Chung-Yao Chao Fellowship Interview 2021

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University of Science and Technology of China

June 5, 2021

Outline

- **Self-Introduction**
- **Publication and Achievements**
- **Research Experience**
  - **Physics Motivation**
  - **Study of P-wave $\chi_{cJ}(J = 0, 1, 2)$ decays**
  - **Study of $e^+e^- \to \Sigma^0\bar{\Sigma}^0$, using Rscan data**
  - **Summary and Outlooks**
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  - **Physics Motivation**
  - **Phase between the Strong and Electromagnetic Amplitudes of $J/\psi(\psi(2S)) \to \Sigma\bar{\Sigma}$ Decays, using $J/\psi(\psi(2S))$ scan data**
  - **Preliminary Results**
  - **Future Prospects**

Resume–Personal Detail

Work Experience:

- **June 2020 - Present:** Postdoctoral researcher at USTC, China
- **June 2013 - 2014:** Visiting Lecturer at Punjab University, Pakistan
- **June 2014 - 2016:** Teacher Trainer at KIPS College, Pakistan

Education:

- **June 2016 - 2020:** (CAS-TWAS fellowship)
  - **Ph.D student** in Nuclear and Particle Physics at USTC, China
- **June 2011 - 2013:** (CGPA 4.0/4.0)
  - **Masters's Degree** in High Energy Particle Physics at Punjab University, Pakistan
- **June 2006 - 2010:** (Gold Medal)
  - **Bachelor's Degree** in High Energy Particle Physics at Punjab University, Pakistan

Research Areas:

- BESIII Collaboration since 2017, I have joined USTC working on:
  - Charmonium Physics → Radiative transition of $\psi(2S)$
  - τ−QCD → Form factor and Relative Phase measurements
- Regularly presented work at BESIII Collaboration meeting and Workshops

Today I will focus on the recent results achieved at USTC and future plans

Publication

- First measurements of $\chi_{cJ} \to \Sigma^- \overline{\Sigma}^+ (J = 0, 1, 2)$ decays → M. Ablikim *et al.* (BESIII Collaboration), Phys. Rev. D **101**, 092002 (2020) **link**

Work Under Review

- Measurement of the $e^+e^- \to \Sigma^0\bar{\Sigma}^0$ cross section from production threshold to 3.02 GeV at BESIII **link**. (BAM-00441 at Collaboration Wide Review stage)

Internal Referee

- Study of Ξ^- Baryon Polarization in $\psi(3686) \to \Xi^-\bar{\Xi}^+$ decay at BESIII (BAM-00487) **link.**

Achievements

- Participate in **Hadron Physics Summer School** in winter, presented a talk on "Improve the detector simulation techniques in Hadron Spectroscopy", JUFA Julich, Germany, September, 2018.
- CAS-TWAS President's Fellowship awarded for Ph.D study.
- University Gold Medal for obtaining first position in Bachelors in HEP.

Previous Work-I

Measurement of BFs of $\chi_{cJ} \to \Sigma^{-}\bar{\Sigma}^{+}$ (J=0,1,2) decays

Models that can predicts the decay rates of $\chi_{cJ} \to B\bar{B}$:

- **Color Octet Mechanism (COM)**
  - The next higher Fock state in the p-wave charmonium so-called **color octet**
  - **This higher state is made up of the $c\bar{c}$ plus a gluon**
- **Helicity Selection Rule (HSR)**
  - When charmonium meson $J_{c\bar{c}}$ decaying into two light mesons h_1 and h_2, the perturbative method gives the asymptotic behavior of the branching ratio as follows:

$$\mathrm{BR}\left[J_{c\bar{c}}(\lambda) \to h_1(\lambda_1)\, h_2(\lambda_2)\right] \sim \left(\frac{\Lambda_{\mathrm{QCD}}^2}{m_c^2}\right)^{|\lambda_1+\lambda_2|+2}$$

  - **If $\lambda_1 + \lambda_2 \neq 0$, which will violate the HSR and it is supposed to be suppressed**
- **Quark Creation Model (QCM)**
  - The **limits of the helicity conservation rule can be removed**, so that some **forbidden** decay processes, *i.e.* $\chi_{c0} \to B\bar{B}$ can be investigated.
  - **This model strengthened decay channels $\chi_{cJ} \to \Lambda\bar{\Lambda}$ (J=0,2) are understood, by including only the color singlet contribution.**
- **Large BFs of $\psi(2S) \to \gamma\chi_{cJ}$ make e^+e^- collisions at the $\psi(2S)$ resonance** a very clean environment for χ_{cJ} investigation.

