Recent quarkonium results from Belle

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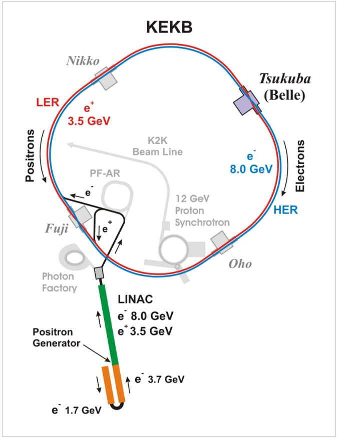
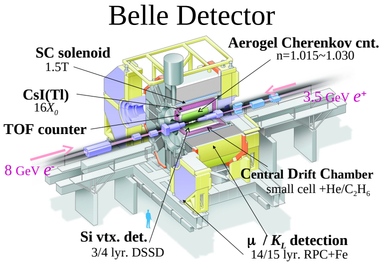
(On behalf of the Belle collaboration)

IPA2022 - Interplay between Particle & Astro particle Physics 2022
Technische Universität, Wien
Sep 05 - 09, 2022

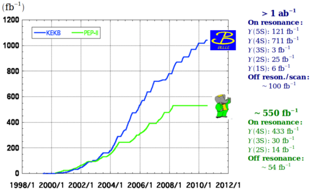
KEKB and belle detector



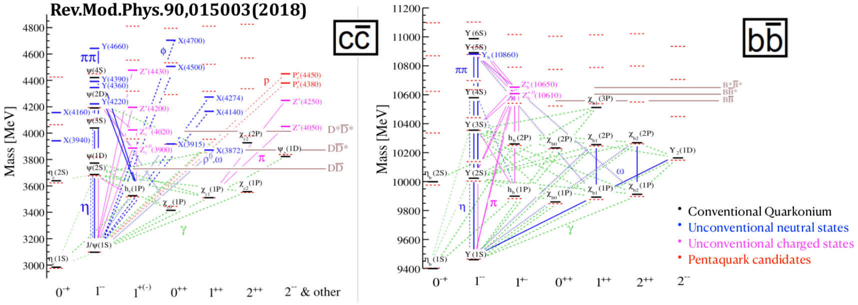


- $e^-(8\ \mathrm{GeV}) \rightarrow\leftarrow \mathrm{e}^+(3.5\ \mathrm{GeV})$
- $\sqrt{s} = 10.58\ \mathrm{GeV} = \mathrm{m}(\Upsilon(4S))$

- Integrated luminosity of $\sim 1\ \mathrm{ab}^{-1}$



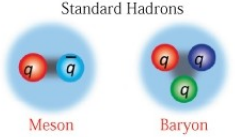
Quarkonium spectroscopy



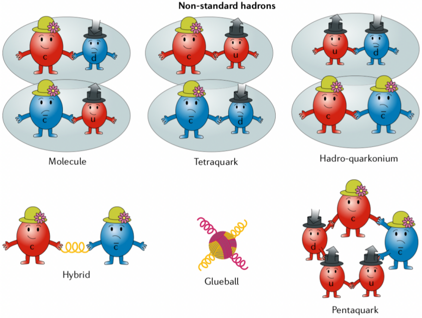
- Quarkonium: $\mathrm{q\bar{q}}$, the simplest hadronic system
- Good agreement below $D\bar{D}/B\bar{B}$ threshold
- There are many states observed in recent decades that are hard to fit into the two families

Exotic states

- Conventional hadrons: consist of 2 or 3 quarks
- The states that do not fit into the ordinary $q\bar{q}/qqq$ scheme in the quark model are referred as exotic states



Quark model [Physics Letters 8, **214**(1964)]

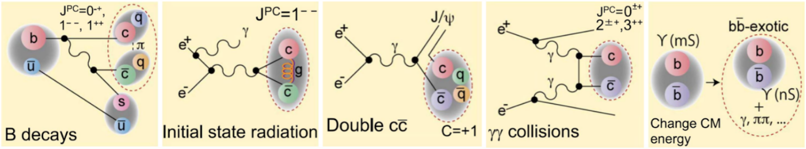


Nature Rev. Phys. **1**(2019)8, **480-494** (2019) Physics Reports **873**,1 (2020)

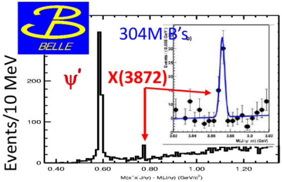
- As of now there is no consensus on a universal model describing all the exotic states
- A systematic search for these states is vital for developing a unified theory and to further understand their properties.

