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Measurement of Singly Cabibbo-suppressed decays ....

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Abstract

Based on 567 pb^{-1} of e^+e^- annihilation data collected with the BESIII detector at the BEPCII produced at $\sqrt{s} = 4.599$ GeV,

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Contents

1 Introduction

Weak decays of charmed baryons provide a useful test of many competing theoretical models and approaches, *e.g.*, the quark model approach to non-leptonic charm decays and Heavy Quark Effect Theory (HQET) [1, 2, 3, 4, 5, 6, 7]. Unlike charmed mesons, the decays of charmed baryons are not colour or helicity suppressed, and allowed to investigate the contribution of W-exchange diagrams.

Since the first observation of the charmed baryon ground state Λ_c^+ in 1979 [8, 9], our knowledge of the physics of charmed baryons developed relatively slow comparing to the charmed mesons. This is due to the relatively small baryon production cross section and absence of a cleanly observable $\Lambda_c^+\bar{\Lambda}_c^-$ resonance in the e^+e^- collider. Though the improved results on masses, widths, lifetimes, production rates and the decay asymmetry parameters have been published by different experiments, however the accuracy of the measured branching ratio remains poor for many Cabibbo-favoured modes, and even worse (beyond 40%) for the Cabibbo-suppressed and W-exchange dominated modes [10]. As a consequence, we are not yet able to distinguish between the decay rate predictions made by different theoretical models. A remarkable progress was presented by BESIII recently [11], which measured the absolute branching fractions of twelve Λ_c^+ Cabibbo-favored hadronic decay modes with a significantly improved precision less than 10% by employing a double tag technique. It is important to improve the accuracy of the branching fractions for the Cabibbo-suppressed and W-exchange dominated modes as well. It is noteworthy that in Ref. [11], the measured branching fraction of golden mode $\Lambda_c^+ \to pK^-\pi^+$ is consistent with PDG results [10], but lower than that of Belle [12] with a significance of about 2σ.

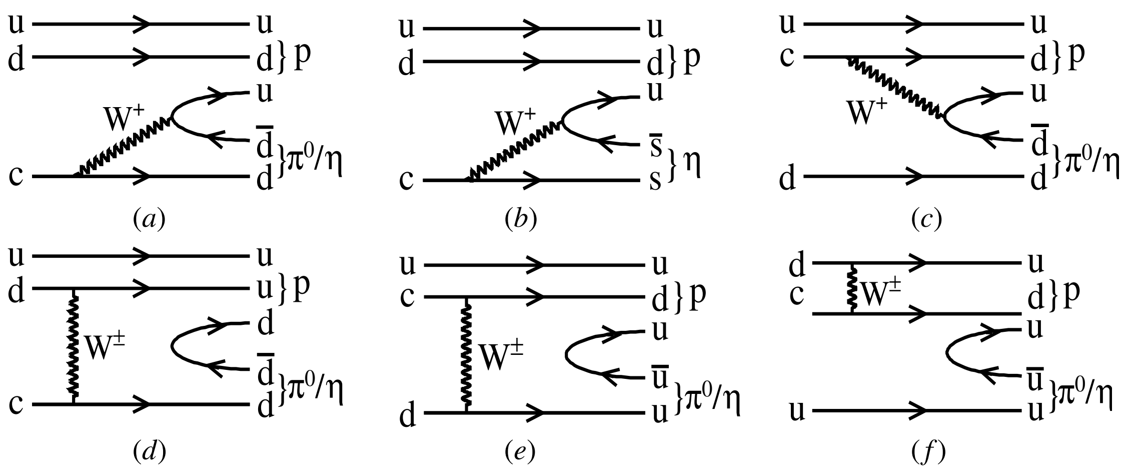

Figure 1: Feynman diagrams, (a,c) internal W-emission for $\Lambda_c^+ \to p\pi^0/p\eta$, (b) internal W-emission for $\Lambda_c^+ \to p\eta$, (d,e,f) W-exchange for $\Lambda_c^+ \to p\pi^0/p\eta$

Theoretically, the Cabibbo-suppressed decays $\Lambda_c^+ \to p\eta$ and $\Lambda_c^+ \to p\pi^0$ proceed dominantly through internal W-emission and W-exchange diagrams, as shown in Fig. 1, while the penguin contribution is presumably very small. The only difference between the two decay modes is the additional internal W-emission amplitude involved s quark (Fig. 1(b)) for the decay $\Lambda_c^+ \to p\eta$. Unlike hadronic decay of heavy mesons, the W-exchange diagram plays an important role in the charmed baryon decays. The measurement of two decay branching fractions and comparison of their branching fractions may be interesting to study the underlying dynamic of charmed baryon decays.

