New Resonances

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On behalf of the BaBar collaboration

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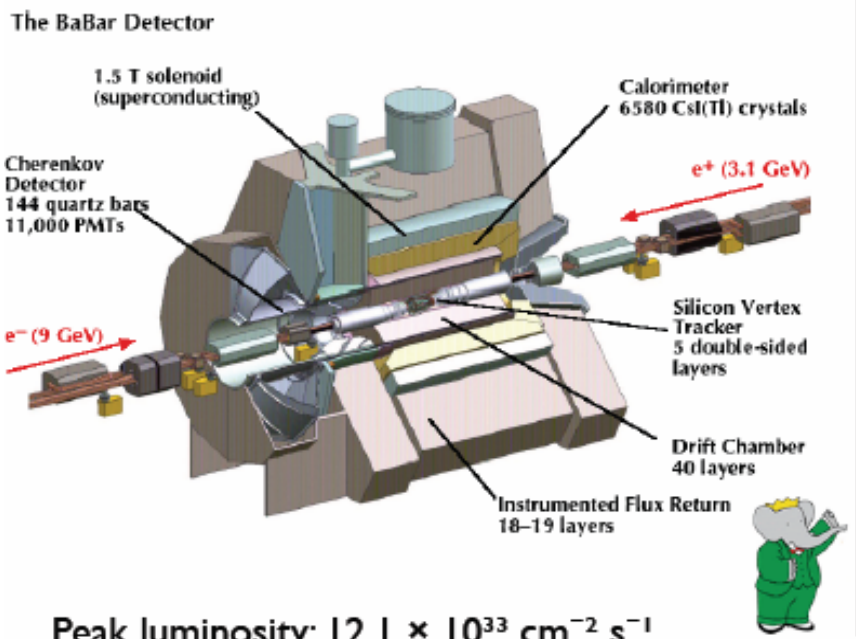
Overview

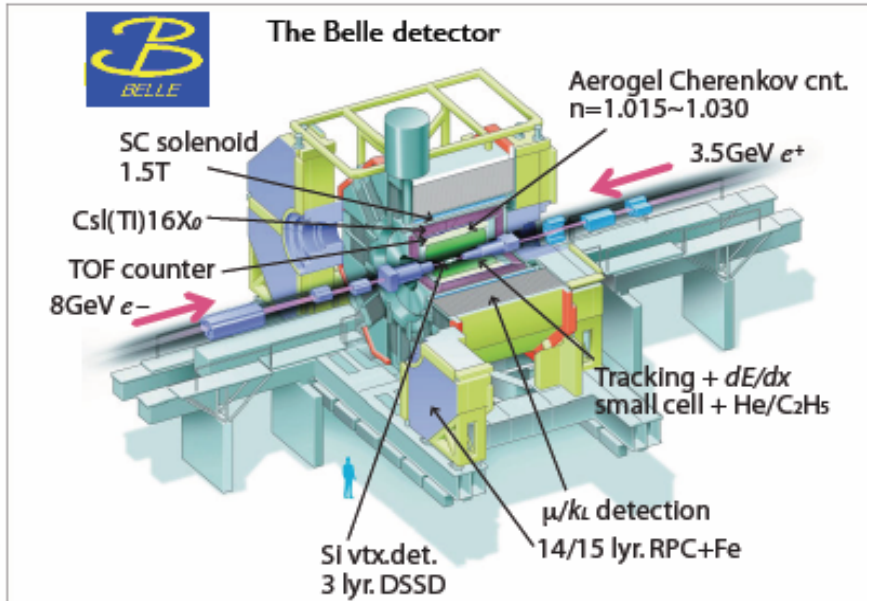
- **Mesons:**
  - $D_{s0}^{*}(2317)$ and $D_{s1}^{*}(2460)$
  - $D_{sJ}^{*}(2860)$ and $X^{*}(2690)$
- **Baryons:**
  - $\Lambda_c(2880)$ and $\Lambda_c(2940)$
  - Ω_c^{*}
  - $\Xi_c(2970)$ and $\Xi_c(3077)$
- **Charmonium like states**
  - X(3872)
  - Y(4260)
  - A new structure observed in ISR $\pi^+\pi^-\psi(2S)$

Many new states, not all appear to be regular states

B-factories



Peak luminosity: 12.1×10^{33} cm^{-2} s^{-1}
Integrated luminosity: 404.6 fb^{-1} (delivered)
Integrated luminosity: 389.2 fb^{-1} (recorded)

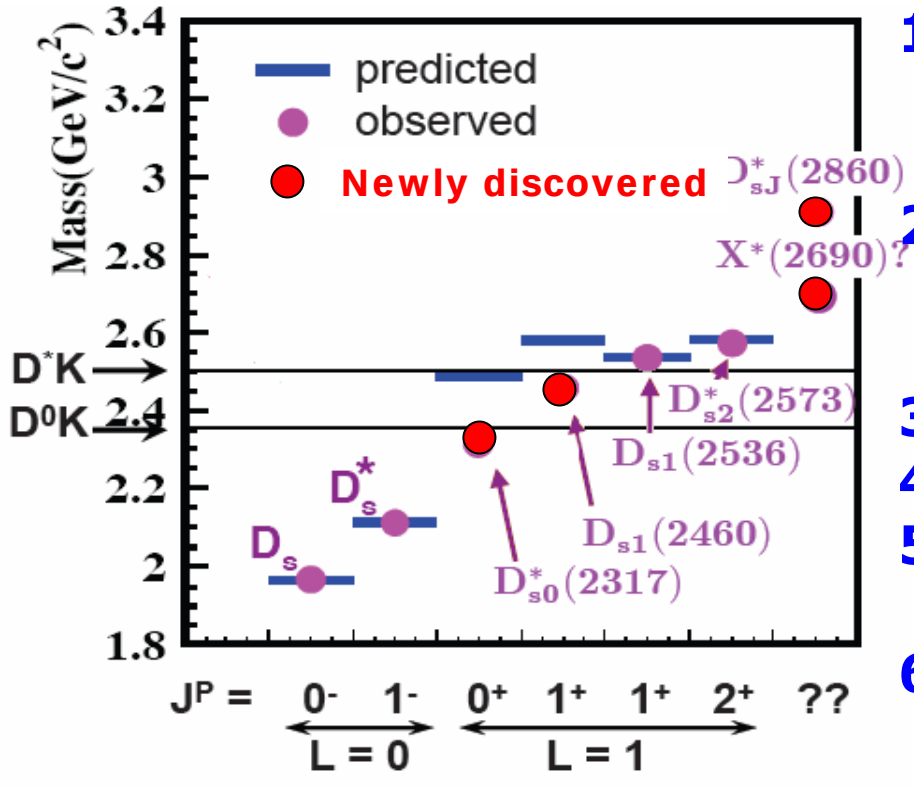


Peak luminosity: 17.1×10^{33} cm^{-2} s^{-1}
Integrated luminosity: 710.3 fb^{-1}

Why charm physics at B-factory: Large cross section 1.3 nb; clean environment, low background and exclusive($b \rightarrow c$) transition.

D_{sJ} states : $c\bar{s}$ Mesons

"*" superscript denotes natural parity $P = (-1)^J$

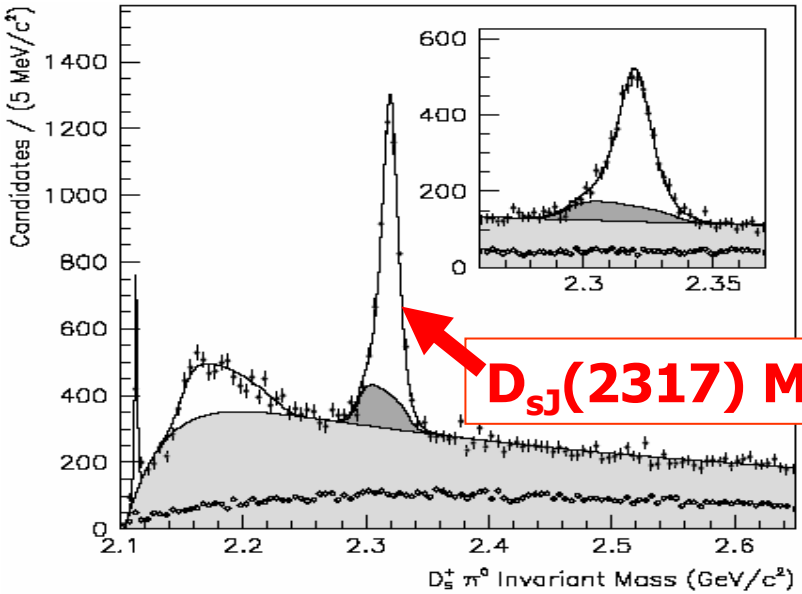


1. 4 states observed before B-factories in agreement with theory prediction.
2. Masses of $D_{s0}^*(2317)$ and $D_{s1}(2460)$ below prediction and $D^{(*)}K$ thresholds.
3. Possible new state: $X^*(2690)$.
4. New state: $D_{sJ}^*(2860)$.
5. Possible interpretation: D_s state, tetra-quarks, molecular states.
6. More detailed understanding is needed.

Update on $D_{sJ}^{*}(2317)$

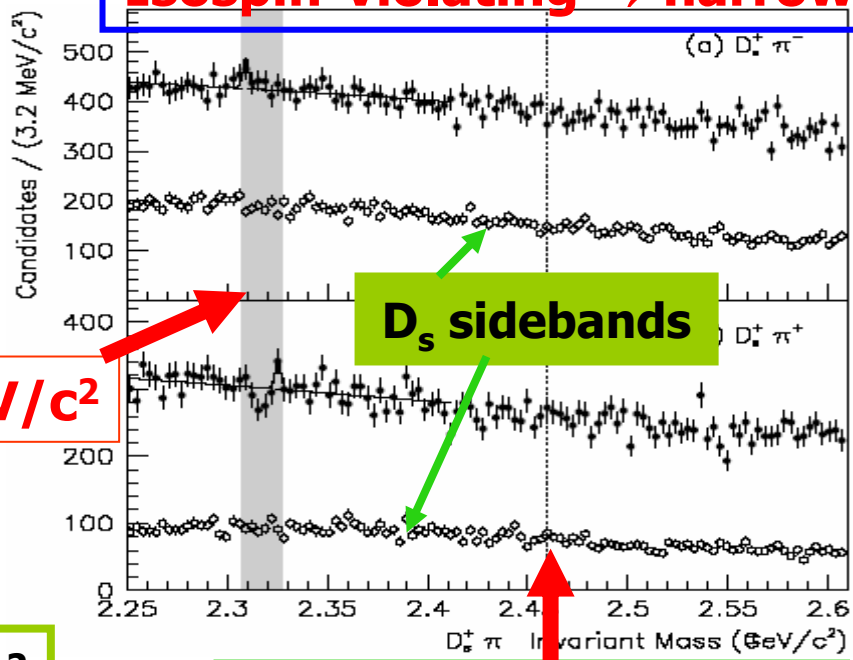
Phys.Rev. D74:032007(2006)

First observed by BaBar, confirmed by Belle, CLEO.



