Connecting the XYZ at BESIII

Ryan Mitchell
Indiana University

Hadron 2013

November 4, 2013

Beijing, China

BESIII
(at IHEP)

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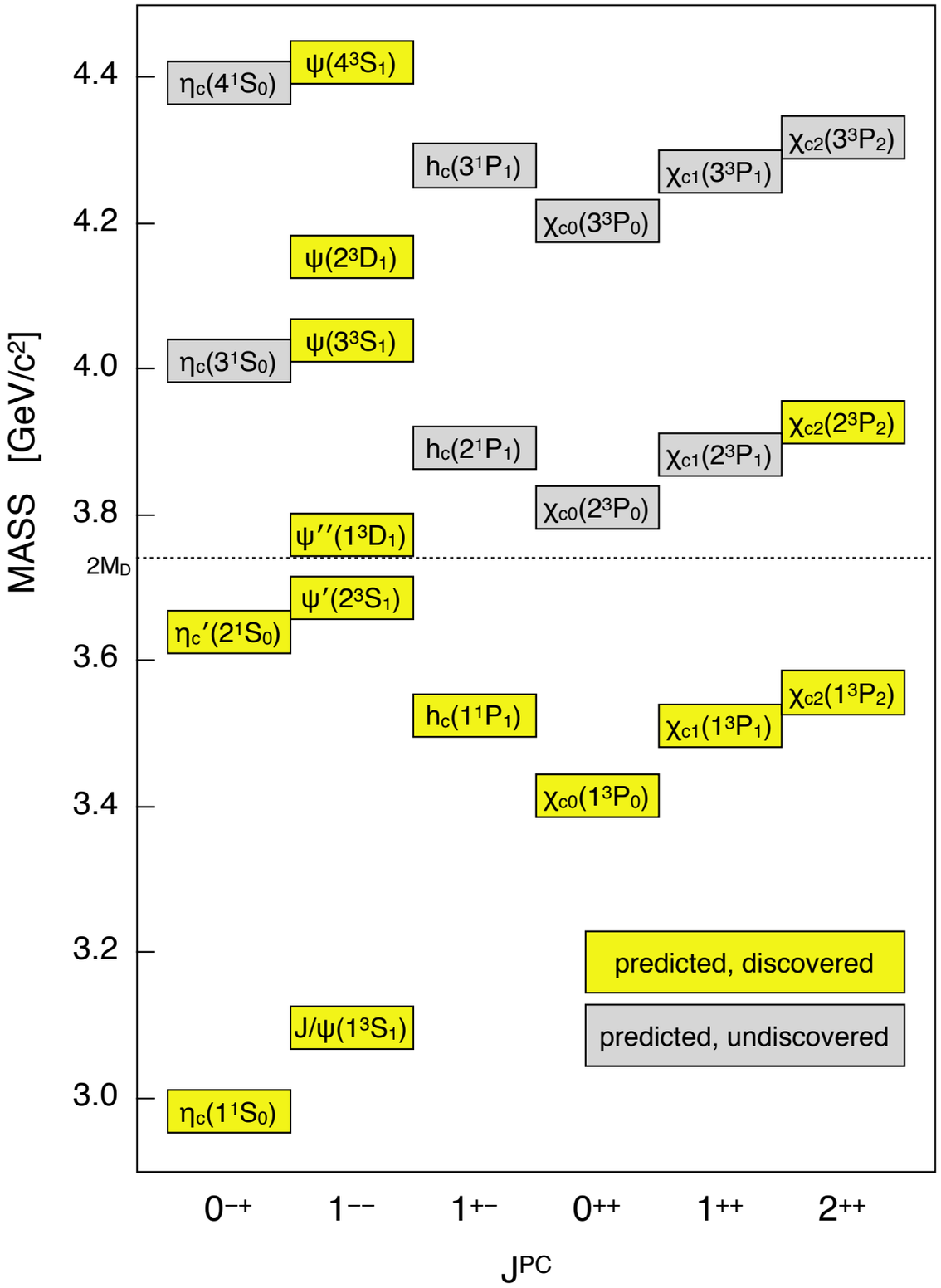

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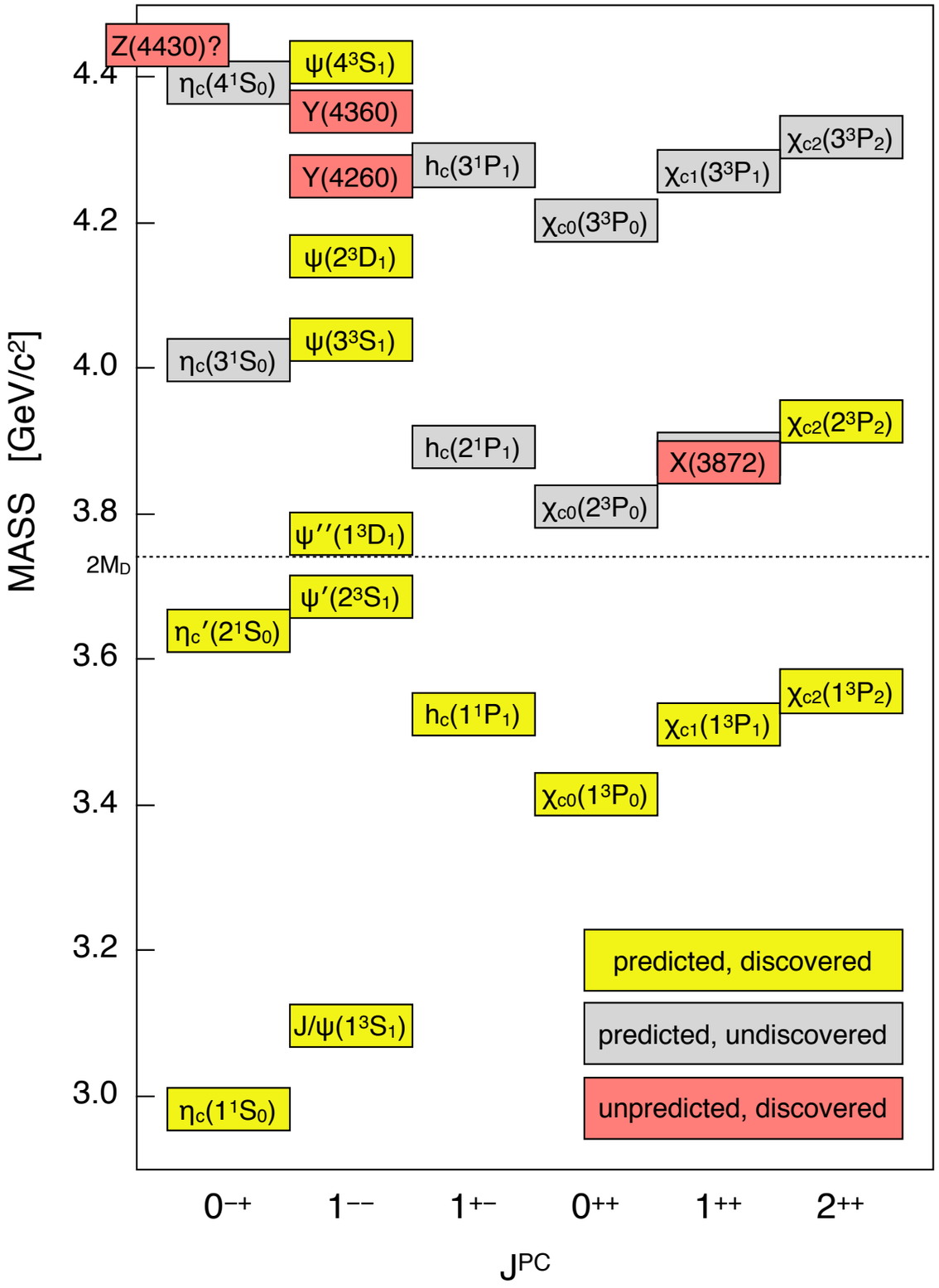

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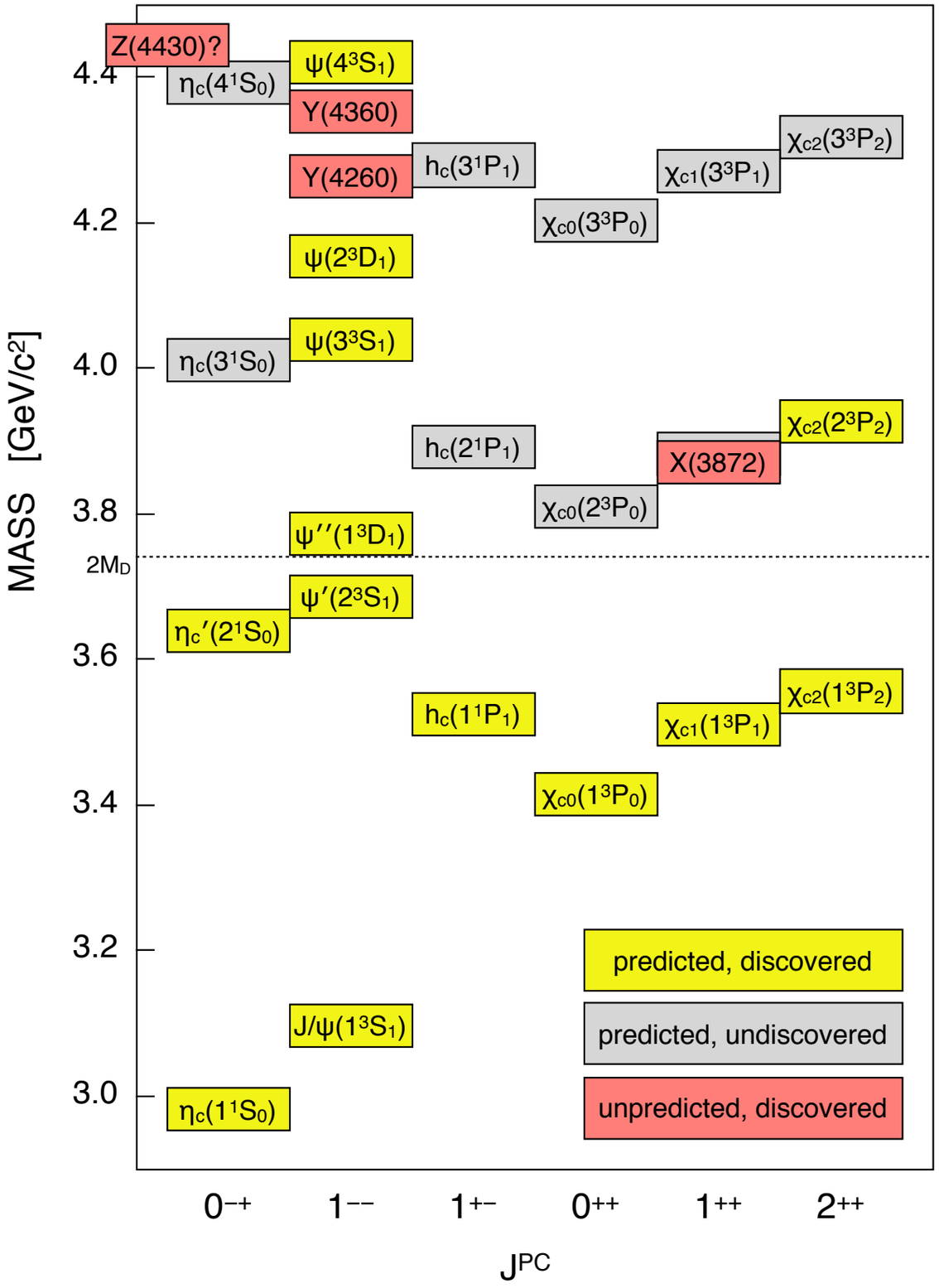

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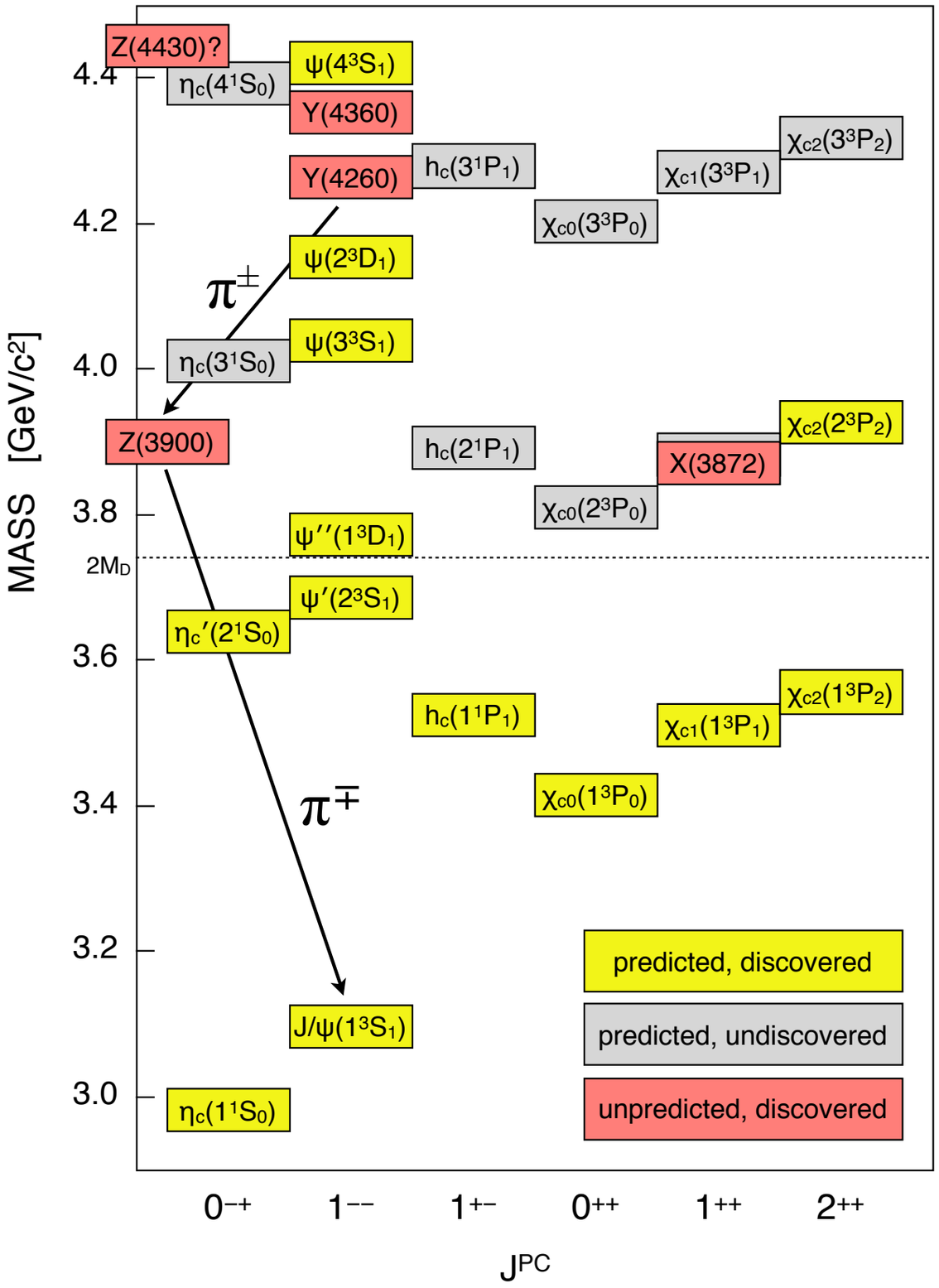

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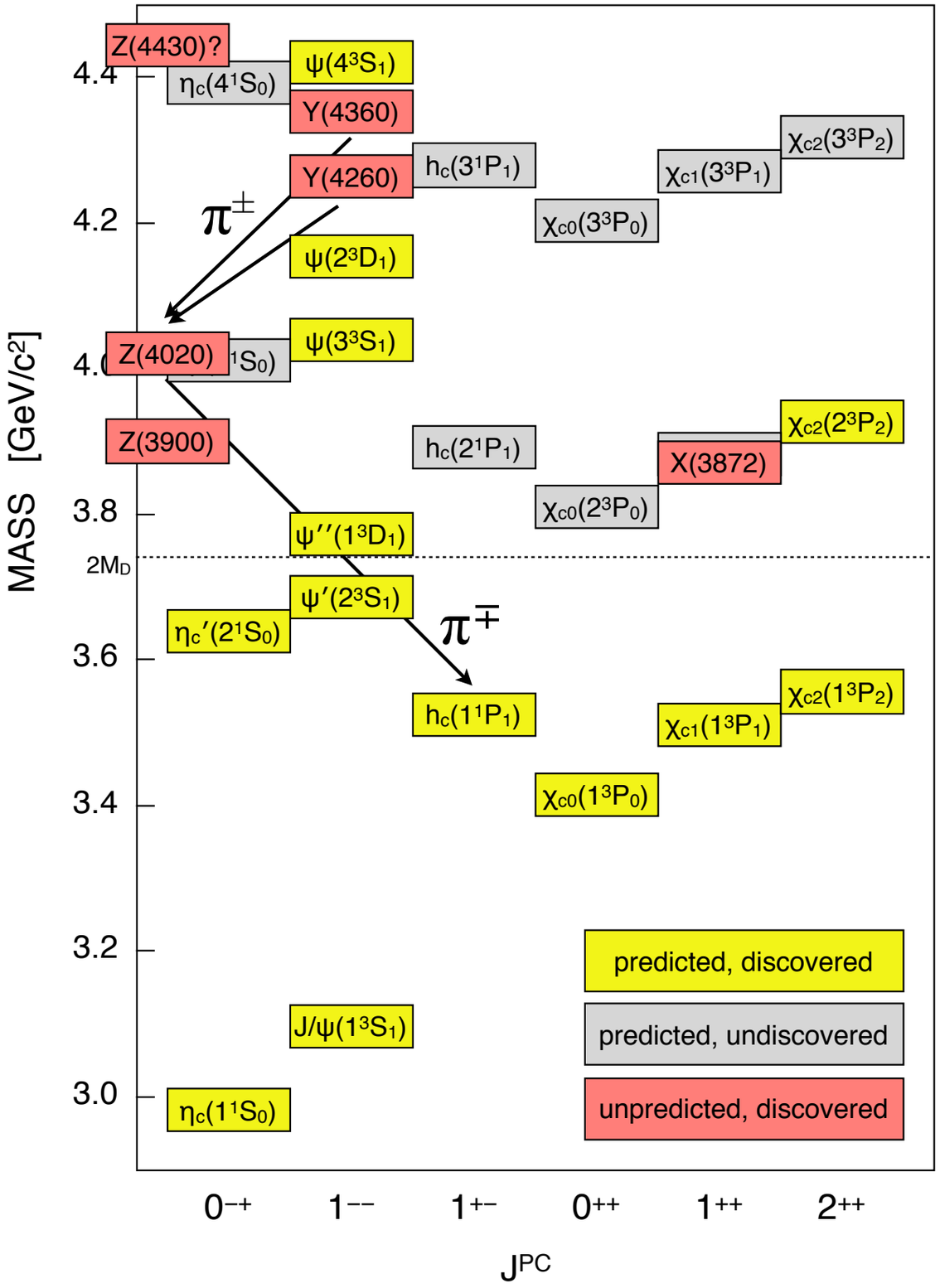

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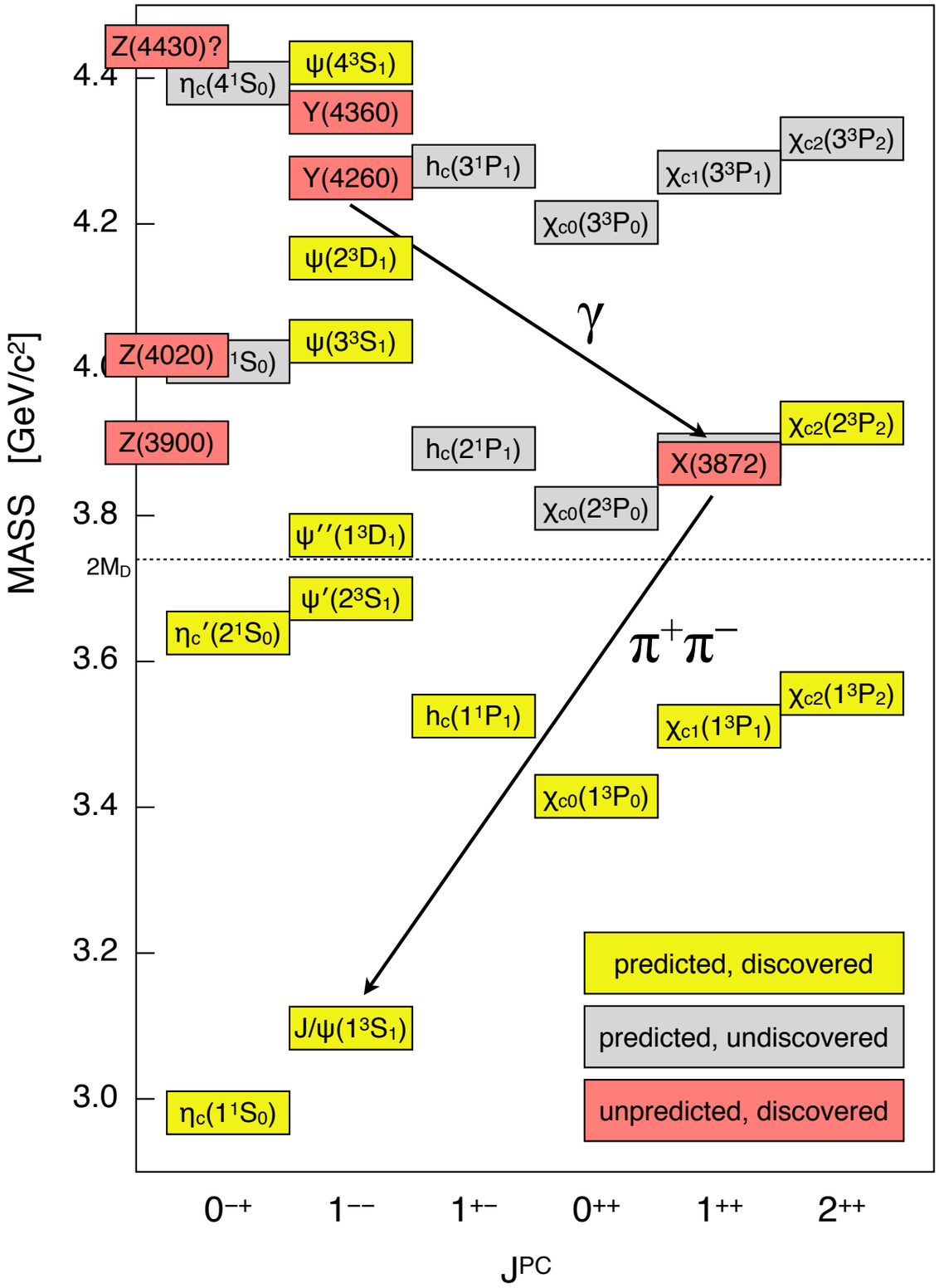

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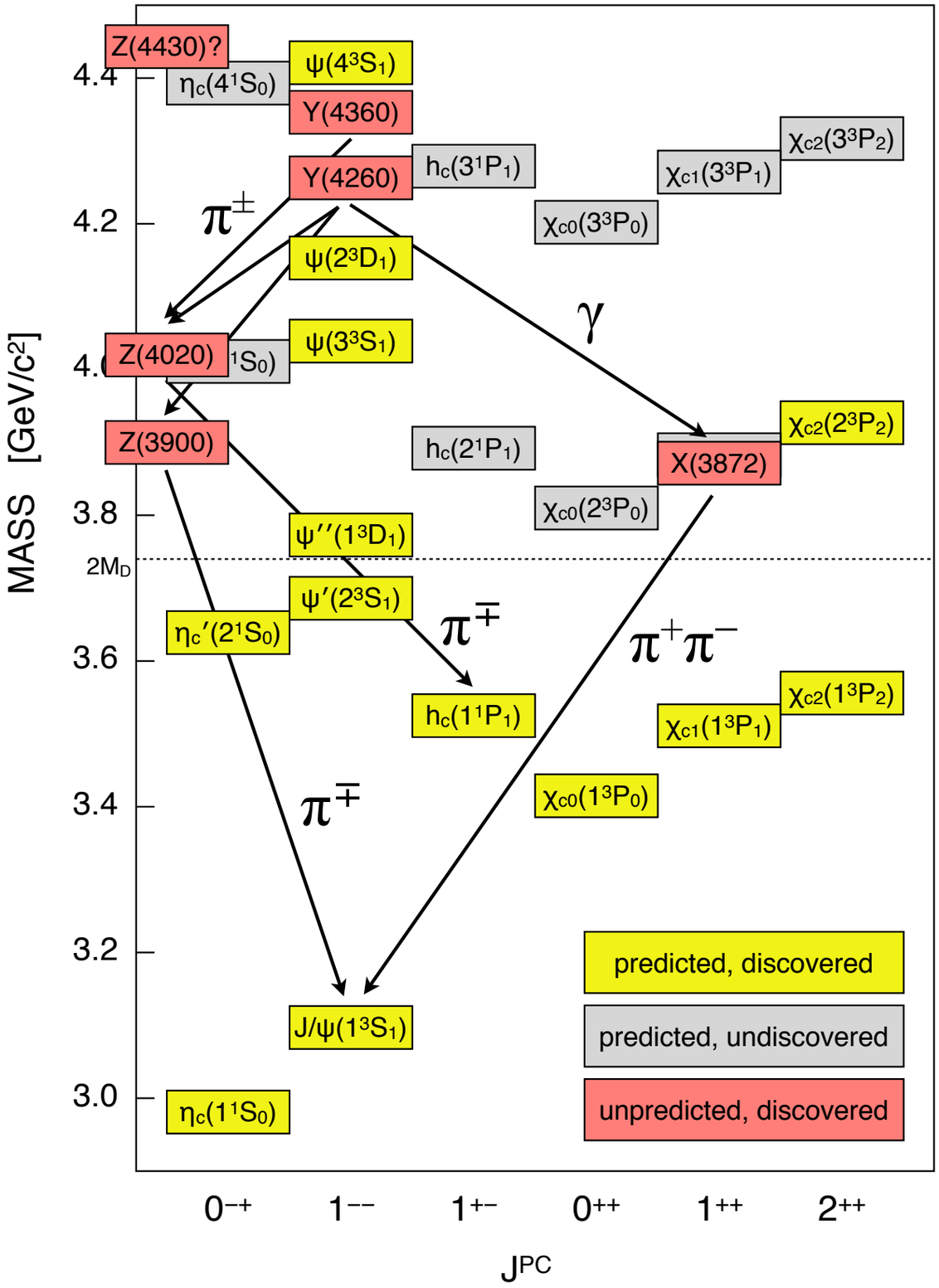

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(VI) We are building connections.

