for $B(D^0 \to K^- e^+ \nu_e)$ from Table 1, yields $R_\pi = 0.11^{+0.06}_{-0.03} \pm 0.1$. This can be compared with the CLEO-II measurement of $B(D^+ \to \pi^0 e^+ \nu_e)$ [21], giving $R_\pi = 0.17 \pm 0.05 \pm 0.03$. From unitarity of the CKM matrix, we have $|V_{cd}/V_{cs}|^2 = 0.051 \pm 0.002$, giving values of $|f_+^\pi(0)/f_+^K(0)| = 1.0^{+0.3}_{-0.2} \pm 0.04$ and $1.3 \pm 0.2 \pm 0.1$ for the MARK-III and CLEO-II results. Model predictions, which range from 0.7 to 1.4 [39], are in agreement with these results. The E653 collaboration [22] reports a measurement, $\Gamma(D^+ \to \rho^0 \mu^+ \nu_\mu)/\Gamma(D^+ \to \overline{K}^{*0} \mu^+ \nu_\mu) = 0.044^{+0.031}_{-0.025} \pm 0.014$, in good agreement with expectations, within the large errors.

Nonresonant semileptonic decays

There is now substantial evidence that Cabibbo-favored semileptonic decays are nearly saturated by $D \to \overline{K} e^+ \nu_e$ and $D \to \overline{K}^* e^+ \nu_e$. Table 9 gives the results of searches for other decays. Early results from the hybrid bubble chamber [37] indicating large nonresonant contributions are clearly inconsistent with much more sensitive later measurements. Limits on the sum of the nonresonant (and higher-mass resonant) decays can be inferred from the comparison of the sum of exclusive rates with the inclusive rate, as discussed below.

Table 9: Limits on specific nonresonant modes.

Experiment	Reference	Mode	$\Gamma/10^{10}$ s^{-1} 90% CL upper limit
E687	[16] FRABETTI 93E	$D^+ \to (K^-\pi^+)_{\rm NR} \mu^+ \nu_\mu$	< 0.4
		$D^+ \to K^-\pi^+\pi^0 \mu^+ \nu_\mu$	< 0.1
E653	[17] KODAMA 93B	$D^0 \to K^-\pi^+\pi^- \mu^+ \nu_\mu$	< 0.3
		$D^0 \to (K^*\pi)^- \mu^+ \nu_\mu$	< 0.4

Inclusive semileptonic decays

The inclusive transition rates are $\Gamma(D^+ \to X e^+ \nu_e) = (16.3 \pm 1.8) \times 10^{10}$ s^{-1} and $\Gamma(D^0 \to X e^+ \nu_e) = (18.6 \pm 2.9) \times 10^{10}$ s^{-1}. These rates are dominated by old MARK-III measurements [23]. Isospin symmetry requires that the Cabibbo-favored semileptonic rates for the two charged states be equal, but small differences can be expected for the Cabibbo-suppressed rates. We ignore these differences, which are expected to be less than 2% of the inclusive rate, and use the average for the two charge states, $\Gamma(D \to X e^+ \nu_e) = (16.9 \pm 1.5) \times 10^{10}$ s^{-1}. This inclusive rate can be compared with the sum of the rates for $D \to \overline{K} e^+ \nu_e$, $D \to \overline{K}^* e^+ \nu_e$, and an estimated 8% contribution for the Cabibbo-suppressed modes, as shown in Table 10. (We average the D^0 and D^+ exclusive rates here as well.) The sum of these rates implies a deficit of slightly less than two standard deviations. CLEO [4] has measured all four of the exclusive K and K^* modes, normalizing to the best measured decay, $D^0 \to K^-\pi^+$. Averaging over the charge states, CLEO obtains $\Gamma(D \to (\overline{K} + \overline{K}^*) e^+ \nu_e) = (14.8 \pm 1.3) \times 10^{10}$ s^{-1}. Adding 8% for Cabibbo-suppressed decays results in a deficit of $(0.9 \pm 2.0) \times 10^{10}$ s^{-1}, consistent with zero. The rather large errors leave some room for small contributions from other exclusive channels. As seen in Table 9, the limits on individual channels are much more stringent.

Table 10: Exclusive transition rates. For comparison, $\Gamma(D \to X e^+ \nu_e) = (16.9 \pm 1.5) \times 10^{10}$ s^{-1}.

Mode	$\Gamma(D^0)/10^{10}$ s^{-1}	$\Gamma(D^+)/10^{10}$ s^{-1}	$\Gamma_{\rm Ave}/10^{10}$ s^{-1}
$D \to \overline{K} e \nu_e$	8.9 ± 0.5	6.3 ± 0.8	8.2 ± 0.4
$D \to \overline{K}^* e \nu_e$	4.8 ± 1.0	4.5 ± 0.4	4.6 ± 0.4
Estimated Cabibbo-suppressed			1.0 ± 0.3
Sum of exclusive rates			13.8 ± 0.6

D_s^+ semileptonic decays

Because ϕ mesons are easy to observe, the first D_s^+ semileptonic decay measured was the decay to a vector, $D_s^+ \to \phi \ell^+ \nu_\ell$. The ratio of decay rates, $R_\phi \equiv \Gamma(D_s^+ \to \phi \ell^+ \nu_\ell)/\Gamma(D_s^+ \to \phi \pi^+)$, has been measured by several experiments (Table 11). The average value given in the table includes both electron and muon results.

Table 11: Measurements of $R_\phi \equiv \Gamma(D_s^+ \to \phi \ell^+ \nu_\ell)/\Gamma(D_s^+ \to \phi \pi^+)$.

Experiment	Reference	R_ϕ
CLEO-I	[28] ALEXANDER 90B	$0.49 \pm 0.10^{+0.10}_{-0.14}$
ARGUS	[27] ALBRECHT 91	$0.57 \pm 0.15 \pm 0.15$
E687	[26] FRABETTI 93G	$0.58 \pm 0.17 \pm 0.07$
CLEO-II	[25] BUTLER 94	$0.54 \pm 0.05 \pm 0.04$
PDG value		0.54 ± 0.05