Exclusive charmonium B decays

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on behalf of the BaBar Collaboration
Introduction

Motivation – Tests models of Hadronic B Decays
  • Factorization Hypothesis – Hadronic decays sensitive to QCD

Exclusive Branching Fraction Measurements
  • Factorization allowed (J/ψ, ψ(2S), and χ_{c1})
  • X(3872) Confirmation in Charged B Decay

Search for Charged partner of X(3872)

Factorization forbidden B Decays
  • Charmonium final states - χ_{c0}, χ_{c2} and h_c

Physics beyond the Standard Model
  • Rare radiative B → J/ψ γ

*All Results are preliminary unless otherwise stated.
Exclusion Branching Fraction Results

Preliminary

<table>
<thead>
<tr>
<th>Channel</th>
<th>Branching fraction ($\times 10^{-4}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$B^0 \to J/\psi K^{*0}$</td>
<td>$12.92 \pm 0.25 \pm 0.75$</td>
</tr>
<tr>
<td>$B^+ \to J/\psi K^{*+}$</td>
<td>$14.34 \pm 0.36 \pm 0.94$</td>
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<tr>
<td>$B^+ \to J/\psi K^+$</td>
<td>$10.55 \pm 0.15 \pm 0.48$</td>
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<tr>
<td>$B^0 \to J/\psi K^0$</td>
<td>$8.73 \pm 0.23 \pm 0.30$</td>
</tr>
<tr>
<td>$B^0 \to \psi(2S) K^{*0}$</td>
<td>$6.65 \pm 0.57 \pm 1.00$</td>
</tr>
<tr>
<td>$B^+ \to \psi(2S) K^{*+}$</td>
<td>$6.03 \pm 0.85 \pm 0.91$</td>
</tr>
<tr>
<td>$B^+ \to \psi(2S) K^+$</td>
<td>$6.31 \pm 0.33 \pm 0.44$</td>
</tr>
<tr>
<td>$B^0 \to \psi(2S) K^0$</td>
<td>$6.60 \pm 0.60 \pm 0.46$</td>
</tr>
<tr>
<td>$B^0 \to \chi_{c1} K^{*0}$</td>
<td>$3.19 \pm 0.37 \pm 0.64$</td>
</tr>
<tr>
<td>$B^+ \to \chi_{c1} K^{*+}$</td>
<td>$2.89 \pm 0.69 \pm 0.93$</td>
</tr>
<tr>
<td>$B \to \chi_{c1} K^+$</td>
<td>$5.72 \pm 0.24 \pm 0.64$</td>
</tr>
<tr>
<td>$B^0 \to \chi_{c1} K^0$</td>
<td>$4.56 \pm 0.39 \pm 0.51$</td>
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</tbody>
</table>

- Analysis using 124M $B\bar{B}$ pairs
- Measurement of exclusive branching fractions better than or comparable to previous measurements (PDG 2004)
- First measurement of $\mathcal{B}(B^+ \to \chi_{c1} K^{*+})$
Exclusive Branching Fraction Results

- Measurement of the charged to neutral ratio at $\Upsilon(4S)$
- Assuming isospin invariance
- PDG 2004 Lifetimes $\tau_{B^+}/\tau_{B^0} = 1.086\pm0.017$

$$R^{+/0} = \frac{\Gamma(\Upsilon(4S) \to B^+B^-)}{\Gamma(\Upsilon(4S) \to B^0\bar{B}^0)} = 1.05\pm0.02\pm0.03$$

- Charge CP Asymmetries

$$A_{CP} = \frac{B(B^+ \to (c\bar{c})K^{+(*))} - B(B^- \to (c\bar{c})K^{-(*))}}{B(B^+ \to (c\bar{c})K^{+(*))} + B(B^- \to (c\bar{c})K^{-(*))}}$$

No Evidence of Direct CP Violation

Preliminary

<table>
<thead>
<tr>
<th>$B^+$ Final State</th>
<th>$A_{CP}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$J/\psi K^+$</td>
<td>$-0.029 \pm 0.014 \pm 0.010$</td>
</tr>
<tr>
<td>$J/\psi K^{++}$</td>
<td>$0.045 \pm 0.025 \pm 0.011$</td>
</tr>
<tr>
<td>$\psi(2S)K^+$</td>
<td>$0.059 \pm 0.051 \pm 0.021$</td>
</tr>
<tr>
<td>$\psi(2S)K^{*+}$</td>
<td>$-0.063 \pm 0.137 \pm 0.050$</td>
</tr>
<tr>
<td>$\chi_{c1}K^+$</td>
<td>$0.011 \pm 0.042 \pm 0.017$</td>
</tr>
<tr>
<td>$\chi_{c1}K^{*+}$</td>
<td>$-0.403 \pm 0.309 \pm 0.237$</td>
</tr>
</tbody>
</table>
$B^\pm \rightarrow J/\psi K^{\pm} \pi^+ \pi^-$ and the X(3872)