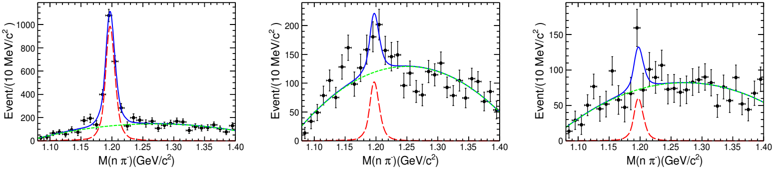
Theoretical and Phenomenological Results

BFs comparison for various $\chi_{cJ} \to B\bar{B}$ in units of 10^{-5}

Mode		χ_{c0}	χ_{c1}	χ_{c2}
$p\bar{p}$	BES	$27.1^{+4.3}_{-3.9} \pm 4.7$	$5.7^{+1.7}_{-1.5} \pm 0.9$	$6.5^{+2.4}_{-2.1} \pm 1.0$
	PDG	22.1 ± 0.08	7.60 ± 0.34	7.33 ± 0.33
	Theory	...	6.4	7.7
$\Lambda\bar{\Lambda}$	BESIII	$33.3 \pm 2.0 \pm 2.6$	$12.2 \pm 1.1 \pm 1.1$	$20.8 \pm 1.6 \pm 2.3$
	PDG	33.0 ± 4.0	11.8 ± 1.9	18.6 ± 2.7
	Theory	$(93.5 \pm 20.5^a, \mathbf{22.1 \pm 6.1^b})$ **(QCM)**	...	$(15.2 \pm 1.7^a, 4.3 \pm 0.6^b)$
		11.9 − 15.1 (COM)	3.9	3.5
$\Sigma^0\bar{\Sigma}^0$	BESIII	$47.7 \pm 1.8 \pm 3.5$	$4.3 \pm 0.5 \pm 0.3$	$3.9 \pm 0.5 \pm 0.3$
	PDG	44.0 ± 4	< 4.0	< 6.0
	Theory	$(\mathbf{25.1 \pm 3.4^a, 18.7 \pm 4.5^b})$	...	$(38.9 \pm 8.8^a, 4.2 \pm 0.5^b)$
		...	3.3	5.0
$\Sigma^+\bar{\Sigma}^-$	BESIII	$50.4 \pm 2.5 \pm 2.7$	$3.7 \pm 0.6 \pm 0.2$	$3.5 \pm 0.7 \pm 0.3$
	PDG	39.0 ± 7.0	< 6.0	< 7.0
	Theory	**5.6 − 6.9 (COM)**	3.3	5.0
$\Xi^-\bar{\Xi}^+$	BESIII	$53.0 \pm 2.7 \pm 0.9$	< 3.4	< 3.7
	PDG	48.0 ± 7.0	8.0 ± 2.1	< 10.0
	Theory	$\mathbf{23.0 \pm 7.0}$ **(QCM)**	...	4.8 ± 2.1
		...	2.4	3.4
$\Xi^0\bar{\Xi}^0$	BESIII	$46.7 \pm 1.9 \pm 2.3$	$7.5 \pm 1.1 \pm 0.5$	$18.3 \pm 1.5 \pm 1.4$
	PDG	31.0 ± 8.0	< 6.0	< 10.0
	Theory	$\mathbf{23.0 \pm 7.0}$ **(QCM)**	...	4.8 ± 2.1
		...	2.4	3.4

- **Experimentally, there are no BFs results of $\chi_{cJ} \to \Sigma^-\bar{\Sigma}^+$**, necessary to further test the validity of **COM, HSR, QCM and prediction of isospin symmetry**.

Fit Results: **The fitted signal yields of $\psi(3686) \to \gamma\chi_{cJ}$ as a function of $M(n\pi^-)$.**



BF measurements of $\chi_J \to \Sigma^-\bar{\Sigma}^+$:

- **First measurement ever**, due to difficult reconstruction of $\boldsymbol{n\bar{n}\pi^+\pi^-}$.
- Prove the **isospin symmetry in strong interaction** comparing to $\chi_{cJ} \to \Sigma^+\bar{\Sigma}^-$.
- **BF of $\chi_{c0} \to \Sigma^-\bar{\Sigma}^+$ do not vanish**, which **demonstrates a strong violation of the HSR**.
- **Both COM and QCM fails to describe our measured result**.

