

Toward a proposal for a R scan below and above the $\psi(2S)$

The BESIII Italian Collaboration ^{1,2,3,4}

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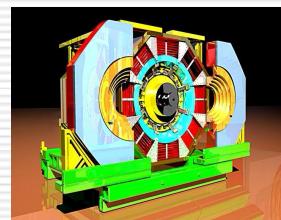
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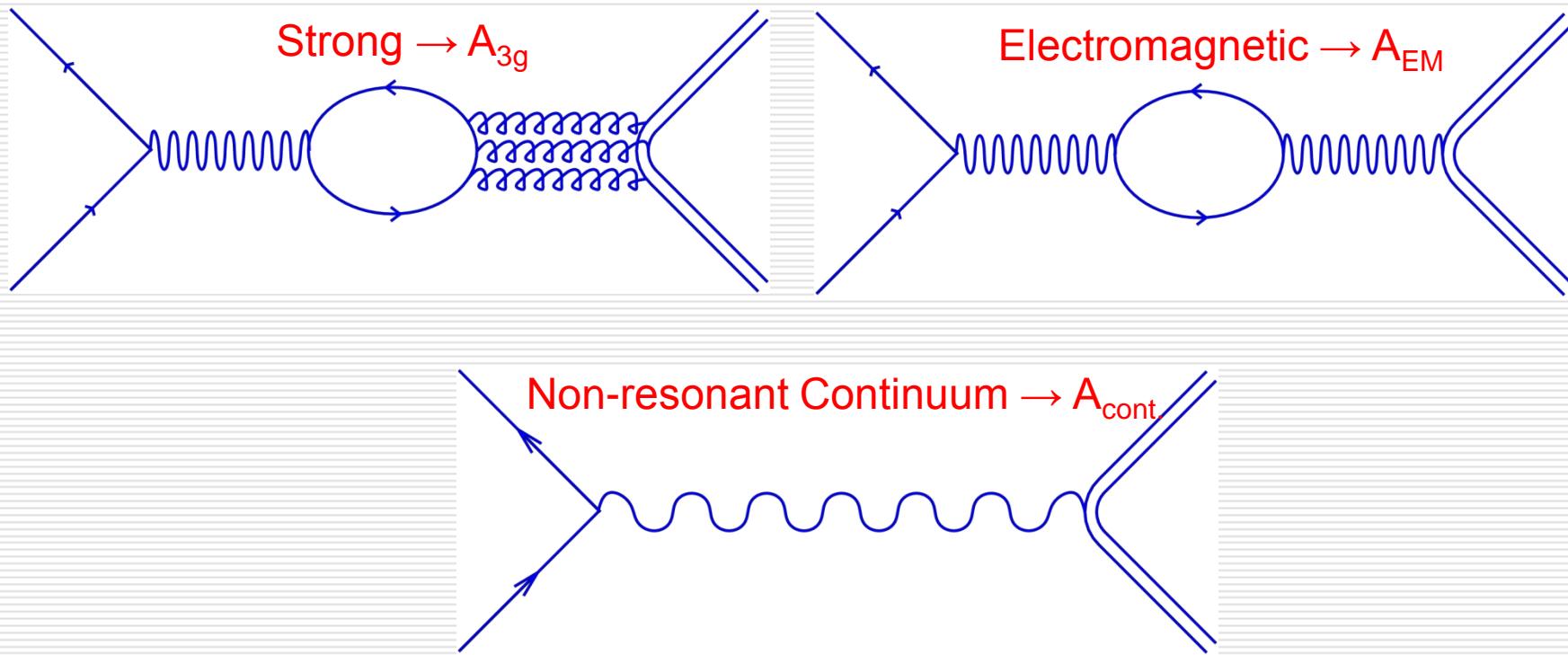


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OUTLINE

- ❑ Vector Charmonium decay mechanisms
- ❑ J/ ψ strong imaginary decay widths, experimental evidences:
 - Vector+Pseudoscalar, Pseudoscalar+Pseudoscalar : $\Phi \sim 90^\circ$
 - Energy scan: $|\Phi| \sim 90^\circ$
 - A possible way to get the continuum phase
- ❑ $\psi''(3770)$ experimental evidences : $\Phi \sim -90^\circ$
- ❑ A model for strong imaginary decay widths
- ❑ The Ψ' Puzzle: controversial evidences for $\psi'(2S)$:
 - V P : J/ Ψ updated : $\Phi \sim 90^\circ$, $\psi'(2S)$ revisited : $\Phi \sim 180^\circ$
 - P P : J/ Ψ updated : $\Phi \sim 90^\circ$, $\psi'(2S)$ revisited : $\Phi \sim 90^\circ$
- ❑ Toward a proposal for a scan, below and above the $\psi'(2S)$

Vector Quarkonium Decay Mechanisms



- (a) $e^+e^- \rightarrow J/\psi \rightarrow \text{hadrons}$ via strong mechanism (b) via em mechanism
(c) non-resonant $e^+e^- \rightarrow \text{hadrons}$ via a virtual photon.
pQCD regime: all amplitudes real (apart BW resonance behaviour),
while data are as if there is an additional i in front of the BW

Experimental Evidences for Imaginary Strong Decay Widths

Model dependent experimental evidences

SU3 and SU3 Breaking in 1^-0^- , 0^-0^- , 1^-1^- decay : $\phi \sim 90^\circ$

$$J/\Psi \rightarrow VP \quad (1^-0^-) \quad \phi = 106^\circ \pm 10^\circ \quad [1]$$

$$J/\Psi \rightarrow PP \quad (0^-0^-) \quad \phi = 89.6^\circ \pm 9.9^\circ \quad [2]$$

$$J/\Psi \rightarrow VV \quad (1^-1^-) \quad \phi = 138^\circ \pm 37^\circ \quad [2]$$

If $A(e^+e^- \rightarrow nn_{\bar{b}ar}) \sim -A(e^+e^- \rightarrow pp_{\bar{b}ar})$ [3]

$B(nn_{\bar{b}ar})/B(pp_{\bar{b}ar}) = 0.98 \pm 0.08 \rightarrow \Phi \sim 89^\circ \pm 8^\circ$ [4] (BESIII)

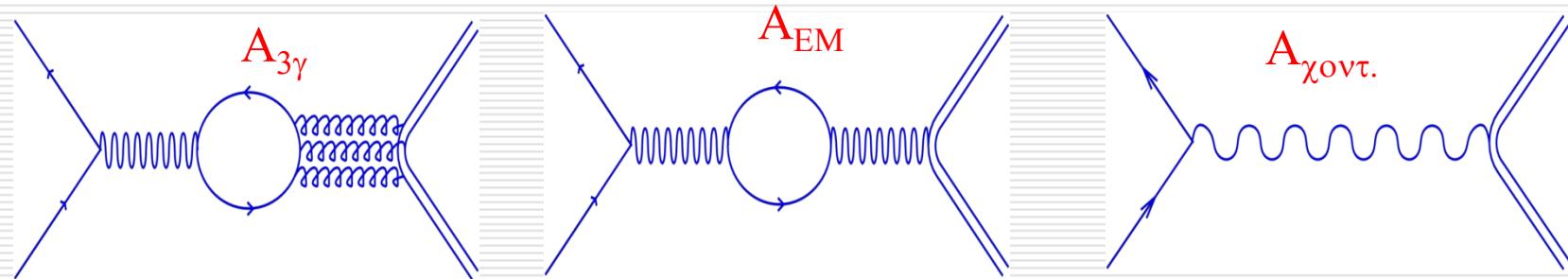
[1] L. Kopke and N. Wermes, Phys. Rep. 174, 67 (1989); J. Jousset et al., Phys. Rev. D41,1389 (1990).

[2] M. Suzuki et al., Phys. Rev. D60, 051501 (1999).

[3] FENICE Coll. NP B517(1998)3, SND Phpsi Rome, Sep (2013).

[4] M. Ablikim et al., Phys. Rev. D 86, 032014 (2012).

Model independent from interference in q^2 behavior

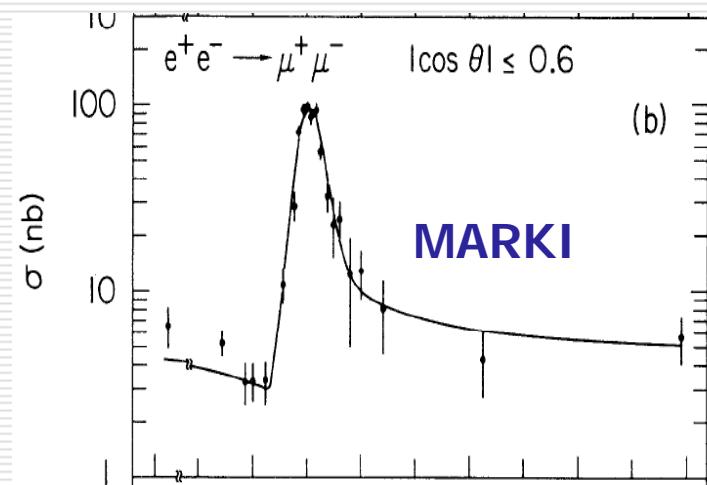


$$\sigma_{\text{born}} = |A_{3g} + A_{EM} + A_{\text{cont}}|^2 = ||A_{3g}|e^{i\varphi} + |A_{EM} + e^{i\varphi'} A_{\text{cont}}||^2$$

Actually $\Phi_{\text{meas}} = \Phi - \delta_{\text{cont}}$ and $|\Phi_{\text{meas}}|$ only is measured,
since it is difficult to get the sign

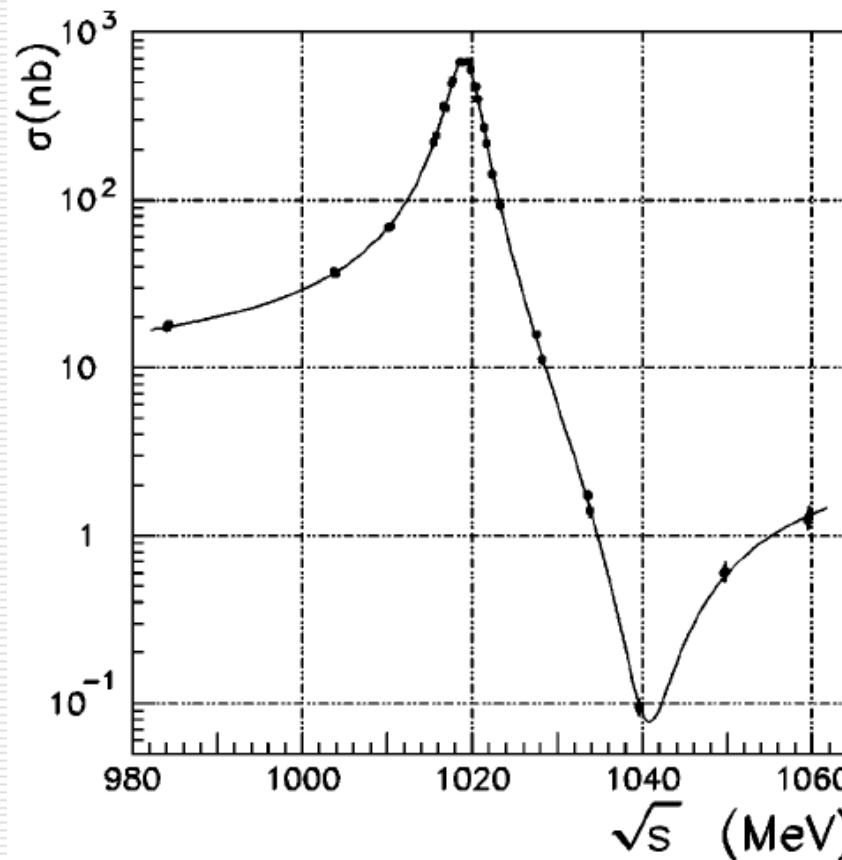
The full interference between A_{EM} and A_{cont} has been observed , as expected, at MARKI(1975), BESII (1995), KDER (2010).

