Table 7: Comparison of theoretical and experimental values of the D^* polarization parameter α and the lepton forward-backward asymmetry A_{FB} in $B \to \overline{D}^* \ell^+ \nu_\ell$ decay. The theoretical values, which depend on the form factor slope $\rho^2_{A_1}$, were obtained by Neubert using HQET with the assumption of a pole form for the form factor.

$\rho^2_{A_1}$	A_{FB}	A_{FB} ($p_\ell > 1$ GeV/c)	α
1.1	0.22	0.16	1.33
0.8	0.22	0.16	1.44
0.5	0.22	0.15	1.55
Expt.	$0.20 \pm 0.08 \pm 0.06$ ARGUS [29]	$0.14 \pm 0.06 \pm 0.03$ CLEO-II [37]	$1.1 \pm 0.4 \pm 0.2$ ARGUS [29]

CLEO has performed least-squares fits using the measured values of A_{FB}, α (averaged over CLEO and ARGUS results), and the histogram of $d\Gamma/dq^2$ (also averaged over CLEO and ARGUS measurements), to obtain values for the ratios of the $B \to \overline{D}^* \ell^+ \nu_\ell$ form factors at $q^2_{\rm max}$. The results of these fits are given in Table 8, together with the predictions of several models. Although the values of the form factor ratios are in agreement with predictions, the precision is not yet sufficient to distinguish among the models.

Table 8: Measurements and predictions for ratios of the form factors for $B \to \overline{D}^* \ell^+ \nu_\ell$, evaluated at $q^2 = q^2_{\rm max}$. The two fits (a) and (b) correspond to different assumptions for the q^2 dependence of the form factors. The fits given in the CLEO paper quoted here combined the A_{FB} measurement from CLEO with ARGUS and CLEO measurements of α and $d\Gamma/dq^2$.

	Ref.	A_2/A_1	V/A_1
CLEO-II Fit (a)	[37]	1.02 ± 0.24	1.07 ± 0.57
CLEO-II Fit (b)	[37]	0.79 ± 0.28	1.32 ± 0.62
ISGW	[13]	1.14	1.27
KS	[38]	1.39	1.54
WSB	[39]	1.06	1.14
HQET-based	[40]	1.26	1.26
HQET-based	[41]	1.14	1.74

Conclusions on B semileptonic decays

Knowledge of B semileptonic decays is advancing rapidly, and many of the values given in this review are likely to be superseded in the near future. The inclusive B semileptonic branching fraction is already one of the most precisely measured quantities in B physics, and experimental errors should continue to improve. Important progress is being made in minimizing the model dependence of this measurement by using dilepton events. Knowledge of the exclusive semileptonic branching ratios is still rather poor: only $B \to \overline{D}^* \ell^+ \nu_\ell$ is known with reasonable precision, and exclusive $B \to X_{\overline{u}} \ell^+ \nu_\ell$ transitions have not yet been measured. By our next edition, this situation may well have changed.

Semileptonic B decays provide important information on $|V_{cb}|$ and $|V_{ub}|$. The inclusive $B \to X_{\overline{c}} \ell^+ \nu_\ell$ decay rate is roughly one hundred times that for $B \to X_{\overline{u}} \ell^+ \nu_\ell$ decays, so that $|V_{ub}|$ is much harder to measure. Furthermore, the model dependence is more severe for measurements of $|V_{ub}|$ than for $|V_{cb}|$. The $B \to X_{\overline{u}} \ell^+ \nu_\ell$ signal is statistically significant only in a very small part of phase space, the lepton spectrum endpoint region, in which model predictions are questionable. In the future, measurements of the q^2 distribution in both inclusive and exclusive $B \to X_{\overline{u}} \ell^+ \nu_\ell$ decays should help to reduce the model dependence, and lattice QCD may be important for improving $|V_{ub}|$ determinations. Finally, because both quarks are heavy in a $B \to X_{\overline{c}} \ell^+ \nu_\ell$ transition, one can use the tools of heavy quark effective theory to predict decay rates. Using $B \to \overline{D}^* \ell^+ \nu_\ell$ in the kinematic region where the D^* has only a small recoil velocity, one can determine $|V_{cb}|$ with relatively little model dependence, even though the data samples are not yet large enough to fully realize the potential of this approach. The methods of HQET may also lead to a precise determination of $|V_{cb}|$ from the inclusive semileptonic rate.

It is important to test HQET in detail. Although form factor measurements are roughly consistent with HQET predictions, the experimental uncertainties are too large at present to allow a stringent test. And although heavy quark symmetry can relate different form factors to the Isgur-Wise function, only nonperturbative techniques such as lattice QCD can actually predict the q^2 dependence of this function. One can expect significant progress in all of these areas during the next few years.