Exotic states (conti.)

- Production mechanism in e^+e^-:

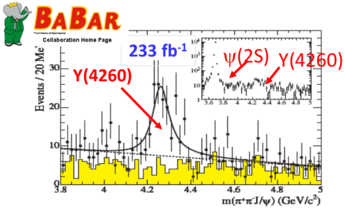


- Some examples:



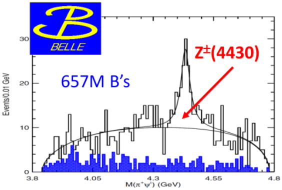
PRL 91 (2003) 262001

$B^{\pm} \rightarrow K^{\pm}\pi^{+}\pi^{-}J/\psi$



PRL 95 (2005) 142001

$e^{+}e^{-} \rightarrow \gamma_{\rm ISR}\pi^{+}\pi^{-}J/\psi$



PRL 100 (2008) 142001

$B \rightarrow K\pi^{\pm}\psi'$

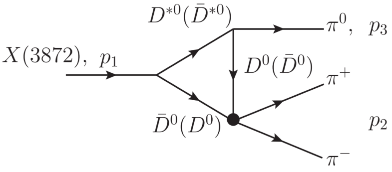
This talk..

1. Search for $X(3872) \to \pi^+\pi^-\pi^0$ (arXiv:2206.08592, submitted to PRD)
2. Measurement of two-photon decay width of $\chi_{c2}(1P)$ in $\gamma\gamma \to \chi_{c2}(1P) \to J/\psi\gamma$ (arXiv:2208.04477, submitted to JHEP)
3. Search for tetraquark states $X_{cc\bar{s}\bar{s}}$ in $D_s^+ D_s^+$ ($D_s^{*+} D_s^{*+}$) final states (Phys. Rev. D **105**, 032002 (2022))

1. Search for $X(3872) \to \pi^+\pi^-\pi^0$

- $X(3872)$ a.k.a. $\chi_{c1}(3872)$ was first observed in 2003 by the Belle Phys. Rev. Lett. **91**, 262001

- Recently, quantum number of $X(3872)$ is determined as $J^{PC} = 1^{++}$ by LHCb
Phys.Rev.Lett. **110**, 222001



- All known X(3872) decays contain open charm or charmonium mesons in the final state; searches for decays to final states without heavy flavour are of great interest

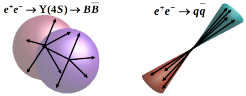
- Models in which the X(3872) is a pure charmonium state predict a significant branching fraction for X(3872) $\to gg \to$ light hadrons

- Predicted $\mathcal{B}(X(3872) \to \pi^+\pi^-\pi^0)$ is $10^{-3} - 10^{-4}$ Phys. Rev. D **99**, 116023

  $\to$ Dominant contribution is from: $X(3872) \to D^0\bar{D}^{*0} \to D\bar{D}^0\pi^0 \to \pi^+\pi^-\pi^0$

$X(3872) \to \pi^+\pi^-\pi^0$: Analysis overview

- $\Upsilon(4S) \to B^0\bar{B}^0/B^+B^-$; $B \to KX(3872)$; $X(3872) \to \pi^+\pi^-\pi^0$
- Dataset: $(772 \pm 11) \times 10^6$ $B\bar{B}$ events



- BDT to suppress the dominant background arises from $e^+e^- \to q\bar{q}$ continuum process
- Presence of resonant backgrounds with same final state, $B \to D\rho$, $B \to K^*\rho$
- Studied two cases:

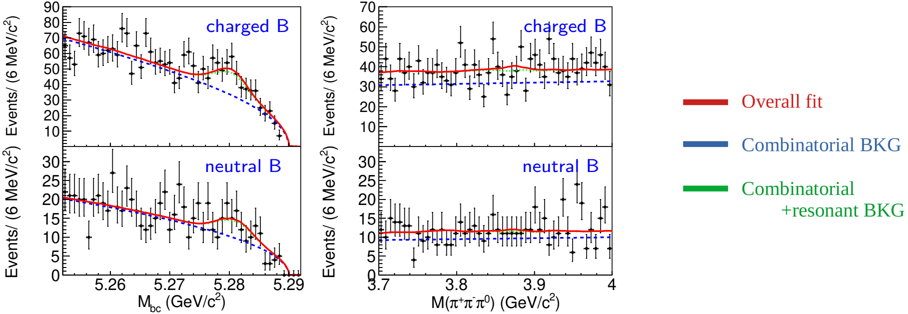
Case I (3π phase space): Pions are distributed uniformly in phase space
Case II ($\pi^+\pi^-$ peaking): Constrain $M_{\pi^+\pi^-}$ to peak close to the $D^0\bar{D}^0$ threshold

