BARYONIC CHARMONIUM DECAYS AT BESIII

Windows on the Universe
Particle Physics

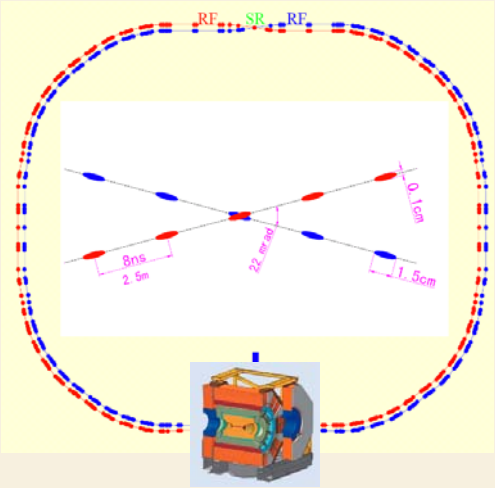
Quy Nhon, August 5 – 11, 2018

SIMONETTA MARCELLO - Torino University and INFN
on behalf of the BESIII Collaboration

OUTLINE

- BESIII EXPERIMENT
- PHYSICS MOTIVATIONS
- MEASUREMENTS WITH J/ψ AND ψ′
  - Nucleon Charmonium Decays
  - Hyperon Charmonium Decays
- CONCLUSIONS AND OUTLOOK

BESIII @ BEPCII



$\sqrt{s} = 2$ - 4.6 GeV

Physics goals cover a diverse range:

- Charmonium: XYZ, spectroscopy, decays to study QCD
- Open Charm: D^0-$\overline{D^0}$ mixing, (semi)leptonic+hadronic decays, …
- Light hadron: meson & baryon spectroscopy, Time-like e.m. form factors, …
- τ : most precise mass measurement …
- … and many more

Beijing e^+e^- Collider

- Double Ring
  237 m circumference
- Large crossing angle: ±11 mrad
- Beam energy
  1.0 – 2.3 GeV
- Design Luminosity
  1×10^{33} cm^{-2} s^{-1} @ $\psi(3770)$
- Achieved 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
- SR mode 0.25A @ 2.5 GeV

BESIII SPECTROMETER

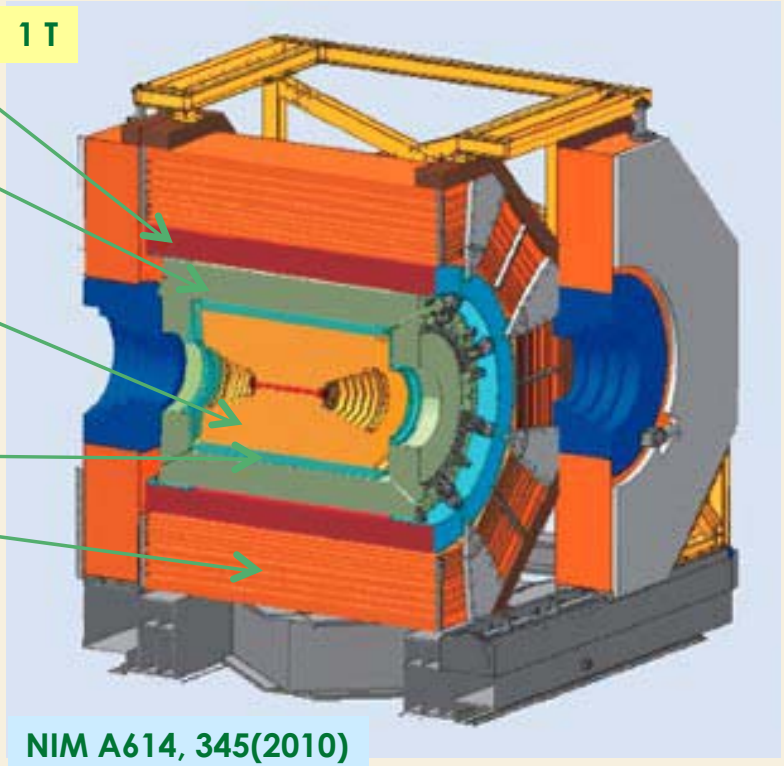
EMC CsI(Tl) crystals
- Energy resolution 2,5% @1GeV
- Spatial resolution 6mm

MDC
- Spatial resolution σ_{xy} = 120μm
- Momentum resolution 0.5% @1GeV
- dE/dx resolution 6%

TOF
- Time resolution 80(110) ps barrell (endcaps)

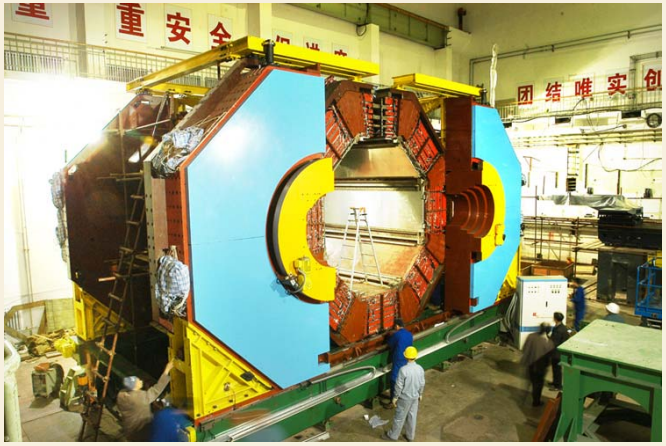
Muon Counter RPC (9)Barrel, (8)Endcaps
- Spatial resolution 1.5 cm