$D_{sJ}(2317)$ MeV/c²

No indication of isopartners.
Isospin-violating → narrow



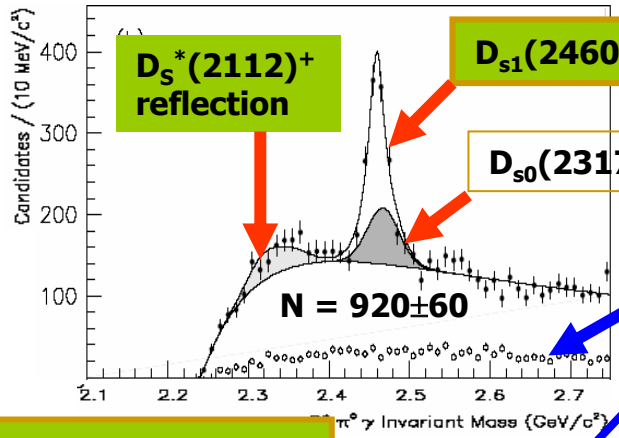
D_s sidebands

M = (2319.6±0.2±1.4) MeV/c²
Γ < 3.8 MeV/c² @ 90% CL

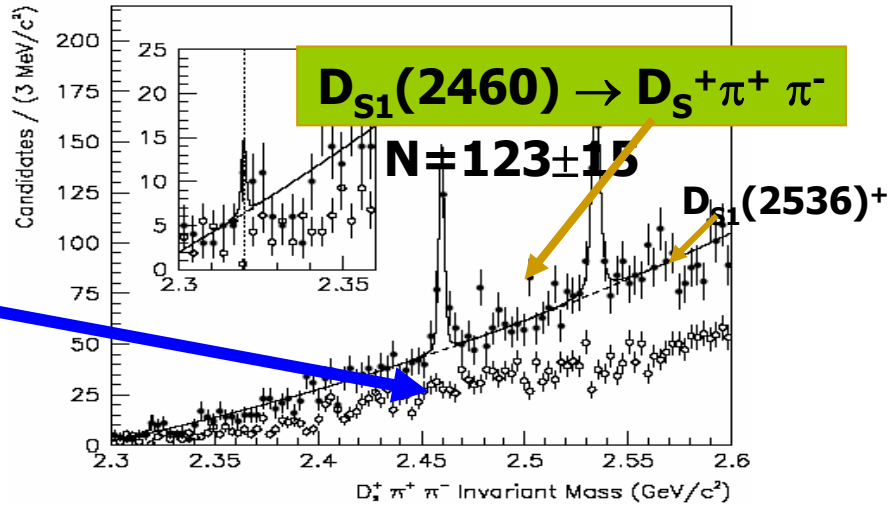
$D_s(2460)$ decay to $D_s\pi$
Forbidden (Parity)

Update on $D_{s1}(2460)$

Phys.Rev. D74:032007(2006)



Background-subtracted



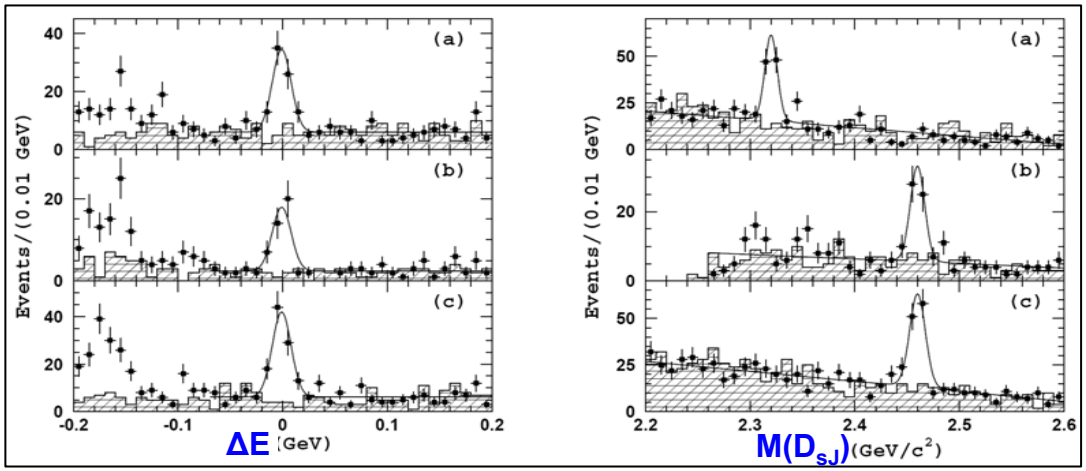
$M(D_{S1}(2460)^+) = (2460.1 \pm 0.2 \pm 0.8)$ MeV/c²

$$\frac{\mathcal{B}(D_{sJ}(2460)^+ \to D_s^+\gamma)}{\mathcal{B}(D_{sJ}(2460)^+ \to D_s^+\pi^0\gamma)} = 0.337 \pm 0.036 \pm 0.038$$

$$\frac{\mathcal{B}(D_{sJ}(2460)^+ \to D_s^+\pi^+\pi^-)}{\mathcal{B}(D_{sJ}(2460)^+ \to D_s^+\pi^0\gamma)} = 0.077 \pm 0.013 \pm 0.008$$

Need to investigate isopartners of $D_{s1}(2460)$ [$D_s^+\pi^+\pi^0$, $D_s^+\pi^-\pi^0$]

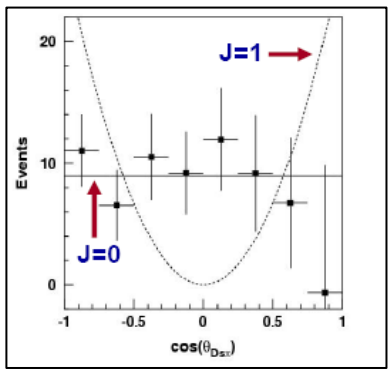
J^P for $D_{sJ}^*(2317)$ and $D_{sJ}^*(2460)$



$D_{sJ}(2317) \rightarrow D_s\pi^0$

$D_{sJ}(2460) \rightarrow D_s^*\pi^0$

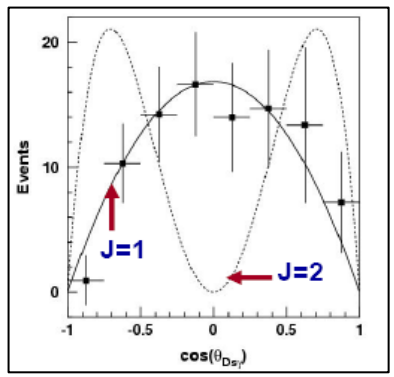
$D_{sJ}(2460) \rightarrow D_s\gamma$



$D_{sJ}(2317) \rightarrow D_s\pi^0$

J = 0: χ^2/d.o.f = 3/8
J = 1: χ^2/d.o.f = 38/8

$J^P = 0^+$



$D_{sJ}(2460) \rightarrow D_s\gamma$

J = 1: χ^2/d.o.f = 4/8
J = 2: χ^2/d.o.f = 89/8

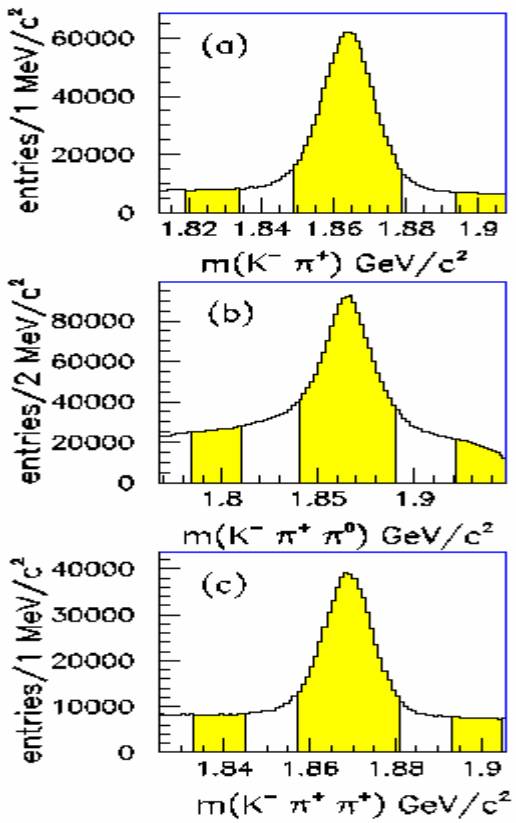
$J^P = 1$

Belle-Conf-0461-2004

New state: $D_{sJ}^*(2860)$

BaBar 240 fb^{-1}
PRL 97:222001 (2006)

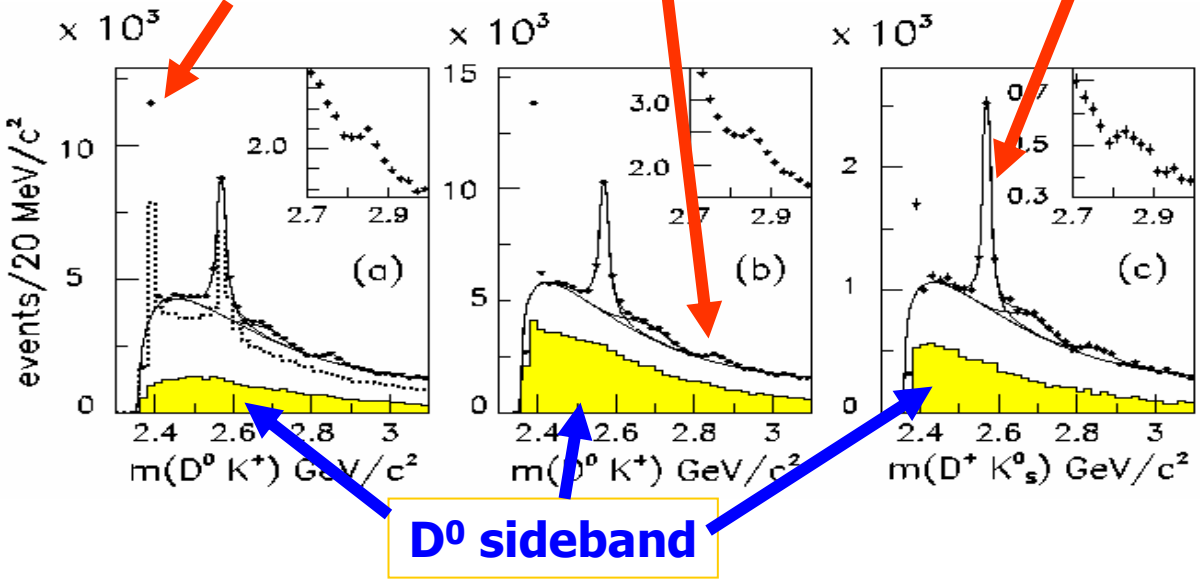
D^0 reconstruction



$D_{s1}(2536)^+ \to D^{*0}K^+$
$D^{*0} \to D^0\gamma$, $D^0\ \pi^0$

$D_{sJ}^*(2860)$

$D_{s2}(2573)^+$

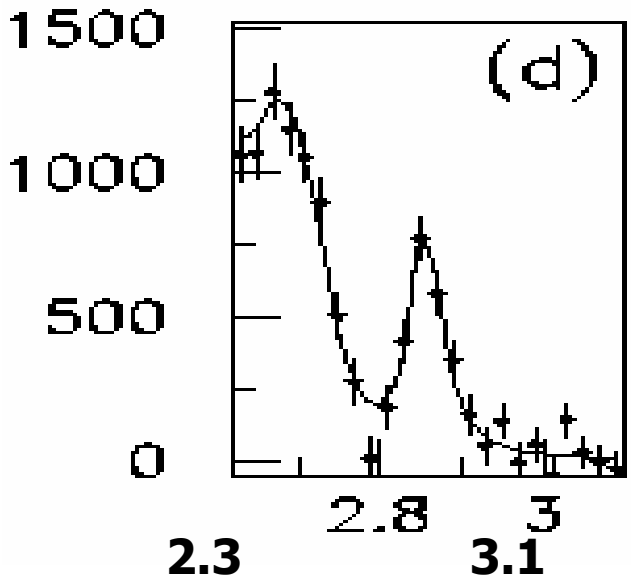


D^0 sideband

Inclusive search: $e^+e^- \to D^0\ K^+ / D^+K_S\ X$
Center-of-mass momentum:
$P^*(DK) > 3.5$ GeV/c to improve signal/background

New state: $D_{sJ}^{*}(2860)$

BaBar 240 fb-1
PRL 97:222001 (2006)



