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"Classicalization" of quarkonia in the quark-gluon plasma

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Recently there has been rapid progress in understanding in-medium dynamics of a quarkonium based on the framework of open quantum system [1-5]. The stochastic potential model [5] introduces thermal fluctuations on Debye screened potential and hence incorporates wave function decoherence. This model however lacks quantum dissipation, which has so far limited its application to early times and has prevented comparison with experimental measurements. In this contribution, we present two strategies that overcome this limitation:

1. quantum-classical matching
   by investigating the localization properties of wave function and in turn of the reduced density matrix, we show, how, at intermediate time scales, one can switch from the quantum dynamics of the stochastic potential model to the classical dynamics of a Langevin equation. It involves matching the Wigner quasi-probability function of the former to the phase space distribution function of the latter. The validity of this matching procedure is discussed.
2. quantum state diffusion
   by directly implementing the quantum state diffusion formalism [6] for the Lindblad master equation [1] of a quarkonium, i.e. mapping the Lindblad master equation to a non-linear stochastic Schrödinger equation (NLSSE) for the wave function. This for the first time provides a direct link between QCD and phenomenological models based on non-linear Schrödinger equations. By numerically solving the corresponding NLSSE, we can capture quantum dissipation and thus the thermalization of quarkonia in a quantum mechanical manner. For simplicity, we discuss this formalism for a single heavy quark in the QGP.

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Primary author: KAJIMOTO, Shiori (Osaka University)

Co-authors: ROTHKOPF, Alexander (Heidelberg University); ASAKAWA, Masayuki (Osaka University); Dr AKAMATSU, Yukinao (Osaka University)

Presenter: KAJIMOTO, Shiori (Osaka University)

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