Two aspects of current CKM - relevance for Super-B

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0. UT-triangle
   - results
   - tree level det.

1. $|V_{ub}|$ 'tension'
   - inclusive
   - exclusive & UT-Fit

2. Ratios: praise or curse

   e.g. $\left|\frac{V_{td}}{V_{ts}}\right|$ Δm_s $B \to V\gamma$

Roman Zwicky, IPPP Durham

UK - Super-B Daresbury 26/27 April 06

0. UT – triangle

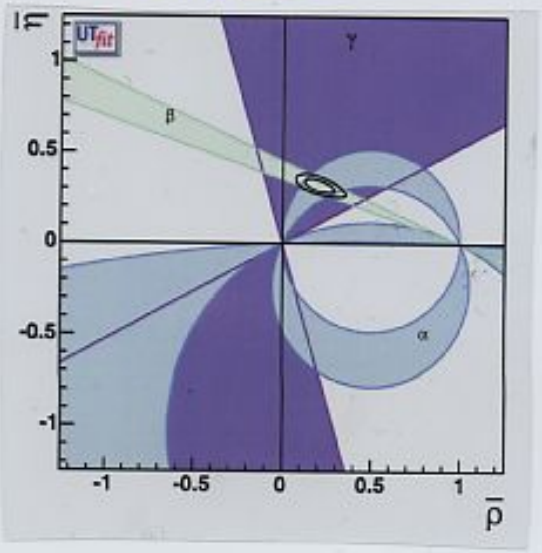
$\sim \left|\frac{V_{ub}}{V_{cb}}\right|$  $\sim \left|\frac{V_{td}}{V_{tb}}\right|$

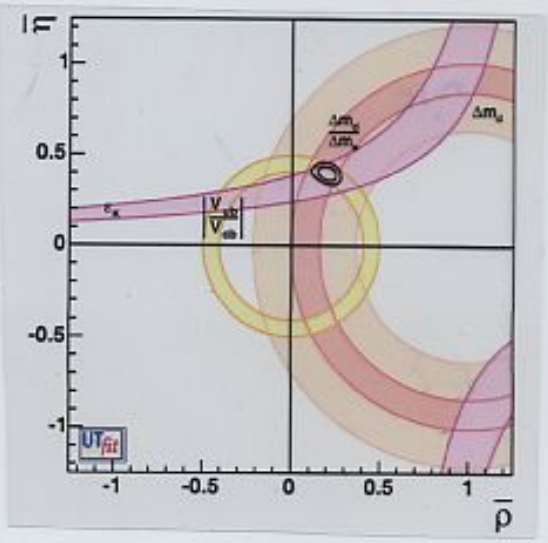
$\Sigma\, V_{dj}\, V_{jb}^{*} = 0$

Area ↔ CP-viol.

1) B-Factories overconstrained (mess.)
UT-triangle impress.

- Angles
- Sides





[Slight missmatch .... tension $|V_{ub}|$ .. later]

2) CP-viol. mesons gov. by CKM
[New Paradigm for Baryon-Asymetry needed
CP-viol. ℓ-sector ($\hat{=}$ ν-masses) ... Sphalerons ??]

3) No New Physics (NP) found so far

Reaction / Strategy

- higher luminosity (statistics)

  Super-B e^+e^- *
  (LHCb) hadron-col. **

  A) Challenge ex. observables

  - 1/mb, α_s - corrections
  - reduce hadronic uncertainties
    (determine many indep. ways ▷ gain conf.)

  B) New (rare) observables open up
  e.g. $B_{dis} \to \mu^+\mu^-$ ** $B \to X_s(K)\,\nu\nu$ *

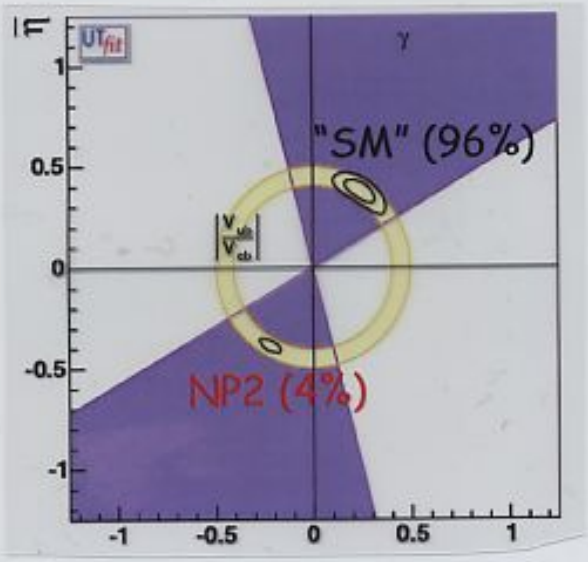
- precision det. of UT from tree-level decays
  (import. CP-viol.)