1/2 photon propagators require $\varphi' = 180^\circ$



The interference pattern between a vector quarkonium and the continuum is not always the same.

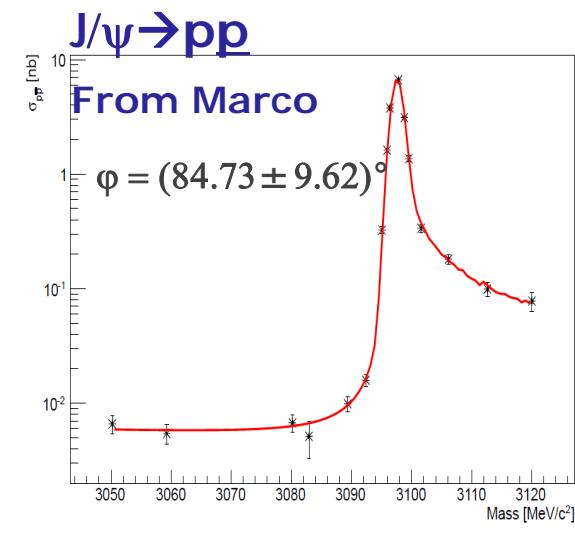
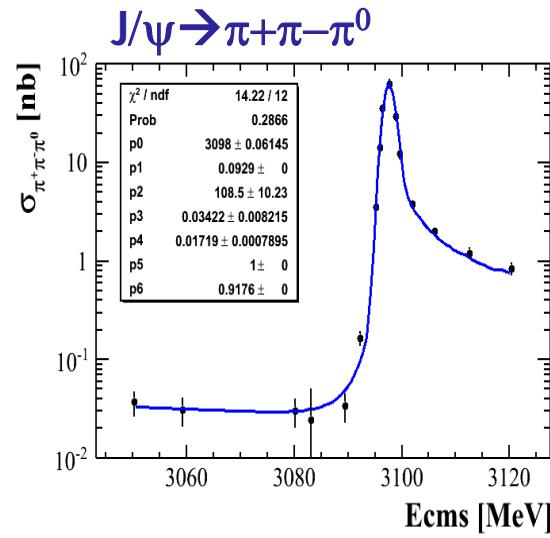
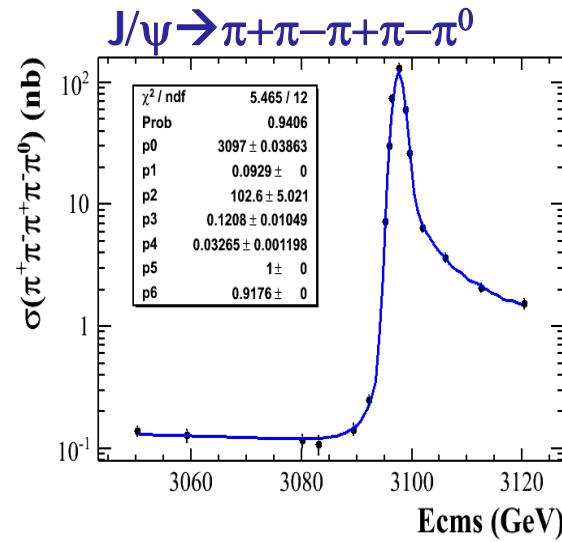
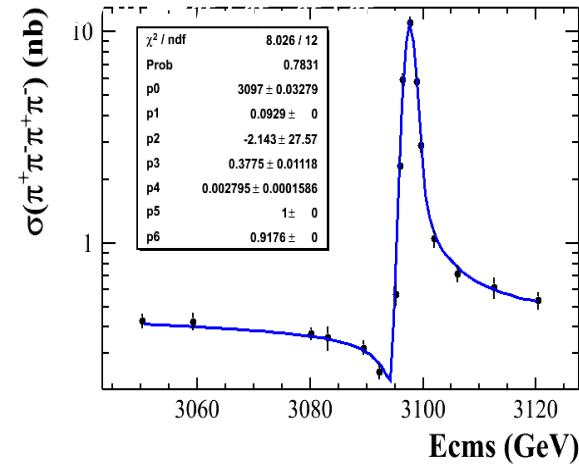
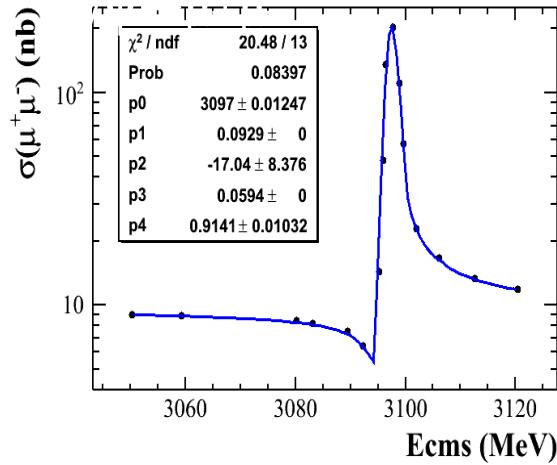
$e^+e^- \rightarrow \pi^+\pi^-\pi^0$ @ VEPP2M



φ~180°

Phys. Rev.D 63, 072002

BESIII J/ ψ scan



Summary of fit results

Channel	$M_{J/\psi}$	Γ (KeV)	φ'
$\mu+\mu-$	3097.33 ± 0.01	92.9 (fixed)	0° (fixed)
$\pi+\pi-\pi+\pi-$	3097.46 ± 0.03	92.9 (fixed)	$(-2.14 \pm 27.59)^\circ$
$\pi+\pi-\pi+\pi-\pi 0$	3097.50 ± 0.04	92.9 (fixed)	0° (fixed)
$\pi+\pi-\pi 0$	3097.50 ± 0.06	92.9 (fixed)	0° (fixed)
$p\bar{p}$	$0.3 + 3096.9$	—	—
Channel	Φ	Br_{out}	Br_{PDG}
$\mu+\mu-$	—	5.94×10^{-2} (fixed)	5.94×10^{-2}
$\pi+\pi-\pi+\pi-$	—	$(3.04 \pm 0.17) \times 10^{-3}$	$(3.55 \pm 0.23) \times 10^{-3}$
$\pi+\pi-\pi+\pi-\pi 0$	$(102.6 \pm 5.1)^\circ$	$(3.55 \pm 0.13) \times 10^{-2}$	$(4.1 \pm 0.5) \times 10^{-2}$
$\pi+\pi-\pi 0$	$(108.4 \pm 10.1)^\circ$	$(1.87 \pm 0.08) \times 10^{-2}$	$(2.07 \pm 0.12) \times 10^{-2}$
$p\bar{p}$	$(84.73 \pm 9.62)^\circ$	$(1.90 \pm 0.05) \times 10^{-3}$	—

Channel	σ_{cont} (nb)	S_E (MeV)
$\mu+\mu-$	—	0.92 ± 0.01
$\pi+\pi-\pi+\pi-$	0.465 ± 0.014	0.92 (fixed)
$\pi+\pi-\pi+\pi-\pi 0$	0.153 ± 0.013	0.92 (fixed)
$\pi+\pi-\pi 0$	0.040 ± 0.010	0.92 (fixed)
$p\bar{p}$	0.006 ± 0.001	0.92 ± 0.01

Experimental evidences for imaginary strong decay widths for other vector charmonium

➤ $\psi'(3868)$:

- ❖ $B(pp_{\bar{b}ar})/B(nn_{\bar{b}ar}) = .84 \pm .05 \rightarrow \Phi \sim 51 \pm 5$ (BESIII internal)
- ❖ Disquieting results on $e^+e^- \rightarrow 4\pi, 6\pi$: No interference (!?)

