Scattering Cross Sections of Charm Mesons by Kaons

T. G. Di, Z. W. Lin, and C. M. Ko

Since charm quarks undergo strong radiative energy loss in a quark-gluon plasma, study of charm meson spectrum in heavy ion collisions may thus provide useful information on the properties of the quark-gluon plasma formed in these collisions [1]. This requires, however, the understanding of charm meson interactions with hadrons as they may also affect the final charm meson spectrum. We have previously studied the scattering cross sections of charm mesons with pions and rho meson using a Lagrangian that is based on gauged SU(4) flavor symmetry but with empirical masses and coupling constants [2]. Taking 1 GeV for the cutoff parameters at the interacting vertices, these cross sections are found to have values of about 10 mb. Since kaons are also abundantly produced, we have extended the model to study the scattering cross sections of charm mesons by kaons.

We have considered both scattering of charm meson D and its resonance D^* with kaon K and its resonance K^*. These reactions include $D(D^*)K \to K(D^*)K$, $D(D^*)K \to D^*\rho$, $D(D^*)K^* \to D(D^*)K^*$, and $D(D^*)K^* \to D^*\rho$. The lowest-order Feynman diagrams for these reactions are given in Fig. 1. As in Ref. 2, we use either the empirical values for the coupling constants or determine them from the SU(4) relations if they are unknown empirically. We have also included monopole form factors at interaction vertices. From QCD sum rule studies [3], the cutoff parameter, Λ, in the form factors are found to have a value of 1 or 2 GeV.

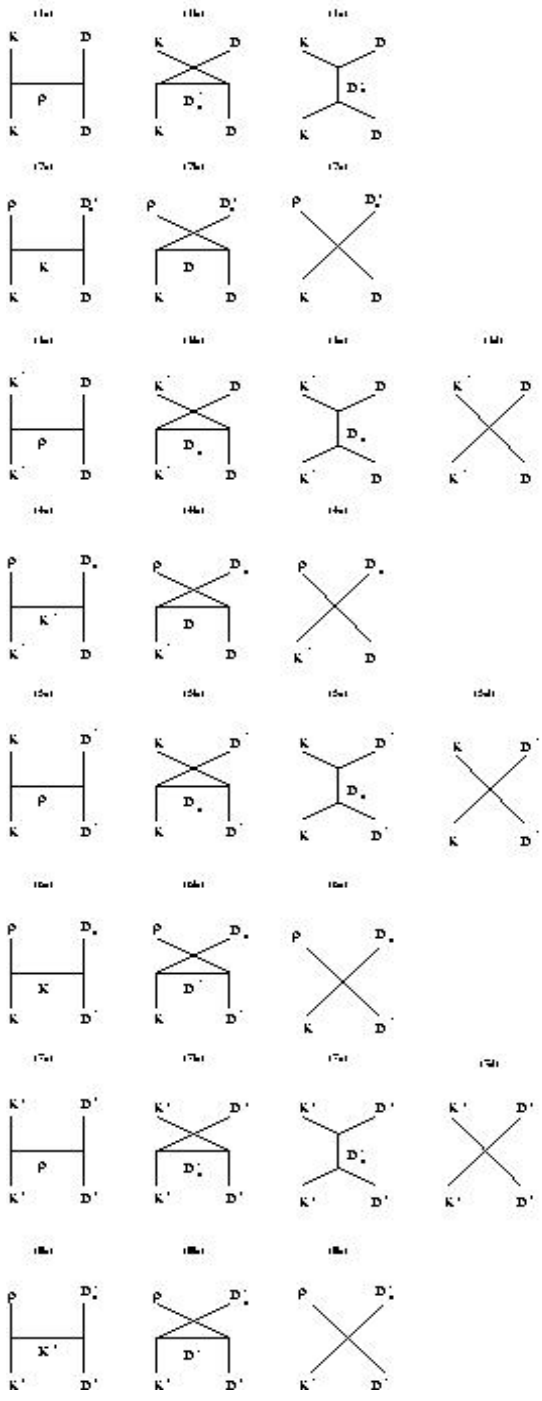

Figure 1: Feynman diagrams for charm mesons scattering by kaon and its resonances.

