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Hard probes of non-equilibrium quark-gluon plasma

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A primary goal in heavy-ion collisions is to learn about non-equilibrium properties of the quark-gluon plasma (QGP), such as the size of its thermalization timescale and the values of its transport coefficients. Hard experimental probes like jets and heavy quarks, as well as photons [1], give direct access to these non-equilibrium properties. However, theoretical challenges have hindered calculating their dynamics in a non-equilibrium QGP. Some of these challenges stem from gauge field instabilities that arise in non-equilibrium, weakly-coupled plasma, and lead to exponentially growing gauge fields [2].

In this talk we show how to handle the gauge field instabilities consistently. We first derive the time evolution of gluon correlators analytically. Building on the formalism elaborated in [1] then allows for a microscopic calculation of jet-medium interaction in a non-thermal QGP. Specifically, we evaluate how jets radiate gluons when they traverse a non-equilibrium medium and show that the medium effects can be factorized into transverse kicks on the jet [3] and a new Schwinger-like effect in the exponentially growing gauge fields. We solve the resulting equations numerically and comment on phenomenological implications for jets and photons. Our calculations not only apply to jets, but also to the kinetic theory of quarks and gluons. We compare our results to commonly used simplifications of the collision kernel in numerical kinetic theory calculations. Finally, we discuss how to explore the effect of non-equilibrium physics on other probes of the QGP, such as the heavy-quark potential.

[1] S. Hauksson et al., Phys. Rev. C97 (2018) 014901.
[2] S. Mrowczynski et al., Phys.Rept. 682 (2017) 1-97.
[3] P. Arnold et al., JHEP 0206 (2002) 030

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