# Formulae of Charmed Meson in Recombination Model

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Utility:

$$\mathcal{S}^q(p) = \int \frac{dq}{q} \sum_i F_i(q) QuenchF(q) S_i^q(p/q) QuenchS(p), \quad \text{if q=c, then i=charm, gluon.} \tag{1}$$

$$\mathcal{SS}^{q_1 q_2}(p_1, p_2) = \int \frac{dq}{q} \sum_i F_i(q) QuenchF(q) S_i^{q_1}(p_1/q) QuenchS(p_1) S_i^{q_2}(\frac{p_2}{q-p_1}) QuenchS(p_2), \tag{2}$$

if q=c, then i=charm, gluon.

$$R_M(p_1, p_2, p) = \frac{g_M}{B(a+1, b+1)} (\frac{p_1}{p})^{a+1} (\frac{p_2}{p})^{b+1} \delta(\frac{p_1}{p} + \frac{p_1}{p} - 1), \quad \text{in which } \frac{a+1}{b+1} \approx \frac{m_1}{m_2}. \tag{3}$$

for $D^0$, $\frac{a+1}{b+1} = \frac{1}{5}$, for $D_s$, $\frac{a+1}{b+1} = \frac{3}{10}$.

$$xD_i^M(x) = \int_0^x \frac{dx_1}{x_1} \int_0^x \frac{dx_2}{x_2} \{S_i^q(x_1), S_i^{\overline{q'}}(x_2)\} R_M(x_1, x_2, x), \tag{4}$$

$$QuenchF(q) = \frac{1}{1 + e^{(3.5-q)/0.5}}, \tag{5}$$

$$QuenchS(q) = 1 - e^{-(q/0.5)^2}, \tag{6}$$

$$QuenchD(q) = 1 - e^{-q^2}. \tag{7}$$

$J/\psi$:

$$\frac{dN_{J/\psi}^{TT}}{p_T dp_T} = \frac{g_{J/\psi} C_c^2 p_T}{4 m_T^{J/\psi}} e^{-p_T/T_c}, \tag{8}$$

$$\frac{dN_{J/\psi}^{TS}}{p_T dp_T} = \frac{g_{J/\psi} C_c}{2 m_T^{J/\psi}} e^{-p_T/2T_c} \mathcal{S}^c(p_T/2), \tag{9}$$

$$\frac{dN_{J/\psi}^{SS^{1j}}}{p_T dp_T} = \frac{g_{J/\psi}}{p_T m_T^{J/\psi}} \mathcal{SS}^{c\bar{c}}(p_T/2, p_T/2), \tag{10}$$

$$\frac{dN_{J/\psi}^{SS^{2j}}}{p_T dp_T} = \frac{g_{J/\psi} \Gamma}{p_T m_T^{J/\psi}} \mathcal{S}^c(p_T/2) \mathcal{S}^{\bar{c}}(p_T/2). \tag{11}$$

$D^0$:

$$\frac{dN_{D^0}^{TT}}{p_T dp_T} = \frac{5 g_{D^0} C_q C_c}{p_0 p_T^6} \int_0^{p_T} dp_1 p_1 e^{-p_1/T_q} (p_T - p_1) e^{-(p_T - p_1)/T_c} (p_T - p_1)^4, \tag{12}$$

$$\frac{dN_{D^0}^{TS}}{p_T dp_T} = \frac{5 g_{D^0}}{p_0 p_T^6} \int_0^{p_T} dp_1 p_1 (p_T - p_1)^4 [C_q e^{-p_1/T_q} S^c(p_T - p_1) + C_c (\frac{p_T}{p_1} - 1) e^{-(p_T - p_1)/T_c} S^{\bar{u}}(p_1)], \tag{13}$$

$$\frac{dN_{D^0}^{SS^{1j}}}{p_T dp_T} = \frac{1}{m_T^{D^0}} \int \frac{dq}{q^2} \sum_{i=g,c} F_i(q) QuenchF(q) D_i^{D^0}(p_T/q) QuenchD(p_T), \tag{14}$$

$$\frac{dN_{D^0}^{SS^{2j}}}{p_T dp_T} = \frac{5 g_{D^0} \Gamma}{m_T^{D^0} p_T^6} \int_0^{p_T} dp_1 (p_T - p_1)^4 \mathcal{S}^{\bar{u}}(p_1) \mathcal{S}^c(p_T - p_1). \tag{15}$$