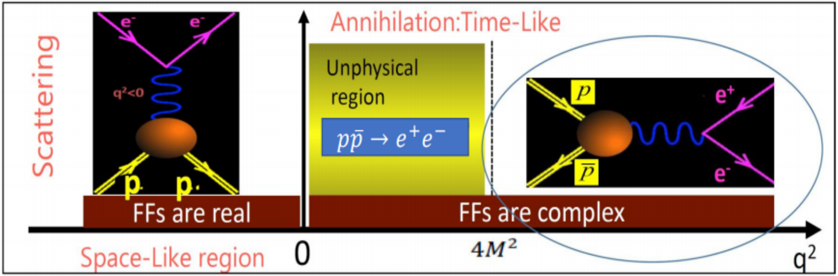
Results of the BFs (in units of 10^{-5}) **for the measurement of** $\chi_{cJ} \to \Sigma^-\bar{\Sigma}^+$

Channel	This work	$S(\sigma)$	BESIII	Theoretical predictions	
	$\chi_{cJ} \to \Sigma^-\bar{\Sigma}^+$		$\chi_{cJ} \to \Sigma^+\bar{\Sigma}^-$	COM	QCM
$\chi_{c0} \to \Sigma^-\bar{\Sigma}^+$	$51.3 \pm 2.4 \pm 4.1$	$30\,\sigma$	$50.4 \pm 2.\ 5 \pm 2.7$	5.9-6.9	18.1 ± 3.9
$\chi_{c1} \to \Sigma^-\bar{\Sigma}^+$	$5.7 \pm 1.4 \pm 0.6$	$5.8\,\sigma$	$3.7 \pm 0.6 \pm 0\ .2$	3.3	...
$\chi_{c2} \to \Sigma^-\bar{\Sigma}^+$	$4.4 \pm 1.7 \pm 0.5$	$3.6\,\sigma$	$3.5 \pm 0.7 \pm 0\ .3$	5.0	4.3 ± 0.4

Work Under Review-II

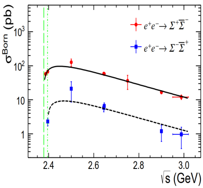
Study of $\Sigma^0\bar{\Sigma}^0$ from $\sqrt{s} = 2.3864$ to 3.0200 GeV using R-scan data

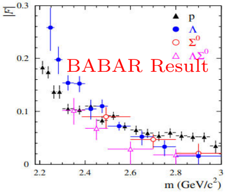
- EMFFs are accessed in kinematical regions of (transfered squared four-momentum) q^2 through study of space- and timelike processes.
- Hyperons are difficult to study in the SL region but TL form factors offers the best opportunity to study of Hyperons.
- Time-like baryons EMFFs is accessible in e^+e^- collision.
- **Our aim to probe the cross section near threshold of hyperon pairs experimentally**.

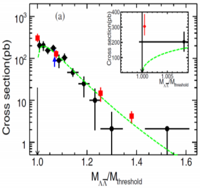


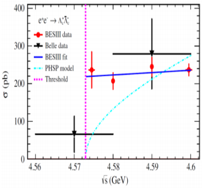
Spin 1/2 Baryons:

- Two independent EMFFs: $G_E(s), G_M(s)$ ($s = q^2$, four momentum transfer).
- In one-photon exchange: ($\tau = \frac{q^2}{4m_B^2}, \beta = \sqrt{1 - \frac{4m_B^2}{q^2}}$, Coulomb factor C)
  - Total cross section: $\sigma_{B\bar{B}}(s) \equiv \frac{4\pi\alpha^2\beta\, C}{3s}[|G_M(s)|^2 + \frac{1}{2\tau}|G_E(s)|^2]$
  - Effective FFs: $|G_{\text{eff}}\,(s)| = \sqrt{\frac{\sigma(s)}{\frac{4\pi\alpha^2\beta C}{3s}[1+\frac{1}{2\tau}]}}$
- **Observed Threshold Enhancement**: For example $p\bar{p}$, $\Lambda\bar{\Lambda}$, $\Lambda_c\bar{\Lambda}_c$, ...
- Hyperons FFs are hardly explored. The precision of hyperons FFs are quite poor and better results to be demanded in future.
  [https://docbes3.ihep.ac.cn/DocDB/0007/000742/004/sigsig.pdf]



