65 papers and 23 years in the ``MS Scheme" my collaboration with Chris since 1986

Guido Martinelli

DIPARTIMENTO DI FISICA
SAPIENZA UNIVERSITÀ DI ROMA

AST Ateneo della Scienza e della Tecnologia

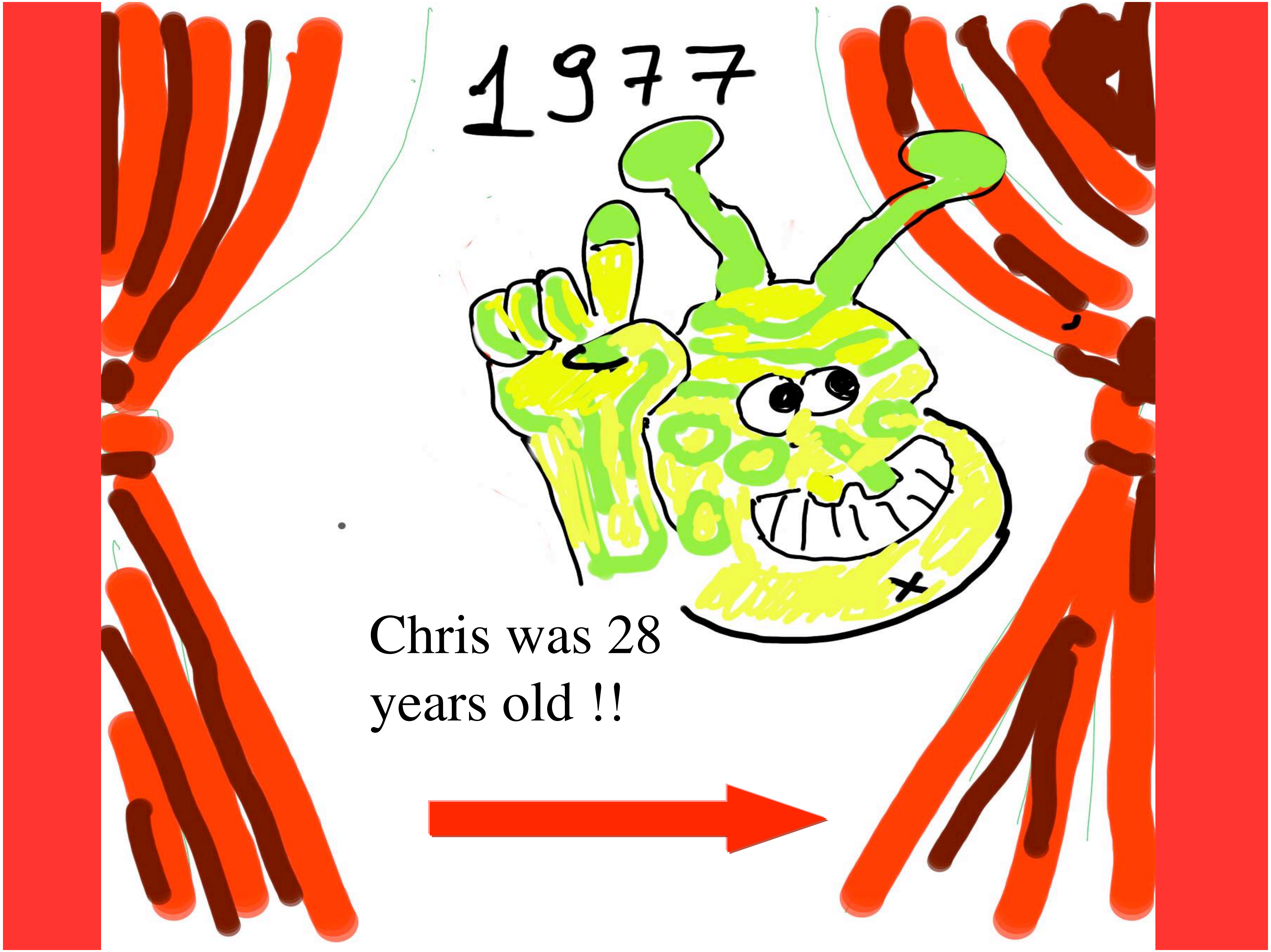
INFN Istituto Nazionale di Fisica Nucleare

Flavianet meeting in Honour
of Chris Sachrajda
Southampton December 15th 2009

Plan of the Talk

1) ***Prologue***

2) ***Outlook***


1977
Chris was 28
years old !!

Ref.TH.2326-CERN

HIGHER ORDER EFFECTS IN ASYMPTOTICALLY FREE GAUGE THEORIES : THE ANOMALOUS DIMENSIONS OF WILSON OPERATORS

E.G. Floratos, D.A. Ross and C.T. Sachrajda
CERN - Geneva

A B S T R A C T

We calculate the anomalous dimensions of the lowest twist, flavour non-singlet operators in the Wilson expansion to two loops. The calculation is performed using dimensional regularization and the minimal subtraction renormalization scheme. The physical relevance of our results in deep inelastic scattering is discussed.

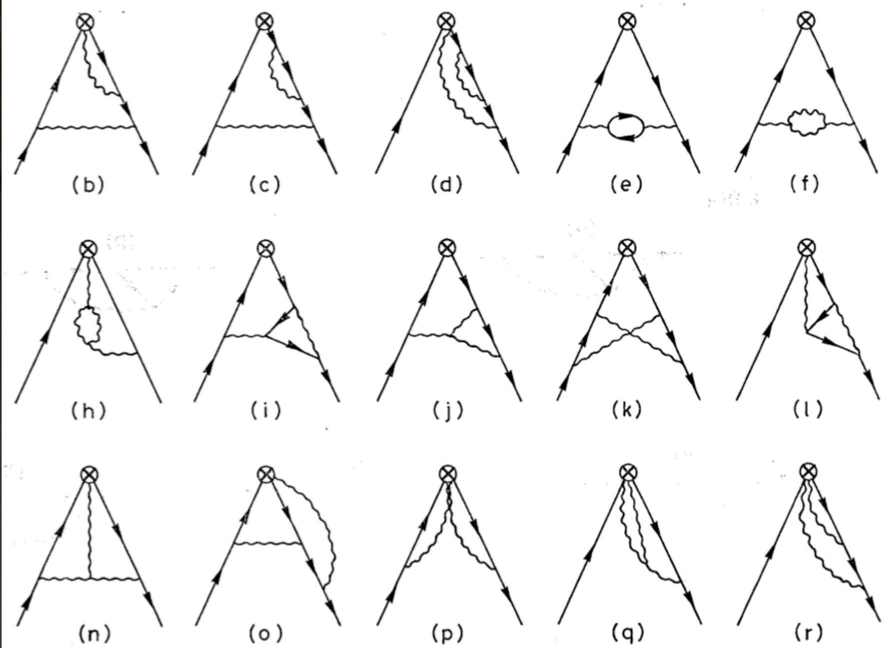


FIG.2


1986
Chris was 37 years old !!
first MS paper ('87)

CERN-TH.4637/87

A LATTICE CALCULATION OF THE SECOND MOMENT OF THE PION'S DISTRIBUTION AMPLITUDE

G. Martinelli and C.T. Sachrajda[+]

CERN - Geneva

A B S T R A C T

We calculate $\langle\xi^2\rangle$, the second moment of the pion's distribution amplitude on a $10^3 \times 20$ lattice, with Wilson fermions in the quenched approximation and at $\beta = 6.0$. We find $\langle\xi^2\rangle = 0.26 \pm 0.13$, in the lattice renormalisation scheme at $a \simeq (1.8\ \mathrm{GeV})^{-1}$. This is in disagreement with the previous lattice determination of this quantity. The reasons for this discrepancy are discussed.

+ On leave of absence from the Department of Physics, The University, Southampton SO9 5NH, United Kingdom.

NO LATEX AT CERN !! Formulae by hand !!

The moments of the distribution amplitude can be expressed as matrix elements of the lowest twist local operators between the hadron and the vacuum[6].

For the pion, defining

$$\xi = x_q - x_{\bar{q}} \tag{1}$$

we have

$$\langle 0 | O^{(0)}_{\mu_0\mu_1\cdots\mu_n} | \pi(p) \rangle = \sqrt{2}\, f_\pi\, p_{\mu_0} p_{\mu_1} \cdots p_{\mu_n} \langle \xi^n \rangle \tag{2}$$

$$+ \text{ terms containing factors of } p^2 g_{\mu_i \mu_j},$$

where f_π is the pion's decay constant ≈94MeV,

$$O_{\mu_0\mu_1\cdots\mu_n} = (-i)^n\, \bar{\psi}\, \gamma_{\mu_0} \gamma_5 \overleftrightarrow{D}_{\mu_1} \cdots \overleftrightarrow{D}_{\mu_n} \psi \tag{3}$$

symmetrized over the Lorentz indices, and

$$\langle \xi^n \rangle \equiv \int_{-1}^{1} d\xi\ \xi^n\, \phi(\xi, Q^2) \tag{4}$$

with the normalisation chosen so that $\langle \xi^0 \rangle = 1$. $\langle \xi^n \rangle$ contains an explicit Q^2 behaviour, where in Eq. (2) Q^2 is the renormalisation scale of the operators $O_{\mu_0 \cdots \mu_1}$. Below we shall present our results for $\langle \xi^2 \rangle$ obtained from a lattice calculation. We start, however, with a brief review of previous calculations of this quantity.