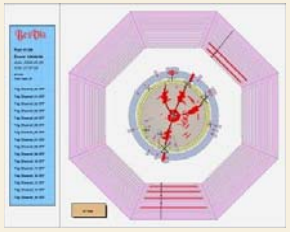
SC Magnet 1 T



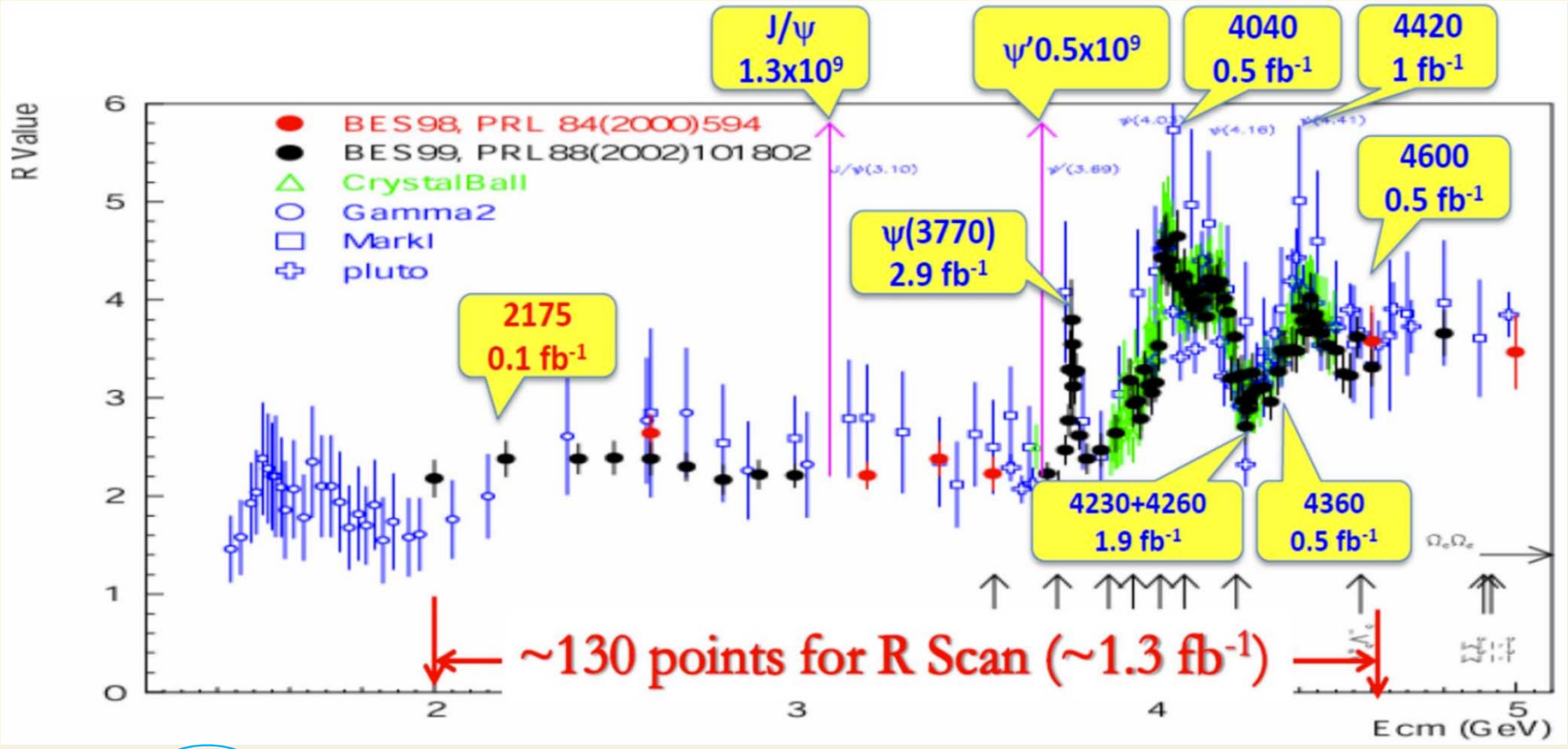
NIM A614, 345(2010)

Excellent performance detector





BESIII DATA SET



- The largest J/ψ, ψ', ψ(3770) and χ_{cJ} data sample collected in the World
- From light meson spectroscopy to $\Lambda_c\Lambda_c$
- Also ISR and more

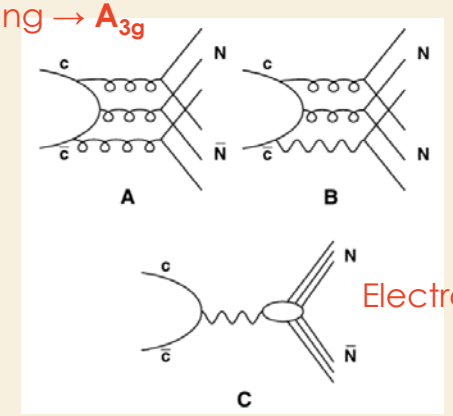
PHYSICS MOTIVATIONS

Focus on J/ψ and ψ′ Two Body Baryonic Decays

- J/ψ and ψ′ decays to hadrons through ggg or ggγ or virtual γ
- J/ψ and ψ′ masses are in the transition regions between perturbative and not-perturbative regime
- Test of flavor-SU(3) symmetry (1)
- Test of pQCD "12% Rule" (2, 3)
- Study of interference between resonant strong and resonant e.m. decay amplitudes (4), predicted to be real (5), but found to be imaginary in many hadronic channels
- Study of polar angle distribution $dN/d\cos\theta \propto 1 + \alpha \cos^2\theta$ as derived by helicity formalism (6-9)

Strong → A_{3g}

Strong → A_{2g}



Electromagnetic → A_γ

1) K.Zhu et al., Int. J. Mod. A30, 1550148 (2015)
2) T. Appelquist and H.D. Politzer, PRL 34, 43(1975)
3) A. De Rujula and S. Glashow, PRL 34 (1975) 46
4) R. Baldini et al., PLB 444 (1998) 111
5) S.J. Brodsky et al., PRL 59 (1987) 621
6) P. Kessler, NPB 15 (1970) 253
7) S.J.Brodsky and G.P.Lepage,PRD 24 (1981) 2848
8) C.Carimalo, IJMPA 2 (1987) 249
9) M. Claudson et al., PRD 25 (1982) 1345

NUCLEON CHARMONIUM DECAYS

arXiv:1803.02039

Study of the decay $\psi' \to p \bar{p}$

- Measured 40 years ago
- Branching fractions and angular distributions have been measured
- Background from initial or final state radiation events

Two charged tracks with net charge = 0

data sample 1.07 x 10^8 ψ'
continuum data at 3.65 GeV: 44 pb^{-1}

Study of the decay $\psi' \to n \bar{n}$

- Measured for the first time
- Branching fractions and angular distributions have been measured
- Background $e^+e^- \to \gamma\gamma$

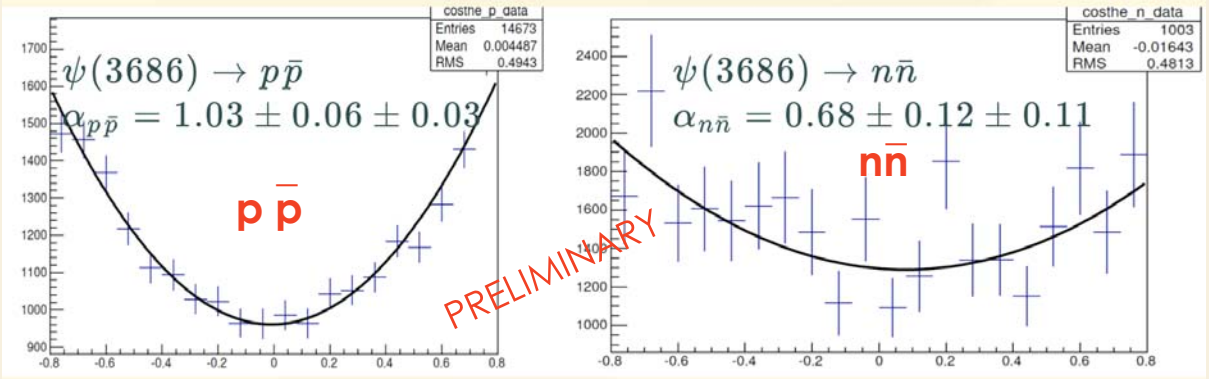
No charged tracks in MDC
Two showers (E > 600MeV, E > 60 MeV) in EMC

NUCLEON CHARMONIUM DECAYS

Study of the decay $\psi' \to p\bar{p}/n\bar{n}$

arXiv:1803.02039

Polar angle distribution



$\alpha_{pp} = 1.03 \pm 0.06 \pm 0.03$ $p\bar{p}$

$\alpha_{nn} = 0.68 \pm 0.12 \pm 0.11$ $n\bar{n}$

α Values

$\mathcal{B}(\psi' \to \bar{p}\,p) = (3.05 \pm 0.02 \pm 0.12)10^{-4}$

$\mathcal{B}(\psi' \to \bar{n}\,n) = (3.06 \pm 0.06 \pm 0.14)10^{-4}$

Quite close $\mathcal{BF}$ BUT Different α value

$$\frac{\mathcal{B}(\psi' \to \bar{p}\,p)}{\mathcal{B}(J/\psi \to \bar{p}\,p)} = (14.4 \pm 0.6)\,\%$$

$$\frac{\mathcal{B}(\psi' \to \bar{n}\,n)}{\mathcal{B}(J/\psi \to \bar{n}\,n)} = (14.8 \pm 1.2)\,\%$$

pQCD 12% Rule is fulfilled

In $J/\psi \to p\bar{p}/n\bar{n}$ decays both $\mathcal{BF}$ and α values are very close and relative phase between strong and e.m. amplitudes is 90°

