The continuum and interference effect in $e^+e^- \to D\overline{D}$ process

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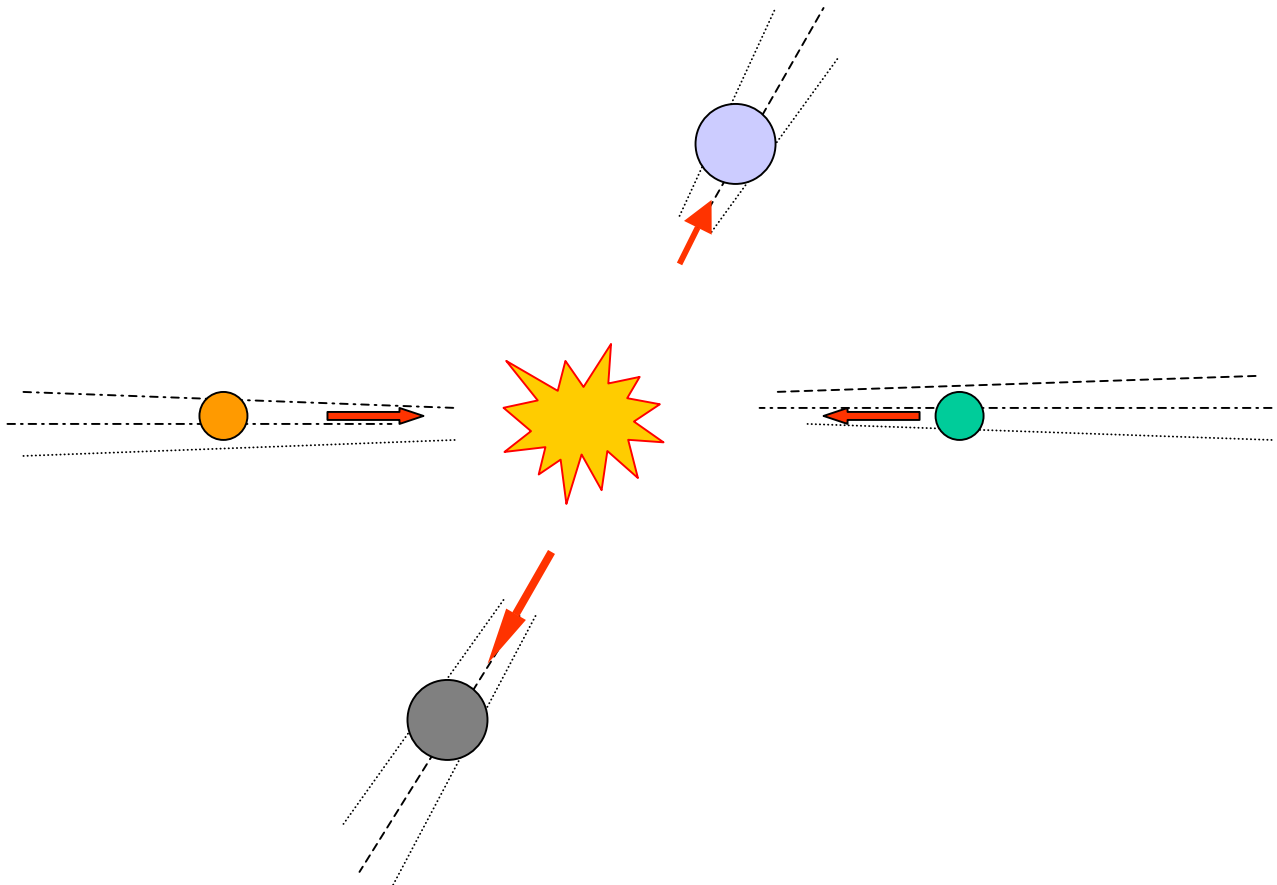
The $e^+e^- \to D\overline{D}$ process just above the threshold of $D\overline{D}$ is important



