Charmonium and Light Meson Spectroscopy

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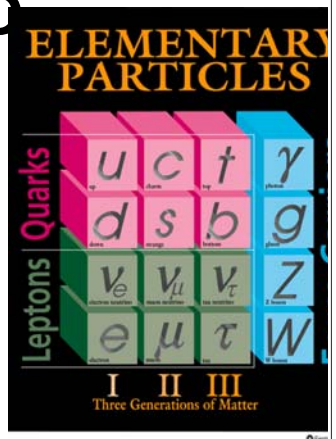
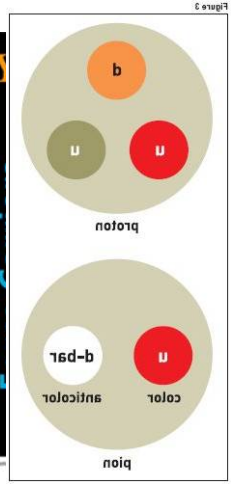
Outline

- Introduction
- Charmonia & Charmonium-like states
- Light meson spectroscopy
- Summary

Introduction - QCD and Quark model

- **Quarks as basic building blocks and QCD describes their interactions leading to bound states:**
  - **Light: π, K, ρ, η, η', Λ, p,n …**
  - **Heavy: charmonium, bottomonium**
  - **Light-heavy: D, B, D_s, B_c …**





- **Various methods to deal with the non-perturbative strong interactions:**
  - **Quark models**
  - **Potential model**
  - **QCD sum rules**
  - **Lattice QCD**

$$V(r) = -\frac{k}{r} + \frac{r}{a^2}$$

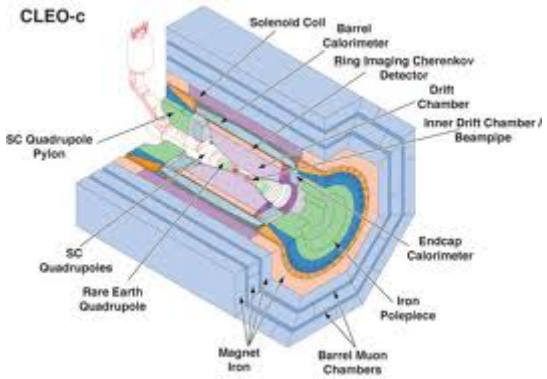
- **How well do we understand the strong interaction? Confinement?**

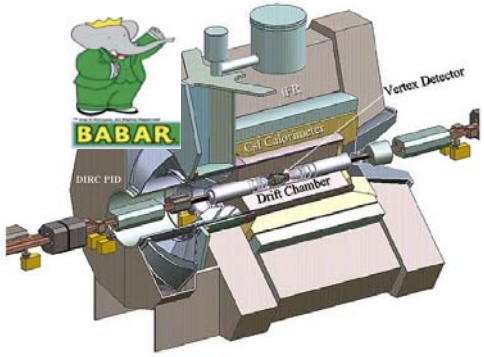
Introduction - Experiments

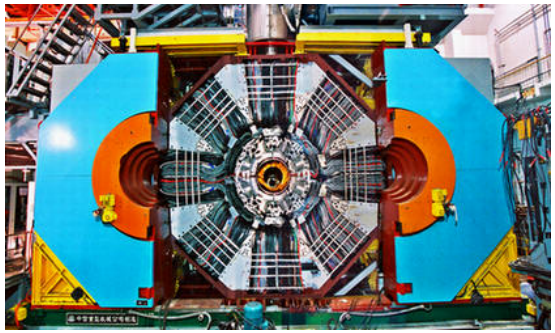
Charm factories
CLEO-c and BES-III

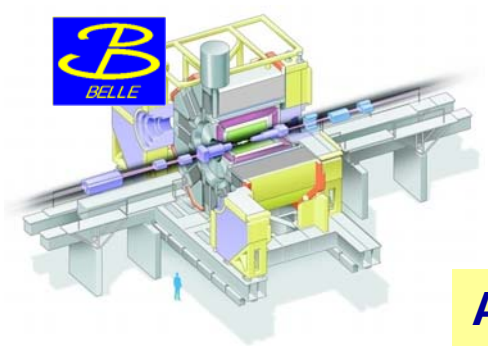
B factories
BaBar and Belle

ϕ factory
And p $\bar{p}$ collider



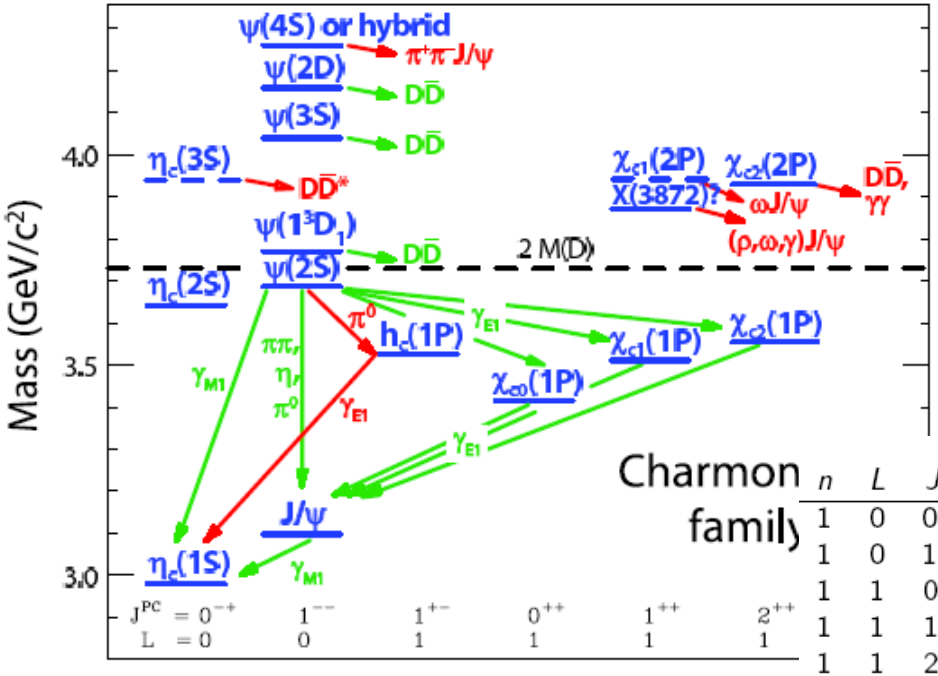






Apology for not covering all!

Charmonium family



From Rev. Mod. Phys. Vol80, 2008

Known charmonium states and candidates, with selected decay modes and transitions.

n	L	J^{PC}	$n^{2S+1}L_J$	Name	Mass(MeV)	Width(MeV)
1	0	0^{-+}	1^1S_0	$\eta_c(1S)$	2981.0 ± 1.1	29.7 ± 1.0
1	0	1^{--}	1^3S_1	J/ψ	3096.916 ± 0.011	92.9 ± 2.8keV
1	1	0^{++}	1^3P_0	$\chi_{c0}(1P)$	3414.75 ± 0.31	10.4 ± 0.6
1	1	1^{++}	1^3P_1	$\chi_{c1}(1P)$	3510.66 ± 0.07	0.86 ± 0.05
1	1	2^{++}	1^3P_2	$\chi_{c2}(1P)$	3556.20 ± 0.09	1.98 ± 0.11
1	1	1^{+-}	1^1P_1	$h_c(1P)$	3525.41 ± 0.16	< 1
1	2	1^{--}	1^3D_1	$\psi(3770)$	3773.15 ± 0.33	27.2 ± 1.0
2	0	0^{-+}	2^1S_0	$\eta_c(2S)$	3638.9 ± 1.3	10 ± 4
2	0	1^{--}	2^3S_1	$\psi(2S)$	$3686.109^{+0.012}_{-0.014}$	304 ± 9keV
		$?^{?+}$		$X(3872)$	3871.68 ± 0.17	< 1.2
		$?^{?+}$		$X(3915)$	3917.5 ± 2.7	27 ± 10
2	1	2^{++}	2^3P_2	$\chi_{c2}(2P)$	3927.2 ± 2.6	24 ± 6
3	0	1^{--}	3^3S_1	$\psi(4040)$	4039 ± 1	80 ± 10
2	2	1^{--}	2^3D_1	$\psi(4160)$	4153 ± 3	103 ± 8
		1^{--}		$X(4260)$	4263^{+8}_{-9}	95 ± 14
		1^{--}		$X(4360)$	4361 ± 13	74 ± 18
4	0	1^{--}	4^3S_1	$\psi(4415)$	4421 ± 4	62 ± 20
		1^{--}		$X(4660)$	4664 ± 12	48 ± 15

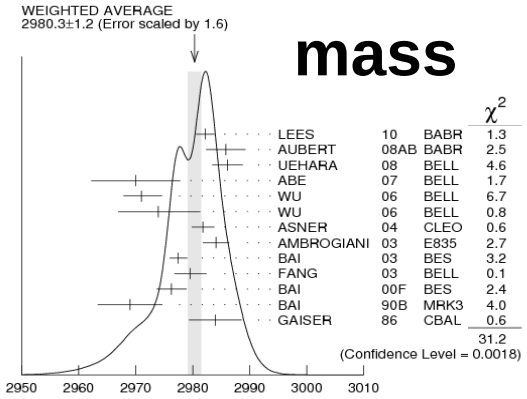
From PDG2012

List based on the quantum number in the potential model.

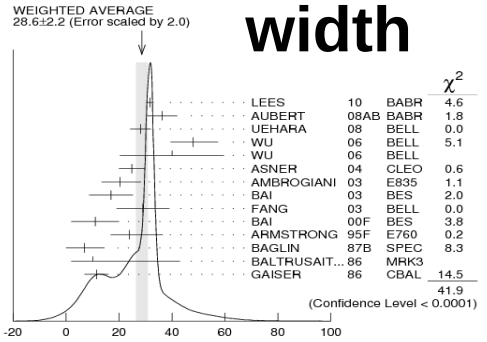
Conventional charmonium states

- Spin-singlets: $\eta_c(1S)$, $h_c(1P)$, $\eta_c(2S)$
- $\chi_{c2}(2P)$
- J/ψ, $\psi(3686)$, $\psi(3770)$
- 1P spin-triplet: χ_{c1}, χ_{c2}, χ_{c3}
- $\psi(4040)(3S)$, $\psi(4160)(2D)$, $\psi(4415)(4S)$
- Missing 1D states

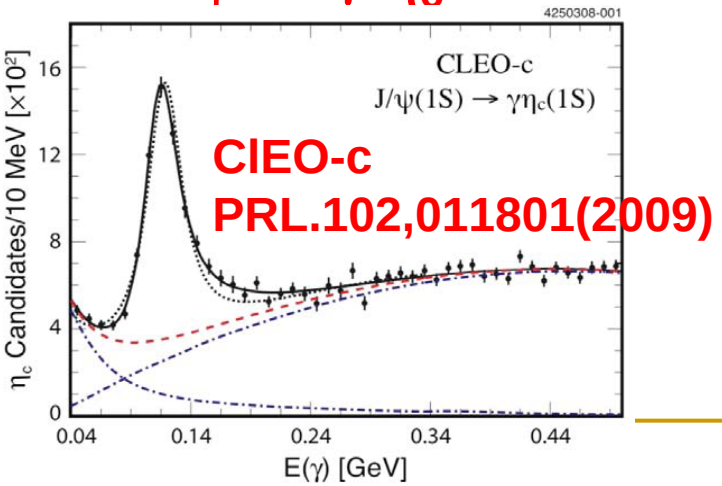
η_c, the lightest charmonium state



PDG (2010)

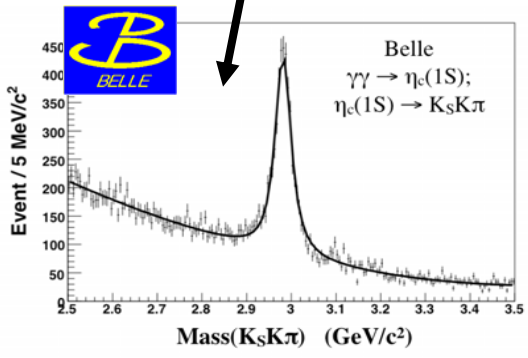


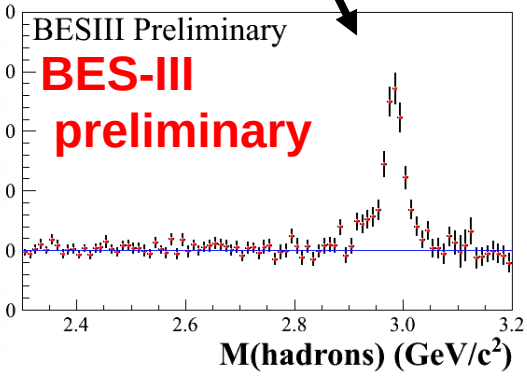
Asymmetric lineshape from J/ψ → γ η_c



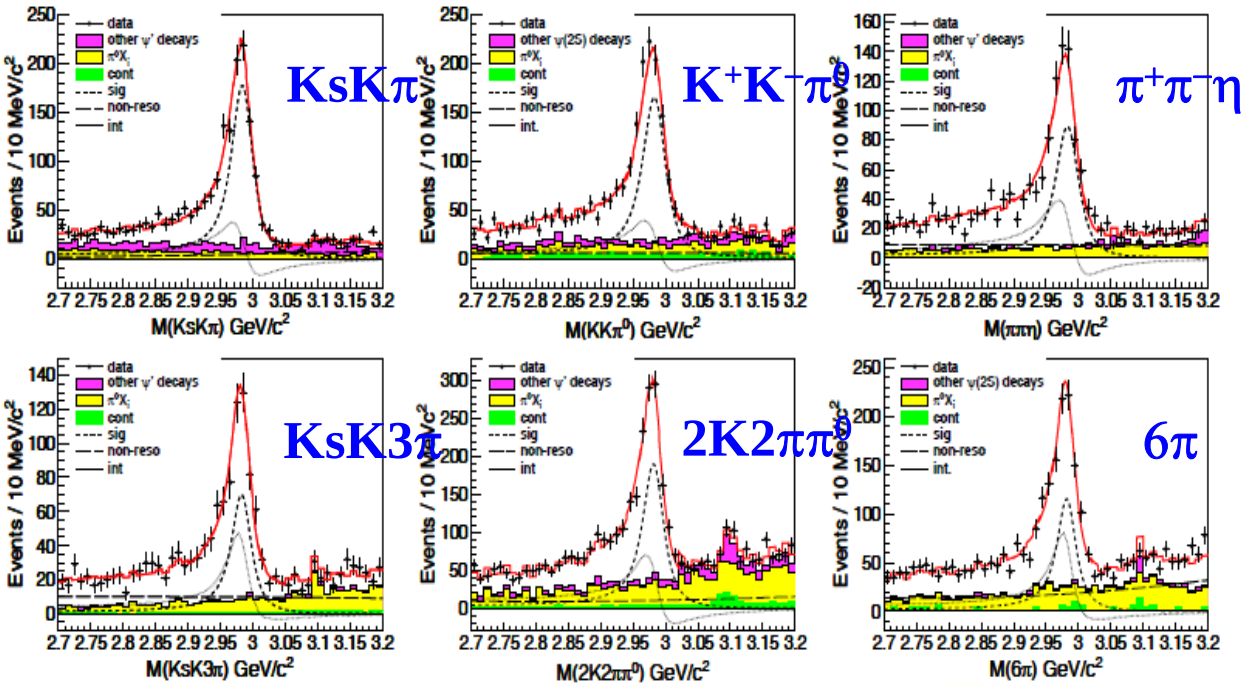
CleO-c PRL.102,011801(2009)