Small lattice $10^3 * 20$ & Quenched , however…

1) Renormalization of lattice operators
2) Mixing with operators of lower dimensions and power divergenciesBreaking of Lorentz invariance and group representazions

Then we worked very hard!

A LATTICE CALCULATION OF THE PION'S FORM FACTOR AND STRUCTURE FUNCTION

G. Martinelli
CERN - Geneva

and

C.T. Sachrajda
Physics Department, The University
Southampton S09 5NH, United Kingdom

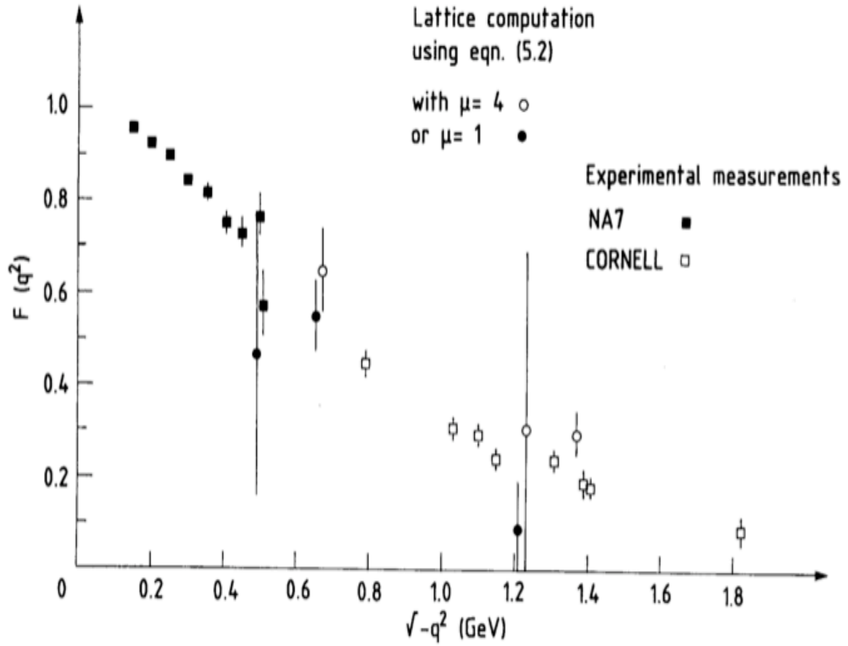


Fig. 6

PION STRUCTURE FUNCTIONS FROM LATTICE QCD

G. Martinelli and C.T. Sachrajda+)
CERN - Geneva

A B S T R A C T

We compute $\langle x \rangle$ and $\langle x^2 \rangle$ of the valence quarks in a pion, on the lattice using Wilson fermions in the quenched approximation. We find $\langle x \rangle = 0.49 \pm 0.08$ and $\langle x^2 \rangle = 0.20 \pm 0.08$ at a scale $\mu \simeq 7$ GeV, in good agreement with experimental data.

CERN-TH.4905/87

THE KAON B-PARAMETER AND K-π AND K-ππ TRANSITION AMPLITUDES ON THE LATTICE

M.B. Gavela*)
Dept. de Fisica Teorica
Univ. Autonoma de Madrid

L. Maiani, S. Petrarca and F. Rapuano
Istituto di Fisica "G. Marconi"
Università degli Studi di Roma "La Sapienza"
and INFN, Sezione di Roma

G. Martinelli
CERN - Geneva

O. Pene
LPTHE - Orsay

and

C.T. Sachrajda
University of Southampton
Southampton S09 5NH

A B S T R A C T

We present the results of a computation of the K°-$\bar{K}^\circ$ and $\Delta I = 3/2$ K-π and K-ππ amplitudes in lattice QCD. The numerical simulation has been done using the standard one-plaquette action and Wilson fermions, in the quenched approximation. Combining the results obtained at $\beta = 6$ on a $10^2\times 20\times 40$ lattice with 30 configurations with those at $\beta = 6.2$ on a $16^3\times 48$ lattice with 15 configurations, we have obtained for the kaon B-parameter $B_{K^\circ-\bar{K}^\circ} = 0.65\pm 0.15$. We have also evaluated the $\Delta I = 3/2$ K-π and K-ππ weak Hamiltonian matrix elements. The relevant renormalized operator O_4 has been found to satisfy soft-pion theorems and chiral Lagrangian relations at the 30% level, and this makes us confident about our results. We find $(\langle K^+|H_W|\pi^+\pi^\circ\rangle/m_K) = (7\pm 2)10^{-8}$ to be compared with the experimental value 3.7×10^{-8}. We suggest the possible physical origin of this difference.

*) On leave of absence of LPTHE, Orsay.

from e.m. form factors and s.f. to semileptonic decays of heavy mesons

A Lattice Study Of Nucleon Structure.
G. Martinelli, (CERN) , Christopher T. Sachrajda, (Southampton U.) . CERN-TH-5042/88, SHEP-87/88-1, May 1988. 23pp.
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(Southampton U.) , G. Martinelli, (CERN & Rome U. &
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Published in Nucl.Phys.B349:598-616,1991.

First calculation of D+ ---> anti-K*0 e+ electron-neutrino in lattice QCD.
V. Lubicz, G. Martinelli, (Rome U. & INFN, Rome) , Christopher T. Sachrajda, (Southampton U.) . ROME-748-1990, SHEP-89-90-13, Jul 1990. 22pp.
Published in Nucl.Phys.B356:301-317,1991.

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Published in Nucl.Phys.B362:475-486,1991.

Heavy flavors on the lattice.
By ELC Collaboration (M.B. Gavela et al.). 1988.
Published in Nucl.Phys.Proc.Suppl.7A:304-317,1989.

and Chris signs papers
as ELC or SPQR

power corrections, effective theories and renormalons

The Invisible renormalon.
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e-Print: hep-ph/9605336

3071 citations

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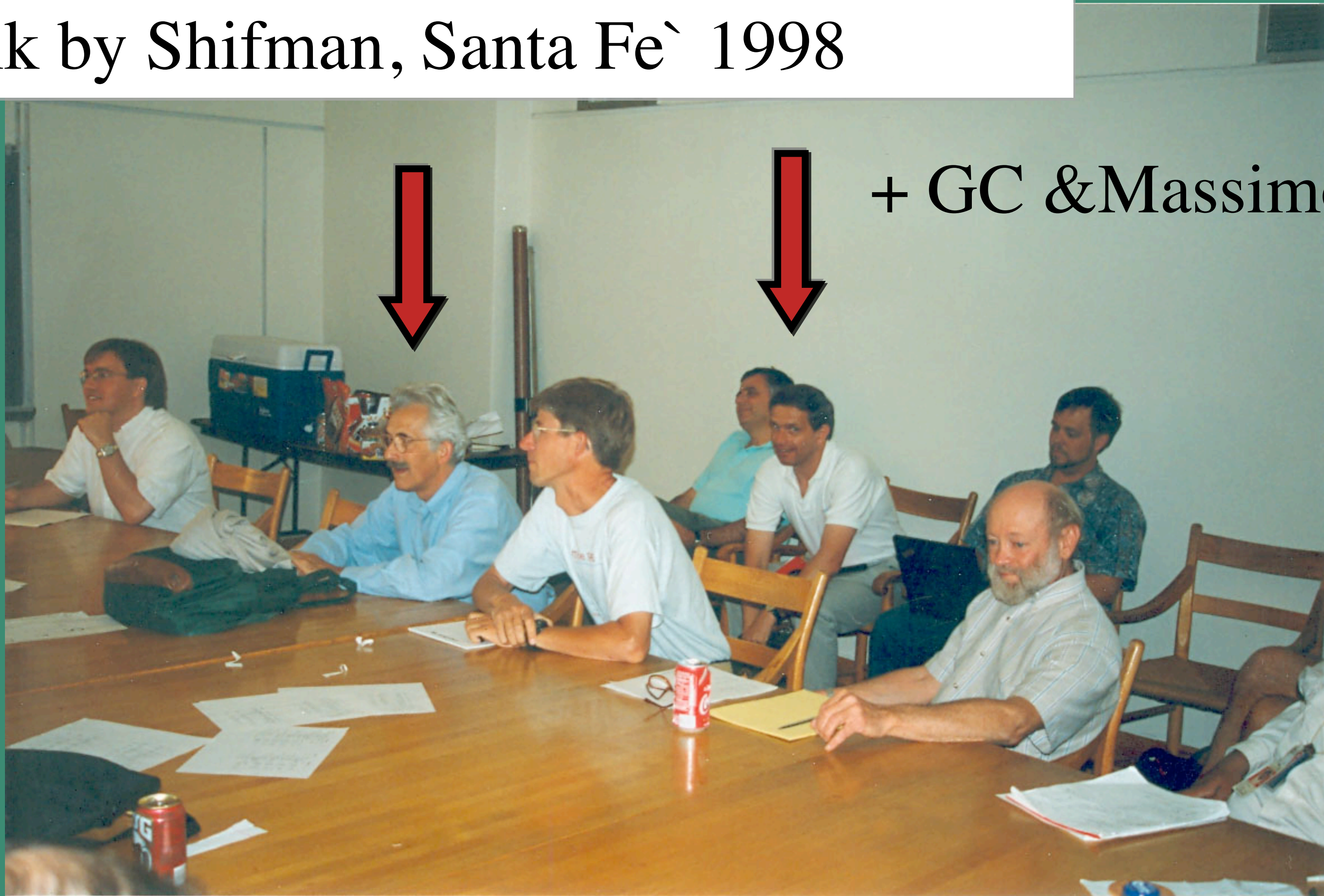
Published in Nucl.Phys.B445:81-108,1995.
e-Print: hep-lat/9411010