In ψ' decays different α values may indicate a more complex mechanism in the decay of $\psi' \to p\bar{p}/n\bar{n}$ with respect to $J/\psi \to p\bar{p}/n\bar{n}$

HYPERON CHARMONIUM DECAYS

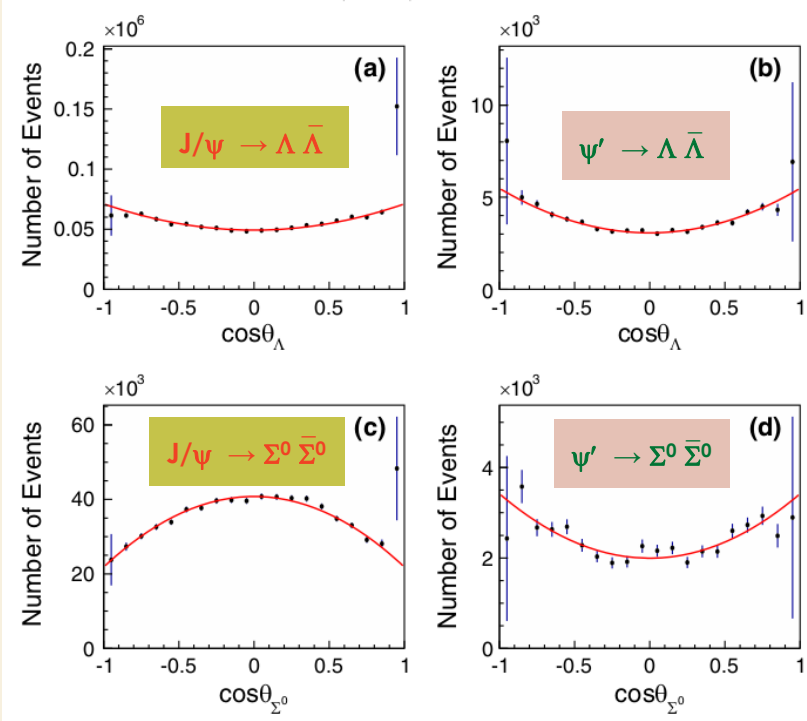
PRD 95 (2017) 052003

Study of J/ψ and $\psi' \to \Lambda\bar{\Lambda}$ and $\Sigma^0\bar{\Sigma}^0$

- **Improved measurements for Branching Fractions**
- **J/ψ decay Improved Angular distribution**
- **ψ' decay Angular distribution for the first time**

data sample
$(1310.6 \pm 7.0) \times 10^6$ J/ψ
$(447.9 \pm 2.9) \times 10^6$ ψ'

Efficiency corrected data



HYPERON CHARMONIUM DECAYS

PRD 95 (2017) 052003

Study of J/ψ and ψ′ → ΛΛ̄ and Σ⁰ Σ̄⁰

Channel	α	$\mathcal{B}$ ($\times 10^{-4}$)
$J/\psi \to \Lambda\bar{\Lambda}$	$0.469 \pm 0.026 \pm 0.008$	$19.43 \pm 0.03 \pm 0.33$
$J/\psi \to \Sigma^0\bar{\Sigma}^0$	$-0.449 \pm 0.020 \pm 0.008$	$11.64 \pm 0.04 \pm 0.23$
$\psi(3686) \to \Lambda\bar{\Lambda}$	$0.82 \pm 0.08 \pm 0.02$	$3.97 \pm 0.02 \pm 0.12$
$\psi(3686) \to \Sigma^0\bar{\Sigma}^0$	$0.71 \pm 0.11 \pm 0.04$	$2.44 \pm 0.03 \pm 0.11$

Improved precision with respect to previous measurements

- **J/ψ Branching fraction results are in good agreement with BESII and BABAR measurements**
- **ψ′ Branching fraction results are in good agreement with BESII, CLEO and Dobbs et al.**
- **There are significant differences with earlier measurements from MARKIII, BES and DM2**
- **Negative α value for $J/\psi \to \Sigma^0\bar{\Sigma}^0$ is confirmed (BESII earlier measurement)**

$$\frac{\mathcal{B}(\psi' \to \Lambda\bar{\Lambda})}{\mathcal{B}(J/\psi \to \Lambda\bar{\Lambda})} = (20.43 \pm 0.11 \pm 0.58)\ \%$$

$$\frac{\mathcal{B}(\psi' \to \Sigma^0\bar{\Sigma}^0)}{\mathcal{B}(J/\psi \to \Sigma^0\bar{\Sigma}^0)} = (20.96 \pm 0.27 \pm 0.92)\ \%$$

- **Test of 12% rule: Results are not in agreement with pQCD expectations**

HYPERON CHARMONIUM DECAYS

Study of $J/\psi \to \Lambda\bar{\Lambda}$

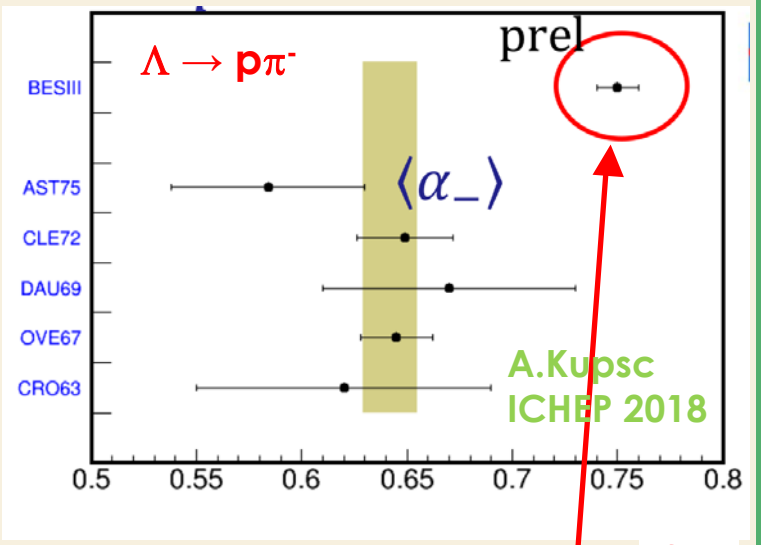
- **Measurement of decay asymmetry parameters**
- **First observation of Λ spin polarisation in the J/ψ decay**

data sample
$(1310.6 \pm 7.0) \times 10^6$ J/ψ

Asymmetry parameters measured incorporating the transverse polarization of Λ and $\bar{\Lambda}$ in the joint angular distribution

Parameters	This work	Previous results	
α_ψ	$0.461 \pm 0.006 \pm 0.007$	0.469 ± 0.027	BESIII
$\Delta\Phi$ (rad)	$0.740 \pm 0.010 \pm 0.008$	–	
α_-	$0.750 \pm 0.009 \pm 0.004$	0.642 ± 0.013	PDG
α_+	$-0.758 \pm 0.010 \pm 0.007$	-0.71 ± 0.08	PDG
$\bar{\alpha}_0$	$-0.692 \pm 0.016 \pm 0.006$	–	
A_{CP}	$-0.006 \pm 0.012 \pm 0.007$	0.006 ± 0.021	PDG
$\bar{\alpha}_0/\alpha_+$	$0.913 \pm 0.028 \pm 0.012$	–	

Preliminary



- **α value precision improved**
- **$\Delta\phi = 42.3° \pm 0.6° \pm 0.5°$ Non zero phase angle**
- **α_- and α_+ Decay asymmetries deviate from PDG avaraged values larger than 5σ**
- **A_{CP} odd observable consistent with CP symmetry**
- **3σ deviation from prediction by isospin symmetry**