No obvious distorted lineshape from γ γ fusion or $h_c \rightarrow \gamma \eta_c$





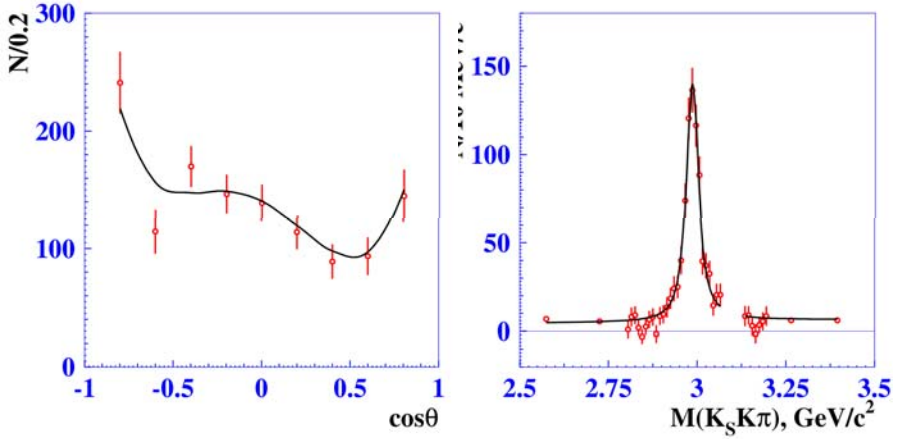
η_c from ψ' or B decay



BES-III

$\psi' \rightarrow \gamma \eta_c$
six exclusive decay Modes
PRL 108, 222002 (2012)

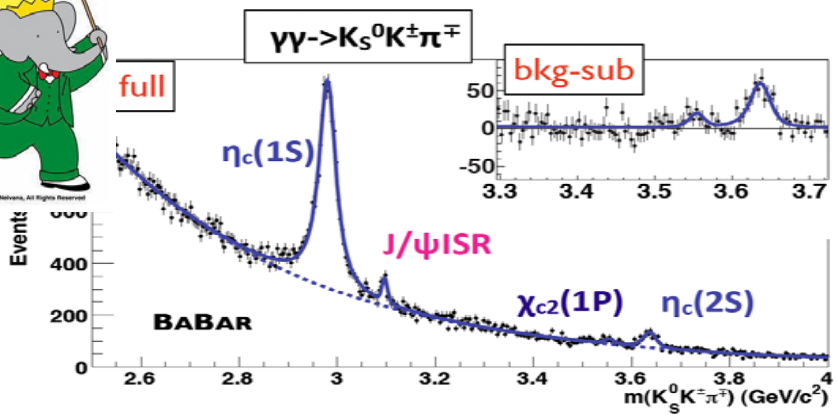
$B \rightarrow K \eta_c$
2D fit
PLB 706, 139-149 (2011)

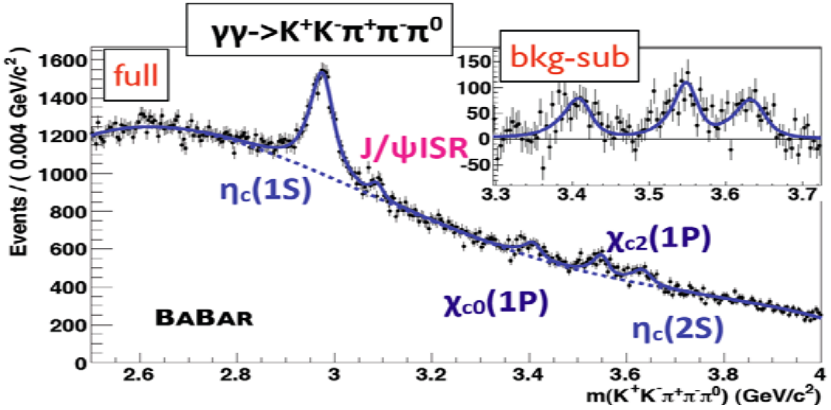


Considering interference may be the key to solve this "puzzle".

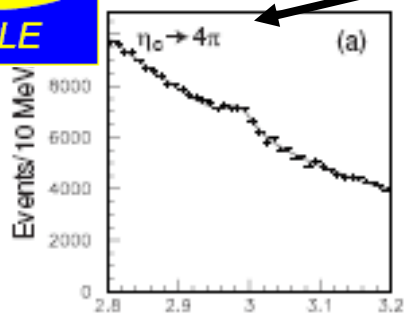
η_c from $\gamma\gamma$ fusion

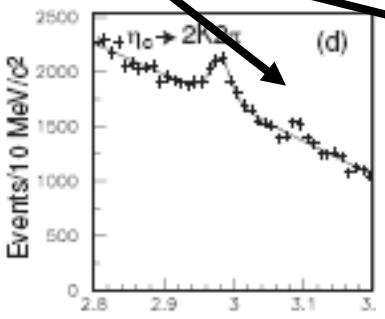
$\eta_c \to K_s K \pi$, PR D81 (2011) 052010; K K 3π, PR D84 (2011) 012004

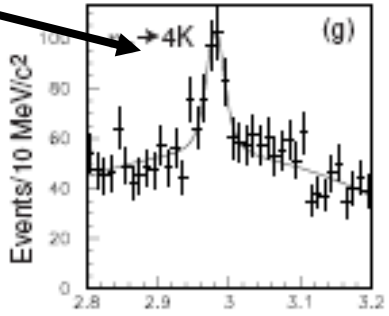


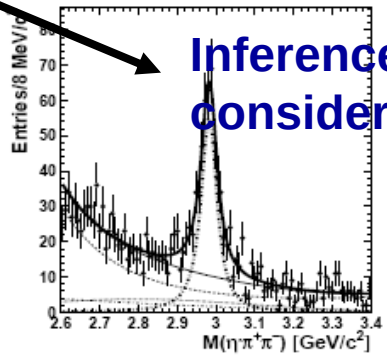


$\eta_c \to$ 4 prongs, EPJC53(2008)1; $\eta_c \to \eta' \pi \pi$, arXiv:1206.5087



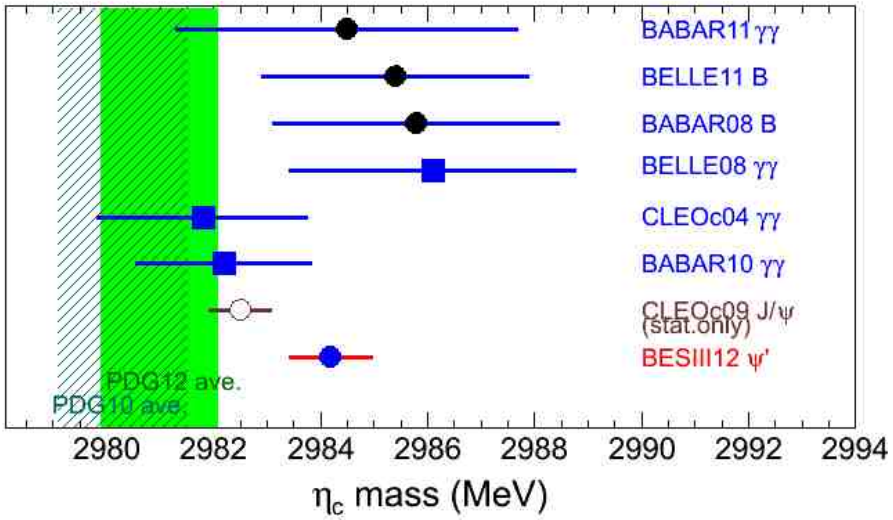


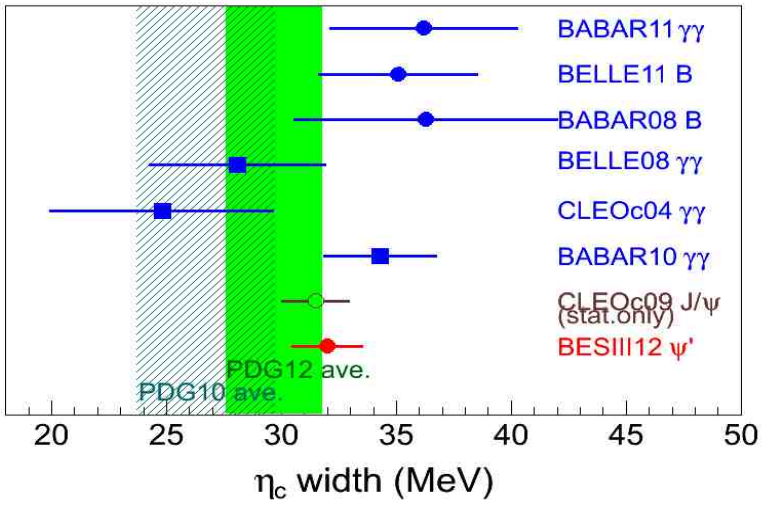




Inference considered

η_c summary of the mass and width





Hyperfine splitting: ΔM(1S) = **112.5 ± 0.8** MeV;

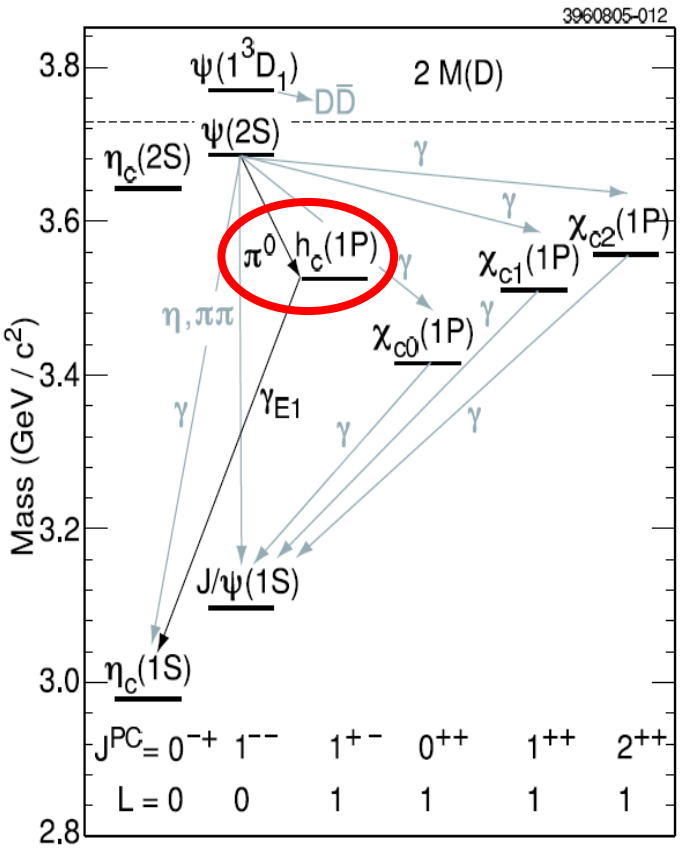
Consistent with potential model and recent lattice QCD.

$$\Delta M_{hf}(nS) = M(n^3S_1) - M(n^1S_0) = \frac{32\pi\alpha_s(m_q)}{9}(\psi(0)/m_q)^2 \Longrightarrow$$

ΔM(1S) ≈ 118 MeV

K. Seth hadron11

$h_c(^1P_1)$, singlet 1P wave state



- **Spin singlet P wave (S=0, L=1)**
- **First evidence: E835 in p $\bar{p}\rightarrow h_c\rightarrow\gamma\eta_c$**

  PRD72 （2005） 032001
- **Potential model: if non-vanishing P-wave spin-spin interaction,**

  $\Delta M_{hf}(1P)=M(h_c)-<M(1\ ^3P_J)>\neq 0$
- **CLEO-c observed h_c in $e^+e^-\rightarrow\psi'\rightarrow\pi^0 h_c$, $h_c\rightarrow\gamma\eta_c$**

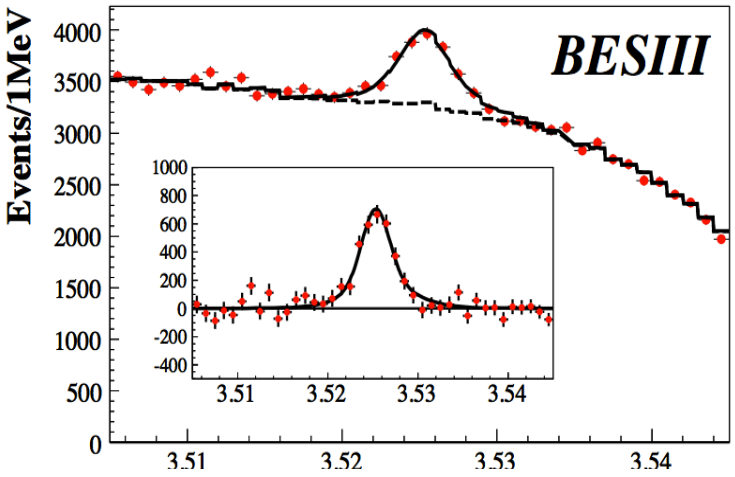
  $\Delta M_{hf}(1P)=0.08\pm0.18\pm0.12$ MeV/c^2