- Extra requirement on $M_{\pi^+\pi^-}$ for case II
- Simultaneous 2D unbinned fit to $M(\pi^+\pi^-\pi^0)$ and $M_{\rm bc}$ $(= \sqrt{E^{*2}_{\rm beam} - \vec{p}^{*2}_B}\,)$ distributions to extract the signal
- $B \to J/\psi K$; $J/\psi \to \pi^+\pi^-\pi^0$ as calibration mode

$X(3872) \to \pi^+\pi^-\pi^0$: Results

[arXiv:2206.08592]

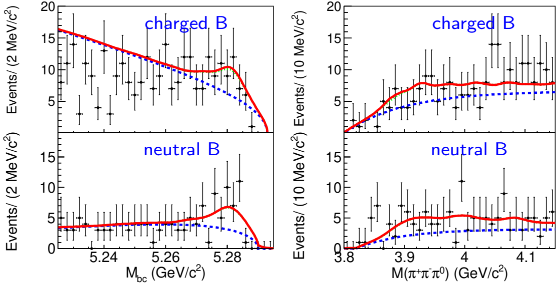
Case I (3π phase space):

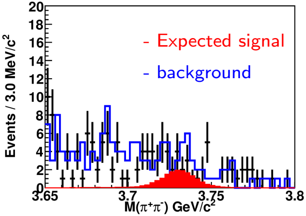


$\to$ No significant signal observed

channel	N_{sig}	Upper Limit (90% CL)
$B^{\pm} \to K^{\pm}X(3872),\ X(3872) \to \pi^+\pi^-\pi^0$	20.3 ± 22.0	$< 1.9 \times 10^{-6}$
$B^0 \to K^0X(3872),\ X(3872) \to \pi^+\pi^-\pi^0$	4.2 ± 4.6	$< 1.5 \times 10^{-6}$
$X(3872) \to \pi^+\pi^-\pi^0$		$< 1.3 \times 10^{-2}$

Case II ($\pi^+\pi^-$ peaking):





$\to$ No significant signal observed

channel	N_{sig}	Upper Limit (90% CL)
$B^\pm \to K^\pm X(3872),\ X(3872) \to \pi^+\pi^-\pi^0$	1.5 ± 5.4	$< 1.5 \times 10^{-7}$
$B^0 \to K^0 X(3872),\ X(3872) \to \pi^+\pi^-\pi^0$	0.3 ± 1.0	$< 1.8 \times 10^{-7}$
$X(3872) \to \pi^+\pi^-\pi^0$		$< 1.2 \times 10^{-3}$

2. Measurement of $\Gamma_{\gamma\gamma}(\chi_{c2}(1P))$ from $\gamma\gamma \to \chi_{c2}(1P) \to J/\psi\gamma$

- The two-photon decay widths ($\Gamma_{\gamma\gamma}(R)$) of mesonic states provide important information for testing models based on QCD

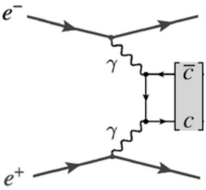
- Theoretical prediction suggest a wide range from 280 eV to 930 eV

Phys. Rev. D **79**, 094016; Rev. D **82**, 034021

- A precise measurement will help to improve our understanding of quarkonium states

- Previous measurements: two approaches

$\gamma\gamma$ decay	$\gamma\gamma$ collision
$586 \pm 16 \pm 13 \pm 29$ eV	$596 \pm 58 \pm 48 \pm 16$ eV
BES III[1]	Belle ($32\ \mathrm{fb}^{-1}$)[2]



$\rightarrow$ At present, the precision of the experimental value of $\Gamma_{\gamma\gamma}(\chi_{c2}(1P))$ using two-photon collision is much lower than the value measured in two-photon decay.

