Charmonium production from nonequilibrium charm and anticharm quarks in Quark –gluon plasma

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Using the transition amplitudes for J/ψ production from charm and anticharm quarks calculated up to NLO in pQCD [1,2] and including the medium effect on the J/ψ wave function and binding energy from a screened Cornell potential between charm and anticharm quarks in QGP [3], we have studied J/ψ production in QGP from nonequilibrium charm and anticharm quarks [4] that are described by the Tallis distribution [5]. We have found that nonequilibrium charm and anticharm quarks suppress the production rate of J/ψ in QGP, compared to the rate from completely thermalized charm and anticharm quarks as shown in the left window of Fig. 1. We have further used the calculated J/ψ production rate in QGP to study J/ψ production in heavy-ion collisions at the RHIC and LHC by using the PHYTIA simulation to obtain the initial charm and anticharm quark distributions and then follow their elastic scattering with light quarks and antiquarks as well as gluons in QGP via the cascade simulation. With the resulting charm and anticharm quark distributions parameterized by the Tsallis distribution, we have found that the suppression in the J/ψ production rate is stronger in higher energy collisions and at higher temperatures, although their time dependence is similar in all cases as shown in the right window of Fig.1. We have also compared our results to those in the literature obtained with the relaxation factor correction using the charm quark relaxation time and found that the latter is similar to our results as shown by the solid line in the right window of Fig.1.

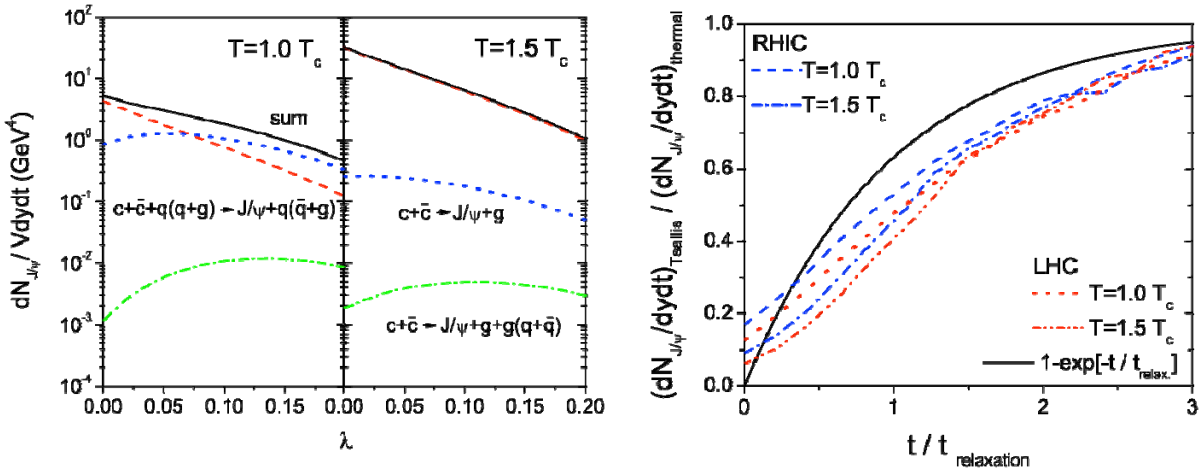

FIG. 1. Left window: Production rate of J/ψ per unit rapidity in QGP at temperatures T = 1.0 (left panel) and 1.5 T_c (right panel) as a function of λ (λ=0 corresponds to a thermally equilibrated distribution) from charm and anticharm quarks that have a Tsallis distribution. Right window: Time dependence of the ratio of the J/ψ production rate from nonequilibrium charm and anticharm quarks to that from completely thermalized charm and anticharm quarks in QGP at T= 1.0 and 1.5 T_c. The solid line is the result based on the relaxation factor correction.

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