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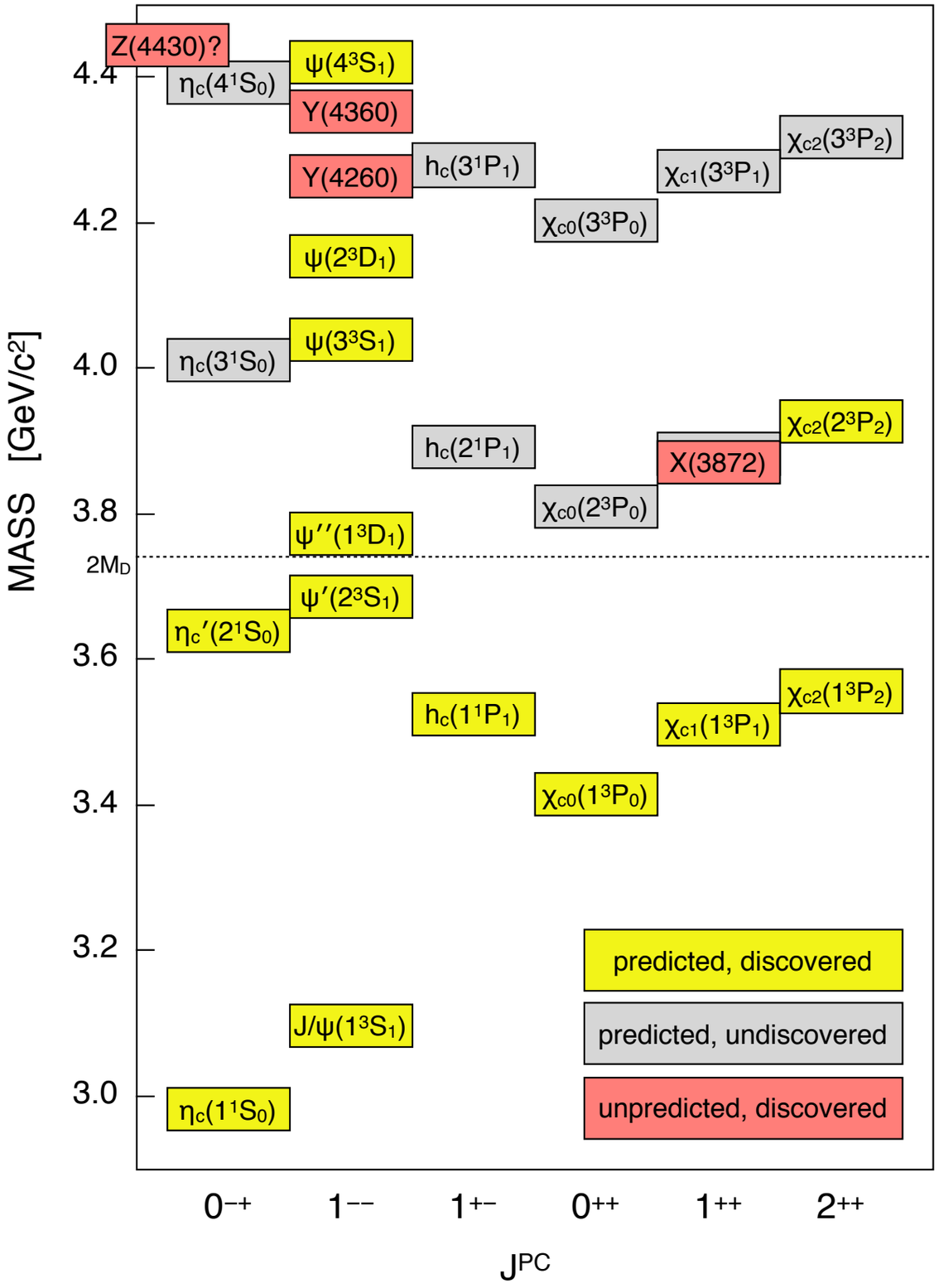

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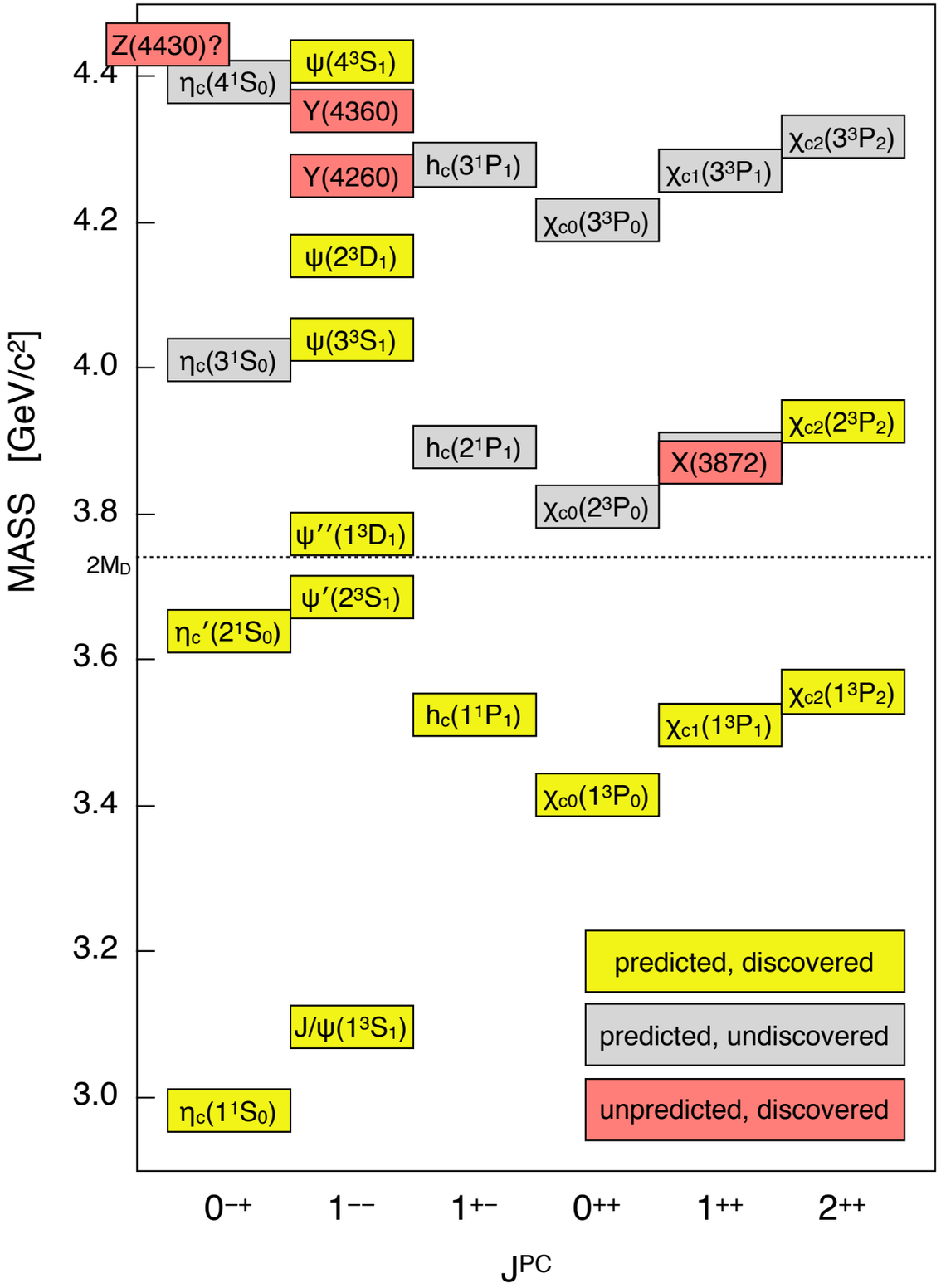

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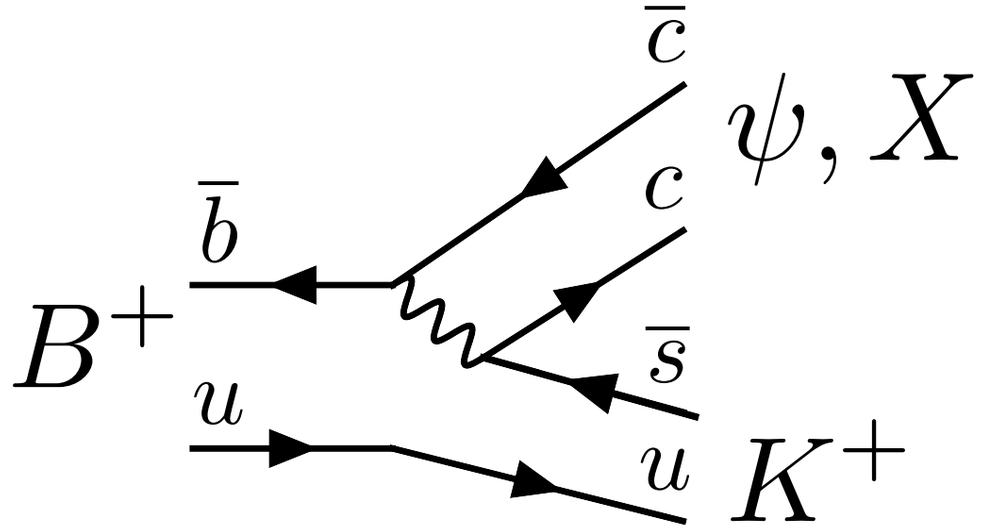

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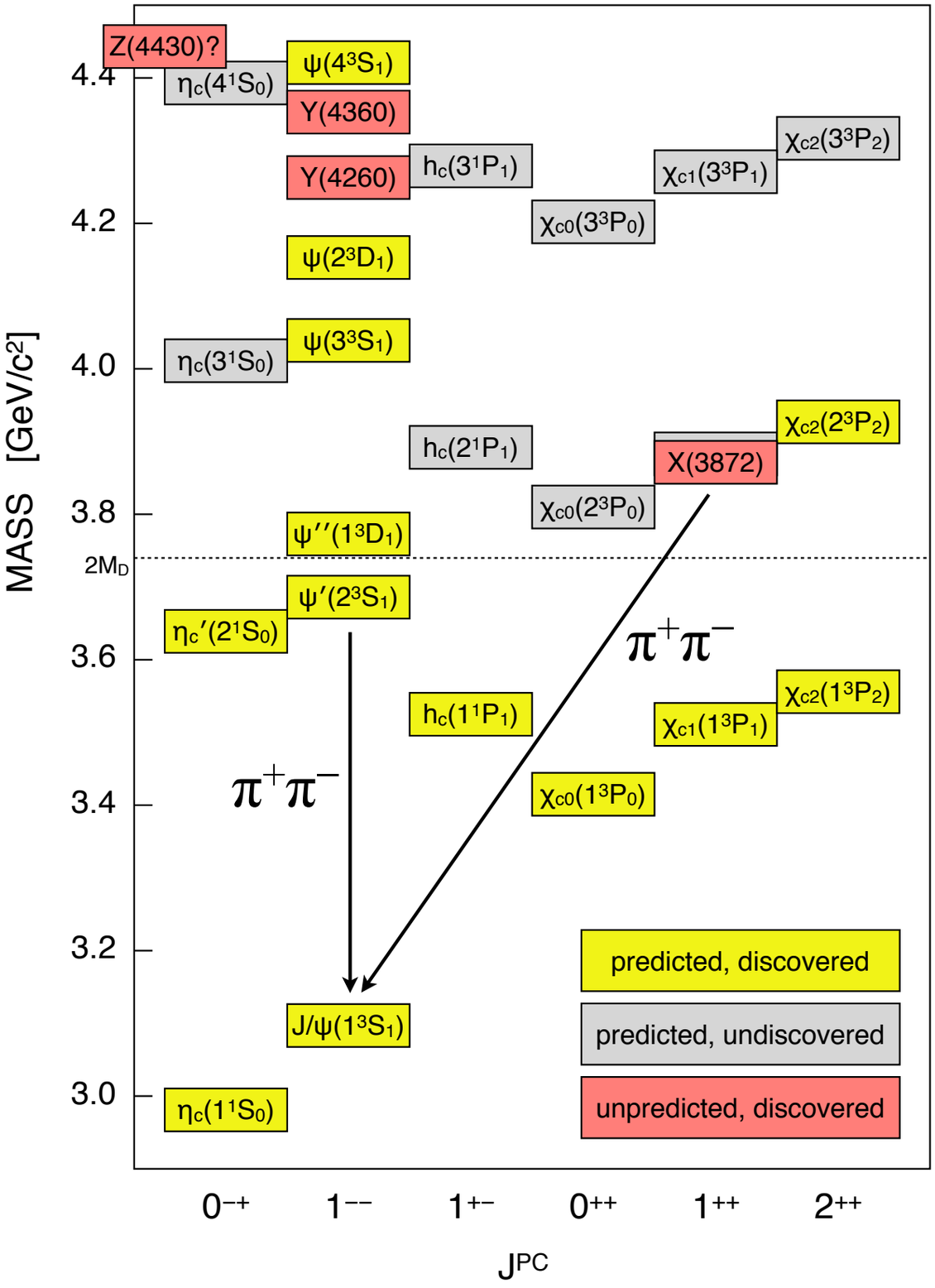

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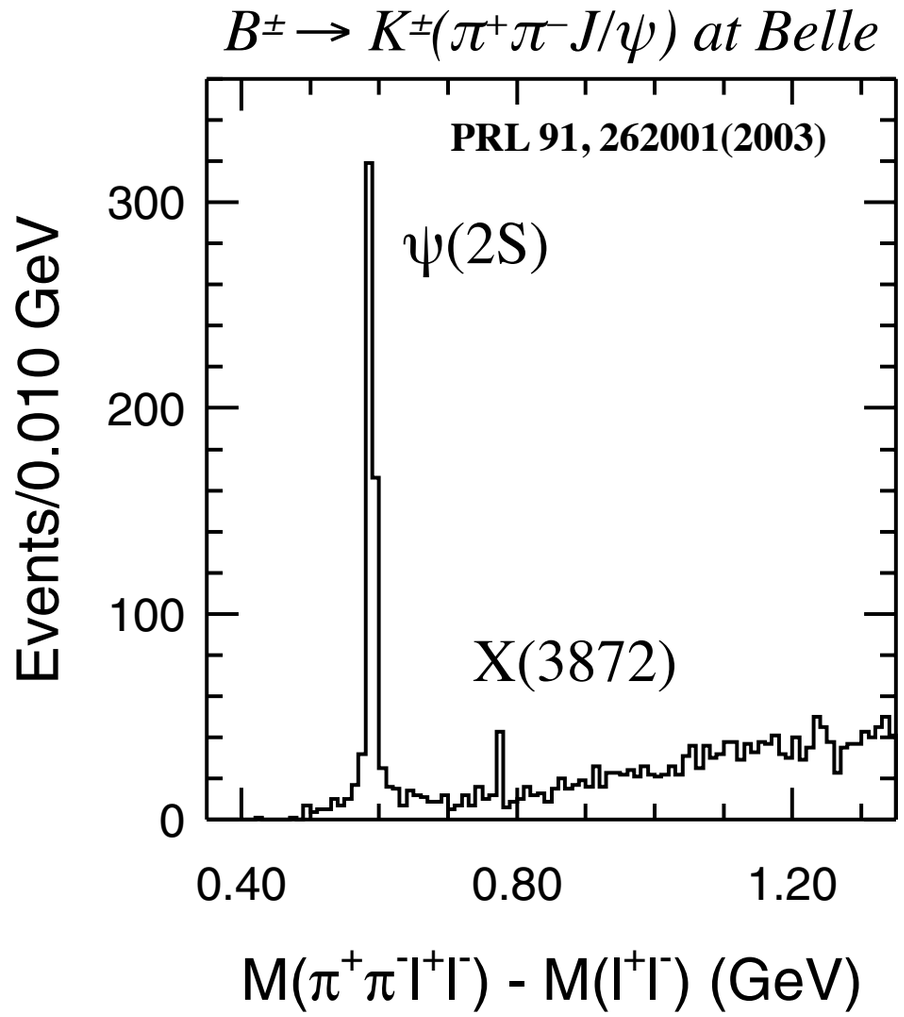

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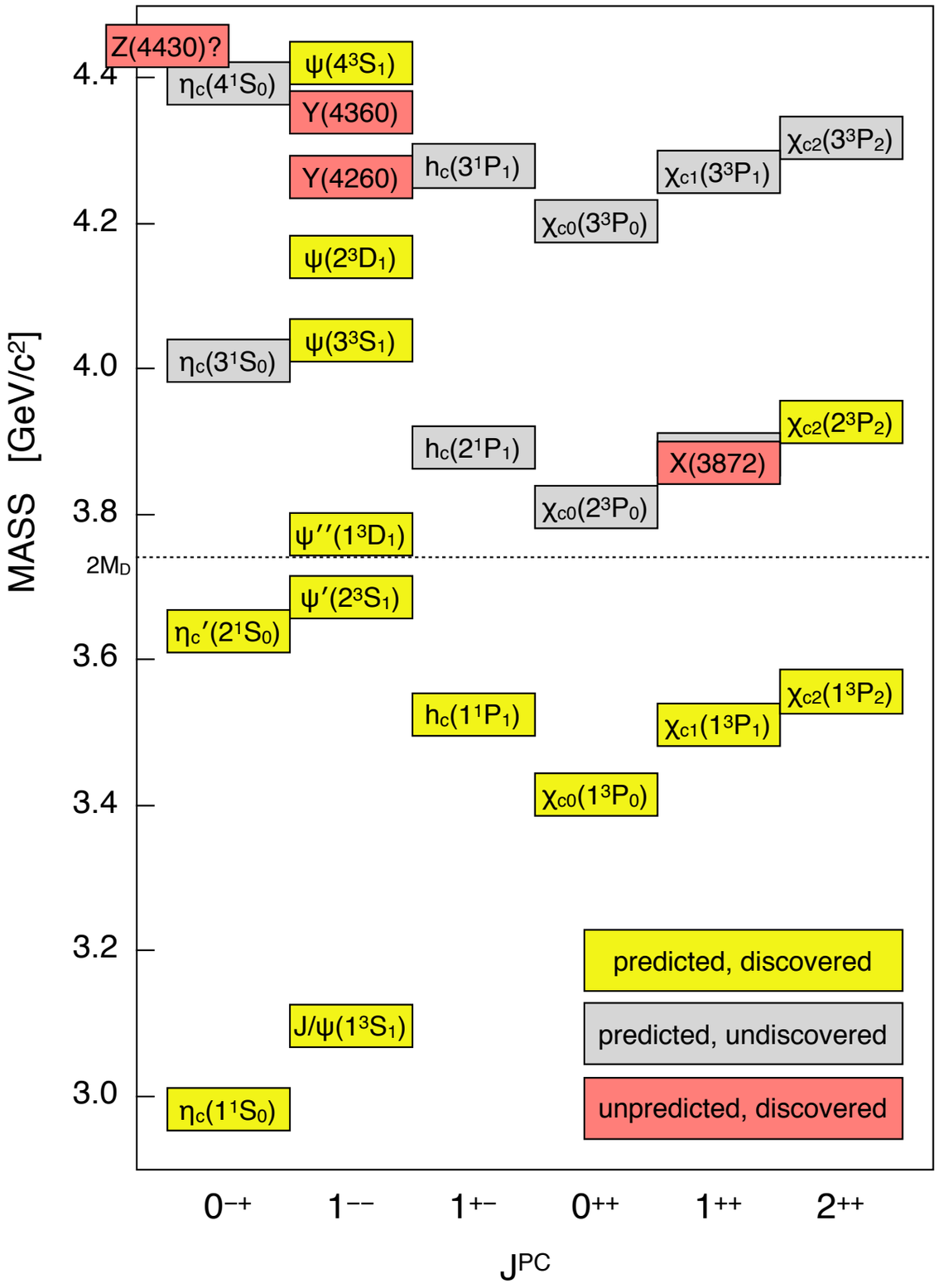

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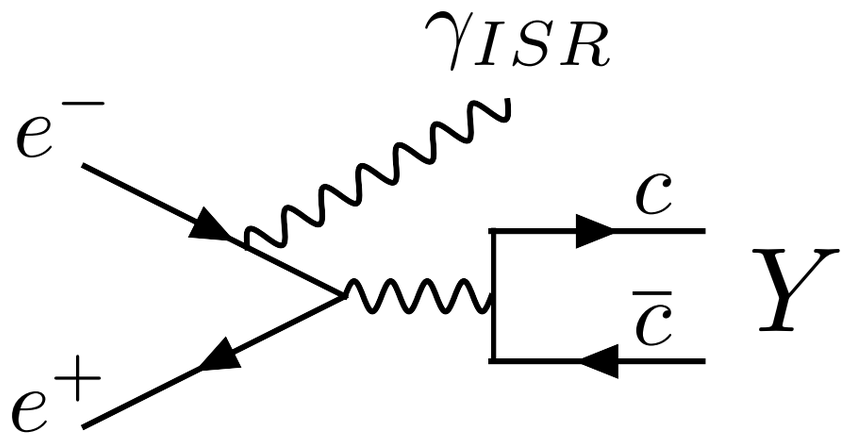

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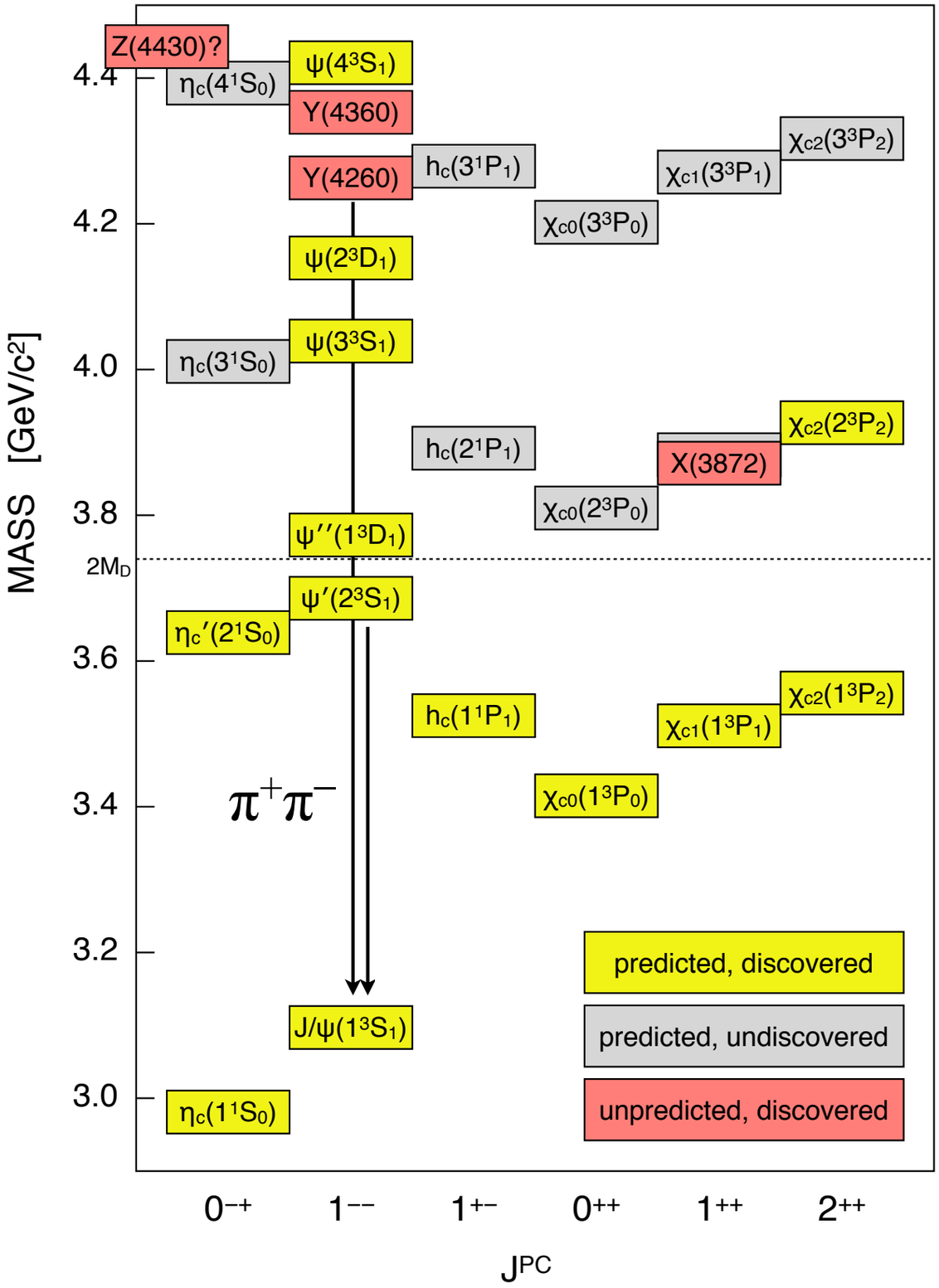

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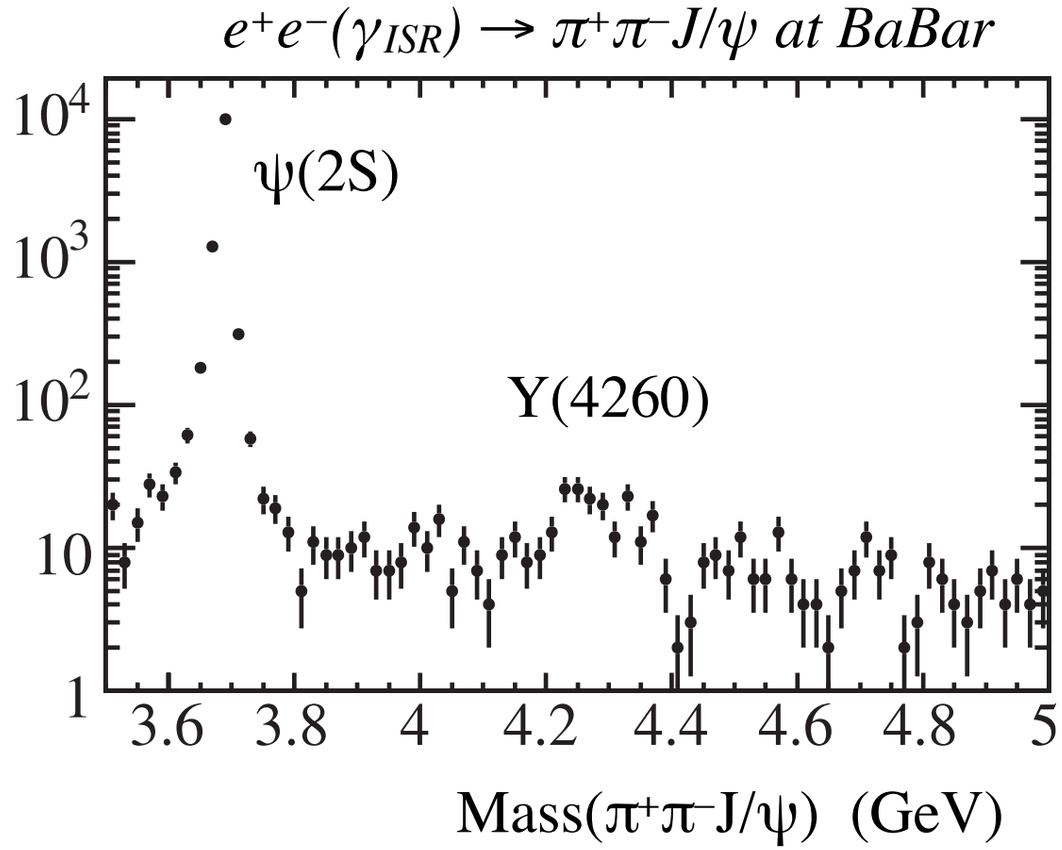

PRL 95, 142001 (2005)

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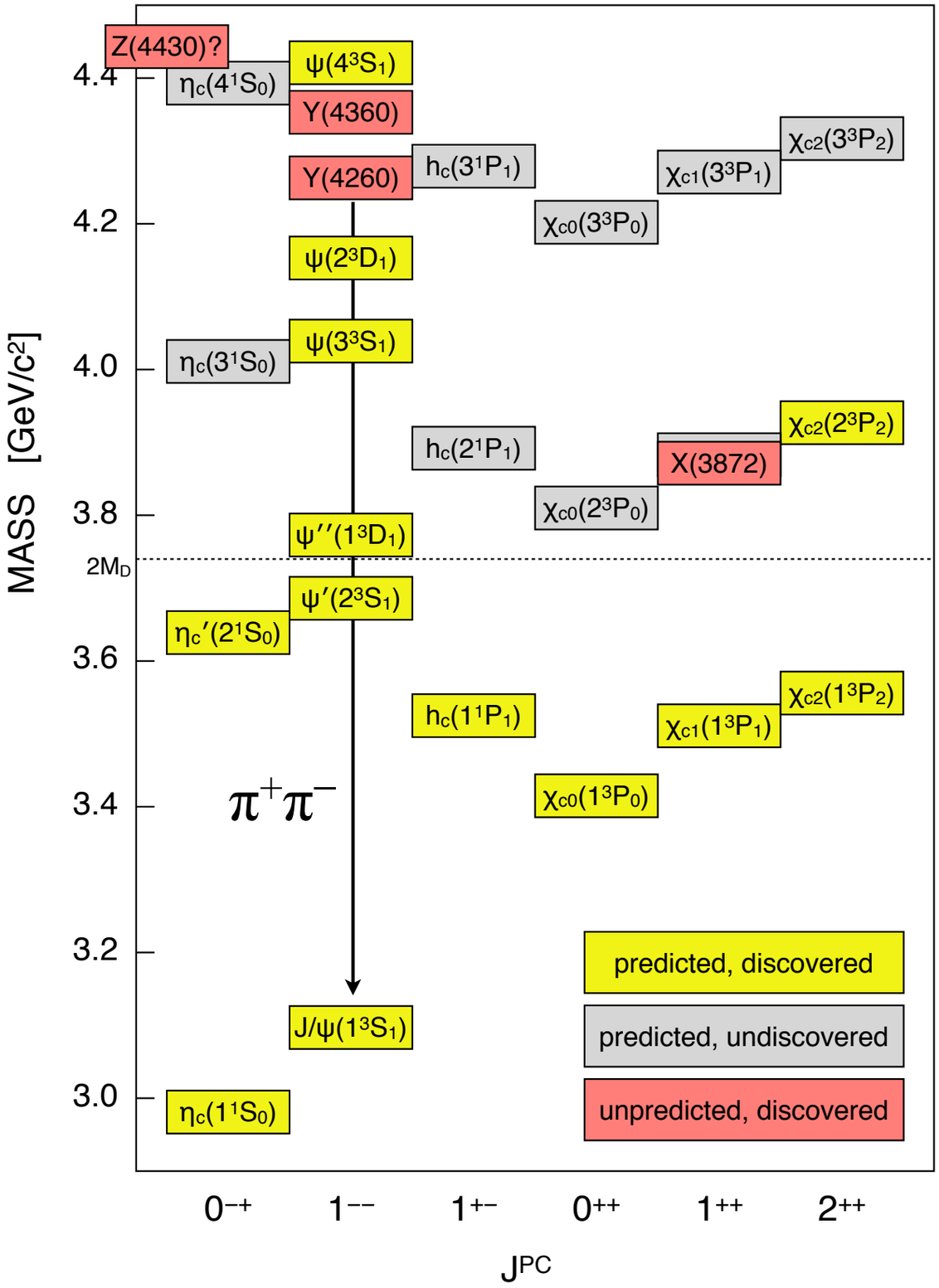