BESII

$$\sigma^{\rm obs}(D^0\overline{D}^0) = (3.58 \pm 0.09 \pm 0.31)\text{nb}$$

$$\sigma^{\rm obs}(D^+D^-) = (2.56 \pm 0.08 \pm 0.26)\text{nb}$$

CLEO-c

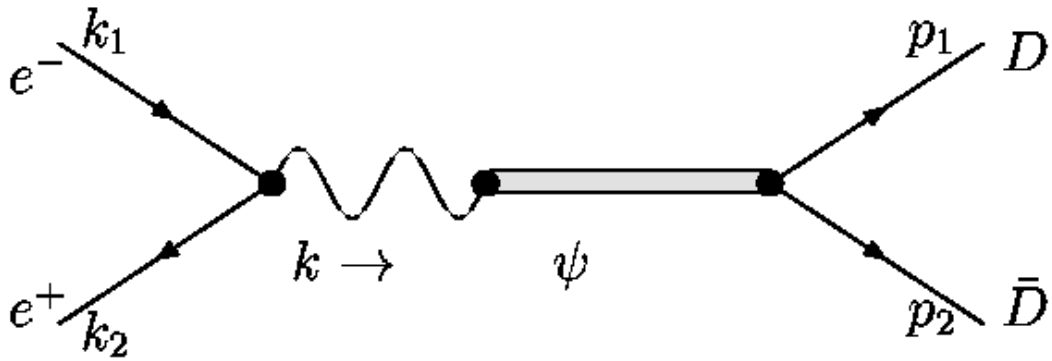
$$\sigma^{\rm obs}(D^0\overline{D}^0) = (3.60 \pm 0.07^{+0.07}_{-0.05})\text{nb}$$