Results call for a new interpretation of ALL Polarisation measurements

HYPERON CHARMONIUM DECAYS

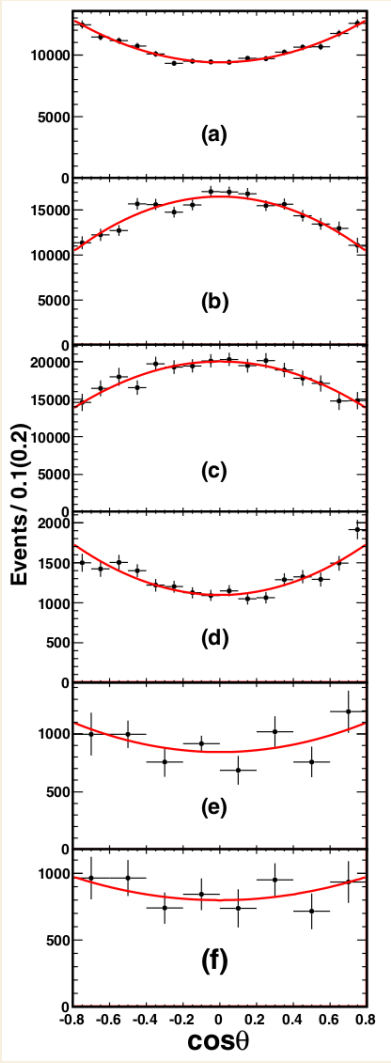
PRD 93 (2016) 072003

Study of J/ψ and $\psi' \to \Sigma(1385)^{\mp}\bar{\Sigma}(1385)^{\pm}$ and $\Xi^- \bar{\Xi}^+$

- $\psi' \to \Sigma(1385)^{\mp}\bar{\Sigma}(1385)^{\pm}$ observed for the first time
- Improved Branching Fractions of the other decays
- J/ψ decays Improved Angular distributions
- ψ' decays Angular distributions for the first time

data sample
$(223.7 \pm 1.4) \times 10^6$ J/ψ
$(106.4 \pm 0.9) \times 10^6$ ψ'

-Single Baryon tag method to achieve higher efficiency and to reduce systematic errors
-Charged tracks of Ξ and $\Sigma(1385)$ decay products in MDC
-Anti-baryon candidate extracted from the mass recoiling against the $\Lambda\pi^{\pm}$ system



Efficiency corrected data

$J/\psi \to \Xi^- \bar{\Xi}^+$

$J/\psi \to \Sigma(1385)^- \bar{\Sigma}(1385)^+$

$J/\psi \to \Sigma(1385)^+ \bar{\Sigma}(1385)^-$

$\psi' \to \Xi^- \bar{\Xi}^+$

$\psi' \to \Sigma(1385)^- \bar{\Sigma}(1385)^+$

$\psi' \to \Sigma(1385)^+ \bar{\Sigma}(1385)^-$

HYPERON CHARMONIUM DECAYS

PRD 93 (2016) 072003

Study of J/ψ and $\psi' \to \Sigma(1385)^{\mp}\bar{\Sigma}(1385)^{\pm}$ and $\Xi^- \bar{\Xi}^+$

Branching fractions (x10^{-4})

Mode	$J/\psi \to$			$\psi(3686) \to$		
	$\Xi^-\bar{\Xi}^+$	$\Sigma(1385)^-\bar{\Sigma}(1385)^+$	$\Sigma(1385)^+\bar{\Sigma}(1385)^-$	$\Xi^-\bar{\Xi}^+$	$\Sigma(1385)^-\bar{\Sigma}(1385)^+$	$\Sigma(1385)^+\bar{\Sigma}(1385)^-$
This work	$10.40 \pm 0.06 \pm 0.74$	$10.96 \pm 0.12 \pm 0.71$	$12.58 \pm 0.14 \pm 0.78$	$2.78 \pm 0.05 \pm 0.14$	$0.85 \pm 0.06 \pm 0.06$	$0.84 \pm 0.05 \pm 0.05$
MarkI [5]	14.00 ± 5.00	…	…	< 2.0	…	…
MarkII [6]	$11.40 \pm 0.80 \pm 2.00$	$8.60 \pm 1.80 \pm 2.20$	$10.3 \pm 2.4 \pm 2.5$	…	…	…
DM2 [7]	$7.00 \pm 0.60 \pm 1.20$	$10.00 \pm 0.40 \pm 2.10$	$11.9 \pm 0.4 \pm 2.5$	…	…	…
BESII [8,12]	$9.00 \pm 0.30 \pm 1.80$	$12.30 \pm 0.70 \pm 3.00$	$15.0 \pm 0.8 \pm 3.8$	$3.03 \pm 0.40 \pm 0.32$	…	…
CLEO [9]	…	…	…	$2.40 \pm 0.30 \pm 0.20$	…	…
BESI [26]	…	…	…	$0.94 \pm 0.27 \pm 0.15$	…	…
PDG [3]	8.50 ± 1.60	10.30 ± 1.30	10.30 ± 1.30	1.80 ± 0.60	…	…

- **Results are in agreement with previous measurements and more precise**

HYPERON CHARMONIUM DECAYS

PRD 93 (2016) 072003

Study of J/ψ and $\psi' \to \Sigma(1385)^{\mp}\bar{\Sigma}(1385)^{\pm}$ and $\Xi^- \bar{\Xi}^+$

α Values

Mode	$J/\psi \to$			$\psi(3686) \to$		
	$\Xi^-\bar{\Xi}^+$	$\Sigma(1385)^-\bar{\Sigma}(1385)^+$	$\Sigma(1385)^+\bar{\Sigma}(1385)^-$	$\Xi^-\bar{\Xi}^+$	$\Sigma(1385)^-\bar{\Sigma}(1385)^+$	$\Sigma(1385)^+\bar{\Sigma}(1385)^-$
This work	$0.58 \pm 0.04 \pm 0.08$	$-0.58 \pm 0.05 \pm 0.09$	$-0.49 \pm 0.06 \pm 0.08$	$0.91 \pm 0.13 \pm 0.14$	$0.64 \pm 0.40 \pm 0.27$	$0.35 \pm 0.37 \pm 0.10$
BESII [8]	$0.35 \pm 0.29 \pm 0.06$	$-0.54 \pm 0.22 \pm 0.10$	$-0.35 \pm 0.25 \pm 0.06$	…	…	…
MarkIII [6]	0.13 ± 0.55	…	…	…	…	…
Claudson *et al.* [10]	0.16	0.11	0.11	0.32	0.29	0.29
Carimalo [11]	0.27	0.20	0.20	0.52	0.50	0.50

- **Most of results are not in agreement with theoretical models**

M. Claudson et al., PRD 25 (1982) 1345
C.Carimalo, IJMPA 2 (1987) 249

$$\frac{\mathcal{B}(\psi' \to \Sigma(1385)^- \bar{\Sigma}(1385)^+)}{\mathcal{B}(J/\psi \to \Sigma(1385)^- \bar{\Sigma}(1385)^+)} = (7.76 \pm 0.55 \pm 0.68)\,\%$$

$$\frac{\mathcal{B}(\psi' \to \Sigma(1385)^+ \bar{\Sigma}(1385)^-)}{\mathcal{B}(J/\psi \to \Sigma(1385)^+ \bar{\Sigma}(1385)^-)} = (6.68 \pm 0.40 \pm 0.50)\,\%$$

$$\frac{\mathcal{B}(\psi' \to \Xi^- \bar{\Xi}^+)}{\mathcal{B}(J/\psi \to \Xi^- \bar{\Xi}^+)} = (26.73 \pm 0.50 \pm 2.30)\,\%$$

