CHARMONIUM DISSOCIATION BY MESONS AND HEAVY ION COLLISIONS

[a] Gennady Lykasov
and
[b] Wolfgang Casssing

[a] *JINR, Dubna, Russia*
[b] *Institut fuer Theoretishe Physik, Giessen University, Giessen, Germany*

C O N T E N T S

HADRONIC BINARY REACTIONS

$$a + b \to c + d$$

$$\mathcal{M}_R(s,t) = C_I g_1^2 F(t)(s/s_0)^{\alpha_R(t)-1}(s/\bar{s}),$$

where C_I is the isotopic factor, $g_1^2 = M_R^2 g_0^2$, $g_0^2/4\pi = 2.7$ is the universal coupling constant determined from the width of the ρ-meson,

$$F(t) = \Gamma(1 - \alpha_R(t))$$

- **Absorbtive corrections**

FSI within the quasi-eichannel approximation:

$$\mathcal{M}(s,b) \;=\; \mathcal{M}_R(s,b)exp(-\chi(s,\mathbf{b})$$

where

$$\chi(s,\mathbf{b}) = C(s)\int ImT_p(s,q^2)e^{i\mathbf{b}\cdot\mathbf{q}} =$$

$$= \frac{\sigma_{cd}C(s)}{4\pi\Lambda_P(s)}exp(-\frac{b^2}{2\Lambda_P(s)})$$

where

$$C(s) = 1 + \frac{\sigma^{inel}_{diff}}{\sigma^{el}}$$

ISI and FSI:

$$\chi(s,\mathbf{b},z) = \chi^{ab}_{-}(s,\mathbf{b},z) \ + \ \chi^{cd}_{+}(s,\mathbf{b},z)$$

where

$$\chi^{ab}_{-}(s,\mathbf{b},z) \ = \ \frac{\sigma^{tot}_{ab}C}{4\pi\Lambda_P}exp(-\frac{b^2}{2\Lambda_P})\frac{1}{\sqrt{2\Lambda_P\pi}}\cdot$$

$$\int^{z}_{-\infty} exp(-\frac{y^2}{2\Lambda_P})dy$$

and

$$\chi^{cd}_{+}(s,\mathbf{b},z) \ = \ \frac{\sigma^{tot}_{cd}C}{4\pi\Lambda_P}exp(-\frac{b^2}{2\Lambda_P})\frac{1}{\sqrt{2\Lambda_P\pi}}\cdot$$

$$\int^{+\infty}_{z} exp(-\frac{y^2}{2\Lambda_P})dy$$

The scattering amplitude in the coordinate space has the following form

$$\mathcal{M}(s,\mathbf{b},z) = \mathcal{M}_R(s,\mathbf{b},z)\cdot$$
$$exp(-[\chi_-^{ab}(s,\mathbf{b},z) + \chi_+^{cd}(s,\mathbf{b},z)])$$
$$\mathcal{M}_R(s,\mathbf{b},z) = \frac{1}{(2\pi)^{3/2}} \int d^2q_t dq_z \mathcal{M}_R(s,q_t,q_z)\cdot$$
$$e^{i\mathbf{q}_t\mathbf{b}} e^{iq_z z} = \mathcal{M}_R(s,t=0) exp(q_0^2\Lambda_R/2)\cdot$$
$$\frac{1}{\Lambda_R^{3/2}} exp(-\frac{b^2+z^2}{2\Lambda_R})$$

Finally the scattering amplitude is

$$\mathcal{M}(s,t) = \frac{1}{(2\pi)^{3/2}} exp(q_0^2\Lambda_R/2) \int d^2b dz\cdot$$
$$\mathcal{M}(s,\mathbf{b},z) e^{-i\mathbf{q}_t\mathbf{b}} e^{-iq_z z}$$
$$\Lambda_R = 2\alpha_R'(0) ln(\frac{s}{s_0}) \ : \ \Lambda_P = 2\alpha_P'(0) ln(\frac{s}{s_0})$$

One can see when $\sigma_{ab}^{tot} = \sigma_{cd}^{tot}$ then $\chi(s,\mathbf{b},z)$ becomes $\chi(s,\mathbf{b})$.