  (consistent with 1P hyperfine splitting = 0)

  PRL101 (2008) 182003
- **Theoretical prediction:**
  - *Y. P. Kuang, PRD65, 094024 (2002)*
  - *Godfrey and Rosner, PRD66, 014012 (2002)*

Observation of h_c in inclusive reaction

E1-tagged $\psi' \to \pi^0 h_c$, $h_c \to \gamma \eta_c$



First observation

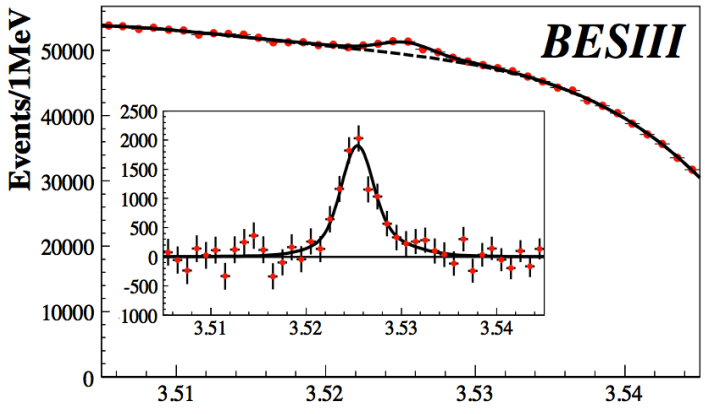
$M(hc) = 3525.40 \pm 0.13 \pm 0.18$ MeV/c^2

$\Gamma(h_c) = 0.73 \pm 0.45 \pm 0.28$ MeV

$B(\psi' \to \pi^0 h_c) = (8.4 \pm 1.3 \pm 1.0) \times 10^{-4}$

$B(h_c \to \gamma \eta_c) = (54.3 \pm 6.7 \pm 5.2)\%$

Inclusive $\psi' \to \pi^0 h_c$

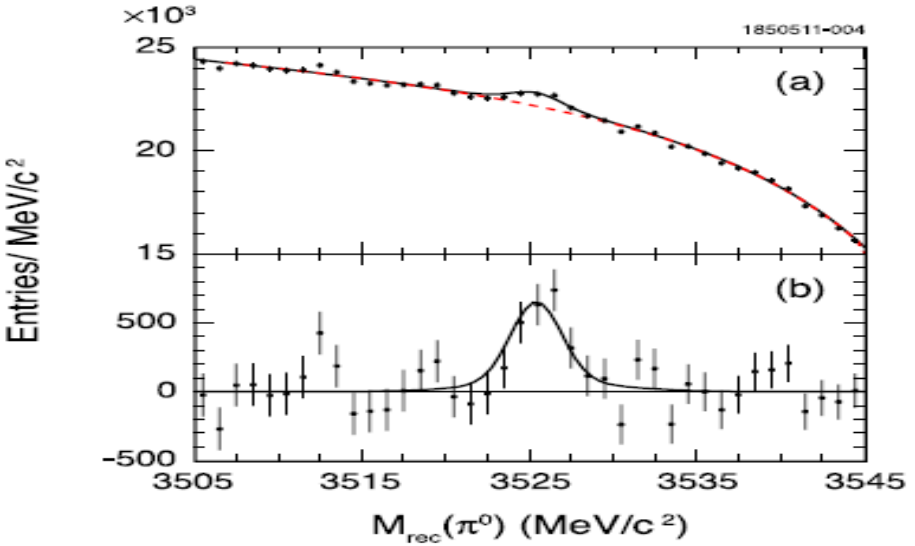


BESIII, PRL 104 (2010) 132002

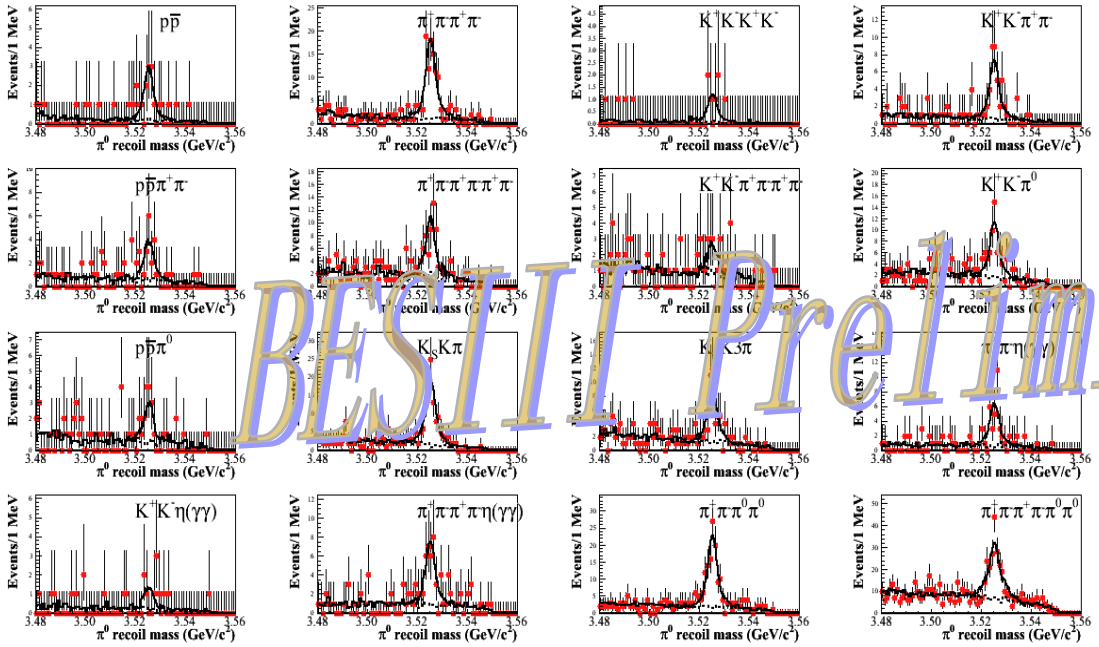
Confirmed by CLEOc

CLEOc, PRD84 104 (2011) 032008

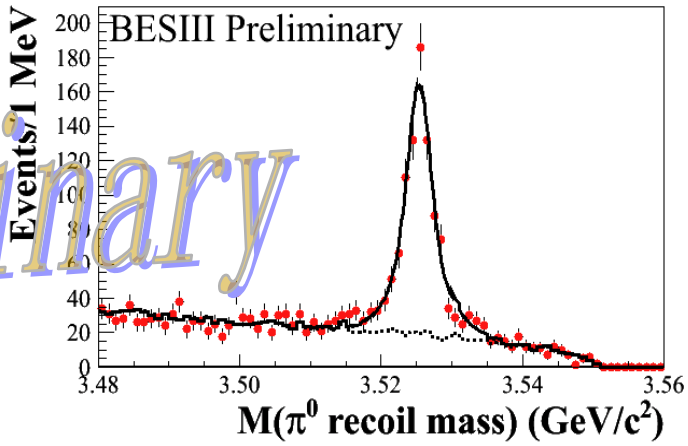
$B(\psi' \to \pi^0 h_c) = (9.0 \pm 1.5 \pm 1.3) \times 10^{-4}$



Observation of h_c in exclusive reaction



Summed π^0 recoil mass



Consistent with BESIII inclusive

CLEOc,

PRL 107(2011) 041803

new h_c production mode

$e^+ e^-$ (4170) $\rightarrow \pi^+ \pi^-$ h_c(1P)

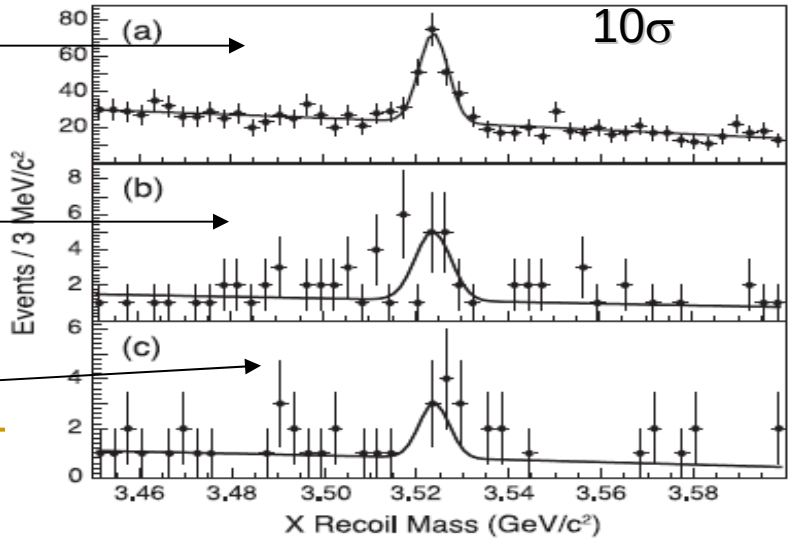
with $h_c \rightarrow \gamma \eta_c$,

12 η_c decay modes

$\pi \pi h_c$ at 4170

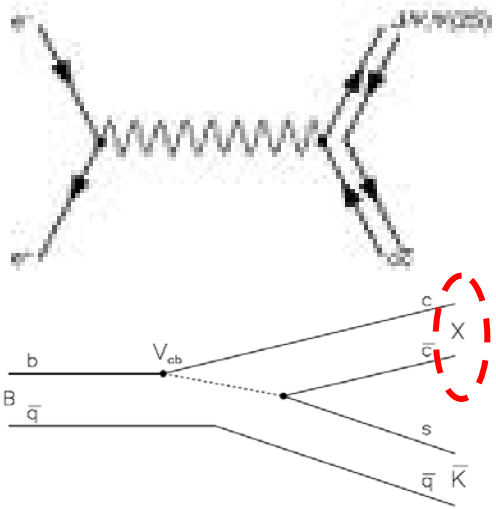
ηh_c at 4170

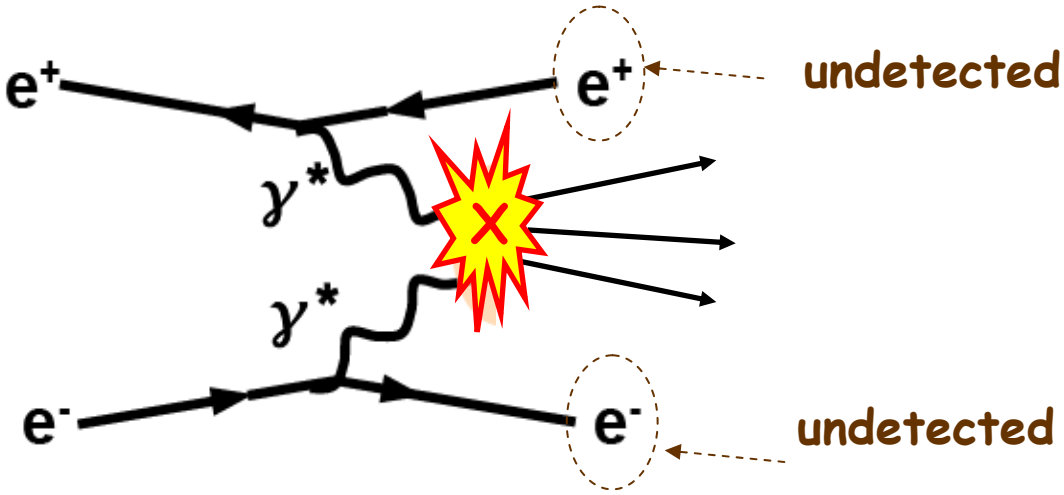
$\pi \pi h_c$ at 4260



$\eta_c(2S)$, confirmed in M1 transition by BESIII

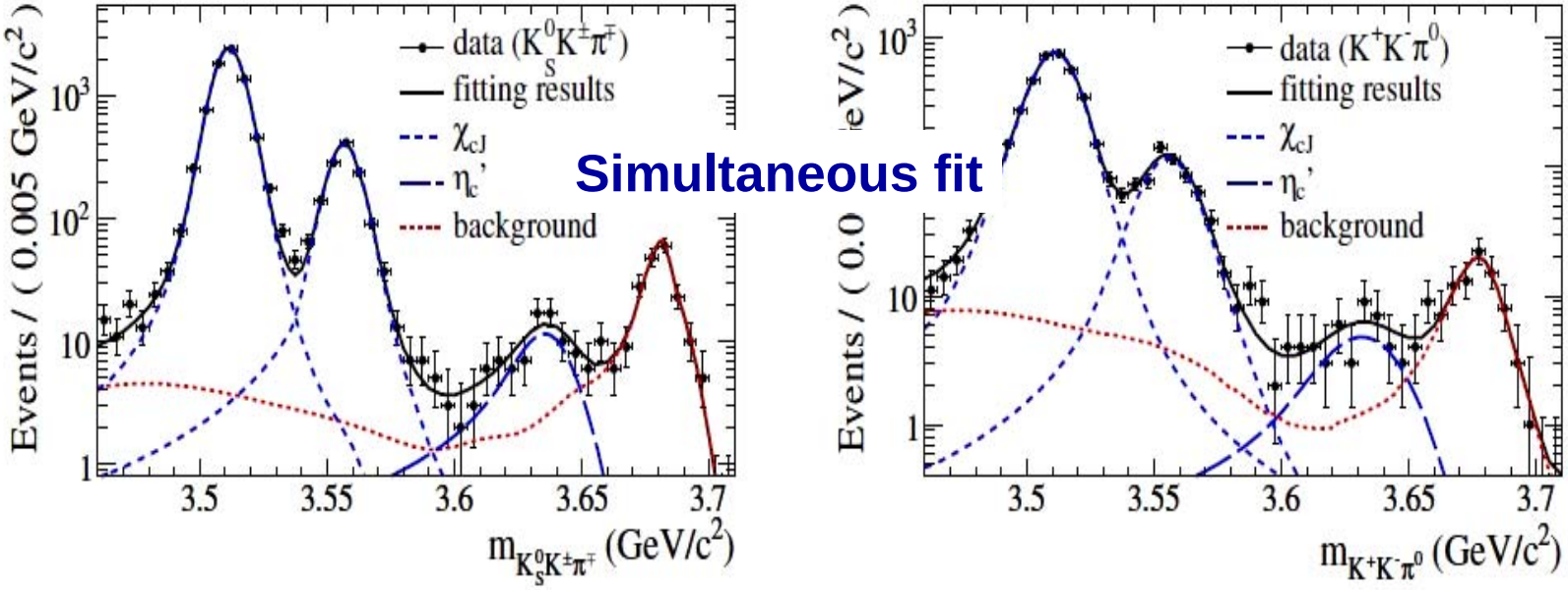
- First "observation" by Crystal Ball in 1982 from $\psi' \to \gamma$ X, never confirmed until BESIII. (Experimental challenge for 50 MeV photon.)
- Observed in different production mechanisms,
  - Double charmonium production (BABAR 2004, 2005, 2011)
  - B→Kh_c(2S) (BELLE 2002)
  - $\gamma\ \gamma \to h_c$ (2S)→KKπ (CLEO-c 2004; BELLE 2008, 2007)