- **Test of pQCD 12% rule: Results are not in agreement especially $\Xi^- \bar{\Xi}^+$ final state**

HYPERON CHARMONIUM DECAYS

PLB 770 (2017) 217

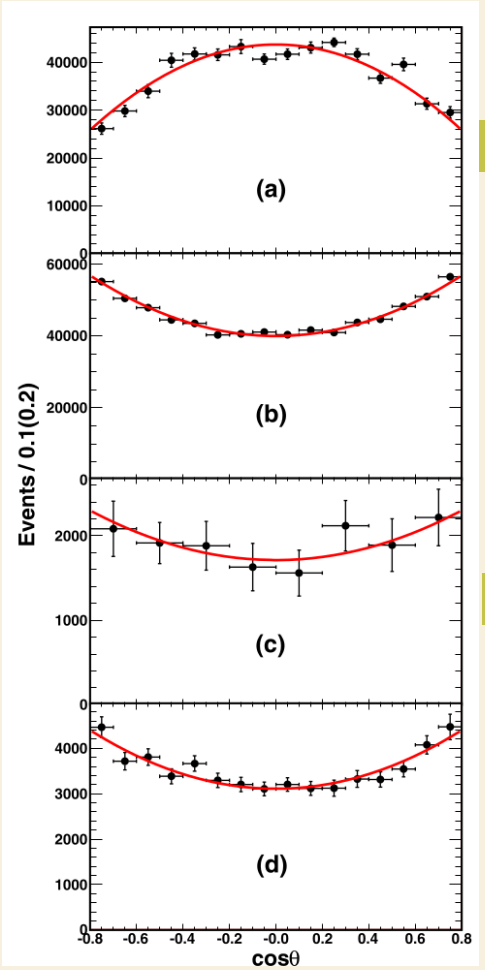
Study of J/ψ and $\psi' \to \Sigma(1385)^0\,\bar{\Sigma}(1385)^0$ and $\Xi^0\,\bar{\Xi}^0$

- $\Sigma(1385)^0\,\bar{\Sigma}(1385)^0$ observed for the first time
- $\Xi^0\,\bar{\Xi}^0$ improved Branching Fraction measurement
- Angular distributions measured for the first time

data sample
$(1310.6 \pm 7.0) \times 10^6$ J/ψ
$(447.9 \pm 2.9) \times 10^6$ ψ'

-Single Baryon tag method to achieve higher efficiency and to reduce systematic errors
-Charged tracks in MDC
-Two photons from π^0 decay: isolated showers in EMC
-Anti-baryon candidate extracted from the mass recoiling against the $\Lambda\pi^0$ system

Efficiency corrected data



$J/\psi \to \Sigma(1385)^0\,\bar{\Sigma}(1385)^0$

$J/\psi \to \Xi^0\,\bar{\Xi}^0$

$\psi' \to \Sigma(1385)^0\,\bar{\Sigma}(1385)^0$

$\psi' \to \Xi^0\,\bar{\Xi}^0$

HYPERON CHARMONIUM DECAYS

PLB 770 (2017) 217

Study of J/ψ and $\psi' \to \Sigma(1385)^0\,\bar{\Sigma}(1385)^0$ and $\Xi^0\,\bar{\Xi}^0$

Branching fractions (x10^{-4})

Mode	$J/\psi \to \Sigma(1385)^0\bar{\Sigma}(1385)^0$	$J/\psi \to \Xi^0\bar{\Xi}^0$	$\psi(3686) \to \Sigma(1385)^0\bar{\Sigma}(1385)^0$	$\psi(3686) \to \Xi^0\bar{\Xi}^0$
This work	$10.71 \pm 0.09 \pm 0.82$	$11.65 \pm 0.04 \pm 0.43$	$0.69 \pm 0.05 \pm 0.05$	$2.73 \pm 0.03 \pm 0.13$
BESII [23]	–	$12.0 \pm 1.2 \pm 2.1$	–	–
CLEO [24]	–	–	–	$2.75 \pm 0.64 \pm 0.61$
Dobbs et al. [25]	–	–	–	$2.02 \pm 0.19 \pm 0.15$
PDG [4]	–	12.0 ± 2.4	–	2.07 ± 0.23

- **Results are in agreement with previous measurements**

Mode	$\frac{\mathcal{B}(\psi\to\Xi^0\bar{\Xi}^0)}{\mathcal{B}(\psi\to\Xi^-\bar{\Xi}^+)}$	$\frac{\mathcal{B}(\psi\to\Sigma(1385)^0\bar{\Sigma}(1385)^0)}{\mathcal{B}(\psi\to\Sigma(1385)^-\bar{\Sigma}(1385)^+)}$	$\frac{\mathcal{B}(\psi\to\Sigma(1385)^0\bar{\Sigma}(1385)^0)}{\mathcal{B}(\psi\to\Sigma(1385)^+\bar{\Sigma}(1385)^-)}$
J/ψ	$1.12 \pm 0.01 \pm 0.07$	$0.98 \pm 0.01 \pm 0.08$	$0.85 \pm 0.02 \pm 0.09$
$\psi(3686)$	$0.98 \pm 0.02 \pm 0.07$	$0.81 \pm 0.12 \pm 0.12$	$0.82 \pm 0.11 \pm 0.11$

- **Test of Isospin symmetry: Results are in agreement within 1σ**

HYPERON CHARMONIUM DECAYS

PLB 770 (2017) 217

Study of J/ψ and $\psi' \to \Sigma(1385)^0\,\bar{\Sigma}(1385)^0$ and $\Xi^0\,\bar{\Xi}^0$

$$\frac{\mathcal{B}(\psi' \to \Sigma(1385)^0\,\bar{\Sigma}(1385)^0)}{\mathcal{B}(J/\psi \to \Sigma(1385)^0\,\bar{\Sigma}(1385)^0)} = (6.44 \pm 0.47 \pm 0.64)\,\%$$

$$\frac{\mathcal{B}(\psi' \to \bar{\Xi}^0\,\Xi^0)}{\mathcal{B}(J/\psi \to \bar{\Xi}^0\,\Xi^0)} = (23.43 \pm 0.26 \pm 1.09)\,\%$$

- **Test of pQCD 12% rule: Results are not in agreement especially $\Xi^0\,\bar{\Xi}^0$ final state**

α Values

Mode	$J/\psi \to \Sigma(1385)^0\bar{\Sigma}(1385)^0$	$J/\psi \to \Xi^0\bar{\Xi}^0$	$\psi(3686) \to \Sigma(1385)^0\bar{\Sigma}(1385)^0$	$\psi(3686) \to \Xi^0\bar{\Xi}^0$
This work	$-0.64 \pm 0.03 \pm 0.10$	$0.66 \pm 0.03 \pm 0.05$	$0.59 \pm 0.25 \pm 0.25$	$0.65 \pm 0.09 \pm 0.14$
Carimalo et al. [6]	0.11	0.16	0.28	0.33
Claudson [7]	0.19	0.28	0.46	0.53

C.Carimalo, IJMPA 2 (1987) 249
M. Claudson et al., PRD 25 (1982) 1345

- **Experimental results are not in agreement with theoretical models**

We can conclude that current theoretical explanations are not satisfactory

A NEW EFFECTIVE MODEL

BESIII Collaboration Meeting
December 2017

A model to explain Λ and Σ^0 both *BF* and Angular distributions in J/ψ and ψ ′ decays has been proposed by *Baldini, Pacetti and Mangoni*

