Experimental Results on $Z_c(3900)$ (BESIII & Belle)

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Outline

1. Discovery of $Z_c(3900)$ at BESIII.
2. Discovery of $Z_c(3900)$ at Belle.
3. CLEO’s data (unpublished).
4. Comparison between different experiments.
5. Future Working Plan for $Z_c(3900)$. 
BESIII’s data

1. BEPCII is a symmetric Collider.
2. BESIII take data at e+e- c.m energy from 2 to 4.6 GeV.
3. Design luminosity $1 \times 10^{33} / \text{cm}^2 / \text{s}$, reach 70%.

BESIII can study XYZ particle above 4 GeV with world’s largest scan data sets.
1. Dec, 2012 to Jan, 2013, BESIII accumulate 525 pb$^{-1}$ data @ 4.26 GeV.
2. Peak position of $\gamma(4260)\rightarrow \pi^+\pi^- J/\psi$ cross section.
3. $N(\mu^+\mu^-)=882 \pm 33$; $N(e^+e^-)=595 \pm 28$; purity $\sim 90\%$. 

PRL 110,252001 (2013).
Z_c(3900) from BESIII

1. Dec, 2012 to Jan, 2013, BESIII accumulate 525 pb^{-1} data @ 4.26 GeV.
2. Peak position of γ(4260)→π^+π^-J/ψ cross section.
3. N(μ+μ-) = 882 ± 33; N(e+e-) = 595 ± 28; purity ~90%.
4. Born cross section: σ^B = (62.9 ± 1.9 ± 3.7) pb at BESIII.
5. Good agreement with Belle and BaBar.
1. Structure in $M(\pi^\pm J/\psi)$ mass distribution.
2. Phase space reflection of $Z_c(3900)$. 
$Z_c(3900)$ from BESIII

PRL 110, 252001 (2013).

1. Structure in $M(p^+J/\psi)$ mass distribution.
2. Phase space reflection of $Z_c(3900)$. 
1. 1D fit to extract resonant parameters.
2. Divided Dalitz plot by diagonal line; Fit $M_{\text{max}}(\pi^{\pm}J/\psi)$ mass distribution.
3. S-Wave Breit Wigner; $p^*q$ phase space factor; efficiency applied.
4. $M=(3899.0 \pm 3.6 \pm 4.9)\text{MeV}; \Gamma=(46 \pm 10 \pm 20)\text{MeV}$.
5. Statistical significance: $>8\sigma$, discovery!
$Z_c(3900)$ from Belle

**Integrated luminosity of B factories**

- KEKB: $> 1 \text{ ab}^{-1}$
  - On resonance: $\Upsilon(5S): 121 \text{ fb}^{-1}$
  - $\Upsilon(4S): 711 \text{ fb}^{-1}$
  - $\Upsilon(3S): 3 \text{ fb}^{-1}$
  - $\Upsilon(2S): 25 \text{ fb}^{-1}$
  - $\Upsilon(1S): 6 \text{ fb}^{-1}$
- PEP-II: $\sim 100 \text{ fb}^{-1}$

- KEKB: $\sim 550 \text{ fb}^{-1}$
  - On resonance: $\Upsilon(4S): 433 \text{ fb}^{-1}$
  - $\Upsilon(3S): 30 \text{ fb}^{-1}$

**ISR technique**

$J^{PC} = 1^{--}$, $\psi', \psi''$, $\Upsilon$...
1. Belle collected data at/near $Y(nS)$ ($n=1,\ldots,5$) resonance.
2. Almost full Belle data sample used: Lum=967 fb$^{-1}$ data.
3. Using ISR photon non-tagged method, $Y(4260)$ was observed significantly.
4. $4.15 < M(\pi^+\pi^-J/\psi) < 4.45$ GeV to select $Y(4260)$ resonance.
5. Dalitz plot also shows structures.
Z(3900)± from Belle

PRL 110, 252002 (2013)
1. Belle use the same fit strategy to $M_{\text{max}}(\pi^\pm J/\psi)$ distribution.
2. S-Wave BW, $p^*q$ phase space factor, efficiency applied.
3. Belle observed 689 events, with 139 background.
4. $M=(3894.5 \pm 6.6 \pm 4.5) \text{ MeV}; \Gamma=(63 \pm 24 \pm 26) \text{ MeV}.$
5. Significance: $5.2\sigma.$
BESIII + Belle + CLEO’s data

1. $Z_c(3900) = Z(3900)^\pm$.
2. CLEO’s data at 4.17 GeV by K. Seth.
3. $M = 3885 \pm 5$ MeV, $\Gamma = 34 \pm 13$ MeV.
4. Significance: $6\sigma$ (Still not published for unknown reason!)

Seth

arXiv: 1304.3036
The $\pi^+\pi^-$ amplitude is similar in $Y(4260) \rightarrow \pi^+\pi^- J/\psi$ decay.

Help understand the $Y(4260)$ and $Z_c(3900)$?
Summary