$$\sigma^{\rm obs}(D^+D^-) = (2.79 \pm 0.07^{+0.10}_{-0.04})\text{nb}$$

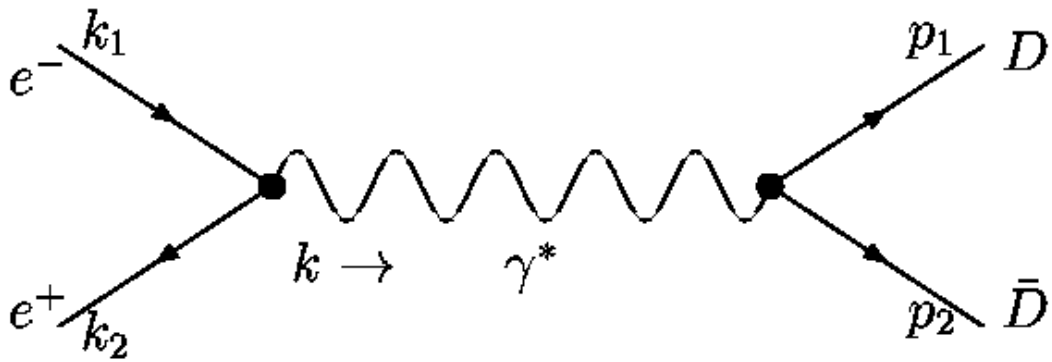
BESII

$$\sigma(D^0\overline{D}^0) = (4.60 \pm 0.12 \pm 0.45)\text{nb}$$

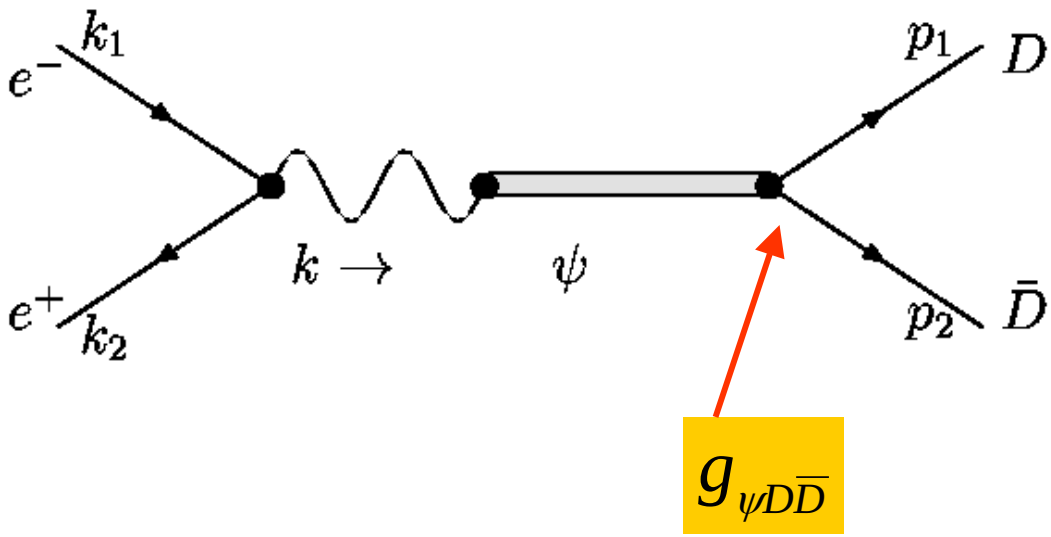
$$\sigma(D^+D^-) = (3.29 \pm 0.10 \pm 0.37)\text{nb}$$



(a)



(b)



$$\langle D(p_1)\bar{D}(p_2)|\psi(p)\rangle$$
$$= -ig_{\psi D\bar{D}}\epsilon^{(\lambda)} \cdot (p_1 - p_2)(2\pi)^4\delta^4(p - p_1 - p_2)$$

$\psi(3770) \to D\overline{D}$?

dominant

$\psi(3770) \to \text{non} - D\overline{D}$ 2% ~3% ?

CLEO-c

$$\sigma_{e^+e^- \to \psi(3770) \to \text{hadrons}} - \sigma_{e^+e^- \to \psi(3770) \to D\overline{D}}$$

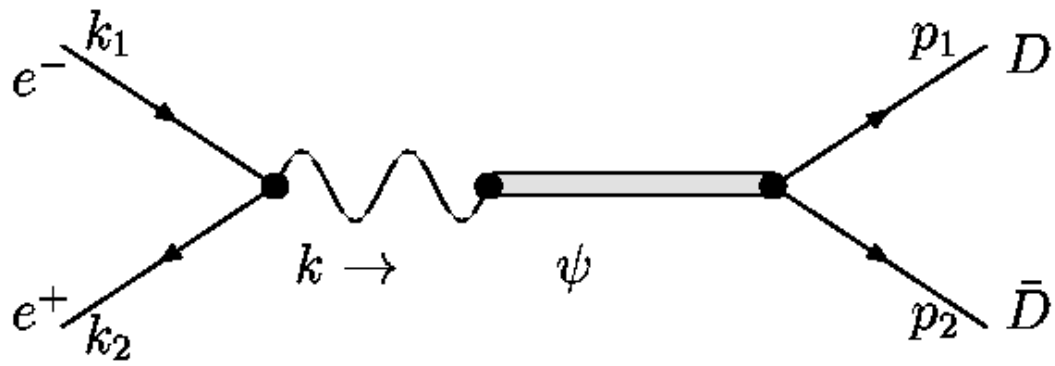
$$= (-0.01 \pm 0.08^{+0.41}_{-0.30})\text{nb}$$

$$\psi(3770) \to D\overline{D} \quad \sim 97\%$$

$$\Longrightarrow \quad g_{\psi D\bar{D}} = 12.7$$

TABLE I: Branching ratio of $Br(\psi(3770) \to D\bar{D})$ and the coupling $g_{\psi D\bar{D}}$.