[1] Phys. Rev. D **96**, 092007 [2] Phys. Lett. B **540**, 33

$\Gamma_{\gamma\gamma}(\chi_{c2}(1P))$: Analysis strategy

- Channel: $e^+e^- \to e^+e^-\chi_{c2}(1P)$; $\chi_{c2}(1P) \to J/\psi\gamma$; $J/\psi \to \mu^+\mu^-, e^+e^-$

- Dataset: $971\ \mathrm{fb}^{-1}$ collected at or near the $\Upsilon(1S)$, $\Upsilon(2S)$, $\Upsilon(3S)$, $\Upsilon(4S)$ and $\Upsilon(5S)$

- Recoiling e^+e^- are left undetected

- The signal $\chi_{c2}(1P)$ produced in quasi-real two-photon collisions are selected with a p_T^* balance requirement:

$$|p_T^{*tot}| = |p_T^{*+} + p_T^{*-} + p_T^{*\gamma}| < 0.15\ \mathrm{GeV/c}$$

- Binned extended maximum-likelihood fit on $\Delta M = M_{\ell^+\ell^-\gamma} - M_{\ell^+\ell^-}$

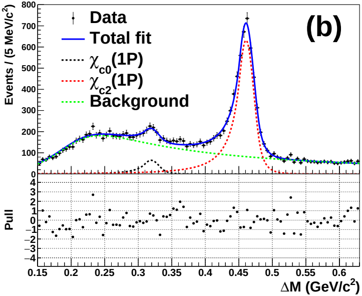
- The two-photon decay width is determined by:

$$\Gamma_{\gamma\gamma}(\chi_{c2}(1P)) = \frac{m^2_{\chi_{c2}(1P)} N_{sig}}{4\pi^2(2J+1)(\int \mathcal{L}dt).\epsilon.\mathcal{L}_{\gamma\gamma}(m_{\chi_{c2}(1P)}).\mathcal{B}(\chi_{c2}(1P)\to J/\psi\gamma).\mathcal{B}(J/\psi\to\ell^+\ell^-)}$$

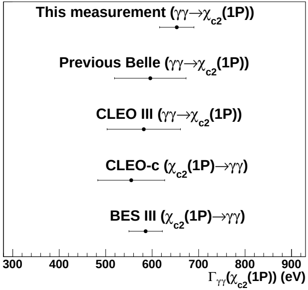
$\Gamma_{\gamma\gamma}(\chi_{c2}(1P))$: Result

[arXiv:2208.04477]

$$N_{\text{sig}}(\chi_{c2}(1P)) = 4960.3 \pm 97.9$$



Experiment	$\Gamma_{\gamma\gamma}(\chi_{c2}(1P))$ (eV)
This measurement	$653 \pm 13 \pm 31 \pm 17$
Previous Belle	$596 \pm 58 \pm 48 \pm 16$
CLEO III	$582 \pm 59 \pm 50 \pm 15$
CLEO-c	$555 \pm 58 \pm 32 \pm 28$
BES III	$586 \pm 16 \pm 13 \pm 29$



→ Most precise measurement of $\Gamma_{\gamma\gamma}(\chi_{c2}(1P))$ in two photon processes and cosistent with previous result from Belle!

3. Search for tetraquark states $X_{cc\bar{s}\bar{s}}$ in $D_s^+ D_s^+$ ($D_s^{*+} D_s^{*+}$)

- Double-heavy tetraquark states (with two heavy quarks and two light quarks)
- A QCD inspired chiral quark model gives prediction for $X_{cc\bar{s}\bar{s}}$ with charge $+2e$ and $J^P = 0^+, 2^+$ Phys. Rev. D **102**, 054023 (2020)
- Expected to be found in $D_s^+ D_s^+$ and $D_s^{*+} D_s^{*+}$ final states
- The predicted masses and widths:

Mode	IJ^P	Mass (MeV/c^2)	Width (MeV)
$X_{cc\bar{s}\bar{s}} \to D_s^+ D_s^+$	00^+	4902	3.54
$X_{cc\bar{s}\bar{s}} \to D_s^{*+} D_s^{*+}$	02^+	4821	5.58
	02^+	4846	10.68
	02^+	4775	23.26

Search for tetraquark states $X_{cc\bar{s}\bar{s}}$: Overview

- $X_{cc\bar{s}\bar{s}} \to D_s^+ D_s^+ \ (D_s^{*+} D_s^{*+})$

$$D_s^{*+} \to D_s^+ \gamma$$

$$D_s^+ \to \phi(\to K^+ K^-)\pi^+, \ \bar{K}^*(892)^0(\to K^- \pi^+)K^+$$

- Data set:

$\Upsilon(1S)$	$\Upsilon(2S)$	$\sqrt{s} = 10.52$ GeV	$\sqrt{s} = 10.58$ GeV	$\sqrt{s} = 10.867$ GeV
6 fb^{-1}	25 fb^{-1}	711 fb^{-1}	121 fb^{-1}	89 fb^{-1}

