$\Lambda_c^+$ BRANCHING FRACTIONS

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

ARGUS (ALBRECHT 88C) and CLEO (CRAWFORD 92) measure $B(\overline{B} \to \Lambda_c^+ X) \cdot B(\Lambda_c^+ \to pK^-\pi^+)$ 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 $\Lambda_c^+ \Xi$ can be neglected, they also measure $B(\overline{B} \to \Lambda_c^+ X)$ to be $(6.2 \pm 0.5 \pm 0.3)\%$ (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 $\Lambda_c^+ \Xi$ 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 $\sigma(e^+e^- \to \Lambda_c^+ X) \cdot B(\Lambda_c^+ \to \Lambda\ell^+\nu_\ell) = (4.15 \pm 1.03 \pm 1.18) \text{ pb}$ and $(4.77 \pm 0.25 \pm 0.66) \text{ pb}$. 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 $(11.2 \pm 1.3) \text{ pb}$.

From these measurements, we extract $R \equiv B(\Lambda_c^+ \to pK^-\pi^+)/B(\Lambda_c^+ \to \Lambda\ell^+\nu_\ell) = 2.40 \pm 0.43$. We estimate the $\Lambda_c^+ \to pK^-\pi^+$ 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 $\Gamma(D \to X\ell^+\nu_\ell) = (0.166 \pm$
0.006) \times 10^{12} \text{ s}^{-1} \text{ and } \tau(\Lambda_c^+) = (0.192 \pm 0.005) \times 10^{-12} \text{ s}, \text{ we calculate } B(\Lambda_c^+ \to pK^-\pi^+) = (7.3 \pm 1.4)\% \cdot fF. \text{ Theoretical estimates for } f \text{ and } F \text{ 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)\% \text{ from } \bar{B} \text{ decays, and } B(\Lambda_c^+ \to pK^-\pi^+) = (7.3 \pm 1.4)\% \cdot fF \text{ from semileptonic } \Lambda_c^+ \text{ decays. If we set } fF = 1.0 \text{ 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^+ \to pK^-\pi^+) = (4.14 \pm 0.91 \pm 1.24)\% \text{ and } B(\Lambda_c^+ \to pK^-\pi^+) = (7.3 \pm 1.4 \pm 2.2)\%. \text{ The weighted average of these two results is } B(\Lambda_c^+ \to pK^-\pi^+) = (5.0 \pm 1.3)\%, \text{ 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^+ \text{ 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} \text{ meson and an antiproton in opposite hemispheres is evidence for a } \Lambda_c^+ \text{ in the hemisphere of the } \overline{p}, \text{ the fraction of such } \overline{D}\overline{p} \text{ events with a } \Lambda_c^+ \to pK^-\pi^+ \text{ decay can be used to determine the } \Lambda_c^+ \to pK^-\pi^+ \text{ branching fraction. CLEO measures } B(\Lambda_c^+ \to pK^-\pi^+) = (5.0 \pm 1.3)\%, \text{ 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} \text{ momentum spectrum in events with a } \Lambda_c^+ \text{ and } \overline{p} \text{ in the same hemisphere, and with a } \overline{D} \text{ and } \overline{p} \text{ in opposite hemispheres; extrapolation of the } \Lambda_c^+ \text{ and } \overline{D} \text{ momentum spectrum below the minimum value used for rejecting } B \text{ decay products; and our limited understanding of backgrounds such as } D\overline{D}N\overline{p} \text{ events).}

We have chosen to continue to assign the value (5.0\pm1.3)\% to the } \Lambda_c^+ \to pK^-\pi^+ \text{ branching fraction (given as PDG 02 below). As was noted earlier, most of the other } \Lambda_c^+ \text{ decay modes are measured relative to this mode.}

New methods for measuring the } \Lambda_c^+ \text{ absolute branching fractions have been proposed [2,3].}
References