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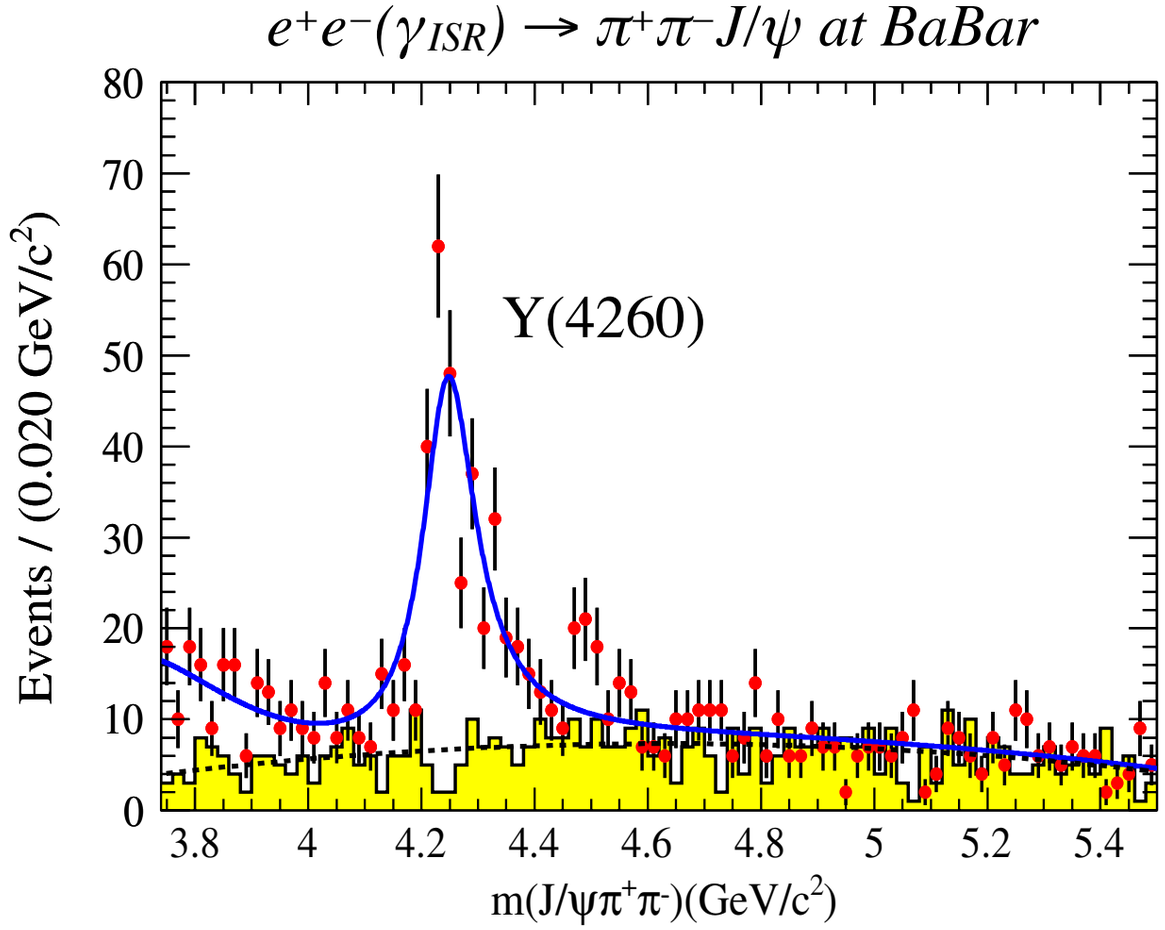

PRD 86, 051102(R) (2012)

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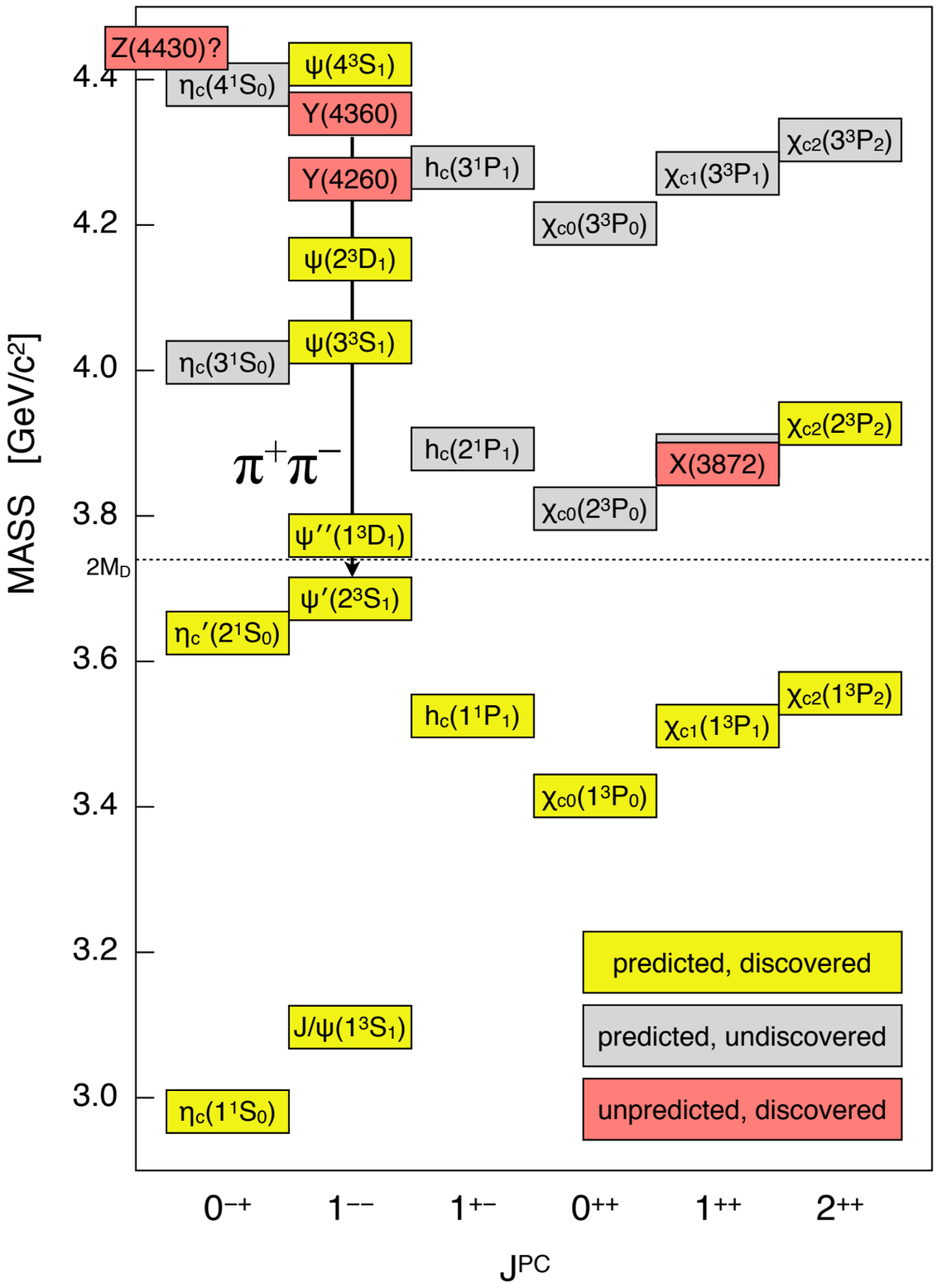

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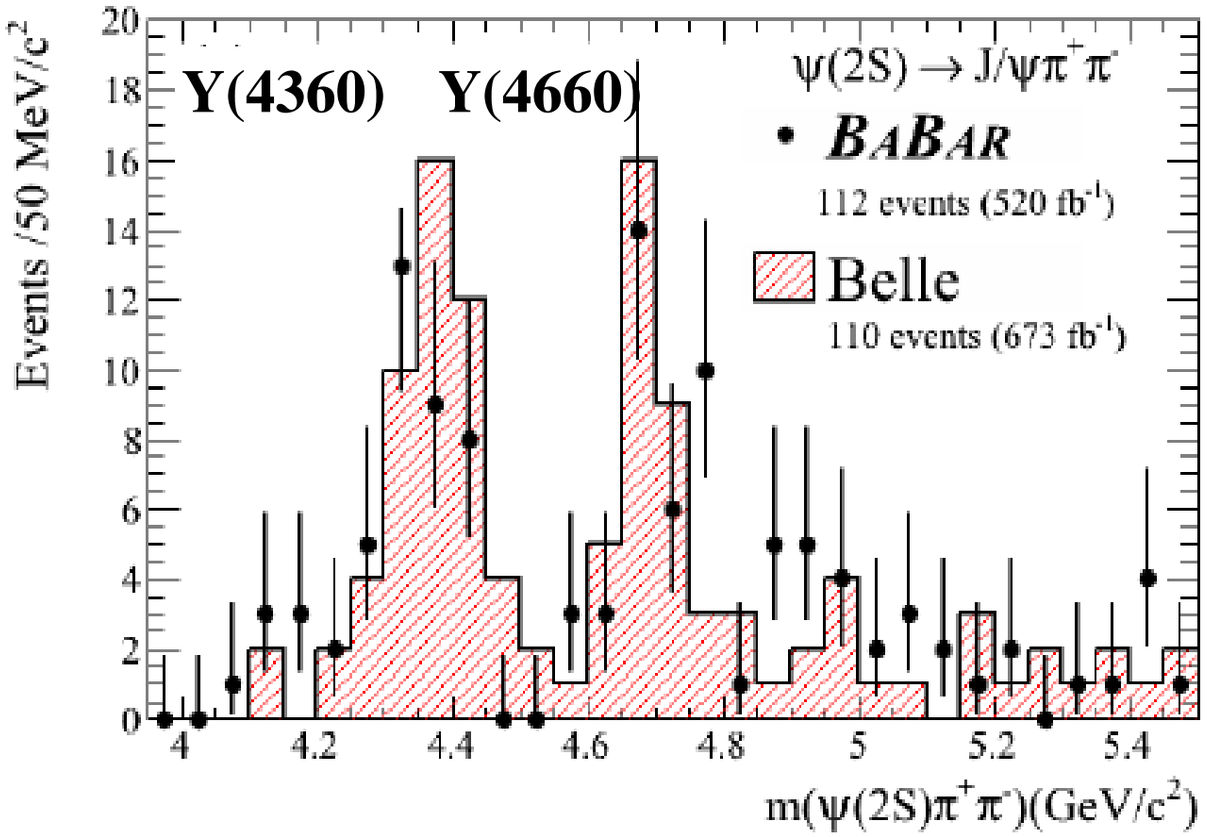
$e^+e^-(\gamma_{ISR}) \rightarrow \pi^+\pi^-\psi(2S)$ at BaBar and Belle



arXiv:1211.6271 and CHARM 2012

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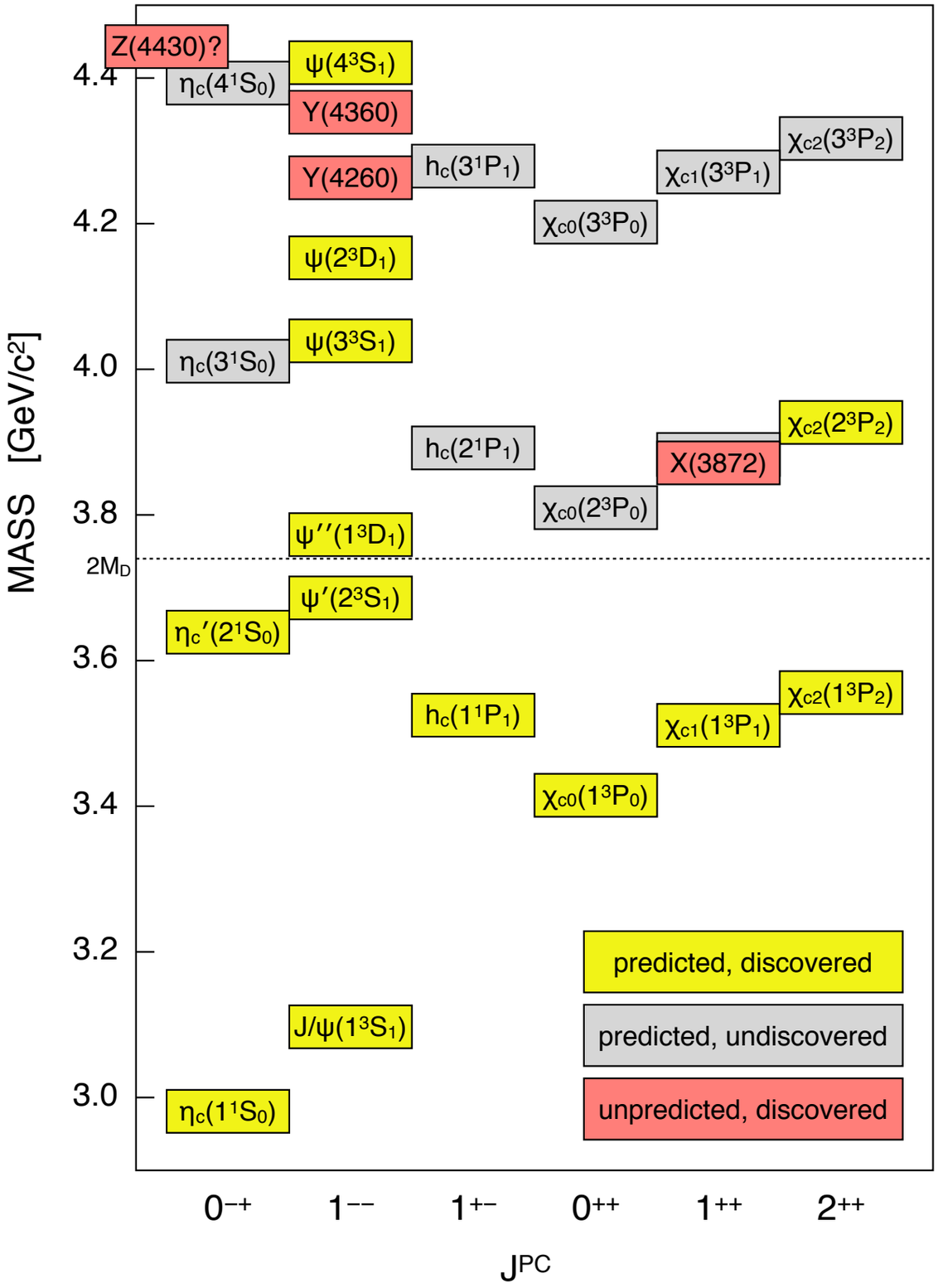
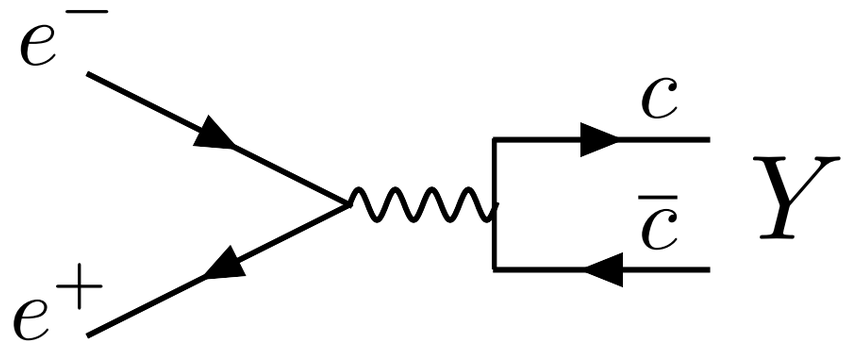


BESIII can produce the **Y(4260)** and **Y(4360)** directly by tuning the BEPCII center of mass energies…



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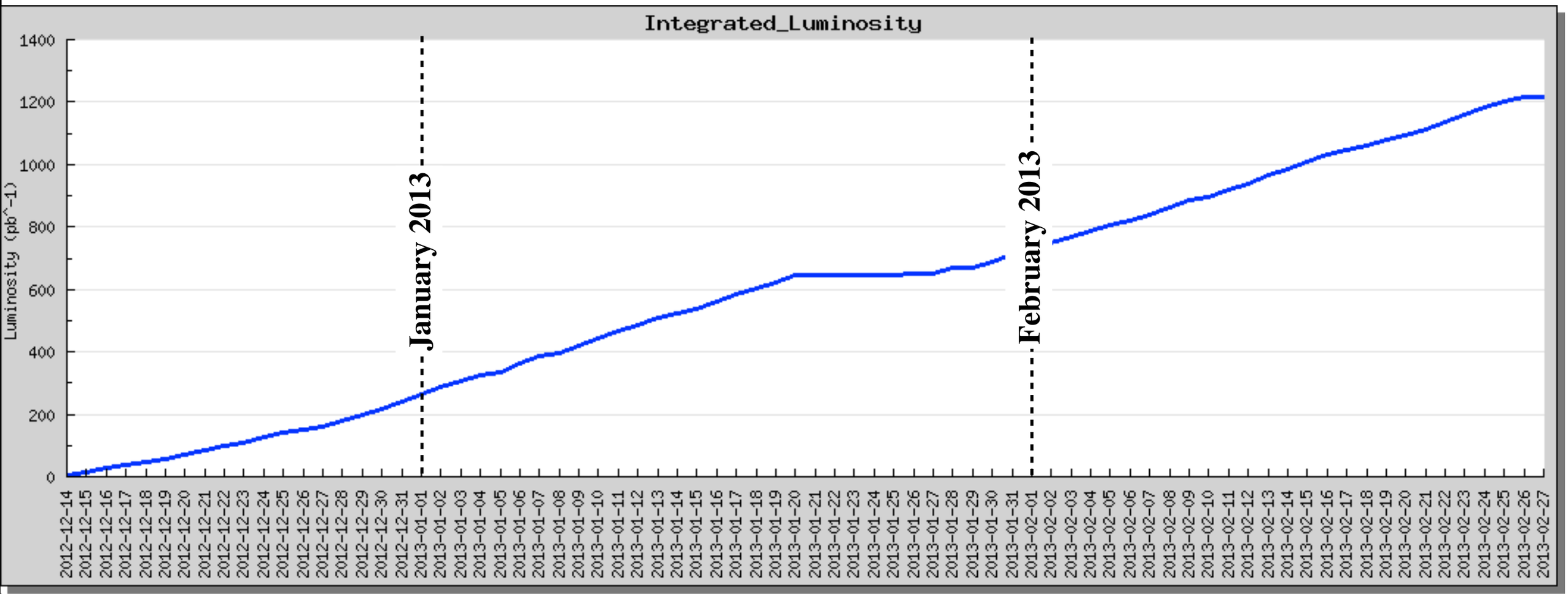
BESIII Initial Round of Data-taking



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(world's largest sample of Y(4260) by ~2×)

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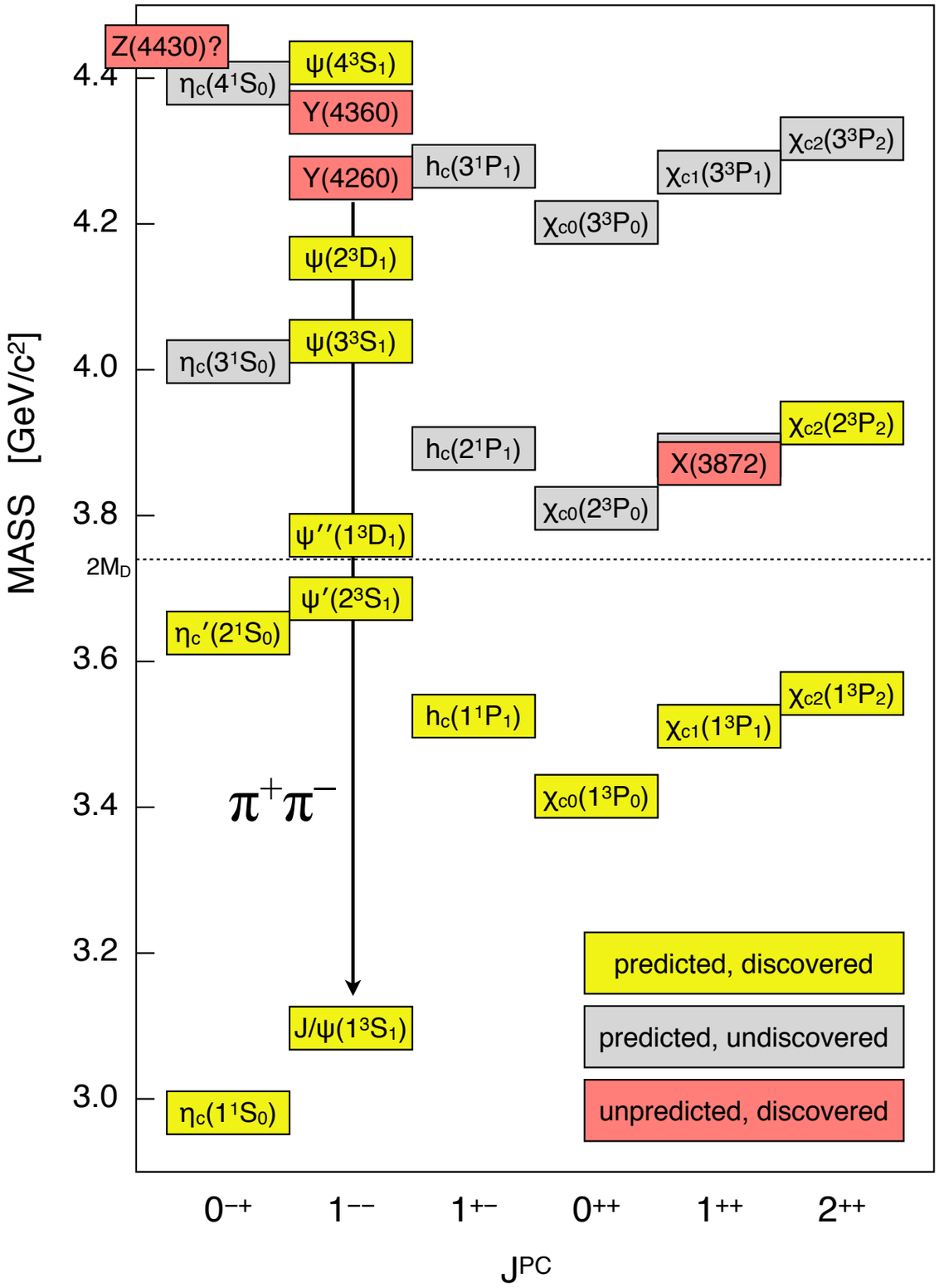
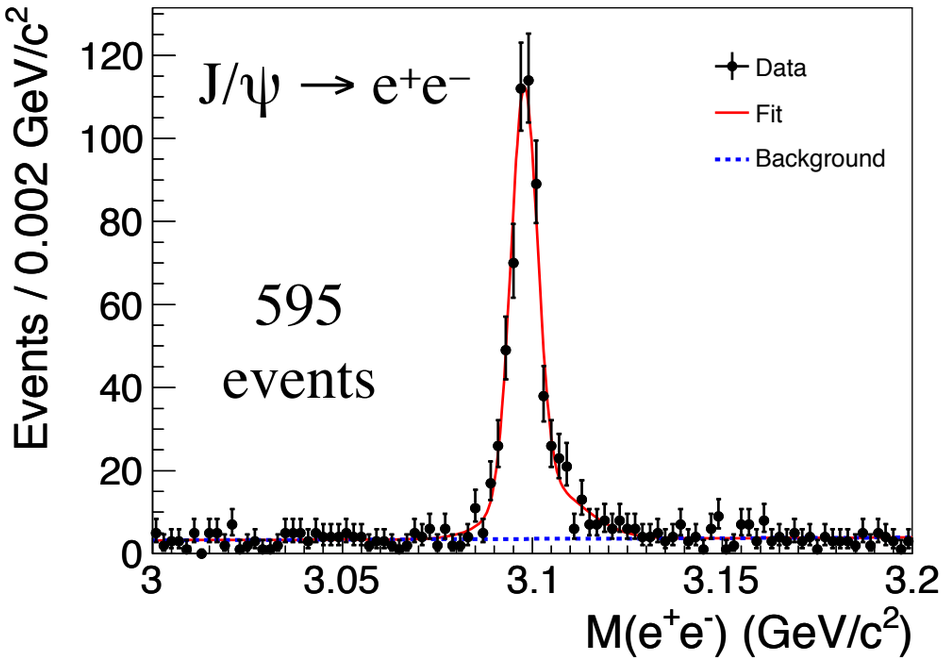
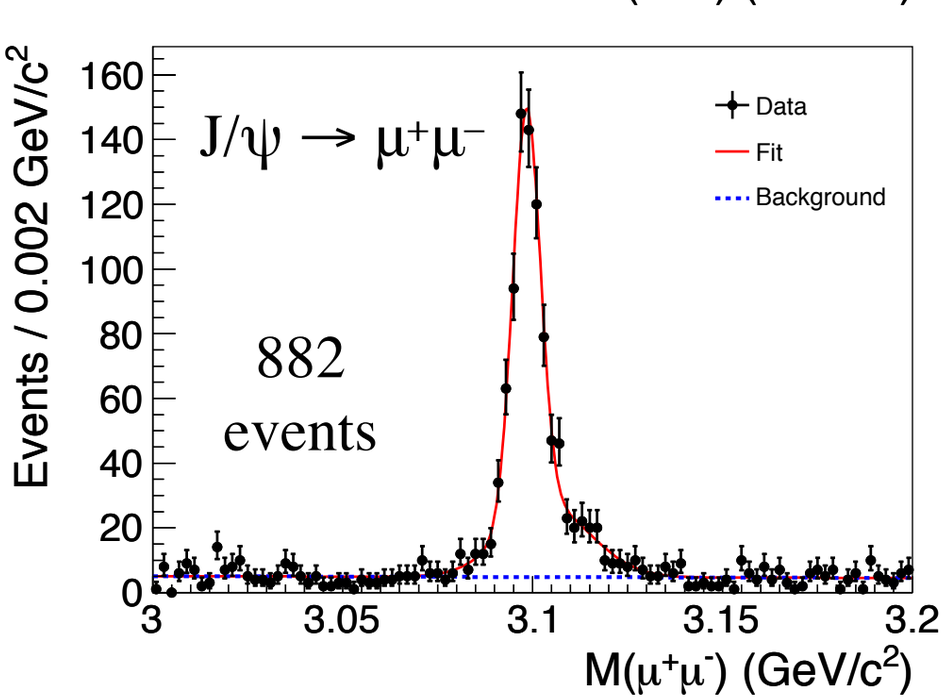


e^+e^- (at 4260 MeV) → $\pi^+\pi^- J/\psi$ at BESIII





PRL 110, 252001 (2013)

(cross section consistent with Belle and BaBar)