Combined 3 modes
Background subtracted

$M = 2856.6 \pm 1.5 \pm 5.0$ MeV/c^2
$\Gamma = 48 \pm 7 \pm 10$ MeV

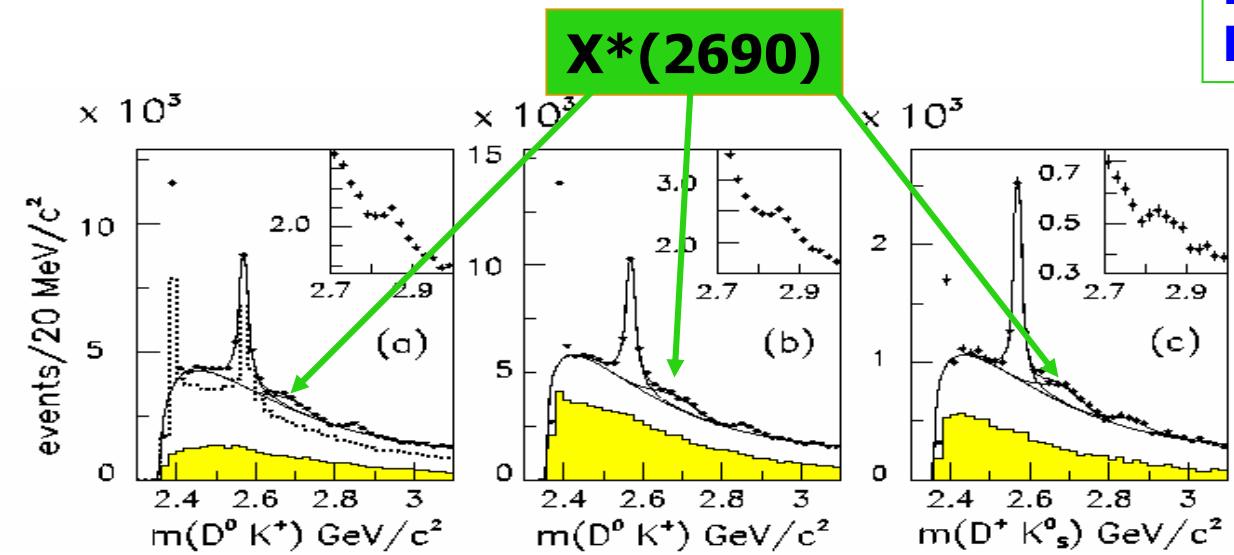
Seen in DK $\rightarrow$ indicates natural-spin parity

Many theoretical speculations…

Radial Excitation of $D_{s0}^{*}(2317)$? $J^P = 3^{-?}$
E.Van Beveren and G. Rupp, hep-ph/0606110
P. Colangelo *et al.*, hep-ph/0607245
F.E. close *et al.*, hep-ph/0608139

Possible Structure at $X^*(2690)$

BABAR,240 fb^{-1}
PRL 97:222001(2006)



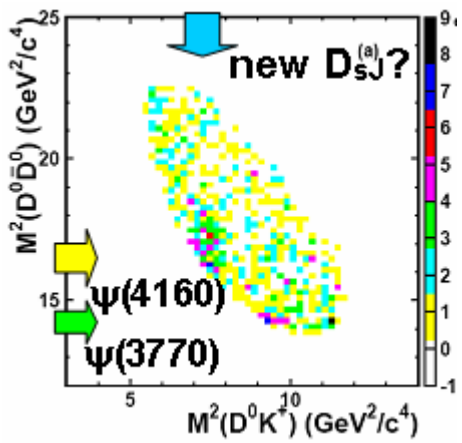
Mass (MeV/c^2) = 2688 ± 4 ± 3

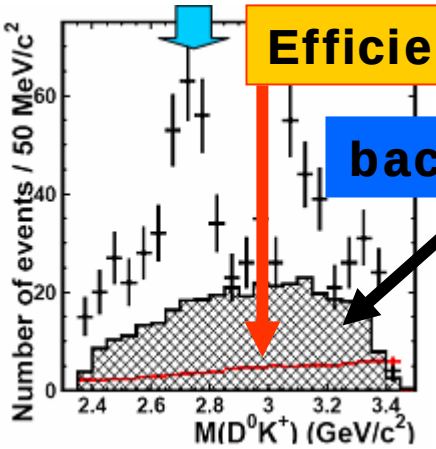
Width (MeV) = 112 ± 7 ± 36

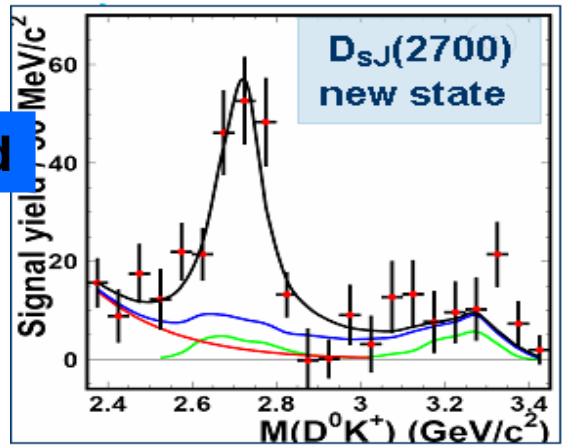
Is it a new particle ?
Need confirmation from other experiment!
need to study the properties with more data

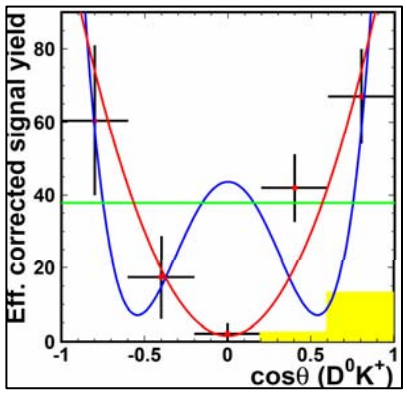
$D_{sJ}^*(2700)$ in $B^+ \to D^0 \bar{D}^0 K^+$

Hep-ex/0608031









ψ(4160) reflection

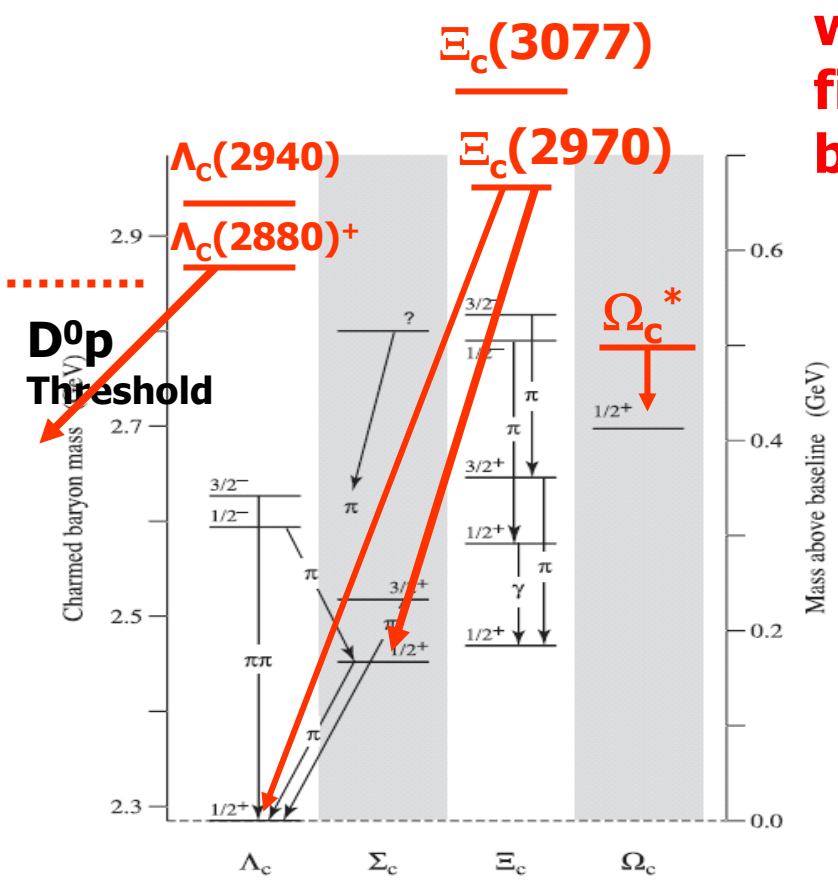
J=0 χ^2/ndf = **185/5**
J=1 χ^2/ndf = **7/5**
J=2 χ^2/ndf = **250/5**

$J^P = 1^-$

Yield = 182±30
Mass (MeV/c²)::
2715±11+11-14
Width (MeV/c²)::
115±20+36-32

$D_{sJ}^*(2700)$ helicity angle distribution (efficiency corrected)

Charm Baryons



1. $\Lambda_c(2940)$ is a new state seen along with $\Lambda_c(2880)$ decaying to D^0p; first observation of charm baryon → charm meson transitions

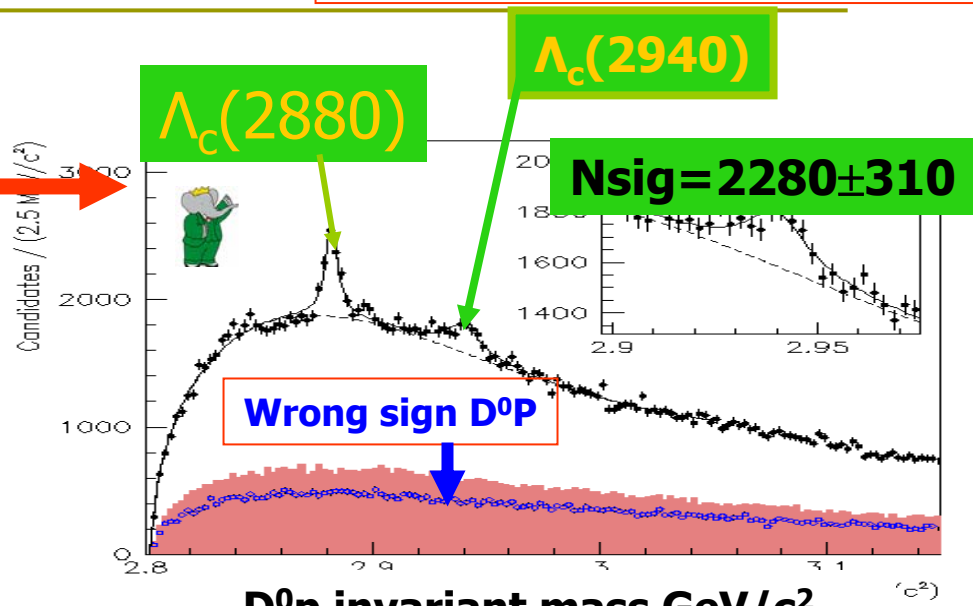
2. Ω_c^* is a newly discovered state that corresponds to the last theoretically predicted charm baryon ground state (L = 0)

3. Two new excited Ξ_c states are observed

Observation of $\Lambda_c(2880)^+$ and $\Lambda_c(2940)^+$ decaying to D^0p

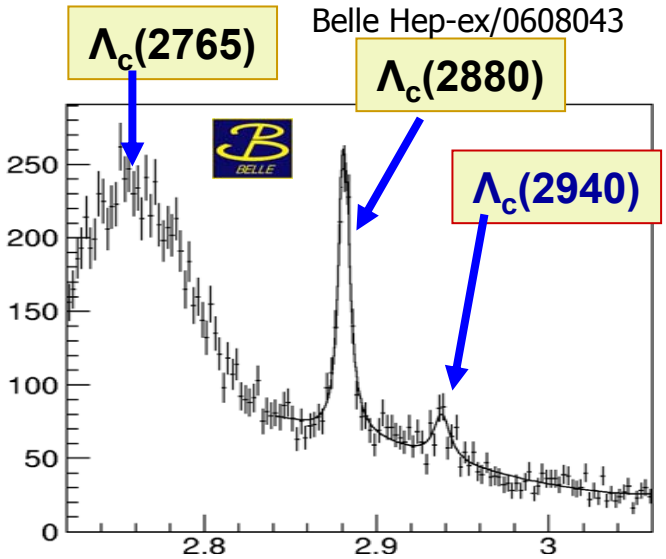
BaBar PRL 98:012001(2007)

New Decay mode: $\Lambda_c(2880)^+ \rightarrow D^0p$ First observation of charm baryon → charm meson



