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# Bottomonium suppression in pNRQCD and open quantum system approach

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Using the potential non-relativistic quantum chromodynamics (pNRQCD) effective field theory in an open quantum system, we derive a Lindblad equation for the evolution of the heavy-quarkonium reduced density matrix that is accurate to next-to-leading order (NLO) in the ratio of the binding energy of the state to the temperature of the medium [1]. The resulting NLO Lindblad equation can be used to more reliably describe heavy-quarkonium evolution in the quark-gluon plasma at low temperatures compared to the leading-order truncation. For phenomenological application, we numerically solve the resulting NLO Lindblad equation using the quantum trajectories algorithm. Averaging over the Monte-Carlo sampled quantum jumps, we obtain the solution to the NLO Lindblad equation without truncation in the angular momentum quantum number of the states considered. We demonstrate the importance of quantum jumps in the nonequilibrium evolution of bottomonium states in the quark-gluon plasma [2]. We show that quantum regeneration of singlet states from octet configurations is necessary to understand experimental results for the suppression of both bottomonium ground and excited states. The values of the heavy-quarkonium transport coefficients used are consistent with recent lattice QCD determinations.

References:

[1] N. Brambilla, M.A. Escobedo, A. Islam, M. Strickland, A. Tiwari, A. Vairo, and P. V. Griend. "Heavy quarkonium dynamics at next-to-leading order in the binding energy over temperature." JHEP, 08:303, 2022.

[2] N. Brambilla, M.A. Escobedo, A. Islam, M. Strickland, A. Tiwari, A. Vairo, and P. V. Griend. "Regeneration of bottomonia in an open quantum systems approach.", Phys.Rev.D 108 (2023) 1, L011502.

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