$$\mathcal{M}_{\pi(\rho)\ J/\Psi}(s,t) = C_I g_1^2 F(t) (s/s_0)^{\alpha_{u\bar{c}}(t)-1} (s/\bar{s}),$$

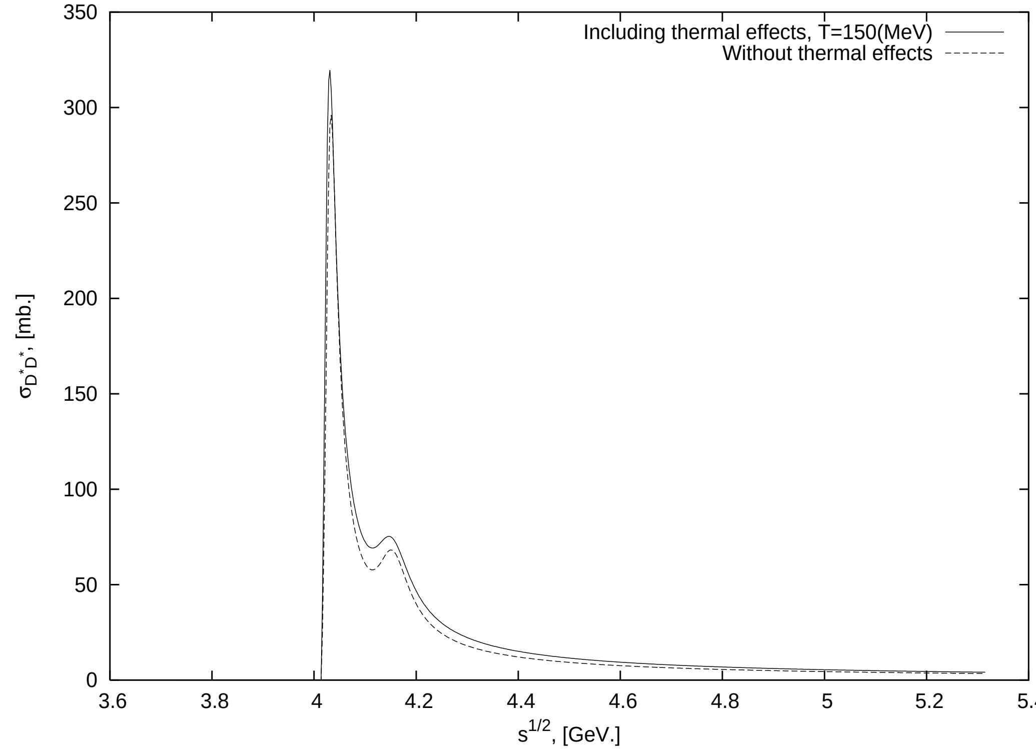

Figure 1: The resonance form of the $\bar{D}^* D^*$ cross section as a function of $\sqrt{s}$.

where the isotopic factor $C_I = \sqrt{2}$ for $\pi(\rho)^{\pm} - J/\Psi$ and $C_I = 1$ for $\pi^0(\rho^0) - J/\Psi$ reactions respectively $g_1^2 = M_{D^*}^2 g_0^2$ is the universal coupling constant and $g_0^2/4\pi = 2.7$ is determined from the width of the ρ-meson $\alpha_{u\bar{c}}(t) = \alpha_{D^*}(t)$ is the D^* Regge trajectory, $\bar{s} = 1$ GeV^2 is a universal dimensional factor, $s_0 = 4.9 GeV^2$ is the flavour dependent scale factor which is determined by the mean transverse mass and the average momentum fraction of quarks in colliding hadrons and $F(t)$ is the form factor describing the t dependence of the residue. We assume that the D^* Regge trajectory is linear and therefore can be expanded over the transfer t

$$\alpha_{D^*}(t) \; = \; \alpha_{D^*}(0) \; + \; \alpha'_{D^*}(0)t \; ,$$

where the intercept $\alpha_{D^*}(0) = -0.86$ and its derivative $\alpha'_{D^*}(0) = 0.5GeV^{-2}$ are found from their relations to the same quantities for the J/Ψ and ρ trajectories which are known

$$(\alpha'_{u\bar{c}})^{-1} = \frac{1}{2}((\alpha'_{c\bar{c}})^{-1} + \alpha'_{u\bar{u}})^{-1}) \; ,$$

where the intercept $\alpha_{u\bar{u}}(0) = 0.5$ and the derivative $\alpha'_{u\bar{u}}(0) = 0.9GeV^{-2}$ of the ρ Regge-trajectory are known very well, $\alpha_{c\bar{c}}(0) = -2.18$ and $\alpha'_{c\bar{c}} = 0.5GeV^{-2}$ are determined by drawing the trajectory through the ψ-meson mass $m_\psi = 3.097GeV$ and the χ-mass $m_\chi = 3.554GeV$. The form factor

