Aspects of a Quark Gluon Plasma

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In identifying a quark gluon plasma (QGP) it is important to develop an understanding of: 1) the mechanism of parton production and plasma equilibration; and 2) the features of an equilibrated plasma.

An ultrarelativistic heavy-ion collision (URHIC) may be modelled via a strong background chrom-electric field, which produces particles via a Schwinger-like mechanism. The evolution of this dense system of partons can be followed using a quantum kinetic equation in which the source term is necessarily non-Markovian.[1] Plasma oscillations almost inevitably arise in this approach and may affect the observed dilepton spectrum.[2]

Aspects of this modelling of the collision may be questionable in QCD but the quantum kinetic equation itself is indubitably applicable to strong-field QED. It has been applied[3] to determine whether focused beams at proposed X-ray free electron laser facilities can cause spontaneous electron-positron pair production from the QED vacuum with the result that, under conditions reckoned achievable at planned facilities, a few hundred particle pairs will be produced per laser period. This is almost unique as a parameter-free application of non-equilibrium quantum mean field theory.

It is easy to motivate the possibility that heavy-meson production cross-sections will be modified in an equilibrated QGP. Clearly, a reliable calculation in-medium must employ a model whose properties are well constrained in vacuum and, ideally, one that preserves Poincaré covariance. The QCD Dyson-Schwinger equations (DSEs) provide a foundation for such approaches.[4] We illustrate this through the extension to $T \neq 0$, of the simple model introduced in Ref. [5]. The model provides the T-dependence of meson Bethe-Salpeter amplitudes and thus the T-dependence of meson observables. That information can be used to study, for example, $J/\psi + \pi \to D^* + \bar{D}$ in medium, a process that can have important consequences at the QGP phase boundary[6] by promoting a Mott-like effect in which the J/ψ enters the continuum as a correlated but unbound $c\bar{c}$ pair.

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