hadron-String-Dynamics (PHSD) transport approach [1, 2], where hadronic and partonic interactions and the dynamics of heavy flavours degrees-of-freedom are included. The scattering of heavy quarks with the QGP particles represents the first step of this study. Therefore, we have determined the elastic scattering cross section ( $\sigma_{elas}^Q$ ) of heavy quarks in vacuum and in the QGP medium. Indeed, the calculation of  $\sigma_{elas}^Q$  at finite temperature in the strongly interacting medium is considered for the first time.

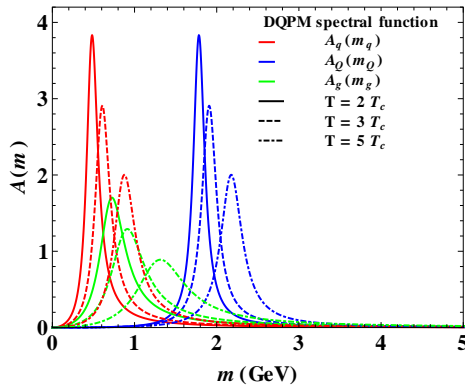


Figure 1: DQPM spectral functions of the gluon ( $A_g(m_g)$ ), light ( $A_q(m_q)$ ) and heavy quarks ( $A_Q(m_Q)$ ) for  $T = 2; 3; 5 T_c$ .

Our determination of  $\sigma_{elas}^Q$  at finite temperature couples pQCD calculation with the dynamical Quasi-Particle Model (DQPM). The partons are considered as off-shell quasi-particles, their masses are described by DQPM spectral functions for different temperatures of the medium. Figure 1 shows the gluon, light and heavy quark DQPM spectral functions at different temperatures. In Fig. 2 we

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show the elastic scattering cross section of heavy quark on a light quark as a function of  $\sqrt{s}$ , the energy in the c.m. of the collision for different temperatures. This figure shows clearly the effect of finite parton masses and widths on the perturbative elastic cross section, [3].

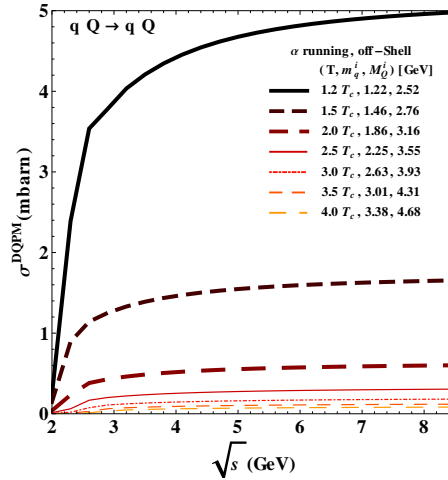


Figure 2: Elastic scattering cross section of heavy quark on light quarks ( $qQ \rightarrow qQ$ ) as a function of  $\sqrt{s}$ , the energy in the c.m. of the collision for different temperatures.

## Heavy quark dynamics

The knowledge of elastic and inelastic scattering cross sections of heavy quarks in a finite temperature medium leads to the relevant evaluation of several physical quantities, the dynamical collisional and radiative energy loss of heavy quarks, their interaction rates, diffusion coefficients, viscosity, etc. Ultimately, the explicit microscopic dynamics of heavy flavours in the QGP and the hadronic phase can be performed within PHSD.

## References

- [1] W. Cassing, and E. L. Bratkovskaya, "Parton-Hadron-String Dynamics: an off-shell transport approach for relativistic energies", Nucl.Phys. A831 (2009) 215-242.
- [2] V. P. Konchakovski, E. L. Bratkovskaya, W. Cassing, V. D. Toneev, S. A. Voloshin, and V. Voronyuk, "Azimuthal anisotropies for Au+Au collisions in the parton-hadron transient energy range", Phys. Rev. C 85 (2012) 044922.
- [3] H. Berrehrah, P.B. Gossiaux, J. Aichelin, E. Bratkovskaya, W. Cassing and M. Bleicher, "Collisional and radiative processes of heavy quarks in vacuum and in the QGP medium", in preparation.