➤ $\psi''(3770)$:

- ❖ non DDbar (small) -> mostly seen through the interference with continuum
- ❖ For a wide resonance: interference at peak = $-2|A_{3g}|/\Gamma_{tot} \sin\varphi \times \text{cont.}$
- ❖ CLEOc and BESIII: $\Phi \sim -90^\circ$, taking into account continuum sign

decay	continuum	$\Psi''(3770)$	sign	
$\rho \pi$	13.1 ± 2.8	7.4 ± 1.3	-	CLEOc, PRD 73(2006)012002
$\phi \eta$	2.1 ± 1.6	4.5 ± 0.7	+	CLEOc, PRD 73(2006)012002
$p p$	0.74 ± 0.08	0.4 ± 0.02	-	BESIII Y.Liang, Nov (2012)

A possible way to get
the continuum phase
(work in progress)

Continuum phase $\delta(s)$

- ◻ Continuum amplitudes should be almost real : $\delta(s) \sim 0^\circ$ or 180°
- ◻ Logarithm Dispersion Relations
relating modulus $|F(s)|^2 \sim \sigma(s)$ and $\delta(s)$ might help:

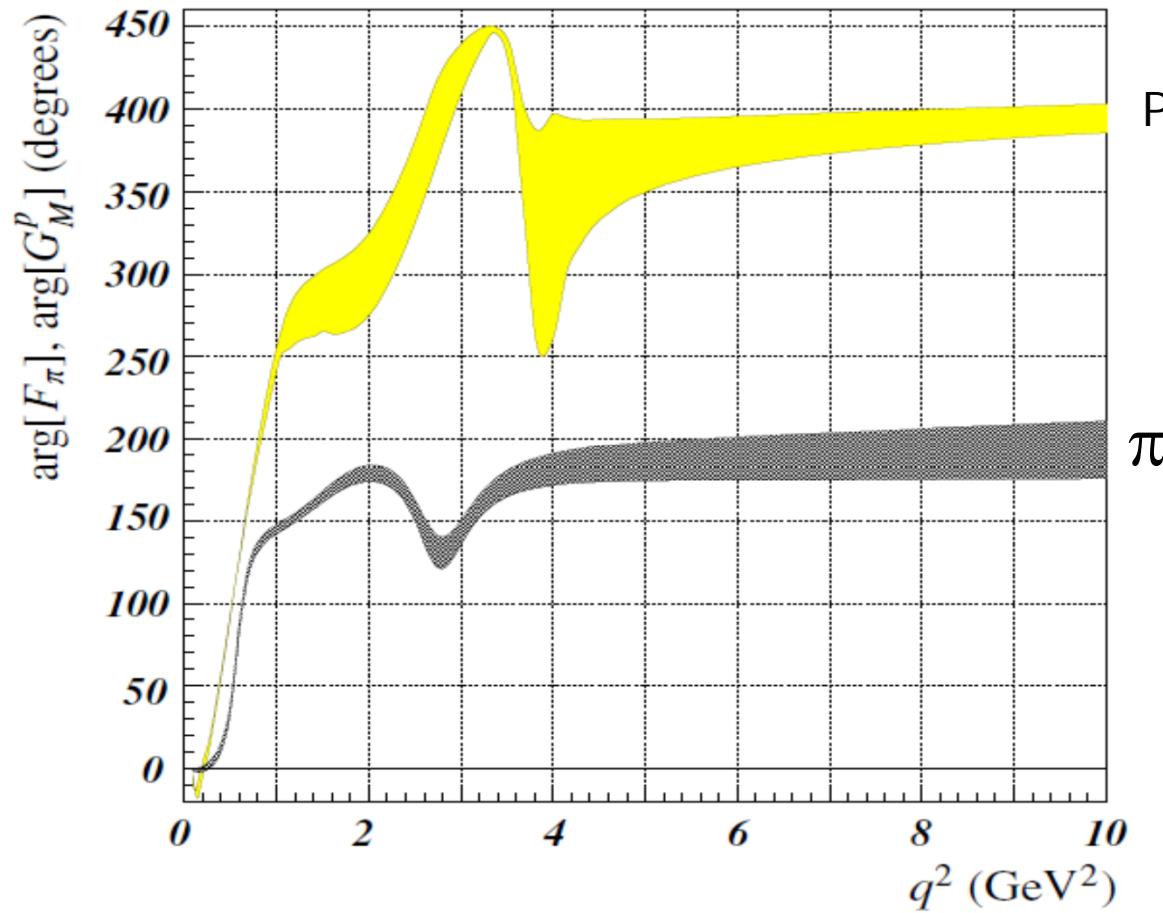
$$\delta(s) = -\frac{\sqrt{s - q_t^2}}{\pi} PV \int_{q_t^2}^{\infty} \frac{\ln|F(t)/F(0)|}{(t-s)\sqrt{t-q_t^2}} dt$$

$$\delta(s) = -\frac{s\sqrt{s - q_t^2}}{\pi} PV \int_{q_t^2}^{\infty} \frac{\ln|F(t)/F(0)|}{t(t-s)\sqrt{t-q_t^2}} dt$$

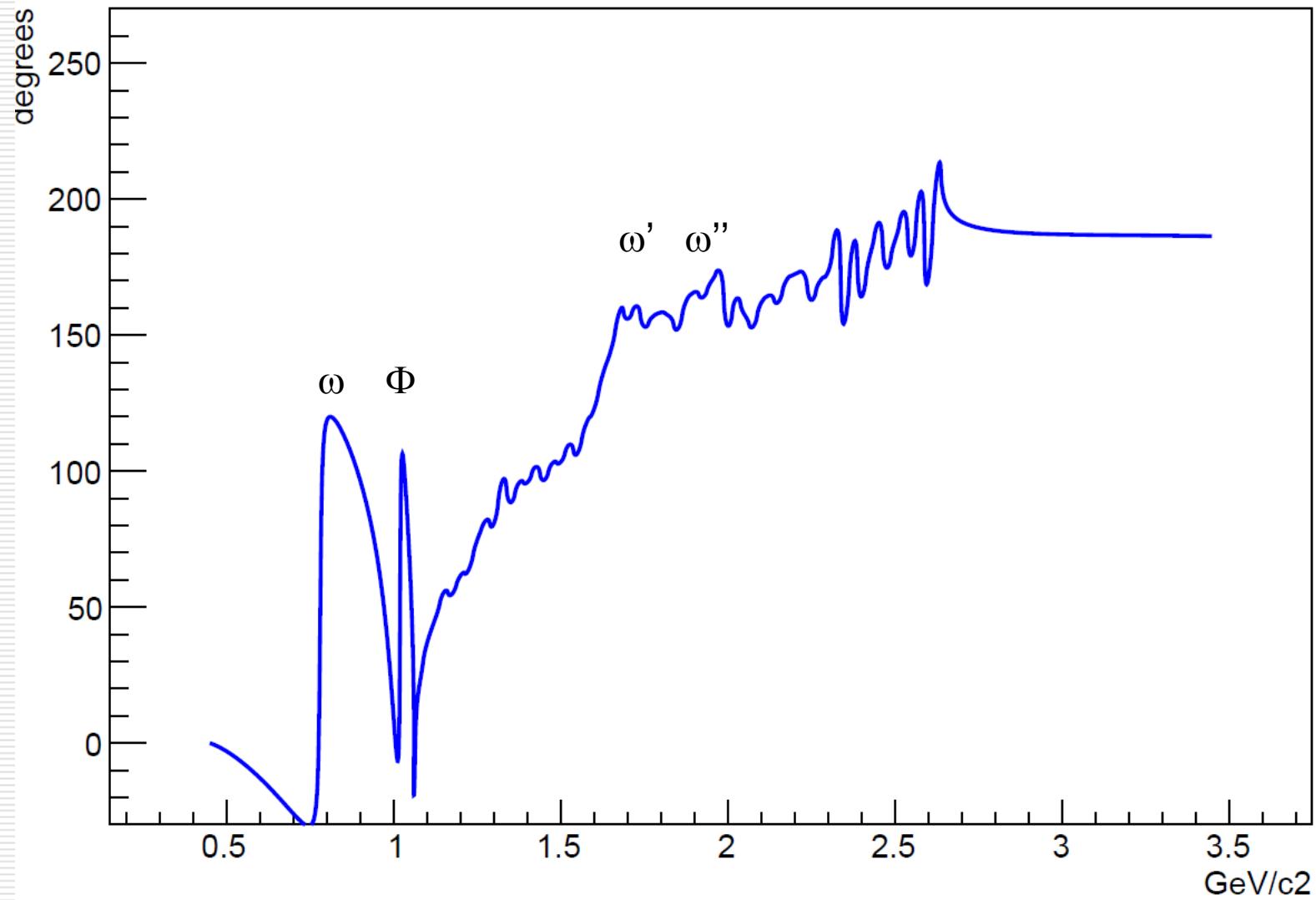
- ◻ Check: phase as expected, if $|F(s)|^2 \sim \text{BW} \sim \sigma(s) / \text{IPS}$
- ◻ Applied to $\sigma(e^+e^- \rightarrow 3\pi)$: $\delta(s) \sim 180^\circ$
 $\sigma(e^+e^- \rightarrow pp_{\bar{b}a})$ (unphysical region): $\delta(s) \sim 360^\circ$
 $\sigma(e^+e^- \rightarrow \pi\pi)$: $\delta(s) \sim 180^\circ$
- ◻ If $\delta(s) \neq 0$ and it is known how 180° or 0° is asympt reached,
from $|\Phi_{\text{meas}}| = |\phi - \delta|$ the sign ($\pm 90^\circ$) might be established

$\pi^+ \pi^-$ and $pp_{\bar{b}ar}$ (through the unphysical region.) phases

(S.Pacetti, R. Baldini... EPJC 11(1999)709... long time ago)



3 π phase according to Dispersion Relations (*work in progress*)



A Breit Wigner cannot describe the J/Ψ

- ❑ Unitarity ($\text{Im } T = \sum_i T_i^+ T_i$) for a Breit-Wigner implies $\sum_i \Gamma_i = \Gamma_{\text{tot}} \rightarrow \Gamma_i$ real and positive
A (large) phase between Γ_i not in agreement with unitarity
- ❑ Looking for a different J/ψ description

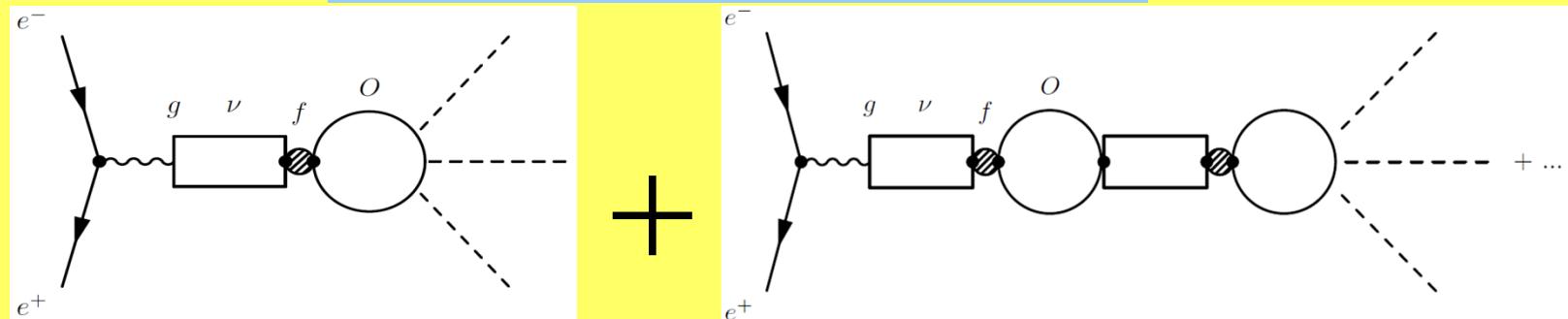
A model to explain
imaginary widths

Quarkonium OZI breaking decay as suggested by Freund and Nambu

(PRL 34(1975), 1645)