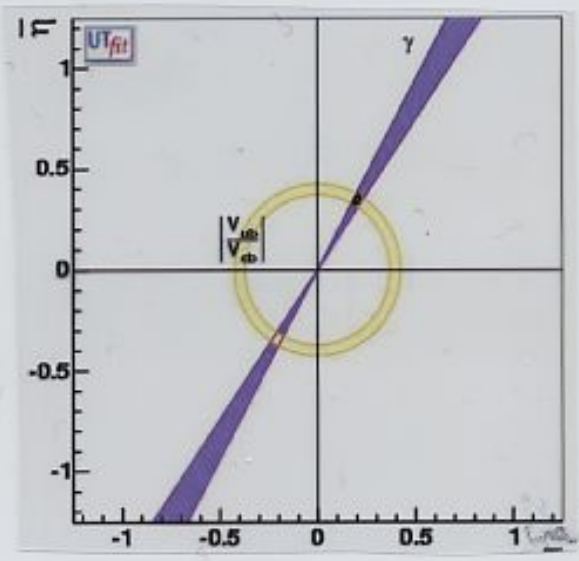
  Reconstruct UT-triangle from $|V_{ub}|$ & γ

	today	LHCb	Super-B
γ	$65 \pm 18°$	$3°$	$1,5°$
$\lvert V_{ub}\rvert$	4.4 ± 0.3 (7%)	—	? later ?

Measuring UT-clock *

"now" 10 years





All models of NP will have to obey this constraint

- comparison LHCb & SuperB ⇒ J. Libby Talk
- more Super-B observables ⇒ I. Biggi Talk

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* from M. Ciuchini's Talk

1. $|V_{ub}|$ (units 10^{-3})

- one of parameters for tree-level UT-Δ

- $|V_{ub}|_{incl.} = 4.4 \pm 5\%_{exp} \pm 5\%_{th}$
- $|V_{ub}|_{excl.} = 3.8 \pm 5\%_{exp} \pm 10\%_{th}$
- $|V_{ub}|_{UT\text{-}\Delta\text{-}Fit} = 3.85 \pm 5\%$

slight tension (1δ-effect) $\Rightarrow$ closer look

[N.B. $B \to \tau\nu \longleftrightarrow |V_{ub} f_B|$

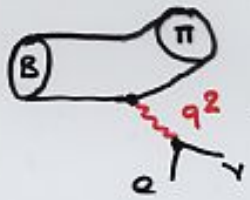
SLAC-Rep. 10% SuperB

Do we get f_B or $|V_{ub}|$?]

Belle recently reported a 4.2δ effect!

$|V_{ub}|_{excl.}$

$B \to \pi e \nu$



From one FF

$\langle \pi(p) | \bar{u} \gamma_\mu b | B \rangle = 2 p_\mu f_+(q^2)$

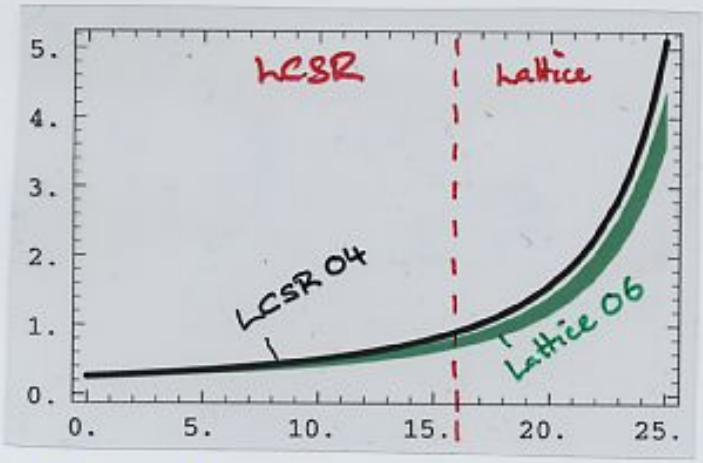
$\sim 10\%$

$$|V_{ub}|^2 = \# \frac{Br(B \to \pi e \nu)}{\int dq^2 \, |f_+(q^2)|^2}$$

Methods:

$q^2 \leq 16\,GeV^2$ LCSR (light-cone sum rules)

$\geq$ Lattice QCD (Idea moving-frame go lower q^2)



"complementarity"

[Connect regimes:

- dispersive bounds
- Bečirević-Kaidalov param. (rather consistent)

Potential of two methods?

Lattice

- statistics
- continuum limit
- confirm domain wall / overlap fermions
  (staggered fermions $\sqrt[4]{\det D}$ debated
  in the lattice community)
- .....

LCSR

- q^2 - spectrum from exp.

BbarOS	ab^{-1}	Super-B	
5	6-7	10	bins
"not enough"	.....	interesting	

- large uncert. π- wave-function
  universal quality (get elsewhere ... $D \to \pi e\nu$ ...)
- check normaliz. $B_0 \to s^2$ - calculation

Non-perturbative physics hard to control
Try to get from as many sources as possible
and gain confidence.

$|V_{ub}|$ incl.

$B \to X_u e \nu$

$$\sum_{X_u} \propto \frac{d\Gamma}{dq^2}$$

For $B \to X_c e \nu$

- OPE excludes q ▷ use Duality relate Br

  [$|V_{cb}|_{excl.} \hat{=} |V_{cb}|_{incl.}$ 2% impressive]

But is charm background $|V_{cb}| \gg |V_{ub}|$

▷ Eliminate background by cuts in phase space

Theory does not like cuts

cuts → new non-pert. objects (Shape-fct $1/m_b$?)

SLAC-Rep: " $|V_{ub}|_{incl.}$ limited ~ 10% "

What has happened ?

Theorists have found cuts and methods which allow to control Shape-fct $\Leftrightarrow$ $1/m_b$-corr.

- Andersen & Gardi
  Extend perturbative region dressed gluon exp.
  Leading $1/m_b$ corrections are kinematical (trivial)
  predict $B \to X_u e\nu$ and $B \to X_s\gamma$ spectrum

- Bosch, Neubert, Lange & Paz
  'Eliminate' shape fct $B \to X_s\gamma$ - spectrum

and others ...

Facts:
* Diff. approaches agree numbers ▷ slide -5-
* validity of approaches debated by protagonists
* tension $|V_{ub}|$ fit & $|V_{ub}|$ excl.
* further progress: 1) α_s-corr.
  2) exp statistics
  both $B \to X_s\gamma$ $B \to X_u e\nu$
  3) spectral data

Spectral data (as in excl. case) allow test approaches

Precision somewhat below 5% already announced for B-factory era. $\Delta|V_{ub}| \sim \Delta|V_{cb}|$ at Super-B?

2. Ratios: praise or curse

$|V_{td}/V_{ts}|$ Δm_s $B \to V\gamma$

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1) $\left|\frac{V_{td}}{V_{ts}}\right|_{SM} = f(|V_{ub}|, \gamma) = 0.216 \pm 13\%$ **

2) $|\quad|_{UT\text{-}Fit} = 0.208 \pm 4\%$

3) $|\quad|_{\Delta m_s/\Delta m_d} = 0.212 \pm 4\%$

4) $|\quad|^{*}_{B \to V\gamma} = 0.179 \pm 12\%_{exp} \pm 8\%_{th}$

- No large/visible NP
- But in case NP dis-blind
  ⇒ "hidding in the ratio" (curse)

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* Using HFAG value for $Br(B \to \rho\gamma)/B(B \to K^*\gamma)$

** $\Delta\gamma \cong 4°$ $\Delta|\ |_{SM} \cong 3\%$

ΔM_q $q=(d,s)$ "B_q oscillation frequency"

SM: "boxes"

+ $(t \leftrightarrow w)$

Experiment: $\Delta M_d = 0.507 \pm 0.004\ ps^{-1}$ HFAG

$\Delta M_s = 17.33\ ^{+0.42}_{-0.21}(stat) \pm 0.07_{(sys)}\ ps^{-1}$

from CDF Vancouver

Theory

$\Delta M_q = [G_F \dots][\eta_B S(x_t)]\ B_q f_{B_q}^2\ |V_{tq}^* V_{tb}|^2$

(1,3)% ✓ pert. 3% 20%

$|V_{tq}^* V_{tb}|$ 12% More room NP

$|V_{td}/V_{ts}|$ 4% ($B_q f_{B_q}^2$ better det. in ratio)

or

ΔM_d: $\beta_{eff} \equiv \beta + \phi_{NP}^d$ Ball / Fleischer hep-ph/0604.....