TOPCITE = 250+
References | LaTeX(US) | LaTeX(EU) | Harvmac | BibTeX | Keywords | Cited 392 times

We collected together about one third
of the number of citations of Chris

Some minor weakness: here Chris is clearly sleeping !!
Nordita 1996

He cannot hide his opinion on the Wilsonian definition of the condensate, talk by Shifman, Santa Fe` 1998



Two of my preferred collaborators in Munich
Ringberg year 2000 meeting

Looking where the no-go teorem goes (Lellouch & Luscher) 2000

two body decays of kaons and quenching

K --> pi pi decays in a finite volume.
C.J.David Lin, (Southampton U.) ,
G. Martinelli, (INFM, Rome & INFN, Rome) ,
Christopher T. Sachrajda, (Southampton U.) ,
M. Testa, (INFM, Rome & INFN, Rome).
ROMA-1395-00, Apr 2001. 25pp.
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e-Print: hep-lat/0104006

5) **K+ ---> pi+ pi0 decays on finite volumes and at next-to-leading order in the chiral expansion.**
C.J.David Lin, (Southampton U.) , G. Martinelli, (Rome U. & INFN, Rome) , E. Pallante, (SISSA, Trieste) , C.T. Sachrajda, (Southampton U. & CERN) , G. Villadoro, (Rome U. & INFN, Rome) .
CERN-TH-2002-130, ROMA-1337-02, SHEP-02-13, SISSA-47-02-EP, Aug 2002. 56pp.
Published in **Nucl.Phys.B650:301-355,2003**.
e-Print: **hep-lat/0208007**

1) **Finite volume partially quenched two pion amplitudes in the I = 0 channel.**
C.J.David Lin, (Southampton U.) , G. Martinelli, (Rome U. & INFN, Rome) , E. Pallante, (SISSA, Trieste & INFN, Trieste) , C.T. Sachrajda, (Southampton U.) , G. Villadoro, (Rome U. & INFN, Rome) . ROMA-1357-03, SHEP-0323, SISSA-69-03-EP, Aug 2003. 10pp.
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Journal Server [doi:10.1016/j.physletb.2003.12.019]
ADS Abstract Service
Bookmarkable link to this information

2) **Finite volume two pion amplitudes in the I = 0 channel.**
C.J.David Lin, (Southampton U.) , G. Martinelli, (Rome U. & INFN, Rome) , E. Pallante, (SISSA, Trieste) , C.T. Sachrajda, (Southampton U.) , G. Villadoro, (Rome U. & INFN, Rome) .
ROMA-1347-02, SHEP-02-28, SISSA-86-02-EP, Dec 2002. 13pp.
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Journal Server [doi:10.1016/S0370-2693(02)03228-8]
ADS Abstract Service
Bookmarkable link to this information

Azzorre 2006 (I don’t know the English translation)

Ringberg 2006 (my dear collaborator Giancarlo)

Chris & the Gyroscopic principle

N(N-1)/2 angles and (N-1)(N-2) /2 phases

N=3 3 angles + 1 phase KM

the phase generates complex couplings i.e. CP violation;

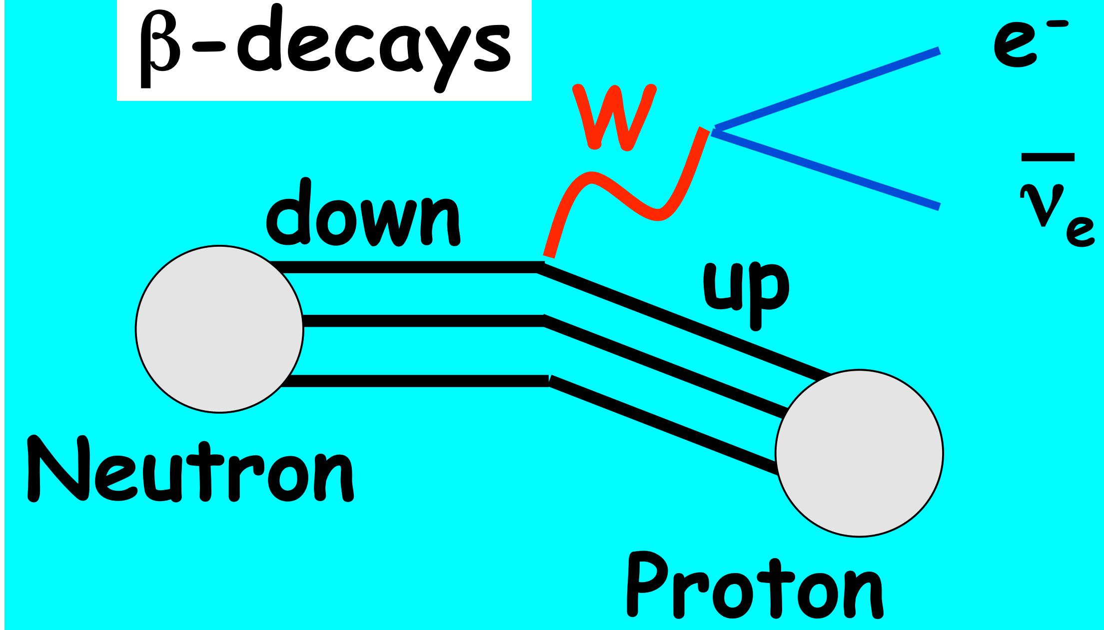
6 masses +3 angles +1 phase = 10 parameters

V_{ud}	V_{us}	V_{ub}
V_{cd}	V_{cs}	V_{cb}
V_{tb}	V_{ts}	V_{tb}

V_{ud}	V_{us}	V_{ub}
V_{cd}	V_{cs}	V_{cb}
V_{td}	V_{ts}	V_{tb}

Quark masses & Generation Mixing

β-decays



$|V_{ud}|$

$|V_{ud}| = 0.9735(8)$

$|V_{us}| = 0.2196(23)$

$|V_{cd}| = 0.224(16)$

$|V_{cs}| = 0.970(9)(70)$

$|V_{cb}| = 0.0406(8)$

$|V_{ub}| = 0.00409(25)$

$|V_{tb}| = 0.99(29)$
(0.999)

The Wolfenstein Parametrization

$1 - 1/2\,\lambda^2$	λ	$A\,\lambda^3(\rho - i\,\eta)$
$-\lambda$	$1 - 1/2\,\lambda^2$	$A\,\lambda^2$
$A\,\lambda^3 \times (1 - \rho - i\,\eta)$	$-A\,\lambda^2$	1

