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STUDIES OF Ξ_c^0 PRODUCTION AND DECAYS AT *BABAR*

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The production of Ξ_c^0's from $c\bar{c}$ continuum and from B decays is studied using 116 fb^{-1} of data collected by the *BABAR* detector. A measurement of the ratio of the branching fractions of the Ξ_c^0 decaying into $\Xi^-\pi^+$ and Ω^-K^+ final states is presented.

1. Introduction

B-factories present excellent opportunities to explore the charmed baryon sector with high precision. The decays of the Ξ_c^0 (csd)[a] into: $\Xi_c^0 \to \Omega^- K^+$ and $\Xi_c^0 \to \Xi^-\pi^+$ have been studied with the high luminosity available at *BABAR*.[1]
A value for the ratio of the respective branching fractions is obtained and improves upon a previous measurement by the CLEO collaboration.[2] Furthermore, signals for $\Upsilon(4S) \to B\bar{B} \to \Xi_c^0 + X$, where X represents the rest of the event, are seen, confirming a previous observation by CLEO at the 3σ level.[3]

The *BABAR* detector is described elsewhere.[4]

2. Decay Topologies and Selection Criteria

The intermediate states are reconstructed through the following decays: $\Xi^- \to \Lambda\pi^-$, $\Omega^- \to \Lambda K^-$ and $\Lambda \to p\pi^-$. A 3σ mass cut is required at each stage of the selection, where σ is the fitted mass resolution. Since the hyperons are long-lived, the signal to background ratio is improved by applying flight cuts on the hyperons' vertex displacements. In addition, particle ID selectors for the proton and the kaons, based on $\mathrm{d}E/\mathrm{d}x$ measurements given by the Silicon Vertex Tracker and the Drift Chamber as well as Cherenkov angle information, have been employed.

The center-of-mass momentum (p^*) of the Ξ_c^0 candidate is required to exceed 1.8 GeV/c. Furthermore, in order to avoid large fluctuations from the edges of the phase-space and detector acceptance effects, the polar angle of the Ξ_c^0 candidate with respect to the collision axis in the center-of-mass frame (θ^*) is limited to the range $-0.8 \leq \cos\theta^* \leq 0.8$ for the $\Xi^-\pi^+$ mode and $-0.8 \leq \cos\theta^* \leq 0.6$ for Ω^-K^+.

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[a]All channels imply the charge conjugates as well, unless otherwise specified.

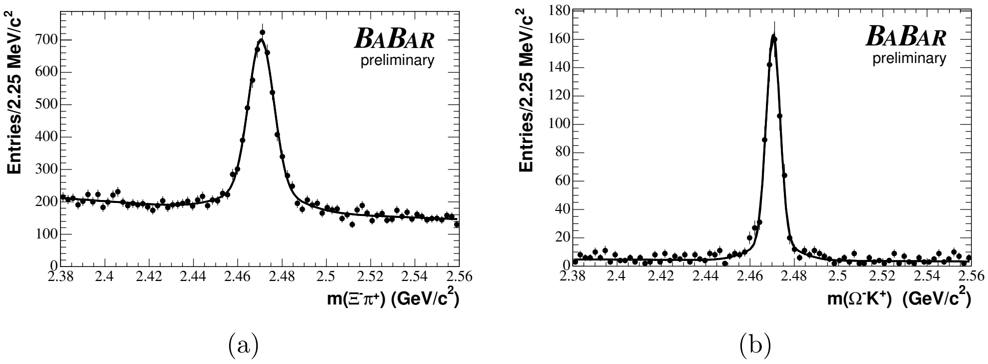


Fig. 1. Invariant mass spectra for Ξ_c^0 with $p^* > 1.8$ GeV/c from (a) $\Xi^-\pi^+$ final state with $-0.8 \leq \cos\theta^* \leq 0.8$, and (b) Ω^-K^+ final state with $-0.8 \leq \cos\theta^* \leq 0.6$. Both spectra are fitted with a double Gaussian function for the signal and a linear background shape.

Figures 1 (a) and (b) show the invariant mass spectra of Ξ_c^0 candidates passing these selection criteria for $\Xi^-\pi^+$ and Ω^-K^+ decay modes, respectively.

3. Ratio of Branching Fractions of Ξ_c^0 to $\Xi^-\pi^+$ and Ω^-K^+

The Ξ_c^0 reconstruction efficiency is obtained from signal Monte Carlo events and parameterized as a function of p^* and cosθ^* in each of the two decay modes. The efficiency-corrected invariant mass spectra are obtained by weighting each event inversely by its efficiency according to its position in (p^*, cosθ^*) space. The efficiency-corrected yield for each mode is obtained from a fit with a double Gaussian function on a linear background.

