Recent Charmonium results at BESIII



Kai Zhu (for BESIII Collaboration)

Institute of High Energy Physics, Beijing, China

MESON 2010, June 10-16, 2010, Cracow, Poland

Outline

- A very fast introduction: BEPCII & BESIII
- Recent charmonium Results:
 - Observation of h_c
 - Measurement of $Br(\chi_{c0,2} \rightarrow PP)$
 - Observation of $\chi_{cJ} \rightarrow VV$.
- Summary





中國科學院為能物招加完備 Institute of High Energy Physics Chinese Academy of Sciences

Why BEPCII & BESIII?





Abundant potential physics with BESIII.

See talk by F. A. Harris in this conference for more details.

Before BESIII



¹P₁ charmonium state (c<u>c</u>) Predicted for a long while Non-strong spin-spin interaction Only decay via $\psi' \rightarrow \pi^0 h_c$ Mass and product Brs are from CLEOc (below)

	Inclusive	Exclusive
Counts	1146 ± 118	136 ± 14
Significance	10.0σ	13.2σ
$M(h_c)$ (MeV)	$3525.35 \pm 0.23 \pm 0.15$	$3525.21 \pm 0.27 \pm 0.14$
$\mathcal{B}_1 imes \mathcal{B}_2 imes 10^4$	$4.22 \pm 0.44 \pm 0.52$	$4.15 \pm 0.48 \pm 0.77$

PRL101,182003(2008)

h_c :how do we observe it?

DATA Sample: ~106M ψ (2S) events collected by BES-III at BEPC-II in March and April 2009

♦ E1-tagged analysis of ψ (2S) → π^0 h_c, h_c → γ η_c ♦ Inclusive analysis of ψ (2S) → π^0 h_c







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Improve detection Compare MC with data



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BW (signal) convolved with D-Gaus (reso) + background. The mass and width of h_c and normalization floated. The BG is represented by the π^0 recoil mass spectrum in the sideband of the E1 photon.



The mass and width of h_c are fixed to the values obtained
from E1-tagged analysis.
The background is parameterized by a 4th-order
polynomial.
BES Collaboration, PRL 104, 132002 (2010)

 $\chi_{c,l}$ decays



Exclusive decay of χ_{cJ} are a good laboratory to test the color-octet mechanism in P-wave charmonium decays.

BR of ח ח, ח'ח, ח'ח' determine the ratio of contributions from SOZI and DOZI processes.

decay width	theory[3]	PDG08
Γ[χ _{c0} → π° π°]/keV	23.5	25 ± 2
$\Gamma [\chi_{c2} \rightarrow \pi^0 \pi^0] / \text{keV}$	1.93	1.4 ± 0.2
Γ[χ _{c0} → ηη] /keV	32.7	25 ± 4
Γ[χ _{c2} → ηη] /keV	2.66	



[1] G.T.Bodwin, et.al., PRD51,1125 (1995)
[2] H.-W. Huang and K.-T. Chao, PRD 54, 6850 (1996)
[3] J. Bolz et. al., Eur.Phys J. C 2:705-719 (1998)
[4]Qiang Zhao, PRD. 72, 074001 (2005)

Study of $\chi_{c0.2} \rightarrow \pi^0 \pi^0$, $\eta \eta (\eta \rightarrow \gamma \gamma, \pi^0 \rightarrow \gamma \gamma)$



Study of $\chi_c \rightarrow VV$, $V = \omega$, ϕ

- $\chi_{cJ} \rightarrow \phi \phi$ and $\chi_{cJ} \rightarrow \omega \omega$ are Singly OZI suppressed
- $\chi_{c1} \rightarrow \phi \phi$ and $\chi_{c1} \rightarrow \omega \omega$ is suppressed by helicity selection rule.
- $\chi_{cJ} \rightarrow \phi \omega$ is doubly OZI suppressed, not measured yet

BESII has some measurements on $\chi_{c0,2} \rightarrow \phi \phi / \omega \omega$ already PLB 642,197(2006), PLB 630,7 (2005)

φ is reconstructed via K⁺ K^{-,} ω is reconstructed via $π^+ π^- π^0$ Vertex information are used to help to select good tracks.



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Study of $\chi_{cJ} \rightarrow \phi \phi$

Candidate of ϕ , reconstructed via KK.



The first measurement of $\chi_{c1} \rightarrow \phi \phi$, which is supposed to be suppressed by helicity selection rule.

channel	$(\times 10^{-4})$	$PDG(\times 10^{-4})$
$\chi_{c0} \to \phi \phi$	8.0 ± 0.4	9.3 ± 2.0
$\chi_{c1} ightarrow \phi \phi$	4.2 ± 0.3	
$\chi_{c2} o \phi \phi$	11.3 ± 0.4	15.4 ± 3.0

Further check on angular distribution





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Study of $\chi_{cJ} \rightarrow \omega \omega$



First observation of $\chi_{cJ} \rightarrow \omega \phi$



- $\chi_{cJ} \rightarrow \phi \omega$ OZI doubly suppressed
- this decay is firstly observed

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- ωφ signals are clearly observed
- backgrounds and contributions from nonresonances are studied with ω & φ sidebands, and continuum data.



Summary

- Some charmonium results at BESIII are obtained with 106M ψ ' data collected recently
 - Observation of hc from $\psi' \rightarrow \pi 0$ hc
 - First measurement: $Br(\psi \rightarrow \gamma h_c) \& Br(h_c \rightarrow \gamma \eta_c)$ seperately, as well as the width of h_c
 - Mass of h_c (confirm CLEOc's observation)
 - Measurement of $\chi_{cJ} \rightarrow PP$, i.e.
 - Br($\chi_{c0,2} \rightarrow \pi^0 \pi^0$), Br($\chi_{c0,2} \rightarrow \eta \eta$)
 - Observation of $\chi_{cJ} \rightarrow VV$
 - $\chi_{c1} \rightarrow \phi \phi$, $\omega \omega$; ($\chi_{c1} \rightarrow \phi \phi / \omega \omega$ are observed for the first time)
 - first observation: $\chi_{c,l} \rightarrow \omega \phi$;
- Further exciting results, which will improve our knowledge at this energy region, are coming Thanks! soon.