In this document, we present studies for the Cabibbo-suppressed decays $\Lambda_c^+ \to p\eta$ and $\Lambda_c^+ \to p\pi^0$ by exploring a single tag method in detail. The signal of $\Lambda_c^+ \to p\eta$ is observed for the first time, and the absolute decay branching fraction $\mathcal{B}(\Lambda_c^+ \to p\eta)$ is measured. No obvious $\Lambda_c^+ \to p\pi^0$ signal is observed, and an upper limit at 90% Confidence Level (C.L.) on the branching fraction is determined, too. The analysis is based on 567 pb^{-1} [13] of e^+e^- annihilation data collected at $\sqrt{s} = 4.599$ GeV with the BESIII detector at the BEPCII, taking advantage of simple clean background and well reconstructed final states.

2 Summary

Based on 567 pb^{-1} of e^+e^- annihilation data collected at $\sqrt{s} = 4.599$ GeV with the BESIII detector at the BEPCII, taking advantage of simple clean environment and excellent detector performance, the Cabibbo-suppressed decays ....

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Appendices

A Substract of the Secondary proton

A sizable of (anti-)proton candidates are produced from the electron/positron beam or particles in final states interacting with the MDC inner wall or residual gas inside beam-pipe, especially for proton. Here, we take the decay mode $\Lambda_c^+ \to p\eta(\gamma\gamma)$ as an example. Fig. 2 shows the compared $V_{\rm r}$ distributions of proton and anti-proton in different samples. In this analysis, we use the scaled inclusive MC to optimize the tight requirement with the $/\sqrt{S+B}$ curve. Fig. 3 shows the efficiency distribution and $S/\sqrt{S+B}$ distribution with different $V_{\rm r}$ requirement. Where, S represents signal events, and B is scaled inclusive MC sample.

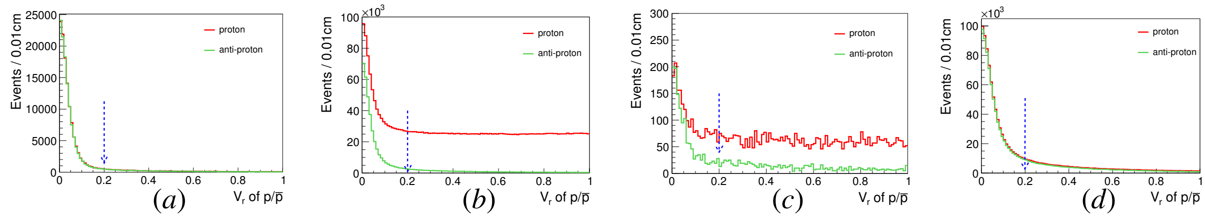

Figure 2: The comparison of $V_{\rm r}$ distributions between proton and anti-proton in different samples. (Anti-)proton selected in (a) $\Lambda_c^+ \to p\eta(\gamma\gamma)$ signal MC, (b)data, (c) $D_{\rm S}D_{\rm S}^*$ inclusive MC sample and (d) $\Lambda_c^+\bar{\Lambda}_c^-$ inclusive MC. The dashed blue arrow shows the $V_{\rm r}$ requirement we apply.

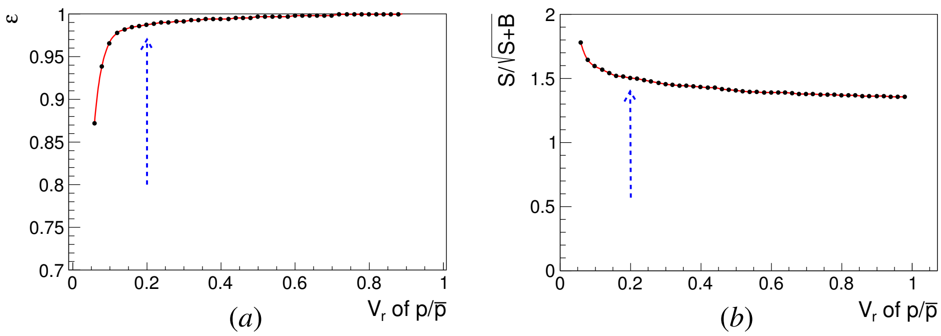

Figure 3: The (a) efficiency and (b) $S/\sqrt{S+B}$ distributions with different $V_{\rm r}$ requirements for signal MC and scaled inclusive MC samples, respectively. The dashed blue arrow shows the $V_{\rm r}$ requirement we apply.