Λ_c^+ BRANCHING FRACTIONS

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Most Λ_c^+ branching fractions are measured relative to the decay mode $\Lambda_c^+ \to p K^- \pi^+$. However, there are no completely model-independent measurements of the absolute branching fraction for $\Lambda_c^+ \to p K^- \pi^+$. Here we describe the measurements that have been used to extract $B(\Lambda_c^+ \to p K^- \pi^+)$, the model-dependence of the results, and the method we have used to average the results.

ARGUS (ALBRECHT 88C) and CLEO (CRAWFORD 92) measure $B(\overline{B} \to \Lambda_c^+ X) \cdot B(\Lambda_c^+ \to pK^-\pi^+)$ to be $(0.30 \pm 0.12 \pm 0.06)\%$ and $(0.273 \pm 0.051 \pm 0.039)\%$. Under the assumptions that decays of \overline{B} mesons to baryons are dominated by $\overline{B} \to \Lambda_c^+ X$ and that $\Lambda_c^+ X$ final states other than $\Lambda_c^+ \overline{N} X$ can be neglected, they also measure $B(\overline{B} \to \Lambda_c^+ X)$ to be $(6.8 \pm 0.5 \pm 0.3)\%$ (ALBRECHT 92O) and $(6.4 \pm 0.8 \pm 0.8)\%$ (CRAWFORD 92). Combining these results, we get $B(\Lambda_c^+ \to pK^-\pi^+) =$ $(4.14 \pm 0.91)\%$. However, the assumption that \overline{B} decay modes to baryons other than $\Lambda_c^+ \overline{N} X$ are negligible is not on solid ground experimentally or theoretically [2]. Therefore, the branching fraction for $\Lambda_c^+ \to pK^-\pi^+$ given above may be low by some undetermined amount.

A second type of model-dependent determination of $B(\Lambda_c^+ \to pK^-\pi^+)$ is based on measurements by ARGUS (ALBRECHT 91G) and CLEO (BERGFELD 94) of $\sigma(e^+e^- \to \Lambda_c^+X) \cdot B(\Lambda_c^+ \to \Lambda\ell^+\nu_\ell) = (4.15 \pm 1.03 \pm 1.18)$ pb and $(4.77 \pm 0.25 \pm 0.66)$ pb. ARGUS (ALBRECHT 96E) and CLEO (AVERY 91) have also measured $\sigma(e^+e^- \to \Lambda_c^+X) \cdot B(\Lambda_c^+ \to pK^-\pi^+)$. The weighted average is (11.2 ± 1.3) pb.

From these measurements, we extract $R \equiv B(\Lambda_c^+ \rightarrow pK^-\pi^+)/B(\Lambda_c^+ \rightarrow \Lambda \ell^+ \nu_{\ell}) = 2.40 \pm 0.43$. We estimate the $\Lambda_c^+ \rightarrow pK^-\pi^+$ branching fraction from the equation

$$B(\Lambda_c^+ \to pK^-\pi^+) = R f F \frac{\Gamma(D \to X\ell^+\nu_\ell)}{1 + |V_{cd}/V_{cs}|^2} \cdot \tau(\Lambda_c^+) , \quad (1)$$

where $f = B(\Lambda_c^+ \to \Lambda \ell^+ \nu_\ell)/B(\Lambda_c^+ \to X_s \ell^+ \nu_\ell)$ and $F = \Gamma(\Lambda_c^+ \to X_s \ell^+ \nu_\ell)/\Gamma(D^0 \to X_s \ell^+ \nu_\ell)$. When we use $1 + |V_{cd}/V_{cs}|^2 = 1.05$ and the world averages $\Gamma(D \to X \ell^+ \nu_\ell) = (0.166 \pm 10^{-1})$

0.006) × 10¹² s⁻¹ and $\tau(\Lambda_c^+) = (0.192 \pm 0.005) \times 10^{-12}$ s, we calculate $B(\Lambda_c^+ \to pK^-\pi^+) = (7.3 \pm 1.4)\% \cdot fF$. Theoretical estimates for f and F are near 1.0 with significant uncertainties.

So, we have two results with significant model-dependence: $B(\Lambda_c^+ \to pK^-\pi^+) = (4.14\pm0.91)\%$ from \overline{B} decays, and $B(\Lambda_c^+ \to pK^-\pi^+) = (7.3\pm1.4)\% \cdot fF$ from semileptonic Λ_c^+ decays. If we set fF = 1.0 in the second result, and assign an uncertainty of 30% to each result to account for the unknown modeldependence, we get the consistent results $B(\Lambda_c^+ \to pK^-\pi^+) =$ $(4.14\pm0.91\pm1.24)\%$ and $B(\Lambda_c^+ \to pK^-\pi^+) = (7.3\pm1.4\pm$ 2.2)%. The weighted average of these two results is $B(\Lambda_c^+ \to pK^-\pi^+) =$ $(F^-\pi^+) = (5.0\pm1.3)\%$, where the uncertainty contains both the experimental uncertainty and the 30% estimate of model dependence in each result. We assigned the value $(5.0\pm1.3)\%$ to the $\Lambda_c^+ \to pK^-\pi^+$ branching fraction in our 2000 Review [1].

A third type of measurement of $B(\Lambda_c^+ \to pK^-\pi^+)$ has been published by CLEO (JAFFE 00). Under the assumption that a \overline{D} meson and an antiproton in opposite hemispheres is evidence for a Λ_c^+ in the hemisphere of the \overline{p} , the fraction of such $\overline{D}\,\overline{p}$ events with a $\Lambda_c^+ \to pK^-\pi^+$ decay can be used to determine the $\Lambda_c^+ \to pK^-\pi^+$ branching fraction. CLEO measures $B(\Lambda_c^+ \to pK^-\pi^+) = (5.0 \pm 1.3)\%$, which is coincidentally exactly the same value as our PDG 00 average given above. The quoted uncertainty includes significant contributions from model-dependent effects (*e.g.*, differences between the \overline{p} momentum spectrum in events with a Λ_c^+ and \overline{p} in the same hemisphere, and with a \overline{D} and \overline{p} in opposite hemispheres; extrapolation of the Λ_c^+ and \overline{D} momentum spectrum below the minimum value used for rejecting *B* decay products; and our limited understanding of backgrounds such as $D\overline{D}N\overline{p}$ events).

We have chosen to continue to assign the value $(5.0 \pm 1.3)\%$ to the $\Lambda_c^+ \to pK^-\pi^+$ branching fraction (given as PDG 02 below). As was noted earlier, most of the other Λ_c^+ decay modes are measured relative to this mode.

New methods for measuring the Λ_c^+ absolute branching fractions have been proposed [2,3].

References

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- 3. P. Migliozzi et al., Phys. Lett. B462, 217 (1999).