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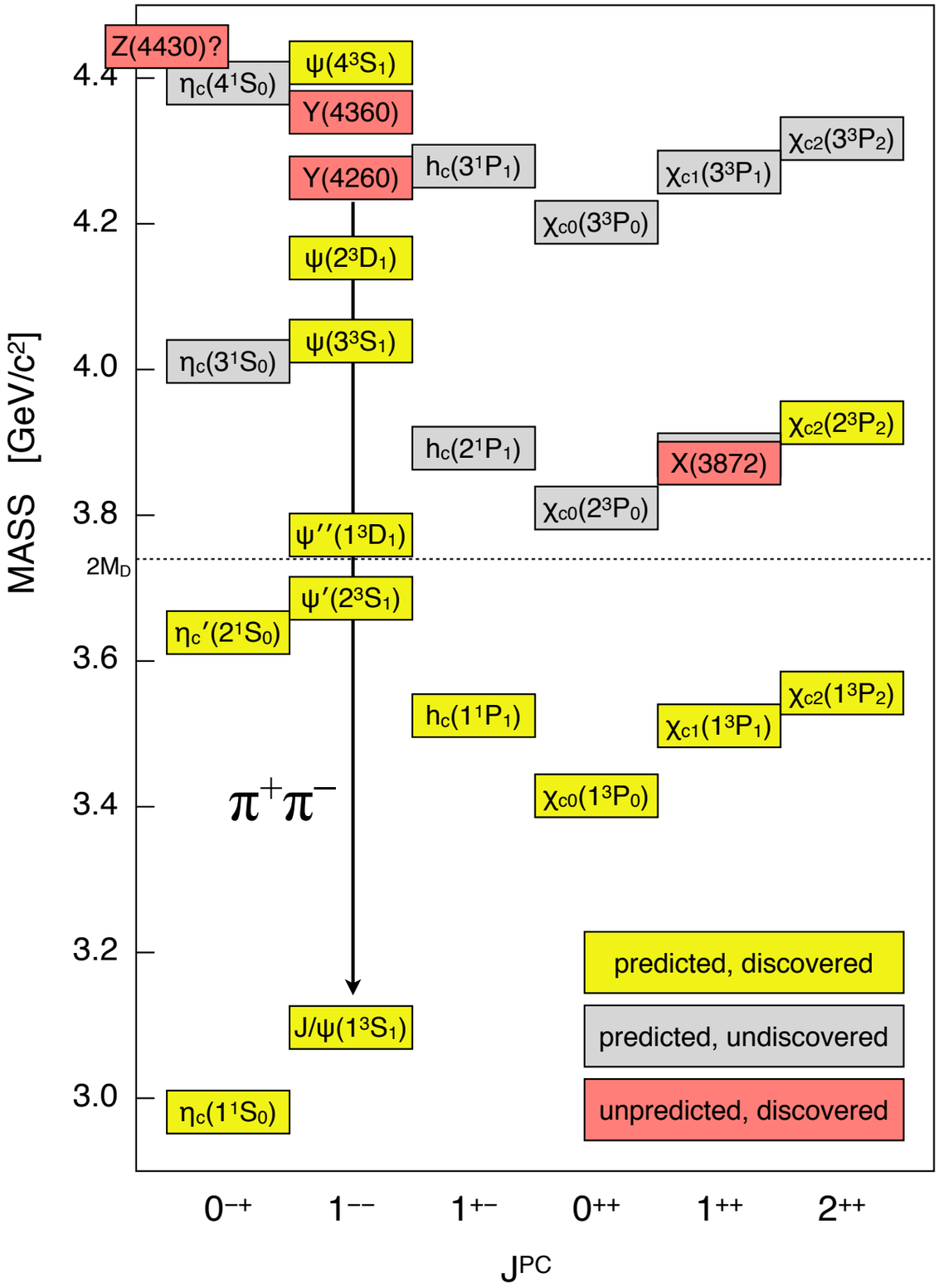

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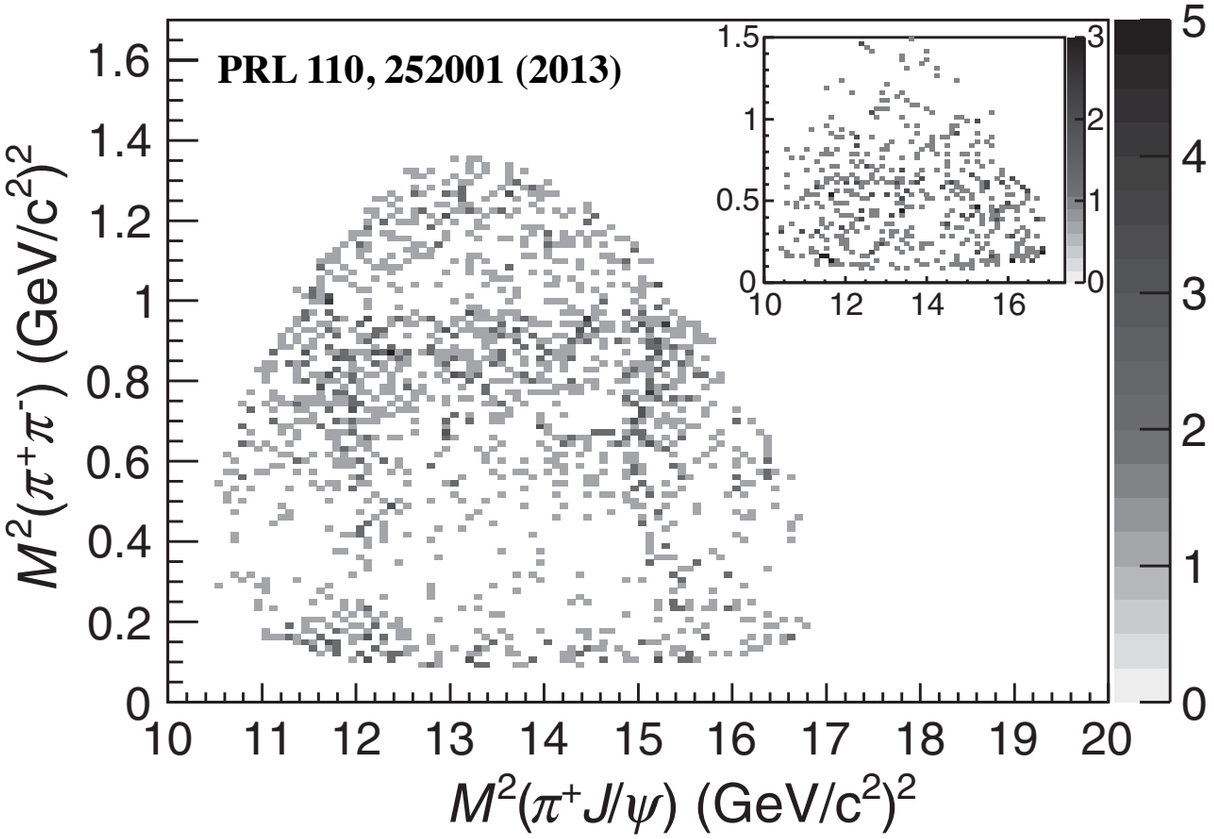

non-trivial substructure in $\pi^+\pi^- J/\psi$

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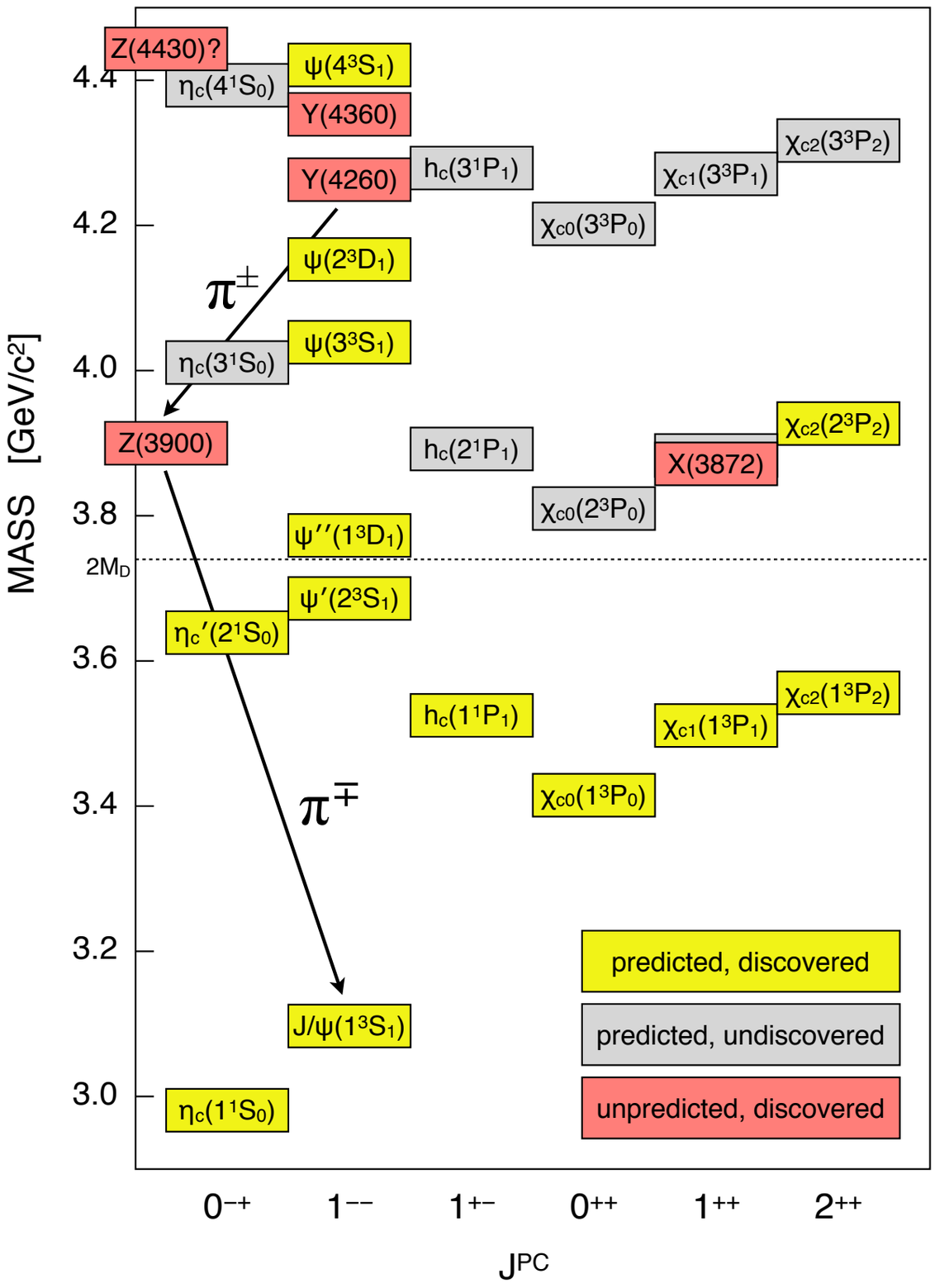

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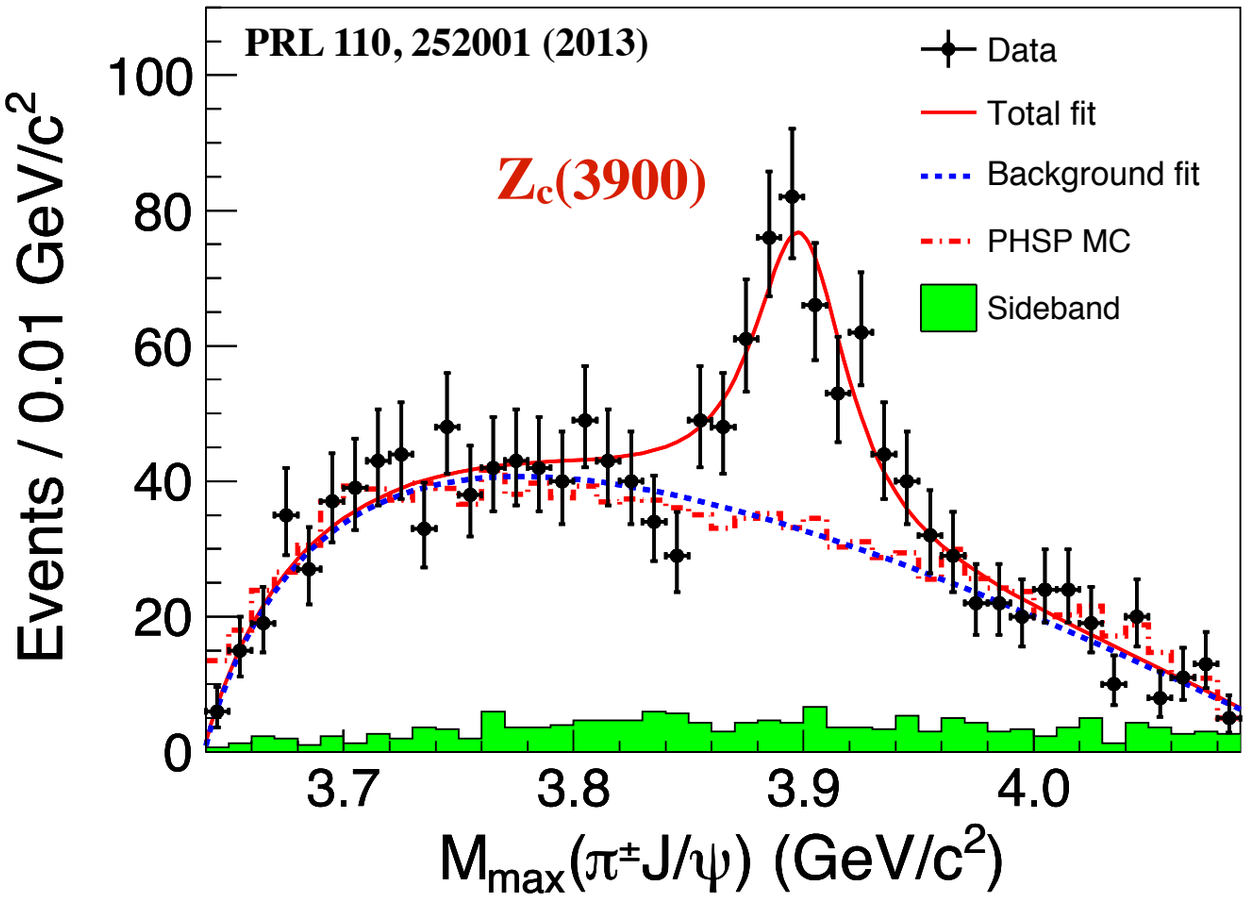

M = 3899.0 ± 3.6 ± 4.9 MeV
Γ = 46 ± 10 ± 20 MeV

⇒ "Charged Charmoniumlike Structure"

(Confirmed by Belle and CLEO data.)

(Many theoretical ideas -- close to D^*D threshold.)

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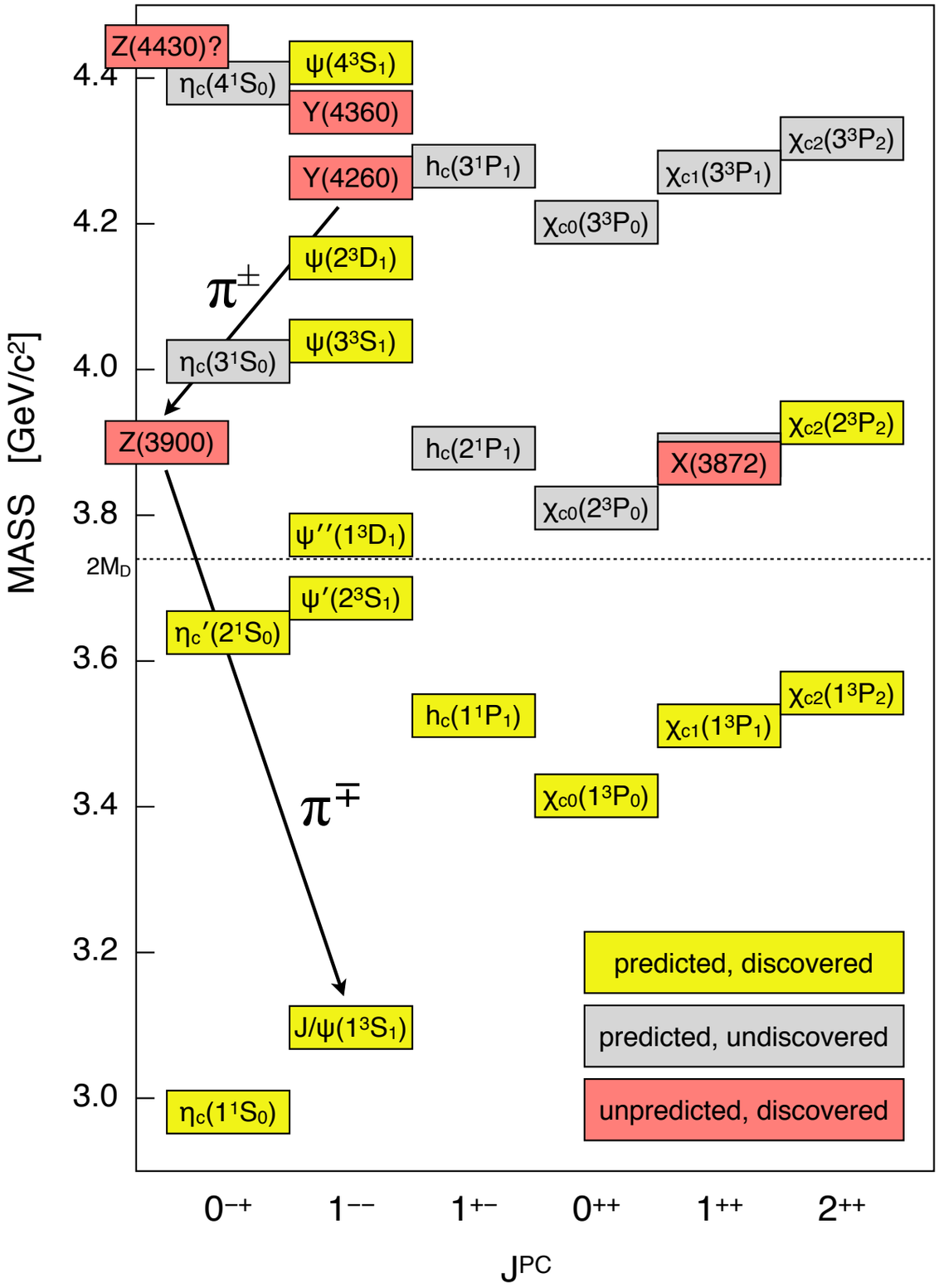
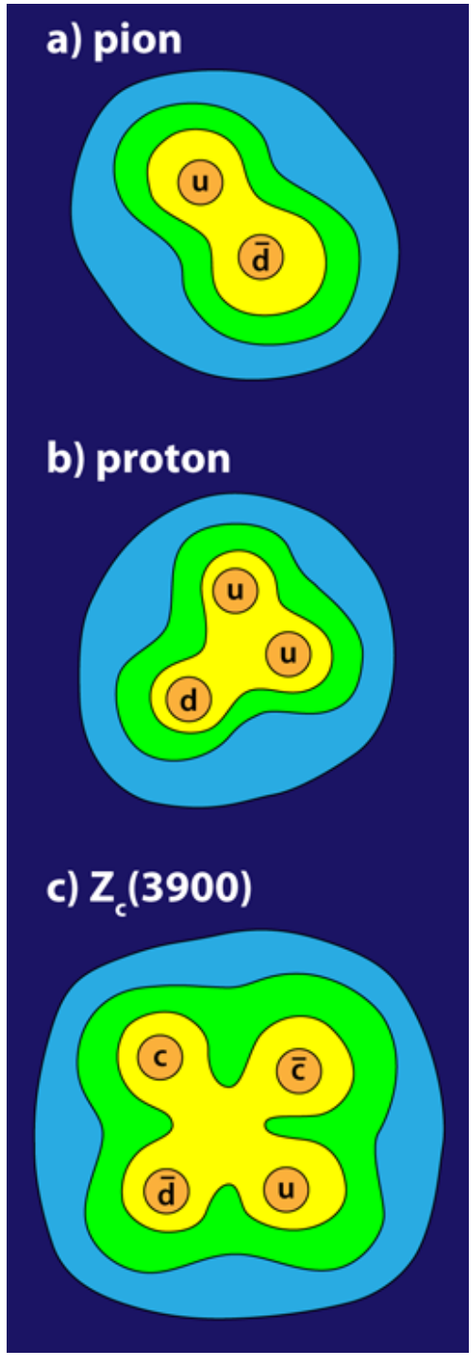


Viewpoint: New Particle Hints at Four-Quark Matter

Eric Swanson, University of Pittsburgh, Pittsburgh, PA 15260, USA

Published June 17, 2013 | Physics **6**, 69 (2013) | DOI: 10.1103/Physics.6.69



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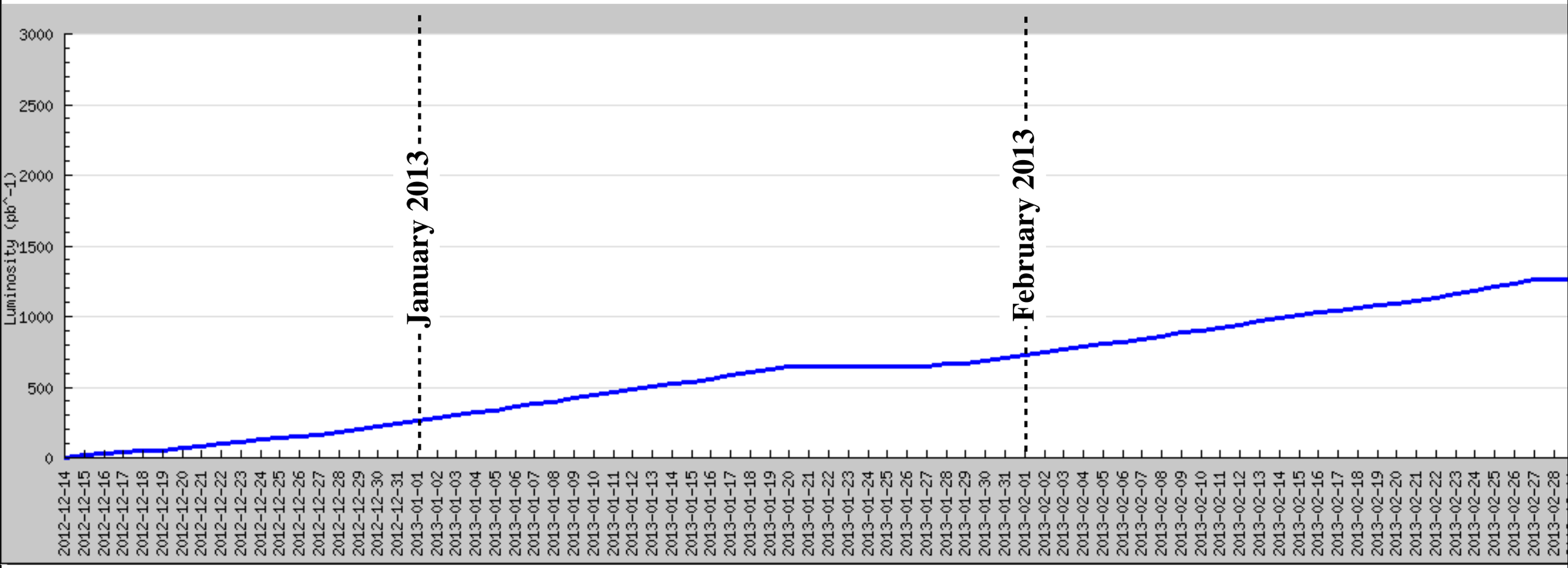

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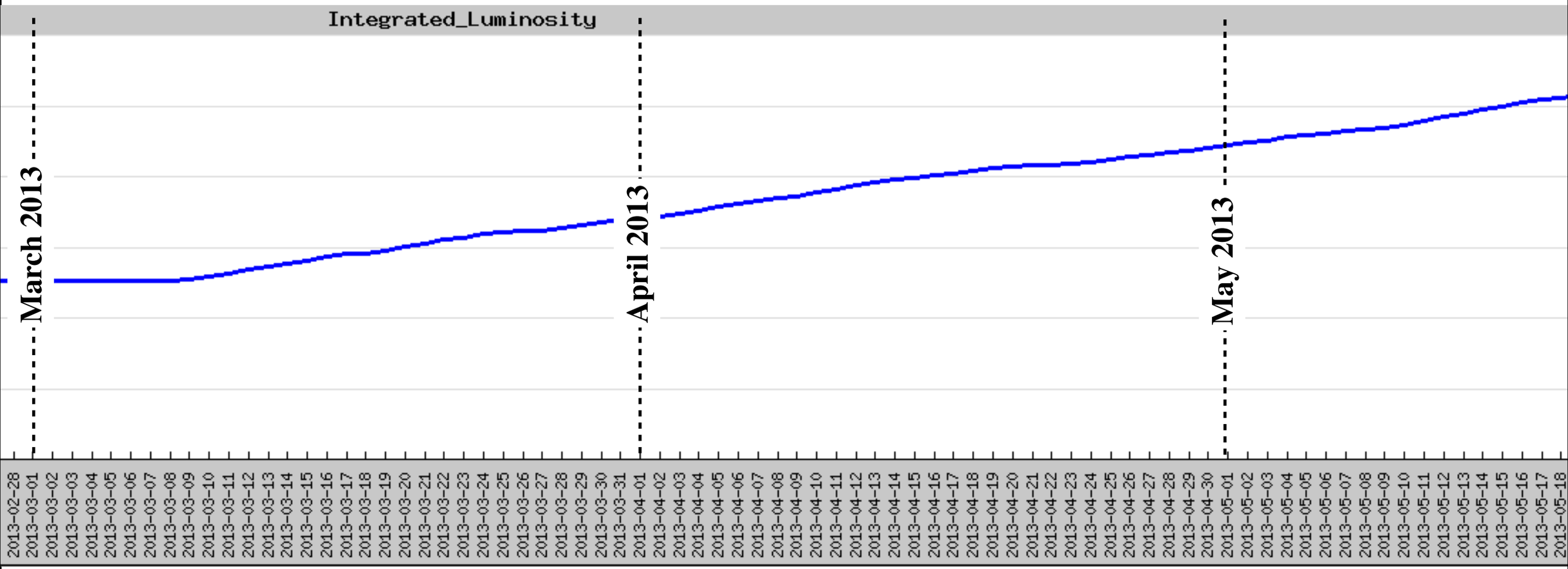

BESIII meeting

4260 (291 pb^{-1})

4210 (52 pb^{-1})

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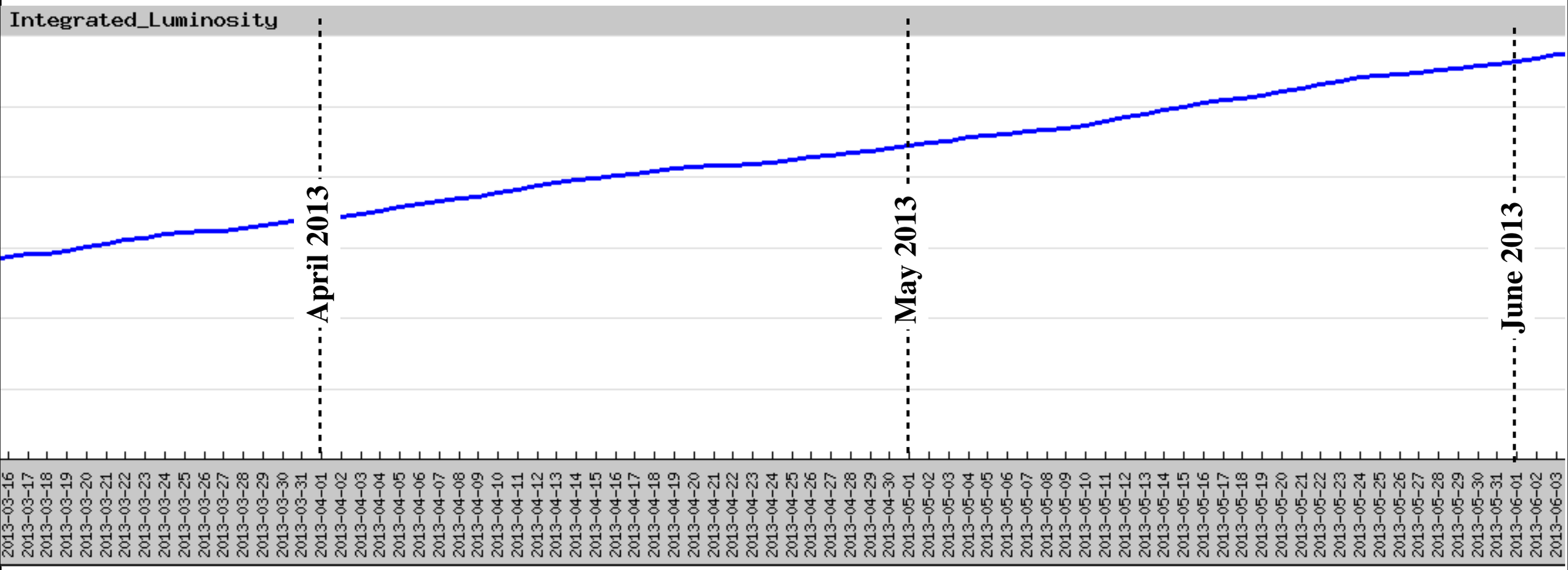
4245 (53 pb^{-1})

