D_s^+ DECAY CONSTANT

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In the Standard Model, the D_s^+ leptonic branching fractions are related to the D_s^+ decay constant f_{D_s} by the equation [1]

$$\mathrm{B}(D_s^+ \to \ell^+ \nu_\ell) = \frac{G_F^2}{8\pi} |V_{cs}|^2 f_{D_s}^2 \frac{\tau_{D_s}}{\hbar} m_{D_s} m_\ell^2 \left(1 - \frac{m_\ell^2}{m_{D_s}^2}\right)^2 . \quad (1)$$

Hence, measurements of $\mathrm{B}(D_s^+ \to \ell^+ \nu_\ell)$ can be used to extract f_{D_s}. Eight experiments have published measurements of the branching fraction for D_s^+ decaying to $\mu^+\nu_\mu$ or $\tau^+\nu_\tau$: WA75 (AOKI 93), BES (BAI 95), E653 (KODAMA 96), L3 (ACCIARRI 97F), CLEO (CHADHA 98), BEATRICE (ALEXANDROV 00), OPAL (ABBIENDI 01L), and ALEPH (HEISTER 02I). All these experiments except BES either explicitly or implicitly measure the leptonic branching fraction relative to the branching fraction for $D_s^+ \to \phi\pi^+$, or for semileptonic D_s^+ or D^0 decays. The semileptonic D_s^+ branching fraction is in turn measured relative to $\mathrm{B}(D_s^+ \to \phi\pi^+)$. The fractional experimental uncertainty on $\mathrm{B}(D_s^+ \to \phi\pi^+)$ is currently 25%. The LEP experiments (L3, OPAL, ALEPH) share a 23% correlated uncertainty in the normalization of the leptonic branching fraction. They use the partial decay rate for $Z \to c\overline{c}$ and the D_s^+ production rate in $Z \to c\overline{c}$ events, which in turn depends on the assumed value of $\mathrm{B}(D_s^+ \to \phi\pi^+)$. BES uses the relative number of events in which one or two D_s decays are fully reconstructed to determine the absolute $D_s^+ \to \mu^+\nu_\mu$ branching fraction; however, only three events are observed in which one D_s^+ decays to a hadronic final state and the other decays to $\mu^+\nu_\mu$ or $\tau^+\nu_\tau$.

We determine the world average value of f_{D_s} from the experimental measurements of the D_s^+ leptonic branching fractions, assuming lepton universality, taking into account correlated uncertainties, and using a consistent and up-to-date set of input parameters [2] for the μ, τ, and D_s^+ masses, the D_s^+ lifetime, V_{cs}, $\mathrm{B}(D_s^+ \to \phi\pi^+)$, and the relative D_s^+ branching fractions. Although the uncertainty on $\mathrm{B}(D_s^+ \to \phi\pi^+)$ is by far the largest

correlated uncertainty, we also take into account correlated uncertainties in the input parameters. Weighting each measurement by its uncorrelated uncertainty, we determine the average leptonic branching fraction for all experiments except BES to be $\mathrm{B}(D_s^+ \to \mu^+\nu_\mu) = 0.00547 \pm 0.00067 \pm 0.00132$, where the second uncertainty in the average is the correlated uncertainty due to $\mathrm{B}(D_s^+ \to \phi\pi^+)$. Since the above average is less (by 1.5σ) than the BES result of $\mathrm{B}(D_s^+ \to \mu^+\nu_\mu) = 0.015^{+0.013+0.003}_{-0.006-0.002}$, the negative uncertainties on the BES measurement are used to calculate the weighted average for all experiments:

$$\mathrm{B}(D_s^+ \to \mu^+\nu_\mu) = 0.00596 \pm 0.00144 \ . \tag{2}$$

Using this value of the branching fraction and including the relatively minor uncertainties on the other parameters in Eq. (1), we extract the world average D_s^+ decay constant:

$$f_{D_s} = (267 \pm 33) \ \mathrm{MeV} \ . \tag{3}$$

References

1. See the note on "Pseudoscalar-Meson Decay Constants" at the beginning of the Meson Particle Listings.
2. Review of Particle Properties 2004.