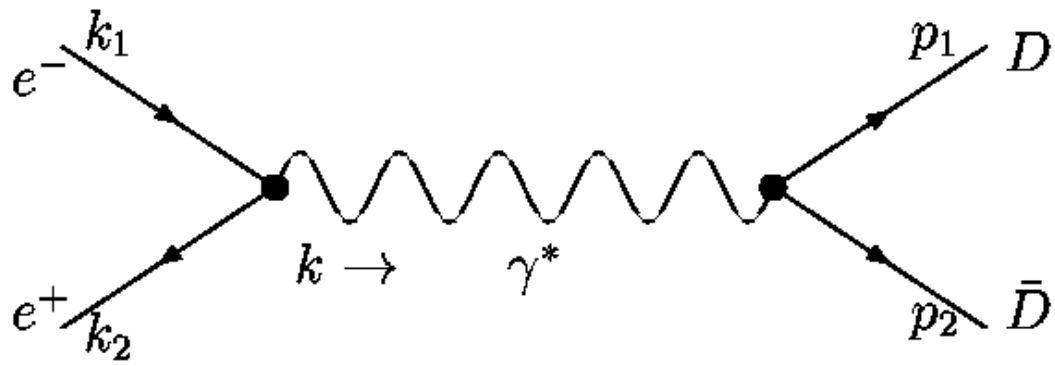
$g_{\psi D\bar{D}}$	$Br(D\bar{D})$	$Br(D^0\bar{D}^0)$	$Br(D^+D^-)$	$\frac{Br(D^0\bar{D}^0)}{Br(D^+D^-)}$
12.7	97.4%	58.0%	39.4%	1.47



$$T_a = ig_{\psi D\bar{D}} Q_c e^2 f_\psi m_\psi (p_1 - p_2)^\mu \times \frac{1}{s - m_\psi^2 + i m_\psi \Gamma_T} \frac{1}{s} \bar{v}(k_2) \gamma_\mu u(k_1)$$

TABLE II: The cross sections of $e^+e^- \to D^0\bar{D}^0$ and D^+D^- at $\sqrt{s} = 3.773$ GeV without the direct virtual photon contribution, which are compared with experimental data. The experimental data are taken from Ref.[4].

	The calculation	Exp. data
$\sigma_{D^0\bar{D}^0}$	6.5 nb	$(4.6 \pm 0.12 \pm 0.45)$ nb
$\sigma_{D^+D^-}$	4.5 nb	$(3.29 \pm 0.10 \pm 0.37)$ nb



$$\langle D(p_1)\bar{D}(p_2)|j^\mu_{\rm em}|0\rangle = F_{D\bar{D}}(q^2)(p_1-p_2)^\mu$$

$$T_b = -ie^2 F_{D\bar{D}}(s)(p_1-p_2)^\mu \frac{1}{s}\bar{v}(k_2)\gamma_\mu u(k_1)$$

$$
\begin{aligned}
T &= ie^2\bar{v}(k_2)\gamma_\mu u(k_1)(p_1-p_2)^\mu \frac{1}{s} \\
&\quad \times[-F_{D\bar{D}}(s)+\frac{g_{\psi D\bar{D}}Q_c f_\psi m_\psi}{s-m_\psi^2+im_\psi\Gamma_T}e^{i\phi}]
\end{aligned}
$$

$$\sigma(e^+e^- \to D^0\bar{D}^0,\ D^+D^-) = \frac{\pi}{3}\frac{(s-4m_D^2)^{3/2}}{s^{5/2}}\alpha^2$$

$$\times\left|-F_{D\bar{D}}(s) + \frac{g_{\psi D\bar{D}}Q_c f_\psi m_\psi}{s-m_\psi^2+im_\psi\Gamma_T}e^{i\phi}\right|^2,$$