V_{ub}

$+ O(\lambda^4)$

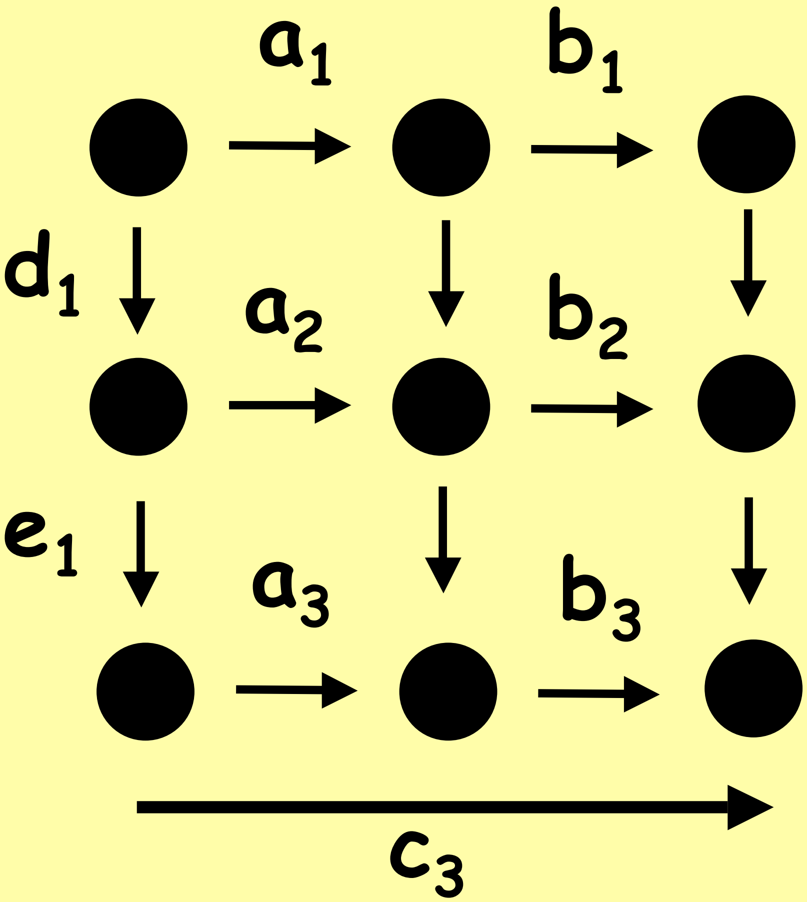
V_{td}

$\sin\theta_{12} = \lambda$
$\sin\theta_{23} = A\,\lambda^2$
$\sin\theta_{13} = A\,\lambda^3(\rho - i\,\eta)$

$\lambda \sim 0.2 \quad A \sim 0.8$

$\eta \sim 0.2 \quad \rho \sim 0.3$

The Bjorken-Jarlskog Unitarity Triangle



$|V_{ij}|$ is invariant under phase rotations

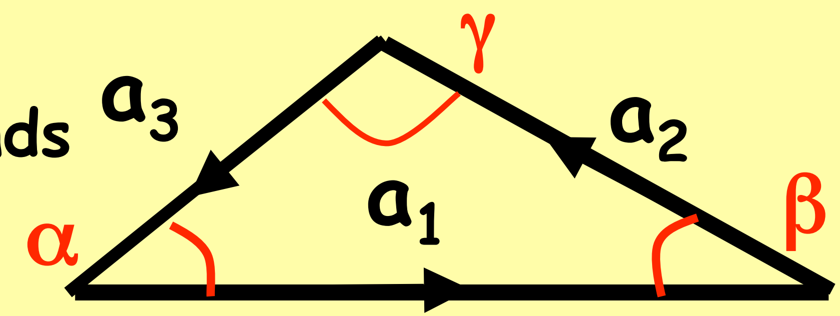
$$a_1 = V_{11} V_{12}^* = V_{ud} V_{us}^*$$

$$a_2 = V_{21} V_{22}^* \quad a_3 = V_{31} V_{32}^*$$

$$a_1 + a_2 + a_3 = 0$$

$$(b_1 + b_2 + b_3 = 0 \text{ etc.})$$

Only the orientation depends on the phase convention



Measure	V_{CKM}	Other NP parameters
$\Gamma(b \to u)/\Gamma(b \to c)$	$\bar{\rho}^2 + \bar{\eta}^2$	$\bar{\Lambda}, \lambda_1, F(1), \ldots$
ε_K	$\eta[(1-\bar{\rho}) + \ldots]$	B_K
Δm_d	$(1-\bar{\rho})^2 + \bar{\eta}^2$	$f_{B_d}^2 B_{B_d}$
$\Delta m_d/\Delta m_1$	$(1-\bar{\rho})^2 + \bar{\eta}^2$	ξ
$A_{CP}(B_d \to J/\psi K_s)$	$\sin 2\beta$	–

For details see:
UTfit Collaboration
hep-ph/0501199
hep-ph/0509219
hep-ph/0605213
hep-ph/0606167
http://www.utfit.org

$$Q^{EXP} = V_{CKM} \times \langle H_F|\hat{O}|H_I\rangle$$

classical UT analysis

sin 2β is measured directly from $B \rightarrow J/\psi K_s$ decays at Babar & Belle

$$\mathcal{A}_{J/\psi K_S} = \frac{\Gamma(B_d^0 \rightarrow J/\psi K_S, t) - \Gamma(\bar{B}_d^0 \rightarrow J/\psi K_S, t)}{\Gamma(B_d^0 \rightarrow J/\psi K_S, t) + \Gamma(\bar{B}_d^0 \rightarrow J/\psi K_S, t)}$$

$$\boxed{\mathcal{A}_{J/\psi K_S} = \sin 2\beta \;\; \sin(\Delta m_d\, t)}$$

DIFFERENT LEVELS OF THEORETICAL UNCERTAINTIES (STRONG INTERACTIONS)

1) First class quantities, with reduced or negligible theor. uncertainties

$A_{CP}(B \to J/\psi K_s)$ γ *from* $B \to DK$

$K^0 \to \pi^0 \nu \bar{\nu}$

2) Second class quantities, with theoretical errors of O(10%) or less that can be reliably estimated

ε_K $\Delta M_{d,s}$

$\Gamma(B \to c, u)$, $K^+ \to \pi^+ \nu \bar{\nu}$

3) Third class quantities, for which theoretical predictions are model dependent (BBNS, charming, etc.)

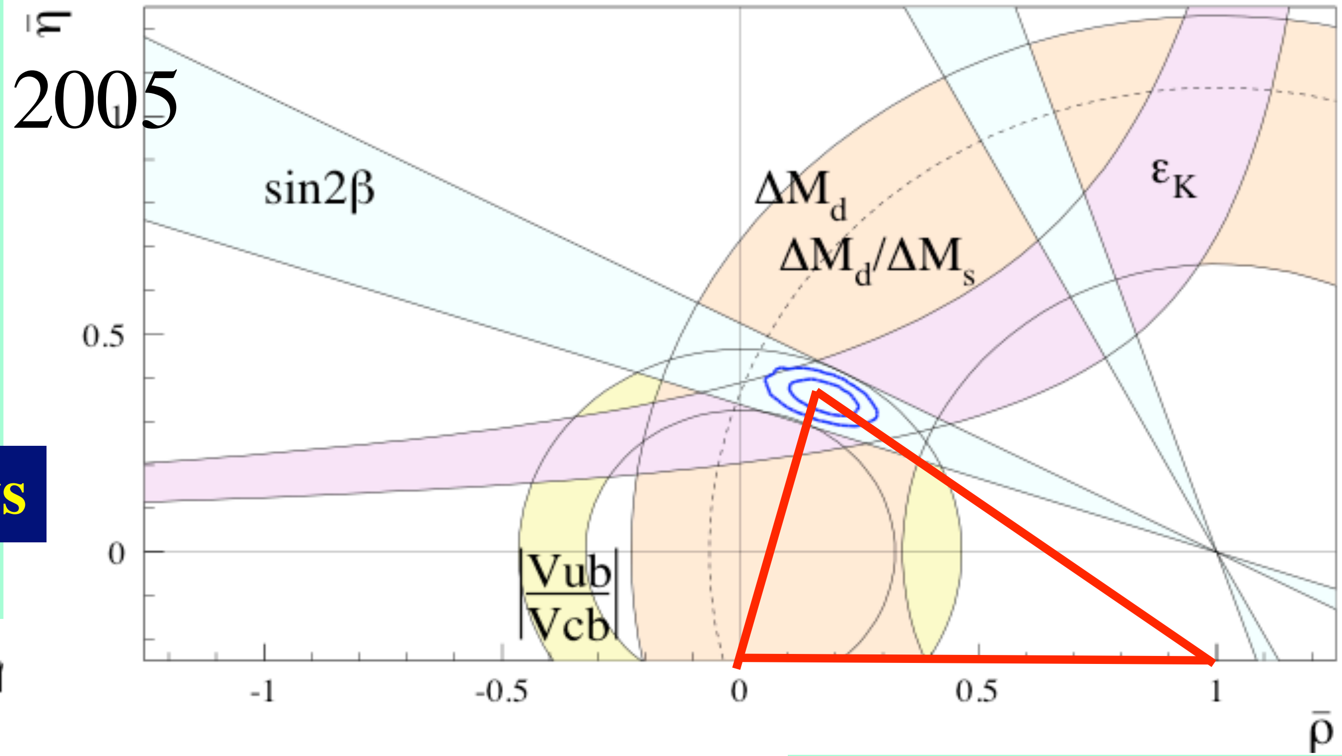
In case of discrepacies we cannot tell whether is *new physics or we must blame the model*

