

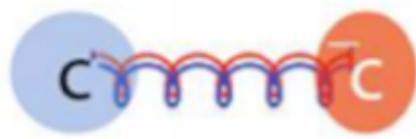
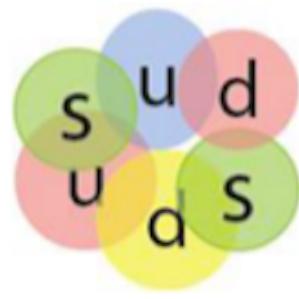
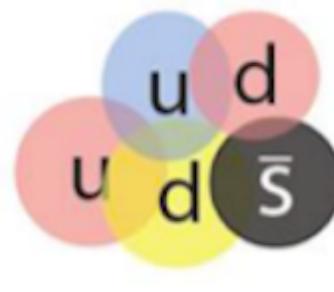
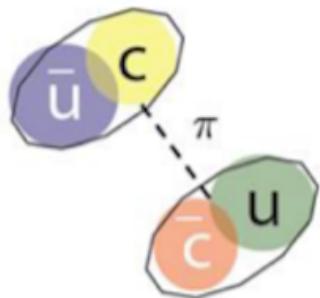


# XYZ states at the BESIII experiment

G. Morello on behalf of the BESIII collaboration

# Possible exotic states

- QCD does NOT forbid states made of gluons and multiquark states (*exotic states*)



The XYZ states can be explained using multiquark models

# $Z_c$ states at BESIII

PRL 110, 252001 (2013), arXiv:1506.06018

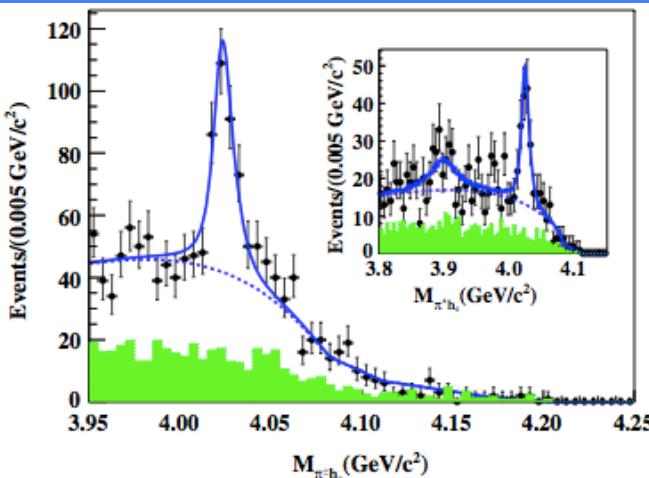
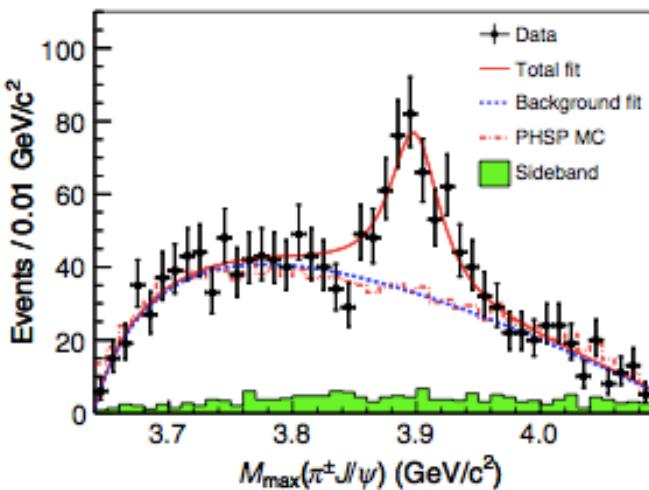
Isospin triplets of  $Z_c(3900)$  discovered in the processes  
 $e^+e^- \rightarrow \pi\pi J/\psi$   
 $Z_c(3900)^{\pm,0}$  decaying in  $\pi^{\pm,0} J/\psi$

$Z_c(3900)^\pm$

- $M = 3899.0 \pm 3.6 \pm 4.9$
- $\Gamma = 46 \pm 10 \pm 20$
- Significance  $> 8\sigma$

$Z_c(3900)^0$

- $M = 3894.8 \pm 2.3 \pm 3.2$
- $\Gamma = 29.6 \pm 8.2 \pm 8.2$
- Significance  $= 10.4\sigma$