D^0p invariant mass GeV/c^2

Belle confirms in $\Sigma_c\,\pi$



$M(\Lambda_c\,\pi^+\,\pi^-)$ GeV/c^2

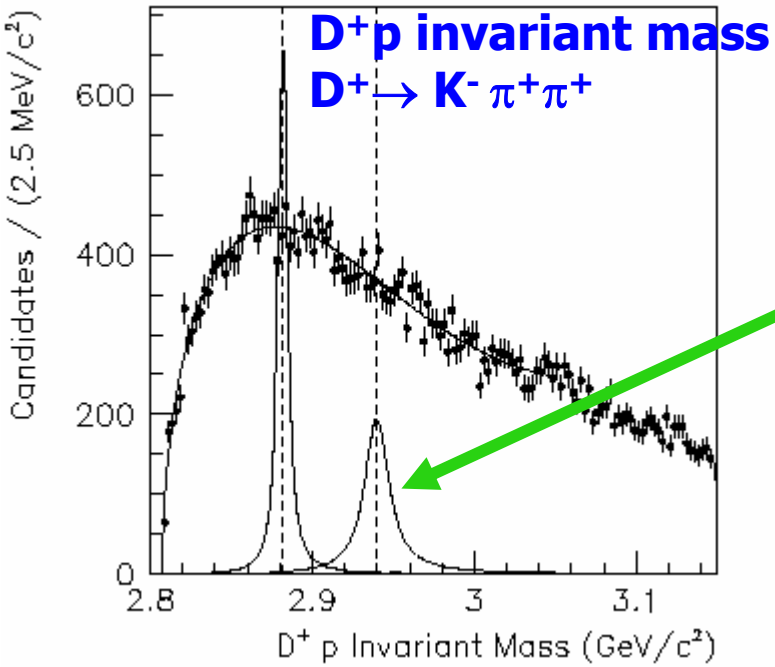
Resonance	Yield	M[MeV/c^2]	Γ[MeV]
$\Lambda_c(2880)$	2800±190	2881.9±01.±0.5	5.8±1.5±1.1
$\Lambda_c(2940)$	2280±310	2939.8±1.3±1.0	17.5±5.2±5.9
$\Lambda_c(2880)$	$880\pm50\pm40$	$2881.2\pm0.2^{+0.4}_{-0.3}$	$5.5^{+0.7}_{-0.3}\pm0.4$
$\Lambda_c(2940)$	$210^{+70+100}_{-40-60}$	$2937.9\pm1.0^{+1.8}_{-0.4}$	$10\pm4\pm5$

Excellent agreement in mass and width

Observation of $\Lambda_c(2880)^+$ and $\Lambda_c(2940)^+$ decaying to D^0p

- Are these states Λ_c or Σ_c ?

PRL 98:012001(2007)



No signals => both $\Lambda_c(2880)$ and $\Lambda_c(2940)$ states are Λ_c's, not Σ_c's

Signals provided same rate and efficiency as D^0p mode

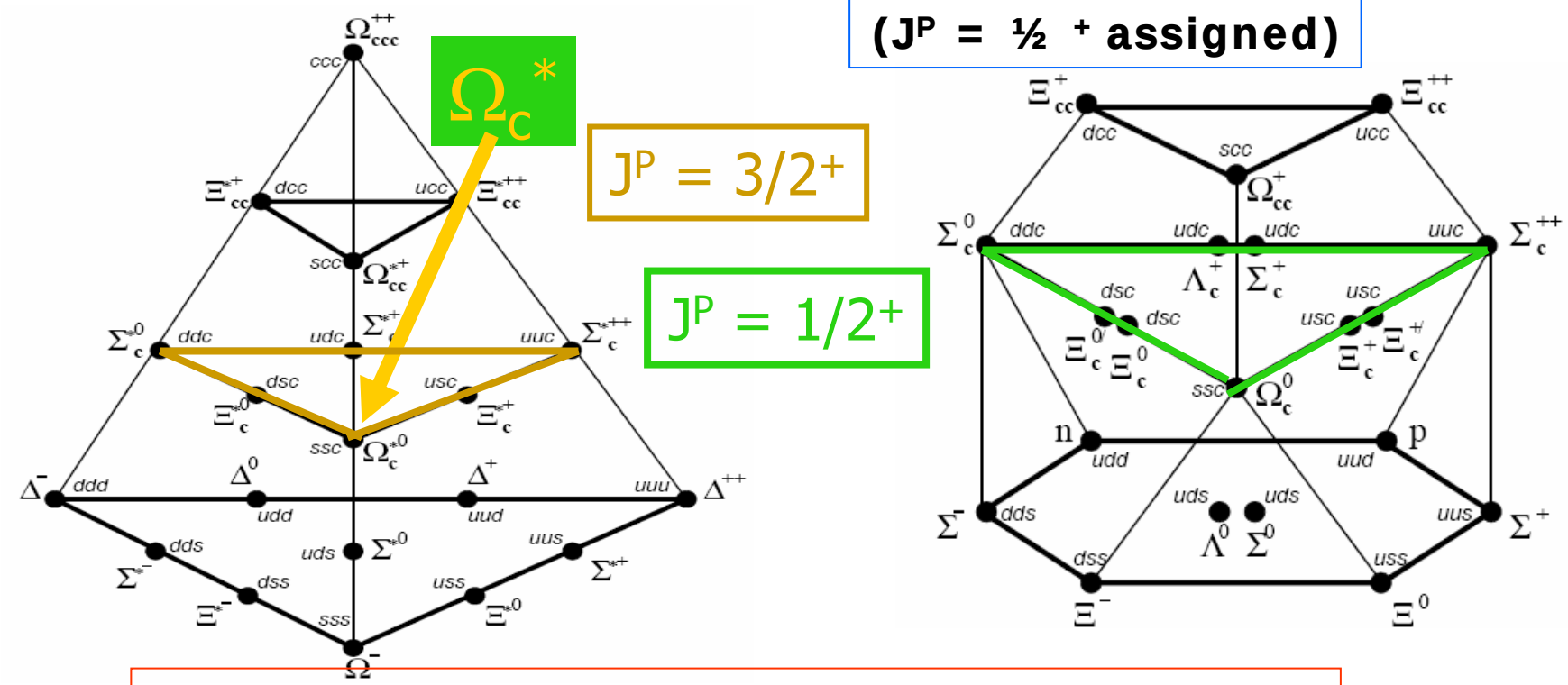
Three different J^p Λ_c states predicted at masses ~2940 MeV/c^2.

(Sascha Migura *et al,*. Eur.Phys.J. A28 (2006) 41)

Discovery of the Ω_c^*

All 9 charm baryon ground states are observed

($J^P = ½^+$ assigned)



5 out of 6 charm baryon excited states are observed; Ω_c^* was missing

Discovery of the Ω_c^*

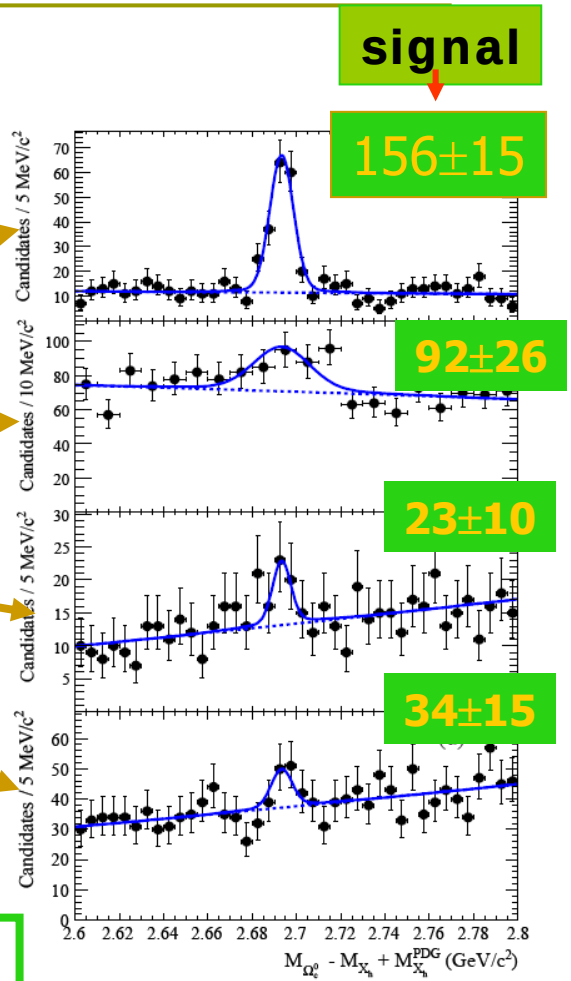
BaBar 231 fb^{-1} PRL 97:232001(2006)

Ω_c^0 is reconstructed in four decay modes using 231 fb^{-1} data

- $\Omega_c^0 \to \Omega^-\pi^+,\ \Omega^- \to \Lambda K^-$
- $\Omega_c^0 \to \Omega^-\pi^+\pi^0,\ \Omega^- \to \Lambda K^-$
- $\Omega_c^0 \to \Omega^-\pi^+\pi^-\pi^+,\ \Omega^- \to \Lambda K^-$
- $\Omega_c^0 \to \Xi^- K^-\pi^+\pi^+,\ \Xi^- \to \Lambda\pi^-$

Scaled momentum x_p for Ω_c^0 is required to be above 0.5 to reduce combinatoric background

M(Ω_c^0) of ±2.5σ used for Ω_c^* search



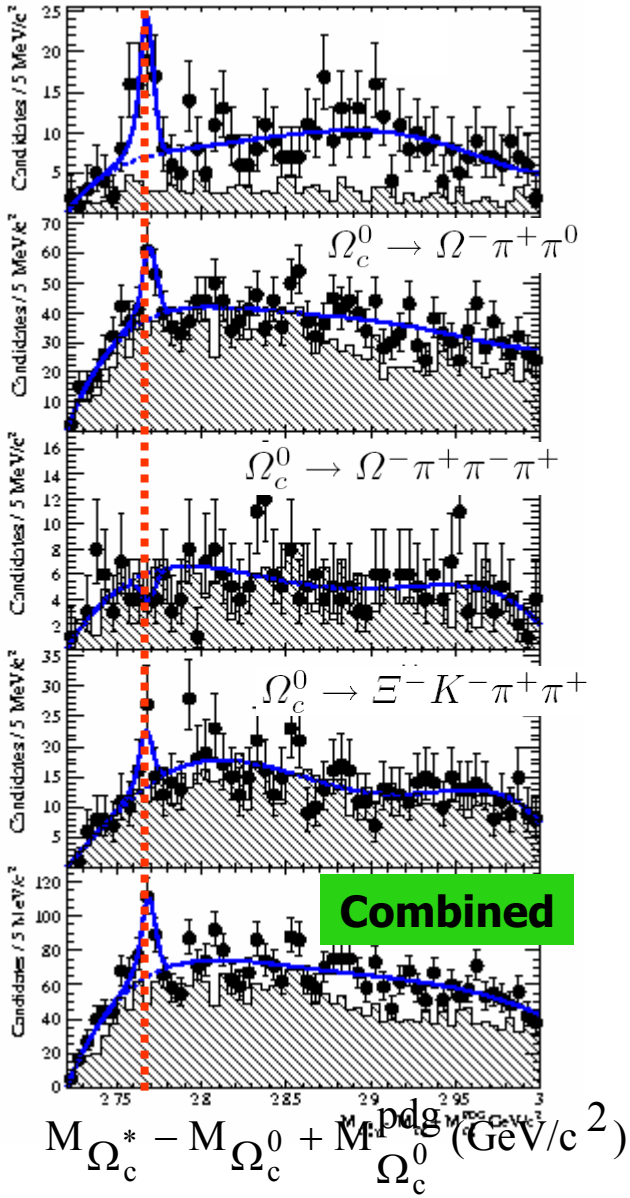
PRL 231 fb^{-1}
97:232001(2006)

Discovery of the Ω_c*

$$\Omega_c^* \rightarrow \Omega_c^0 \gamma \;\; (\Omega_c^0 \rightarrow \Omega^- \pi^+)$$

is most significant channel at 4.2σ

No signal found in the Ω_c^0 mass Sidebands (hatched area)



Measurements

Mass difference with Ω_c^0, yields and Significances measured in each decay.