$B \to K\pi$ $B \to \pi^0 \pi^0$

$B \to \phi K_s$

Unitary Triangle SM

semileptonic decays



Experimental co

Meas.	$V_{CKM}\times$other	$(\bar\rho,\bar\eta)$
$\frac{b\to u}{b\to c}$	$\lvert V_{ub}/V_{cb}\rvert^2$	$\bar\rho^2+\bar\eta^2$
Δm_d	$\lvert V_{td}\rvert^2 f^2_{B_d} B_{B_d}$	$(1-\bar\rho)^2+\bar\eta^2$
$\frac{\Delta m_d}{\Delta m_s}$	$\left\lvert\frac{V_{td}}{V_{ts}}\right\rvert^2 \xi^2$	$(1-\bar\rho)^2+\bar\eta^2$
ϵ_K	$f(A,\bar\eta,\bar\rho,B_K)$	$\propto \bar\eta(1-\bar\rho)$
$A(J/\psi K^0)$	$sin2\beta$	$\frac{2\bar\eta(1-\bar\rho)}{\sqrt{\bar\eta^2+(1-\bar\rho)^2}}$

K^0 - $\overline{K}^0$ mixing

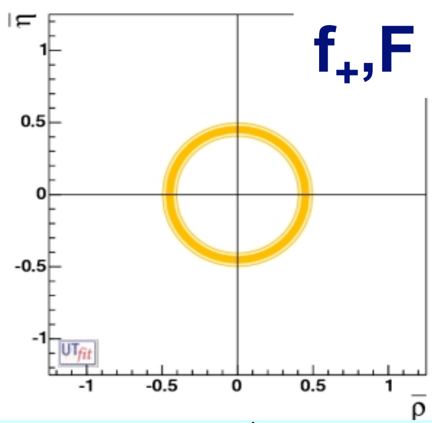
$B^0_{d,s}$ - $\overline{B}^0_{d,s}$ mixing

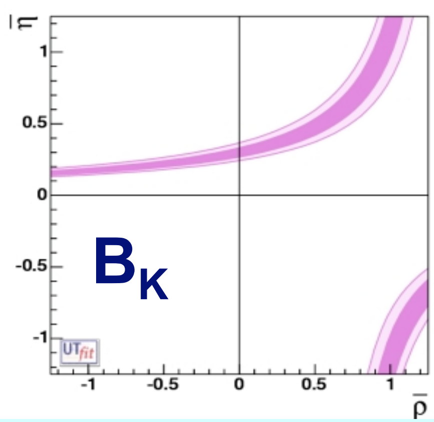
B_d Asymmetry

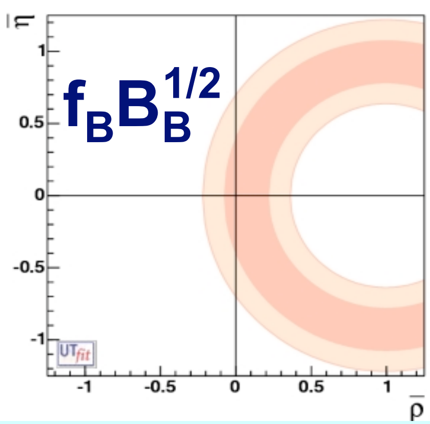
Classical Quantities used in the Standard UT Analysis

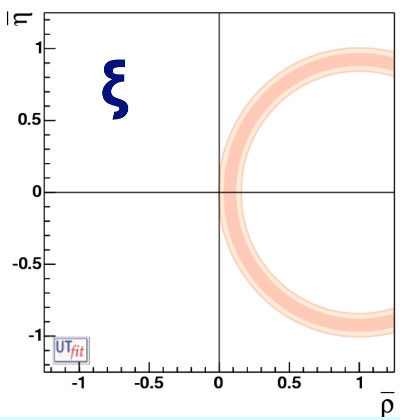
levels @ 68% (95%) CL

V_{ub}/V_{cb}	ε_K	Δm_d	$\Delta m_d/\Delta m_s$









UT-LATTICE

Inclusive vs Exclusive
Opportunity for lattice QCD
see later

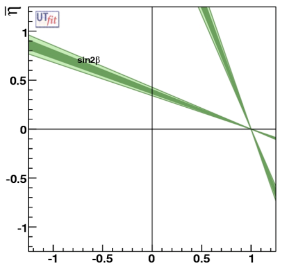
before
only a lower bound

New Quantities used in the UT Analysis

UT-ANGLES

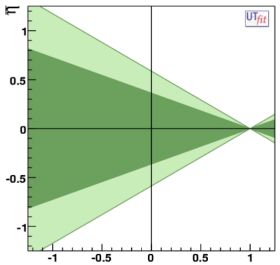
Several new determinations of UT angles are now available, thanks to the results coming from the B-Factory experiments

$\sin 2\beta$



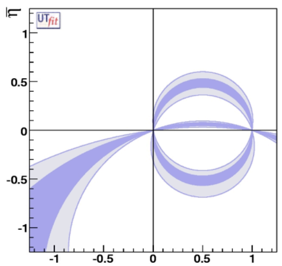
$B \to J/\Psi K^0$

$\cos 2\beta$



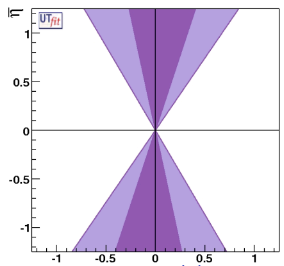
$B \to J/\Psi K^{*0}$

α



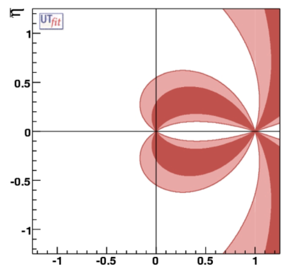
$B \to \pi\pi, \rho\rho$

γ



$B \to D^{(*)}K$

$\sin(2\beta+\gamma)$

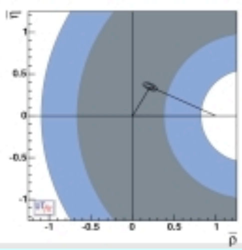


$B \to D^{(*)}\pi, D\rho$

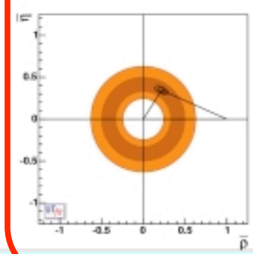
New Constraints from B and K rare decays (not used yet)

New bounds are available from rare B and K decays. They do not still have a strong impact on the global fit and they are not used at present.

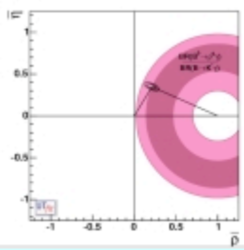
$K \to \pi \nu \bar{\nu}$



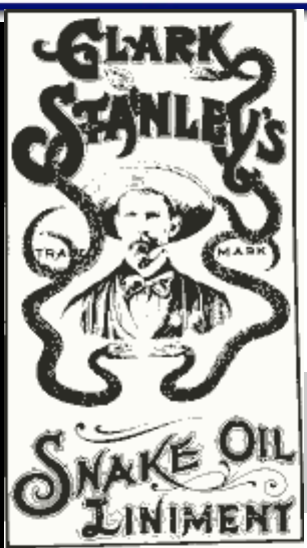
$B \to \tau \nu$



$(B \to \rho/\omega\, \gamma)/(B \to K^* \gamma)$



THE COLLABORATION

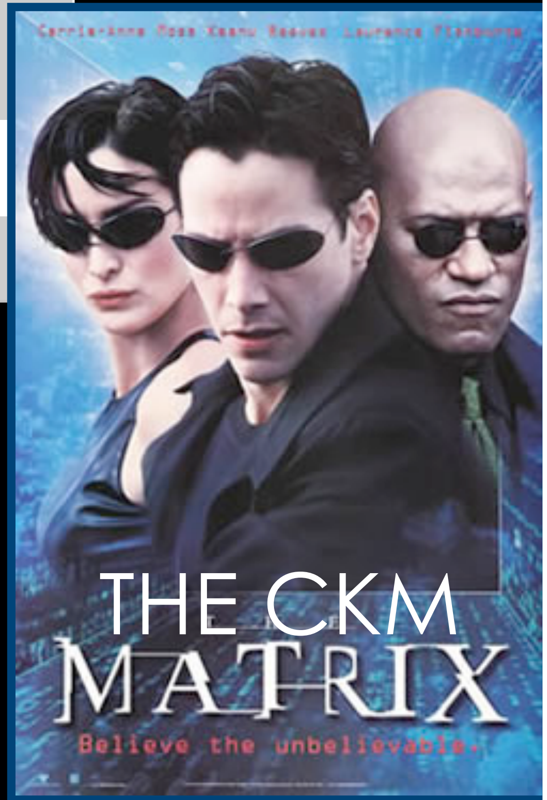


M.Bona, M.Ciuchini, E.Franco, V.Lubicz,
G.Martinelli, F.Parodi,M.Pierini,
P.Roudeau, C.Schiavi,L.Silvestrini,
V. Sordini, A.Stocchi, V.Vagnoni