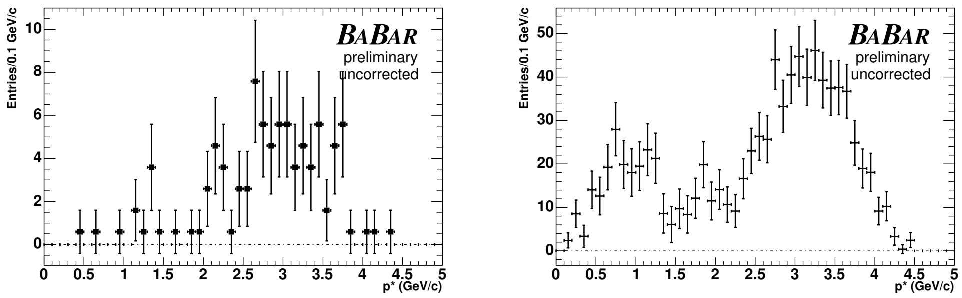
For $p^* > 1.8$ GeV/c, the signal is dominated by $c\bar{c}$ continuum production and the angular distribution of the data is well-described by a $(1 + \cos^2\theta^*)$ function. This is used to estimate the fractions of Ξ_c^0's expected to lie in the selected angular regions for each mode. Extrapolating from the fiducial region, as described in section 2, into the full range $-1 \leq \cos\theta^* \leq +1$ for the $\Xi^-\pi^+$ and Ω^-K^+ modes, the following ratio of branching fractions is obtained:

$$\frac{B(\Xi_c^0 \to \Omega^-K^+)}{B(\Xi_c^0 \to \Xi^-\pi^+)} = 0.296 \pm 0.018 \text{ (stat.)} \pm 0.030 \text{ (sys.)}.$$

The dominant sources of systematic uncertainty are the fit functions used to obtain the signal yield, fits to the cosθ^* distributions, and the efficiency parametrizations.

4. Ξ_c^0 Production Studies

An insight into the production of Ξ_c^0 baryons, from $c\bar{c}$ continuum and from B decays, can be obtained by analyzing their p^* distribution (allowing for $p^* \leq 1.8$ GeV/c).



(a) (b)

Fig. 2. Mass sideband-subtracted p^* distribution of reconstructed Ξ_c^0's ($\Xi_c^0 \to \Omega^- K^+$) without efficiency correction in (a) 10.7 fb^{-1} of off-peak data and (b) 105.4 fb^{-1} of on-peak data.

The p^* distribution from the Ξ_c^0 signal region[b] for the off-peak data (collected at approximately 40 MeV/c^2 below the $B\bar{B}$ production threshold) is shown without any efficiency correction in Figure 2 (a) for the $\Omega^- K^+$ final state. These data represent Ξ_c^0 production from $c\bar{c}$ continuum only. The background under the Ξ_c^0 signal in the data is estimated from the mass sidebands in the reconstructed Ξ_c^0 mass spectrum and then removed. There are very few entries below 2 GeV/c, which represents the approximate kinematic cut-off for production from B decays. Figure 2 (b) shows the p^* distribution in on-peak data (collected at the $B\bar{B}$ threshold) after background subtraction, again without any efficiency correction. The peak below 1.8 GeV/c clearly represents Ξ_c^0 production from B decays. Similar behavior is seen for the $\Xi^-\pi^+$ decay mode. A study of simulated events containing Ξ_c^0's produced from $c\bar{c}$ continuum and B decays shows an agreement between data and Monte Carlo.

5. Summary

A preliminary measurement of the ratio of branching fractions of Ξ_c^0 to $\Omega^- K^+$ and $\Xi^-\pi^+$ is obtained using $c\bar{c}$ continuum data. The evidence for the production of Ξ_c^0 from $\Upsilon(4S) \to B\bar{B} \to \Xi_c^0 + X$ is seen in the $\Xi^-\pi^+$ and, for the first time in the $\Omega^- K^+$ final state.

References

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2. CLEO Collaboration, S. Henderson *et al.*, Phys. Lett. B **283**, 161 (1992).
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4. The *BABAR* Collaboration, B. Aubert *et al.*, Nucl. Instrum. Methods A **479**, 1 (2002).

[b]Region within a 3σ mass window