$\eta_c(2S)$ via M1 transition

BESIII, PRL 89 (2012) 162002



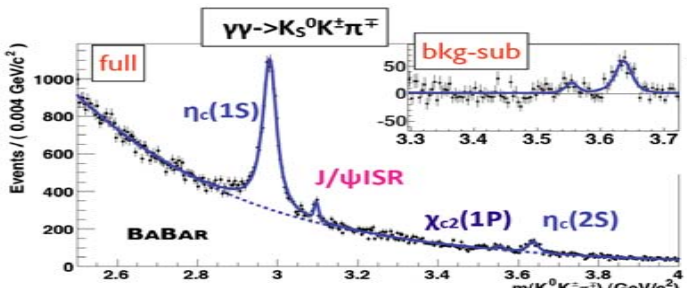
➢ **Br($\psi' \rightarrow \gamma\eta_c(2S)$)=($6.8 \pm 1.1_{stat} \pm 4.5_{sys}$) $\times 10^{-4}$**

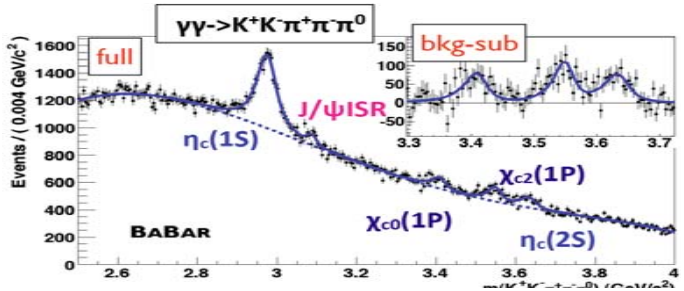
CLEO-c: $<7.6\times10^{-4}$ (PRD81,052002(2010))

Potential model: $(0.1-6.2)\times10^{-4}$ (PRL89,162002(2002))

ηc(2S), from γ γ

PR D84 (2011) 012004, K_s K π and KKπππ^0

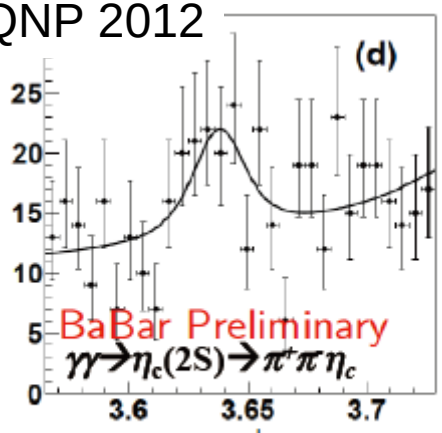




✓ Most precise mass and width measurements:

- $M(\eta_c(2S)) = 3638.5 \pm 1.5_{(stat)} \pm 0.8_{(syst)}$ MeV/c^2
- $\Gamma(\eta_c(2S)) = 13.4 \pm 4.6_{(stat)} \pm 3.2_{(syst)}$ MeV

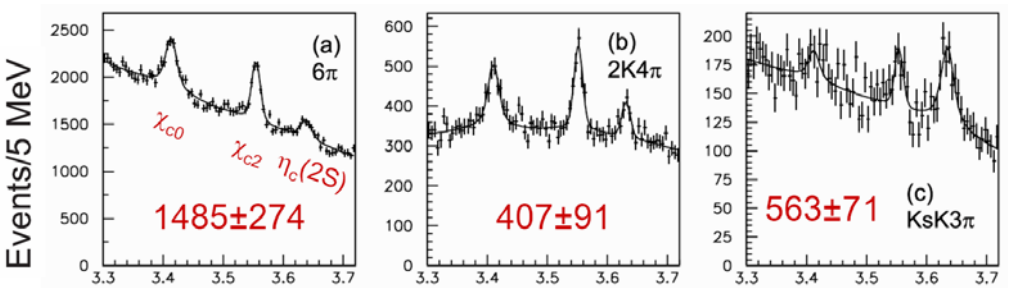
QNP 2012



$\mathcal{B}(\eta_c(2S) \to \eta_c \pi^+ \pi^-) < 7.4\%$

(compatible with prediction $< 2.2\%$)

ICHEP2010, $\eta_c(2S) \to$ 6 prongs

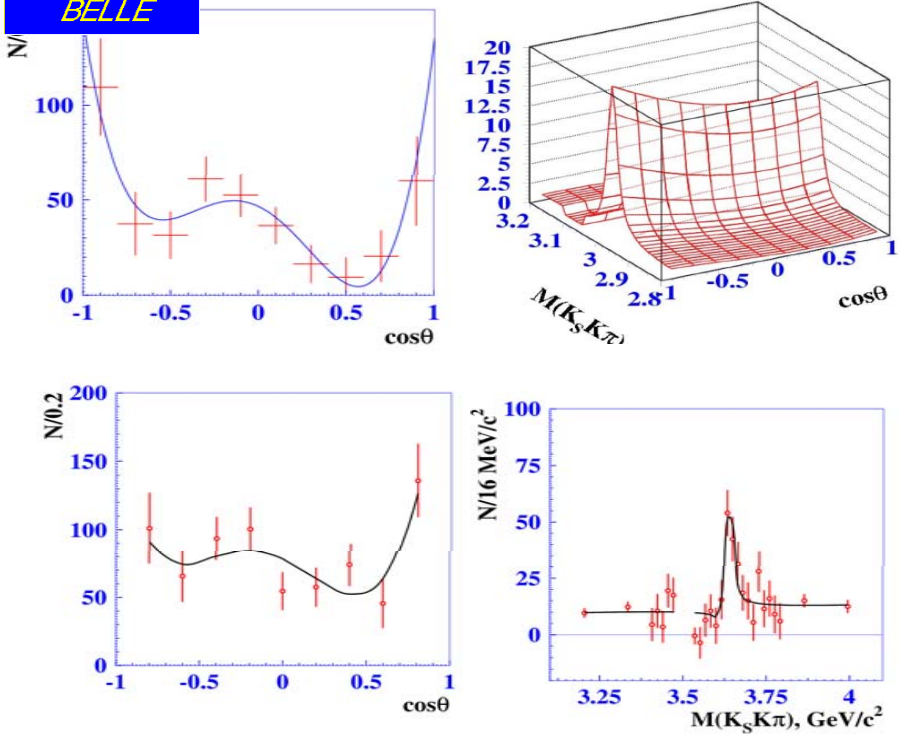


Ave: M:3636.9±1.1±2.5 ±5.0 Γ:9.9±3.2±2.6±2.0

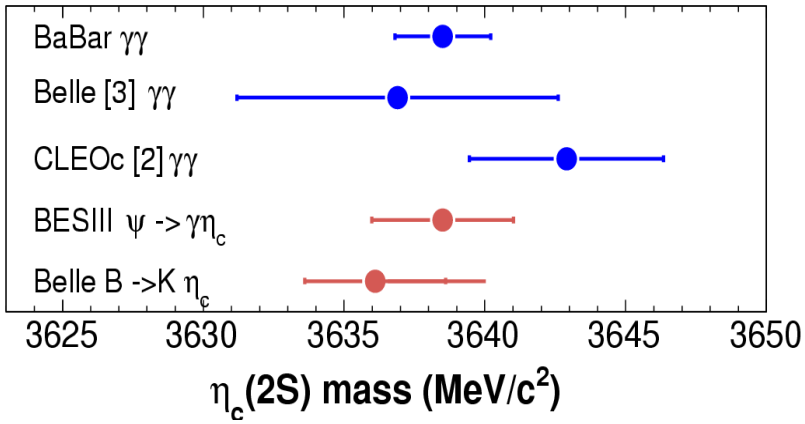
$\eta_c(2S)$, from B decays

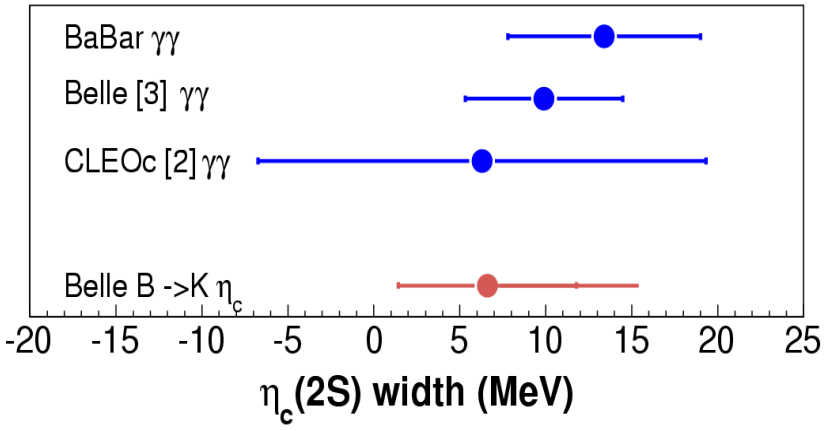
- Perform a $M(K_sK\pi)$ & $\cos\theta$ 2D fit
- Interference is important (Γ:6.6/41.1)

PLB 706 (2011) 139



Summary of $\eta_c(2S)$



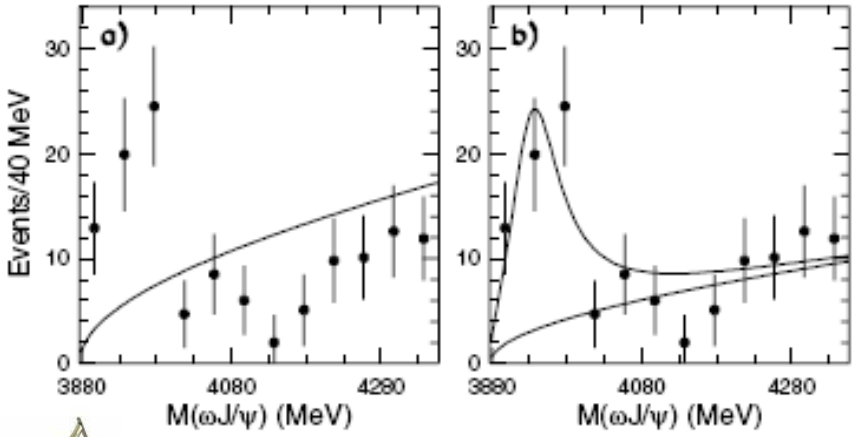


$\chi_{c2}(2P)$, previous Z(3930)

PRL 94 (2005) 182002

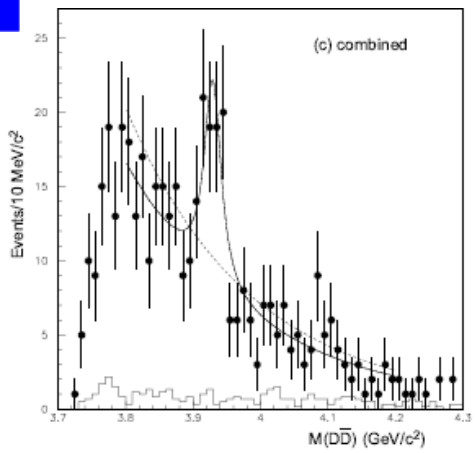
Firstly observed in B → K ω J/ψ

Near ω J/ψ threshold



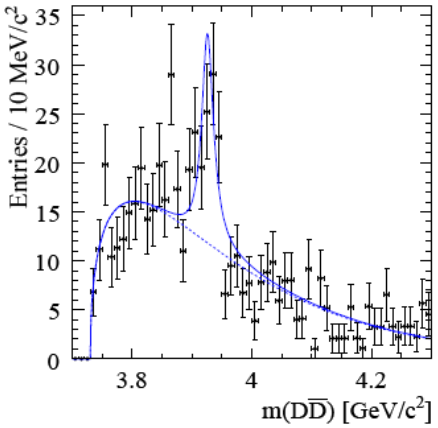
PRL 96 (2006) 082003

γ γ →D D



PRD 81 (2006) 092003

γ γ →D D



BELLE:

M(MeV): 3929 ± 5 ± 2

Γ(MeV): 29 ± 10 ± 2

BABAR:

M(MeV): 3926.7 ± 2.7 ± 1.1

Γ(MeV): 21.3 ± 6.8 ± 3.6

Ave:

M(MeV): 3927.2 ± 2.6

Γ(MeV): 24 ± 6

Charmonium-like states

- X(3872)
- X(3823): the missing $^3D_2$ state?
- 1^{--} states:
  - Y(4008), Y(4260), Y(4360), Y(4630), Y(4660)
  - G(3900)
  - Discovery of $\psi(4040,4160) \rightarrow \eta J/\psi$
- Y(4140): observed in ϕ J/ψ by CDF, not confirmed by BELLE and LHCb.
- Charged Z: not solidly established.