Cern, Roma, Genova, Orsay, Bologna

2008 (2009) ANALYSES

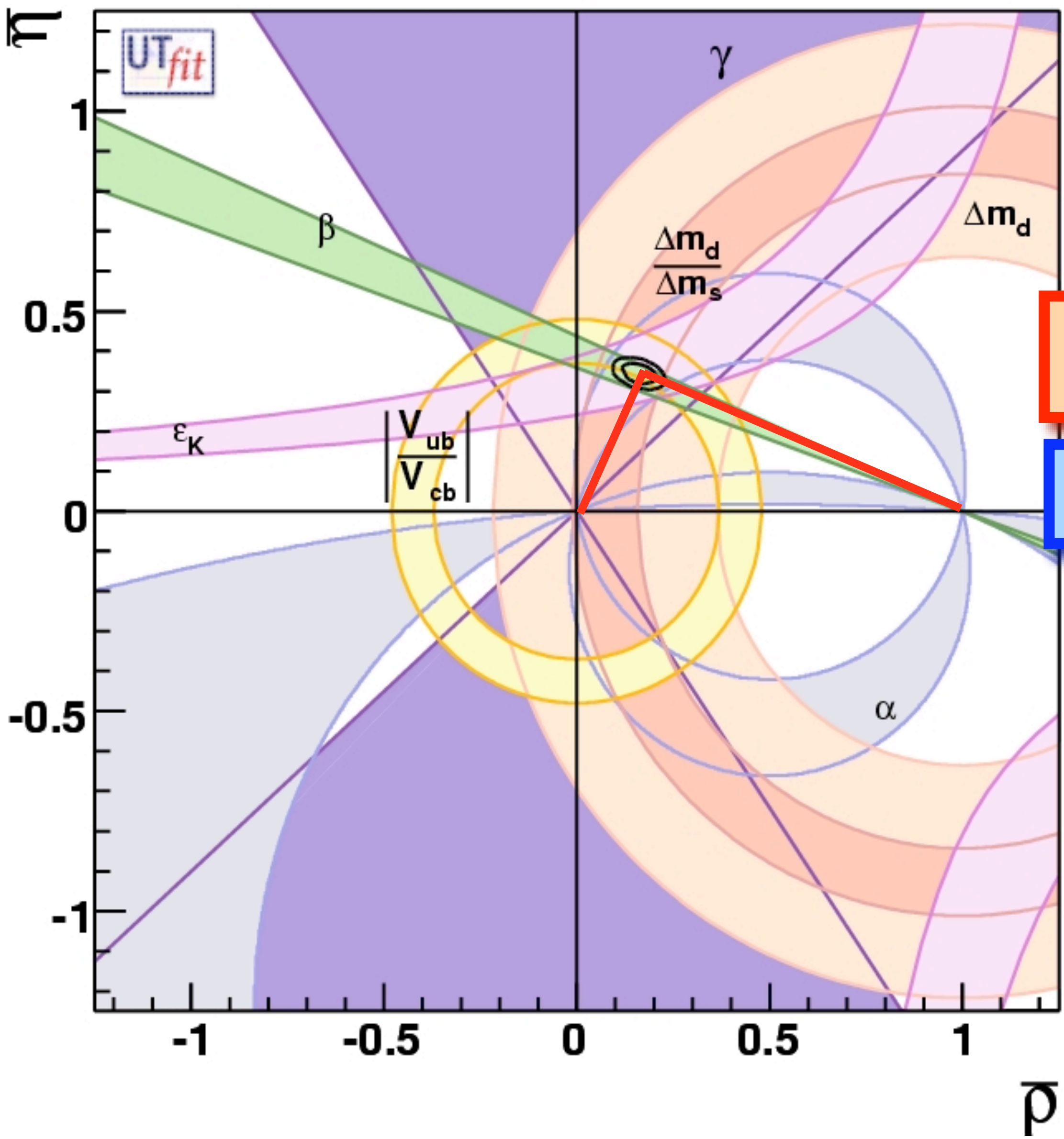
- New quantities included
- Upgraded exp. numbers (after ICHEP '08)
- (CDF) & D0 new measurements



www.utfit.org

Results for ρ and η & related quantities

With the constraint fromΔm_s



contours @ 68% and 95% C.L.

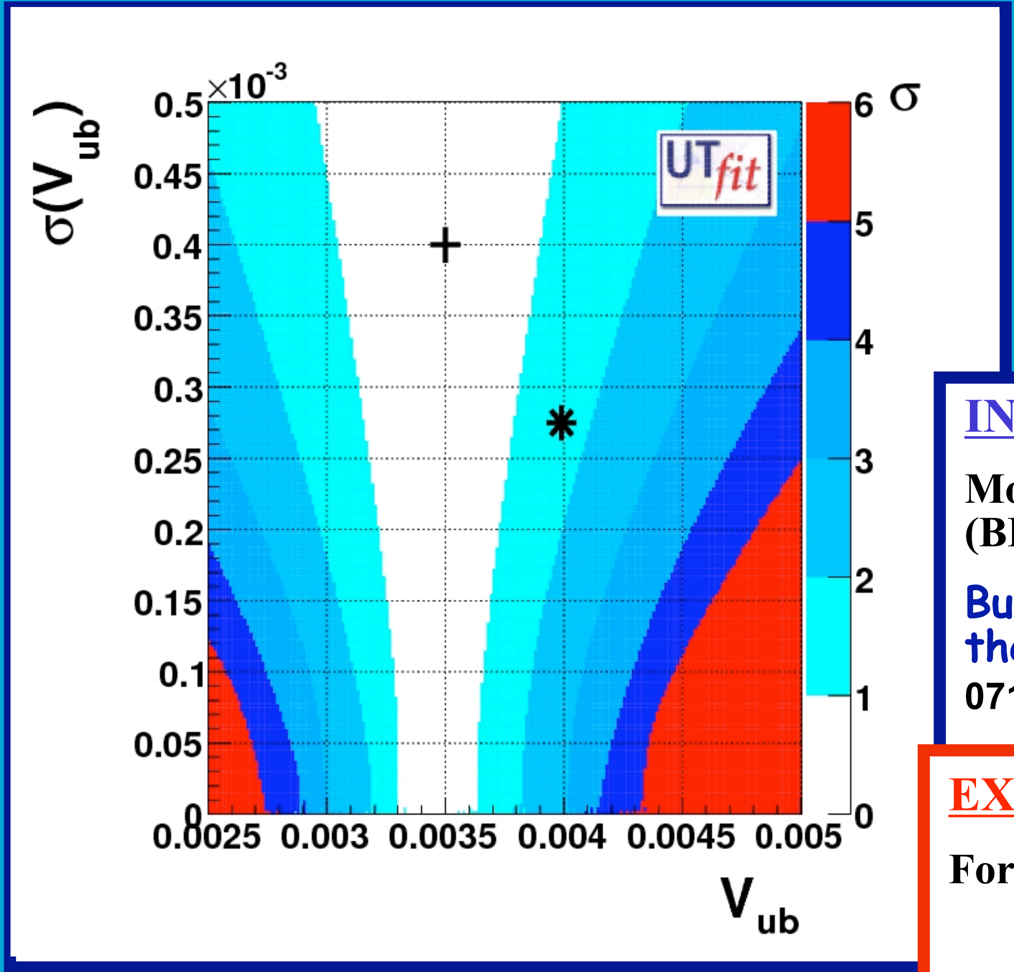
ρ = 0.155 ± 0.022

η = 0.342 ± 0.014

$\alpha = (92.0 \pm 3.4)^0$
$\sin 2\beta = 0.695 \pm 0.020$
$\gamma = (65.6 \pm 3.3)^0$

Tension between inclusive Vub and the rest of the fit

Tension between inclusive Vub and the rest of the fit



INCLUSIVE $V_{ub} = (43.1 \pm 3.9)\ 10^{-4}$

Model dependent in the threshold region (BLNP, DGE, BLL)

