J/ψ Suppression in an Equilibrating Parton Plasma *

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J/ψ suppression due to color screening has been proposed to probe deconfinement. This requires that the interactions of J/ψ with hadrons and deconfined partons are different. A parton-based calculation of J/ψ-hadron cross section via an operator product expansion gives a very small break-up cross section at low energies. Only at very high energies, this cross section will reach its asymptotic value of a few mb. Therefore, a slow J/ψ is very unlikely to be absorbed inside a hadron gas of reasonable temperature.

On the other hand, a deconfined partonic system contains much harder gluons which can easily break up a J/ψ. A study of the energy dependence of the gluon-J/ψ inelastic cross section shows a strong peak just above the break-up threshold of the gluon energy, $\epsilon_0 = 2M_D - M_{J/\psi}$, where $M_{J/\psi}$ and M_D are the J/ψ and D meson masses, respectively. In the pre-equilibrium stage, i.e., before the partons have reached equilibrium, the average parton transverse momentum is sufficiently large to break up a J/ψ, provided the partons are deconfined. The dissociation of the J/ψ will continue during the whole equilibration process until the effective temperature drops below a certain value or the beginning of hadronization, whichever takes place first. Therefore measurements of J/ψ suppression can probe the deconfinement of the early partonic system and shed light on the subsequent equilibration process, provided that possible nuclear effects on the production of $Q\bar{Q}$ pairs and on pre-resonance charmonium states are understood and taken into account.

In this paper we first calculated the thermal gluon-J/ψ dissociation cross section at different temperatures and for different J/ψ transverse momentum. We then follow the evolution of an initially produced parton gas toward equilibrium and calculate the resulting total survival probability of a J/ψ and its p_T-dependence.

Shown in Fig. 1 are the J/ψ survival probabilities in the deconfined and equilibrating parton plasma at RHIC and LHC energies with initial conditions given by HIJING Monte Carlo simulations. We find that there is stronger J/ψ suppression at LHC than at RHIC energy, due both to the higher initial parton densities and longer lifetime of the parton plasma. The increase of the survival probabilities with the J/ψ transverse momentum is a consequence of the decrease of the thermal cross section with increasing P_T at high temperatures and the shorter time spent by a higher-p_T J/ψ inside the parton plasma.

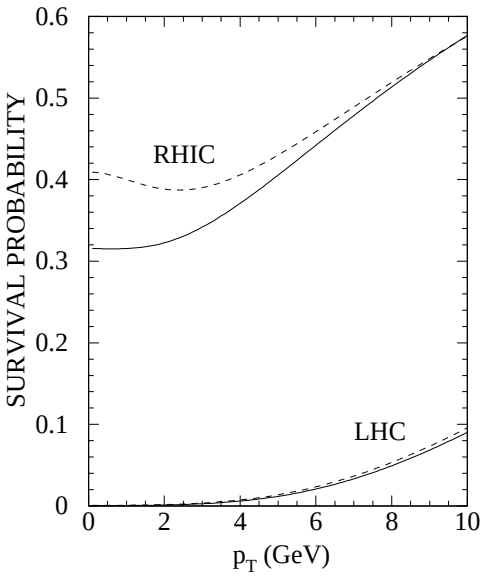

Figure 1: The survival probability of J/ψ in an equilibrating parton plasma at RHIC and LHC energies with initial conditions given by HIJING.

For a parton system with a low initial temperature (below 300 MeV), the p_T dependence of the survival probability should be flatter. One can therefore use the p_T dependence to shed light on the initial temperature and the evolution of the system.

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