- Quarkonium as a superposition of
 - A narrow resonance ν
(coupled to leptons, but not directly to hadrons)
 - A wide resonance (a glueball O)
(not coupled to leptons, but strongly coupled to hadrons)

f is the coupling between ν and O



- An infinity of radial O recurrences
- Many referred to this model mainly to explain $\text{Br}(\psi') / \text{Br}(J/\psi)$ anomalies
(S. J. Brodsky, G. P. Lepage, S. F. Tuan, PRL 59, 621(1987)
W.S. Hou, C.Y. Ko, NTUTH-97-11, 1997)

Narrow and wide glueball O superposition

P.J.Franzini, F.J.Gilman, PR D32, 237 (1985)

$$A_{strong} = \frac{g\sqrt{\Gamma_{e^+e^-}} \times f^2 \times \sqrt{\Gamma_o}}{(M_v - W - 0.5i\Gamma_v) \times (M_o - W - 0.5i\Gamma_o) - f}$$

assuming $\Gamma_o \gg \Gamma_{J/\Psi}$, $f \sim 0.5\sqrt{\Gamma_o(\Gamma_{J/\Psi} - \Gamma_v)}$

$$A_{strong} \sim \frac{ig\sqrt{\Gamma_{e^+e^-}} \times f \times \sqrt{\Gamma_o}}{\Gamma_o(M_{J/\Psi} - W - 0.5i\Gamma_{J/\Psi})} \quad A_{em} \sim \frac{g\Gamma_{e^+e^-}}{(M_{J/\Psi} - W - 0.5i\Gamma_{J/\Psi})}$$

■ The additional 90° phase is naturally achieved

- J/ ψ shape reproduced if: $|f| \sim 0.012 \text{ GeV}$, $M_o \sim M_{J/\Psi}$, $\Gamma_o \sim 0.65 \text{ GeV}$
- Cross section affected far from the J/ ψ (no contradiction with BES, PR 54(1996)1221)
- $\psi''(3770)$ decay phases agree with Nambu suggestion.
- ψ' unclear; $\psi' \rightarrow J/\psi \pi\pi$ (?)

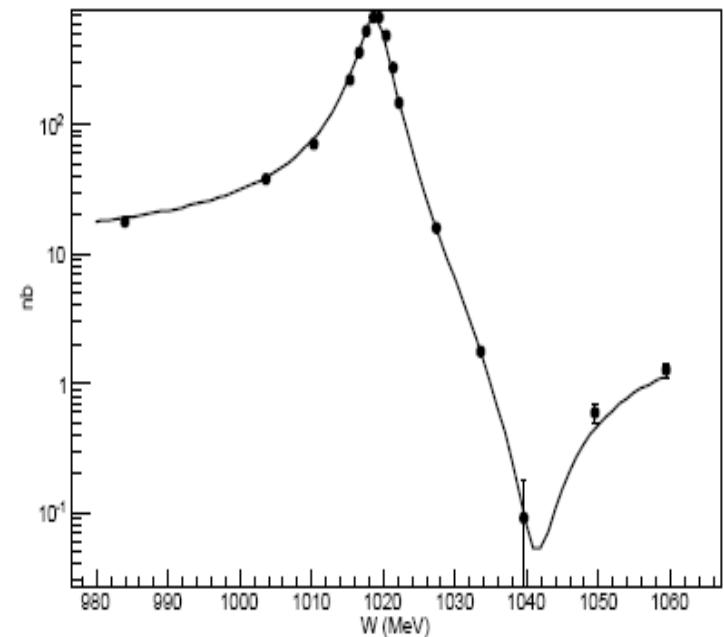
SND $\pi^+ \pi^- \pi^0$

SND measured $\Phi \rightarrow \pi^+ \pi^- \pi^0$, OZI breaking.
 ϕ interferences with ω and ω' tails:
 $\varphi \sim 180^\circ$ (interference dip is after the Φ)

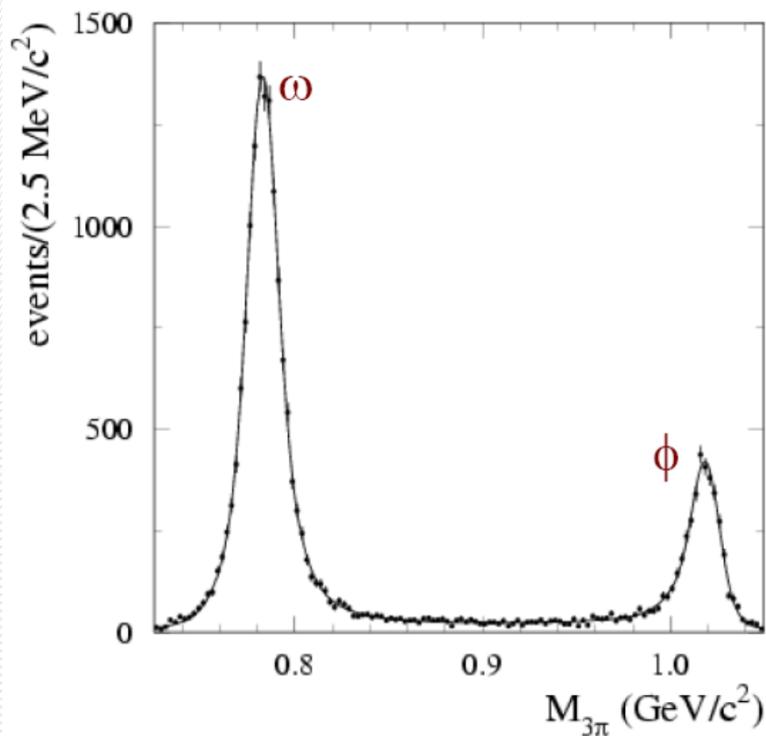
Fit SND Φ and continuum data with
 $f = -0.016 \text{ GeV}$ (close to J/Ψ !)

$$M_O = 1.34 \text{ GeV}$$

$$\Gamma_O \sim 0.5 \text{ GeV}$$



SND data on 3π and present model prediction



BaBar found indeed an unexpected resonance (O ?)
at 1.35 GeV , wide 0.45 GeV

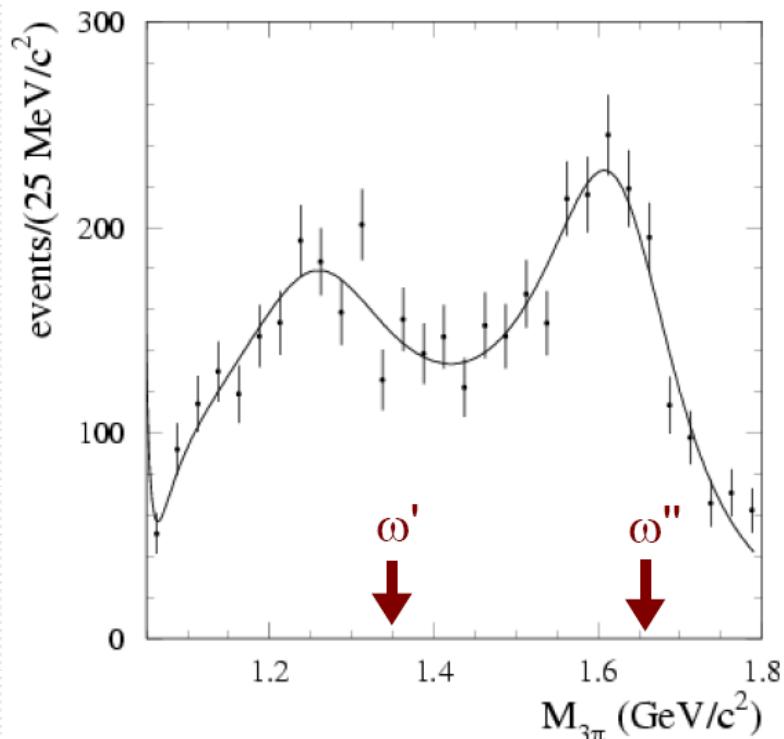
Masses and widths

$$M_{\omega'} = (1350 \pm 20 \pm 20) \text{ MeV}/c^2$$

$$\Gamma_{\omega'} = (450 \pm 70 \pm 70) \text{ MeV}/c^2$$

$$M_{\omega''} = (1660 \pm 10 \pm 2) \text{ MeV}/c^2$$

$$\Gamma_{\omega''} = (230 \pm 30 \pm 20) \text{ MeV}/c^2$$



The ψ' Puzzle

VP decay updated and revisited

SU_3 and SU_3 Breaking Amplitudes

Use reduced amplitudes $B=B_0 / P^*{}^3$

Process $J/\psi \rightarrow$	Amplitude
$\rho^+ \pi^-, \rho^0 \pi^0, \rho^- \pi^+$	$g + e$
$K^{*+} K^-, K^{*-} K^+$	$g(1 - s) + e$
$K^{*0} \bar{K}^0, \bar{K}^{*0} K^0$	$g(1 - s) - 2e$
$\omega\eta$	$(g + e)X_\eta + \sqrt{2}rg(\sqrt{2}X_\eta + Y_\eta)$
$\omega\eta'$	$(g + e)X_{\eta'} + \sqrt{2}rg(\sqrt{2}X_{\eta'} + Y_{\eta'})$
$\phi\eta$	$(g(1 - 2s) - 2e)Y_\eta + rg(\sqrt{2}X_\eta + Y_\eta)$
$\phi\eta'$	$(g(1 - 2s) - 2e)Y_{\eta'} + rg(\sqrt{2}X_{\eta'} + Y_{\eta'})$
$\rho^0 \eta$	$3eX_\eta$
$\rho^0 \eta'$	$3eX_{\eta'}$
$\omega\pi^0$	$3e$
$\phi\pi^0$	0

J/ ψ

Vector +Pseudoscalar

Parameter	Fit
SU ₃ strong Amplitude g	7.22 ± 0.38
SU ₃ breaking strange s	0.18 ± 0.04
SU ₃ breaking DOZI r	-0.04 ± 0.02
E.M. Amplitude e	0.75 ± 0.04
Phase f	81.51 ± 6.75

J/ ψ

Vector + Pseudoscalar

Decay	Amplitude	PDGx10 ⁴	Fitx10 ⁴	$\Delta\chi^2$
$\rho^0 \pi^0$	$g e^{i\phi} + e$	169.0 ± 15.0	133.00	1.13
$K^+ K^-$	$g (1-s) e^{i\phi} + e$	51.2 ± 3.0	51.5	0.01
$K^0 \bar{K}^0$	$g (1-s)e^{i\phi} - 2e$	43.9 ± 3.1	48.5	0.48
$\omega \eta$	$(g X + d)e^{i\phi} + eX$	17.4 ± 2.0	18.5	0.06
$\phi \eta$	$(g (1-2s)Y + d)e^{i\phi} - 2eY$	7.5 ± 0.8	3.9	4.02
$\rho \eta$	$3eX$	1.9 ± 0.2	2.2	0.30
$\omega \pi$	$3e$	4.5 ± 0.5	4.1	0.11
$\omega \eta'$	$(g X' + d')e^{i\phi} + eX'$	7.0 ± 7.0	11.9	0.10
$\phi \eta'$	$(g (1-2s)Y' + d')e^{i\phi} - 2eY'$	4.0 ± 0.7	6.1	1.87
$\rho \eta$	$3eX'$	1.1 ± 0.2	1.1	0.04

Ψ'
Vector + Pseudoscalar

Parameter	Fit
SU ₃ strong Amplitude g	0.49 ± 0.04
SU ₃ breaking strange s	-0.04 ± 0.13
SU ₃ breaking DOZI r	-0.04 ± 0.08
E.M. Amplitude e	0.18 ± 0.02
Phase f	159.± 12.