Using a cutoff parameter Λ =1 *GeV,* the cross sections for *D* meson scattering by *K* and *K** are shown in Fig. 2, while those for *D** scattering by *K* and *K** are shown in Fig. 3 as functions of the center-of-mass energy. In both cases, the cross sections for the elastic scattering $D(D^*)K \to D(D^*)K$ and $D(D^*)K^* \to D(D^*)(K^*)$ are about 10 mb at low energy and decrease slightly at high energy. These cross sections are comparable to those for *D* meson scattering by pion and rho meson. The cross sections for inelastic scattering are much smaller, with only a few tens mb for $D^*K \to D^*\rho$, and is another order of magnitude smaller for $DK \to D^*\rho$. These results are increased by about a factor of two when the cutoff parameter Λ is doubled.

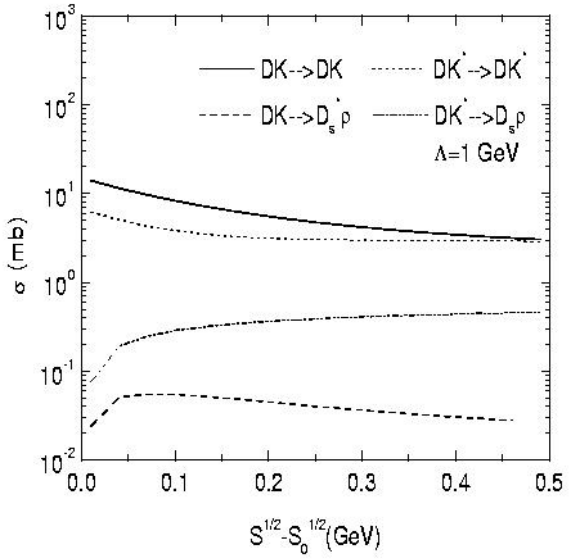

Figure 2: Cross sections for charm meson scattering by kaon and its resonance.

Although there are less kaons than pions in the hot hadronic matter formed in relativistic heavy ion collisions, the larger kaon mass makes them more effective in randomizing the momentum distribution of charm mesons. It is thus of interest to use the cross sections obtained here in a transport model to study the effect of hadronic scatterings on the final charm meson spectrum. Such a study using a multiphase transport model (AMPT) [4] is currently underway.

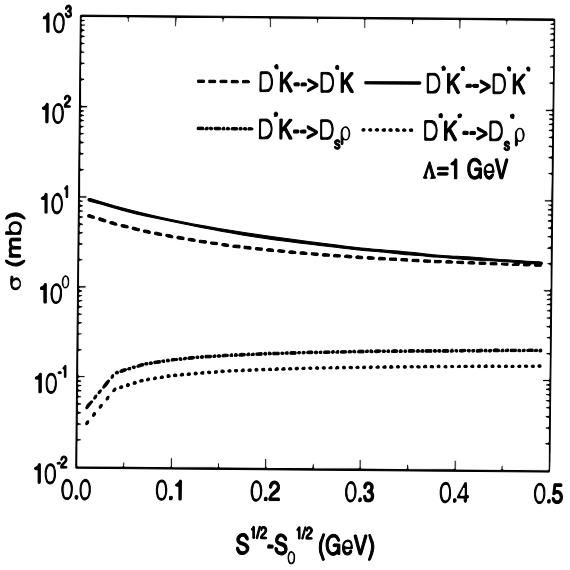

Figure 3: Cross sections for charm meson resonance scattering by kaon and its resonance.

References

[1] Z. W. Lin and M. Gyulassy, Phys. Rev. C **51**, 2177 (1995); Z. W. Lin, R. Vogt, and X. N. Wang, *ibid*. **57**, 899 (1998).

[2] Z. W. Lin, T. G. Di, and C. M. Ko, Nucl. Phys. **A689**, 965 (2001); Z. W. Lin, C. M. Ko, and B. Zhang, Phys. Rev. C **61**, 024904 (2000).

[3] F. S. Navarra and M. Nielsen, Phys. Lett. **B433**, 285 (1998); F. O. Duraes, F. S. Navarra, and M. Nielsen, *ibid*., **498**, 169 (2001).

[4] B. Zhang, C. M. Ko, B. A. Li, and Z. W. Lin, Phys. Rev. C **61**, 067901 (2000); Z. W. Lin, S. Pal, C. M. Ko, B. A. Li, and B. Zhang, *ibid*. **64**, 011902 (2001); Nucl. Phys. **A698**, 375c (2002).