Gluon dissociation of J/ψ beyond the dipole approximation

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Using a nonrelativistic potential model, we have derived the cross section for the leading-order gluon dissociation of J/ ψ at zero temperature by including the full gluon wave function [1]. In the limit of long gluon wavelength, the usually used cross section based on the dipole approximation [2,3] is recovered. In this process, the gluon can be absorbed by either heavy quarks or by the exchanged gluon between them. Both processes contribute equally in the dipole approximation in the large N_c limit. The cross section is, however, smaller beyond the dipole approximation as shown in Fig. 1, and this is mainly

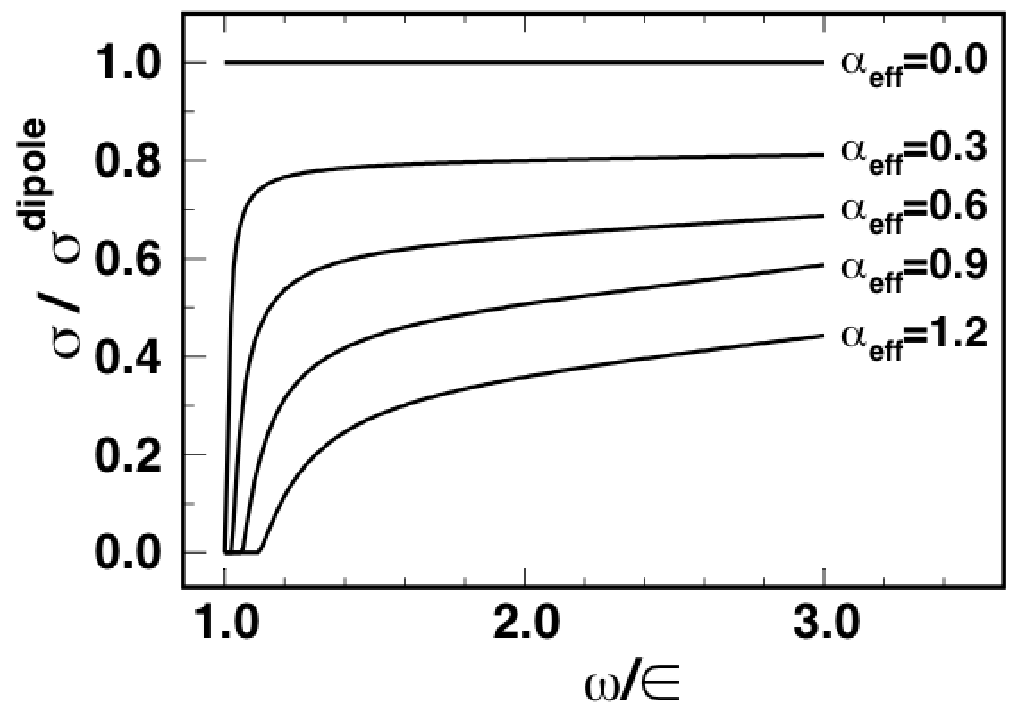

FIG. 1. Ratio of J/ψ dissociation cross section calculated beyond the dipole approximation to that with the dipole approximation as a function of the ratio of the gluon energy in the quarkonium frame and the J/ψ binding energy.

due to the latter process because the momentum of the gluon affects the range of the external gluon induced transition potential. We have also found that the angular distribution of the relative momentum of heavy quarks in the final state is modified with the inclusion of the full gluon wave function, leading to heavy quarks more likely to be scattered close to the momentum of the initial gluon rather than perpendicular to it as in the dipole approximation as shown in Fig. 2. At finite temperature, including the full gluon wave function only slightly modifies the dissociation width of a J/ψ at high temperature whether the charm quark potential is taken to be the internal energy or the free energy from the lattice calculations, but it significantly reduces the dissociation width at low temperature in the case that the internal energy from the lattice calculations is used as the charm quark potential.

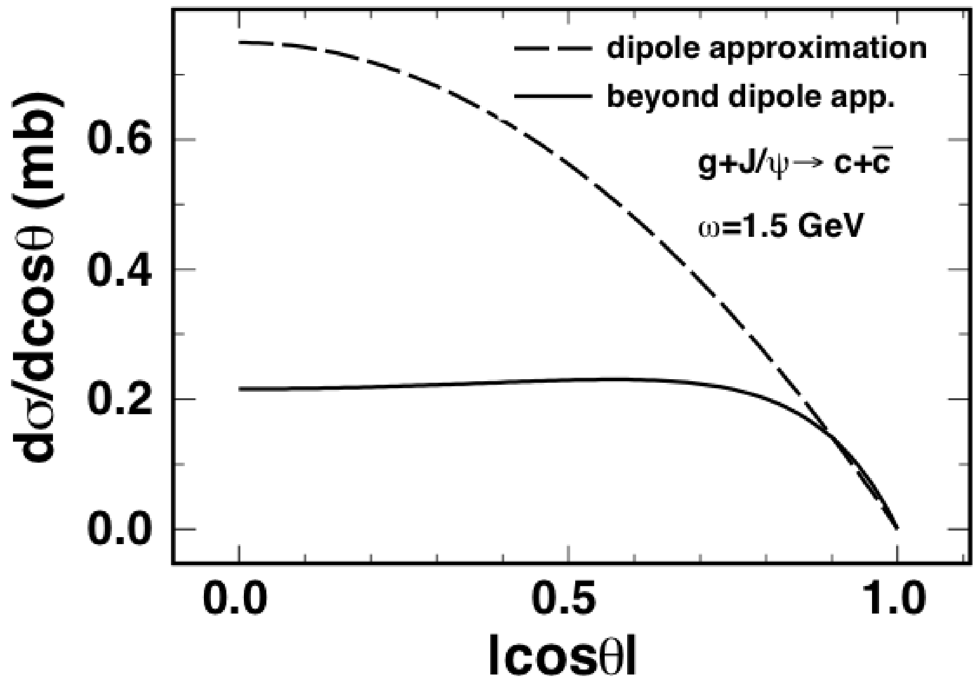

FIG. 2. Differential cross section for the gluon dissociation of J/ψ as a function of |cos θ| for the gluon energy ω = 1.5 GeV in the J/ψ frame, where θ is the angle between the momentum of the gluon and the relative momentum of final charm and anticharm quarks.

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