But with a different modelling of the threshold region [U.Aglietti et al., 0711.0860] $V_{ub} = (36.9 \pm 1.3 \pm 3.9)\ 10^{-4}$

EXCLUSIVE $V_{ub} = (34.0 \pm 4.0)\ 10^{-4}$

Form factors from LQCD and QCDSR

V_{UB} PUZZLE

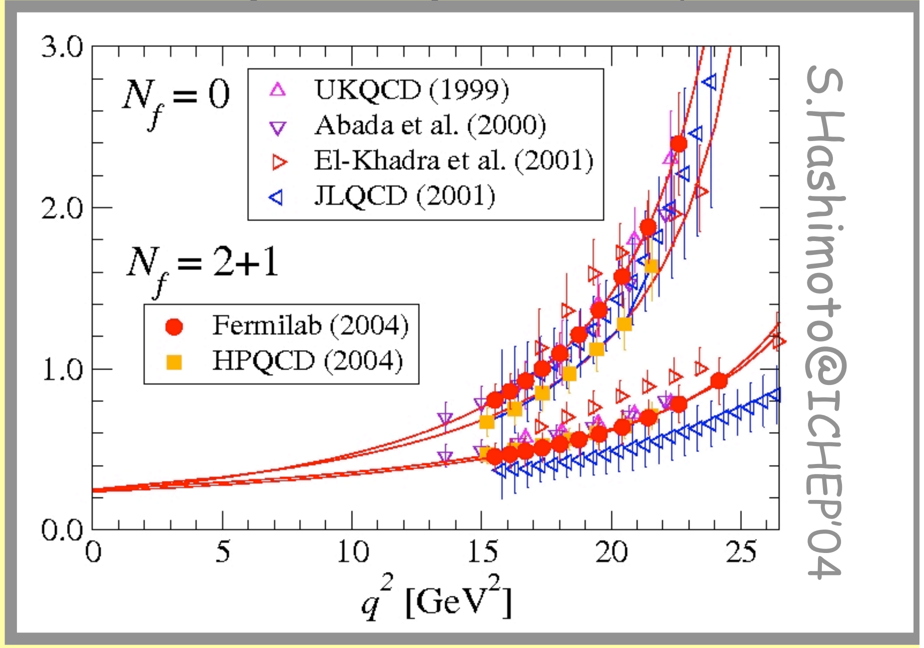
$\lvert V_{ub}\rvert \times 10^4$	excl.	35.0	4.0	Lattice QCDSR
$\lvert V_{ub}\rvert \times 10^4$	incl.	44.9	3.3	HQET+Model
$\lvert V_{ub}\rvert \times 10^4$	average	40.9	2.5	

Inclusive: uses non perturbative parameters most **not** from lattice QCD (fitted from the lepton spectrum)

$$\bar{\Lambda} \quad \lambda_1 \sim \frac{\bar{b}\vec{D}^2 b}{2m_b} \quad \lambda_2 \sim \frac{\bar{b}\sigma_{\mu\nu}G^{\mu\nu}b}{2m_b}$$

Exclusive: uses non perturbative form factors from LQCD and QCDSR

$$f^+(q^2) \quad V(q^2) \quad A_{1,2}(q^2)$$



V_{UB} PUZZLE

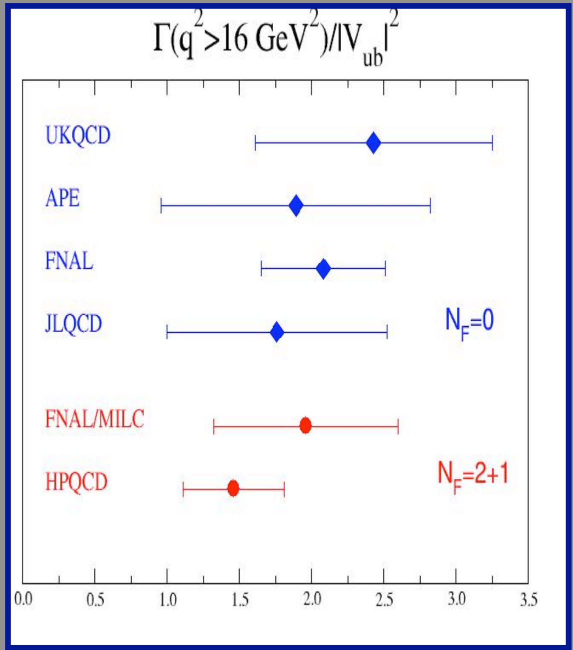
Khodjamirian

Recent $|V_{ub}|$ determinations from $B \to \pi l \nu_l$

[ref.]	$f^+_{B\pi}(q^2)$ calculation	$f^+_{B\pi}(q^2)$ input	$\|V_{ub}\| \times 10^3$
Okamoto et al.	lattice ($n_f = 3$)	-	3.78±0.25±0.52
HPQCD	lattice ($n_f = 3$)	-	3.55±0.25±0.50
Arnesen et al.	-	lattice⊕SCET	$3.54 \pm 0.17 \pm 0.44$
BecherHill	-	lattice	$3.7 \pm 0.2 \pm 0.1$
Flynn et al	-	lattice ⊕ LCSR	$3.47 \pm 0.29 \pm 0.03$
Ball, Zwicky	LCSR	-	$3.5 \pm 0.4 \pm 0.1$
this work	LCSR	-	$3.5 \pm 0.4 \pm 0.2 \pm 0.1$

V_{UB} PUZZLE

LATTICE QCD:
improve V_{ub} excl. to solve the tension



Beneke CERN '08

$|V_{ub}|$ crisis (about to be resolved?)

- $|V_{ub}| f_+^{B\pi}(0) = (9.1 \pm 0.6 \pm 0.3) \times 10^{-4}$ from semileptonic $B \to \pi l \nu$ spectrum + form factor extrapolation (Ball, 2006)
  Also lattice results (HPQCD) tend to small values.
- $|V_{ub}| f_+^{B\pi}(0) = (8.1 \pm 0.4\,(?)) \times 10^{-4}$ from $B \to \pi^+\pi^-, \pi^+\pi^0, \pi\rho, \ldots$ + factorization
  (MB, Neubert, 2003; Arnesen et al, 2005; MB, Jäger, 2005)

$\Longrightarrow$ $|V_{ub}| \simeq 3.5 \times 10^{-4}$, in contrast to determination from moments of inclusive $b \to u \ell \nu$ decay, which was $|V_{ub}| \simeq (4.5 \pm 0.3) \times 10^{-4}$.

But: according to (Neubert, LP07) $|V_{ub}| \simeq (3.7 \pm 0.3) \times 10^{-4}$ after reevaluation of m_b input and omitting $B \to X_s \gamma$ moments!

Hadronic Parameters From UTfit

1) Predictions vs Postdictions
2) Lattice vs angles
3) V_{ub} inclusive, V_{ub} exclusive vs sin 2β
4) Experimental determination of lattice parameters

IMPACT of the NEW MEASUREMENTS on LATTICE HADRONIC PARAMETERS

$$f_{B_s}\hat{B}_{B_s}^{1/2} \quad \xi \quad \hat{B}_K$$

Comparison between experiments and theory

Comparison between experiments and theory

exps vs predictions

$f_{Bs}\sqrt{B_{Bs}} = 270 \pm 30$ MeV

lattice

$f_{Bs}\sqrt{B_{Bs}} = 265 \pm 4$ MeV

UTA 2% ERROR !!