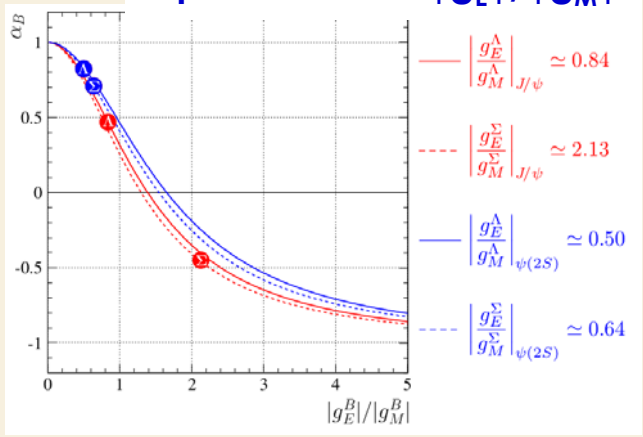
- **An effective model with the SU(3)-driven Lagrangian**

$$\mathcal{L}_{\Sigma\Lambda} = (G_0 + G_1)\Sigma^0\bar{\Sigma}^0 + (G_0 - G_1)\Lambda\bar{\Lambda}$$

Two types of symmetry breakings
Quark mass effects and E.M. effects

- **The interplay between leading G_0 and subleading G_1 contributions to the decay amplitudes determines the signs and values of α parameter**

α parameter vs $|g_E|/|g_M|$



Channel	BESIII	α	$\mathcal{B}$ ($\times 10^{-4}$)
$J/\psi \to \Lambda\bar{\Lambda}$		$0.469 \pm 0.026 \pm 0.008$	$19.43 \pm 0.03 \pm 0.33$
$J/\psi \to \Sigma^0\bar{\Sigma}^0$		$-0.449 \pm 0.020 \pm 0.008$	$11.64 \pm 0.04 \pm 0.23$
$\psi(3686) \to \Lambda\bar{\Lambda}$		$0.82 \pm 0.08 \pm 0.02$	$3.97 \pm 0.02 \pm 0.12$
$\psi(3686) \to \Sigma^0\bar{\Sigma}^0$		$0.71 \pm 0.11 \pm 0.04$	$2.44 \pm 0.03 \pm 0.11$

- **In case of J/ψ subleading contributions appear dominated by mass SU(3) breaking effects**

CONCLUSIONS

- The **largest J/ψ and ψ′ data sets** available in the World has been used by BESIII to measure for the first time or with improved statistics **Branching Fractions** and **Angular Distributions** for Two body Baryonic Decays
- **Large discrepancy** with **"12% rule"** has been found for most of the channels
- **Some α values** from the polar angle distributions are not consistent with naive predictions of pQCD models, which don't take into account higher order corrections for quark masses and e.m. effects
- Study of these baryonic decays may shed light on the **hadronization** process
- The **high precision** of the recent measurements demands a step forward on improved theoretical calculations to explain consistently the measurements
- Recently, **an effective model** which explains **α values** and ***BF*** for $\Lambda\bar{\Lambda}$ and $\Sigma\bar{\Sigma}$ decays has been proposed

THANK YOU !

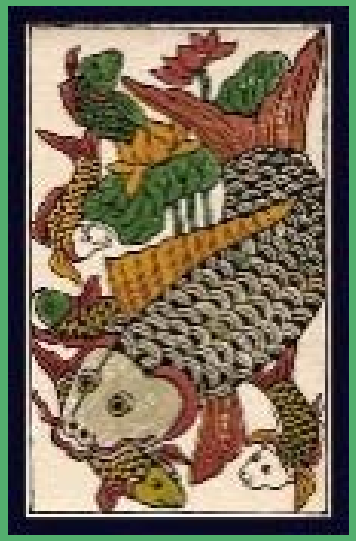
25th Anniversary of the Rencontres du Vietnam

Aug 5 – 11

ICISE

WINDOWS ON THE UNIVERSE 2018

SPARE

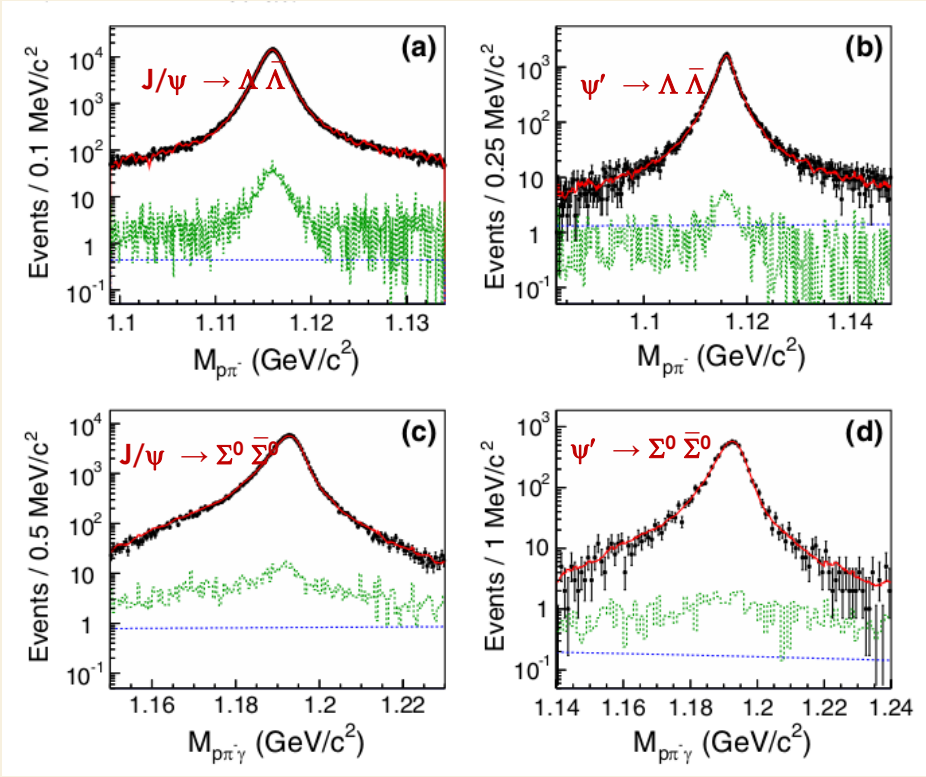


HYPERON CHARMONIUM DECAYS

Study of J/ψ and $\psi' \to \Lambda\bar{\Lambda}$ and $\Sigma^0\bar{\Sigma}^0$

PRD 95 (2017) 052003

data sample
$(1310.6 \pm 7.0) \times 10^6$ J/ψ
$(447.9 \pm 2.9) \times 10^6$ ψ'



$p\pi^-$ and $p\pi^-\gamma$
Invariant mass distributions

-Green dashed histograms:
MC simulated backgrounds
-Blue dotted line: other backgrounds

HYPERON CHARMONIUM DECAYS

Study of $J/\psi \rightarrow \Lambda\Lambda$

α_ψ **value from polar angle distribution**

$\Delta\phi$ **= 42.3°±0.6°±0.5° Phase angle between Electric and magnetic amplitudes**

α_- **Decay asymmetry for** $\Lambda \rightarrow p\pi^-$

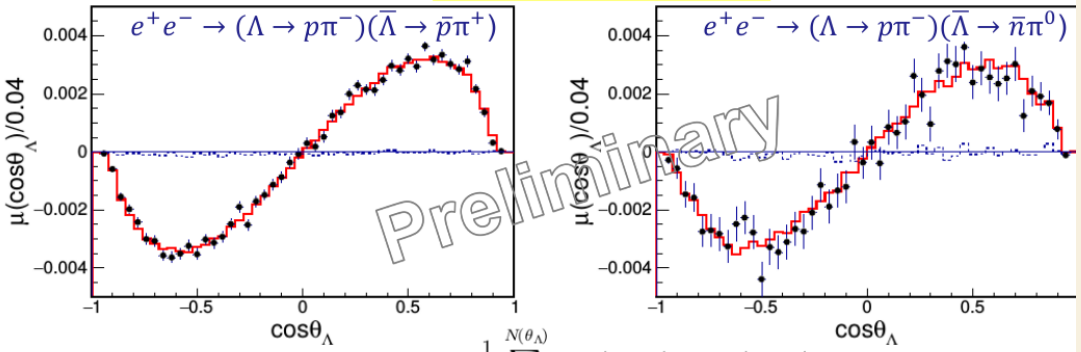
α_+ **Decay asymmetry for** $\bar{\Lambda} \rightarrow \bar{p}\,\pi^+$