$\chi^2/\text{DFR} = 0.96$

Ψ'

Vector + Pseudoscalar

Decay	Amplitude	PDGx10 ⁴	Fitx10 ⁴	Δχ ²
$\rho^0 \pi^0$	$g e^{i\phi} + e$	0.32 ± 0.13	0.28	0
$K^+ K^-$	$g (1-s) e^{i\phi} + e$	0.17 ± 0.08	0.19	0
$K^{*0} K^0$	$g (1-s)e^{i\phi} - 2e$	1.09 ± 0.20	1.15	0.04
$\omega \eta$	$(g X+d)e^{i\phi} + eX$	$.00 \pm 0.11$	0.08	0.06
$\phi \eta$	$(g (1-2s)Y+d)e^{i\phi} - 2eY$	0.28 ± 0.90	0.24	0.10
$\rho \eta$	$3eX$	0.22 ± 0.06	0.15	0.22
$\omega \pi$	$3e$	0.21 ± 0.06	0.26	0.10
$\omega \eta'$	$(g X' +d')e^{i\phi} + eX'$	0.32 ± 0.25	0.03	0.23
$\phi \eta'$	$(g (1-2s)Y' +d')e^{i\phi} - 2eY'$	0.31 ± 0.16	0.29	0.02
$\rho \eta$	$3eX'$	0.19 ± 0.17	0.08	0.11

PP decay revisited

Pseudoscalar Pseudoscalar Decay Revisited

- Open question about $J/\Psi \rightarrow \pi\pi$ decay, since pure em :

$$B^{\pi\pi} = |E^{\pi\pi}|^2, \text{ while}$$

$$B^{\pi\pi} = (1.47 \pm .23) 10^{-4} \text{ from PDG}$$

$$|E^{\pi\pi}|^2 = B^{\mu\mu} \sigma(e^+e^- \rightarrow \pi^+\pi^-)/\sigma(e^+e^- \rightarrow \mu\mu) =$$

$$= (0.46 \pm .23) 10^{-4} \text{ extrapolated from BaBar}$$

$$B^{\pi\pi} \neq |E^{\pi\pi}|^2 \text{ by 3 s.d.}$$

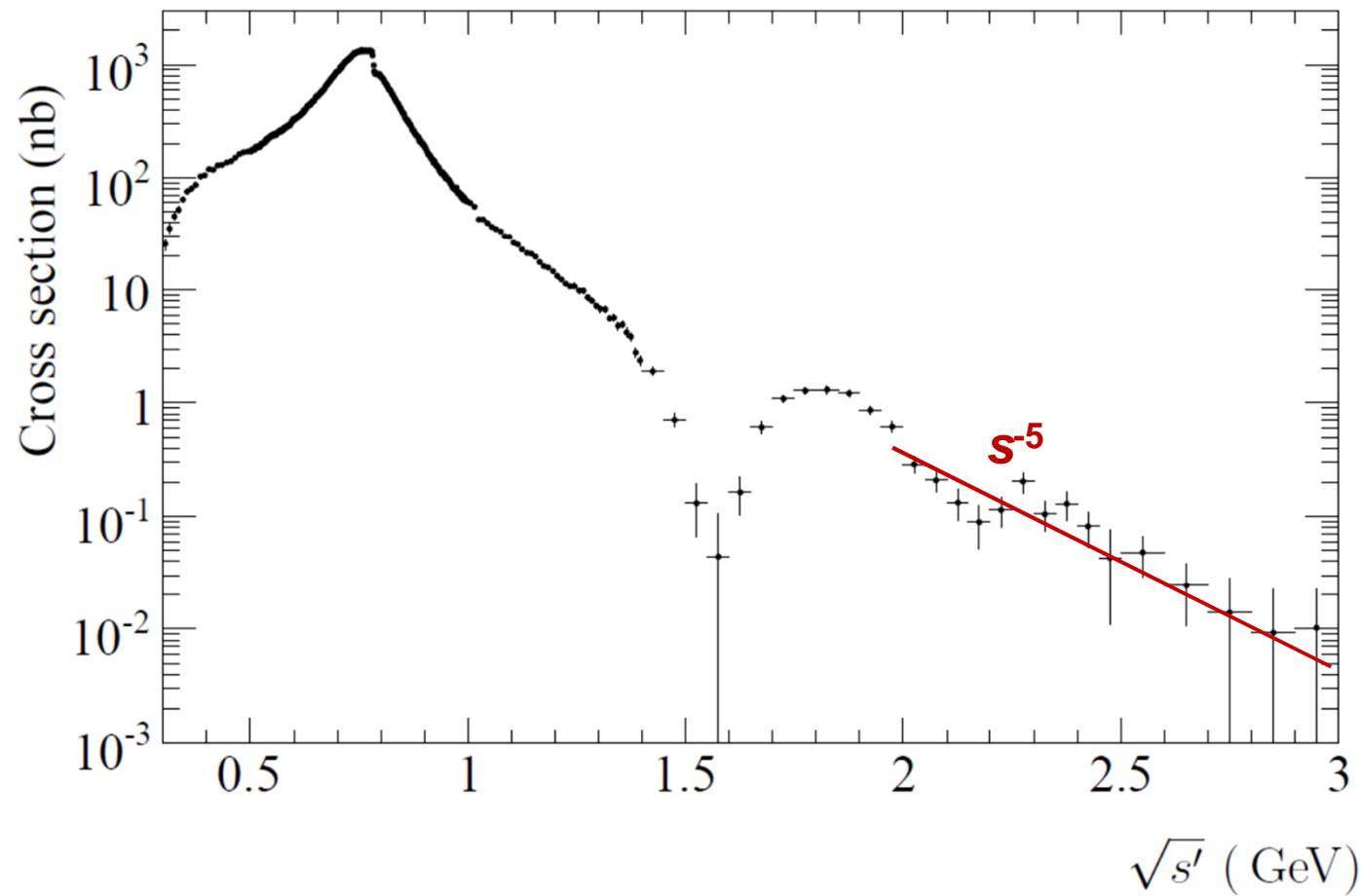
- $\pi\pi$ cross section slope B ,

asymptotically it is expected $B = -2-4 \times n_q = -6$

$$B^{\pi\pi} \sim -10 \pm 2$$

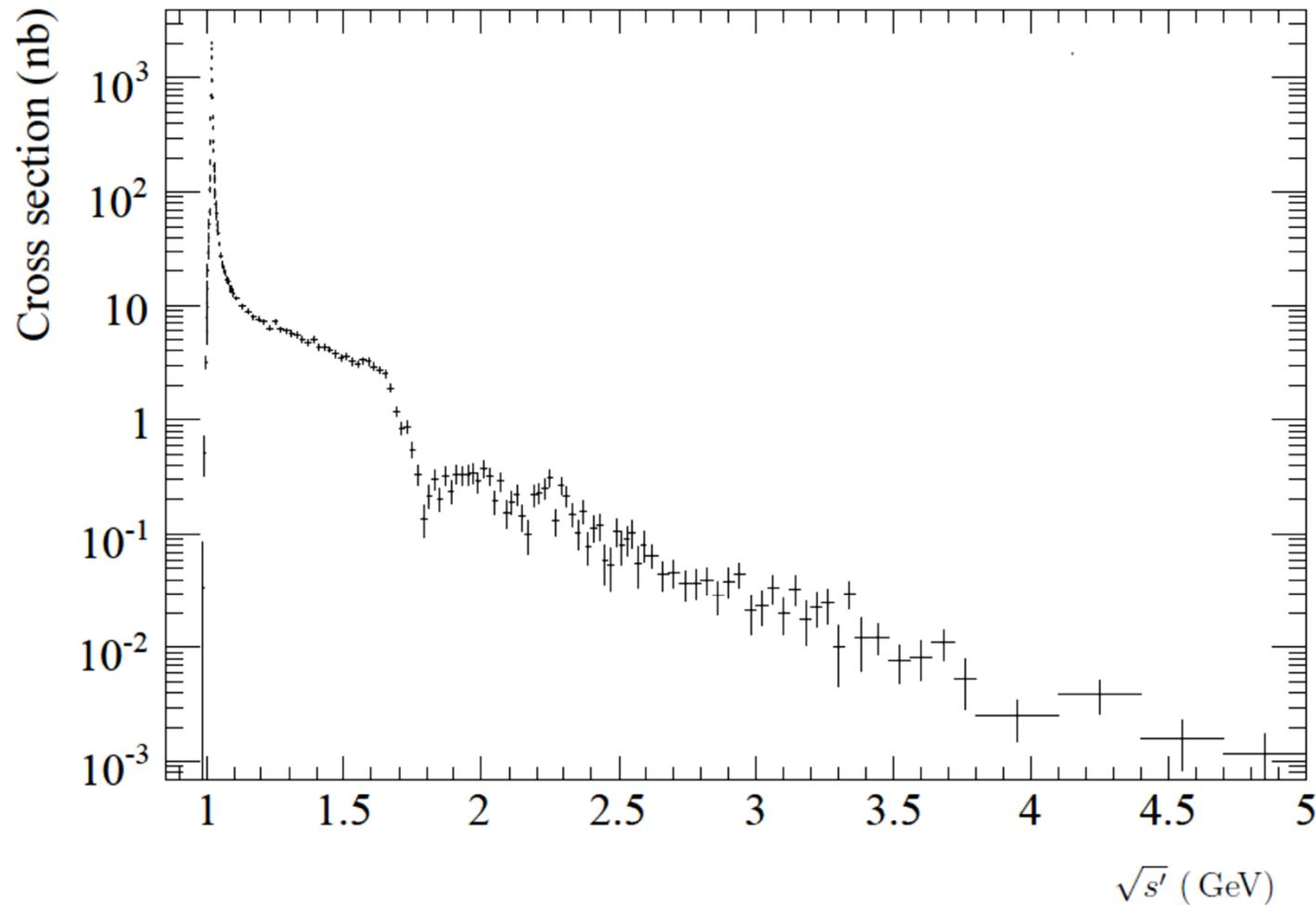
BaBar: $e^+e^- \rightarrow \pi^+\pi^-$ cross section