- Studied the invariant mass distribution of $D_s D_s$ system for the signal search

- For $\Upsilon(1S)$ and $\Upsilon(2S)$:

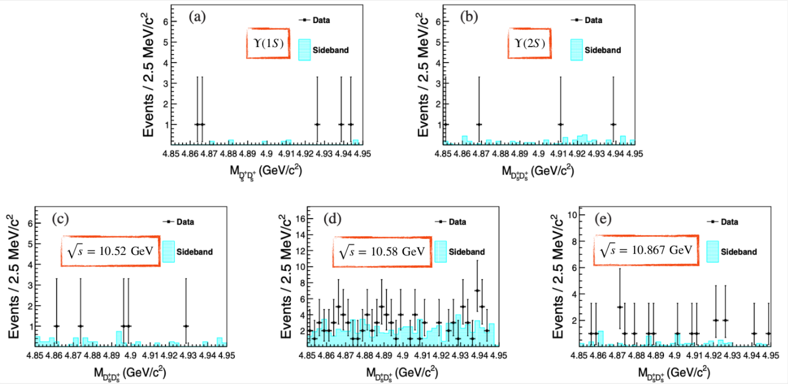
$$\mathcal{B}^{\mathrm{UP}}(\Upsilon(\mathrm{nS}) \to \mathrm{X_{cc\bar{s}\bar{s}}} + \mathrm{anything}) \times \mathcal{B}(\mathrm{X_{cc\bar{s}\bar{s}}} \to \mathrm{D_s D_s}) \to \boxed{\frac{N^{\mathrm{UP}}}{N_{\Upsilon(1S,2S)} \times \sum_i \varepsilon_i \mathcal{B}_i}}$$

- For $\sqrt{s} = 10.52, \ 10.58$ and 10.867 GeV :

$$\sigma^{\mathrm{UP}}(e^+ e^- \to X_{cc\bar{s}\bar{s}} + \mathrm{anything}) \times \mathcal{B}(\mathrm{X_{cc\bar{s}\bar{s}}} \to \mathrm{D_s D_s}) \to \boxed{\frac{N^{\mathrm{UP}} \times |1 - \Pi|^2}{\mathcal{L} \times \sum_i \varepsilon_i \mathcal{B}_i \times (1+\delta)_{\mathrm{ISR}}}}$$

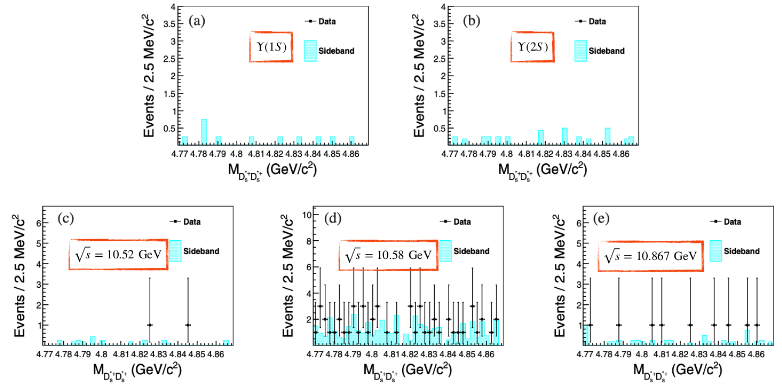
$X_{cc\bar{s}\bar{s}} \to D_s^+ D_s^+$: Signal extraction

- No significant signal observed in the invariant-mass spectra



$X_{cc\bar{s}\bar{s}} \rightarrow D_s^{*+} D_s^{*+}$: Signal extraction

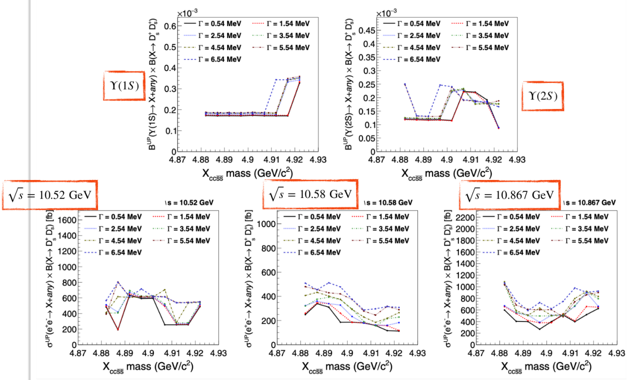
- No significant signal observed in the invariant-mass spectra



$X_{cc\bar{s}\bar{s}} \to D_s^+ D_s^+$ U.L.

