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Time Evolution of Heavy Quarkonium in the Quark-Gluon Plasma from a Stochastic Potential Model

In relativistic heavy ion collisions, the suppression of heavy quarkonia, such as charmonia and bottomonia, is considered as one of the important signals for the formation of a quark-gluon plasma. Understanding the behavior of heavy quarkonia in such hot matter would enable us in turn to extract the properties of the quark-gluon plasma from experimental data. And while lattice QCD studies have made progress in elucidating fully equilibrated quarkonium, our knowledge of its out-of equilibrium dynamics relevant for heavy-ion collisions remains scarce.

Here we present numerical results for the non-equilibrium real-time evolution of heavy quarkonium states in the quark-gluon plasma based on a recently proposed stochastic potential model [1-3] . The model adds a noise term to the real-valued Debye screened potential term. This noise term explains naturally the complex potential between a heavy quark and a heavy anti-quark, which has been found by both perturbative calculation and lattice calculation, i.e. the imaginary part is related to nontrivial noise correlations. The addition of the noise term to the potential leads to a stochastic Schrödinger equation, which implements unitary time evolution and provides insight on an important mechanism to play a role in the time evolution of a heavy quarkonium: decoherence of the wave function.

We investigate how the quarkonia evolve with the stochastic Schrödinger equation derived from the stochastic potential. In particular, we show the time evolution of the ground and excited states, and how it depends on the temperature of the environment and the correlation length of the noise.

[1] Y. Akamatsu, A. Rothkopf, Phys.Rev. D85 (2012) 105011

[2] A. Rothkopf, JHEP 1404 (2014) 085

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Preferred Track

Quarkonia

Collaboration

Not applicable

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