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$D_s$:

$$\frac{dN_{D_s}^{TT}}{p_T dp_T} = \frac{660 g_{D_s} C_s C_c}{p_0 p_T^{13}} \int_0^{p_T} dp_1 p_1 e^{-p_1/T_s}(p_T - p_1) e^{-(p_T-p_1)/T_c} p_1^2 (p_T - p_1)^9, \tag{16}$$

$$\frac{dN_{D_s}^{TS}}{p_T dp_T} = \frac{660 g_{D_s}}{p_0 p_T^{13}} \int_0^{p_T} dp_1 p_1^3 (p_T - p_1)^9 [C_s e^{-p_1/T_s} S^c(p_T - p_1) + C_c(\frac{p_T}{p_1} - 1) e^{-(p_T-p_1)/T_c} S^{\bar{s}}(p_1)], \tag{17}$$

$$\frac{dN_{D_s}^{SS^{1j}}}{p_T dp_T} = \frac{1}{m_T^{D_s}} \int \frac{dq}{q^2} \sum_{i=g,c} F_i(q) QuenchF(q) D_i^{D_s}(p_T/q) QuenchD(p_T), \tag{18}$$

$$\frac{dN_{D_s}^{SS^{2j}}}{p_T dp_T} = \frac{660 g_{D_s} \Gamma}{m_T^{D_s} p_T^{13}} \int_0^{p_T} dp_1 p_1^2 (p_T - p_1)^9 \mathcal{S}^{\bar{s}}(p_1) \mathcal{S}^c(p_T - p_1). \tag{19}$$

# I. RESULTS

## A. 2023.07.04

Despite violating ratio of mass, we set $\frac{a+1}{b+1} = \frac{2}{3}$ for $D^0$, like Kaon, and $\frac{a+1}{b+1} = \frac{3}{4}$ for $D_s$ owing to smaller ratio of mass. The parameters and results are following.

TABLE I: Parameters used in v16, in which $\gamma_0$ and $q_0$ are only for charm quark.

| | $C_q$ | $T_q$ | $C_s$ | $T_s$ | $C_c$ | $T_c$ | $\gamma_0$ | $q_0$ | $g_{J/\psi}$ | $g_{D^0}$ | $g_{D_s}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.76 TeV | 23.2 | 0.39 | 11.0 | 0.51 | 0.8 | 0.68 | 3.0 | 7.0 | 1.0 | 2.3 | 1.0 |
| 5.02 TeV | 22.0 | 0.42 | 10.0 | 0.545 | 0.5 | 0.83 | 3.0 | 7.0 | | | |

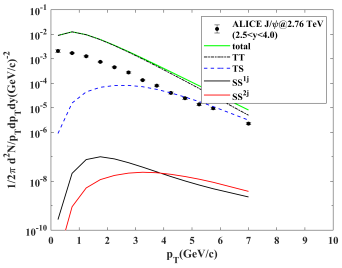


FIG. 1: 2.76 TeV $J/\psi$

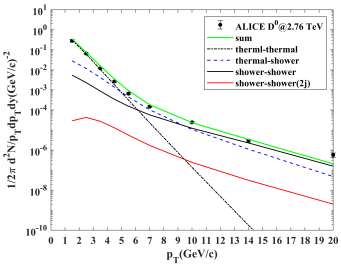


FIG. 2: 2.76 TeV $D^0$

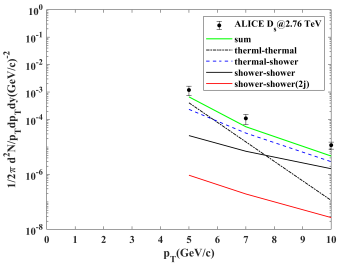


FIG. 3: 2.76 TeV $D_s$

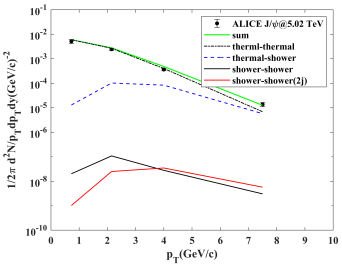


FIG. 4: 5.02 TeV $J/\psi$

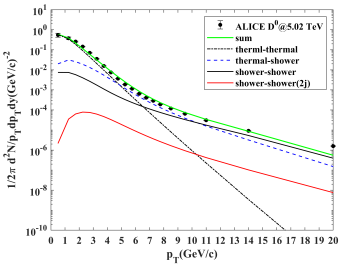


FIG. 5: 5.02 TeV $D^0$

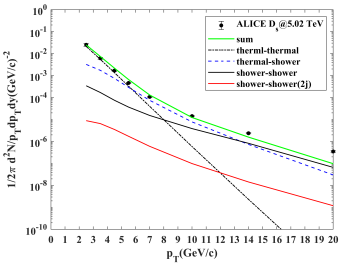


FIG. 6: 5.02 TeV $D_s$

FIG. 7: Results of parameters in Tab.I.