Cross sections are compared for $X_p > 0.5$

$$R = \frac{\sigma(e^+e^- \rightarrow \Omega_c^* X, x_p(\Omega_c^*) > 0.5)}{\sigma(e^+e^- \rightarrow \Omega_c^0 X, x_p(\Omega_c^0) > 0.5)}$$

Discovery of the Ω_c^*

BaBar 231 fb^{-1}, PRL97:232001(2006)

Decay mode	ΔM (MeV/c^2)	Y (Events)	S (σ)	$\epsilon_{\Omega_c^*}/\epsilon_{\Omega_c^0}$	R
$\Omega_c^0 \to \Omega^-\pi^+$	$69.9 \pm 1.4 \pm 1.0$	$39^{+10}_{-9} \pm 6$	4.2	0.35	$0.71^{+0.19}_{-0.18} \pm 0.11$
$\Omega_c^0 \to \Omega^-\pi^+\pi^0$	$71.8 \pm 1.3 \pm 1.1$	$55^{+16}_{-15} \pm 6$	3.4	0.34	$1.76^{+0.71}_{-0.69} \pm 0.21$
$\Omega_c^0 \to \Omega^-\pi^+\pi^-\pi^+$	69.9 (fixed)	$-5 \pm 5 \pm 1$	-	0.33	$-0.66^{+0.74}_{-0.66} \pm 0.13$
$\Omega_c^0 \to \Xi^-K^-\pi^+\pi^+$	$69.4^{+1.9}_{-2.0} \pm 1.0$	$20 \pm 9 \pm 3$	2.0	0.35	$1.70^{+1.02}_{-1.00} \pm 0.34$
Combined	$70.8 \pm 1.0 \pm 1.1$	$105 \pm 21 \pm 6$	5.2	0.34	

$1.01 \pm 0.23 \pm 0.11$

Data from all four Ω_c^0 decay modes are combined and fit yields: $105 \pm 21 \pm 6$

Combined data give a 5.2σ signal significance.

Δm ($m_{\Omega c}^*$ - $m_{\Omega c}^0$)= $(70.8 \pm 1.0 \pm 1.1)$ MeV/c^2

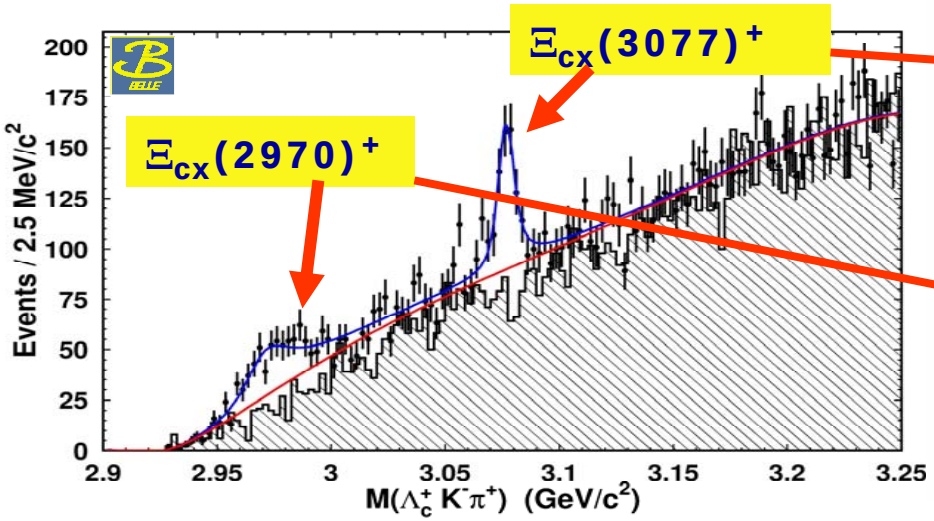
Theory range Δm = 50 – 94 MeV/c^2

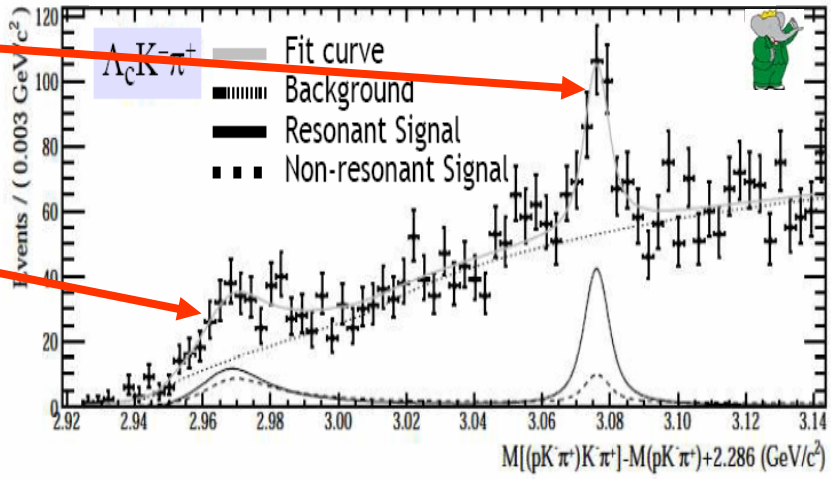
For $X_P > 0.5$, all the Ω_c^0 may results from Ω_c^* production, but uncertainty large.

Observation of $\Xi_c(2970)^+$ and $\Xi_c(3077)^+$

New charm strange baryons

BaBar confirms these states





Fit results and comparison to BELLE results:

	Mass (MeV/c^2)	Width (MeV)	Yield (Events)	Significance
BABAR $\Xi_c(2980)^+$	$2967.1 \pm 1.9 \pm 1.0$	$23.6 \pm 2.8 \pm 1.3$	$284 \pm 45 \pm 46$	$7.0\,\sigma$
Belle $\Xi_c(2980)^+$	$2978.5 \pm 2.1 \pm 2.0$	$43.5 \pm 7.5 \pm 7.0$	405 ± 51	$6.3\,\sigma$
BABAR $\Xi_c(3077)^+$	$3076.4 \pm 0.7 \pm 0.3$	$6.2 \pm 1.6 \pm 0.5$	$204 \pm 35 \pm 12$	$8.6\,\sigma$
Belle $\Xi_c(3077)^+$	$3076.7 \pm 0.9 \pm 0.5$	$6.2 \pm 1.2 \pm 0.8$	326 ± 40	$9.7\,\sigma$

PRL97:162001(2006) **(hep-ex/0607042)**

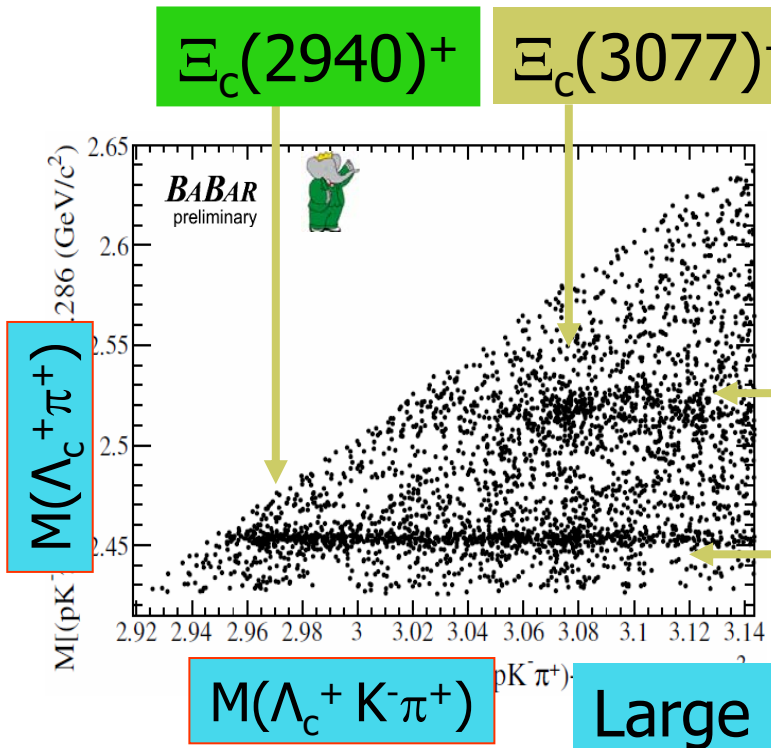
Observation of $\Xi_c(2970)^+$ and $\Xi_c(3077)^+$

The phase-space factor included in the fit by BaBar has significant effect on $\Xi_c(2970)^+$ parameters but not on those of $\Xi_c(3077)^+$ (far enough from threshold)

(hep-ex/0607042)

Sub-resonance yields:

	Yield (Events)	Significance
$\Xi_c(2980)^+ \to \Sigma_c(2455)^{++}K^-$	$132 \pm 31 \pm 5$	4.9σ
$\Xi_c(2980)^+ \to \Lambda_c^+ K^-\pi^+$	$152 \pm 37 \pm 45$	4.1σ
$\Xi_c(3077)^+ \to \Sigma_c(2455)^{++}K^-$	$87 \pm 20 \pm 4$	5.8σ
$\Xi_c(3077)^+ \to \Sigma_c(2520)^{++}K^-$	$82 \pm 23 \pm 6$	4.6σ
$\Xi_c(3077)^+ \to \Lambda_c^+ K^-\pi^+$	$35 \pm 24 \pm 16$	1.4σ

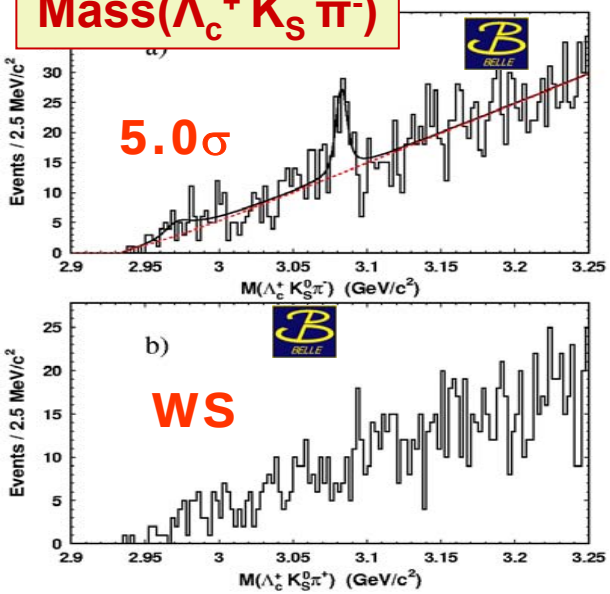


2D fit: Ξ_c^+ states fit with BW convolved with Resolution function, explicit phase-space factor for Ξ_c^+

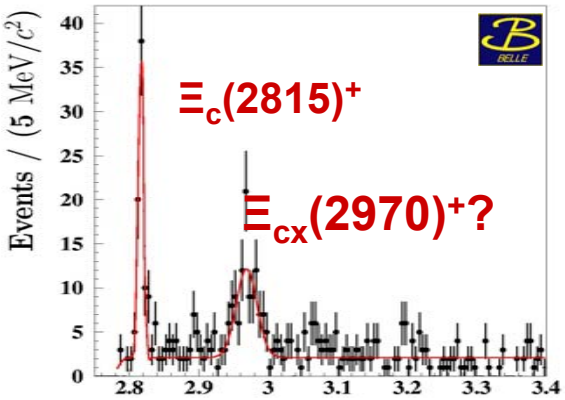
Large contributions via intermediate Σ_c^{++}!

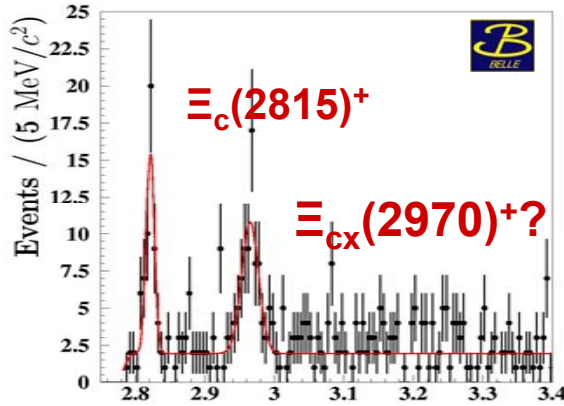
$\Xi_c(2970)^+$ and $\Xi_c(3077)^+$

Mass($\Lambda_c^+ K_S \pi^-$)



Another channel for $\Xi_{cx}(2970)^+$





$\Xi_c(2645)^0\pi^+$ $\Xi_c(2645)^+\pi^-$

Isopartner of $\Xi_c(2970)$ and $\Xi_c(3077)$ seen ?