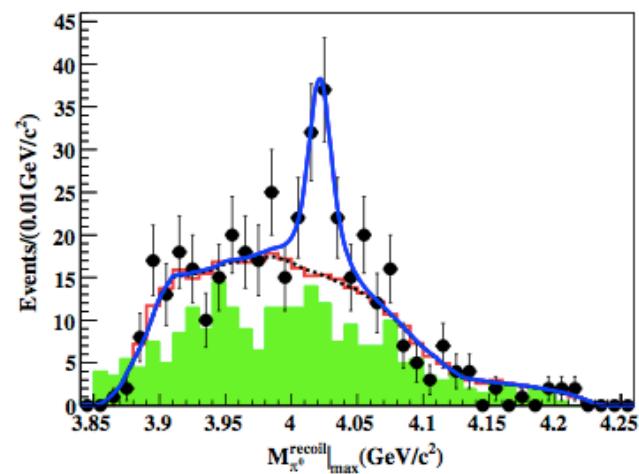


- $M = 4022.9 \pm 0.8 \pm 2.7$
- $\Gamma = 7.9 \pm 2.7 \pm 2.6$
- Significance  $> 8.9\sigma$

PRL 111, 242001 (2013)

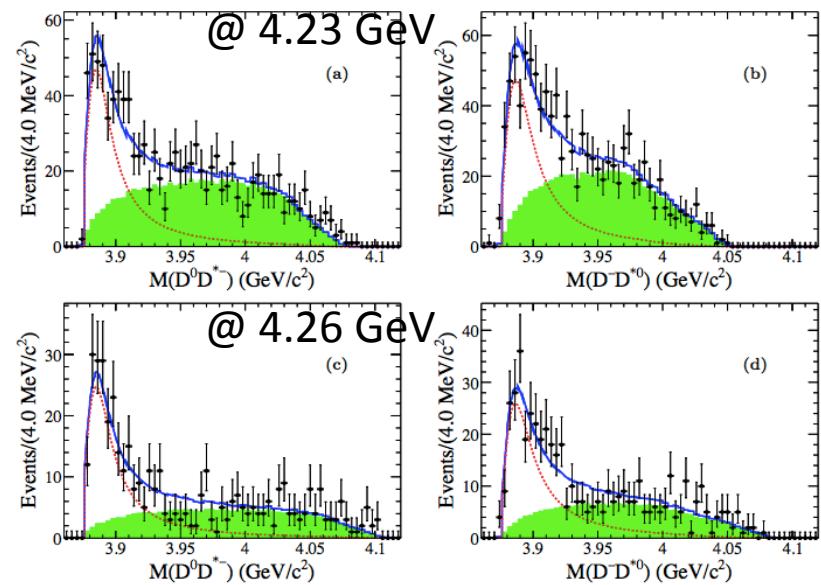
PRL 113, 212002 (2014)

Isospin triplets of  $Z_c(4020)$  discovered in the processes  
 $e^+e^- \rightarrow \pi\pi h_c$  looking at the invariant mass of  $\pi h_c$



- $M = 4023.9 \pm 2.2 \pm 3.8$
- $\Gamma$  fixed to charged partner
- Significance  $= 5\sigma$

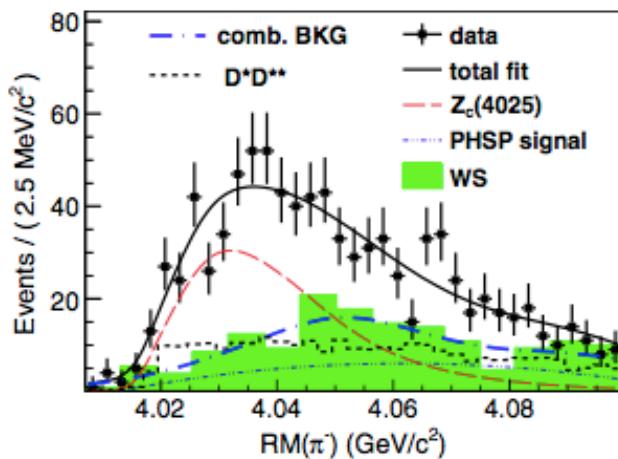
# $Z_c$ states at BESIII



PRL 112, 022001 (2014)  
arXiv:1509.01398

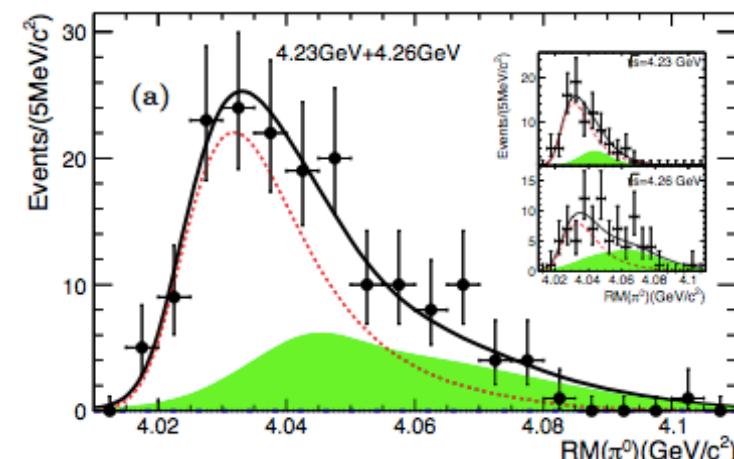
In the process  $e^+e^- \rightarrow \pi^\pm (D\bar{D}^*)^\mp$  the presence of charged  **$Z_c(3885)$**  has been found, then confirmed by studies of  $e^+e^- \rightarrow \pi^\pm (D^0\bar{D}^{*\pm})$