α_0 **Decay asymmetry for** $\bar{\Lambda} \rightarrow \bar{n}\pi^0$

$A_{CP} = (\alpha_y + \alpha_{antiY})/(\alpha_y - \alpha_{antiY})$
CP asymmetry observable

Fit results

$\Delta\Phi = 42.3^o \pm 0.6^o \pm 0.5^o$



Moment: $\mu(\cos\theta_\Lambda) = \frac{1}{N}\sum_i^{N(\theta_\Lambda)} (\sin\theta_1^i \sin\phi_1^i - \sin\theta_2^i \sin\phi_2^i)$

A.Kupsc ICHEP 2018

Parameters	This work	Previous results	
α_ψ	$0.461 \pm 0.006 \pm 0.007$	0.469 ± 0.027	BESIII
$\Delta\Phi$ (rad)	$0.740 \pm 0.010 \pm 0.008$	–	
α_-	$0.750 \pm 0.009 \pm 0.004$	0.642 ± 0.013	PDG
α_+	$-0.758 \pm 0.010 \pm 0.007$	-0.71 ± 0.08	PDG
$\bar{\alpha}_0$	$-0.692 \pm 0.016 \pm 0.006$	–	
A_{CP}	$-0.006 \pm 0.012 \pm 0.007$	0.006 ± 0.021	PDG
$\bar{\alpha}_0/\alpha_+$	$0.913 \pm 0.028 \pm 0.012$	–	

Preliminary

HYPERON CHARMONIUM DECAYS

PRD 93 (2016) 072003

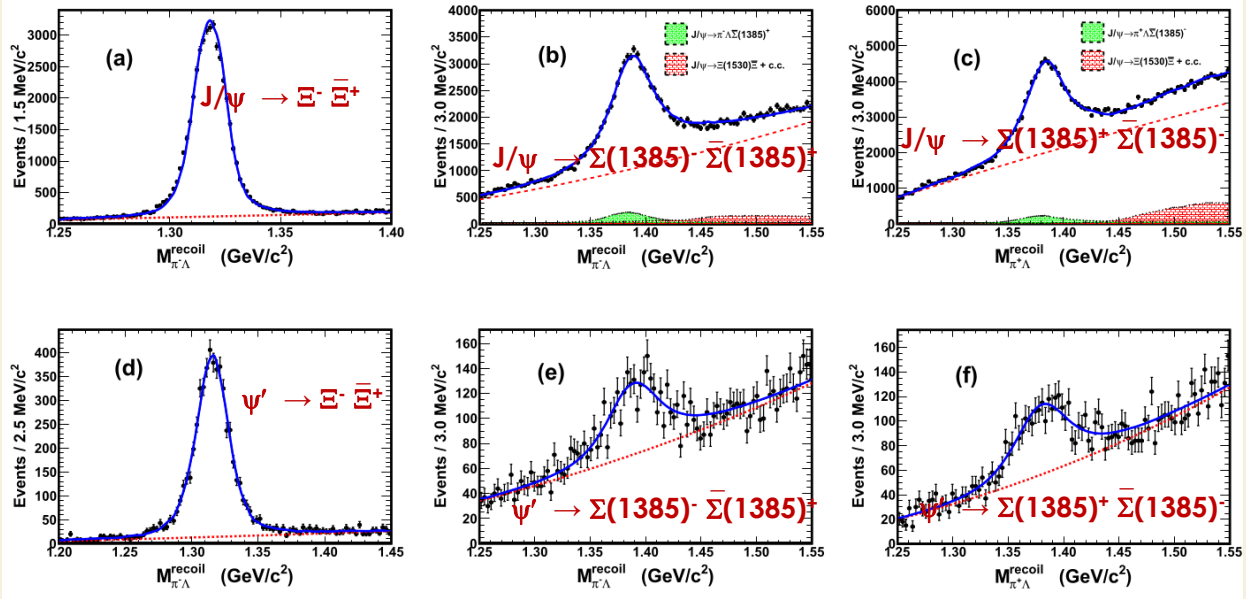
Study of J/ψ and $\psi' \to \Sigma(1385)^{\mp}\bar{\Sigma}(1385)^{\pm}$ and $\Xi^- \bar{\Xi}^+$

- **$\psi' \to \Sigma(1385)^{\mp}\bar{\Sigma}(1385)^{\pm}$ observed for the first time**

data sample
$(223.7 \pm 1.4) \times 10^6$ J/ψ
$(106.4 \pm 0.9) \times 10^6$ ψ'

-Single Baryon tag method to achieve higher efficiency and to reduce systematic errors
-Charged tracks of Ξ and $\Sigma(1385)$ decay products in MDC
-Anti-baryon candidate extracted from the mass recoiling against the $\Lambda\pi^{\pm}$ system

Recoil Mass Spectra of $\pi^-\Lambda$ and $\pi^+\Lambda$



-Hatched histos: peaking background
-Red dashed line: combinatorial background

HYPERON CHARMONIUM DECAYS

Study of J/ψ and $\psi' \to \Sigma(1385)^0\,\bar{\Sigma}(1385)^0$ and $\Xi^0\,\bar{\Xi}^0$

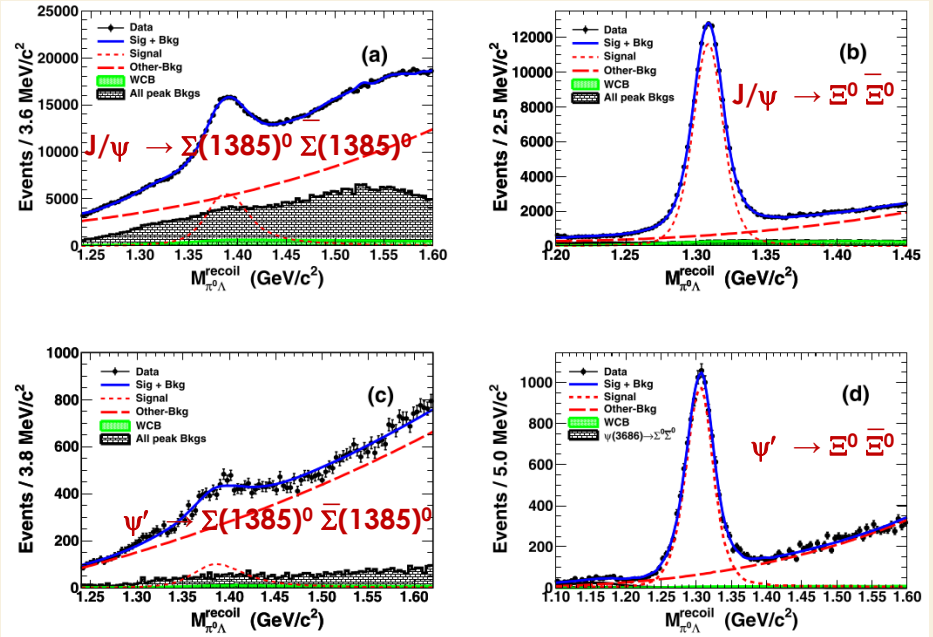
- **$\Sigma(1385)^0\,\bar{\Sigma}(1385)^0$ observed for the first time**