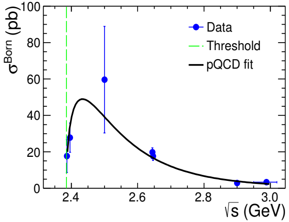


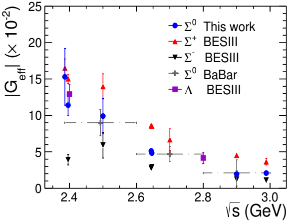




Outlooks:

- Cross section lineshape for $e^+e^- \to \Sigma^0\bar{\Sigma}^0$ is well fitted by **pQCD-motivated function**.
- Improved precision compared to BaBar's measurements over 50% **above** $\sqrt{s} \geqslant 2.5000$ **GeV**.
- **Novel method** has applied at production threshold, **no significant signal is observed at 2.3864 GeV.**
- An **asymmetry of isospin triplet** is observed, and consistent with their **incoherent sum of squared of charges of valence quraks**.
- Cross section between Λ and Σ^0 is shown to provide the **proof for diquark-correlation**.
- **For complete determination of FFs more data sets will be needed in future at BESIII.**





- **Our results provide a valuable experimental inputs to understand the hyperons-antihyperons production in both strong and EM interactions.**

Proposed Work joint effort of USTC and Ferra group Itlay

Phase between the Strong and Electromagnetic Amplitudes of $J/\psi(\psi(2S)) \to \Sigma\bar{\Sigma}$ Decays, using $J/\psi(\psi(2S))$ scan data

J/ψ Strong and EM Decay Amplitudes:

Resonant contributions:

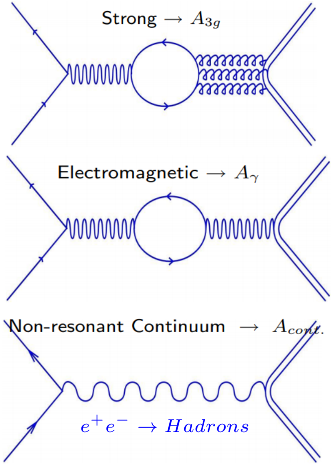
- pQCD: all amplitudes almost real[1,2]
- QCD → small phases foreseen $\Phi_{3g,\gamma} \sim 10^{\circ}$
- Experimental observation → Large Phase foreseen

Non-resonant continuum:

In pQCD regime

- $A_{\gamma} \epsilon \mathcal{R}$
- If both real, continuum and resonant amplitudes must interfere
- Phase b/w $A_{3g}, A_{\gamma} \rightarrow (\Phi_{3g,\gamma} \sim 0^{\circ}/180^{\circ})$

→ No theory can give the satisfactory explanation of the origin of $\Phi_{3g,\gamma}$ → better knowledge of it may lead profound understanding of charmonia decays.



Phys.Lett. B **791, 375 (2019)**

[1] Phys. Rev. Lett. **59**, 621 (1987)

[2] Nucl. Phys. B **246**, 52 (1984)

$J/\psi/\psi(2S)$ strong and electromagnetic decay amplitudes

Theoretical predication:

- Model depended approach using SU(3) flavor symmetry suggested:
  - $\Phi_{3g,\gamma} \sim 90^\circ \to$ **No interference**

Experimental results:

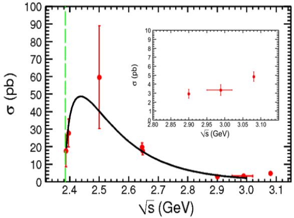
- Indirect results based on SU(3)
  - $J/\psi \to \mathrm{N\bar{N}}\ (1/2^+ 1/2^-)$ $\Phi_{3g,\gamma} = (88.7 \pm 8.1)^\circ$ [1]
  - $J/\psi \to \mathrm{VP}\ (1^- 0^-)$ $\Phi_{3g,\gamma} = (106 \pm 10)^\circ$ [2]
  - $J/\psi \to \mathrm{PP}\ (0^- 0^-)$ $\Phi_{3g,\gamma} = (89.6 \pm 9.9)^\circ$ [3]
  - $J/\psi \to \mathrm{VV}\ (1^- 1^-)$ $\Phi_{3g,\gamma} = (138 \pm 37)^\circ$ [3]
  - $\psi(2S) \to \mathrm{PP}\ (0^- 0^-)$ $\Phi_{3g,\gamma} = (95 \pm 15)^\circ$ [4]
  - $\psi(2S) \to \mathrm{N\bar{N}}\ (1/2^+ 1/2^-)$ $\Phi_{3g,\gamma} = (-98 \pm 25)^\circ$ or $(134 \pm 25)^\circ$
  - $\psi(2S) \to \mathrm{VP}\ (1^\pm 0^-)$ $\Phi_{3g,\gamma} \sim 0^\circ$ No evidence for large phase
- Direct results through lineshape scan
  - $J/\psi \to 5\pi$ $\Phi_{3g,\gamma} = (84 \pm 3.6)^\circ$ or $(-84.9 \pm 3.6)^\circ$
- **All analyses revealed that a relative orthogonal phase exist b/w A_{3g} and A_γ**

