ψ (2S) Decays to Baryon-Antibaryon Pairs

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A sample of over 3M ψ' decays registered in the BES detector are used to study final states containing pairs of octet and decuplet baryons. We report branching ratios for $\psi' \to p\overline{p}$, $\Lambda\overline{\Lambda}$, $\Sigma^0\overline{\Sigma}^0$, $\Xi^-\overline{\Xi}^+$, $\Delta^{++}\overline{\Delta}^{--}$, $\Sigma^+(1385)\overline{\Sigma}^-(1385)$, and upper limits for $\Xi^0(1530)\overline{\Xi}^0(1530)$, $\Omega^-\overline{\Omega}^+$. These results are compared to expectations based on flavor-$SU(3)$ symmetry.

1 Introduction

One major puzzle in hadronic ψ decays is the large discrepancy between the decay widths for $J/\psi(1S) \to \rho\pi$ and K^*K and the corresponding widths for $\psi(2s)$ decays. These modes are expected to proceed via $\psi \to ggg$, with widths that are proportional to the square of the $c\bar{c}$ wave function at the origin, which is well determined from dilepton decays. The prediction, known as *"the 15% rule,"* is

$$\frac{\mathcal{B}(\psi' \to X_{had})}{\mathcal{B}(J/\psi \to X_{had})} = \frac{\mathcal{B}(\psi' \to e^+e^-)}{\mathcal{B}(J/\psi \to e^+e^-)} = 0.147 \pm 0.023,$$

where X_{had} designates any exclusive hadronic decay channel. Experimentally, the $\psi(2s) \to \rho\pi$ and K^*K are reduced by factor of sixty and twenty, respectively, from these naive expectations[1]. There is very little data on ψ' to baryon states.

2 This experiment

We report preliminary results of measurements of the branching fractions for $\psi' \to B_i\overline{B_i}$, where $B_i = \{p, \Lambda, \Sigma^0, \Xi^-, \Delta^{++}, \Sigma^-(1385), \Xi^0(1530), \Omega^-\}$, using a sample of 3.44×10^6 ψ' events produced via e^+e^- annihilations at the BEPC collider and observed by the BES detector[2].

We plot our results for the branching fractions in Fig. 1, along with previous limits and results. The numerical values are summarized in Table 1, where a comparison with 15%-rule expectations is provided. Our measured value for the $\mathcal{B}(\psi' \to p\overline{p})$ is higher than the value given in the PDG table, which comes from low statistics measurements[3]. The $\psi' \to p\overline{p}$ and $\Lambda\overline{\Lambda}$ results are in good agreement with 15%-rule expectations. The rule works less

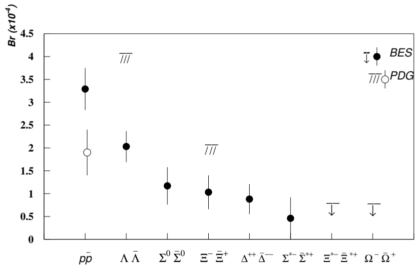

Figure 1: The measured branching fractions for $\psi' \to B_i\overline{B_i}$ decays. Previous measurements are indicated for comparison.

well for the $\Xi^-\overline{\Xi}^+$, $\Sigma^0\overline{\Sigma^0}$, $\Delta^{++}\overline{\Delta}^{--}$, $\Sigma^{*+}\overline{\Sigma^*}^-$ modes, which are somewhat below expectations. However, there is no dramatic suppression as in the case of vector-pseudoscalar meson final states. We see no $\psi' \to \Xi^{*0}\overline{\Xi^*}^0$ and $\Omega^-\overline{\Omega}^+$, and give 90% CL upper limits for these modes.

Table 1: Measured $\psi' \to B\overline{B}$ branching ratio values.

Decay Mode	Branching fraction
$p\overline{p}$	$(3.29 \pm 0.33 \pm 0.32) \times 10^{-4}$
$\Lambda\overline{\Lambda}$	$(2.03 \pm 0.27 \pm 0.20) \times 10^{-4}$
$\Sigma^0\overline{\Sigma}^0$	$(1.17 \pm 0.39 \pm 0.12) \times 10^{-4}$
$\Xi^-\overline{\Xi}^+$	$(1.03 \pm 0.35 \pm 0.13) \times 10^{-4}$
$\Delta^{++}\overline{\Delta}^{--}$	$(0.88 \pm 0.32 \pm 0.10) \times 10^{-4}$
$\Sigma^-(1385)\overline{\Sigma^*}^+$	$(0.46 \pm 0.46 \pm 0.13) \times 10^{-4}$
$\Xi^{*0}\overline{\Xi^*}^0$	$< 0.72 \times 10^{-4}$
$\Omega^-\overline{\Omega}^+$	$< 0.71 \times 10^{-4}$

3 Discussion

In the context of flavor $SU(3)$, a pure $c\overline{c}$ state is a flavor singlet and, in the limit of $SU(3)$-flavour symmetry, the phase-space-corrected reduced branching ratios to any baryon octet pair, $|M_i|^2$, where $|M_i|^2 = \mathcal{B}(\psi' \to B_i\overline{B_i})/\pi p^*/\sqrt{s}$, p^* is the momentum of the baryon in the ψ' rest frame, should be the same for every octet baryon, B_i. Deviations from this rule would indicate non-

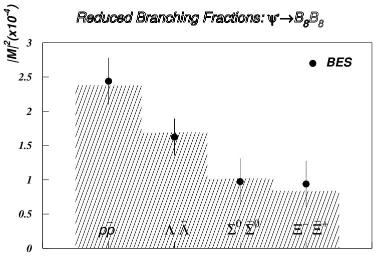

Figure 2: The reduced branching fractions $|M_i|^2$ for $\psi' \to B_8\overline{B_8}$ decays. The shaded bars indicate results of a fit to an SU(3)-symmetry breaking model with an antisymmetric-octet amplitude that is $\sim 22\%$ of the SU(3)-conserving singlet term.

SU(3)-singlet contributions to the decay amplitude. In Fig. 2, we plot the reduced branching fractions derived from our measurements for $\psi' \to B_8\overline{B_8}$. The data are inconsistent with strict flavor-SU(3) (χ^2/dof = 15.0/3). Fitting the data with a simple SU(3)-violating model[4] gives an octet decay amplitude that $\sim$ 22% that of the singlet amplitude. This is bigger than the $\sim$ 8% octet amplitudes that come from similar fits to the corresponding J/ψ reduced branching ratios.

References

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