PLB 770 (2017) 217

data sample
$(1310.6 \pm 7.0) \times 10^6$ J/ψ
$(447.9 \pm 2.9) \times 10^6$ ψ'

-Single Baryon tag method to achieve higher efficiency and to reduce systematic errors
-Charged tracks in MDC
-Two photons from π^0 decay: isolated showers in EMC
-Anti-baryon candidate extracted from the mass recoiling against the $\Lambda\pi^0$ system

Recoil Mass Spectra of $\pi^0\Lambda$



-Black hatched line: peaking background
-Green hatched histos: wrong combination ($\pi^0\Lambda$) background WCB
-Red dashed line: other backgrounds

NUCLEON CHARMONIUM DECAYS

arXiv:1803.02039

Study of the decay $\psi' \to p \bar{p}$

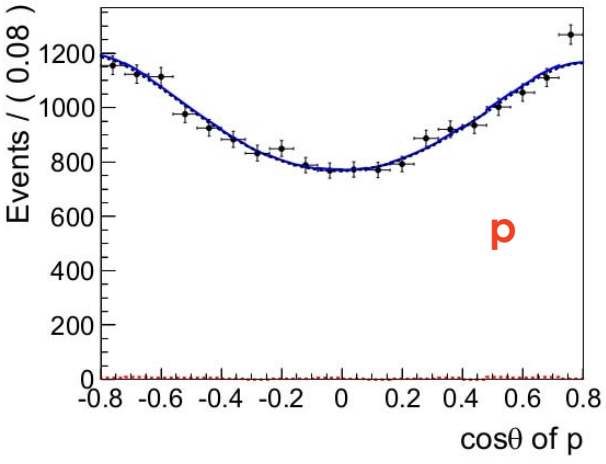
- **Measured 40 years ago**
- **Background from initial or final state radiation events**
- **Branching fractions and angular distributions have been measured**

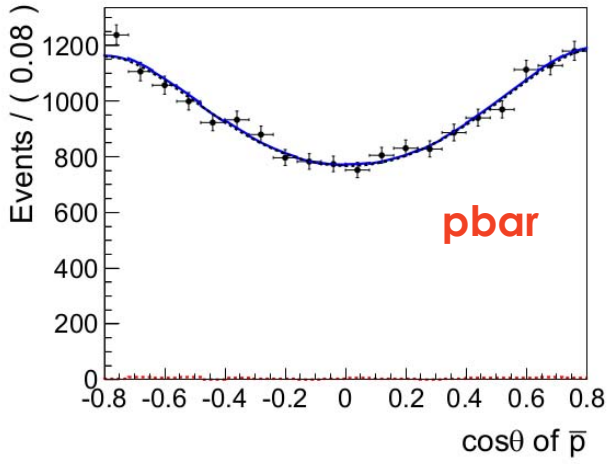
data sample: 1.07 x 10^8 ψ'
continuum data at 3.65 GeV: 44 pb^{-1}

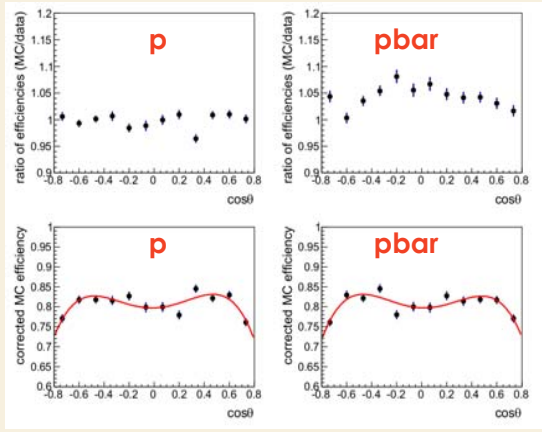
Two charged tracks with net charge = 0

$\mathcal{B}(\psi' \to \bar{p}\, p) = (3.05 \pm 0.02 \pm 0.12)10^{-4}$

$\alpha = 1.03 \pm 0.06 \pm 0.03$







Corrected MC efficiencies

NUCLEON CHARMONIUM DECAYS

arXiv:1803.02039

Study of the decay $\psi' \to n\bar{n}$

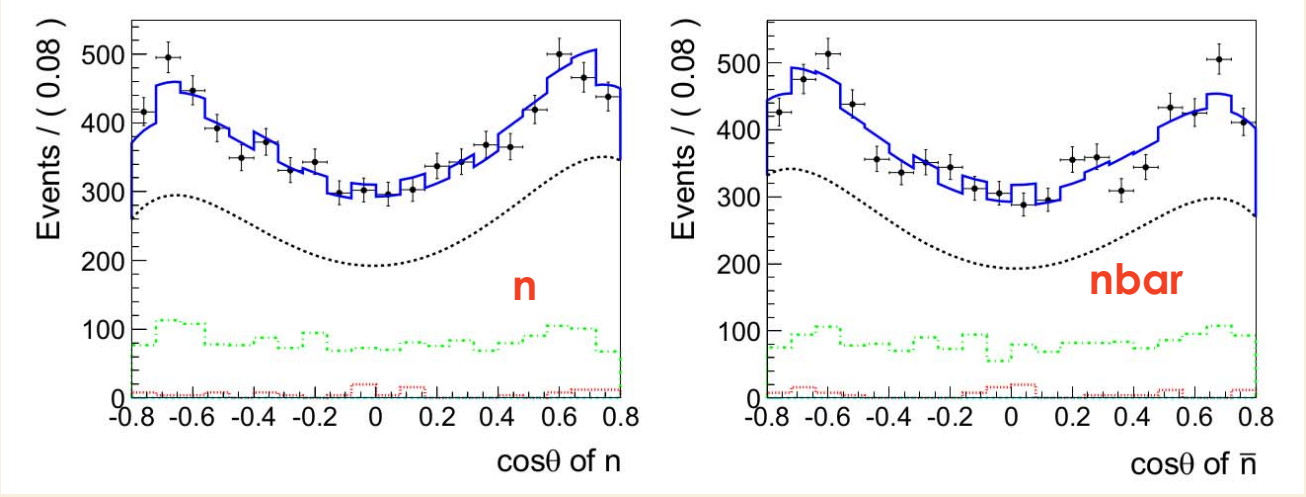
- **Measured for the first time**
- **Background** $e^+e^- \to \gamma\gamma$
- **Branching fractions and angular distributions have been measured**

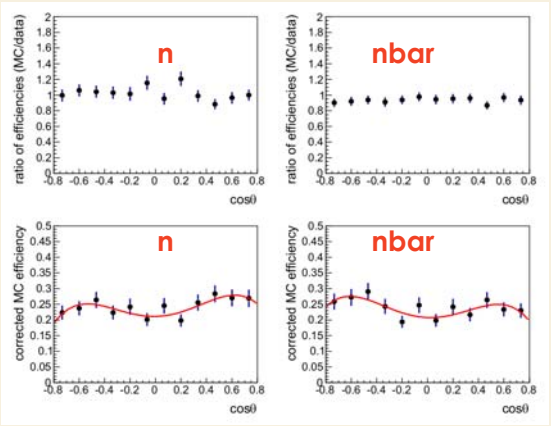
data sample 1.07 x 10^8 ψ'
continuum data at 3.65 GeV: 44 pb^{-1}

No charged tracks in MDC
Two showers (E > 600MeV, E > 60 MeV) in EM

$\mathcal{B}(\psi' \to \bar{n}n) = (3.06 \pm 0.06 \pm 0.14)10^{-4}$

$\alpha = 0.68 \pm 0.12 \pm 0.11$





Corrected MC efficiencies