[Phys. Rev. D **105**, 032002]

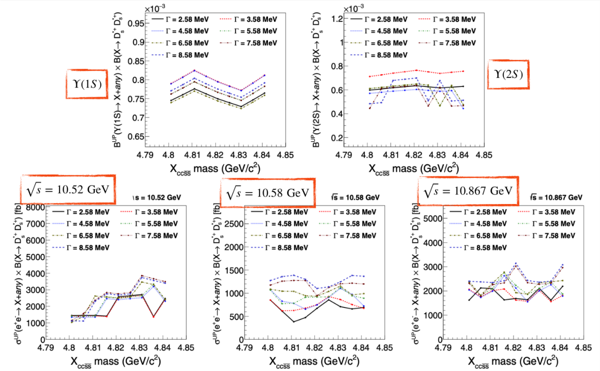
- $\mathcal{B}^{\mathrm{UP}}(\Upsilon(\mathrm{nS}) \to \mathrm{X}_{cc\bar{s}\bar{s}} + \text{anything}) \times \mathcal{B}(\mathrm{X}_{cc\bar{s}\bar{s}} \to \mathrm{D}_s^+\mathrm{D}_s^+)$ for $\Upsilon(1S)$ & $\Upsilon(2S)$:
- $\sigma^{\mathrm{UP}}(e^+e^- \to X_{cc\bar{s}\bar{s}} + \text{anything}) \times \mathcal{B}(\mathrm{X}_{cc\bar{s}\bar{s}} \to \mathrm{D}_s^+\mathrm{D}_s^+)$ for $\sqrt{s} = 10.52,\ 10.58\ 10.867$ GeV



$X_{cc\bar{s}\bar{s}} \to D_s^{*+} D_s^{*+}$ U.L.

[Phys. Rev. D **105**, 032002]

- $\mathcal{B}^{\rm UP}(\Upsilon(\rm nS) \to \rm X_{cc\bar{s}\bar{s}} + anything) \times \mathcal{B}(\rm X_{cc\bar{s}\bar{s}} \to D_s^{*+} D_s^{*+})$ for $\Upsilon(1S)$ & $\Upsilon(2S)$:
- $\sigma^{\rm UP}(e^+e^- \to X_{cc\bar{s}\bar{s}} + \rm anything) \times \mathcal{B}(\rm X_{cc\bar{s}\bar{s}} \to D_s^{*+} D_s^{*+})$ for $\sqrt{s} = 10.52,\ 10.58\ 10.867$ GeV



- Numerical values of the U.L. are listed in the backup.

Summary

- Belle keeps producing exciting results even after ending the data taking more than a decade ago

- Using the full Belle data, we report;

  → a first search for the decay $X(3872) \to \pi^+\pi^-\pi^0$
  (arXiv:2206.08592, submitted to PRD)

  → measurement of two-photon decay width of $\chi_{c2}(1P)$ in $\gamma\gamma \to \chi_{c2}(1P) \to J/\psi\gamma$ (arXiv:2208.04477, submitted to JHEP)

  → and a search for tetraquark states $X_{cc\bar{s}\bar{s}}$ in $D_s^+ D_s^+$ ($D_s^{*+} D_s^{*+}$)
  (Phys. Rev. D **105**, 032002 (2022))

- Belle II is already in the game and several exciting results are expected to be out soon! (see talk on Belle II prospects by A. Boschetti)

Thank you!

Backup: $X_{cc\bar{s}\bar{s}} \to D_s^+ D_s^+$ U.L.

TABLE III. Summary of 90% CL upper limits with the systematic uncertainties included on the product branching fractions of $\Upsilon(1S)/\Upsilon(2S) \to X_{cc\bar{s}\bar{s}}(\to D_s^+ D_s^+) +$ anything.