$F(t)$ determining the t dependence of the residue was presented as follows

$$F(t) = \Gamma(1 - \alpha_{D}{}^{*}(t)) \ , \qquad (1)$$

where $\Gamma(...)$ is the Gamma function.

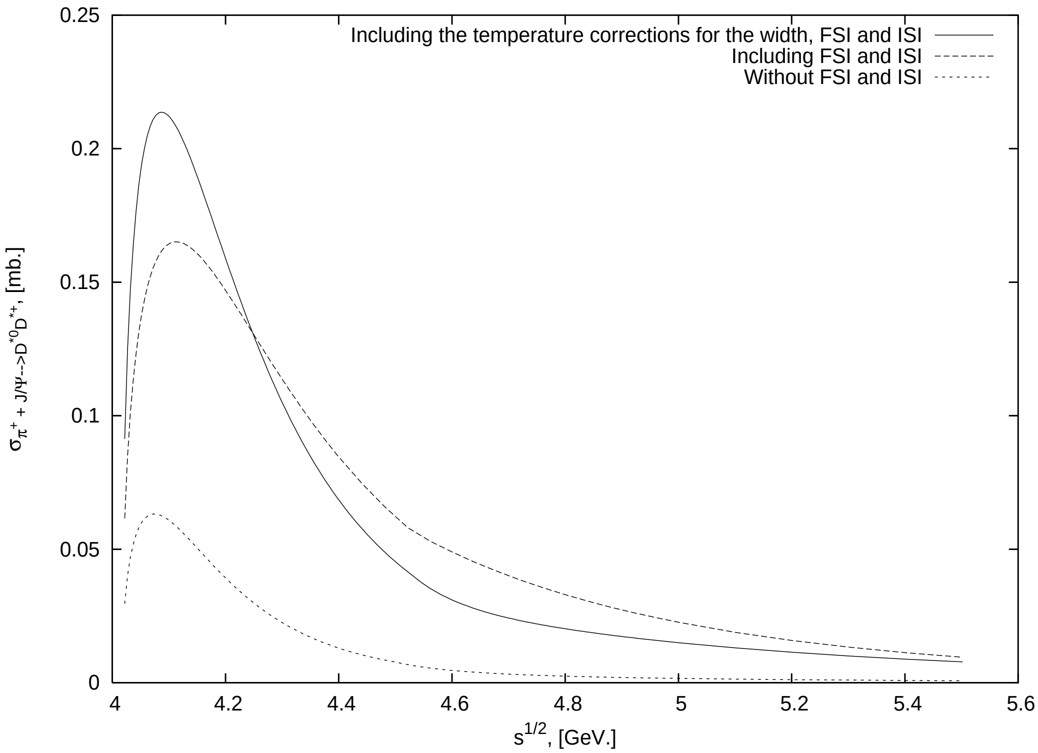

Figure 2: The cross section of the reaction $\pi^{+} + J/\Psi \rightarrow D^{*+} + \bar{D}^{*0}$ as a function of $\sqrt{s}$.

• CONCLUSION •

I.

The enhancement of open charm production measured in NA-50 experiment on $A-A$ collisions can be explained by secondary meson-nucleon interactions. (W.Cassing, L.Kondratyuk, G.L., M.Rzjanin: Phys.Lett.,B513, 1(2001))

II.

This success stimulated to apply our approach to the analysis of processes like $(c\bar{c})$ dissociation by mesons in a medium

III.

Applying the simple Regge theory to such processes we found that the ISI and FSI effects should be included at energies close to the threshold of $D\bar{D}$.

IV.

These effects modify the form of the cross section too much.

V.

The main in-medium effect is the temperature dependence of the $(c\bar{c})$ width. It also changes such cross section.