- $M = 3883.9 \pm 1.5 \pm 4.2$
- $\Gamma = 24.8 \pm 3.3 \pm 11.0$
- Significance  $> 10\sigma$



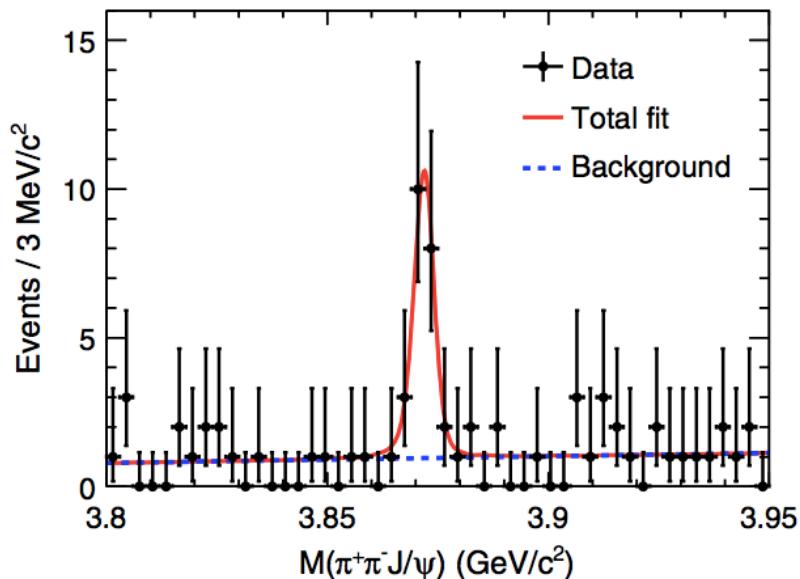
PRL 112, 132001 (2014)  
In the process  
 $e^+e^- \rightarrow \pi^\pm (D^*D^*)^\mp$  the presence of charged  **$Z_c(4025)$**  has been confirmed.

- $M = 4026.3 \pm 2.6 \pm 3.7$
- $\Gamma = 24.8 \pm 5.6 \pm 7.7$
- Significance  $> 10\sigma$



- $M = 4025.5^{+2.0}_{-4.7} \pm 3.1$
- $\Gamma = 23.0 \pm 6.0 \pm 1.0$
- Significance  $> 5.9\sigma$

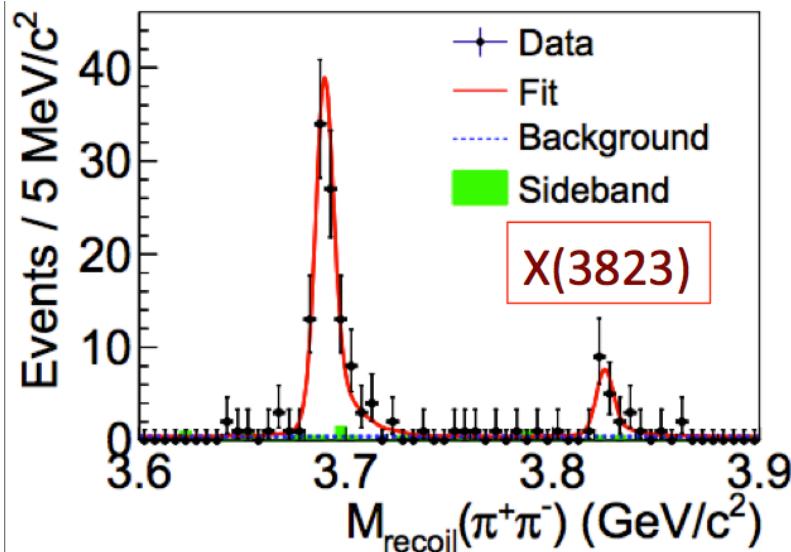
# X states at BESIII



$J^{PC} = I^{++}$  state, studied in the processes  
 $e^+e^- \rightarrow \gamma \pi^+\pi^- J/\psi$   
**X(3872)** decaying in  $\pi^+\pi^- J/\psi$

- $M = 3871.9 \pm 0.7 \pm 0.2$
- $\Gamma < 2.4$  @ 90% C.L.