Summary of fit $\Xi_c(2970)$

hep-ex/0608012

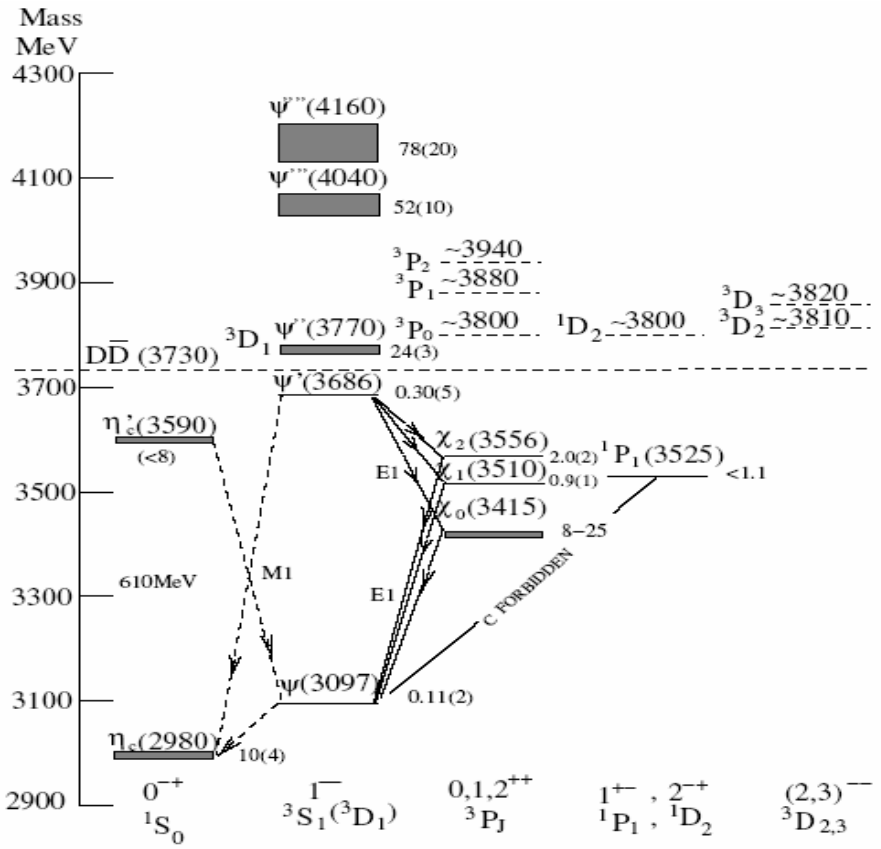
Ξ_c decay mode	# of events	mass [MeV/c^2]	width [MeV]
$\Xi_c^+ \to \Xi^-\pi^+\pi^+$	77.0 ± 10.9	2967.6 ± 2.3(stat)	15 ± 2
$\Xi_c^0 \to \Xi^-\pi^+$	54.4 ± 9.3	2964.9 ± 2.3(stat)	12 ± 3
$\Xi_c^0 \to \Lambda K^-\pi^+$	100.2 ± 15.2	2973.0 ± 4.0(stat)	25 ± 5
$\Xi_c^0 \to pK^-K^-\pi^+$	35.6 ± 7.6	2970.9 ± 2.0(stat)	9 ± 2

New Charmonium like states

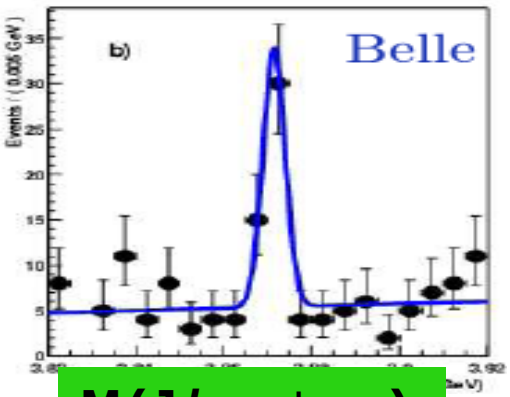
1. Charmonium states below $D\bar{D}$ threshold are in good agreement with theory.

2. New states observed in B-factories (and CDF, CLEO-c) do not match theoretical Explanations very well

3. My focus will be on the X(3872) and Y(4260) states



X(3872): B→X(3872) (→J/ψπ⁺π⁻)K



M(J/ψ π⁺ π⁻)

First observed by Belle BELLE - PRL 91, 262001 (2003)

Confirmed by CDF, D0 and BaBar

1. **World average mass**

$M_X = 3871.9 \pm 0.5$ MeV/c2

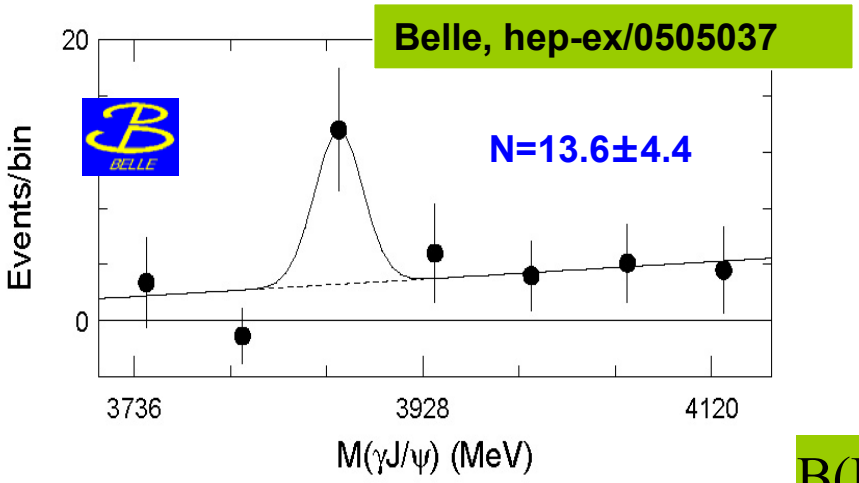
2. **Width:** $\Gamma < 2.3$ MeV/c2 at 90% CL

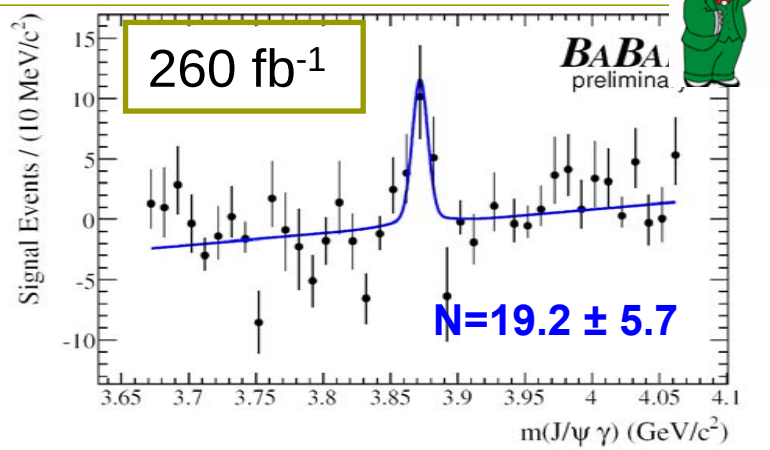
3. **Mass is close to $D^0 D^{*0}$ threshold**

$(M_{D^0} + M_{D^{*0}} = 3871.8 \pm 0.4$ MeV/c2)

(new Cleo-c D^0 mass measurement) hep-ex/0701016

$X(3872) \to J/\psi\,\gamma$





$$B(B^+ \to X(3872)K^+, X \to \psi\gamma) = (3.4 \pm 1.0 \pm 0.3) \times 10^{-6}$$

$$B(B^+ \to X(3872)K^+, X \to \psi\gamma) = (1.8 \pm 0.6 \pm 0.1) \times 10^{-6}$$

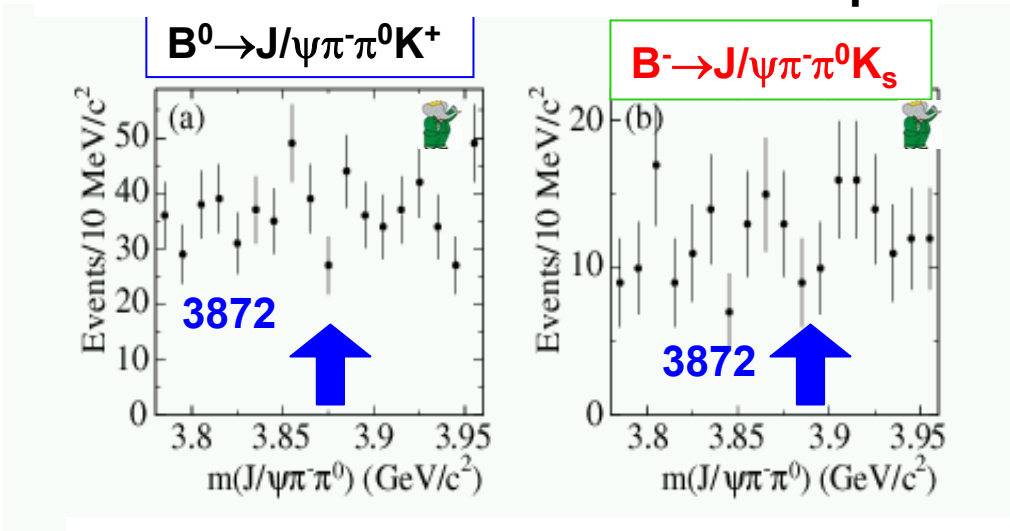
$$\frac{B(X(3872) \to \psi\gamma)}{B(X(3872) \to \psi\pi^+\pi^-)} = 0.34 \pm 0.14$$

Implications:

- **C=+ for the X(3872)**
- **I=1 for the ($\pi\pi$) in J/ψ π^+ π^-**
- **forbidden J/$\psi\pi^0\pi^0$, J/$\psi\pi^0$, and J/ψ η decays ; I=0 favored for X(3872), so the J/ψ π^+ π^- decay is isospin violating (small width)**

Search for X(3872) charged partners

1. **Exclusive reconstruction technique**



BaBar 221 fb $^{-1}$ PRD 71, 031501 (2005)

No charged partner observed

$BR(B^0 \to X(3872)^-K^+, X(3872)^- \to J/\psi\pi^-\pi^0) < 5.4 \cdot 10^{-6}$ at 90% CL

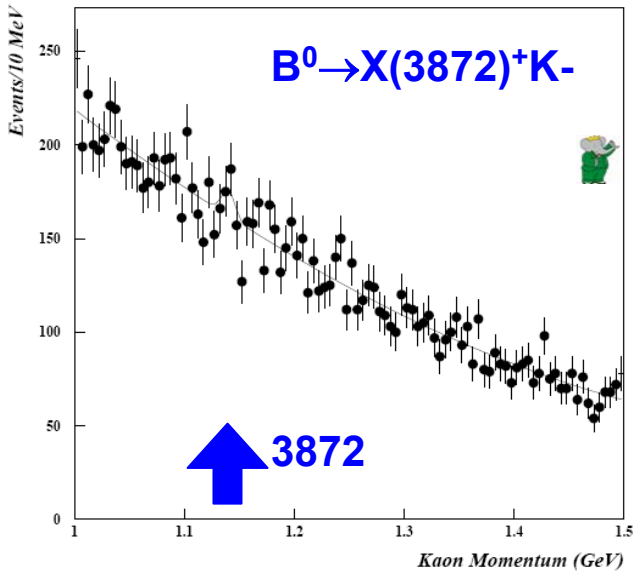
$BR(B^- \to X(3872)^-\bar{K}^0, X(3872)^- \to J/\psi\pi^-\pi^0) < 22 \cdot 10^{-6}$ at 90% CL