arXiv: 1205.2228v1

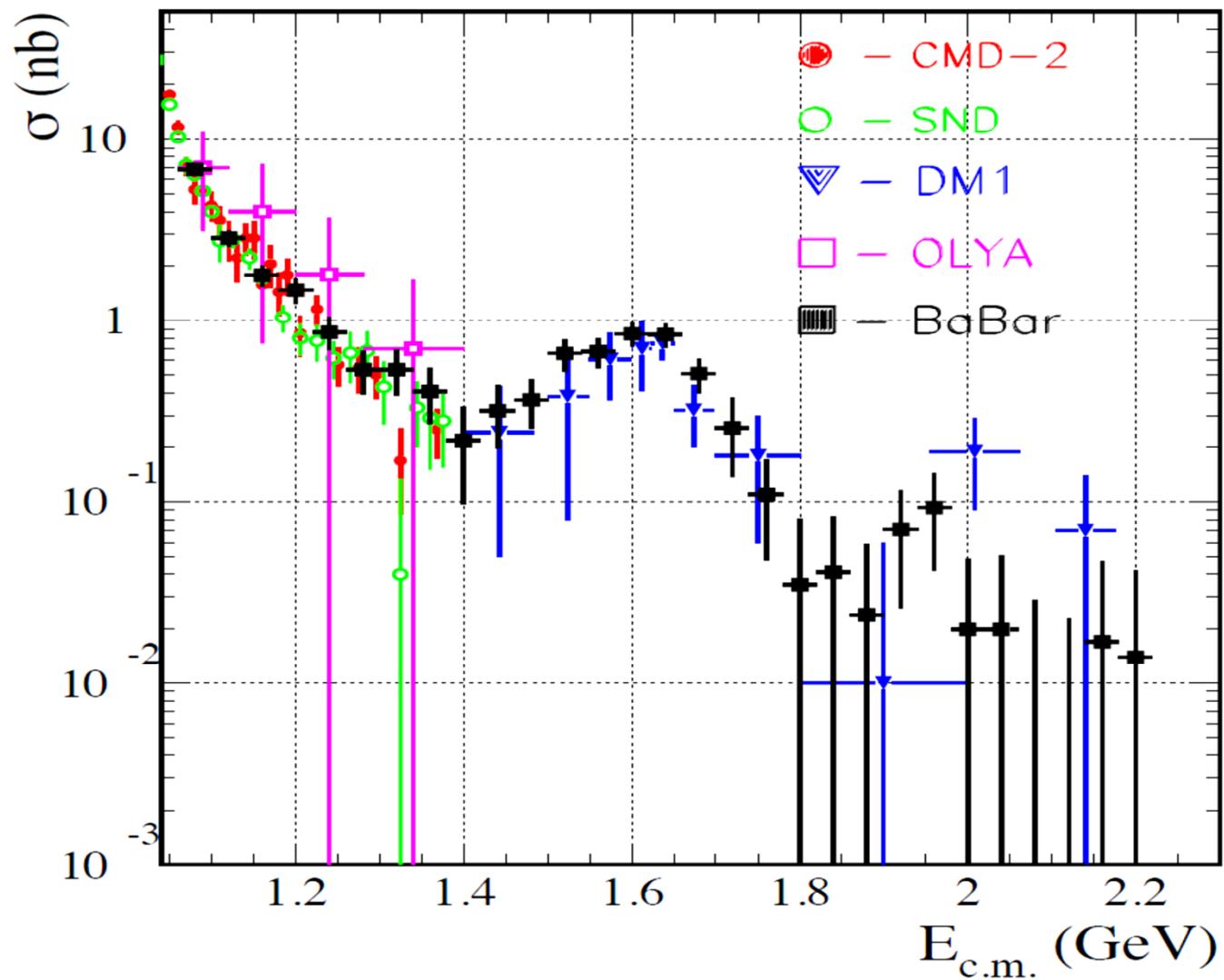


$e^+ e^- \rightarrow K^+ K^-$

arXiv: 1306.3600v1



$e^+ e^- \rightarrow KS\bar{KL}$



Pseudoscalar Pseudoscalar Decay Revisited

- It is possible to avoid $\pi\pi$ inconsistencies and complications from s quark mass.
by means of KK BR's and $|E^{KK}|$ only
- $B^{+-} = |S|^2 + |E^{+-}|^2 + 2 |S||E^{+-}| \cos \Phi$
 $B^{SL} = |S|^2 + |E^{SL}|^2 - 2 |S||E^{SL}| \cos \Phi$
- $|E^{+-}|^2 = B^{\mu\mu} \sigma(e^+e^- \rightarrow K^+K^-) / \sigma(e^+e^- \rightarrow \mu\mu)$
 $|E^{SL}|^2 \sim 0$, since $\sigma(e^+e^- \rightarrow K_S K_L) \ll \sigma(e^+e^- \rightarrow K^+K^-)$
CLEOc :
 $\sigma(e^+e^- \rightarrow K_S K_L) = (0.032 \pm 0.016) \text{ pb}$ at $W=4.17 \text{ GeV}$
 $\sigma(e^+e^- \rightarrow K_S K_L) \sim 0.6 \text{ pb}$ at J/Ψ , $\sim 0.1 \text{ pb}$ at Ψ'
(at most)

Pseudoscalar Pseudoscalar Decay

□ J/Ψ :

$$B^{+-} = (2.37 \pm 0.31) 10^{-4} \quad B^{\text{SL}} = (1.66 \pm 0.26) 10^{-4}$$

$$|E^{+-}|^2 = (1.3 \pm 0.6) 10^{-4} \quad \text{from BaBar}$$

$$\Phi = \mathbf{83.7^\circ \pm 9.0^\circ} \quad (2.37 \sim 1.66 + 1.3 + 2.9 x \cos\Phi)$$

□ Ψ' :

$$B^{+-} = (6.30 \pm 0.70) 10^{-5} \quad B^{\text{SL}} = (5.26 \pm 0.25) 10^{-5}$$

$$|E^{+-}|^2 = (0.7 \pm 0.4) 10^{-5} \quad \text{from BaBar}$$

$$\Phi = \mathbf{95^\circ \pm 11^\circ} \quad (6.3 \sim 5.26 + 0.7 + 3.8 x \cos\Phi)$$

Φ at the Ψ' from $K^*(892)K$ Decay Only

- $K^*(892)$ K decay: possible to avoid SU_3 assumptions and complications from s quark mass, since CLEOc measured the continuum cross sections
 - CLEOc (arXiv:hep-ex/0509011v2):
 $\sigma(e^- e^- \rightarrow K^{*0} K^0 + cc) = (23.5 \pm 5.3) \text{ pb}$ at $W=3.67 \text{ GeV}$
 $\sigma(e^- e^- \rightarrow K^{*+} K^- + cc) \sim (1 \pm 0.9) \text{ pb}$
 $|E^{+-}|^2 \sim 0.1 \times 10^{-5}$ $|E^{00}|^2 \sim 28 \times 10^{-5}$
 - $B^{+-} = (1.7 \pm 0.8) \times 10^{-5}$ $B^{00} = (10.9 \pm 2.0) \times 10^{-5}$
 $B^{+-} = |S|^2 + |E^{+-}|^2 + 2x|S||E^{+-}|\cos\Phi$
 $B^{00} = |S|^2 + |E^{00}|^2 - 2x|S||E^{00}|\cos\Phi$
 $S^2 \sim 2.7 \times 10^{-5}$ $\cos\Phi \sim (1.7 - 2.7 - 0.1) \times 10^{-5} / (2 \times 5 \times 1 \times 10^{-6})$
- $\Phi = 159^\circ \pm 24^\circ \text{ again like VP !}$**

Toward a proposal for a Ψ' scan

OLD BES DATA (2005)

