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Charmonium: Recent Results and New Opportunities

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The States of Charmonium

Precision measurements and radiative decay

Discovery

Properties and decays

New decay modes

Radiative decay and $X+J/\psi$ modes observed.

Scan for new structure, including Y(4260)



"Recent Results"

A lot has been happening in the past few years!

I will present my own personal selection of highlights, but many stories will go untold here.





Note: Radiative Transitions Calculated in Lattice QCD



Decays of the $\psi(3770)$



Two Examples (Both from CLEO-c)



Phys.Rev.Lett.96(2006)082004

ψ(3770)→γχ_{cJ}



Phys.Rev.Lett.96(2006)182002 and hep-ex/0605070

Testing "Survival Before Annihilation" by Searching for $\Psi(2S) \rightarrow \eta_c 3\pi$

CLEO-c (brand new)



Artoisenet, et al., Phys.Lett. B628(2005)211

Upper limit of 6.7 events

This gives a 90% CL limit on the branching ratio of 1.1×10⁻³

Histogram shows a signal level of 1% which is the model prediction.

Charmonium from the B-Factories

Examples:

Belle: X(3940) through

$$e^+e^- \rightarrow J/\psi + X$$



<u>BaBar</u>:Y(4260) through

$$e^+e^- \rightarrow (\gamma)Y(4260)$$

 $Y(4260) \rightarrow \pi^+\pi^- J/\psi$

Summary (from Helmut Marsiske, FPCP 06)

State	Mass (MeV)	Width (MeV)	Decay Modes	JPC
X(3872)	3871.2±0.6	<2.3	π⁺π⁻J/ψ γJ/ψ D⁰D⁰π⁰	 ++
X(3940)	3943±9	<52	D*D	0-+?
Y(3940)	3943±17	87±34	ωJ/ψ	C=+1
Z(3930)	3929±6	29±10	DD	2++
Y(4260)	4259 ⁺⁸ -10	88 ⁺²⁴ -23	ππJ/ψ	I

Y(4260) Confirmation from CLEO-c



"New Opportunities"

• CLEO-c plans to take 30M $\psi(2S)$ this summer

After that, our remaining running time (through March 2008) will be devoted to production of D and D_s .

- Expect more from the B-Factories, but...
- The future belongs to BES III!

More precision measurements, decays of the χ_{cJ} and h_c , investigations of higher charmonia.



Conclusions

Charmonium has seen many recent discoveries and a lot of renewed interest.

It is a testing ground for many models of hadronic physics, including calculations in Lattice QCD.

The future has a lot to offer!