2. **Inclusive search using recoil technique**

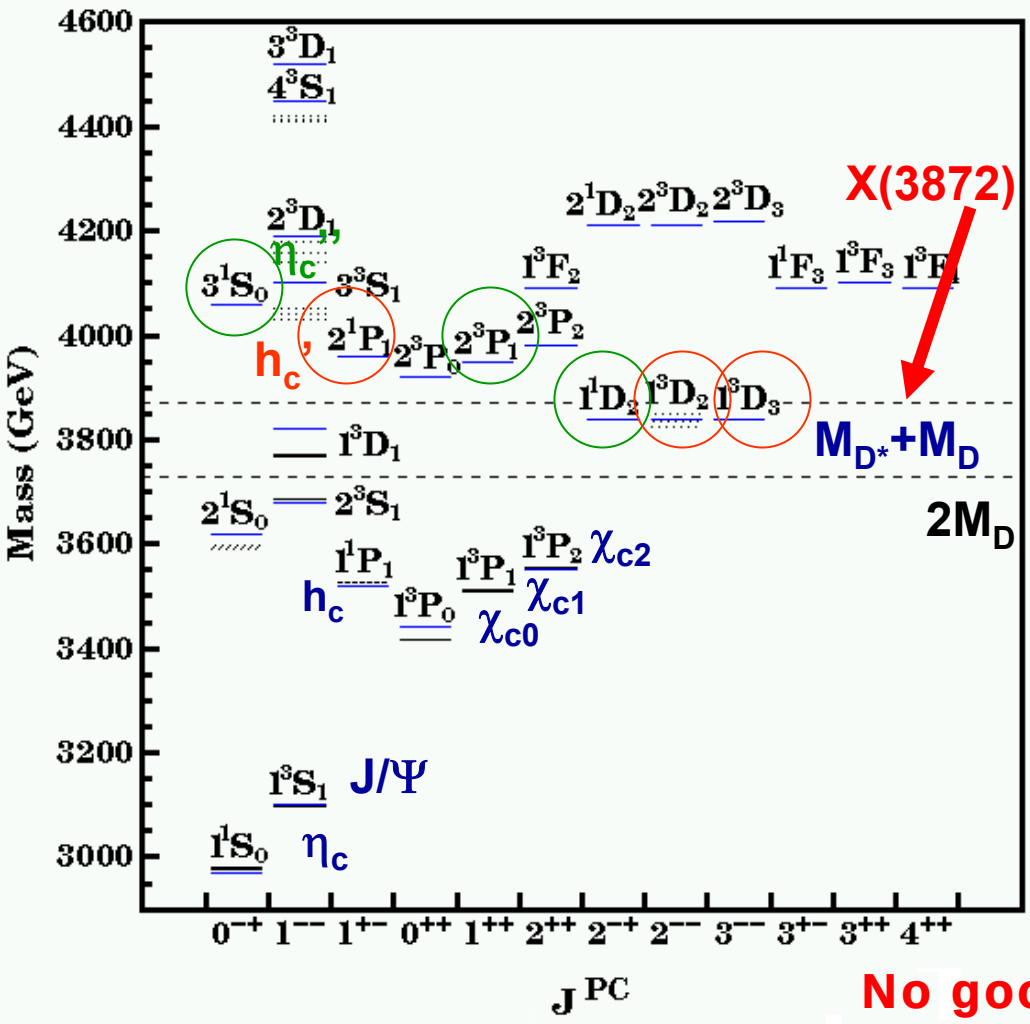
PRL 96, 052002 (2006)

Inclusive $K^\pm$ momentum on B^0 recoil
No signal is observed for charged partners

$BR(B^0 \to X(3872)^+K^-) < 5 \cdot 10^{-4}$ at 90% CL



Is X(3872) a charmonium state?



η_c'' — M too low and Γ too small

h_c' — Angular dist. Rule out 1^{+-}

χ_{c1}' — $\Gamma(\gamma J/\Psi)$ too small

ψ_2 — $\Gamma(\gamma\chi_{c1})$ too small

η_{c2} — $\pi\pi\eta_c$ should dominate $\pi\pi J/\Psi$

ψ_3 — $\Gamma(\gamma\chi_{c2})$ too small

No good $c\bar{c}$ candidate for X(3872)

X(3872) as a bound state?

- $J^{PC} = 1^{++}$ is favored
- $M_X \sim M_D + M_D^*$

  N.A Tornqvist, phys letter B590, 209(2004)
- $\Gamma(X \to \psi\gamma) < \Gamma(X \to J/\psi\pi\pi)$

  Swanson PLB 598, 197 (2004)
- $\Gamma(X \to D^0 D^0 \pi^0)$ too large ?

  Swanson PLB 598, 197 (2004)

Y(4260) observation

BaBar 233 fb^{-1}
PRL 95, 142001 (2005)

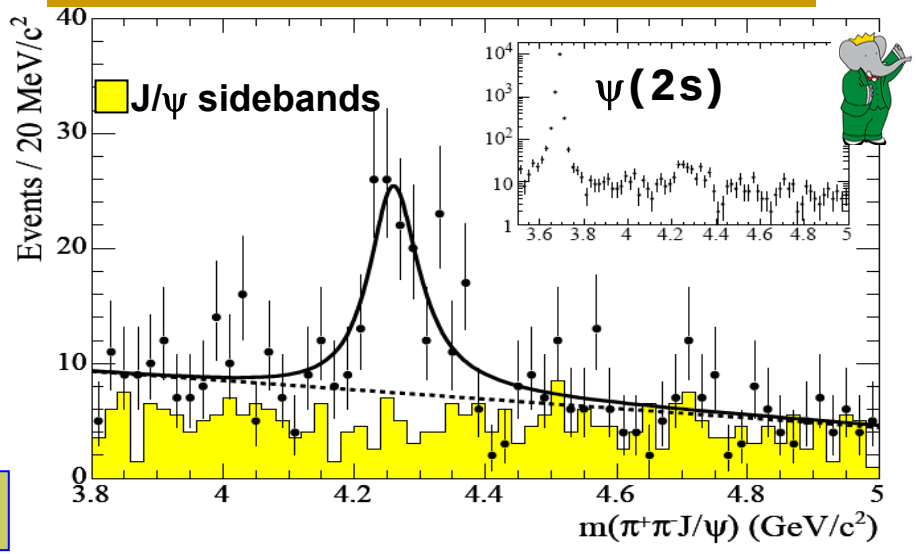
Peak cross section:
$\sigma(e^+e^- \to Y, Y \to \pi^+\pi^- J/\psi) = (51 \pm 12)$ pb

Assuming single resonance

$$\Gamma_{ee}^{Y} \times \mathrm{B}(Y(4260) \to \pi^+\pi^- \mathrm{J}/\psi) = (5.5 \pm 1.0^{+0.8}_{-0.7})\ \mathrm{eV}$$

Observed in ISR → **$J^{PC} = 1^{--}$**

$e^+e^- \to \gamma_{ISR}\ J/\psi\pi^+\pi^-\ J/\psi \to e^+e^-, \mu^+\mu^-$

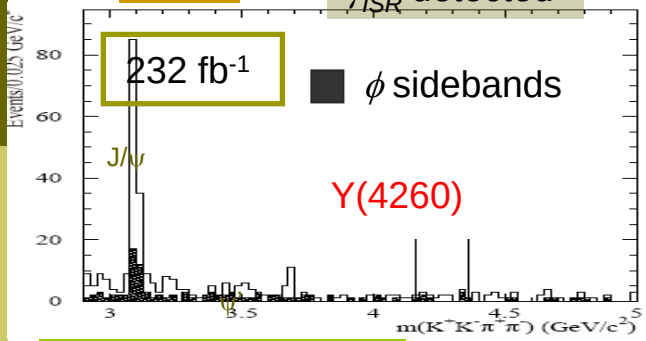


Confirmations from CLEO-c, CLEO-III and Belle

ISR $\pi^+\pi^- J/\psi$	BaBar	CLEO-III	Belle (Preliminary)
Yield	125 ± 23 (>8σ)	$14.1^{+5.2}_{-4.2}$ (4.9σ)	165 ± 24 (>7σ)
Mass(MeV/c²)	$4259 \pm 8^{+2}_{-6}$	$4283^{+17}_{-16} \pm 4$	$4295 \pm 10^{+11}_{-5}$
Width (MeV)	$88 \pm 23^{+6}_{-4}$	$70^{+40}_{-25} \pm 5$	$133 \pm 26^{+13}_{-6}$

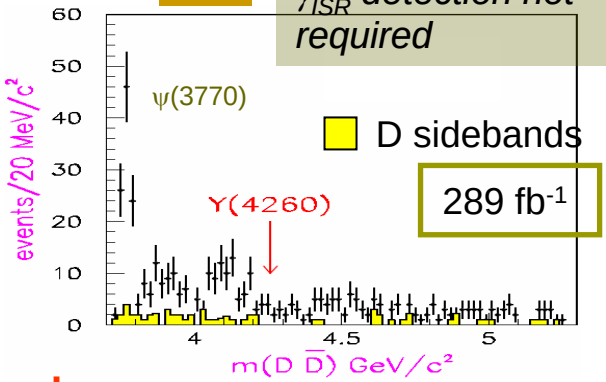
Search for other Y(4260) decays

$\phi\pi^+\pi^-$ — γ_{ISR} detected

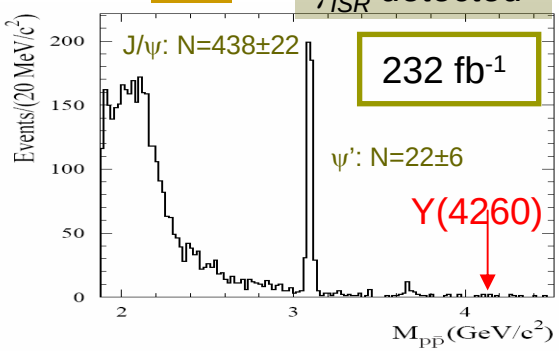


PRD 73,011101 (2006)

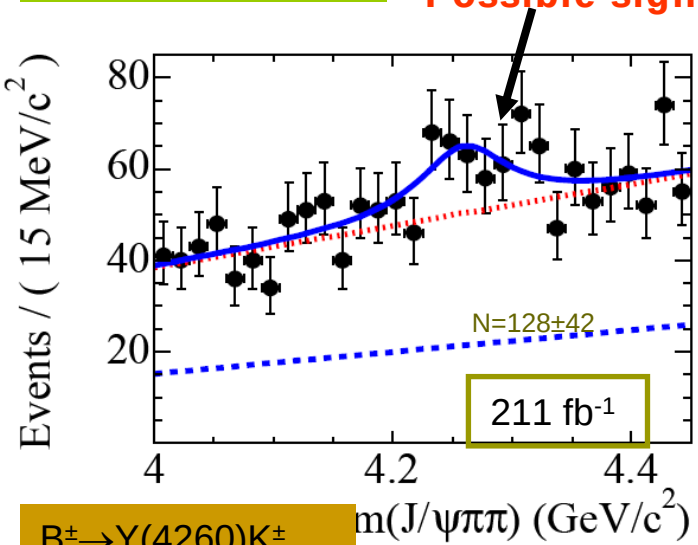
$D\bar{D}$ — γ_{ISR} detection not required



$p\bar{p}$ — γ_{ISR} detected



Possible signal



$B^{\pm} \to Y(4260)K^{\pm}$
$Y(4260) \to J/\psi\ \pi^+\pi^-$

$$\Gamma^{Y}_{ee} \times B(Y(4260) \to \pi^+\pi^-\varphi < 0.4ev \ \ 90\%CL$$

No signal

$$\frac{B(Y(4260) \to D\bar{D}}{B(Y(4260) \to \pi^+\pi^-\psi)} < 7.6 \ \ 95\%CL$$

No signal

$$\frac{B(Y(4260) \to p\bar{p})}{B(Y(4260) \to \pi^+\pi^-\psi)} < 0.13 \ \ 90\%CL$$

No signal

$$B(B^- \to Y(4260)K^-) \times B(Y(4260) \to \psi\pi^+\pi^-)$$
$$= (2.0 \pm 0.7 \pm 0.2) \times 10^{-5}$$

