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Quarkonium transport in weakly and strongly coupled plasmas

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Suppression of open heavy flavors and quarkonia in heavy-ion collisions is among the most informative probes of the quark-gluon plasma. Interpreting the full wealth of data obtained from the collision events requires a precise understanding of the evolution of heavy quarks and quarkonia as they propagate through the nearly thermal and strongly coupled plasma. In particular, a systematic theoretical calculation of the dissociation and recombination rates of quarkonia had been lacking until recently.

It has recently been shown in [1] that such a calculation requires the evaluation of a gauge-invariant correlator of chromoelectric fields dressed with Wilson lines, which is very similar to, but different from the correlator used to define the well-known heavy quark diffusion coefficient [2]. In this talk, we will show a complete next-to-leading order (NLO) calculation result of the chromoelectric field correlator for quarkonium at finite temperature [3], which only differs from that for open heavy quarks by a temperature-independent constant. We explain both their similarities and differences. Crucial insights are obtained by studying them in temporal axial gauge, where these correlators would naively be equal [4]. Finally, going beyond perturbation theory, we will explain how to perform an AdS/CFT calculation of the analogous correlator for quarkonium in $\mathcal{N} = 4$ SYM and show some preliminary results in the strong coupling limit [5].

[1] X. Yao and T. Mehen, "Quarkonium Semiclassical Transport in Quark-Gluon Plasma: Factorization and Quantum Correction,"JHEP 02 (2021) 062
[2] J. Casalderrey-Solana and D. Teaney, "Heavy quark diffusion in strongly coupled N=4 Yang-Mills"
[3] T. Binder, K. Mukaida, B. Scheihing-Hitschfeld, X. Yao, "Non-Abelian Electric Field Correlator at NLO for Dark Matter Relic Abundance and Quakonium Transport,"JHEP 01 (2022) 137
[4] B. Scheihing-Hitschfeld, X. Yao, "Gauge Invariance of Non-Abelian Field Strength Correlators: the Axial Gauge Puzzle,"arXiv:2205.04477 [hep-ph]
[5] G. Nijs, B. Scheihing-Hitschfeld, X. Yao, in preparation

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