$\psi(2S)$ Scan

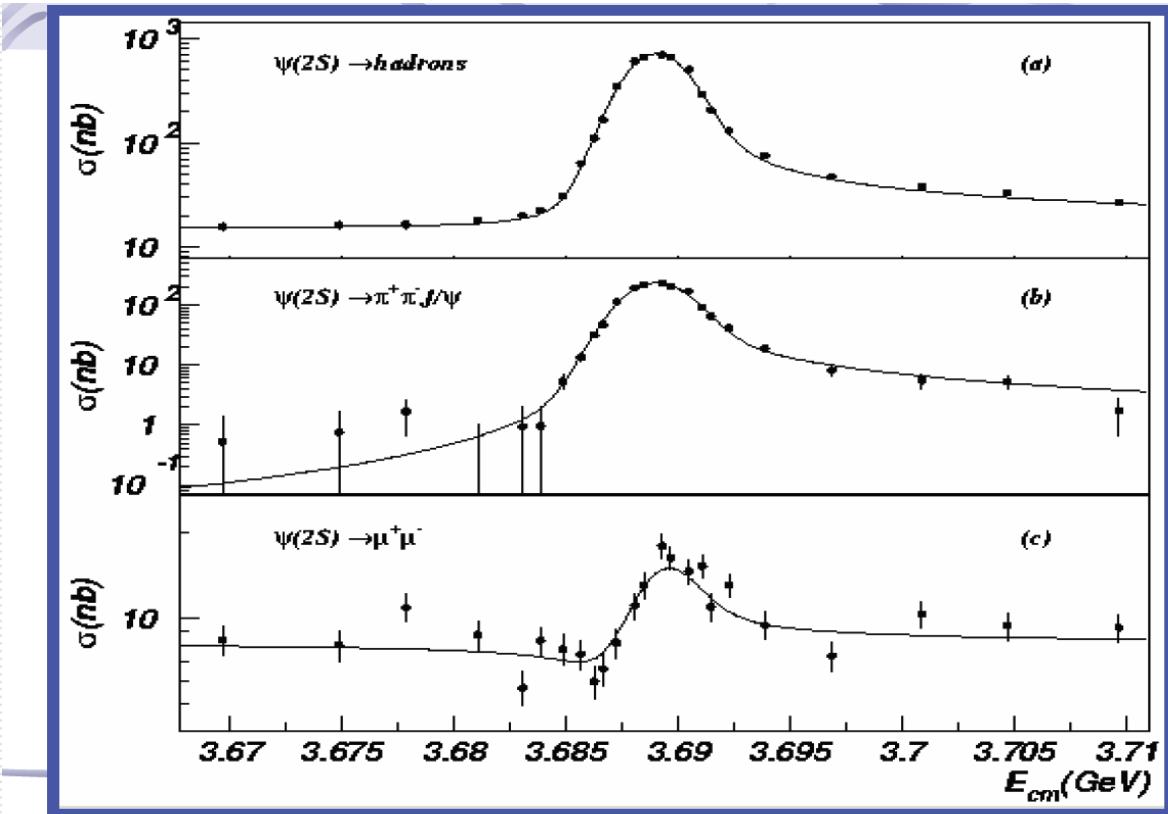
Purpose: Improve accuracies of $\psi(2S)$ parameters: Γ , Γ_h , Γ_μ , $\Gamma_{\pi\pi J/\psi}$, $B(h)$, $B(\mu)$, and $B(\pi^+ \pi^- J/\psi)$.

Group	yr	Γ (KeV)	Γ_h (KeV)	$B(\mu\mu)(10^{-3})$	$B(\pi^+ \pi^- J/\psi)$ (%)
MARKI	75	228 ± 56	224 ± 56	9.3 ± 1.6	32 ± 4
SPEC	75			7.7 ± 1.7	
DASP	79	202 ± 57		9.9 ± 3.2	36 ± 6
E760	92	306 ± 39			
E760	97			8.3 ± 0.86	28.3 ± 2.9
E835	00			7.4 ± 0.53	
PDG	00	277 ± 31		10.3 ± 3.5	31.0 ± 2.8

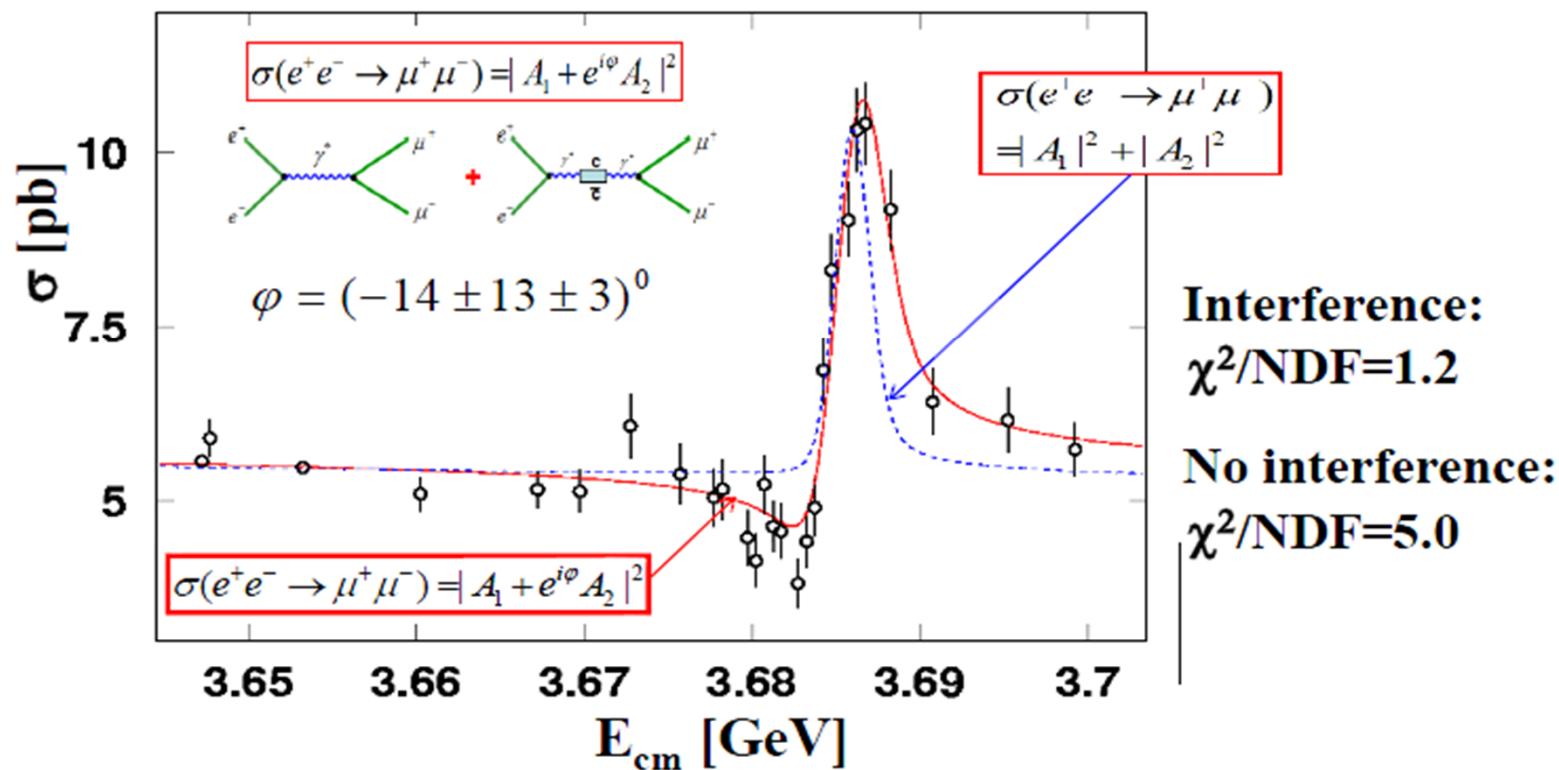
$\Psi(2S) \rightarrow \mu^+ \mu^-$ and $\Psi(2S) \rightarrow \pi^+ \pi^- J/\psi$ are important for identifying $\Psi(2S)$ decays in B-factory and other experiments.

- Scanned 24 energy points from 3.67 and 3.71 GeV.
- Integrated luminosity = 1150 nb^{-1}
- Four channels: $\psi(2S) \rightarrow \text{hadrons}$, $\mu^+ \mu^-$, $e^+ e^-$, and $\pi^+ \pi^- J/\psi$

OLD BES DATA (2005)