$$F_{D\bar{D}}(s) = \frac{m_\psi^2 F_0}{s}$$

参数

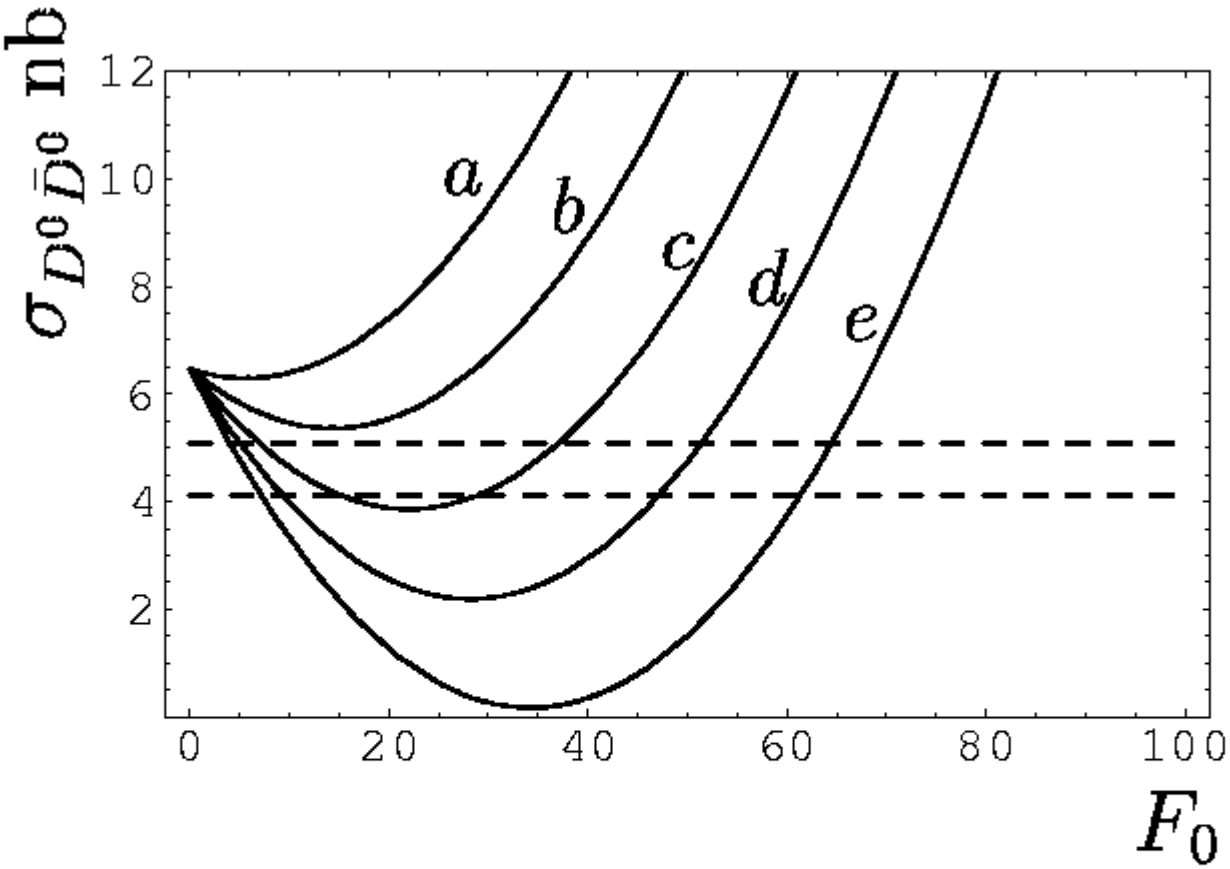


FIG. 2: The cross section of $e^+e^- \to D^0\bar{D}^0$ at $\sqrt{s} = 3.773$ GeV, varying with the parameter F_0 and the relative phase ϕ. The plots a, b, c, d and e are for $\phi = 0$, $\pi/12$, $\pi/6$, $\pi/4$ and $\pi/2$, respectively.

TABLE III: The numerical results for the cross sections of $e^+e^- \to D^0\bar{D}^0$ and D^+D^- at $\sqrt{s} = 3.773$ GeV with some values of (F_0, ϕ).

(F_0, ϕ)	$(8.0, \pi/6)$	$(6.0, \pi/4)$	$(5.0, \pi/2)$	Exp. data [4]
$\sigma_{D^0\bar{D}^0}$	4.9 nb	4.8 nb	4.8 nb	$(4.6 \pm 0.12 \pm 0.45)$nb
$\sigma_{D^+D^-}$	3.4 nb	3.4 nb	3.3 nb	$(3.29 \pm 0.10 \pm 0.37)$nb