Overview of X(3872)

- **First observed in B→K(J/ψπ⁺π⁻) by Belle in 2003**
  - ***mass is very close to the $D^{*0}D^0$ threshold***
  - ***width is less than exp. resolution***
  - **Confirmed by Babar, CDF and D0**

Production:
- **in $p\bar{p}$ collision**
- **in B decays**

Decay:
- **opep charm ~50%**
- **charmonium ~O(%)**

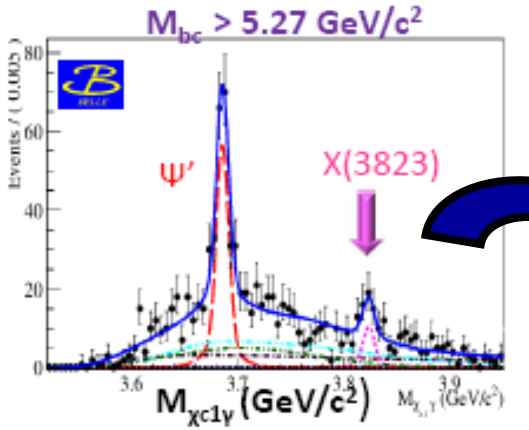
- **Quantum number**
  - **M(ππ) likes look a ρ ; X(3872) →γ J/ψ ➔ C =+1**
  - **ππJ/ψ angular analysis by CDF ➔ 1^{++} or 2^{-+}**

Interpretations: **Still other possibilities**

- **charmonium state:**
  - **1^{++} $\chi_{c1}(2P)$:** ***large BF($\chi_{c1}(2P)$ →J/ψ γ) expected***
  - **2^{-+} $\eta_{c2}(^1D_2)$:** ***large width expected***
- **DD* molecule:** ***hard to explain the large radiative decay rate, ππJ/ψ rate and the production in pp***
- **tetraquark:** ***no partner or charged partner was found***
- **cc-gluon hybrids:** ***mass too low***

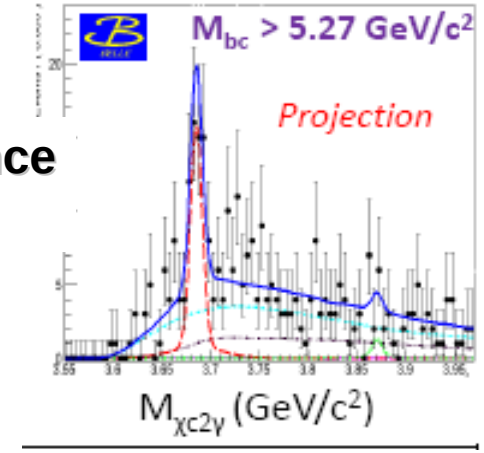
Many good talks.

X(3823): the missing $^3D_2$ state?



What's it?

No strong evidence from $\gamma\ \chi_{c2}$



preliminary $B^{\pm} \to \chi_{c1}\gamma K^{\pm}$

$^3D_2$ mass is quite near and the observed peak has not been seen in $D\bar{D}$ ($^3D_2 \not\to D\bar{D}$ is expected).

Peak at
3823.5±2.8 MeV/c^2

Yield: 4.2σ (syst. Included)
33.2±9.1

Clear evidence of signal at 3823 MeV/c^2

X(3823) seems to be the missing Ψ_2 from the charmonium spectrum .

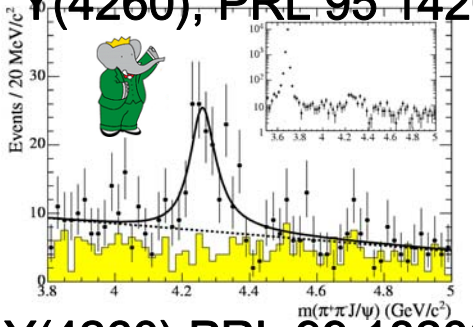
S. Godfrey & N. Isgur, PRD 32, 189 (1985)
E. Eichten et al., PRL 89,162002 (2002), PRD 69, 094019 (2004)

Charm 2012, Belle, Vishal Bhardwaj

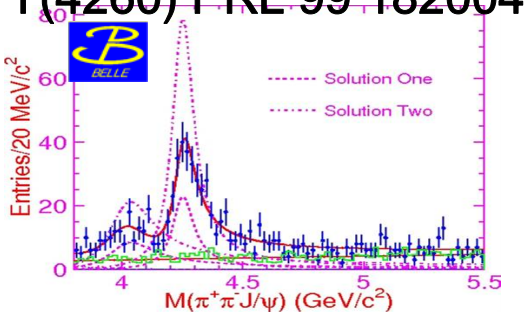
1^{--} states from ISR process

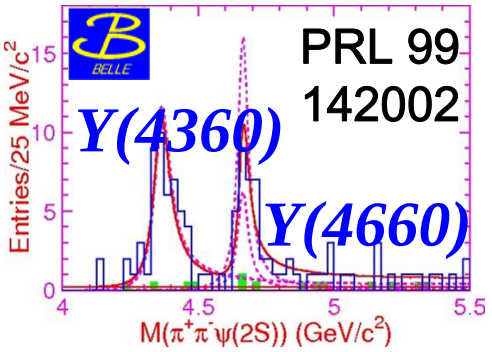
Many Y peaks, large partial width to $\pi\pi J/\psi$ of $\pi\pi\psi'$

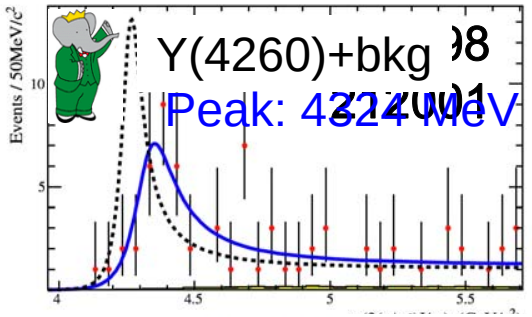
Y(4260), PRL 95 142001

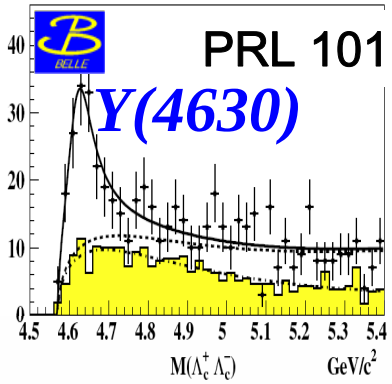


Y(4260) PRL 99 182004

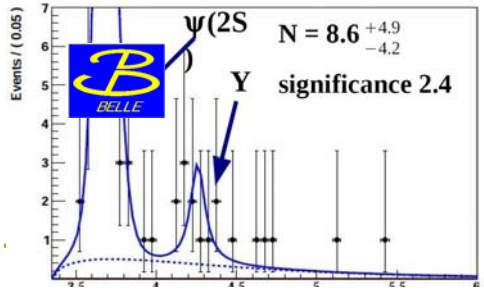




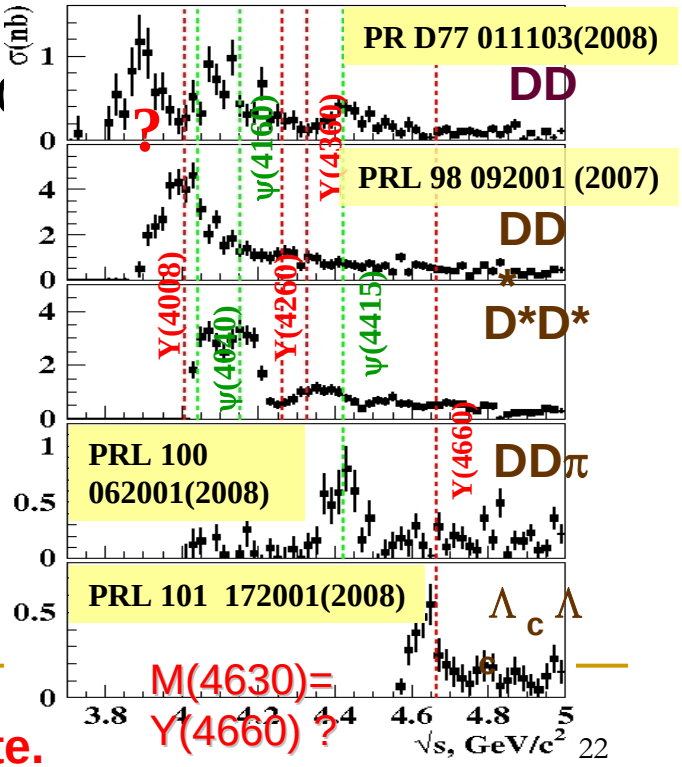




A. Vinokurova EPS 2011,



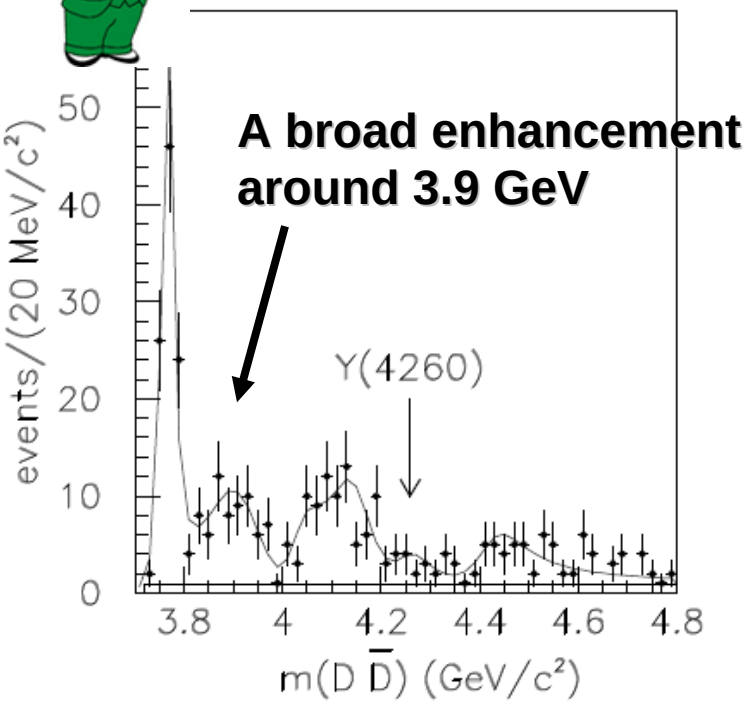
No sign of $Y \rightarrow D^{(*)}D^{(*)}$



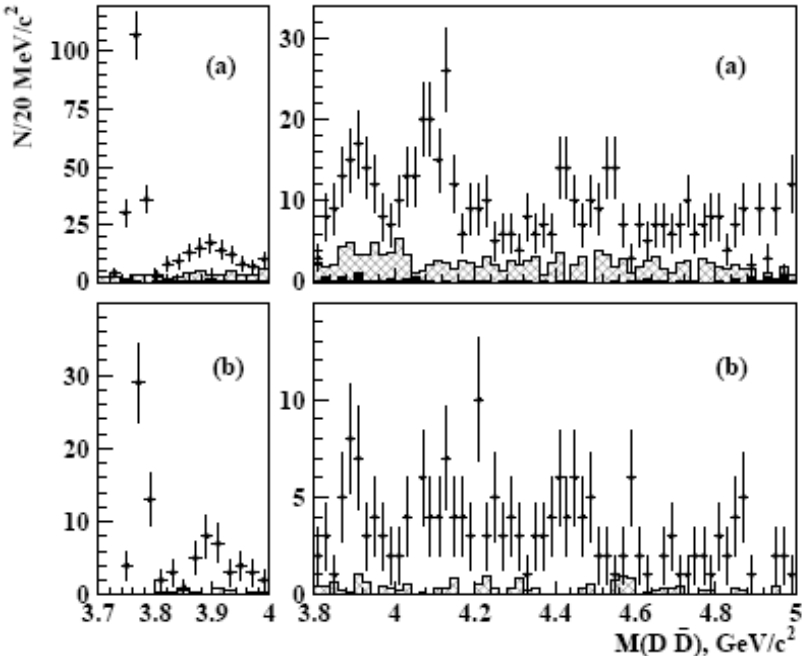
Y states located in where only one ccbar vector state.

G(3900), another 1^{--} state from ISR process

PRD 76 (2007):111105

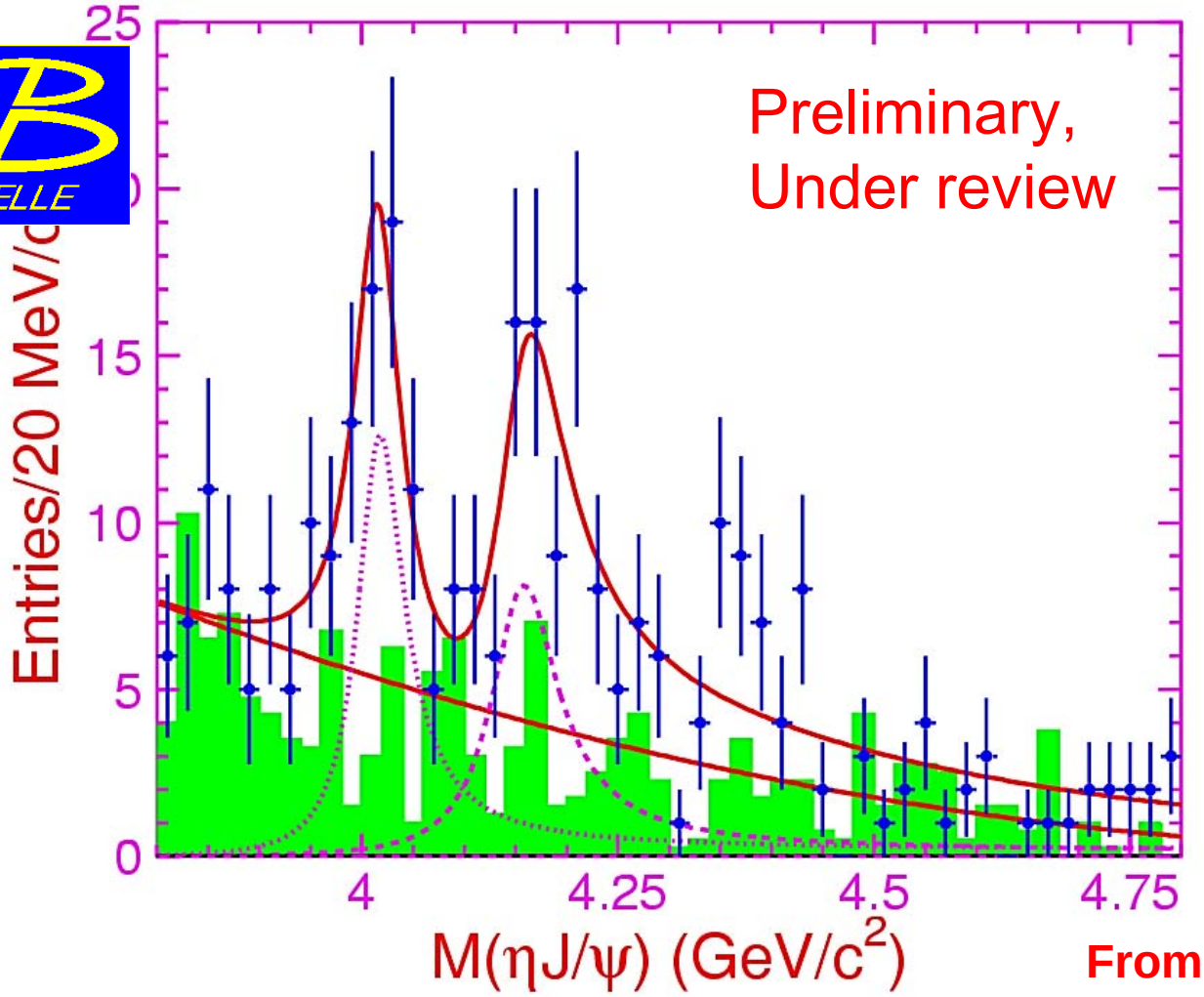


PRD77 (2008):011103



***G*(3900) enhancement is located in a mass region where the quark model does not have a corresponding ccbar vector state.**

