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quantum evolution of heavy quark dipoles in the thermal bath of QGP in relativistic heavy ion collisions

In the dynamical evolutions of heavy ion collisions, heavy quark dipoles such as $c\bar{c}$ (or $b\bar{b}$) are produced from parton hard scatterings, and need a formation time to evolve into a certain bound states. Different from proton-proton collisions, the hot medium (called QGP) will affect the internal evolutions of heavy quark dipole due to color screening and parton inelastic collisions. This will change the fractions of J/ψ and $\psi(2S)$ in a $c\bar{c}$ dipole. We employ the time-dependent Schr\"odinger equation to study the $c\bar{c}$ wavefunction evolution, with heavy quark potential to be color-screened potential from Lattice QCD and also an imaginary part for the dissociation of bound states. By projecting the wavefunction to eigenstates of Cornell potential, we obtain the time evolutions of J/ψ and ψ(2S) fractions in the $c\bar{c}$ dipole. Further more, we extend this calculations from the static medium to an evolving system, where we can see a nontrival effect of this hot medim effect at different temperature regions. We present how color screening and parton scattering effects change the double ratio of $R_{AA}^{\psi(2S)}/R_{AA}^{J/\psi}$ in static medium and a cooling system.

Summary

In the Quark-Gluon Plasma produced in heavy ion collisions, heavy quark dipoles will suffer color screening effect and parton inelastic scatterings. These will result in dissociations and transitions of bound states in a $c\bar{c}$ dipole produced from initial parton hard scatterings. We employ the time-dependent Schr\"odinger equation to study this quantum effect of thermal bath on the sub-system of $c\bar{c}$.

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