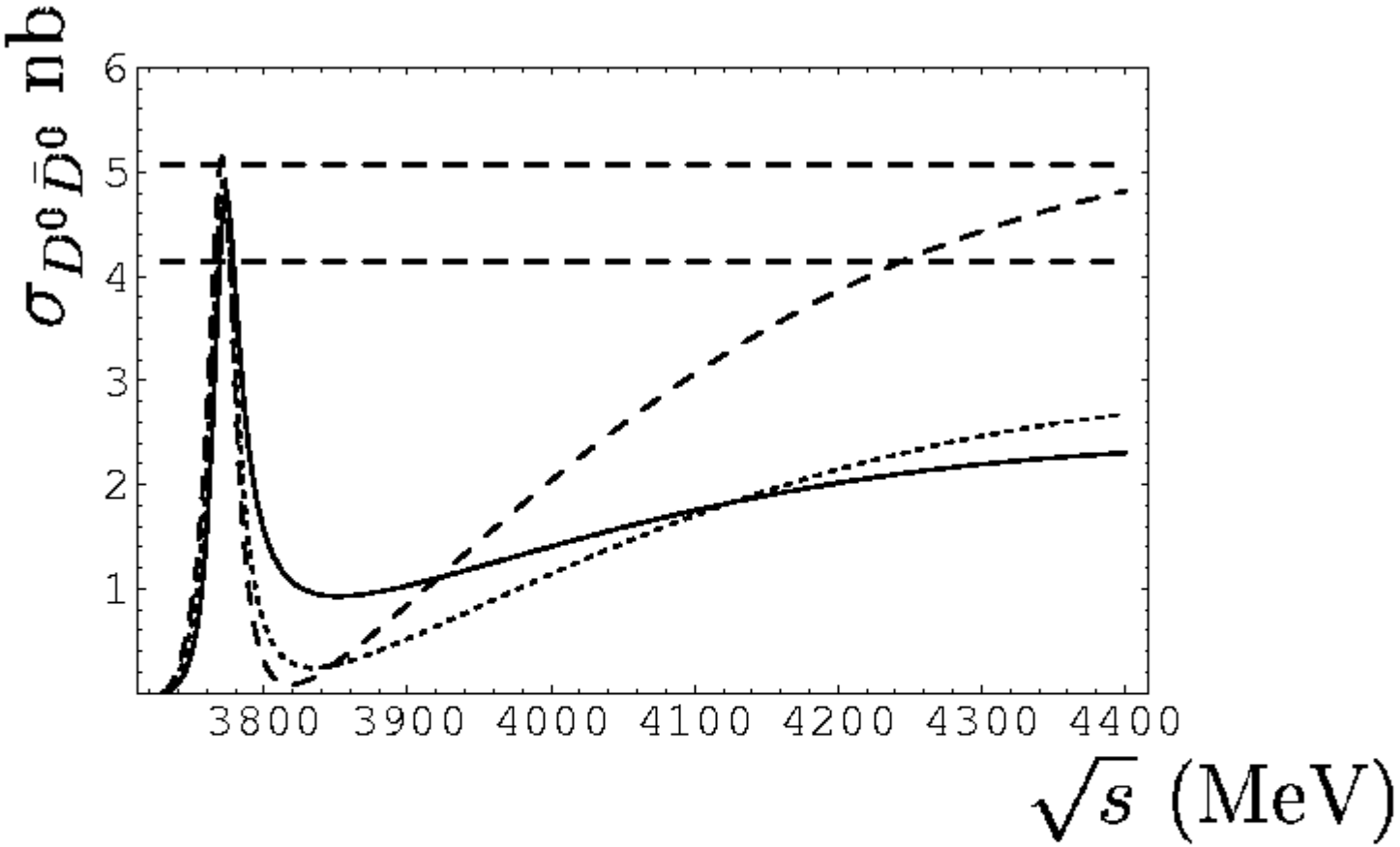
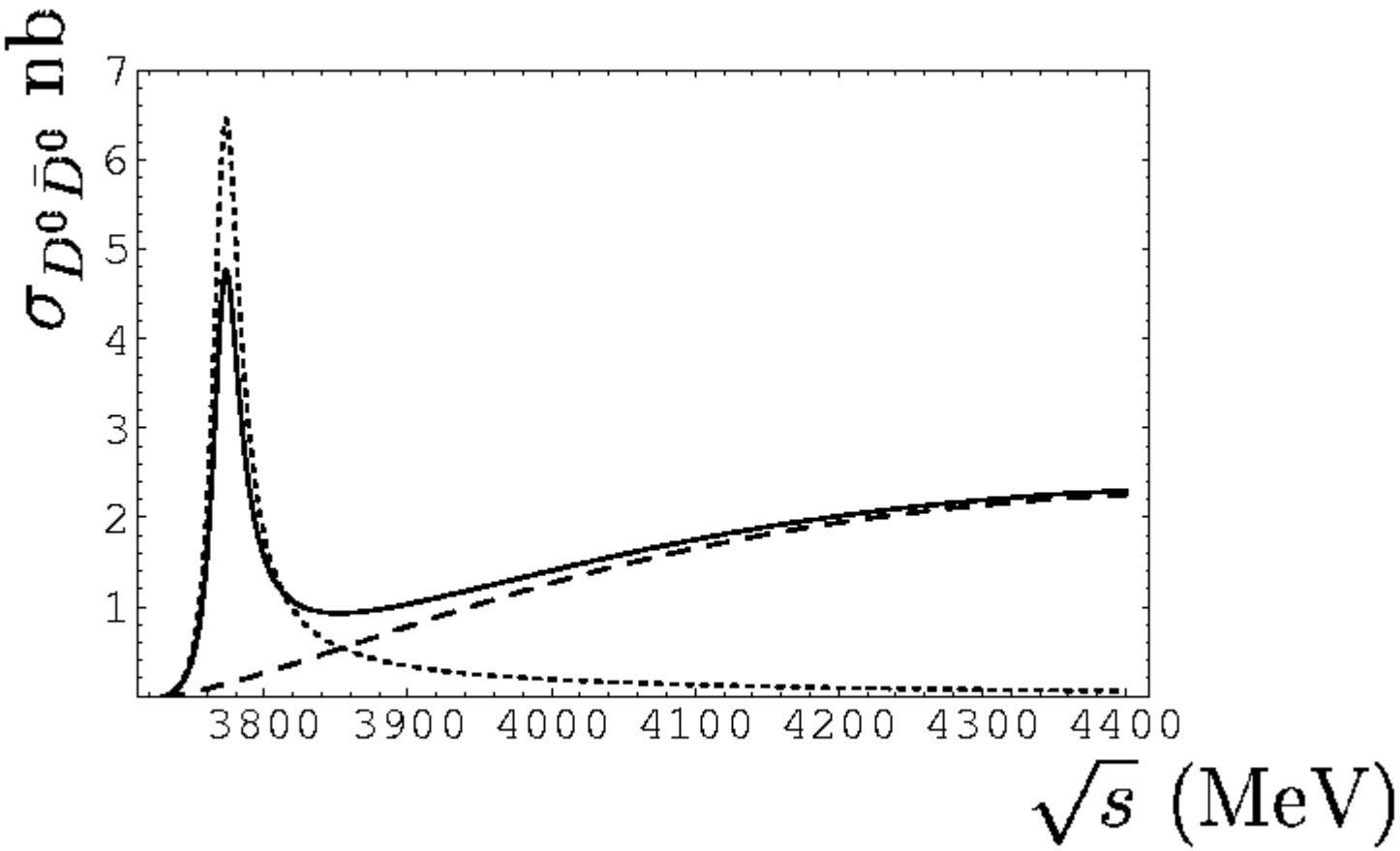


FIG. 3: The cross section of $e^+e^- \to D^0\bar{D}^0$ changing with the center-of-mass energy $\sqrt{s}$. The solid curve is for $(F_0, \phi) = (5.0, \pi/2)$, the dotted one for $(6.0, \pi/4)$, and the dashed for $(8.0, \pi/6)$.


$\sigma_{D^0\bar{D}^0}$ nb
7
6
5
4
3
2
1
3800 3900 4000 4100 4200 4300 4400
$\sqrt{s}$ (MeV)