Discovery of ψ(4040,4160)→ηJ/ψ

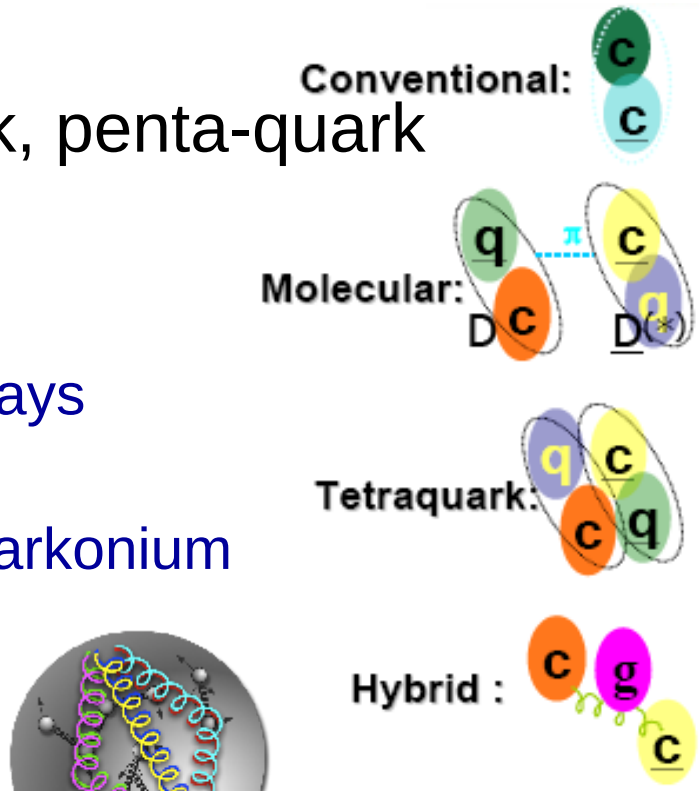


From Z.Q. Liu

~1% level hadronic transition rates are high for charmonium states (Γ~1 MeV). Are they exotic?

Light hadron spectroscopy

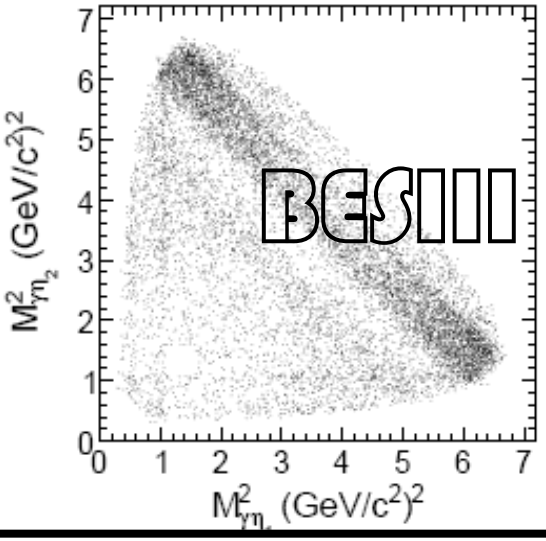
- QCD predicts new forms of hadrons except of mesons and baryons:
  - Multi-quark states: tetra-quark, penta-quark
  - Hybrids: qqg, qqqg …
  - Glueballs: gg, ggg …
    - Flavor-blindness of glueball decays
    - Glueball couplings to $\gamma\gamma$
    - Glueball production in heavy quarkonium radiative decays
    - Chiral suppression
    - Charmonium hadronic decays
    - Other glueball-favored process



Light hadrons in this talk

- Three scalar states $f_0(1500)$, $f_0(1710)$, $f_0(2100)$ and a tensor $f'_2(1525)$ from $J/\psi \rightarrow \gamma\,\eta\,\eta$
- X(1810)
- Confirmed of X(1835) and two new structure
- First observation of $\gamma\,\gamma \rightarrow \omega\,\omega$, $\phi\,\phi$, $\omega\,\phi$

Preliminary PWA results of $J/\psi \to \gamma\eta\eta$ @ BESIII



Resonance	Mass(MeV/c^2)	Width(MeV/c^2)	$\mathcal{B}(J/\psi \to \gamma X \to \gamma\eta\eta)$	Significance
$f_0(1500)$	1468^{+14+20}_{-15-74}	$136^{+41+8}_{-26-100}$	$(1.61^{+0.29+0.41}_{-0.32-1.28}) \times 10^{-5}$	8.2 σ
$f_0(1710)$	1759^{+6+14}_{-6-25}	172^{+10+31}_{-10-15}	$(2.35^{+0.07+1.23}_{-0.07-0.72}) \times 10^{-4}$	25.0 σ
$f_0(2100)$	2081^{+13+23}	273^{+27+65}_{-24-18}	$(9.99^{+0.57+5.52}_{-0.52-2.21}) \times 10^{-5}$	13.9 σ
$f_2(1525)$	1513^{+3}	75^{+12+15}_{-10-9}	$(3.41^{+0.43+1.22}_{-0.50-1.23}) \times 10^{-5}$	11.0 σ
$f_2(1810)$	1822^{+29+61}_{-24-54}	$229^{+52+64}_{-42-152}$	$(5.38^{+0.60+3.31}_{-0.67-2.24}) \times 10^{-5}$	6.4 σ
$f_2(2340)$	$2362^{+31+139}_{-30-59}$	$334^{+62+164}_{-54-99}$	$(5.58^{+0.61+1.93}_{-0.65-1.81}) \times 10^{-5}$	7.6 σ

$f_0(1710)$ and $f_0(2100)$ are dominant scalars

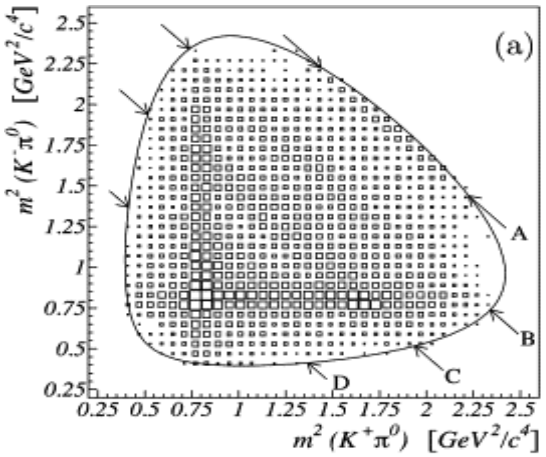
$f_0(1500)$ exists. (8.2σ)

$f'_2(1525)$ is the dominant tensor.

$f_0(1500)$ in $\pi\pi$, 4π, $\eta\eta$, $\eta\eta'$, $K\bar{K}$

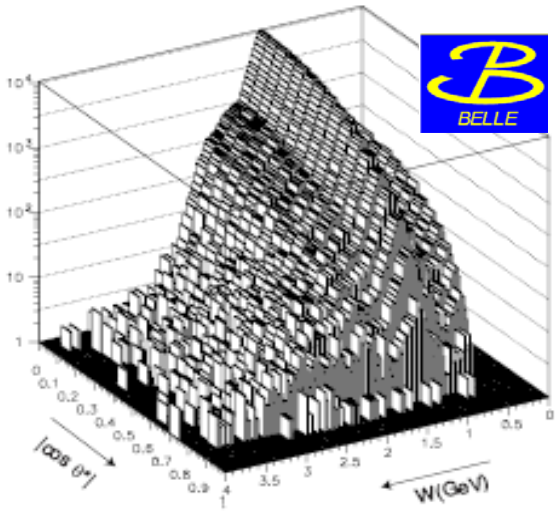
Crystal Ball, PLB 639 (2006) 165-171

$K\bar{K}$ in $p\bar{p} \to K K \pi^0$



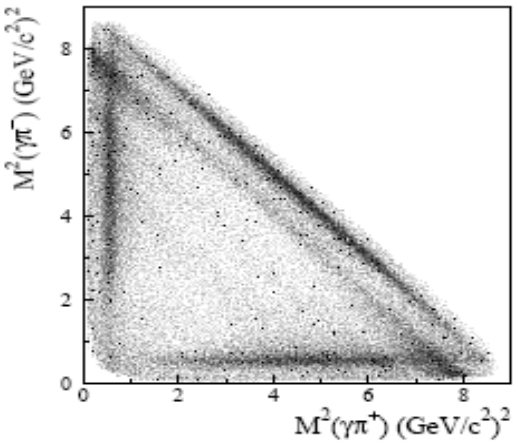
PR D78 (2008) 052004

$\pi^0\pi^0$ in $e^+e^- \to \pi^0\pi^0 e^+ e^-$



BESII PLB642 (2006) 441-448

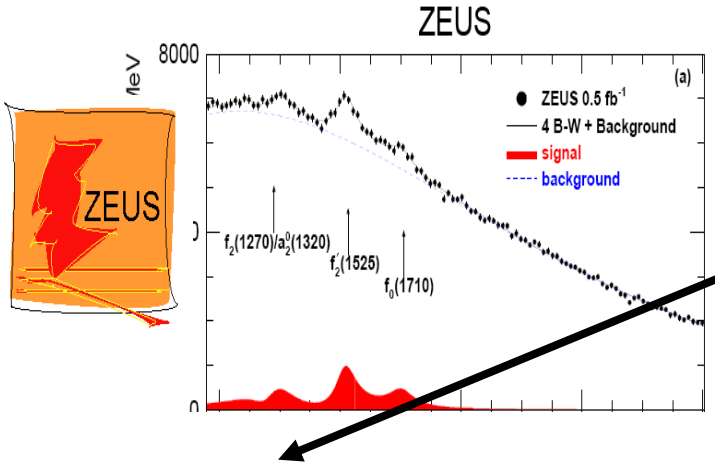
$\pi\pi$ in $J/\psi \to \gamma\gamma\pi\pi$



$f_0(1710)$ in $\pi\pi$, $\omega\omega$, $\eta\eta$,, $K\bar{K}$

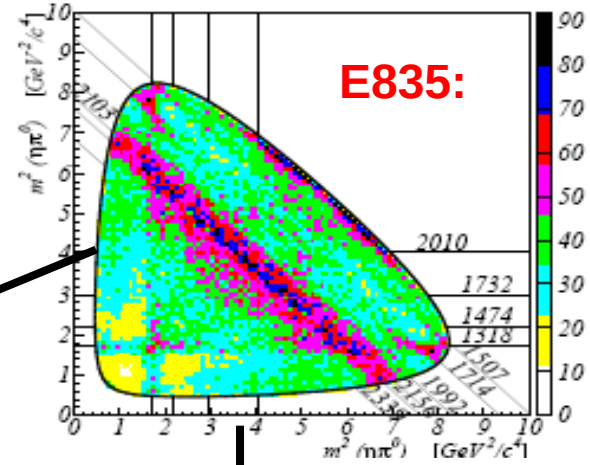
PRL 101 (2008) 112003

$K_S K_S$ in e p collision



PRD73 (2006) 052009

$\eta\eta$ in p $\bar{p} \rightarrow \eta\eta\pi^0$



BESII:

