Production rates of hyperons and charmed baryons from $e^+e^-$ annihilation near $s = 10.52$ GeV

M. Niyama¹, T. Nakano², M. Sumihama³, T. Matsuda⁴ (presenter), Belle Collaboration

¹Kyoto University, ²Research Center for Nuclear Physics(RCNP), Osaka University, ³Gifu University, ⁴University of Miyazaki

Abstract

We have measured the inclusive production cross sections of hyperons and charmed baryons from $e^+e^-$ annihilation using a 800 fb⁻¹ data sample taken near the $Y(4S)$ resonance with the Belle detector at the KEKB asymmetric-energy $e^+e^-$ collider. The feed-down contributions from heavy particles are subtracted using our data, and the direct production cross sections are compared for the first time. The results are discussed from the viewpoint of the diquark structure in baryons.

1. Introduction

In the $e^+e^-$ annihilation, hadrons are produced after the $e^-e^- ightarrow qar{q}$ creation and in the fragmentation process. The observed production cross sections (c) show an interesting dependence on their masses, $\sqrt{s}$, where $x$, $m$, and $s$ are the total spin and the mass of a hadron and a slope parameter, respectively.

Issues (Motivation)

• Feed-down contributions from heavy particles are subtracted?
• Large errors in ARGUS results
• How about charmed baryons?
• Study at Belle 1

2. Belle data of KEK, Japan

Integrated luminosity:

• 52.8 ± 1.0 fb⁻¹ on (ARGUS) measurements for charmed baryons ($x \approx 0.78$ GeV)

3. Reconstruction of $S=1$ hyperons

4. Reconstruction of $S=2$ hyperons

5. Inclusive differential cross sections, hyperons

• Inclusive cross sections (including feed-down contributions from heavy particles) are obtained as a function of hadron scaled momentum ($x$), where $x = p/p_{T}$.
• Peak around $x \approx 0.2-0.3$ for hyperons are produced in soft processes. Peak positions for $D$ and $D(1520)$ seem slightly higher than the other hyperons. Total cross sections for $S=1$ hyperons are obtained using Monte Carlo simulation assuming $d\sigma/dx = 0.1 x < 0.1$.

6. Inclusive differential cross sections, charmed baryons

• Peaks around $x \approx 0.6-0.7$ in charm quarks are produced in $s^3 \rightarrow s^2$.
• Peak positions for heavier particle seem higher.
• More energetic fragmentation process is necessary to produce heavy particle.
• Total cross sections of new R.l states are obtained by fitting Leading/Leading model.

7. Feed-down subtracted (direct) cross section

• The feed-down contributions from heavy particles are subtracted using our data, and the direct production cross sections are compared for the first time.
• Cross sections before feed-down subtraction are consistent with previous measurements but much higher precision (previous measurements are not shown in the figures.).

8. Results for hyperons

9. Results of charmed baryons

10. Discussion

• Assuming that a quark pair picks up a diquark from vacuum is due to Schwinger-like “funnel effect”, the production cross sections of $\Lambda_2$ and $\Sigma_2$ are $\sqrt{s}$-indepndent.

11. Summary

• Production cross sections of hyperons and charmed baryons are measured near the $Y(4S)$ energy using Belle data.
• Using only Belle data, distributions for hyperons are measured.
• Slightly Higher Peak positions for $D$ and $D(1520)$.
• Feed-down distributions for charmed baryons are measured.
• Peak positions for heavier particle seem higher.
• Total cross sections for hyperons are measured.
• Consistent with previous measurements with much higher precision.
• Direct total cross sections are obtained.
• Clear exponential dependence on baryon masses.
• No enhancements for $\Lambda_c(2595)$.
• Suppression of $\Sigma_c(1385)$ and $\Xi_c(1530)$.
• Suppression of diquark structure in ground and low-lying $\Lambda_c$, $\Sigma_c$, $\Xi_c$.
• Input of absolute Branching Fraction for $\Xi_c$ is helpful.


An updated version of this study will be submitted to Phys. Rev. D.