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Heavy quark thermalization using phonon-heavy quark EFT (ϕ-EFT)

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The description of heavy quarks inside the QGP medium, especially at low momenta, remains challenging from first principles, due to large coupling strength and gluon occupation numbers. An alternative way to formulate a description in terms of perturbative degrees of freedom is the interaction of the heavy quarks with the collective excitations of the medium in the form of phonons. This description is derived as an effective field theory (EFT) and therefore allows for a natural occurring power counting of the allowed interactions. This EFT has already been established in our previous work (arXiv:2510.13942), where we have derived the phonon-heavy quark interactions and calculated their thermal scattering cross section.
In this work, we use these results, together with the heavy quark expansion, to calculate the heavy quark drag coefficient A. Subsequently, we compare our results with the drag coefficient obtained from AdS/CFT calculations to determine the previously unknown Wilson coefficients for the quark-phonon coupling. Finally, we will use these coefficients to solve the Boltzmann equation for the heavy quark distribution, studying its thermalization in the QGP via soft phonon interactions.

Authors: KIRCHNER, Andreas (Duke University); MUELLER, Berndt; ROY, Jyotirmoy (Duke University); Dr WAEBER, Sebastian

Presenter: KIRCHNER, Andreas (Duke University)

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