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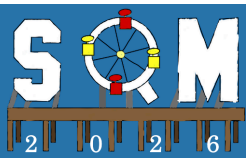

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Heavy quark transport in quark-gluon plasma beyond the non-relativistic limit

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The dynamics of heavy quarks in quark-gluon plasma (QGP) formed in heavy ion collisions provide a unique window to characterize its properties. Existing approaches to describe heavy quarks in medium rely either on quasiparticle-based models of QGP, or on assuming that the momentum transfer from the medium follows Gaussian statistics. However, neither of these assumptions can be taken for granted in QCD. In fact, in the prototypical theory that is strongly coupled $\mathcal{N} = 4$ SYM, it has been long known there are no momentum-carrying quasipaticles, and furthermore, we have recently shown that the momentum transfer from the medium is far from being Gaussian [1]. Since then, we showed that the asymmetry of said momentum transfer between energy loss and energy gain —which affects all moments of the distribution, not only its Gaussian characteristics —is, in fact, universal [2]. The deviations from Gaussianity can be substantial even at moderate Lorentz boost factors $\gamma = E/M$
$gtrsim2$.

Therefore, in order to connect the initial heavy quark production cross section with the final hadron p_T spectrum in a way that is consistent with QFT principles, new methods are needed. In this talk, we present a new transport description of heavy quarks that encodes all of the non-Gaussian features of the momentum transfer from the medium, all of which can be defined and in principle calculated in QCD, without relying on any assumptions regarding the strength of the coupling. As a demonstrative example, we discuss how heavy quark stopping and equilibration takes place in $\mathcal{N} = 4$ SYM. This paves the way towards extracting information about novel fundamental properties of QGP.

[1] 2501.06289
[2] 2504.21139

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