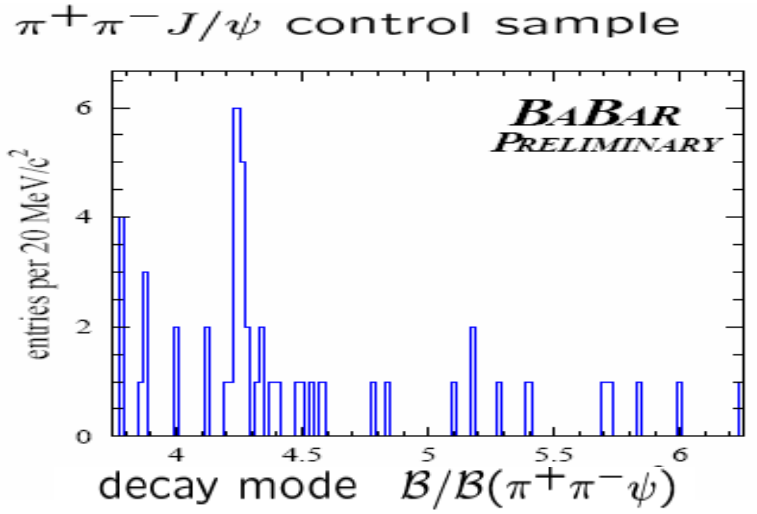
3σ

Y(4260) other modes

CLEO, PRL 96:162003(2006)

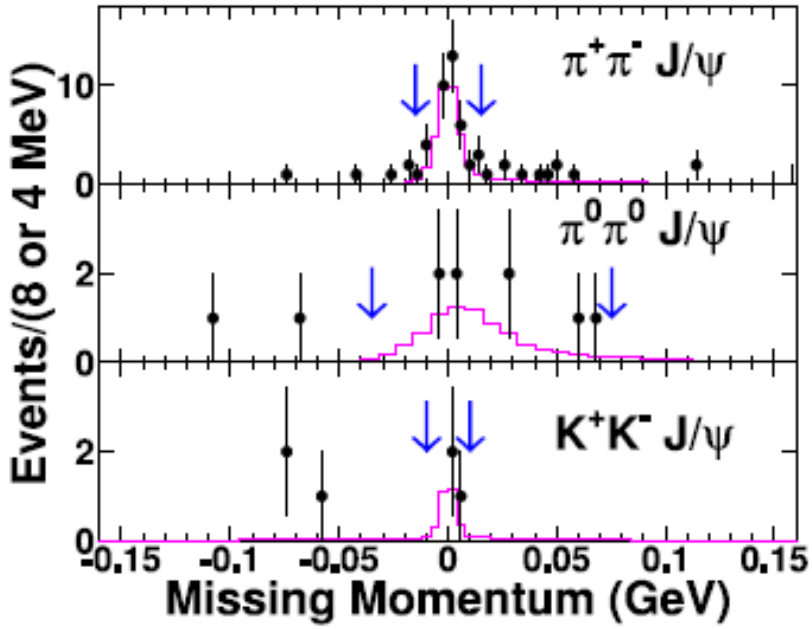
two new modes seen :

$e^+e^- \rightarrow (J/\Psi\,\gamma\,\gamma)\gamma$



decay mode	$\mathcal{B}/\mathcal{B}(\pi^+\pi^-\psi)$
$\eta J/\psi$	< 1.4 @ 90%
$\pi^0 J/\psi$	< 0.6 @ 90%
$\gamma\chi_{c1}$	< 3.6 @ 90%
$\gamma\chi_{c2}$	< 2.6 @ 90%
$\gamma\gamma J/\psi$	< 1.2 @ 90%

Hep-ex/0608004



$\pi^+\pi^- J/\psi$: $\sigma = (58^{+12}_{-10} \pm 4)$ pb

$\pi^0\pi^0 J/\psi$: $\sigma = (23^{+12}_{-8} \pm 1)$ pb

$K^+K^- J/\psi$: $\sigma = (9^{+9}_{-5} \pm 1)$ pb

Y(4260) interpretation

- Not a charmonium (1^{--})

T.Barnes, S.Godfrey and E.S. Swanson, phys.Rev.D72:054026,2005

- Tetra quark? Predicts $D_s^+ \bar{D}_s^- >> D\bar{D}$

L.Maiani *etal.* Phys.Rev.D72:031502(2005)

- An hybrid meson?
  - Hybrids favored 2-body decay to (P=+,P=-) $D\bar{D}, D^*\bar{D}^*$,$D\bar{D}^*$ suppressed
  - Y decays to $DD_1(2420)$ should dominate!!
- Y(4260) on the (quenched) Lattice QCD: 1^{--}:

  $m = 4.38 \pm .15$ GeV/c^2

  Xiang-Qian Luo, Yan Liu, Phys.Rev.D74:034502,2006

$e^+e^- \rightarrow \pi^+\pi^-\psi(2S)$

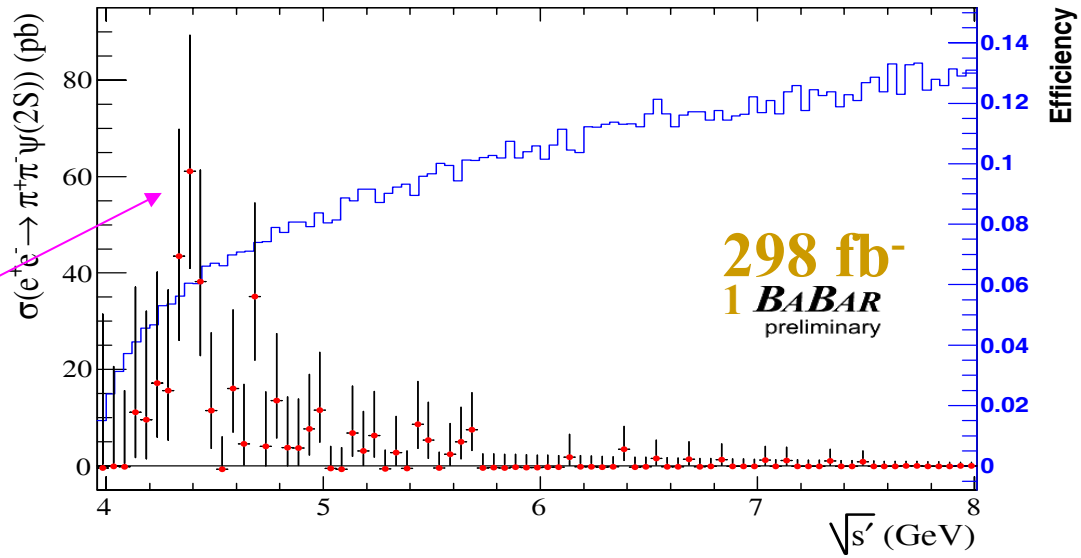
Hep-ex/0610057

$\sigma(e^+e^- \rightarrow \pi^+\pi^-\psi(2S))$ from threshold up to 8 GeV is calculated by

$$\frac{d\sigma(s,x)}{dx} = W(s,x)\,\sigma(s(1-x))$$

$x \equiv 2E_\gamma^*/\sqrt{s}$; $s' = s(1-x)$;

W(s,x): ISR photon emission probability;

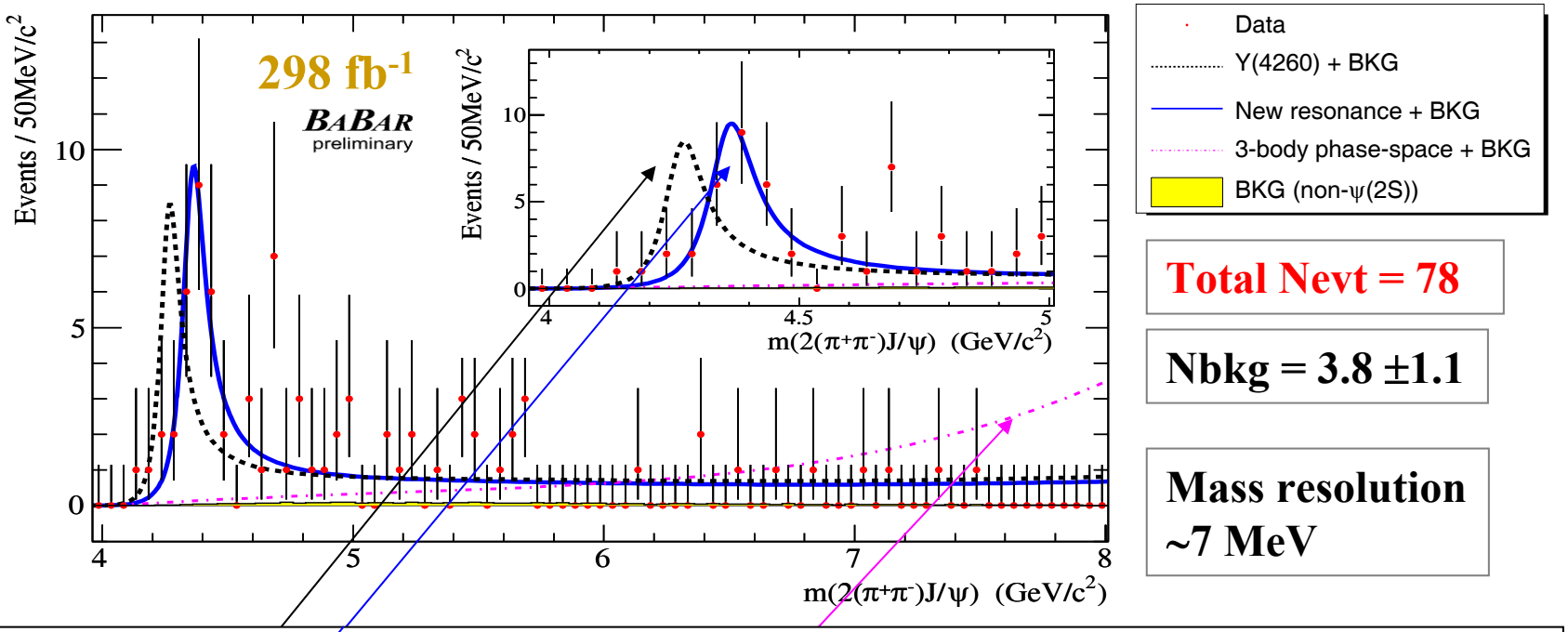


The maximum cross section is about 60 pb around 4.35 GeV

Possible new state ?

Is it Y(4260) ?

Hep-ex/0610057



Total Nevt = 78

Nbkg = 3.8 ±1.1

Mass resolution ~7 MeV

Incompatible with **Y(4260), ψ(4415),** or **S-wave 3-body phase-space production**

Assuming a single resonance ⇒ mass=(4324±24) MeV/c², Γ=(172±33) MeV (statistical errors only)

good for low mass region, but insufficient to fully describe the full spectrum.

χ^2-prob	Y(4260)	ψ(4415)	Y(4350)
Full mass	6.5×10^{-8}	1.3×10^{-13}	29%

Conclusion-I

- Better understanding of $D_{s0}(2317)$ and $D_{s1}(2460)$.
- Observation of new state $D_{sJ}^{*}(2860)$.
- Enhancement at 2690 MeV/c^2; is it a new state , same as the $D_{sJ}^{*}(2700)$?
- Observation of $\Lambda_c(2940)\rightarrow D^0p$; improved mass of $\Lambda_c(2880)^+$; 1st measurement of width; first observation charm baryon $\rightarrow$ charm meson transitions; confirmed by Belle in $\Lambda_c\pi^+\pi^-$ mode
- Ω_c^{*} discovered; now all ground states (L=0) singly charmed baryons have been seen.

Conclusion-II

- Observation of $\Xi_c(2970)^+$ and $\Xi_c(3077)^+$ states by Belle and confirmed by BaBar; observation of significant quasi-two-body decays with $\Sigma_c\pi$ by BaBar
- Better understanding of X(3872)
  - No signal observed for charged partner
  - $J^{PC} = 1^{++}$ favored
- Y(4260)
  - $J^{PC} = 1^{--}$ (ISR /e^+e^- production)
  - Two new decay modes ($J/\psi\pi^0\pi^0$, $J/\psi\ K^+K^-$) observed by CLEO, need confirmation
- Y(4350) is a new state?
- **More surprise could come with more data at B-factories!**