$\mathcal{B}(\Upsilon(1S)/\Upsilon(2S) \to X_{cc\bar{s}\bar{s}} + \text{anything}) \times \mathcal{B}(X_{cc\bar{s}\bar{s}} \to D_s^+ D_s^+)$ $(\times 10^{-4})$							
	$\Gamma_{X_{cc\bar{s}\bar{s}}}$ (MeV)						
$M_{X_{cc\bar{s}\bar{s}}}$ (MeV/c^2)	0.54	1.54	2.54	3.54	4.54	5.54	6.54
4882	1.7/1.2	1.7/1.2	1.8/1.2	1.8/1.3	1.8/1.2	1.9/2.5	1.9/2.5
4887	1.7/1.2	1.7/1.2	1.8/1.2	1.8/1.2	1.8/1.2	1.9/1.3	1.8/1.3
4892	1.7/1.2	1.7/1.2	1.8/1.2	1.8/1.2	1.8/1.2	1.9/1.3	1.8/1.3
4897	1.7/1.2	1.7/1.2	1.8/1.2	1.8/1.2	1.8/1.2	1.9/1.3	1.8/2.5
4902	1.7/1.2	1.8/1.1	1.8/2.2	1.8/2.3	1.8/2.2	1.9/2.4	1.9/2.4
4907	1.7/2.2	1.7/2.2	1.8/2.3	1.8/2.3	1.8/2.3	1.9/1.9	1.8/1.9
4912	1.7/2.2	1.7/2.2	1.8/1.8	1.8/1.8	1.8/1.8	1.9/1.9	3.4/1.9
4917	1.7/1.9	1.7/1.8	3.3/1.9	3.4/1.8	3.4/1.8	3.5/1.8	3.4/1.8
4922	3.3/0.9	3.3/0.9	3.4/0.9	3.5/1.8	3.5/1.8	3.6/1.9	3.5/1.7

TABLE IV. Summary of 90% CL upper limits with the systematic uncertainties included on the cross sections of $e^+e^- \to X_{cc\bar{s}\bar{s}}(\to D_s^+ D_s^+) +$ anything at $\sqrt{s} = 10.52/10.58/10.867$ GeV.

$\sigma(e^+e^- \to X_{cc\bar{s}\bar{s}} + \text{anything}) \times \mathcal{B}(X_{cc\bar{s}\bar{s}} \to D_s^+ D_s^+)$ $(\times 10^2 fb)$							
	$\Gamma_{X_{cc\bar{s}\bar{s}}}$ (MeV)						
$M_{X_{cc\bar{s}\bar{s}}}$ (MeV/c^2)	0.54	1.54	2.54	3.54	4.54	5.54	6.54
4882	4.8/2.5/6.0	5.0/2.6/6.6	5.1/3.2/6.7	4.1/3.2/10.3	4.1/4.1/10.9	3.9/4.8/10.4	5.7/5.1/10.6
4887	1.9/3.4/4.0	2.0/3.5/5.4	4.2/3.6/5.5	4.1/3.8/5.6	6.2/4.3/5.9	8.0/4.6/6.8	8.0/4.5/7.6
4892	6.4/3.1/4.0	6.5/3.4/4.2	6.7/3.4/5.1	7.0/3.9/5.0	6.1/4.0/5.1	6.2/4.3/6.1	6.1/5.1/5.9
4897	5.9/1.9/2.7	6.1/2.6/3.8	6.0/3.3/3.9	6.2/3.7/5.0	6.1/3.7/6.3	6.2/4.2/6.0	7.2/4.8/7.3
4902	6.0/1.9/4.0	6.1/1.8/3.8	6.1/2.3/5.1	6.3/2.9/5.0	6.1/2.9/5.1	6.2/3.7/6.1	6.2/3.8/6.2
4907	2.6/1.8/5.1	4.9/1.8/5.3	5.1/1.8/5.1	5.2/1.9/5.0	7.1/2.3/5.1	6.2/2.8/4.7	6.1/2.9/7.5
4912	2.6/1.6/4.0	2.6/1.6/4.1	2.7/1.6/6.6	2.8/1.6/6.7	2.9/1.9/7.8	5.4/2.5/7.3	5.4/3.0/9.6
4917	2.6/1.2/5.2	2.6/1.6/6.6	2.7/1.6/9.0	2.8/2.2/9.1	5.4/2.2/9.0	5.4/3.2/8.6	5.4/3.2/8.9
4922	4.9/1.1/6.2	5.0/1.2/6.5	5.2/1.8/6.6	5.4/2.3/7.9	5.4/2.7/8.3	5.5/2.9/9.0	5.5/3.1/9.2

Backup: $X_{cc\bar{s}\bar{s}} \to D_s^{*+} D_s^{*+}$ U.L.

TABLE V. Summary of 90% CL upper limits with the systematic uncertainties included on the product branching fractions of $\Upsilon(1S) \to X_{cc\bar{s}\bar{s}}(\to D_s^{*+} D_s^{*+})$ + anything/$\Upsilon(2S) \to X_{cc\bar{s}\bar{s}}(\to D_s^{*+} D_s^{*+})$ + anything.

