On- and off-shell heavy quark transport properties in the quark-gluon plasma*

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Within the aim of a dynamical study of on- and off-shell heavy quarks Q in the quark gluon plasma (QGP) - as produced in relativistic nucleus-nucleus collisions - we study the heavy quark collisional scattering on partons of the QGP and the underlying transport properties.

The collisional scattering cross sections σ^Q_{elas} are evaluated for perturbative partons (massless on-shell particles) and for dynamical quasi-particles (massive off-shell particles as described by the dynamical quasi-particles model "DQPM") using the leading order Born diagrams [1]. Figure 1 shows the elastic cross section of charm quark on a "u" quark as a function of $\sqrt{s}$, the energy in the c.m.s. of the collision for different temperatures. Comparing the DpQCD (Dressed pQCD) and IEHTL (Infrared Enhanced HTL) models where the partons have the DQPM pole masses in the first and are off-shell quasi-particles dressed by DQPM spectral functions in the second, we demonstrate that the finite width of the quasi-particles in the DQPM has little influence on σ^Q_{elas} except close to thresholds. The size of σ^Q_{elas} is dominated by the infrared regulator which in the finite temperature medium is determined by a dynamical gluon mass.

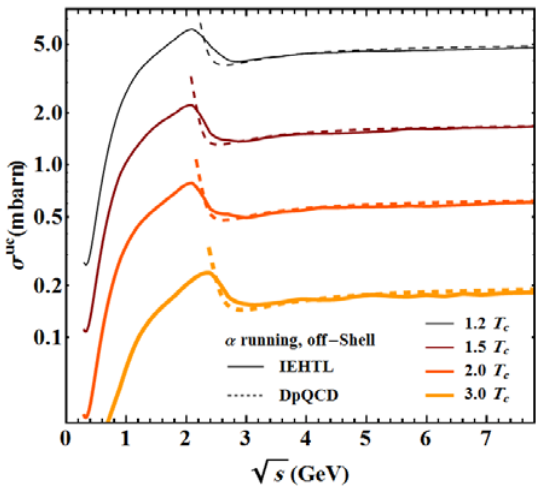

Figure 1: Elastic cross section of $uc \to uc$ for off-shell (solid lines) and on-shell partons (dashed lines) as a function of $\sqrt{s}$ for different temperatures.

Based on σ^Q_{elas} in a finite temperature medium [1], the on- and off-shell heavy quark dynamical collisional energy loss and transport coefficients are computed [2,3]. As an example, the charm drag coefficient is shown in figure 2 where both the on- and off-shell partons are employed. The Q momentum dependence of the drag is small in the non-perturbative models DpQCD/IEHTL compared to a pQCD calculations (HTL-GA with α constant or running). Our comprehensive comparison between perturbative and non-perturbative QCD based models shows out significant differences for the different Q transport characteristics. Nevertheless, our conclusion is that an explicit transport calculations in comparison to experimental data are needed to pin down the appropriate scenario, since the microscopic ingredients and the QGP background description are coupled and are specific to each model. The Q scattering cross sections and transport properties [1-3] will form the basis of a consistent study of the heavy quark dynamics in heavy-ion collisions at SPS, RHIC and LHC energies by implementing the partonic processes into the PHSD transport approach.

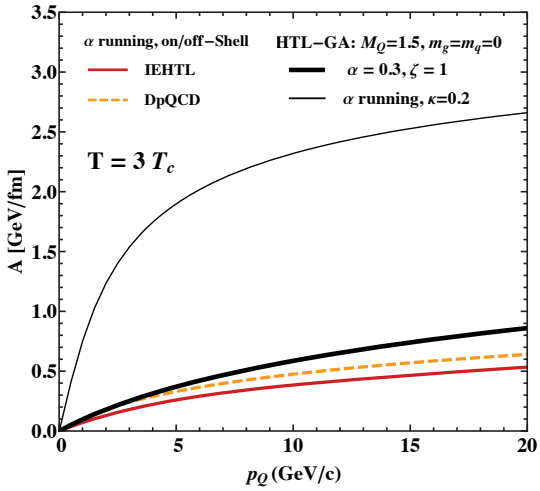

Figure 2: c-quark drag coefficient A from non-perturbative approaches DpQCD/IEHTL and the perturbative model HTL-GA as a function of the c-quark momentum.

References

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[2] H. Berrehrah, E. Bratkovskaya, W. Cassing, P.B. Gossiaux, J. Aichelin, *arXiv:1311.0736 [hep-ph]*.

[3] H. Berrehrah, E. Bratkovskaya, W. Cassing, P.B. Gossiaux, J. Aichelin., "Dynamical collisional energy loss and transport properties of on-shell and off-shell heavy quarks in vacuum and in the Quark-Gluon Plasma, *To be published*.

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