4230 (1011 pb^{-1})

BESIII Additional Round of Data-taking



91 pb^{-1})

4230 (1011 pb^{-1})

4210 (52 pb^{-1})

4220 (52 pb^{-1})

4245 (53 pb^{-1})

3810 (48 pb^{-1})

3900 (50 pb^{-1})

4090 (50 pb^{-1})

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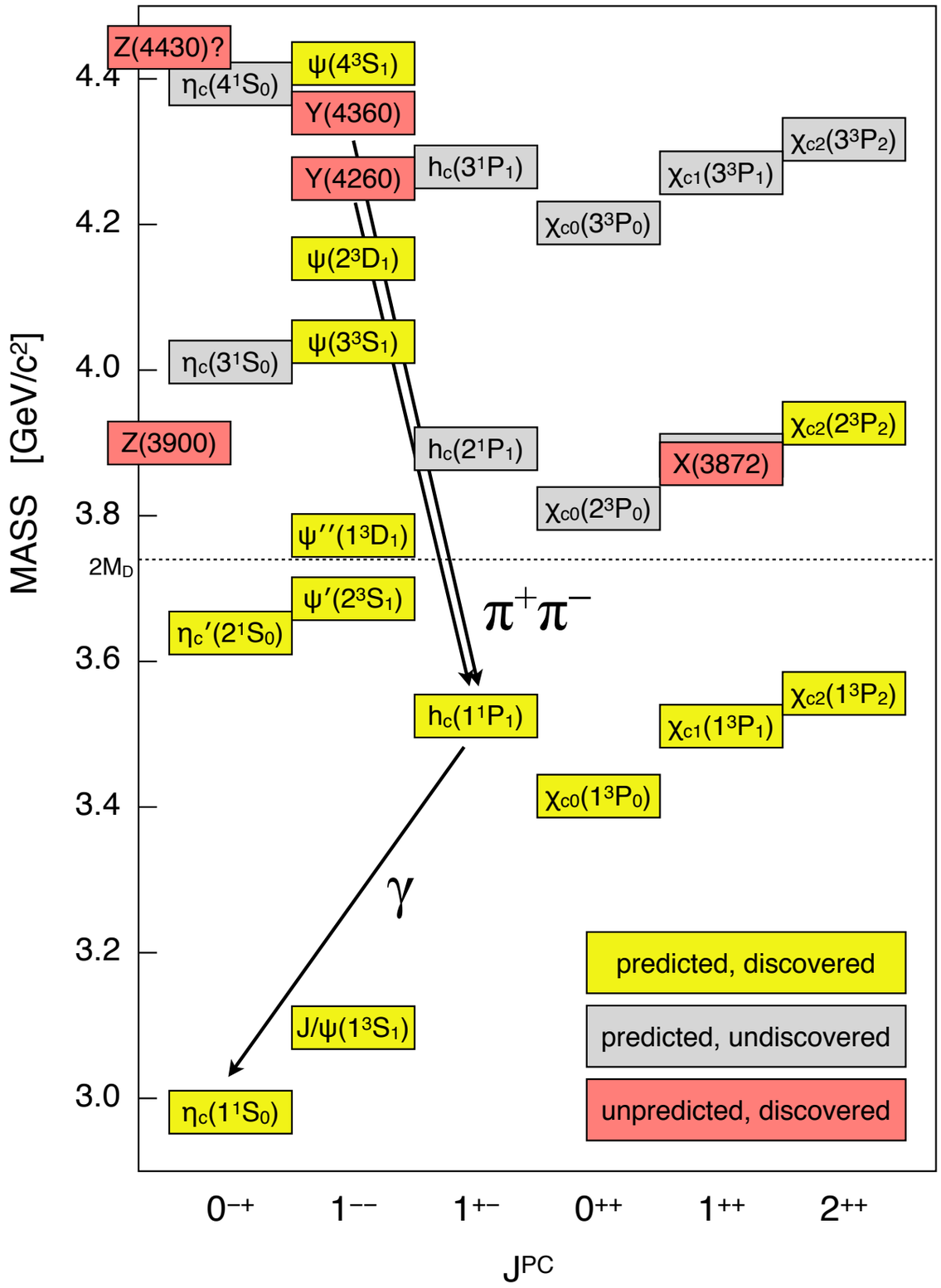
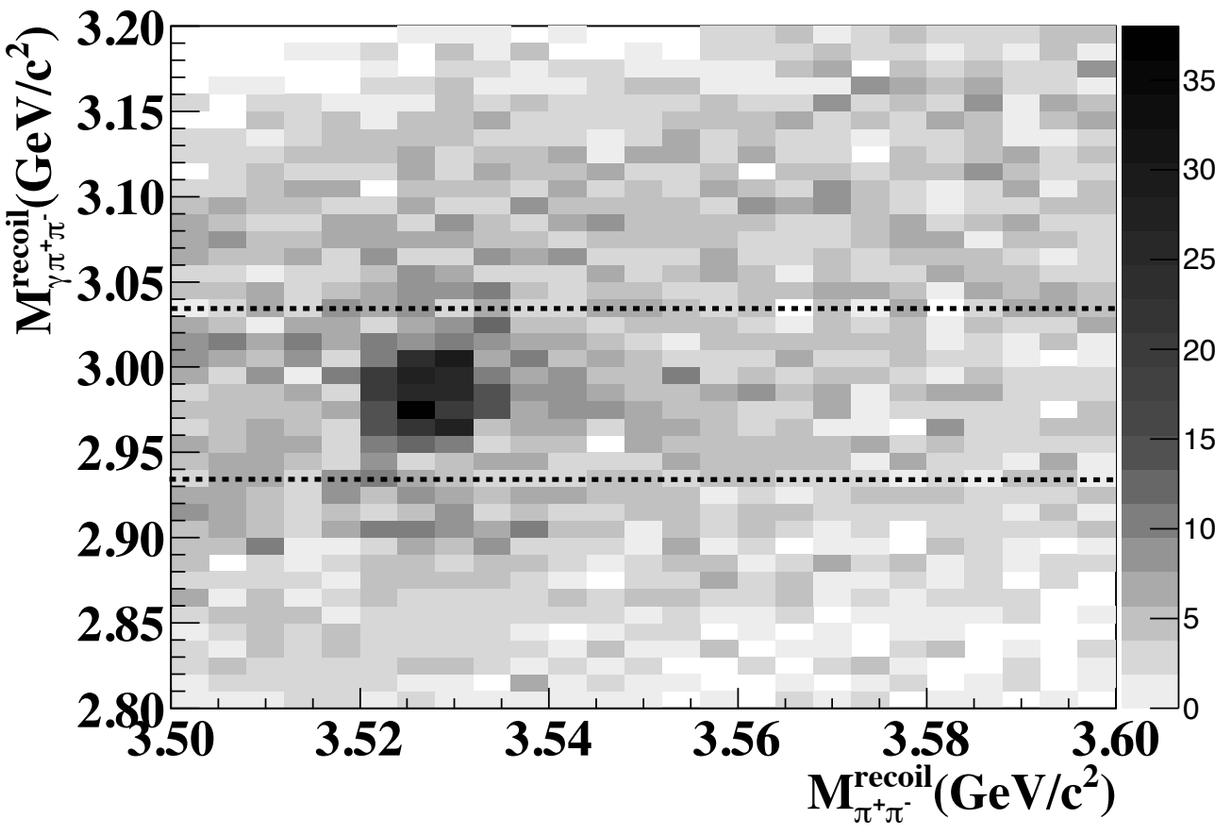


e^+e^- *(at 4260 MeV)* $\rightarrow \pi^+\pi^- h_c(1P)$ *at BESIII*



arXiv:1309.1896

Exclusively reconstruct the process:

$e^+e^- \rightarrow \pi^+\pi^- h_c(1P)$

$h_c(1P) \rightarrow \gamma\eta_c(1S)$

$\eta_c(1S) \rightarrow$ **16 decay channels**

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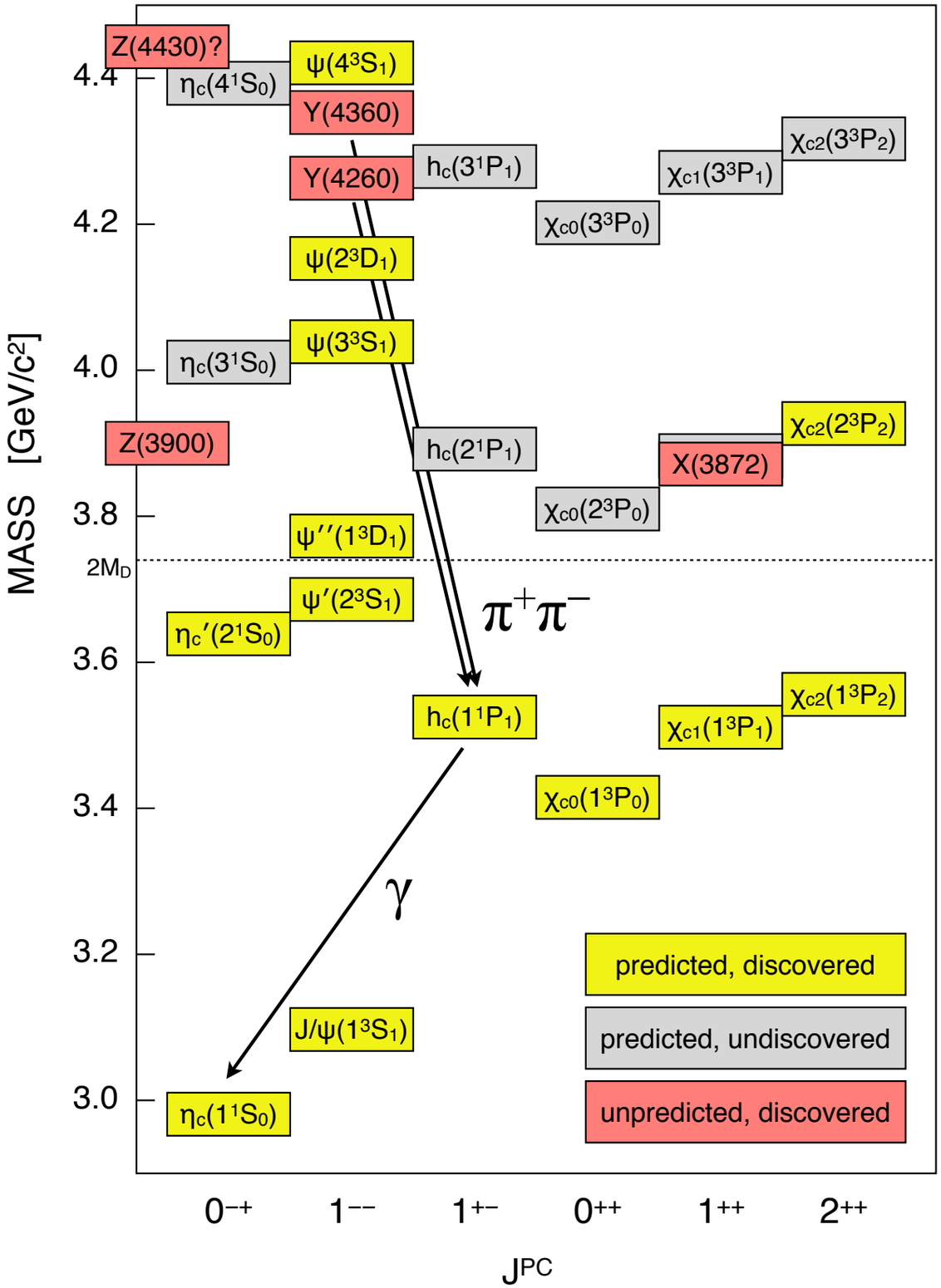

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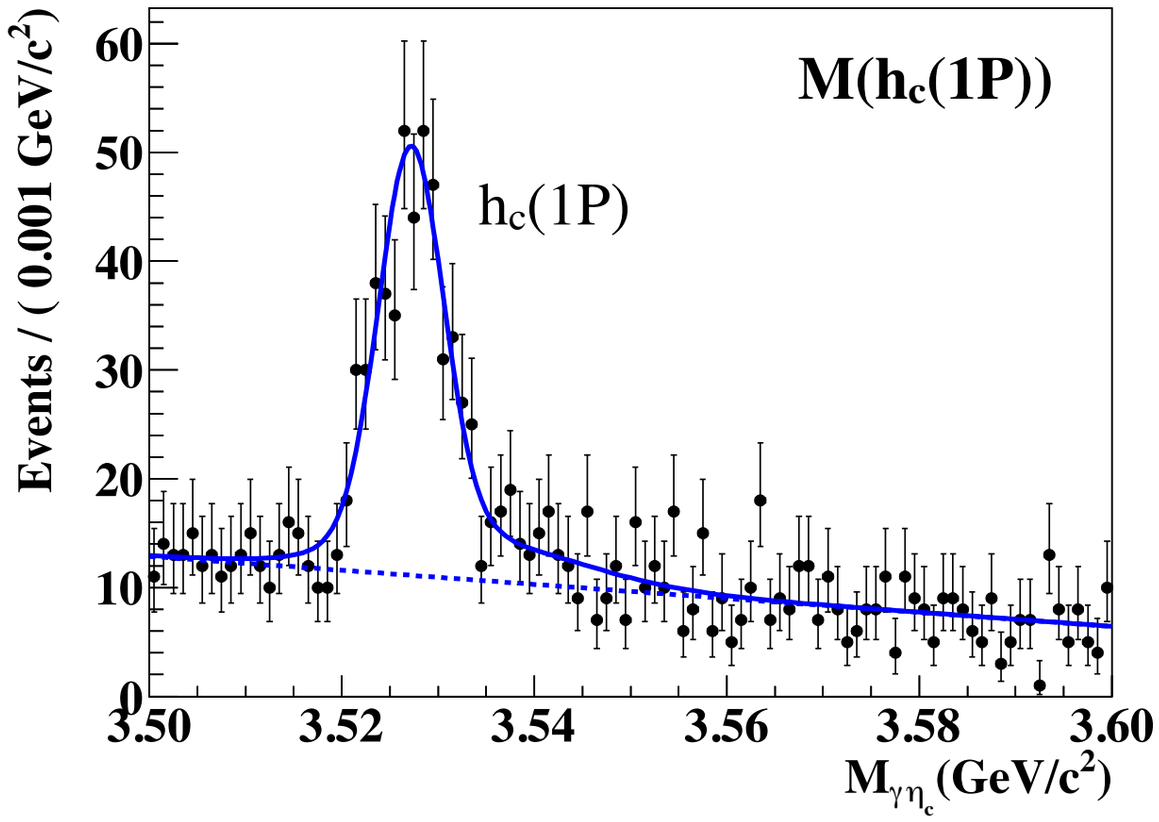

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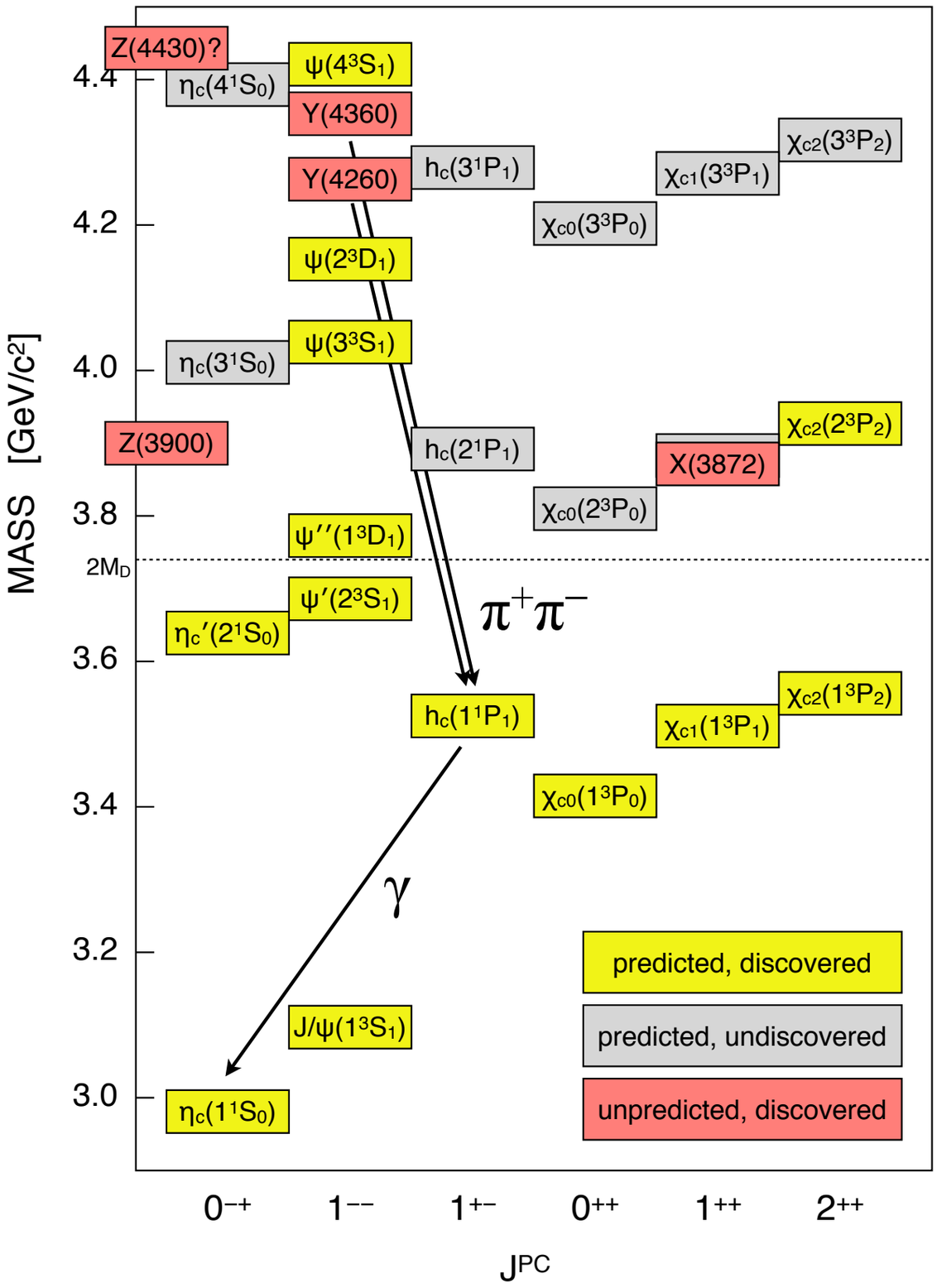

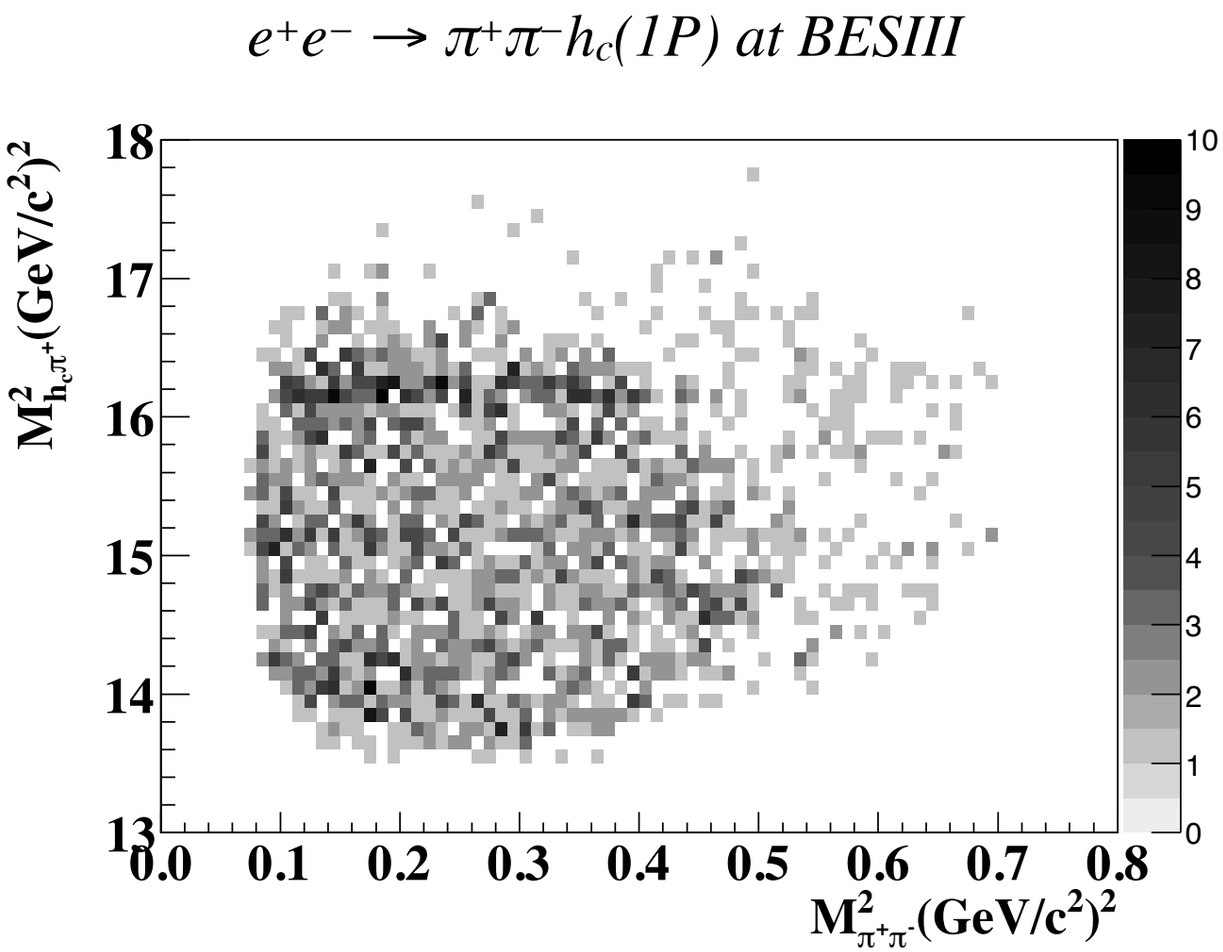

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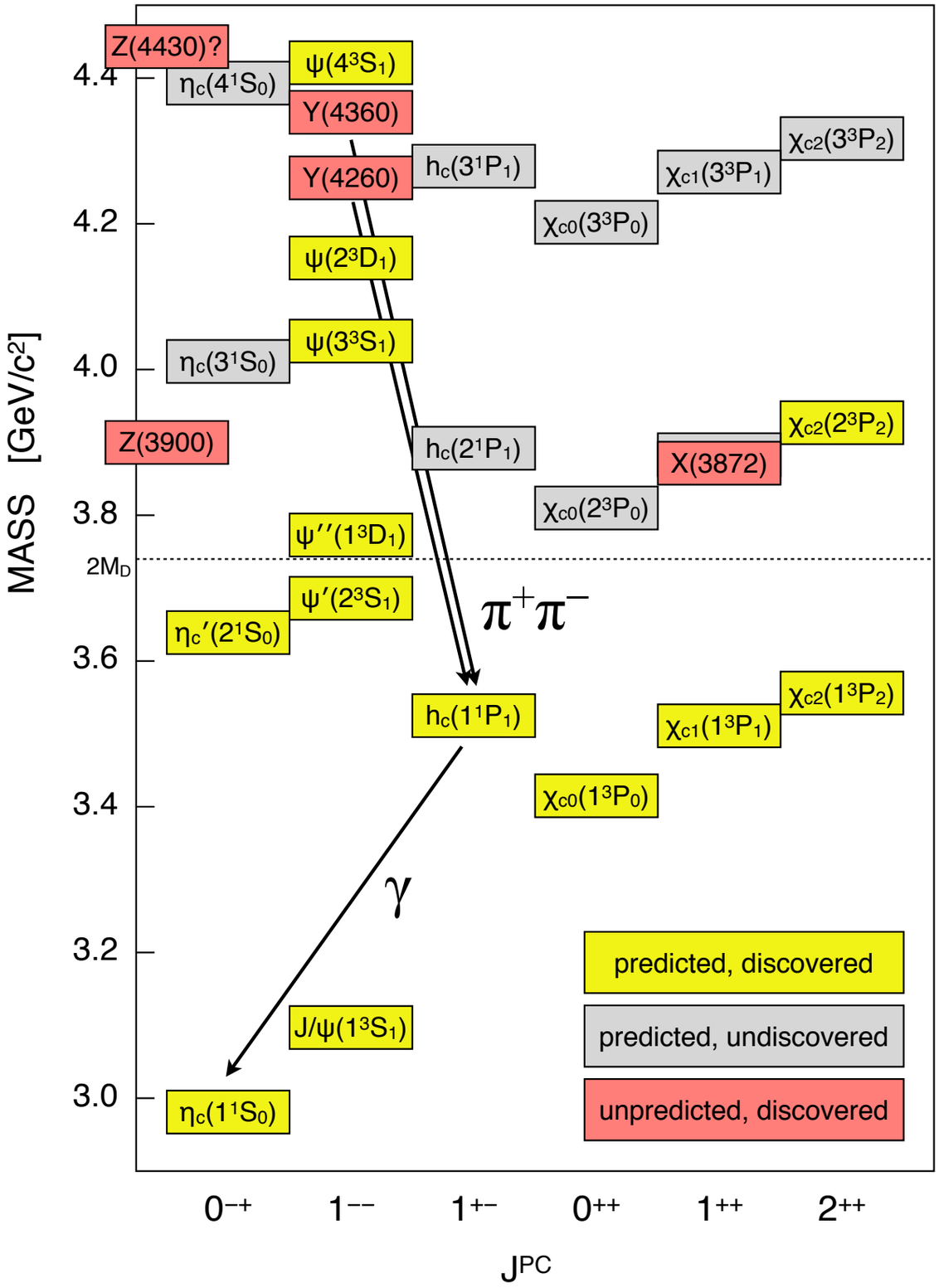