$\mathcal{B}(\Upsilon(1S)/\Upsilon(2S) \to X_{cc\bar{s}\bar{s}}$ + anything) $\times \mathcal{B}(X_{cc\bar{s}\bar{s}} \to D_s^{*+} D_s^{*+})$ ($\times 10^{-4}$)							
	$\Gamma_{X_{cc\bar{s}\bar{s}}}$ (MeV)						
$M_{X_{cc\bar{s}\bar{s}}}$ (MeV/c^2)	2.58	3.58	4.58	5.58	6.58	7.58	8.58
4801	7.5/6.0	7.9/7.1	7.9/5.7	7.6/6.1	7.4/6.1	7.6/4.4	7.7/4.8
4806	7.6/6.1	8.1/7.3	8.1/5.8	7.8/6.2	7.5/6.2	7.8/6.1	7.9/4.9
4811	7.8/6.2	8.3/7.4	8.2/5.9	7.9/6.3	7.7/6.3	7.9/6.2	8.0/6.8
4816	7.6/6.3	8.1/7.5	8.1/6.0	7.8/6.4	7.6/6.4	7.8/6.3	7.9/6.9
4821	7.5/6.3	8.0/7.6	7.9/6.0	7.7/6.5	7.4/6.5	7.7/6.4	7.8/7.0
4826	7.4/6.3	7.8/7.5	7.8/6.0	7.6/6.4	7.3/6.4	7.6/4.7	7.6/5.1
4831	7.3/6.2	7.7/7.4	7.7/5.9	7.5/4.7	7.2/4.7	7.5/6.2	7.5/6.8
4836	7.5/6.2	7.9/7.5	7.9/5.9	7.6/6.4	7.4/6.4	7.6/4.6	7.7/5.1
4841	7.6/6.3	8.1/7.6	8.1/4.4	7.8/4.8	7.6/4.8	7.8/4.7	7.9/5.1

TABLE VI. Summary of 90% CL upper limits with the systematic uncertainties included on the cross sections of $e^+e^- \to X_{cc\bar{s}\bar{s}}(\to D_s^{*+} D_s^{*+})$ + anything at $\sqrt{s} = 10.52/10.58/10.867$ GeV.

$\sigma(e^+e^- \to X_{cc\bar{s}\bar{s}}$ + anything) $\times \mathcal{B}(X_{cc\bar{s}\bar{s}} \to D_s^{*+} D_s^{*+})$ ($\times 10^2 fb$)							
	$\Gamma_{X_{cc\bar{s}\bar{s}}}$ (MeV)						
$M_{X_{cc\bar{s}\bar{s}}}$ (MeV/c^2)	2.58	3.58	4.58	5.58	6.58	7.58	8.58
4801	14.5/8.5/16.2	14.1/8.5/20.7	13.4/10.8/20.4	14.1/10.7/23.7	10.3/10.9/23.8	11.5/11.7/23.2	11.1/12.7/24.1
4806	14.5/6.1/21.2	14.2/6.2/18.3	13.5/8.3/17.3	14.1/7.7/18.2	14.0/10.4/18.3	15.5/12.6/17.8	11.1/13.6/23.7
4811	14.5/3.8/21.0	14.2/6.3/20.2	13.5/7.8/19.9	14.1/7.8/20.9	26.2/10.4/23.2	23.7/12.7/22.6	23.0/13.9/23.4
4816	14.1/4.7/16.3	13.8/6.8/20.8	24.6/6.6/26.3	25.8/9.1/27.6	25.6/9.5/27.8	28.3/12.4/23.3	27.5/13.0/24.2
4821	25.8/6.7/16.9	25.2/7.5/16.2	24.1/7.5/21.2	25.1/9.0/22.3	24.9/9.2/19.3	27.6/9.5/30.2	26.8/11.0/31.4
4826	26.4/8.6/16.4	25.8/9.3/15.8	24.6/9.1/15.6	25.7/9.1/18.6	25.5/10.2/18.7	28.3/11.2/23.4	27.5/11.4/24.3
4831	27.1/7.0/21.1	26.5/8.6/20.3	25.2/11.0/20.1	26.4/11.2/21.0	34.7/11.5/23.4	38.5/12.0/22.8	37.4/12.5/23.6
4836	13.8/6.6/16.2	13.5/7.5/15.6	32.0/9.7/23.3	33.4/9.4/23.7	33.1/9.6/23.8	36.6/12.2/23.2	35.6/13.8/24.1
4841	24.7/6.9/21.9	24.2/6.7/18.1	23.1/7.2/17.9	24.1/8.9/18.8	23.9/9.9/24.3	34.9/12.0/29.6	34.0/13.4/30.8