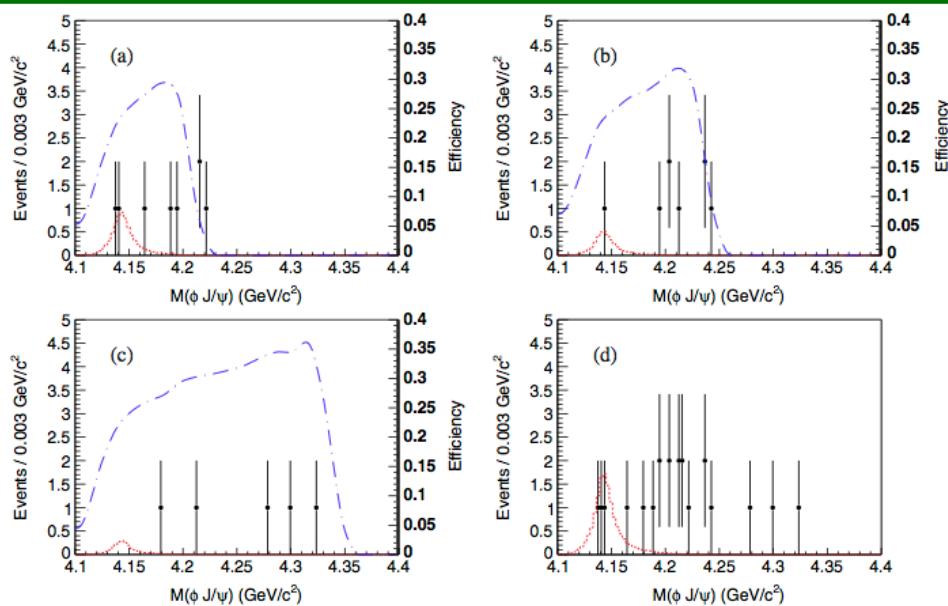
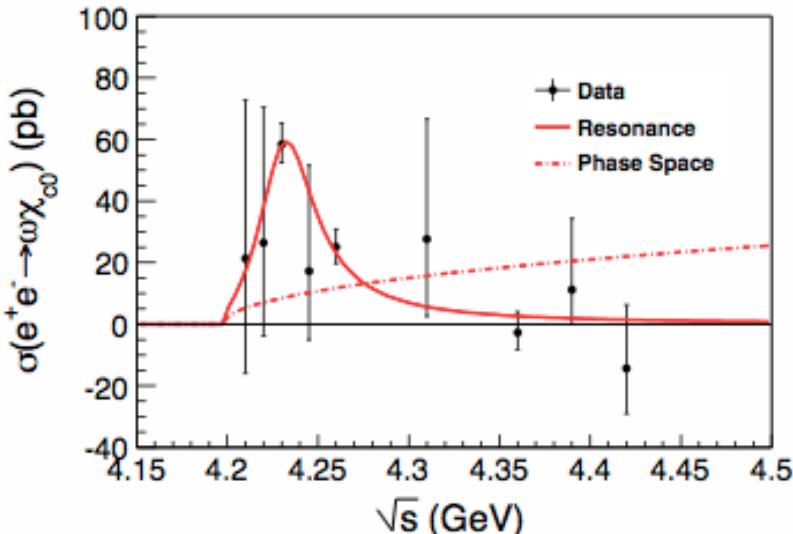
Interpreted as a meson molecule [PLB 725, 127 (2013)] or as a tetraquark [Nucl. Ph. B 886, 665 (2014)]



$$e^+e^- \rightarrow \gamma \chi_{c1,c2}$$

- Simultaneous fit to data sets at different  $E_{\text{cm}}$
- $M = 3821.9 \pm 1.3 \pm 0.7 \text{ MeV}/c^2$
- Observed with a significance of  $6.2\sigma$
- Created in the **Y(4360)** or  **$\psi(4415)$**  decay [PRL 115, 011803 (2015)]

# $\Upsilon$ states at BESIII



$\sigma(e^+e^- \rightarrow \gamma \text{ Y(4140)}) \cdot B(\text{Y(4140)} \rightarrow \phi J/\psi)$ :

- $4.23 \text{ GeV} < 0.35 \text{ pb at 90\% CL}$
- $4.26 \text{ GeV} < 0.28 \text{ pb at 90\% CL}$
- $4.36 \text{ GeV} < 0.33 \text{ pb at 90\% CL}$

PRD 91, 032002

# Outlook

- A great contribution of BESIII in studies of exotic states
- A deeper investigation of these states is needed and will be performed with a new data set from BESIII
- The experiment BESIII is improving the detector performances (a new Inner Tracker based on CGEM technology)