PLB642 (2006) 441

$\pi\pi$ in $J/\psi \rightarrow \gamma\pi\pi$

PRD (2005) 092002

$\pi\pi$, K K in $\chi_{c0} \rightarrow$ 2 K 2 π

PLB603 (2004) 138

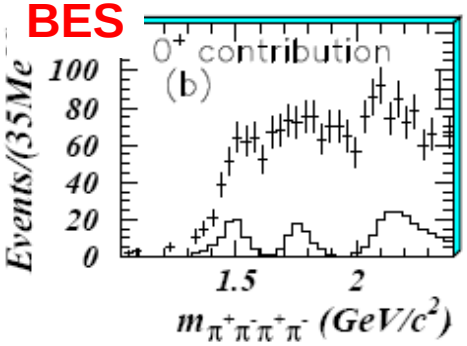
K K in $J/\psi \rightarrow \omega$ K K

$f_0(2100)$ in $\pi\pi$, $\eta\eta$, 4π

PLB472 (2000) 207-214

4π in $J/\psi \rightarrow \gamma\, 4\pi$

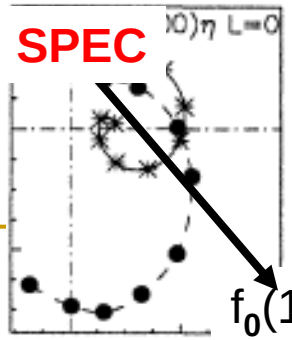
BES



PLB491 (2000) 47-58

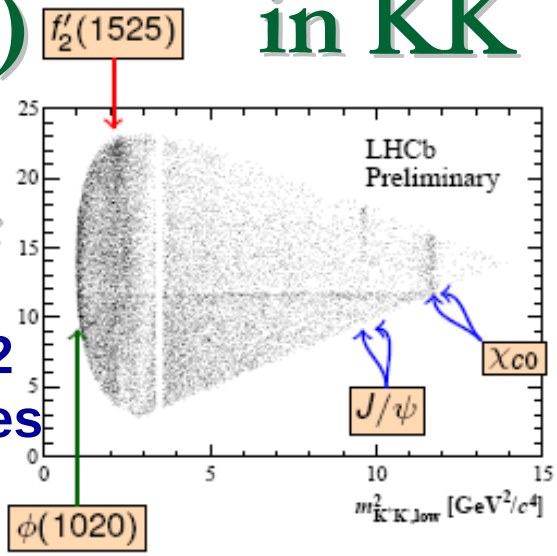
$\eta\eta$ in p $\bar{p}$ collision

SPEC



$f_0(1500)$

$f'_2(1525)$ in KK



ICHEP 2012

F. Rodrigues

B $\rightarrow$ 3K

$m^2_{K^\pm K^\mp\ low} < m^2_{K^\pm K^\mp\ high}$

M(ω ϕ) threshold enhancement in $J/\psi \to \gamma\,\omega\,\phi$

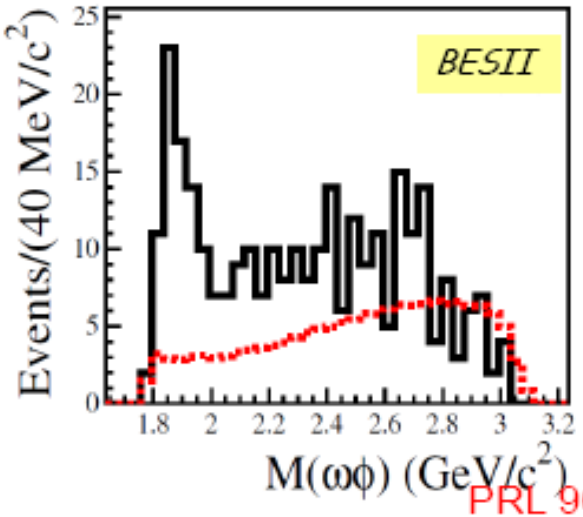
BESII, PRL 96(2006) 162002

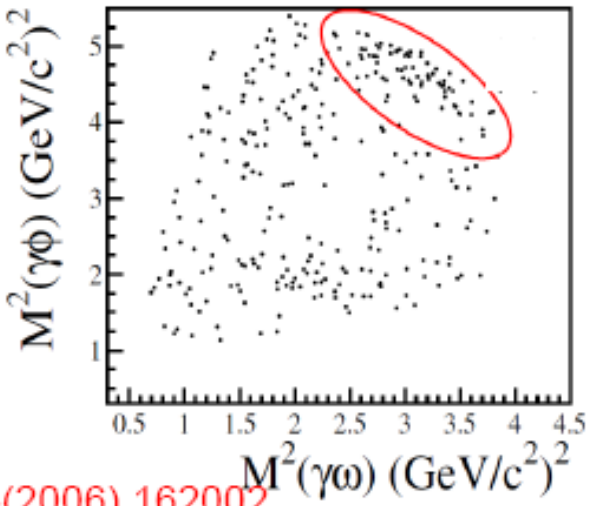
For X(1810):

$$M = 1812^{+19}_{-26} \pm 18\ \mathrm{MeV/c^2}$$

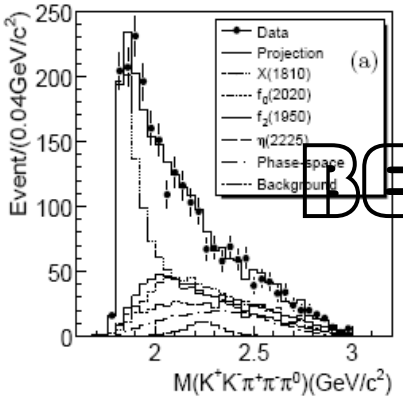
$$\Gamma = 105 \pm 20 \pm 28\ \mathrm{MeV/c^2}$$

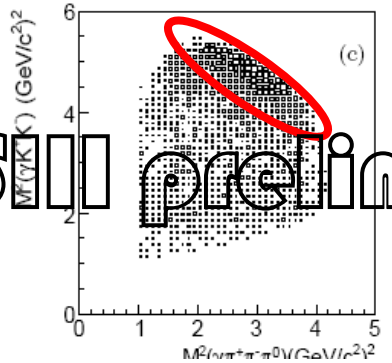
J^{PC} favors 0^{++} over 0^{-+} and 2^{++}





PRL 96(2006) 162002





BESIII preliminary

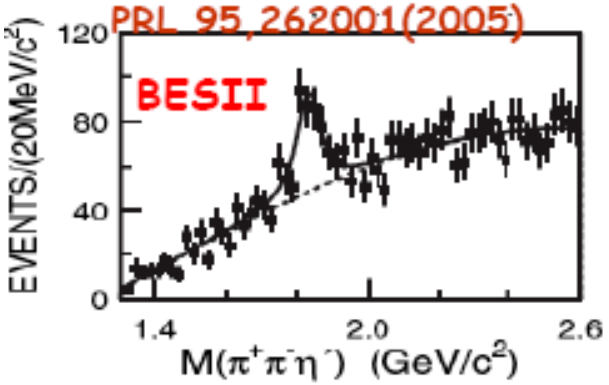
TABLE I: Results from the best PWA fit solution.

Resonance	J^{PC}	M(MeV/c^2)	Γ(MeV/c^2)	Events	$\Delta\mathcal{S}$	Δndf	Significance
$X(1810)$	0^{++}	1795 ± 7	95 ± 10	1319 ± 52	783	4	$> 30\sigma$
[illegible]	2^{++}	1944	472	665 ± 40	211	2	20.4σ
[illegible]	0^{++}	1992	442	715 ± 45	100	2	13.9σ
$\eta(2225)$	0^{-+}	2240	190	70 ± 30	23	2	6.4σ
phase space	0^{-+}	2400	5000	319 ± 24	45	2	9.1σ

$f_0(1710)/f_0(1790)$ or new state ?

Confirmation of X(1835) and two new structures @ BESIII

PRL 95,262001(2005)



$J/\psi \to \gamma\eta'\pi^+\pi^-$
$\eta' \to \eta\pi^+\pi^-$
$\eta' \to \gamma\rho$

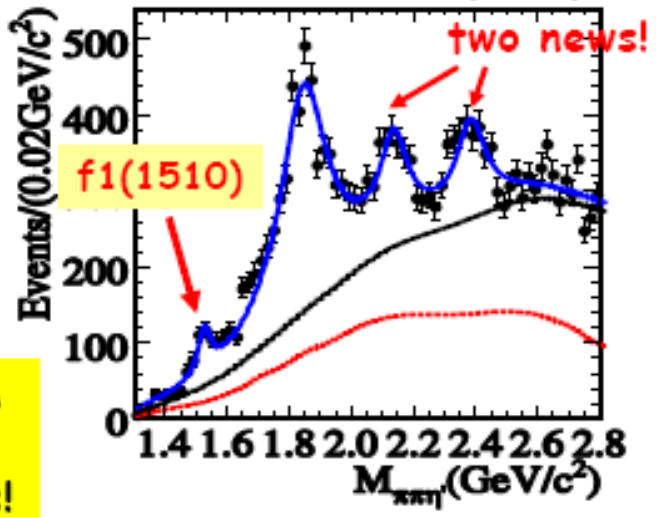
BESII result(Stat. sig. ~ 7.7σ):

$M = 1833.7 \pm 6.1(stat) \pm 2.7(syst) MeV$

$\Gamma = 67.7 \pm 20.3(\text{stat}) \pm 7.7(\text{syst})\text{MeV}$

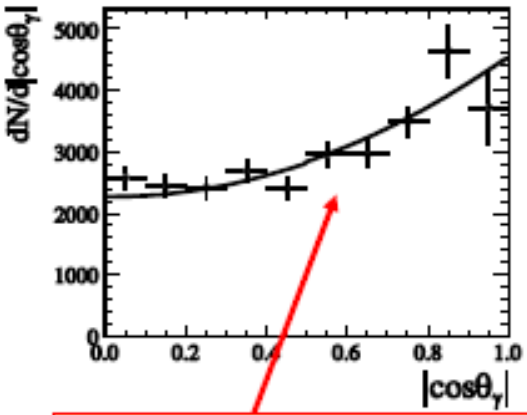
BESIII: 225M J/ψ events, new structures!

PRL 106, 072002(2011)



BESIII fit results:

Resonance	M(MeV/c^2)	Γ(MeV/c^2)	Stat.Sig.
X(1835)	$1836.5 \pm 3.0^{+5.6}_{-2.1}$	$190.1 \pm 9.0^{+38}_{-36}$	>20σ
X(2120)	$2122.4 \pm 6.7^{+4.7}_{-2.7}$	$83 \pm 16^{+31}_{-11}$	7.2σ
X(2370)	$2376.3 \pm 8.7^{+3.2}_{-4.3}$	$83 \pm 17^{+44}_{-6}$	6.4σ



X(1835) consistent with 0^{-+}, but the others are not excluded

An amplitude analysis could help with interpretation for the additional new structures!

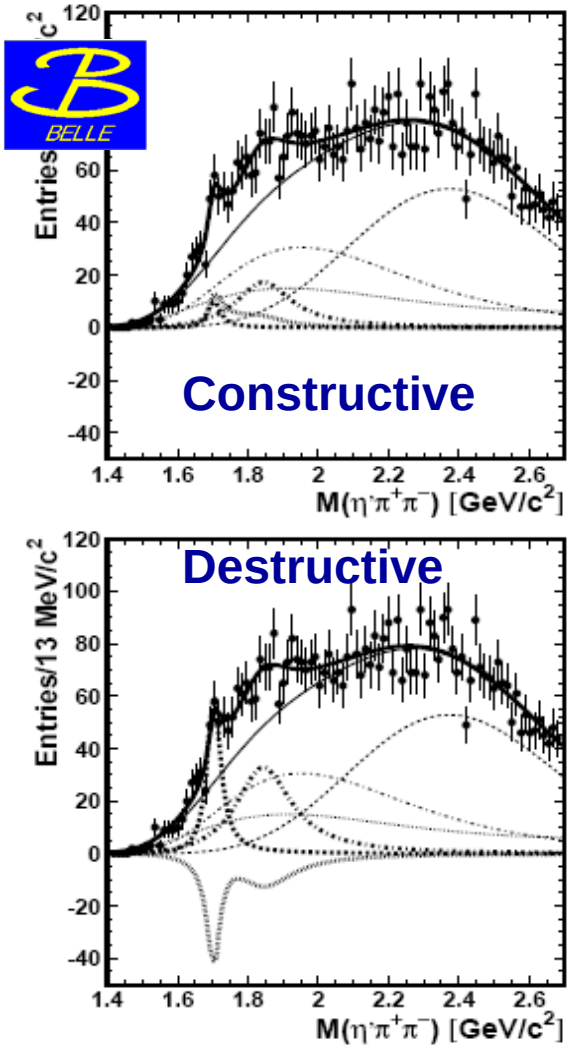
S.S. Fang, CD2012

X(1835) more

Confirmed in $\gamma\gamma$ process

$e^+ e^- \to e^+ e^- \pi\pi\eta'$

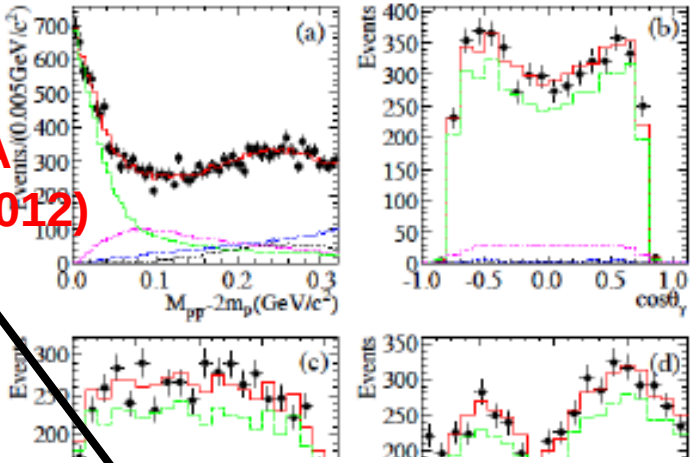
arXiv:1206.5087



Mass is very close to the $p\bar{p}$ enhancement

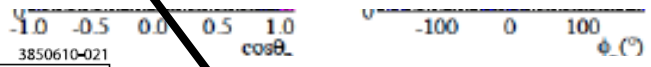
Same state? Very different width?

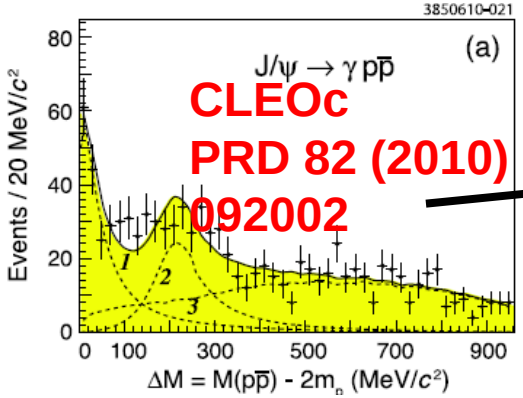
BESIII PWA
PRL 108 (2012) 112003



M = 1832 +19-5(stat)+18-17(sys)+-19(mod)

Γ < 76 MeV @ 90% C.L.





