

Λ_c^+ BRANCHING FRACTIONS

Revised 2002 by P.R. Burchat (Stanford University).

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

ARGUS (ALBRECHT 88C) and CLEO (CRAWFORD 92) measure $B(\bar{B} \rightarrow \Lambda_c^+ X) \cdot B(\Lambda_c^+ \rightarrow pK^-\pi^+)$ 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 \bar{B} mesons to baryons are dominated by $\bar{B} \rightarrow \Lambda_c^+ X$ and that $\Lambda_c^+ X$ final states other than $\Lambda_c^+ \bar{N}X$ can be neglected, they also measure $B(\bar{B} \rightarrow \Lambda_c^+ X)$ 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 $B(\Lambda_c^+ \rightarrow pK^-\pi^+) = (4.14 \pm 0.91)\%$. However, the assumption that \bar{B} decay modes to baryons other than $\Lambda_c^+ \bar{N}X$ are negligible is not on solid ground experimentally or theoretically [2]. Therefore, the branching fraction for $\Lambda_c^+ \rightarrow pK^-\pi^+$ given above may be low by some undetermined amount.

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

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

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

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

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

So, we have two results with significant model-dependence: $B(\Lambda_c^+ \rightarrow pK^-\pi^+) = (4.14 \pm 0.91)\%$ from \bar{B} decays, and $B(\Lambda_c^+ \rightarrow pK^-\pi^+) = (7.3 \pm 1.4)\% \cdot f F$ from semileptonic Λ_c^+ decays. If we set $f F = 1.0$ in the second result, and assign an uncertainty of 30% to each result to account for the unknown model-dependence, we get the consistent results $B(\Lambda_c^+ \rightarrow pK^-\pi^+) = (4.14 \pm 0.91 \pm 1.24)\%$ and $B(\Lambda_c^+ \rightarrow pK^-\pi^+) = (7.3 \pm 1.4 \pm 2.2)\%$. The weighted average of these two results is $B(\Lambda_c^+ \rightarrow pK^-\pi^+) = (5.0 \pm 1.3)\%$, where the uncertainty contains both the experimental uncertainty and the 30% estimate of model dependence in each result. We assigned the value $(5.0 \pm 1.3)\%$ to the $\Lambda_c^+ \rightarrow pK^-\pi^+$ branching fraction in our 2000 *Review* [1].

A third type of measurement of $B(\Lambda_c^+ \rightarrow pK^-\pi^+)$ has been published by CLEO (JAFFE 00). Under the assumption that a \bar{D} meson and an antiproton in opposite hemispheres is evidence for a Λ_c^+ in the hemisphere of the \bar{p} , the fraction of such $\bar{D}\bar{p}$ events with a $\Lambda_c^+ \rightarrow pK^-\pi^+$ decay can be used to determine the $\Lambda_c^+ \rightarrow pK^-\pi^+$ branching fraction. CLEO measures $B(\Lambda_c^+ \rightarrow pK^-\pi^+) = (5.0 \pm 1.3)\%$, 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 \bar{p} momentum spectrum in events with a Λ_c^+ and \bar{p} in the same hemisphere, and with a \bar{D} and \bar{p} in opposite hemispheres; extrapolation of the Λ_c^+ and \bar{D} momentum spectrum below the minimum value used for rejecting B decay products; and our limited understanding of backgrounds such as $D\bar{D}N\bar{p}$ events).

We have chosen to continue to assign the value $(5.0 \pm 1.3)\%$ to the $\Lambda_c^+ \rightarrow pK^-\pi^+$ 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

1. D.E. Groom *et al.* (Particle Data Group), *Review of Particle Physics*, Eur. Phys. J. **C15**, 1 (2000).
2. I. Dunietz, Phys. Rev. **D58**, 094010 (1998).
3. P. Migliozzi *et al.*, Phys. Lett. **B462**, 217 (1999).