1) β_{eff} constrain ΔM_d

2) $\beta = f(|V_{ub}|, \gamma)$

▷ ϕ_{NP}^d $\begin{cases} -10° \pm 5° & |V_{ub}|_{incl.} \\ -2.5 \pm 8° & |V_{ub}|_{excl.} \end{cases}$ 2σ-effect NP-phase !!

Again due to $|V_{ub}|_{incl.}$ .... more drastic than UT-Δ

$B \to K^* \gamma$ vs $B \to \rho \gamma$

the exclusive $b \to (s,d)\,\gamma$ famous FCNC

$$R \equiv \frac{Br(B \to (\rho,\omega)\gamma)}{Br(B \to K^* \gamma)}$$

$$\text{QCD} = \text{Fact.} \quad \left|\frac{V_{td}}{V_{ts}}\right|^2 \underbrace{\left|\frac{T_1^{\rho,\omega}(0)}{T_1^{K^*}(0)}\right|^2}_{\xi^{-2}_{B\to V\gamma}} (\text{kin.})\,(1+\Delta R)$$

* $R^{\text{HFAG}}_{\text{exp}} \sim 25\%$
  - (Recall $Br(B \to K^*\gamma) \sim 5\%$ ..... statistics reduce 25% cons.)
  - Belle / Babar "diff." ρ_0-channel, isospin ... stay tuned

* $\xi_{B\to V\gamma} = 1.17 \pm 0.09$ Ball RZ JHEP 06

  after series paper dedicated SU(3)
  - acceptable agreement $Br(B \to K^*\gamma)$
  - still possible crosscheck $D \to \pi K$ CLEO / Belle
  - would benefit midep. det. $f_{K^*}^{\perp}, f_{\rho}^{\perp}$ (Lattice)

  once again uncert. cancel in ratio (praise) and NP? (curse)

* ΔR $1/m_b$-corrections

accidentaly CKM supressed

(estimates in preparation)

Conclusions

CKM describes CP-viol. mesons
UT-Δ overconstrained B-Fact.
⇒ precision are ... get UT-Δ from γ, |Vub| treated

1) higher order calc. α_s $B \to X_s \ell^+\ell^-$ e.g.
   $1/m_b^3$ $B \to X_{c,u}\, e\nu$
2) reduce hadronic uncertainties (crosscheck ≡ validate appr.)
3) new rare decays can be attacked at Super-B
   $B \to X_s(K)\, \nu\nu$ etc

Even now: highly non trivial flavour physics explored

- ΔM_s, ΔM_d NP possible
- $B \to V\gamma$ "

Up to now ... often take ratios in order to control hadr. uncert.
But eventually NP also cancels in ratio.

▷ efforts in dir. 1) & 2) desirably in order
to get away from ratios in the future

$B \to K^*\gamma$ vs $B \to \rho\gamma$
experiment. (also theory) maturate ... become non-trivial check
also learning ground $B \to K^* ll$ $B \to K\nu\nu$ etc
SU(3) important ... further validate $D \to \frac{\pi}{K}$ c.f. 2)

$|V_{ub}|_{incl.}$ tension $\mathcal{B}(\text{eff}) \sim |V_{ub}|_{fit}$

- exclusive & inclusive theorists (experimentalists?) critically investigate test their methods
- both $|V_{ub}|_{excl.}$ & $|V_{ub}|_{incl.}$ would benefit from spectral data "powerful test"
- Super-B will further constrain $|V_{ub}|$

Repeating the obvious...

- one cannot overdesign a Super-B factory
- assuming SUSY realized incl. 120 parameters only very few are flavour blind !!

▷ Flavour physics mendatory "to sort things out"

Thank You for Attention

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