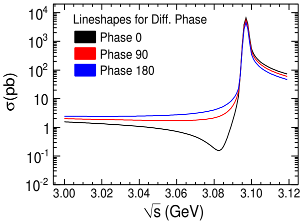
[1] Phys. Rev. D **86**, 032014 (2012)
[2] Phys. Rev. D **41**, 01389 (1990)
[3] Phys. Rev. D **60**, 051501 (1999)
[4] Phys. Rev. D **74**, 011105 (2006)

Why this measurement is important?

- Jump has been observed while studied $e^+e^- \to \Sigma^\circ\bar{\Sigma}^\circ$ at 3.08 GeV at BESIII.
- $J/\psi \to \Sigma^\circ\bar{\Sigma}^\circ$ decays the phase may not be compatible with 90°.
- Scan below and at $J/\psi(\psi(2S))$ resonance data provides unique opportunity for the first ever phase measurement of hyperon-antihyperon ($\Sigma^\circ\bar{\Sigma}^\circ$) at BESIII.
- It should be a bed-test for perturbative QCD (pQCD) model predictions, SU(3) symmetry and SU(3) symmetry breaking hypotheses.
- With a model independent fit to study the interference pattern

BAM-00441





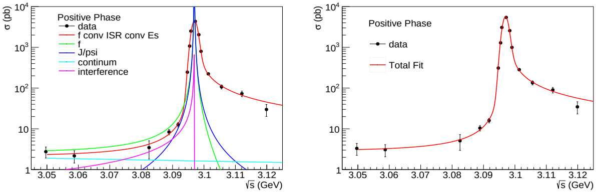
Phase Measurement

Prelimanry Results

Preliminary Results by J/ψ lineshape

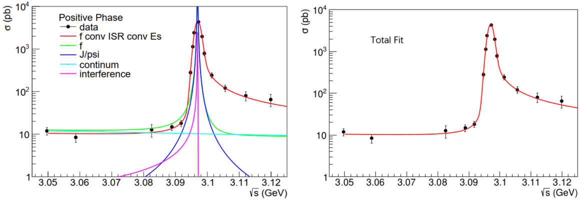
1. Fitting Result for $J/\psi \to \Sigma^\circ \bar{\Sigma}^\circ$

Preliminary value of phase: $\Phi_{3g,\gamma} \approx \pm(157.0 \pm 49.3)^\circ$ $\to$ **Ref.link1**



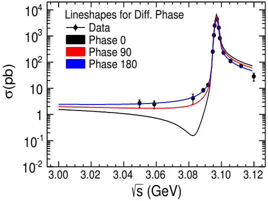
2. Fitting Result for $J/\psi \to \Sigma^+ \bar{\Sigma}^-$

Preliminary value of phase: $\Phi_{3g,\gamma} \approx \pm(114.5 \pm 12.7)^\circ$ $\to$ **Ref.link2**



Summary of Phase determination

- Preliminary results reveal that $\Phi_{3g,\gamma}$ amplitudes of $J/\psi \to \Sigma^{\circ}\bar{\Sigma}^{\circ}$decay is not compatible with $\sim 90^{\circ}$.
- Current result is inconsistent with prediction based on SU(3) octet baryons and favor to the pQCD.
- First measurement ever, since we always treated the phase for SU(3) octet baryons to be same as $\sim 90^{\circ}$.
- Large relative phase value brings a new challenge for theoretician to deeply understand the quarkonium dynamic.