CLEOc
PRD 82 (2010) 092002

$$M(R_{\rm thr}) = 1837^{+10+9}_{-12-7}\ {\rm MeV}/$$

$$\Gamma(R_{\rm thr}) = 0^{+44}_{-0}\ {\rm MeV}/c^2,$$

This enhancement has not been observed in

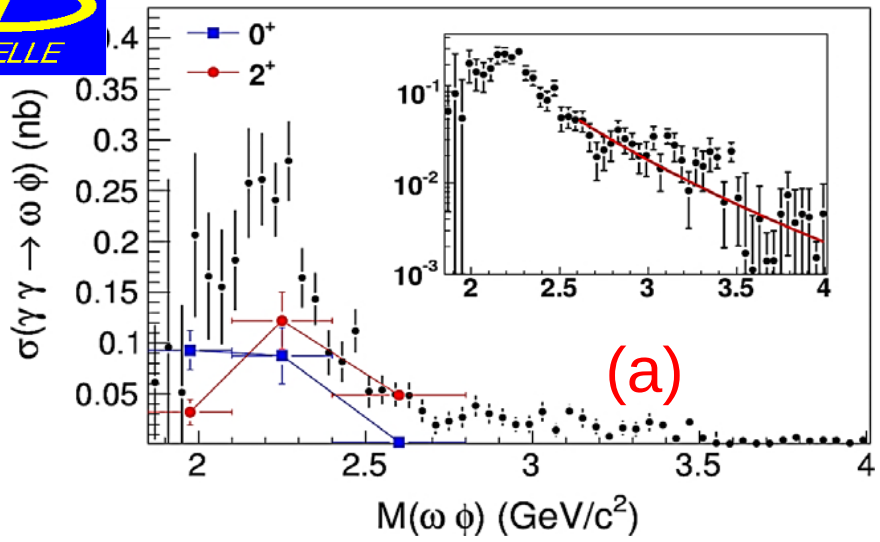
$\psi' \to \gamma p \bar{p}$,
PRL 99 (2007) 011802

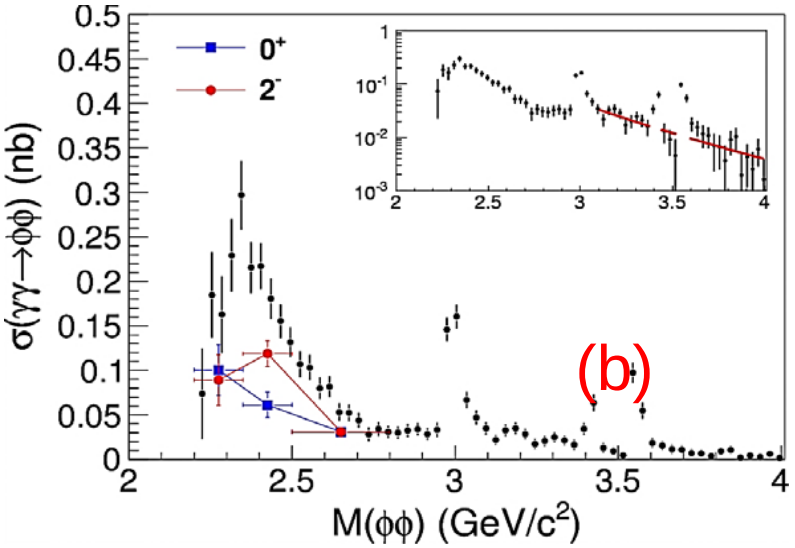
$\Upsilon(1S) \to \gamma p \bar{p}$,
PRD 73 (2006) 032001

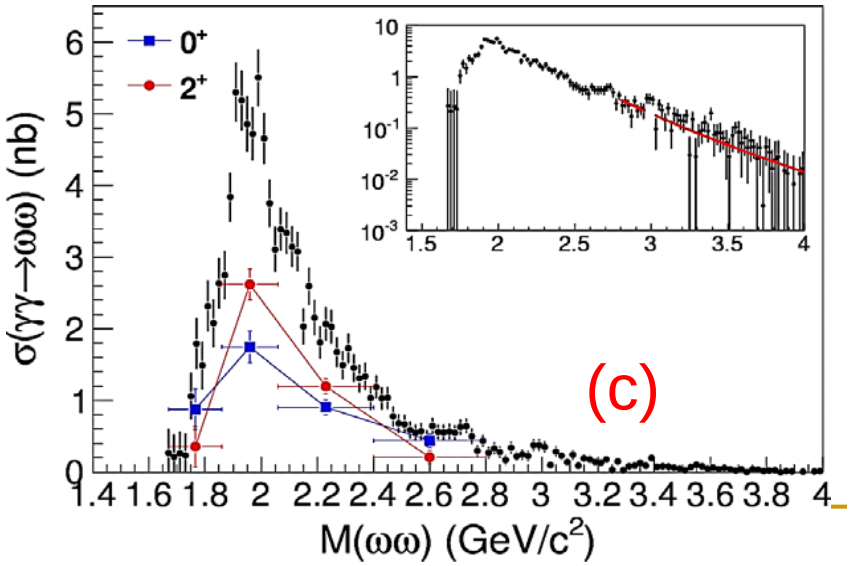
$J/\psi \to \omega p \bar{p}$
EPJC 53 (2008) 15

First observation of $\gamma\gamma \rightarrow \omega\phi, \phi\phi, \omega\omega$

Phys. Rev. Lett.108 (2012) 232001







1. First measurement of σ_{tot} and σ(spin, parity)
2. Main components:
   1. Scalar (continuum QCD)
   2. Tensor (resonance)
3. Large difference to theory
4. Perfect process to study tetra-quark state

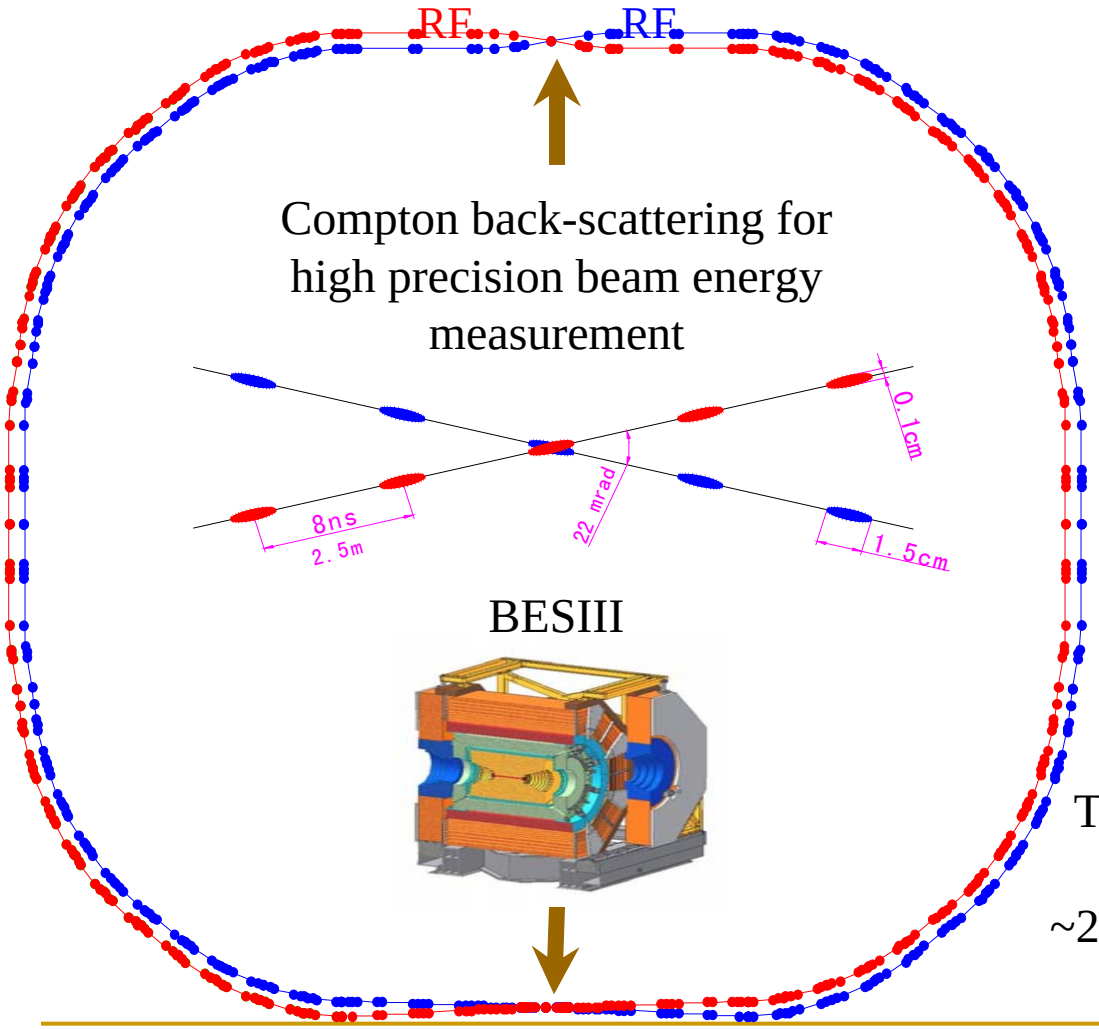
Summary

- Charmonium and light hadron spectrum provide a platform to study non-perturbative mechanism
  - Charm and B-factories: many expected and unexpected discoveries!
  - Precision improvement below open charm threshold
  - Observation of X/Y/Z provide challenge and chance.
  - Many newly found light resonances. Are they really new? What's their nature?
- (Exciting) future
  - Potential model, Lattice QCD, sum rules, novel method
  - Fore-front experimental methods: K-matrix in PWA, machine learning techniques (MVA), etc…
  - BELLEII, PANDA, SUPERB, LHCb UPGRADE, etc …

Thanks!

BACKUP

BEPCII and BESIII



BEPCII: double-ring

Beam energy: 1-2.3 GeV

Design Luminosity:

1×10^{33} cm^{-2}s^{-1}

Optimum energy: 1.89 GeV

Energy spread: 5.16×10^{-4}

No. of bunches: 93

Bunch length: 1.5 cm

Total current: 0.91 A

BESIII detector:

Helium-based drift chamber:

0.5% @ 1GeV/*c*, d*E*/d*x*~6%

TOF: 80 ps (barrel), 110 ps (endcap)

CsI EM calorimeter:

~2.5% (barrel), ~5% (endcaps) @ 1GeV

1T Superconducting magnet

Muon system: 9 layers of RPC

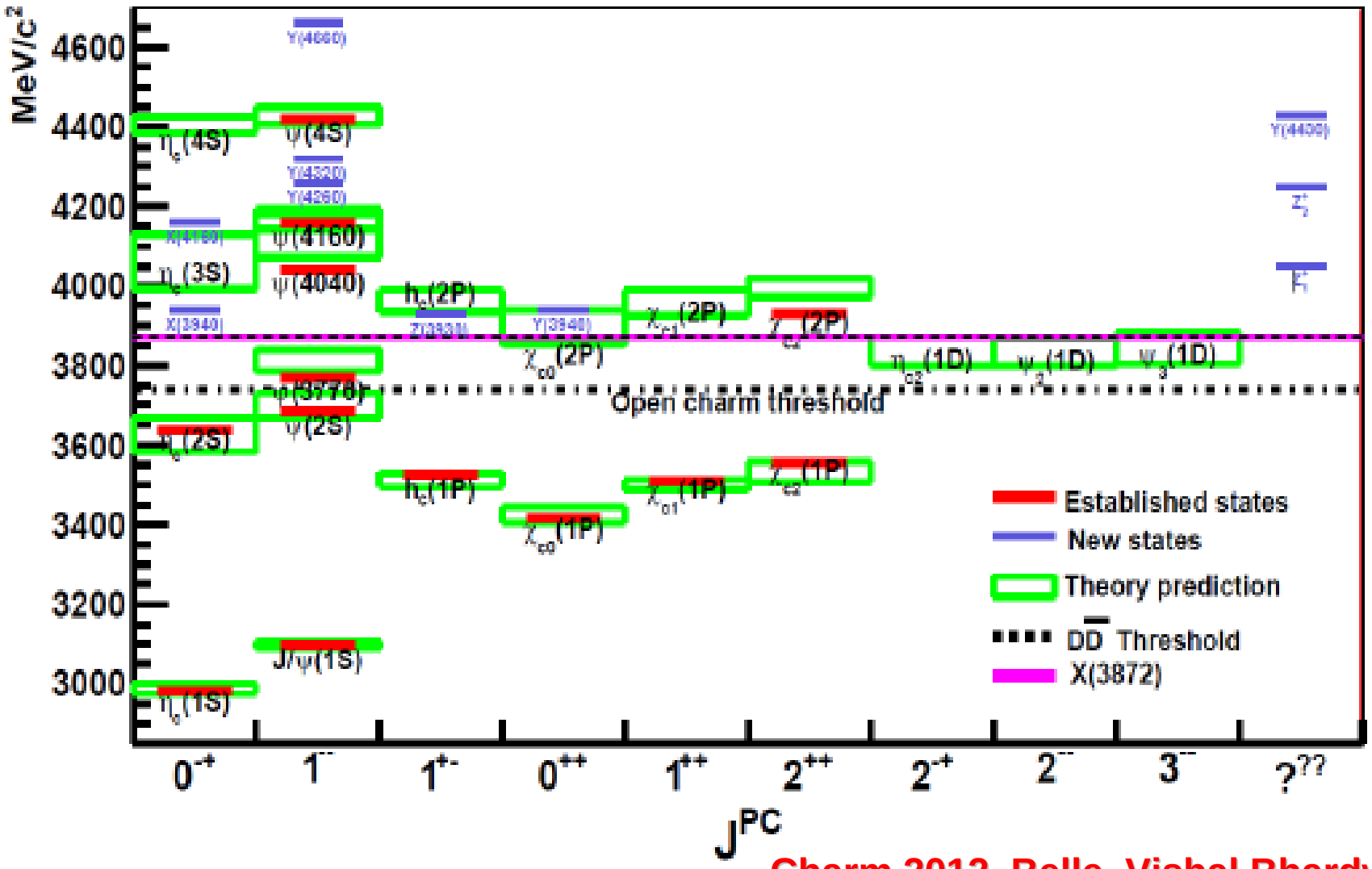
BESIII data samples

- 2009: 106 million ψ'
  225 million J/ψ
- 2010: ~900 pb^{-1} $\psi(3770)$
- 2011: ~1900 pb^{-1} $\psi(3770)$
  470 pb^{-1} @ 4.01 GeV
- 2012: ~0.3 billion ψ'
  ~0.7 billion J/ψ, started from 5th April

First e^+e^- collision event on 19th July, 2008

Peak luminosity have reached 0.65×10^{33} @ 3.770 GeV

Blois2012, BESIII, Y.P. Guo



Charm 2012, Belle, Vishal Bhardwaj