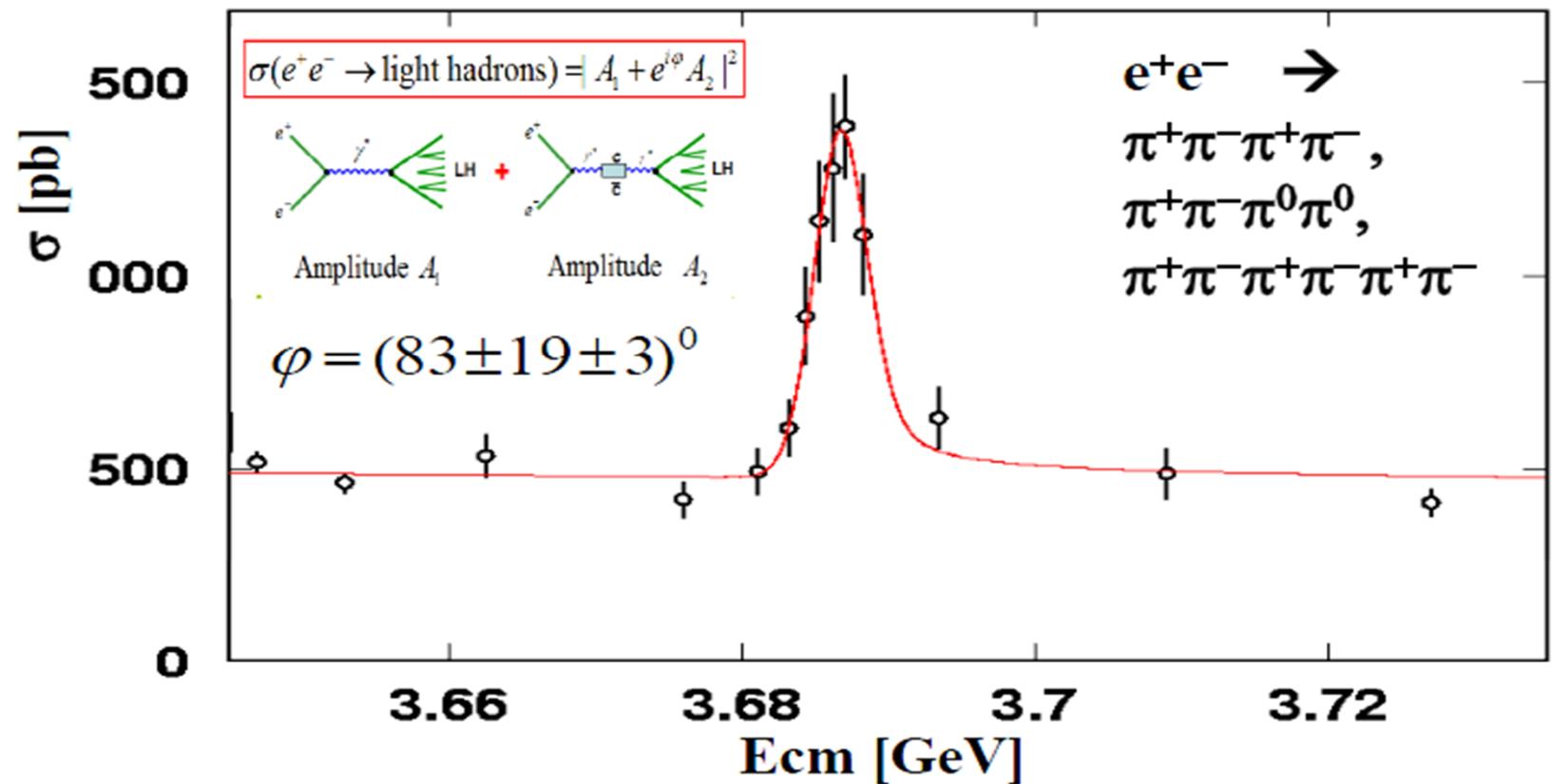


Interference between the EM production & $\psi(3686)$ decay to $\mu^+\mu^-$



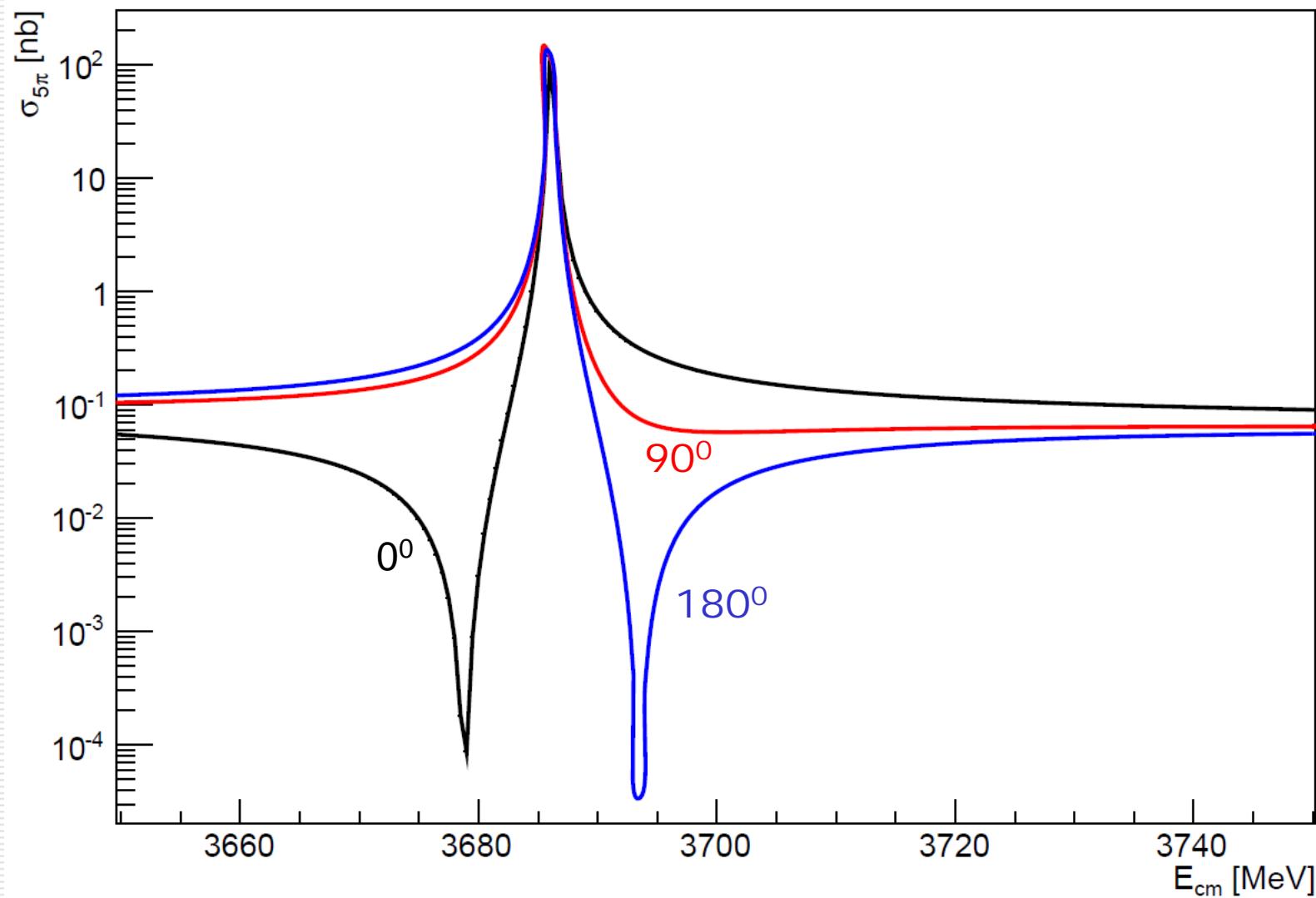
Gang Rong's report on BES-III Collaboration Summer Meeting, 2--6 June, 2011, NU, Nanjing

Interference between the EM production & $\psi(3686)$ decay to light hadrons

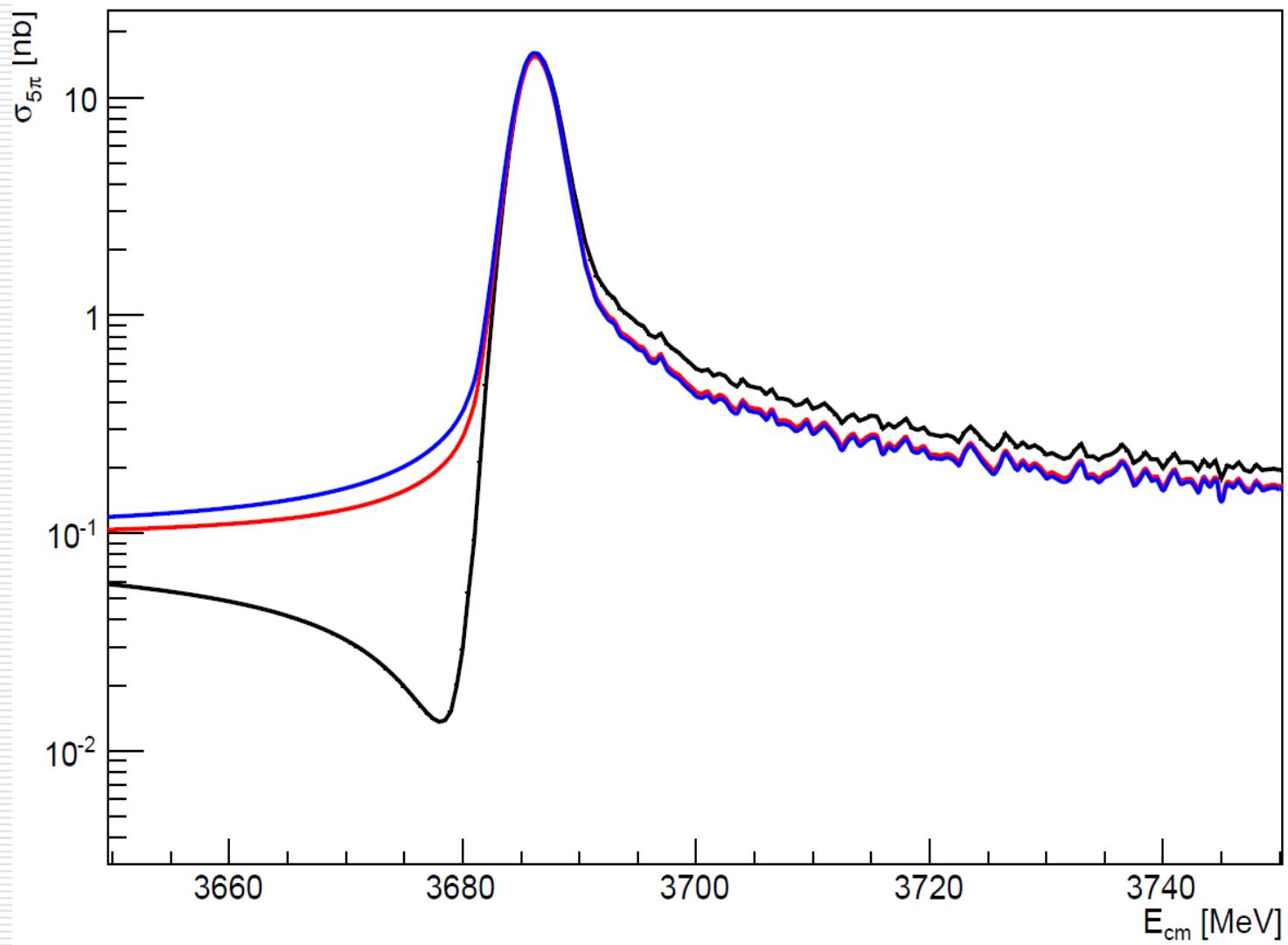


Gang Rong's report on BES-III Collaboration Summer Meeting, 2--6 June, 2011, NU, Nanjing

Ψ' 5 π ideal cross section (no ISR, no beam spread)



ψ' scan observed 5π cross section (ISR and beam spread included)
ISR $E_\gamma < 100$ MeV



First integrated luminosity estimation

- Present J/ Ψ measurements : $\Delta\Phi \sim 10^0$
(enough to distinguish between 90^0 and 180^0)
- From J/ Ψ to Ψ' :

Decay	$BR_{\Psi'}/BR_{J/\Psi}$	$cont_{\Psi'}/cont_{J/\Psi}$
$2\pi^+ 2\pi^- \pi^0$	$< 10^{-1}$	$\sim 5 \times 10^{-1}$
$p\bar{p}_{\text{bar}}$	$\sim 10^{-1}$	$\sim 10^{-1}$
$K^+ K^-$	$\sim 3 \times 10^{-1}$	$\sim 5 \times 10^{-1}$
$\pi^+ \pi^-$	$\sim 5 \times 10^{-1}$	$\sim 2 \times 10^{-1}$
VP	$2 \times 10^{-3} - 2 \times 10^{-2}$	

- Present J/ Ψ measurements : $L_{\text{int}}^{J/\Psi} \sim 100 \text{ pb}^{-1}$
since BRs and cross sections $\Psi' < 10^{-1} \text{ J}/\Psi \rightarrow L_{\text{int}}^{\Psi'} \sim 1 \text{ fb}^{-1}$
- $T \sim 86.4 \text{ ks} \times 5 \times 10^{32} \times 10^6 \times 1.3 < \text{1 month}$

Conclusions (work in progress)

- the J/ Ψ scan shows that $\Phi \sim |90^\circ|$
- Updated VP and PP J/ Ψ decays data confirm this result
- An explanation can be put forward
- $\Psi''(3770)$ present data suggest $\Phi \sim -90^\circ$

- Updated VP and PP Ψ' decays data are contradictory:
VP and $K^*(892)K$: $\Phi \sim 180^\circ$
PP : $\Phi \sim 90^\circ$
- A scan below and above the Ψ' is proposed
- In the first approximation $L_{int} \Psi' \sim 1 \text{ fb}^{-1}$, $T < 1 \text{ month}$

Thanks for

谢谢

your attention