All $B^\pm \rightarrow J/\psi K^{\pm} \pi^+ \pi^-$ candidates
- $\text{BF}(B^\pm \rightarrow J/\psi K^{\pm} \pi^+ \pi^-) = (116\pm7\pm9) \times 10^{-5}$
- Precision better by x2 w.r.t. present average

$B^- \rightarrow J/\psi K^- \pi^+ \pi^-$ candidates for X(3872)
- Mass region $3862 \text{MeV} < m_{J/\psi \pi \pi} < 3882 \text{MeV}$
- $\text{BF}(B^\pm \rightarrow X(3872)K^{\pm}) \times \text{BF}(X(3872) \rightarrow J/\psi \pi^+ \pi^-) = (1.28 \pm 0.41) \times 10^{-5}$

Other Searches
- $B^\pm \rightarrow h_c(J/\psi \pi^+ \pi^-)K^{\pm}$: BR $< 3.4 \times 10^{-6}$
- $B^\pm \rightarrow J/\psi D^0(K\pi)\pi^\pm$: BR $< 5.2 \times 10^{-5}$

Submitted for Publication
(hep-ex/0406022)

8/29/04
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Search for X(3872) Charged Partner

Possible Decay of $X(3872) \rightarrow J/\psi \rho^0(\pi^+\pi^-)$

- If pions are from $\rho^0$ then charged partner $X^\pm(3872) \rightarrow J/\psi \rho^\pm$ may exist
- Assuming isospin conservation and $X^\pm$ is a member of an isotriplet
  $\Rightarrow \Gamma(B \rightarrow X^0K) = 2 \cdot \Gamma(B \rightarrow X^0K)$

Analysis on 213 million $B \bar{B}$ events

- Fits Consistent with Peaking Background
- $\text{BR}(B^0 \rightarrow J/\psi \pi^+ \pi^- K^+) < 5.8 \times 10^{-6}$ \text{ 90\%C.L.}
- $\text{BR}(B^\pm \rightarrow J/\psi \pi^+ \pi^- K_S^0) < 11 \times 10^{-6}$
- Results do not support isovector hypothesis
- Probability isovector hypothesis is correct $< 1:600$

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Factorization
Suppressed Decays

BF(B→χ_{c0} K) comparable to factorization allowed

- Seen on Belle and BaBar in χ_{c0}→ππ,KK
- Analysis presented here: χ→J/ψγ
- 124M B̅B events

Upper limits in χ_{c2} are an order of magnitude smaller than factorization allowed decays

<table>
<thead>
<tr>
<th>B(10^{-4}) Limits @ 90%C.L.</th>
<th>χ_{c2}</th>
<th>χ_{c0}</th>
</tr>
</thead>
<tbody>
<tr>
<td>K^{+}</td>
<td>&lt;0.22</td>
<td>&lt;8.0</td>
</tr>
<tr>
<td>K^{*+}</td>
<td>&lt;0.14</td>
<td>&lt;45</td>
</tr>
<tr>
<td>K^{+}</td>
<td>&lt;0.36</td>
<td>&lt;12</td>
</tr>
<tr>
<td>K^{0}</td>
<td>&lt;0.44</td>
<td>&lt;13</td>
</tr>
</tbody>
</table>

Preliminary
Tests of the Standard Model

Preliminary

$B^0 \to J/\psi \gamma$ – Possible probe of physics beyond the SM

- Right handed charged current
- Non-spectator intrinsic charm in the $B^0$ meson

SM estimate $\text{BR}(B^0 \to J/\psi \gamma) = 7.65 \times 10^{-9}$

No signal events found in data

$\text{BR}(B^0 \to J/\psi \gamma) < 1.6 \times 10^{-6}$ @ 90\%C.L.

Blind Analysis on 123M $B\bar{B}$

(hep-ex/0408018)
Summary of Results

Factorization allowed (J/ψ, ψ(2S), and χ_{c1})

- Improved branching fraction precision

Factorization forbidden B decays

- Limits for χ_{c2} Order of Magnitude below Allowed
- No evidence seen in h_c → J/ψ π^+π^−

X(3872) Charmonium-like resonance

- Confirmation and BF measurement in Charged B Decay

Charged partner of X(3872)

- Excluded isovector hypothesis

Rare radiative B → J/ψ γ

- No deviations from the SM prediction

8/29/04

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