- Since phase 90° is virtually impossible in $\psi(2S)$ decays as predicted. So, it is matter of great concern the large phase is consistent with the $\psi(2S)$ data.

Summary – Outlooks

- Exciting 4-years of PhD at USTC and China.
- I have joined BESIII Collaboration since 2017 and published one article in Physical Review D and completed one Memo-BAM-00441.
- Starting from June 2020 till now, I am postdoctoral researcher at USTC.
- On-going analysis BAM-00441 is in CWR stage at BESIII and intended general to be Physics Letters B.
- At present, I am assigning internal referee of BAM-00487 at BESIII.
- **Responsible for phase project at USTC and already achieved preliminary results for two process $J/\psi \to \Sigma^{\circ}\bar{\Sigma}^{\circ}$and $J/\psi \to \Sigma^{+}\bar{\Sigma}^{-}$.**

Future plan

- Active participation in Physics measurements using BESIII data and focus on phase study through $J/\psi(\psi(2S))$ lineshape scan (direct approach).
- Our plan to present the phase measurement $J/\psi \to \Sigma^{\circ}\bar{\Sigma}^{\circ}$ in upcoming BESIII Workshop held in Lanzhou University.
- **Use my expertise in hyperon reconstruction to explore new aspects by studying $\psi(2S) \to \Sigma^{0}\bar{\Sigma}^{0}$ lineshape.**

Thanks for your attention!

Back up

Ecm (GeV)	RunID	BEMS ECM(GeV)	$L_{int}(nb^{-1})$
3.0500	28312 – 28346	3.050206 ± 0.000026	14919 ± 161
3.0600	28347 – 28381	3.059257 ± 0.000028	15060 ± 161
3.0830	28382 – 28387, 28466 – 28469	3.083060 ± 0.000023	4769 ± 55
3.0900	28388 – 28416, 28472 – 28475	3.089418 ± 0.000022	15558 ± 165
3.0930	28417 – 28453, 28476 – 28478	3.092324 ± 0.000025	14910 ± 160
3.0943	28479 – 28482	3.095261 ± 0.000084	2143 ± 25
3.0952	28487 – 28489	3.095994 ± 0.000081	1816 ± 21
3.0958	28490 – 28492	3.096390 ± 0.000075	2135 ± 25
3.0969	28493 – 28495	3.097777 ± 0.000076	2069 ± 26
3.0982	28496 – 28498	3.098904 ± 0.000075	2203 ± 25
3.0990	28499 – 28501	3.099606 ± 0.000093	756 ± 11
3.1015	28504 – 28505	3.101923 ± 0.000106	1612 ± 21
3.1055	28506 – 28509	3.106144 ± 0.000090	2106 ± 25
3.1120	28510 – 28511	3.112615 ± 0.000093	1720 ± 21
3.1200	28512 – 28513	3.120442 ± 0.000115	1264 ± 16

B.X. Zhang, Luminosity measurement for J/psi phase and lineshape study

- **Analysis Environment: Under the BOSS 6.6.4.p01**

$\psi(2S)$ Phase Scan – Real Data

Ecm (GeV)	RunID	Number of Run	Data taken time	$\mathcal{L}$ (pb^{-1})
3.5815	55375 – 55461	83	180505 – 180508	84.604 ± 0.082
3.6702	55462 – 55541	80	180508 – 180512	83.582 ± 0.084
3.6081	55542 – 55635	91	180512 – 180515	83.060 ± 0.083
3.6828	55636 – 55662	26	180516 – 180516	28.175 ± 0.049
3.6842	55663 – 55690	28	180517 – 180518	27.840 ± 0.048
3.6853	55691 – 55716	25	180519 – 180519	25.342 ± 0.046
3.6865	55717 – 55737	20	180519 – 180520	24.481 ± 0.045
3.6914	55738 – 55795	57	180520 – 180523	68.647 ± 0.076
3.7098	55796 – 55859	60	180523 – 180525	69.326 ± 0.077

B.X. Zhang, Luminosity measurement for $\psi(2S)$ phase and lineshape study

- **Analysis Environment: Under the BOSS 7.0.4**

To Fit the Lineshape:

- The cross section of $e^+e^- \rightarrow \Sigma^{\circ}\bar{\Sigma}^{\circ}$ is expressed as:
  $\sigma(W) = \left| D \frac{Se^{i\phi}+E}{M_{J/\psi}-W-i\Gamma_{J/\psi}/2} - C \right|^2$
- $\boldsymbol{B}_{J/\psi\rightarrow\Sigma^0\bar{\Sigma}^0} = constant \times \left|\boldsymbol{S}e^{i\phi} + \boldsymbol{E}\right|^2$
- where constant $= 1/0.3894 \times 10^9$ (pb-to- GeV^{-2} conversion factor)
- $J/\psi \rightarrow e^+e^-$ **Amplitude:** $D = \frac{\Gamma_{J/\psi}/2}{M_{J/\psi}} \sqrt{12\pi B_{J/\psi\rightarrow e^+e^-}}$

For Continuum Amplitude:

- $\sigma_{\text{cont}}(W) = \sigma_o(\frac{W_o}{W})^{\text{pQCD}} = C^2$
- $C = \sqrt{\sigma_{\text{o}}(3\text{GeV})} \left(\frac{3\text{GeV}}{W}\right)^{\frac{p\text{QCD}}{2}=5}$

Electromagnetic Amplitude: EM contribution to the Feynman diagram, we look at ratio b/w B_{out} of the final state and $B_{\mu\mu}$. EM amplitude simplified as:

- $E = \sqrt{\frac{C^2}{\sigma_{e^+e^-\rightarrow\mu^+\mu^-}} B_{J/\psi\rightarrow\mu^+\mu^-}}$

Fitting Procedure

To Fit the Lineshape: To incorporating the the effect of radiative function $F(x, W)$ and Energy Spread S_E in the fit, the dressed Born cross section is modified as;

- **Step1.** Incorporating the radiative correction $F(x, W)$:
  $\sigma'(W) = \int_0^{1-\left(\frac{W_{\min}}{W}\right)^2} dx F(x, W)\sigma(W\sqrt{1-x})$
- **Step2.** Energy spread S_E is included by convolving with Gaussian function by set the width of S_E. The Born cross section becomes:
  $\sigma''(W) = \int_{W-nS_E}^{W+nS_E} \frac{1}{\sqrt{2\pi}S_E} \exp\left(\frac{-(W-W')^2}{2S_E^2}\right) \sigma'(W')\, dW$

Minimization Function: The fitting parameters are obtained by means of χ^2-minimization as:

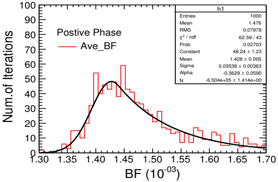
$$\chi^2_{\min} = \sum_{i=1}^{15} \frac{\left(\sigma_i^{\rm obs} - \sigma''(W_i)\right)^2}{\left(\Delta\sigma_i^{\rm obs}\right)^2 + \left[\left(\sigma''\left(W_i + \frac{\Delta W_i}{2}\right) - \sigma''\left(W_i - \frac{\Delta W_i}{2}\right)\right)\right]^2},$$

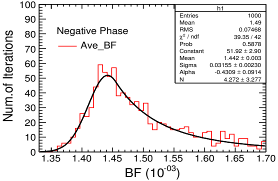
where error along X-axis, is projected along the Y-axis.

Preliminary Result $J/\psi \to \Sigma^0\bar{\Sigma}^0$- Solution-I,II

Branching Fractions:

- Since the parameters are high correlated therefore, the error in the $BF(J/\psi \to \Sigma^0\bar{\Sigma}^0)$ is obtained after parametrized the value of each parameter.





This Work

- **In PDG: BF =** $(1.172 \pm 0.031) \times 10^{-3}$
- **For +ve phase:** BF $=(1.428 \pm 0.035) \times 10^{-3}$
- **For -ve phase:** BF $=(1.442 \pm 0.032) \times 10^{-3}$
- Floating all parameters in a fit such as; Strong, Continuum, $\Phi_{3g,\gamma}$ and S_E.

Solution	$\Delta\Phi_{3g,\gamma}(^\circ)$	**SE (MeV)**	$BF(J/\psi \to \Sigma^0\bar{\Sigma}^0)$	χ^2/ndf
Sol-I	157.0 ± 49.3	0.915 ± 0.0004	$(1.428 \pm 0.035) \times 10^{-03}$	9.36/11.0
Sol-II	-156.7 ± 47.4	0.915 ± 0.0004	$(1.442 \pm 0.032) \times 10^{-03}$	9.36/11.0

Fitting results on J/ψ lineshape from $\Sigma^0\bar{\Sigma}^0$ with statistical error only.