Discussion session on exclusive V_{ub}

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* best exclusive channels to extract V_{ub}:

$$B \to \pi \ell \nu$$

$$B_s \to K \ell \nu$$

$$\Lambda_b \to p \ell \nu$$

...

V_{ub} from $\Lambda_b \to p\ell\nu_\ell$

* experimental and/or theoretical advantages of considering Λ_b semileptonic decays for determining V_{ub}

* recent lattice calculations of the relevant f.f.'s [arXiv:1503.01421]
  - relativistic b quark (with non-perturbative improvements)
  - $N_f = 2+1$ dynamical sea quarks (RBC/UKQCD gauge ensembles)
    two strange sea quark masses and three light sea quark masses
  - six valence pion masses in the range 230 - 350 MeV
  - two lattice spacings: a ~ 0.085 and 0.11 fm
  - **one lattice volume: L ~ 2.7 fm**
  - z-expansion applied to the lattice data

$$f(q^2) = \frac{1}{1 - q^2/(m^f_{\rm pole})^2}\left[a^f_0\left(1 + c^f_0\frac{m^2_\pi - m^2_{\pi,\rm phys}}{\Lambda^2_\chi}\right) + a^f_1\, z(q^2)\right] \times\left[1 + b^f\,\frac{|\mathbf{p}'|^2}{(\pi/a)^2} + d^f\,\frac{\Lambda^2_{\rm QCD}}{(\pi/a)^2}\right],$$

are all systematics under control ?

... slides from Daping Du

* recent experimental results from LHCb [arXiv:1504.01568] on $\Lambda^0_b \to p\mu^-\bar{\nu}_\mu$

$$|V_{ub}| = \left(3.27 \pm 0.15_{\rm exp.} \pm 0.17_{th} \pm 0.06_{V_{cb}}\right)\cdot 10^{-3}$$

5%

PDG '14 average: $|V_{ub}|_{excl.} = (3.28 \pm 0.29)\cdot 10^{-3}$

* experimental and theoretical prospects ...

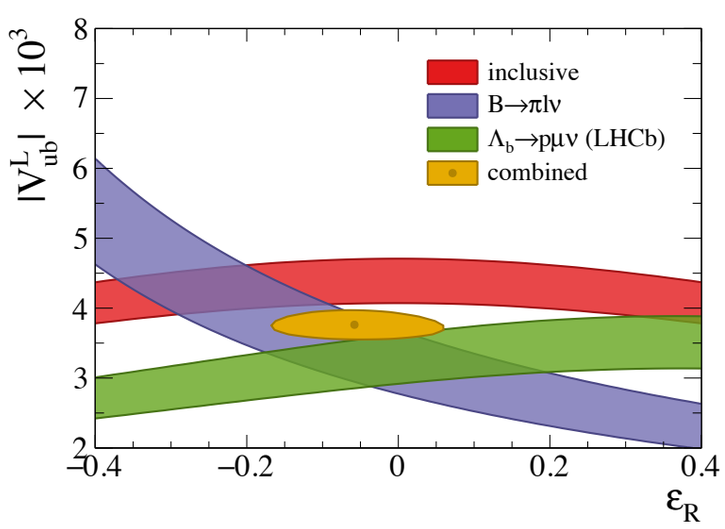

Figure 3: **Experimental constraints on the left-handed coupling, $|V^L_{ub}|$ and the fractional right-handed coupling, ϵ_R.** While the overlap of the 68% confidence level bands for the inclusive and exclusive world averages of past measurements suggested a right handed coupling of significant magnitude, the inclusion of the LHCb $|V_{ub}|$ measurement does not support this.

V_{ub} from $B \to \pi \ell \nu_\ell$

* experimental issues: tagged (uniform acceptance, high S/B, low statistics) versus untagged (cuts, low S/B, high statistics) measurements?

PDG '14 averages:

$$|V_{ub}|_{excl.} = (3.28 \pm 0.29) \cdot 10^{-3} \text{ (untagged)}$$
$$|V_{ub}|_{incl.} = \left(4.41 \pm 0.15_{\text{exp}}\ {}^{+0.15}_{-0.17}{}_{th}\right) \cdot 10^{-3}$$

* prospects at Belle-II ... which precision can be reached ?

* two new high-precision lattice calculations: RBC/UKQCD [arXiv:1501.05373] and FNAL/MILC [arXiv:1503.07839]

$$|V_{ub}|_{RBC/UKQCD} = (3.61 \pm 0.32) \cdot 10^{-3}$$
$$|V_{ub}|_{FNAL/MILC} = (3.72 \pm 0.16) \cdot 10^{-3}$$

4%

... discussed in Du's talk

- the mix of data and theoretical f.f.'s is now systematically adopted (correlations?)

* latest determination using LC QCDSR ($q^2 < 12$ GeV^2):

$$|V_{ub}|_{LC-QCDSR} = \left(3.32^{+0.26}_{-0.22}\right) \cdot 10^{-3}$$

7%

... discussed in Alex's talk

* which (theoretical) precision can be reached within few years ? ... 2% from lattice (Du's talk) ?

* what about experiments on $B \to \pi \tau \nu$ [sensitivity to the scalar form factor $f_0(q^2)$] ? ... connections with $B \to \tau \nu$ or $B \to \mu \nu$?

* possibility to use $D \to \pi \ell \nu$ to constrain f.f.'s of $B \to \pi \ell \nu$ [PRD91, 052022] (... slides by Vera Luth)

V_{ub} from other final meson states:

$$B \to \left(\rho, \omega, \eta, \eta', \ldots\right) \ell \nu_\ell \quad \text{and} \quad B_s \to K\left(K^*\right) \ell \nu_\ell$$

* important cross-checks for B $\to \pi \ell \nu$ and possible sensitivity to NP (final vector mesons)

* experimental issues at LHCb or Belle-II: statistics ? backgrounds ($\pi\pi$)?

* <u>theoretical issues for lattice calculations</u>:

  - $\varrho(\omega)$-meson decays for light pions

  - disconnected diagrams (typically very noisy) in the case of final isoscalar mesons η or η' (see arXiv:1406.5449)

  - $B_s \to K \ell \nu$ is as feasible as B $\to \pi \ell \nu$ (see, e.g., arXiv:1406.2279)

* <u>theoretical issues for LC QCDSR</u>:

  - which precision can be reached for B $\to \varrho(\omega) \ell \nu$

  - are DA's known for K, η and η' mesons ?

  - B $\to K^* (\to K\pi) \ell \nu$ recently addressed in arXiv:1503.09063 (... slides by Van Dyk)