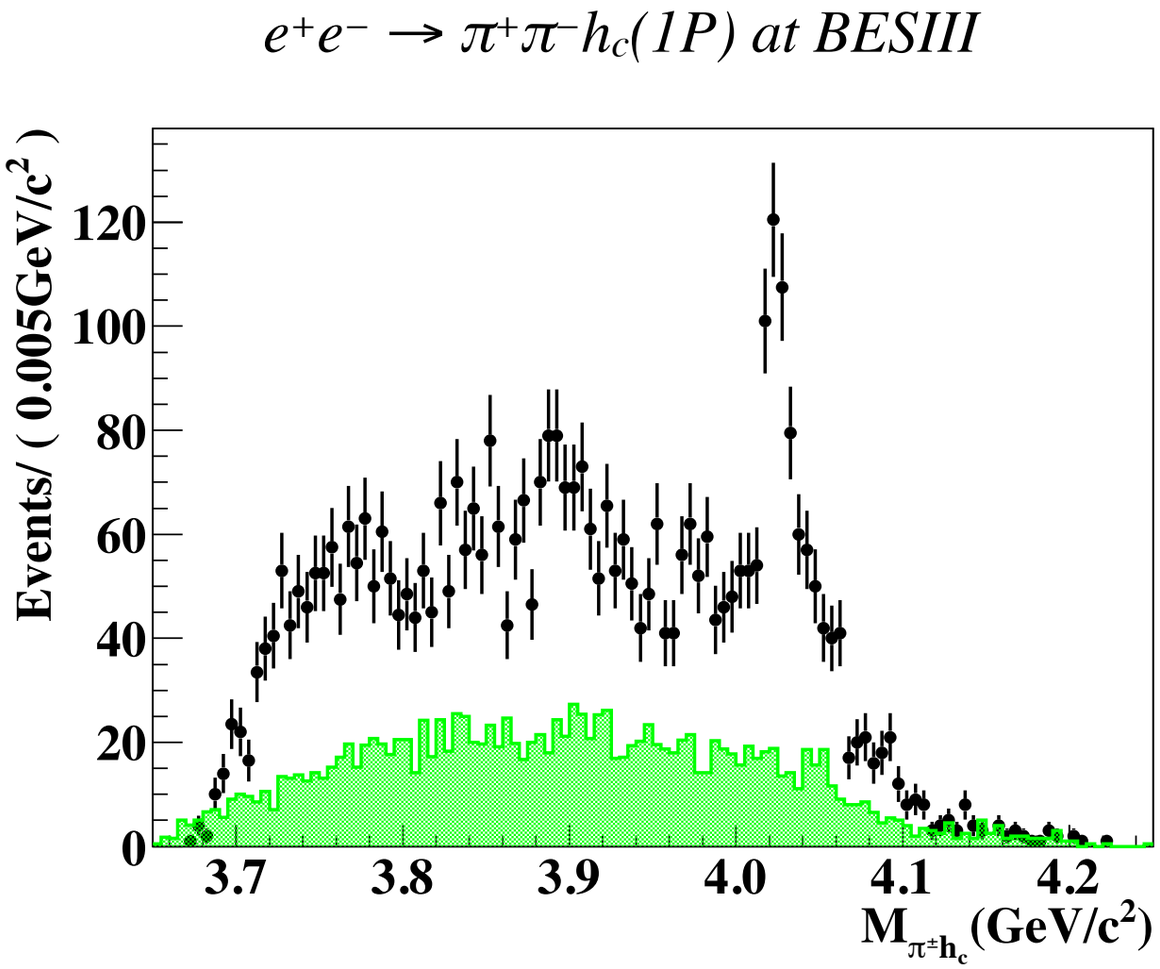

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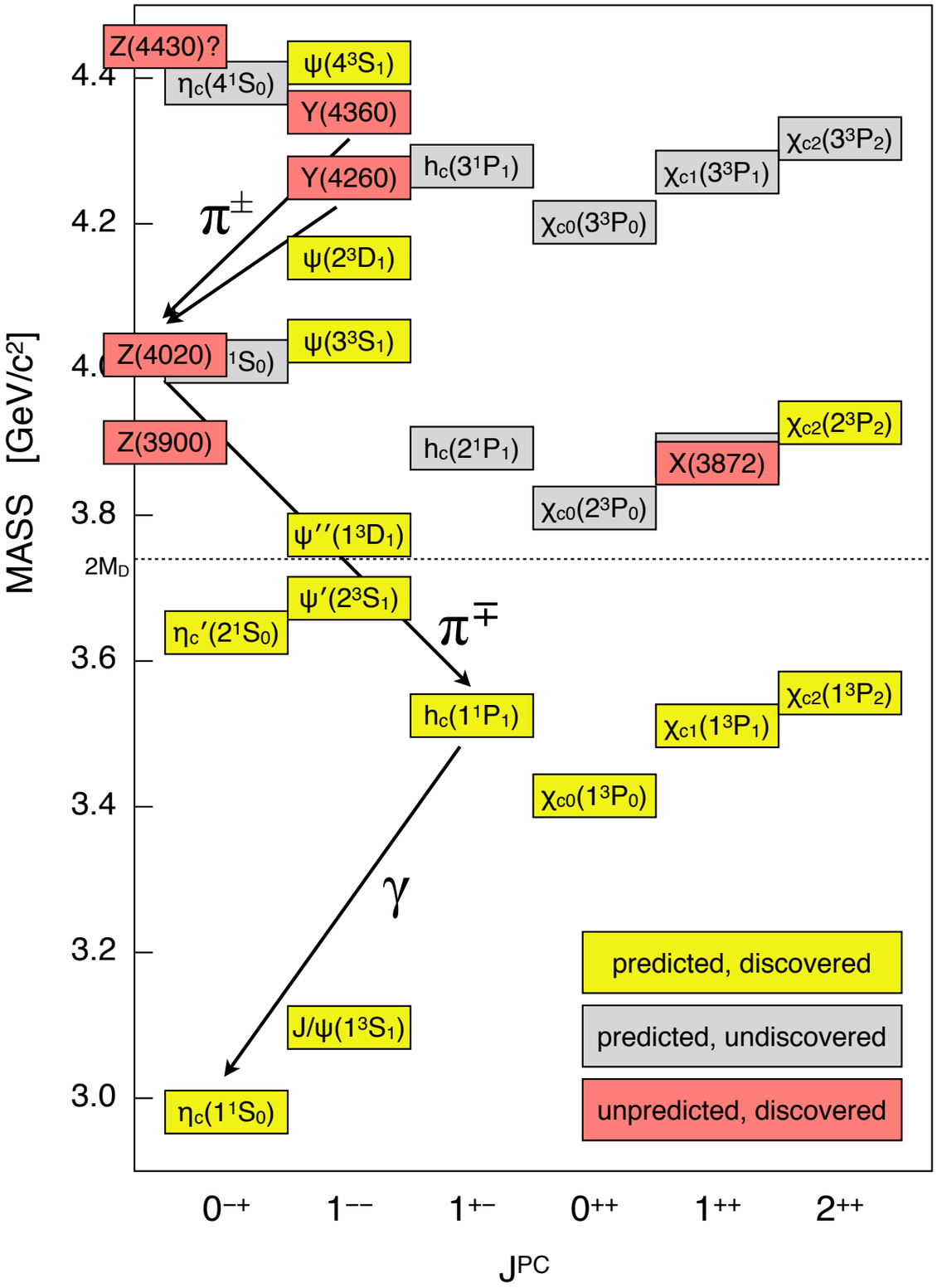
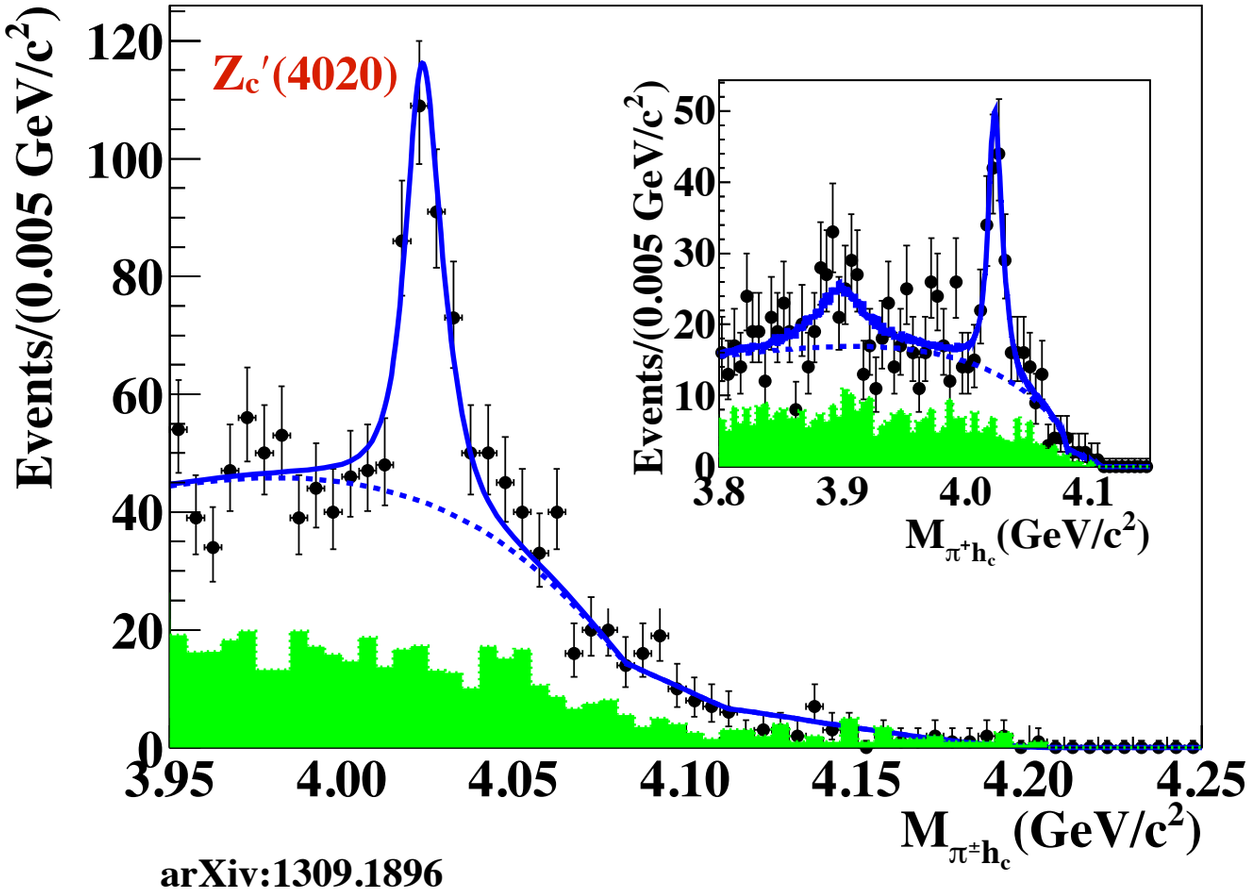
$h_c(1P) \rightarrow \gamma\eta_c(1S)$

$\eta_c(1S) \rightarrow$ **16 decay channels**

Connecting the XYZ at BESIII



$e^+e^- \to \pi^+\pi^- h_c(1P)$ *at BESIII*



arXiv:1309.1896

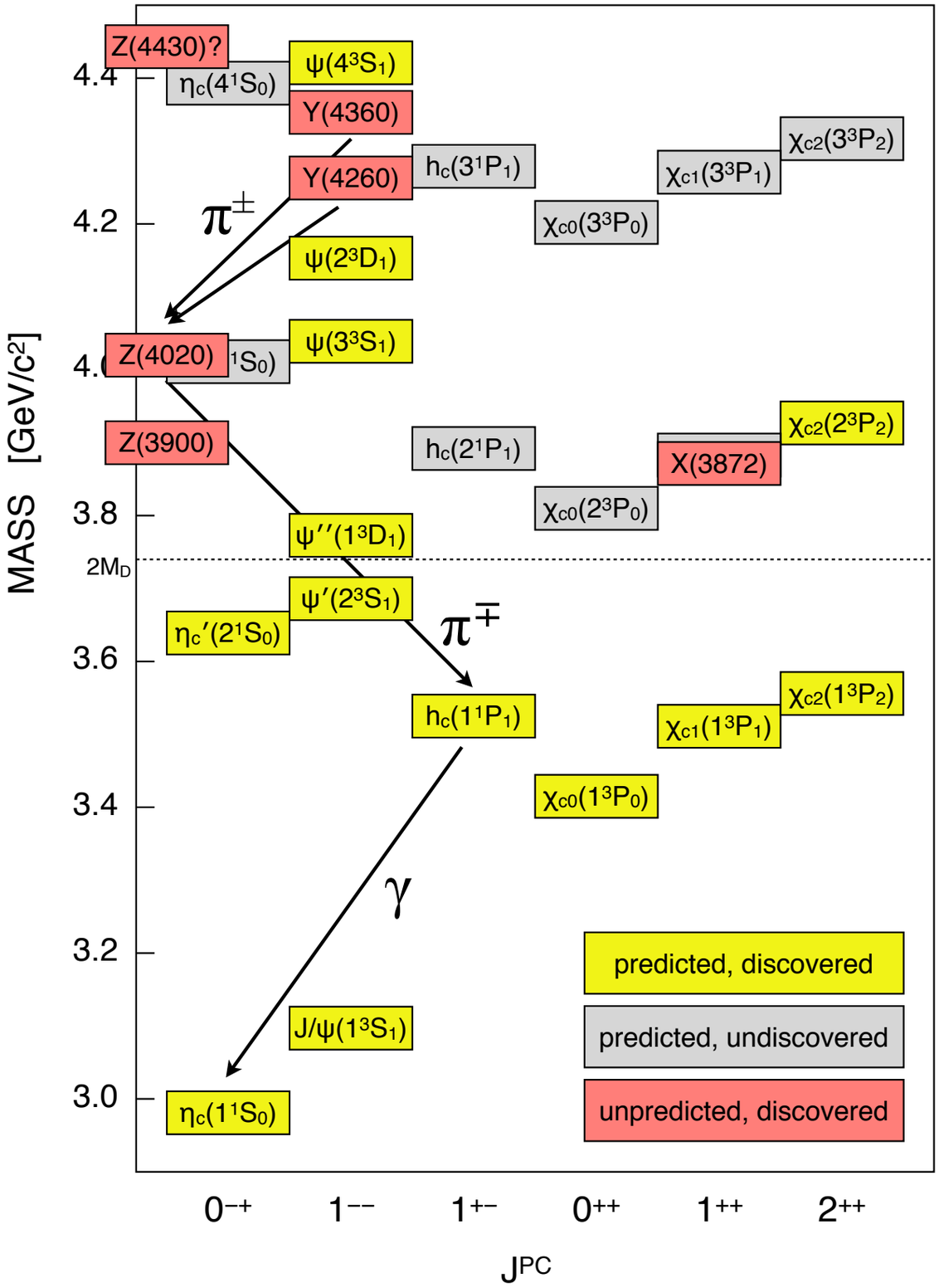
⇒ "Charged Charmoniumlike Structure"

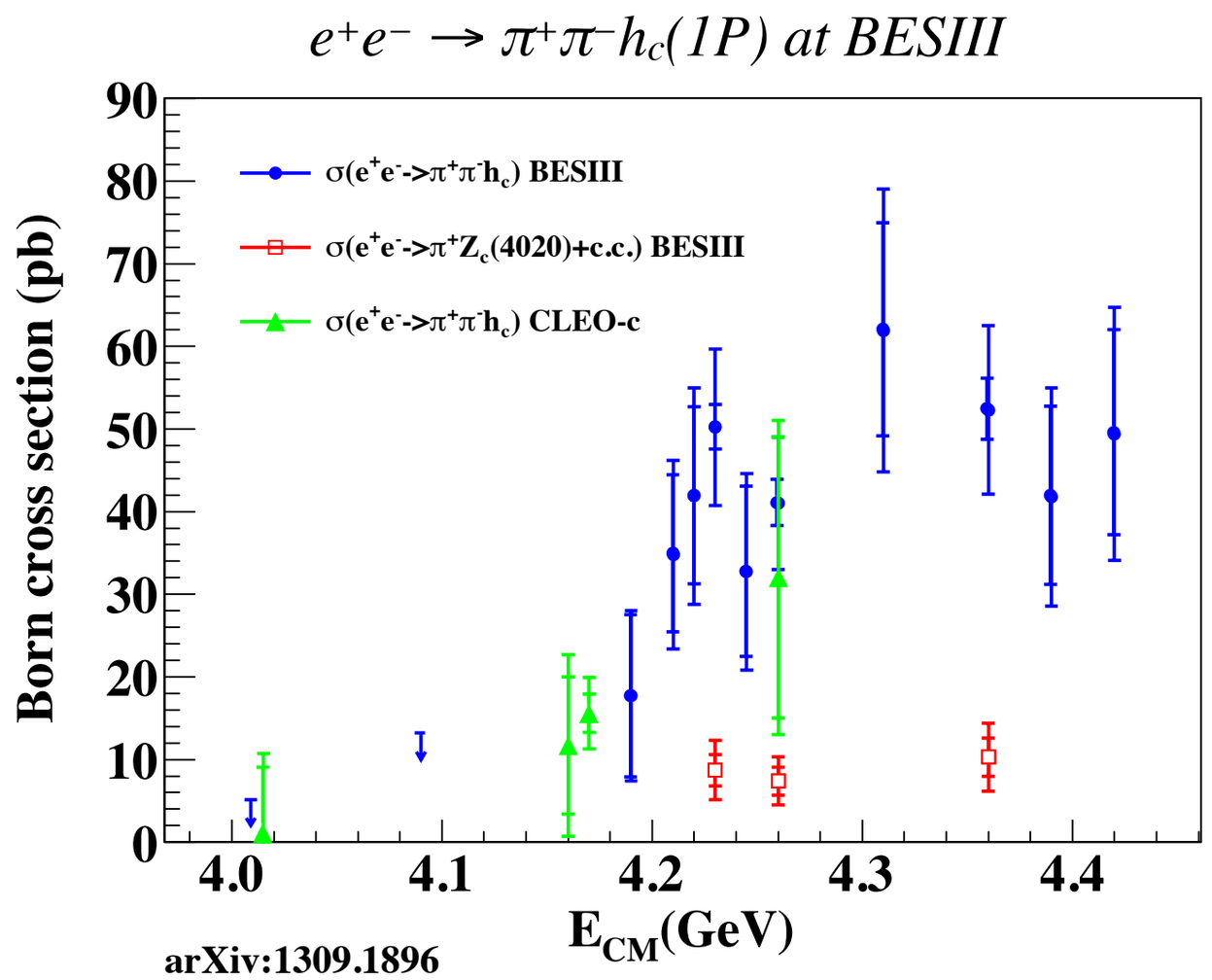
(this time close to D^*D^* threshold)

$M = 4022.9 \pm 0.8 \pm 2.7$ MeV

$\Gamma = 7.9 \pm 2.7 \pm 2.6$ MeV

Connecting the XYZ at BESIII



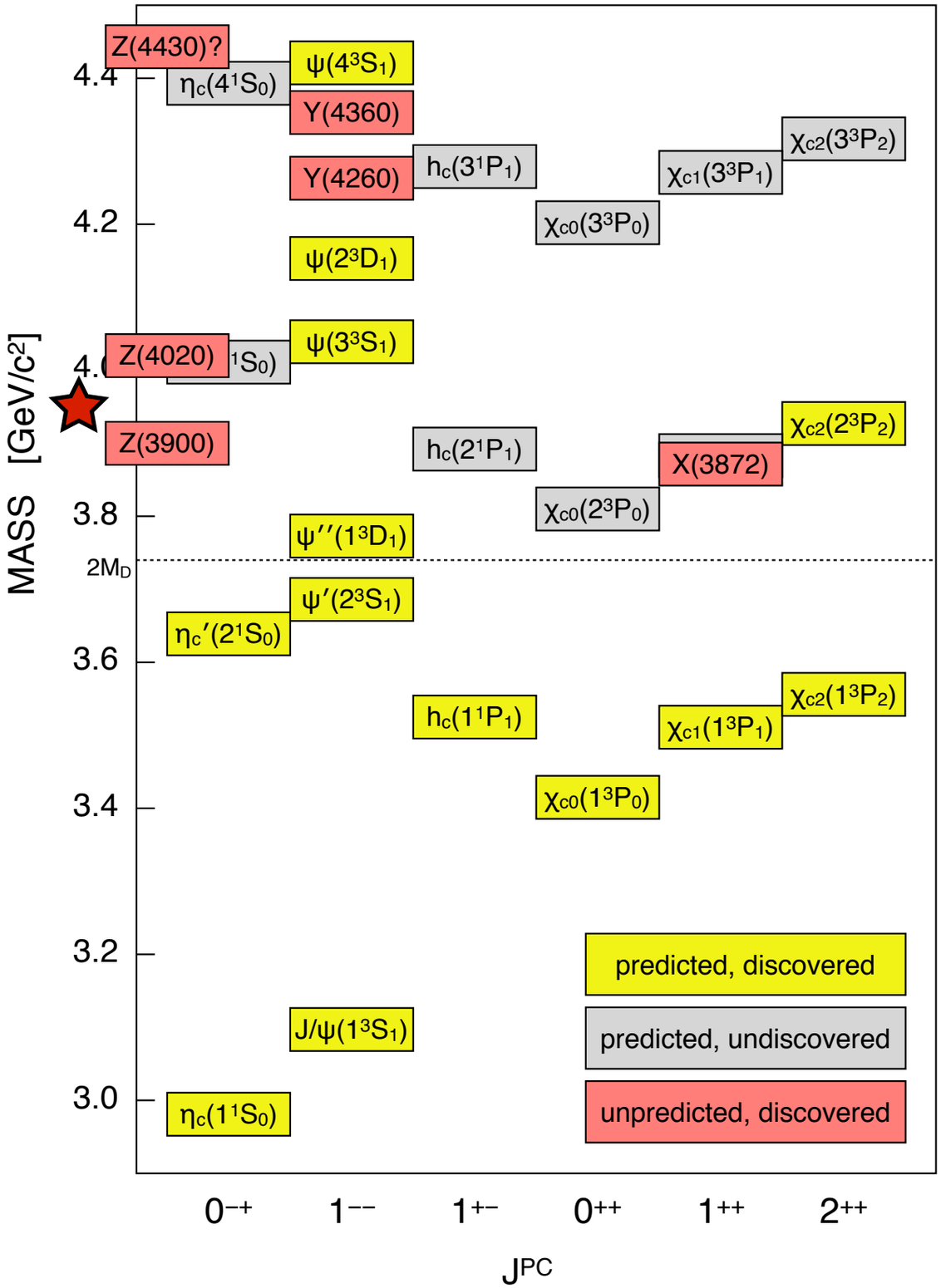


The cross section shape requires more data…

Is it a combination of the **Y(4260)** and **Y(4360)**?

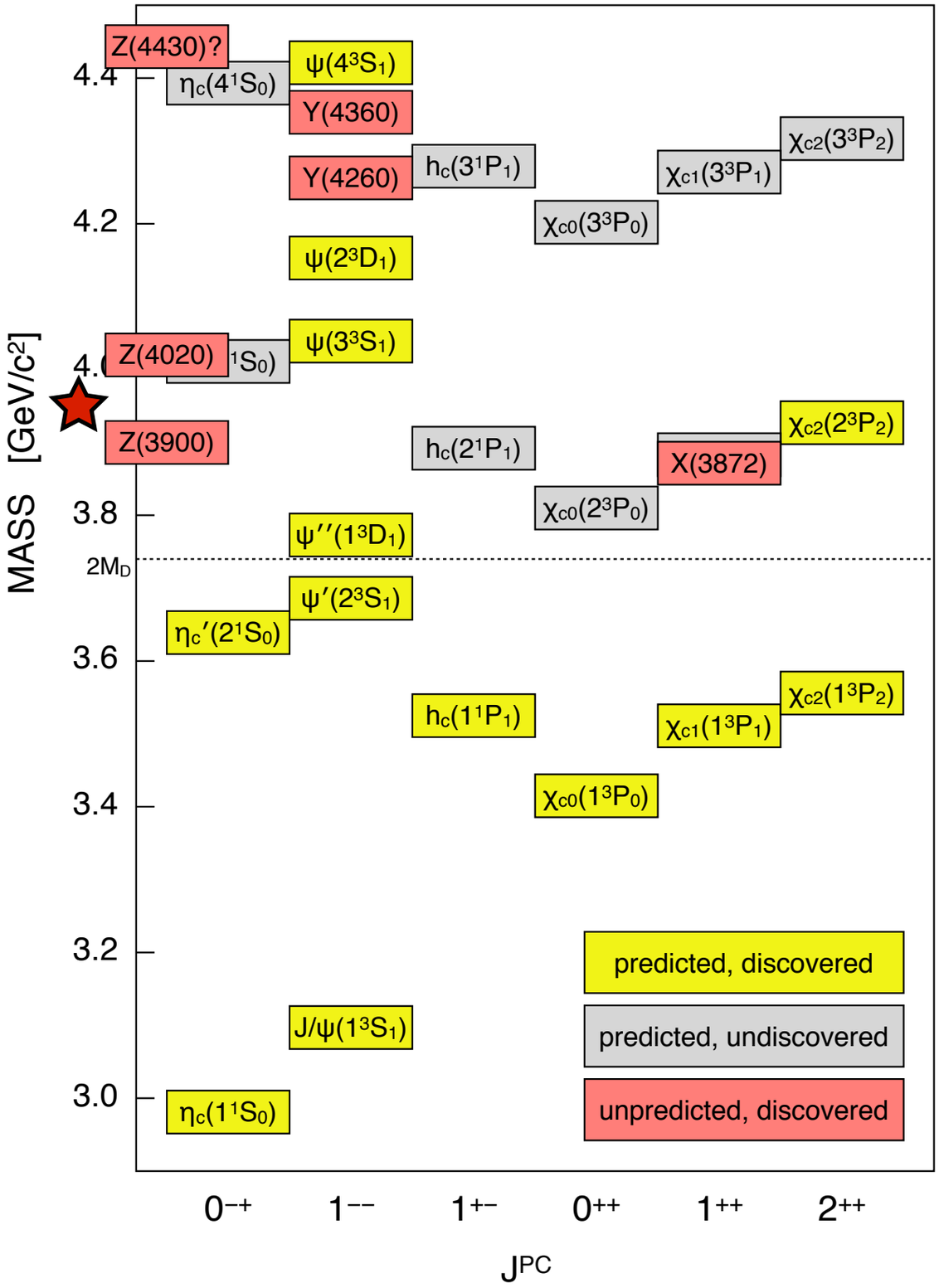
Or something completely different?

Connecting the XYZ at BESIII



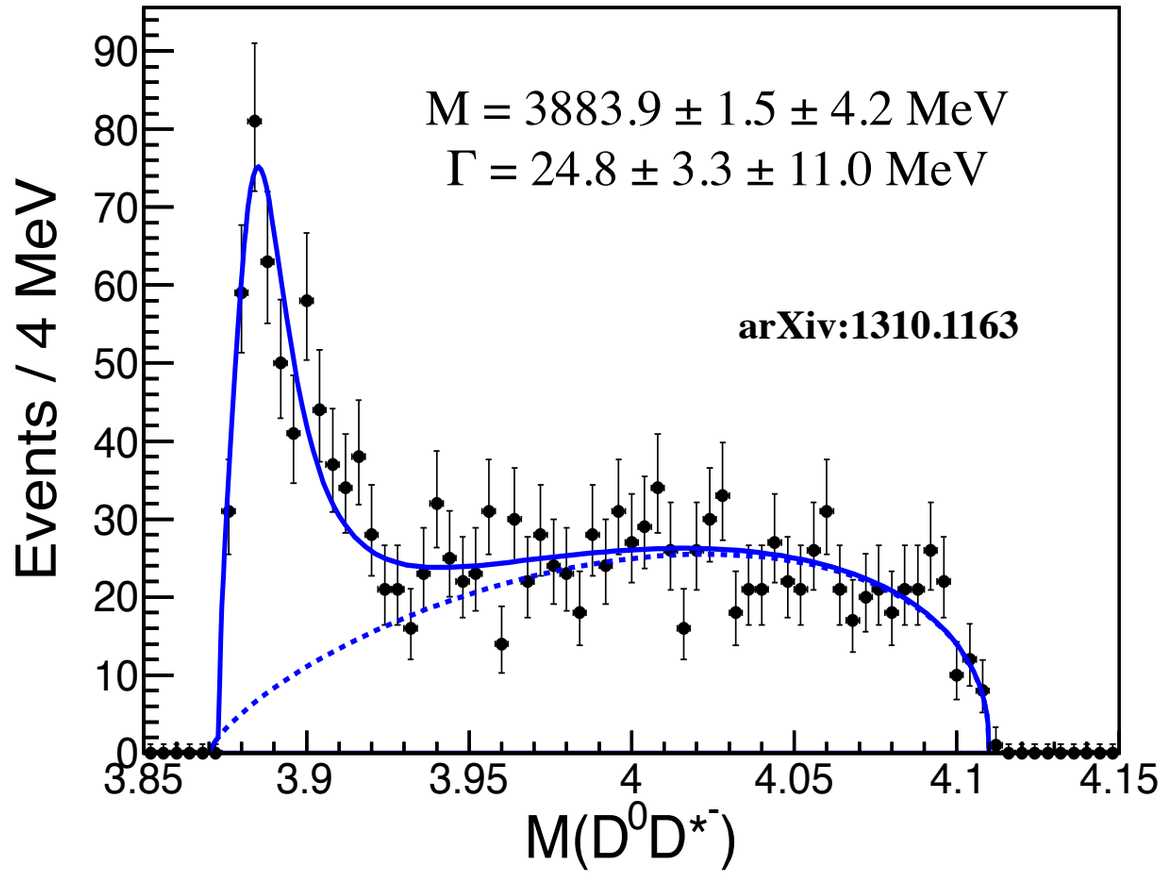
The $Z_c(3900)$ is close to DD^* threshold...

Connecting the XYZ at BESIII



The $Z_c(3900)$ is close to DD^* threshold...

