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Quarkonia productions in heavy ion collisions: coupled Boltzmann transport equations

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Quarkonia can be used as probes of quark-gluon plasma (QGP), a hot nuclear environment produced in heavy ion collisions. Quarkonia become unbound or "melt" at sufficiently high temperature due to the significant screening of the color attraction. In this sense, quarkonia can be thought of as thermometers of QGP. But extracting the melting temperature from experimental measurements is much involved. To this end, we develop a set of coupled Boltzmann transport equations of heavy quarks and quarkonia. It includes elastic and inelastic scattering of heavy quarks with the medium, dissociations and recombinations (in-medium formations) of quarkonia. The dissociation and recombination processes are calculated in potential non-relativistic QCD (pNRQCD). The effective field theory pNRQCD is valid because the heavy quark mass is large and the distance between the heavy quark antiquark pair is small inside quarkonia, compared with the thermal scales. We solve the Boltzmann equations by Monte Carlo simulations with given initial conditions and medium backgrounds. We will present how the system of heavy quarks and quarkonia approaches equilibrium in a static QGP box, which indicates that the dissociation and recombination are implemented in a consistent way. Then we will present calculations with realistic initial conditions and hydrodynamical backgrounds. The initial momenta of heavy quarks and quarkonia are generated from event generators such as Pythia with nuclear parton distribution functions while the initial positions are sampled from binary collisions. We will also compare the calculations with experimental measurements. Finally, we will discuss future plans towards a more complete understanding of quarkonia production mechanisms in heavy ion collisions.

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