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}. The most precise measurements of $D_s^+ \to \ell^+ \nu_\ell$ branching fractions come from L3 (ACCIARRI 97F), CLEO (CHADHA 98), BEATRICE (ALEXANDROV 00), OPAL (ABBIENDI 01L), and ALEPH (HEISTER 02I); see the end of the D_s^+ Data Listings for the references. All of these measurements either explicitly or implicitly measure the leptonic branching fraction relative to the branching fraction for $D_s^+ \to \phi\pi^+$. This fraction has, since our 2004 edition, changed from $3.6 \pm 0.9\%$ to $4.4 \pm 0.6\%$. The $D_s^+ \to \ell^+ \nu_\ell$ measurements of CLEO and BEATRICE are explicitly normalized to $D_s^+ \to \phi\pi^+$, and so can be easily updated. 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 $\mathrm{B}(D_s^+ \to \phi\pi^+)$.

We determine an average value of f_{D_s} from the above-mentioned five most precise measurements of the $D_s^+ \to \ell^+ \nu_\ell$ 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 other relevant branching fractions. Although the uncertainty on $\mathrm{B}(D_s^+ \to \phi\pi^+)$ is by far the largest uncertainty, we also take into account correlated uncertainties in other input parameters. Using both $D_s^+ \to \mu^+ \nu_\mu$ and $D_s^+ \to \tau^+ \nu_\tau$ branching fractions, and assuming lepton universality, we obtain

$$\mathrm{B}(D_s^+ \to \mu^+ \nu_\mu) = 0.0074 \pm 0.0013 \ . \quad (2)$$

Using this value (which is not the same as the $D_s^+ \to \mu^+\nu_\mu$ branching fraction in our Summary Tables, because we do not there use lepton universality), and including the relatively minor uncertainties on the other parameters in Eq. (1), we extract the world average D_s^+ decay constant:

$$f_{D_s} = (294 \pm 27)\ \text{MeV}\ . \tag{3}$$

References

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