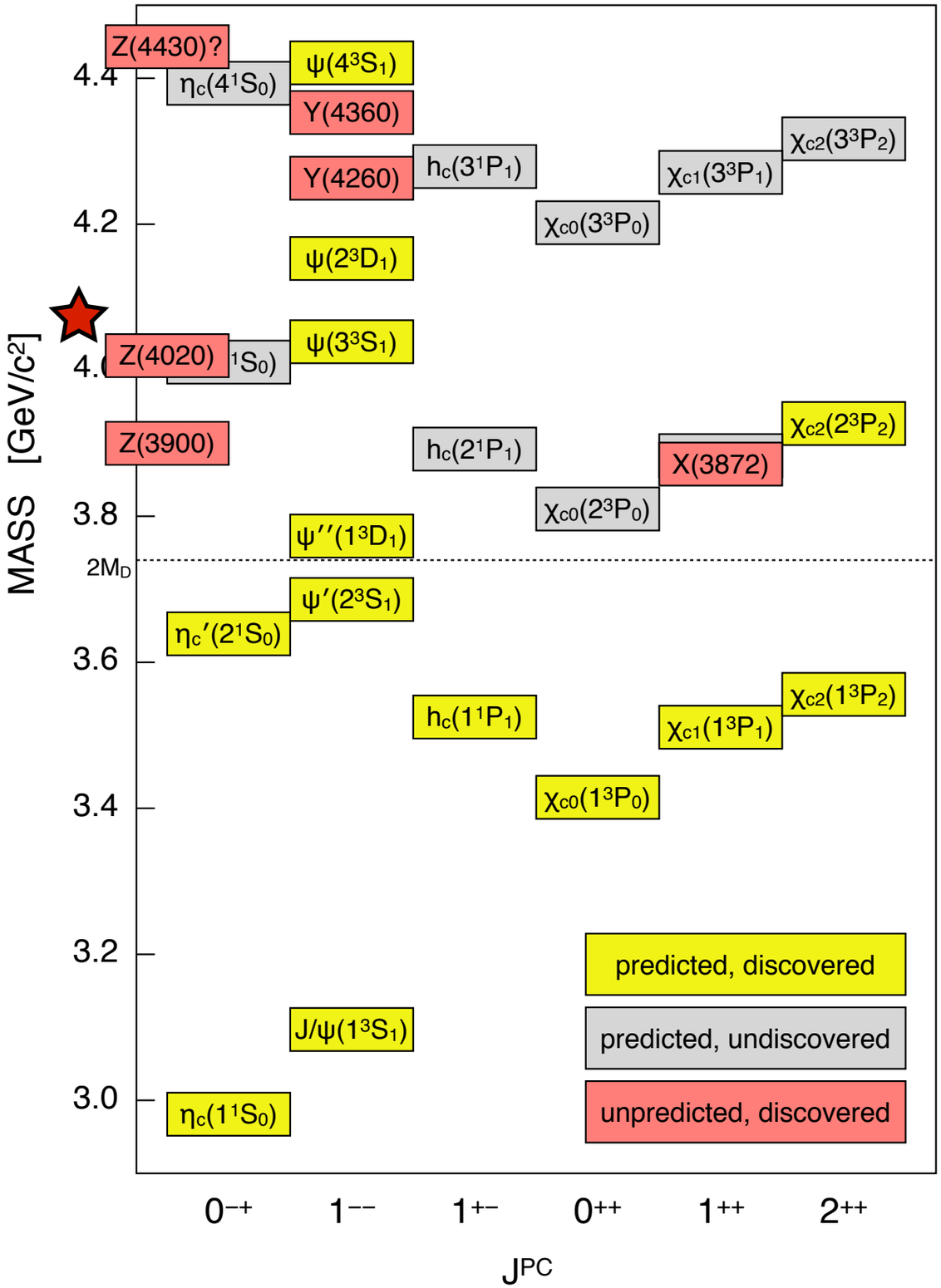
e^+e^- (at 4.26 GeV) → $\pi^+ D^0 D^{*-}$ at BESIII



... and BESIII sees structure in DD^*.

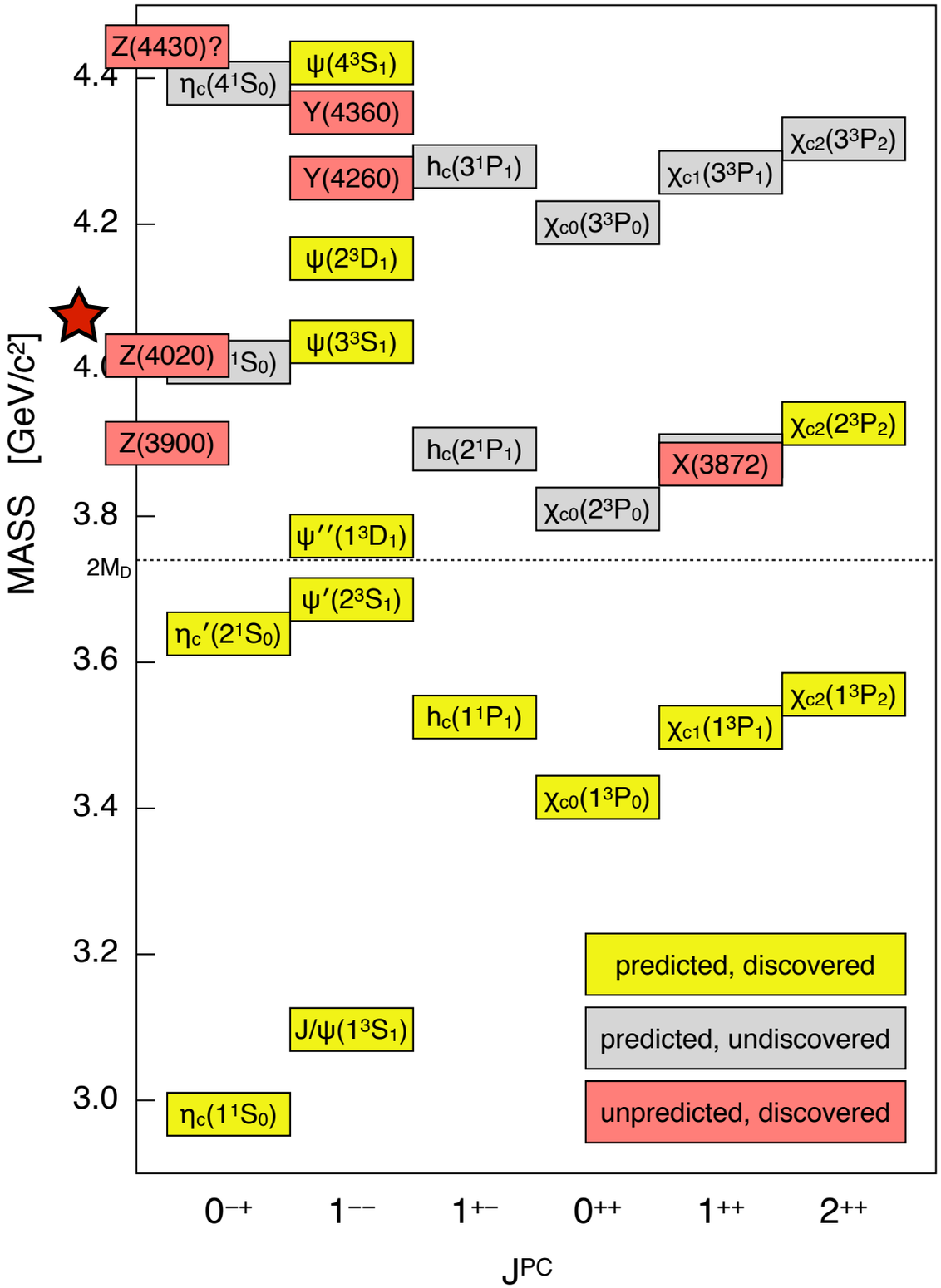
Reconstruct the π^+ and $D^0 \to K^-\pi^+$ and infer the D^{*-}.
(Also analyze $\pi^+ D^- D^{*0}$ with the same method.)

Connecting the XYZ at BESIII



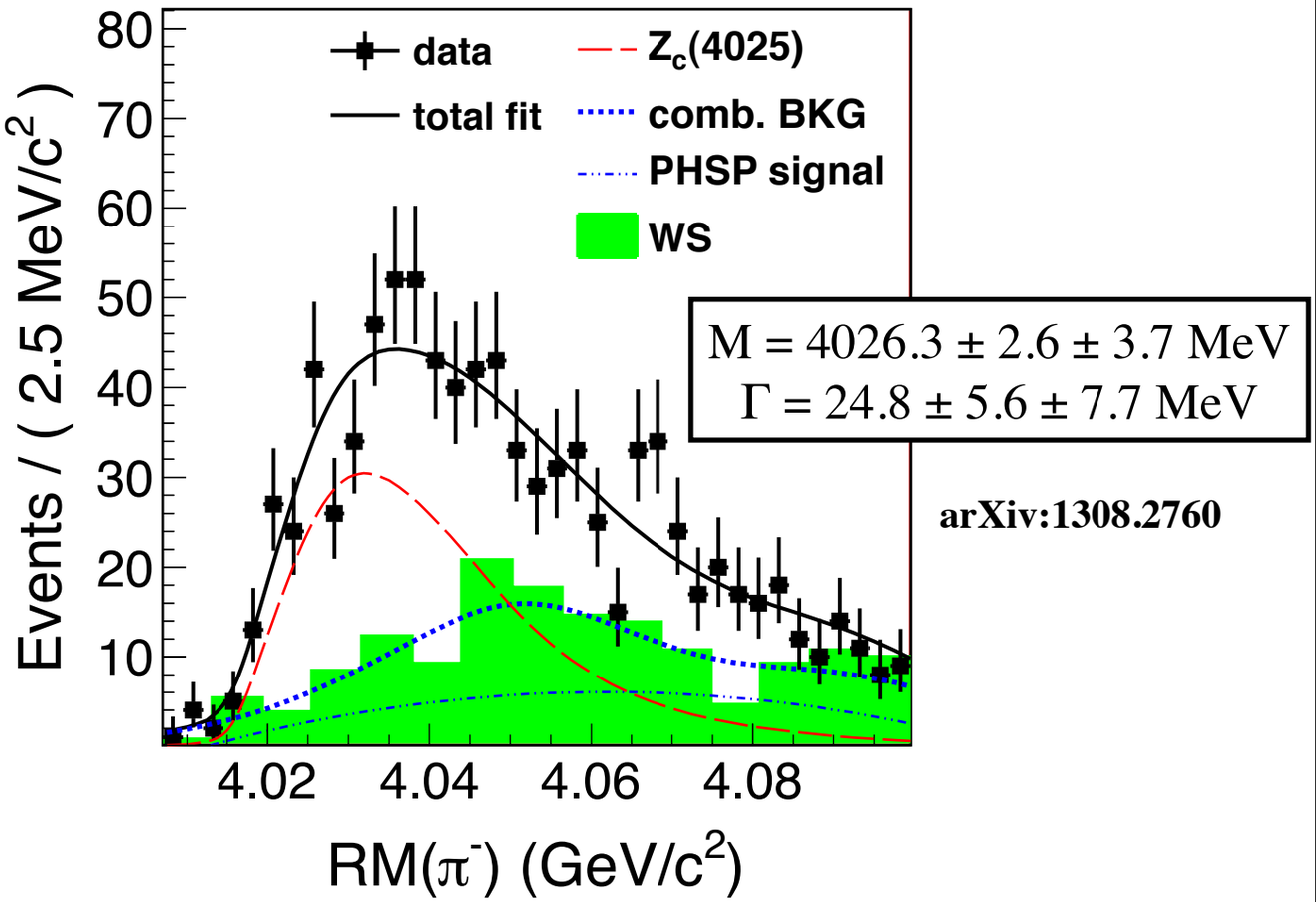
The $Z_c'(4020)$ is close to D^*D^* threshold...

Connecting the XYZ at BESIII



The $Z_c'(4020)$ is close to D^*D^* threshold...

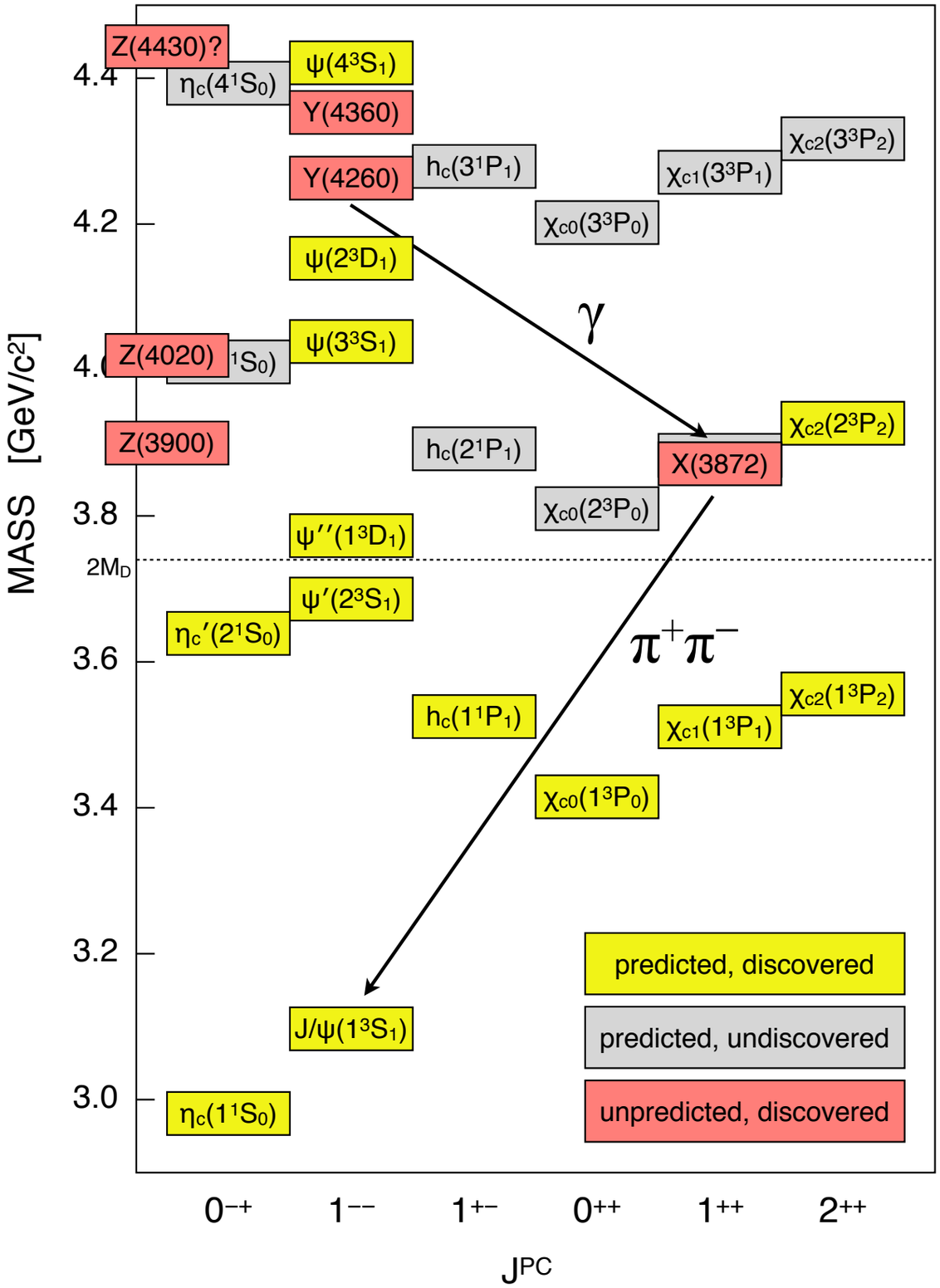
e^+e^- (at 4.26 GeV) → $\pi^\pm(D^*D^*)^\mp$ at BESIII



... and BESIII sees structure in D^*D^*.

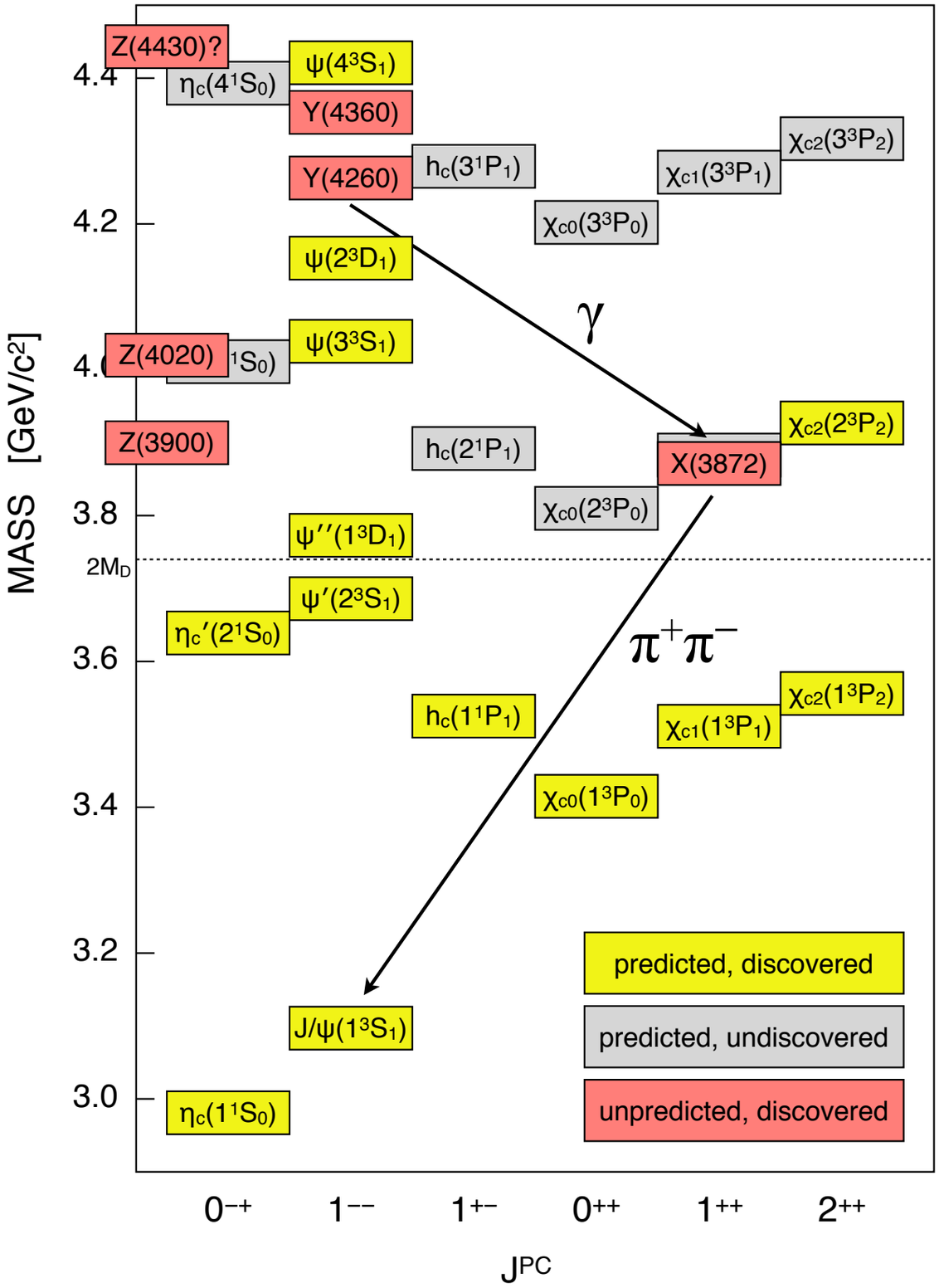
Reconstruct the π^-, a $D^+ \to K^-\pi^+\pi^+$, and a π^0 from a D^*.

Connecting the XYZ at BESIII

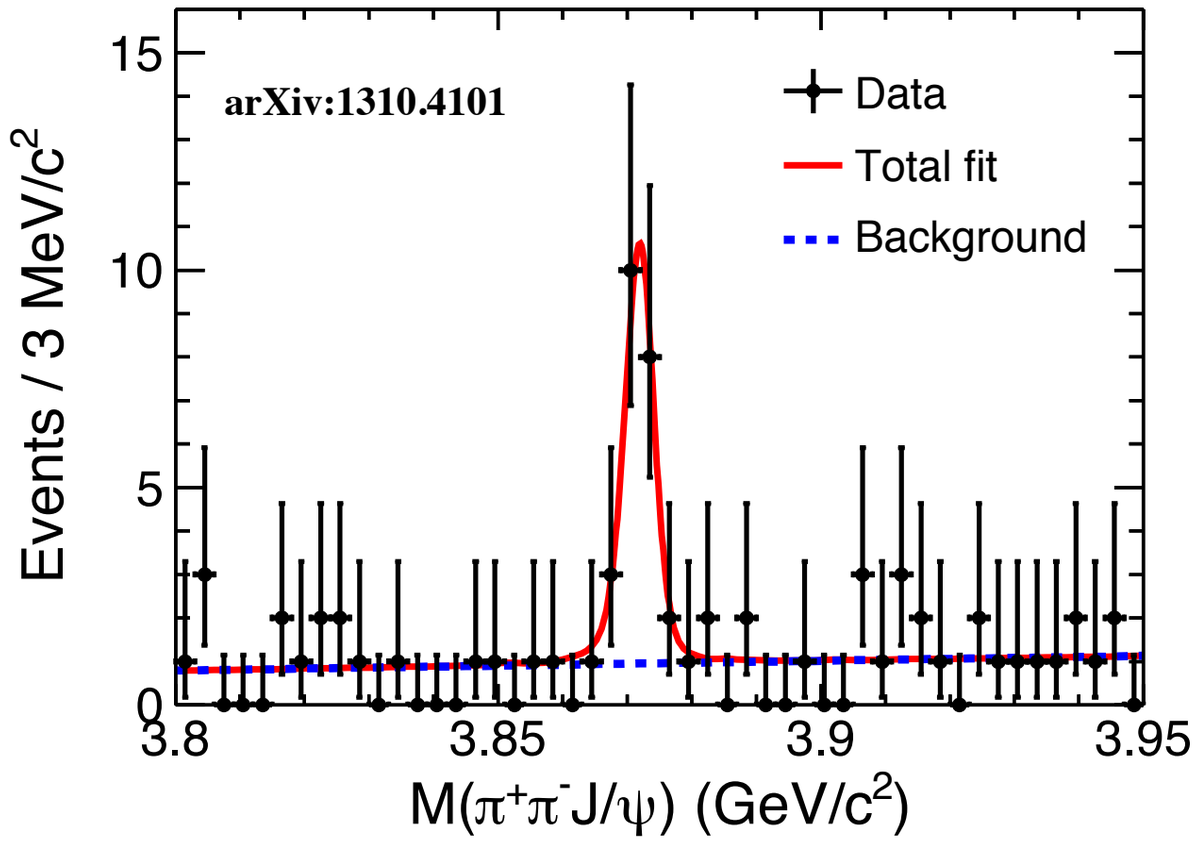


Search for Y(4260) → γX(3872)...

Connecting the XYZ at BESIII



$e^+e^- \to \gamma(\pi^+\pi^- J/\psi)$ *at BESIII*



⇒ "Observation of the X(3872)"

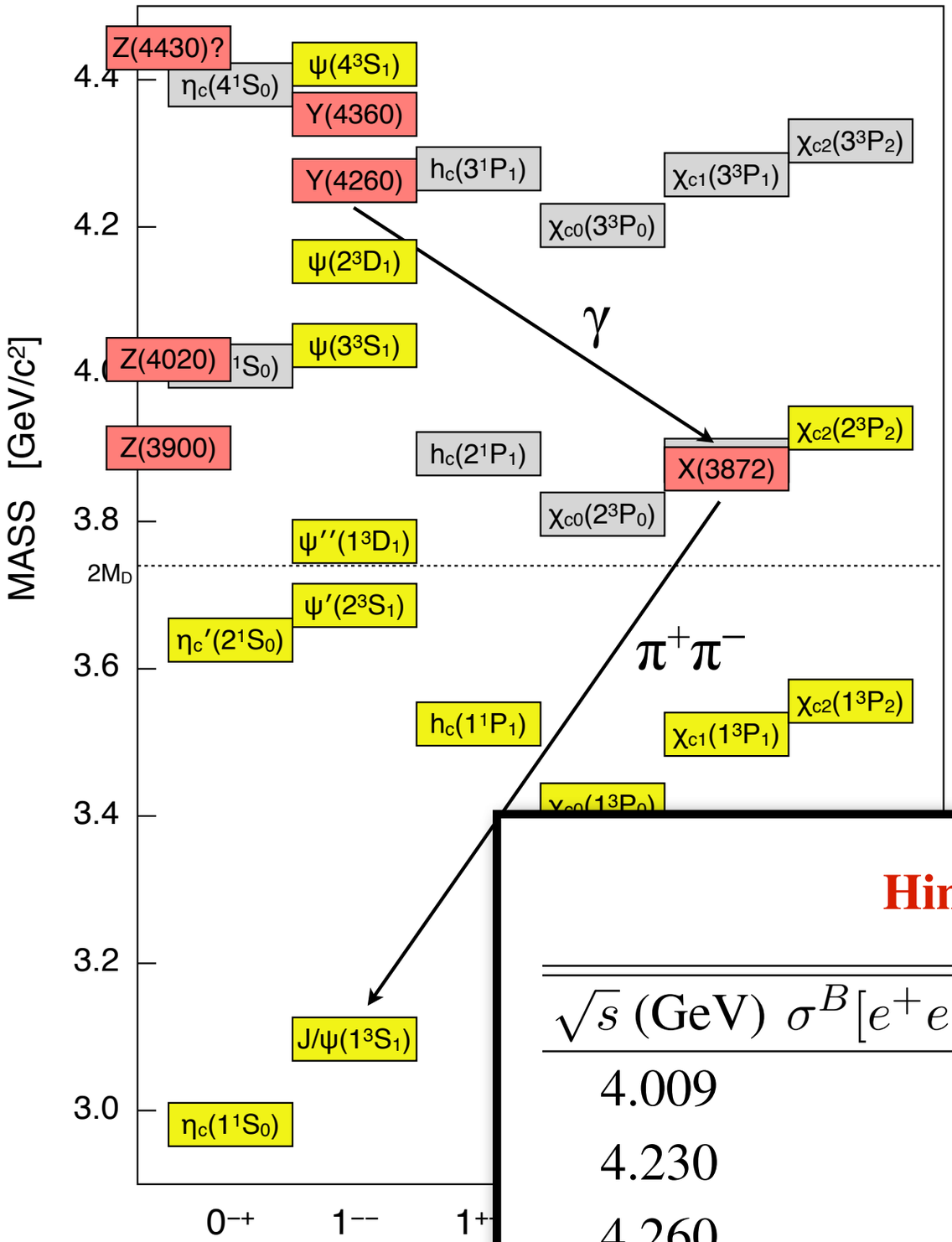
significance = 6.3σ

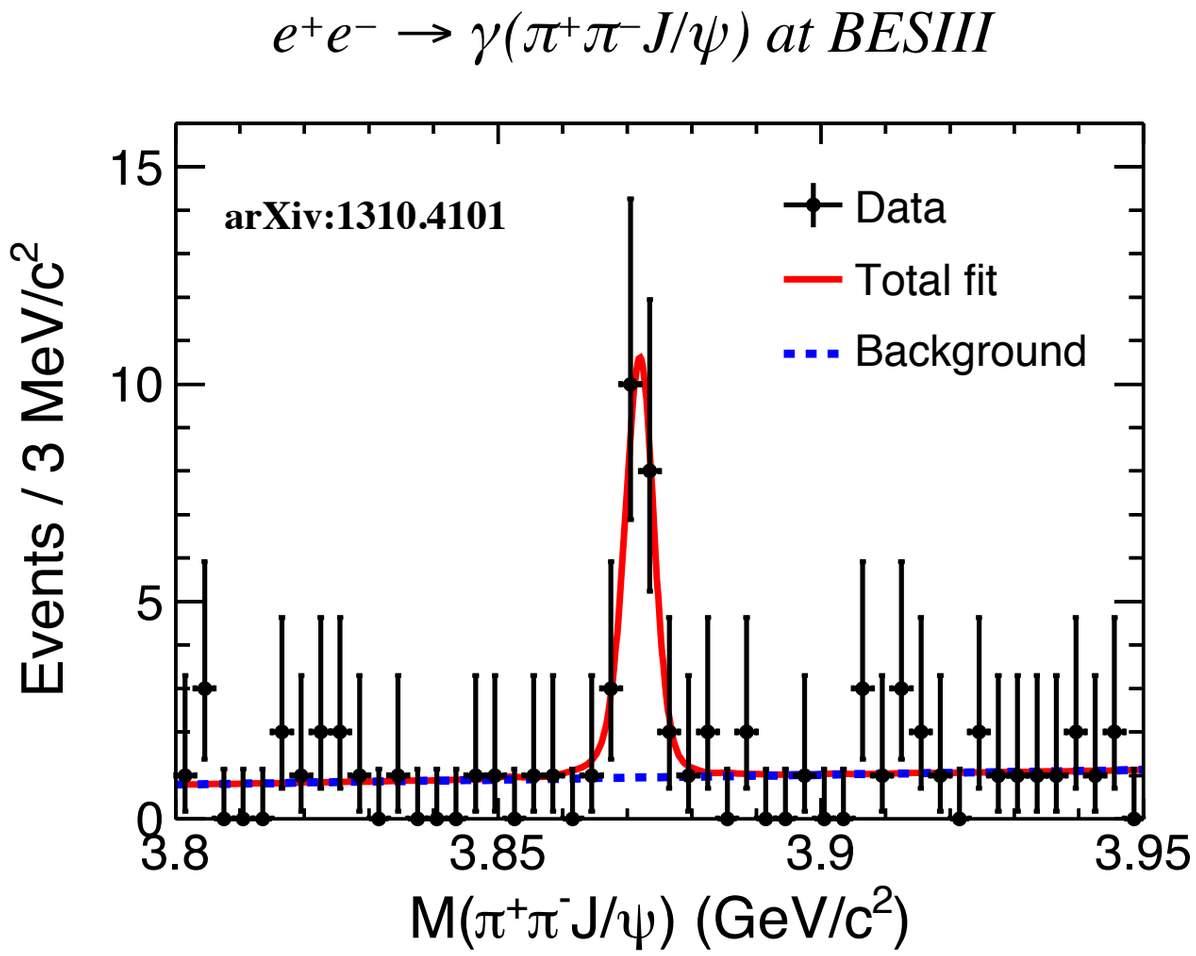
N = 20.1 ± 4.5 events

M = 3871.9 ± 0.7 ± 0.2 MeV

Γ consistent with resolution

Connecting the XYZ at BESIII

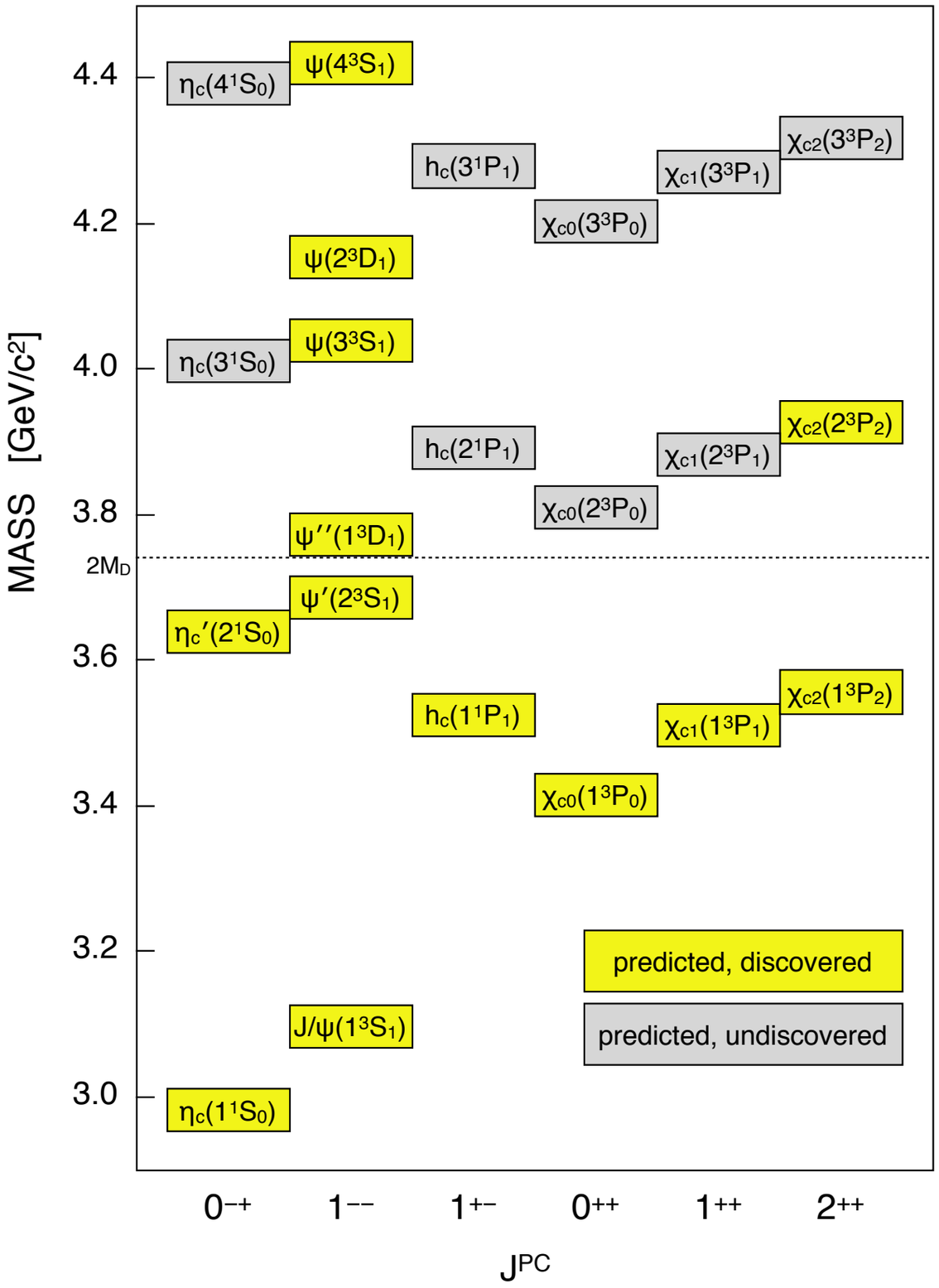




Hints that this is Y(4260) → γX(3872)

$\sqrt{s}$ (GeV)	$\sigma^B[e^+e^- \to \gamma X(3872)] \cdot \mathcal{B}(X(3872) \to \pi^+\pi^- J/\psi)$ (pb)
4.009	< 0.12
4.230	$0.29 \pm 0.10 \pm 0.02$
4.260	$0.36 \pm 0.13 \pm 0.03$
4.360	< 0.39

Connecting the XYZ at BESIII



(I) The quark model describes most of charmonium remarkably well. $(c\bar{c})$

(II) But the *"XYZ"* states point beyond the quark model. $(c\bar{c}g, c\bar{q}q\bar{c}, (c\bar{q})(q\bar{c}), c\bar{c}\pi\pi)$

(III) BESIII can directly produce the **Y(4260)** and **Y(4360)** in e^+e^- annihilation.

(IV) BESIII has observed "charged charmoniumlike structures" — the **Z_c(3900)** and the **Z_c'(4020)**.

(V) BESIII has also observed a transition to the **X(3872)**.

(VI) We are building connections.

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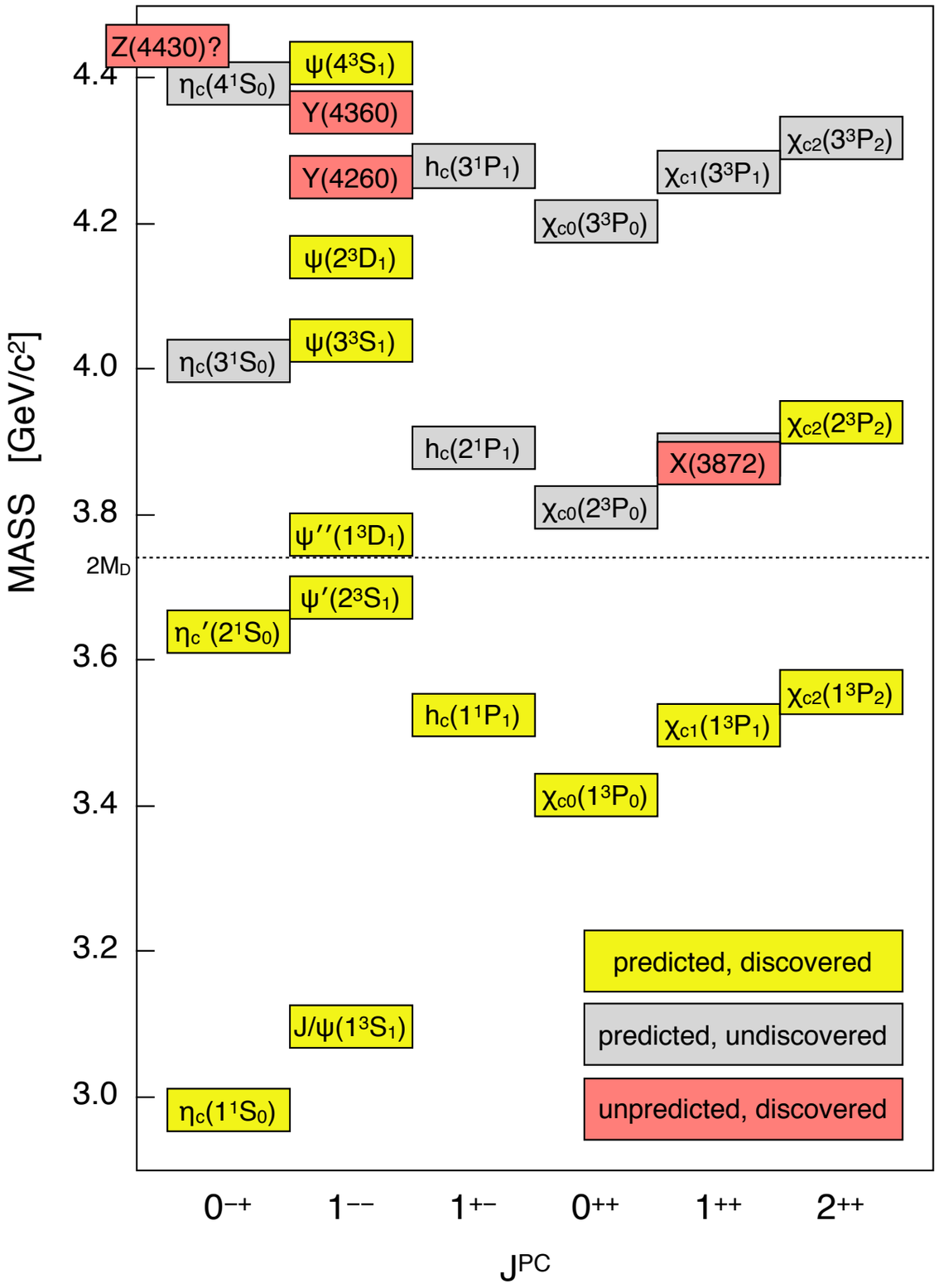

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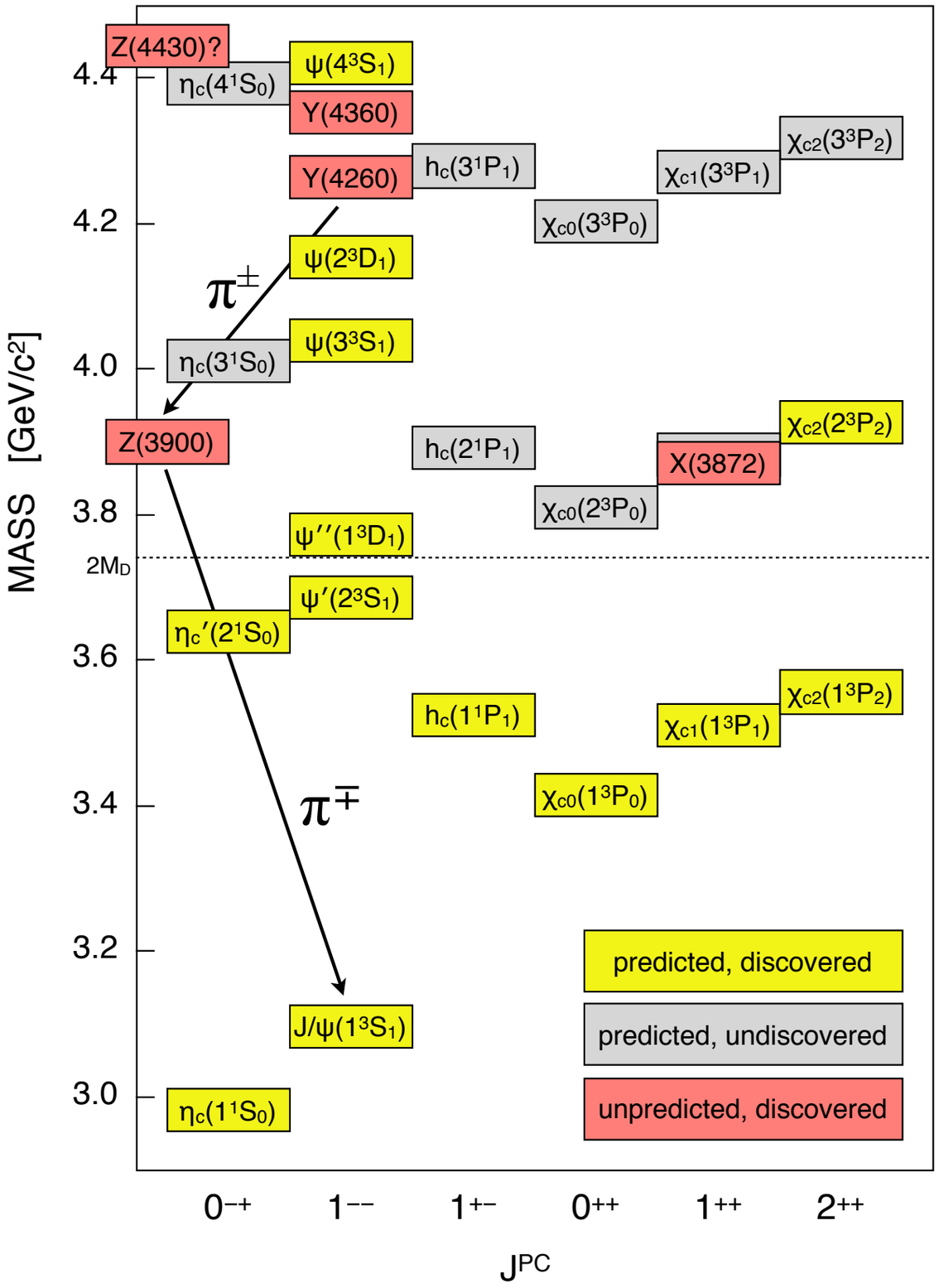

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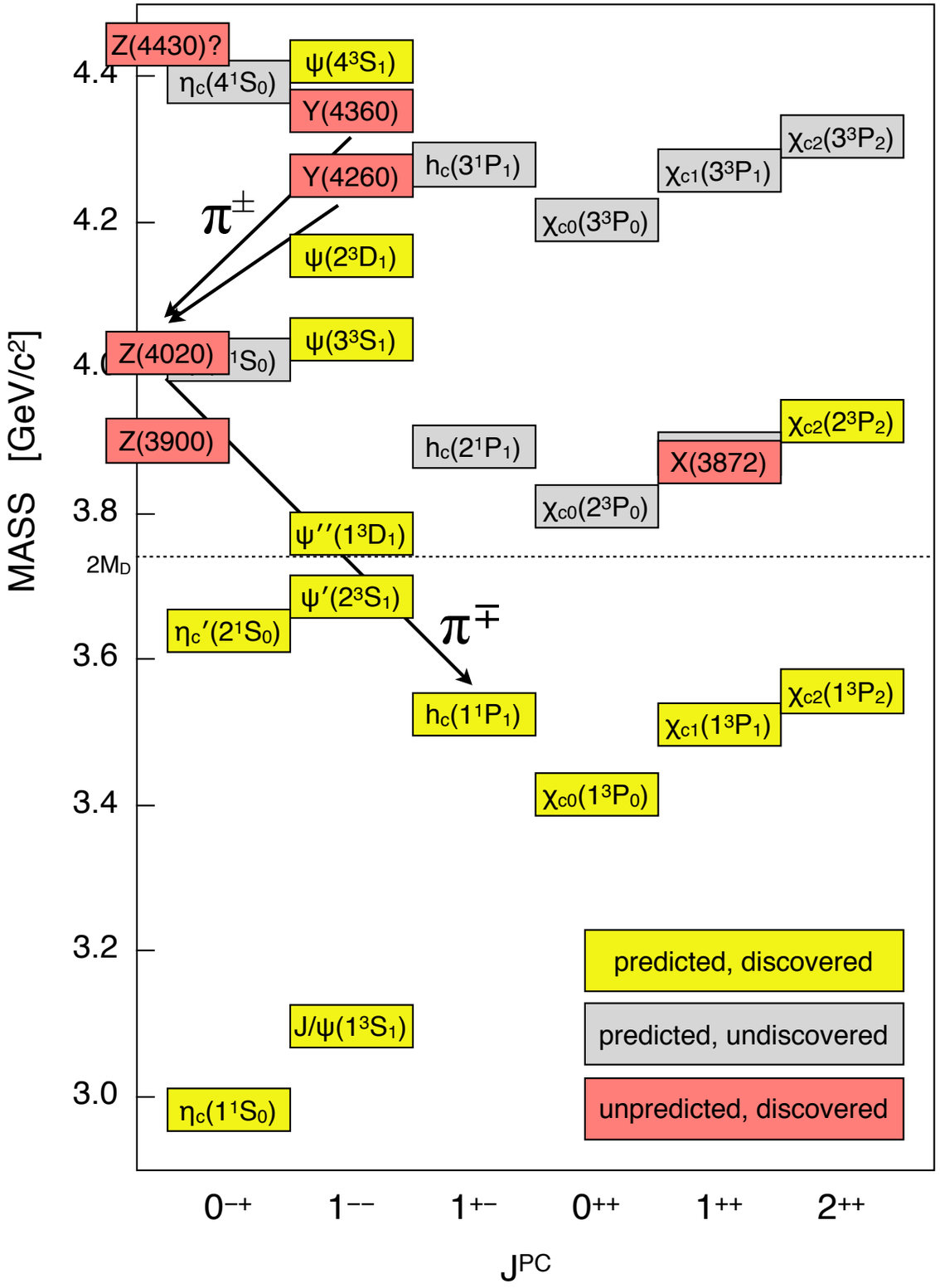

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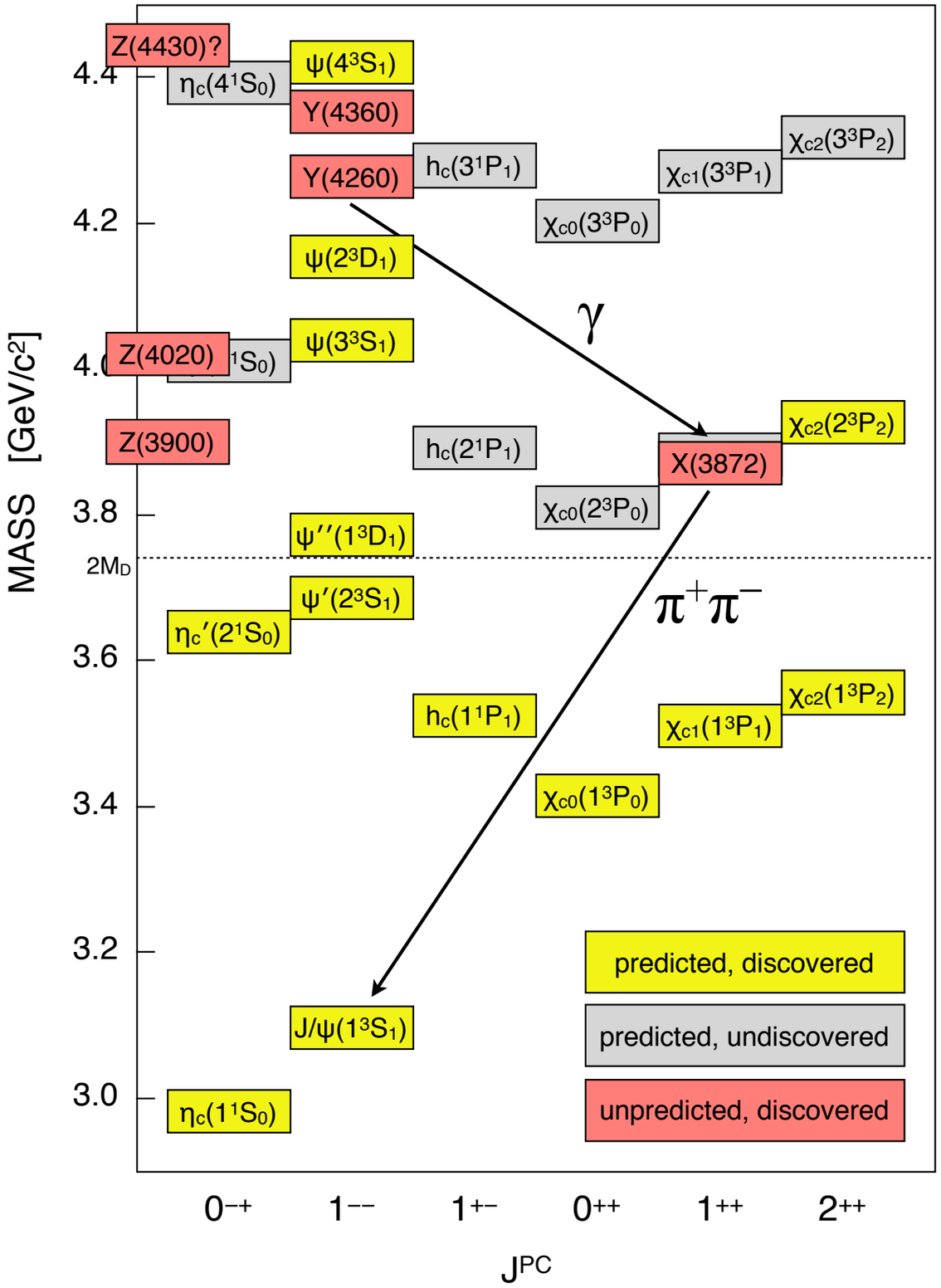

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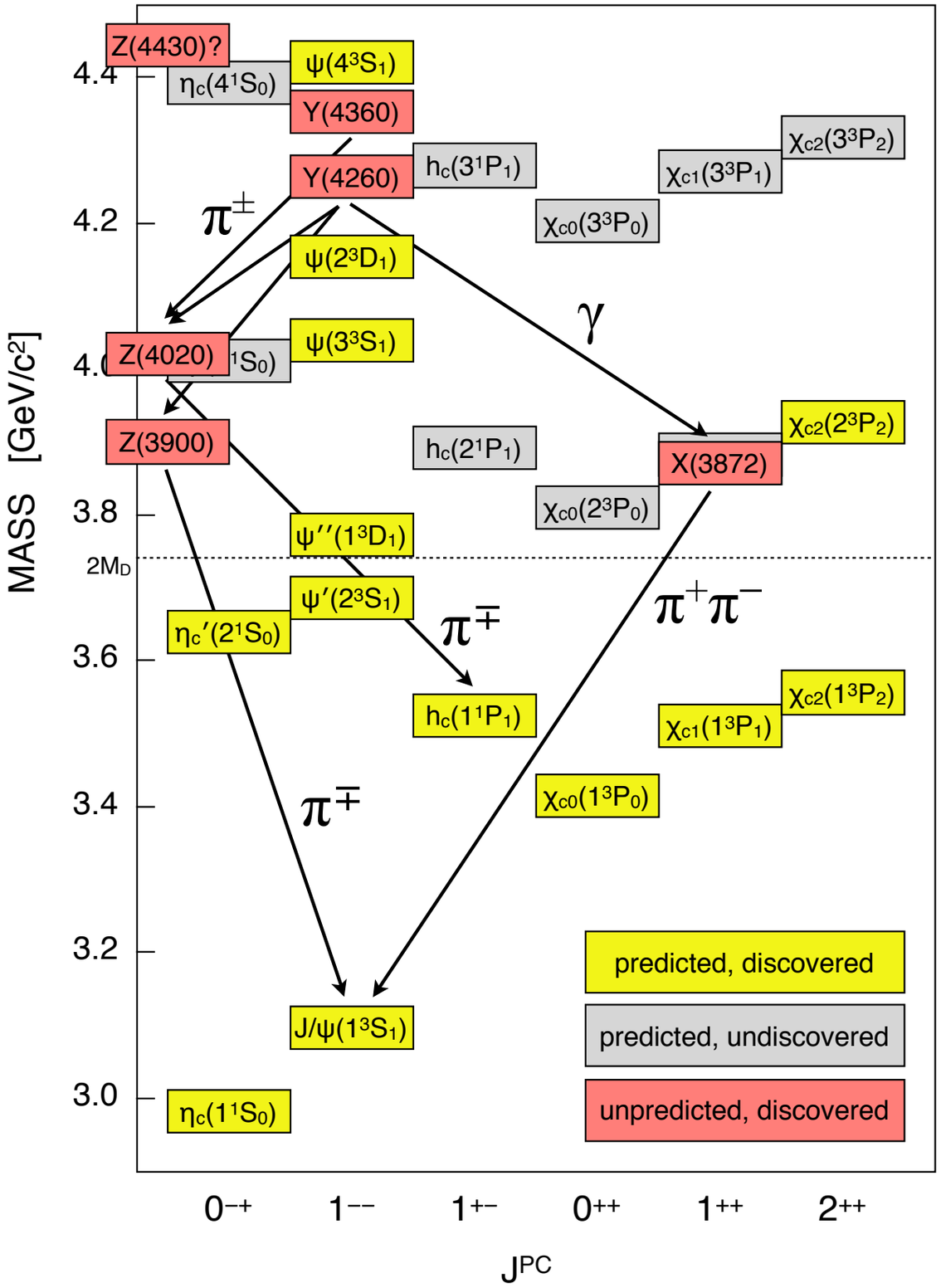

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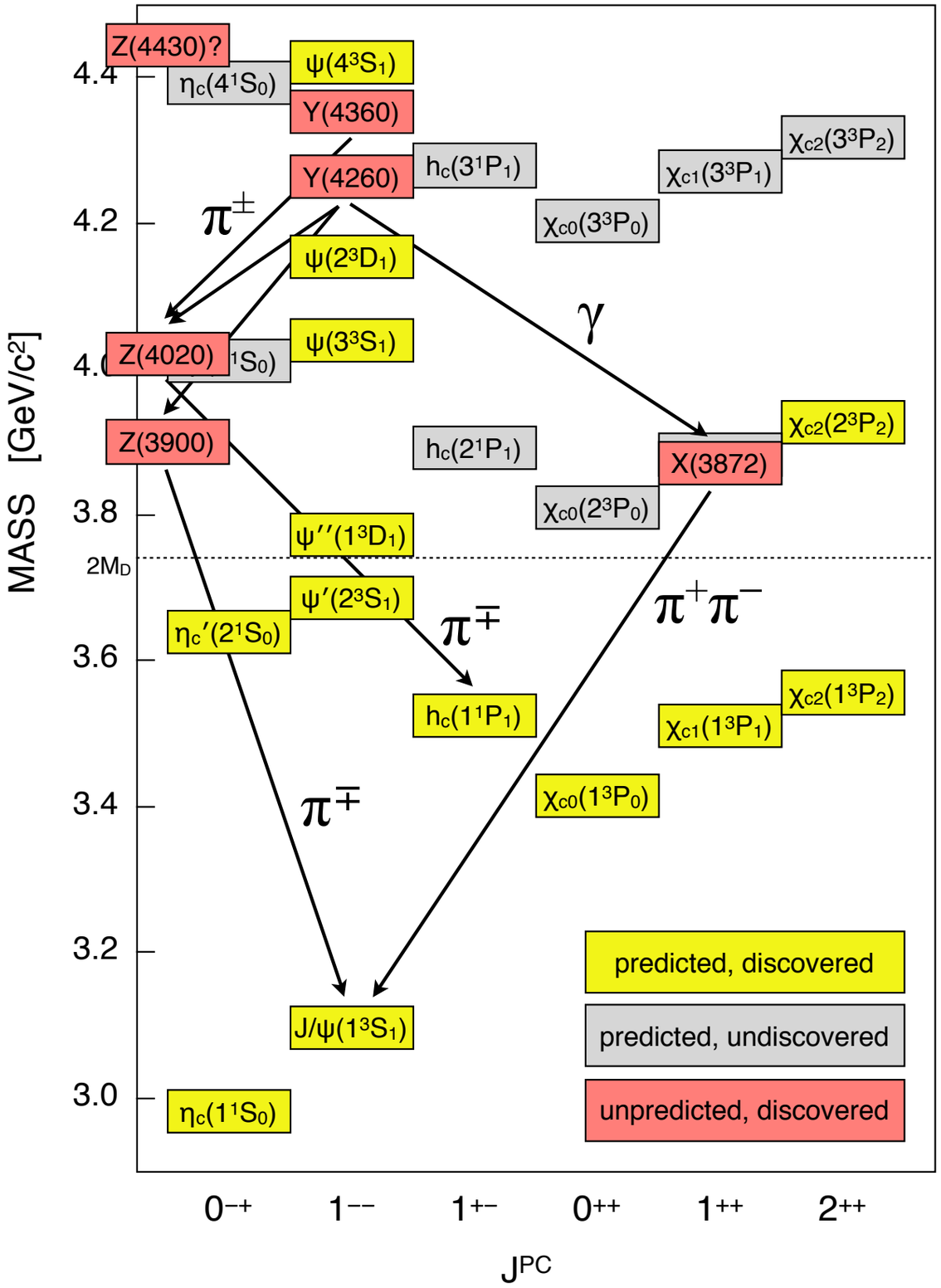

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(VI) We are building connections.

(VII) But there is much left to do… *and a new running period begins soon…*

Stay Tuned! Thank you…