$\xi = 1.25 \pm 0.06$ **UTA**

$\xi = 1.21 \pm 0.04$

lattice

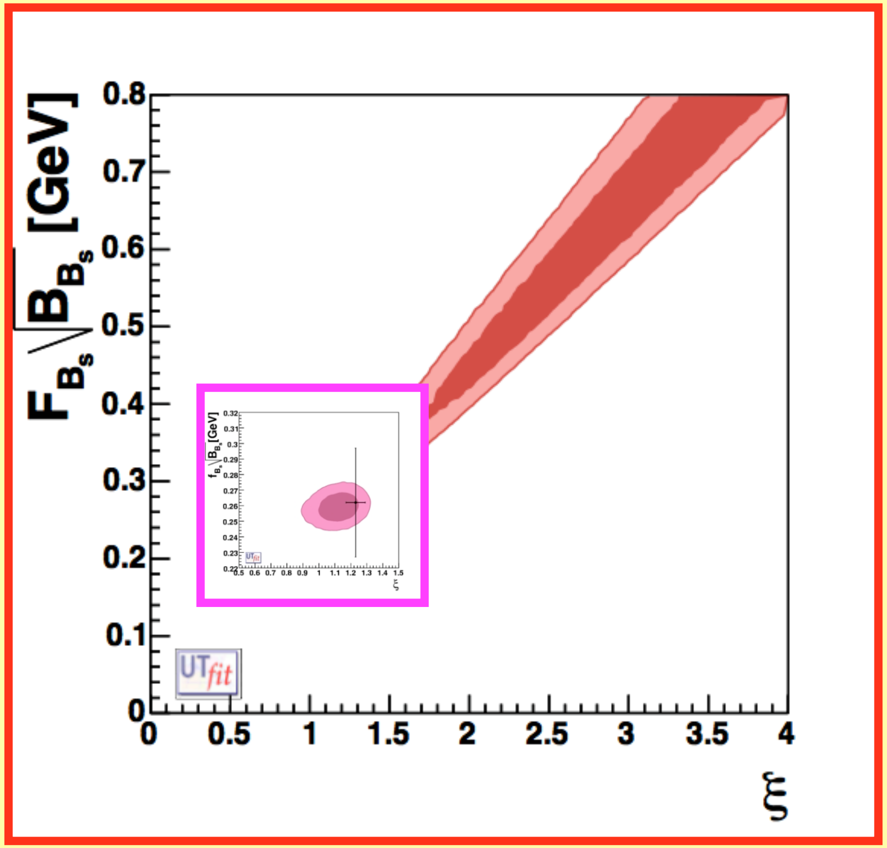
$B_K = 0.75 \pm 0.07$

$B_K = 0.75 \pm 0.07$

V. Lubicz and C. Tarantino 0807.4605

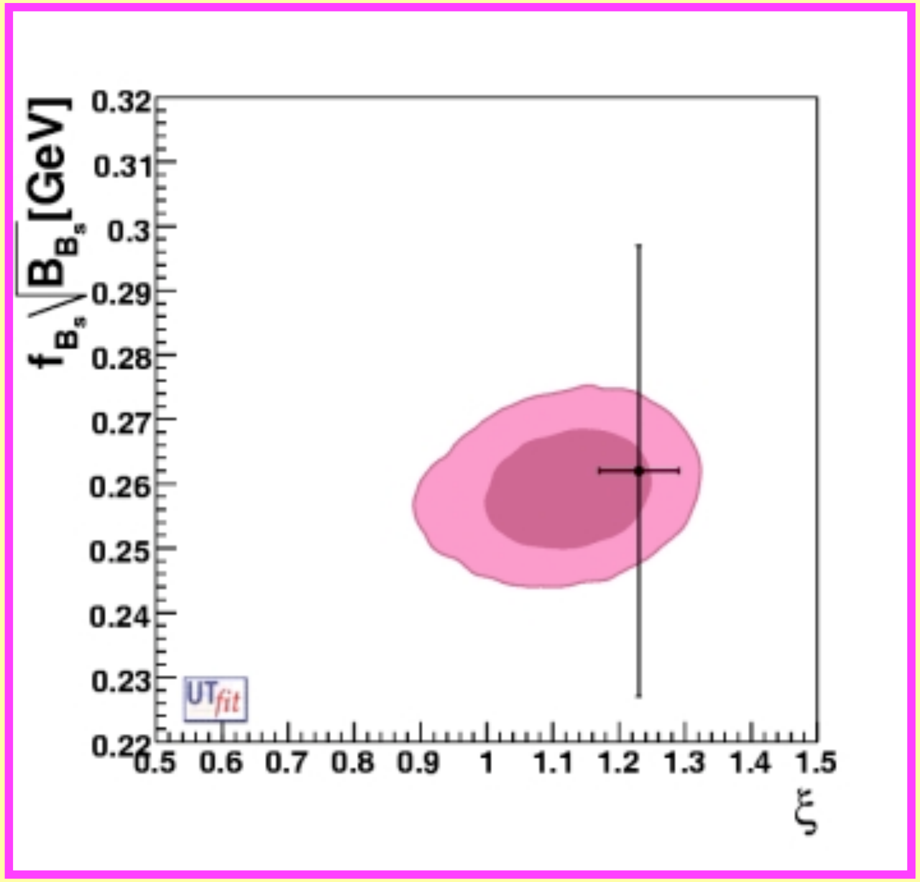
SPECTACULAR AGREEMENT (EVEN WITH QUENCHED LATTICE QCD)

NEW



$F_{B_s}\sqrt{B_{B_s}}$ [GeV]
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0 0.5 1 1.5 2 2.5 3 3.5 4
ξ
UTfit

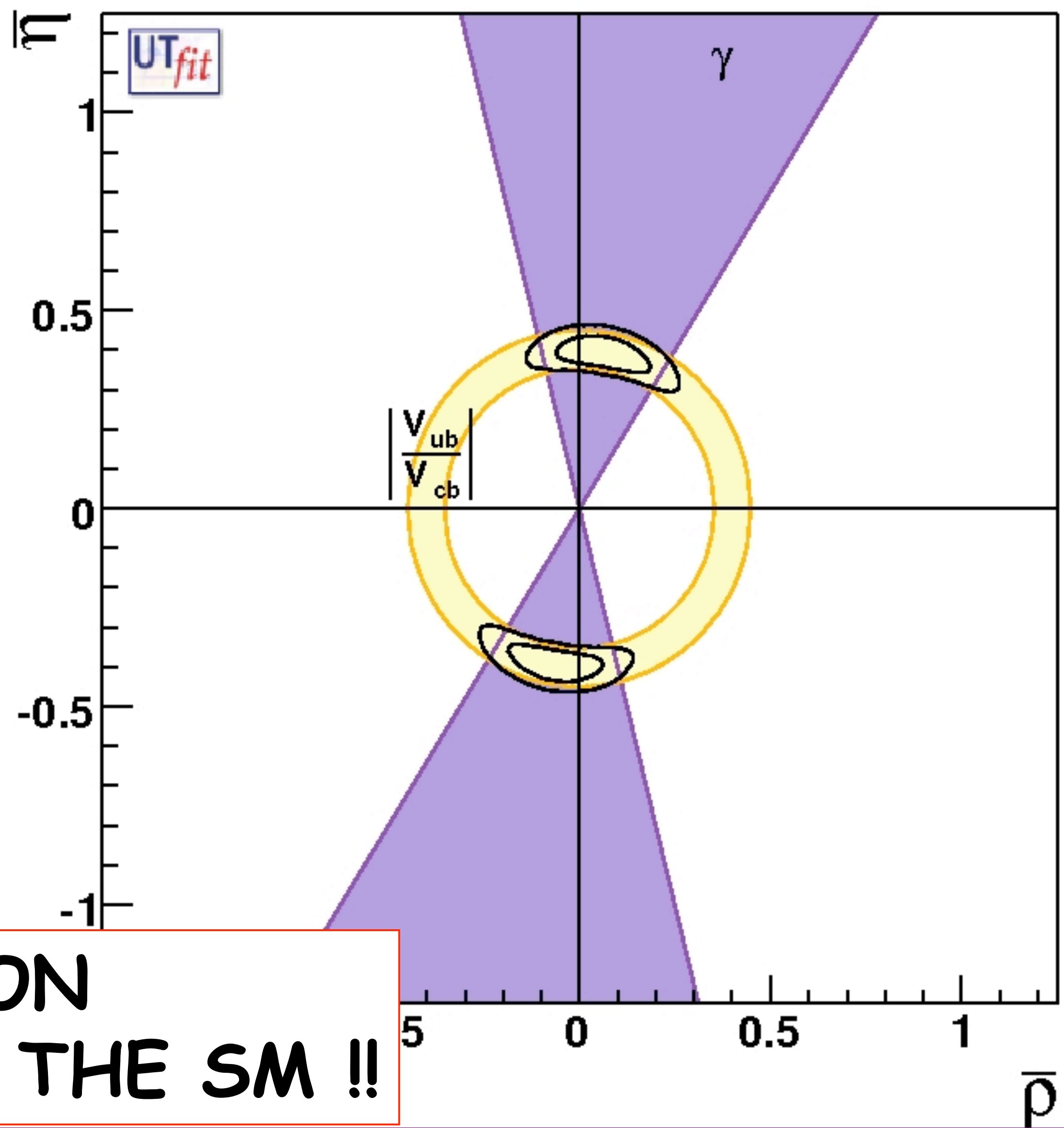
OLD



$f_{B_s}\sqrt{B_{B_s}}$ [GeV]
0.32
0.31
0.3
0.29
0.28
0.27
0.26
0.25
0.24
0.23
0.22
0.5 0.6 0.7 0.8 0.9 1 1.1 1.2 1.3 1.4 1.5
ξ
UTfit


…. beyond
the Standard Model

Only tree level processes Vub/Vcb and B-> DK$^{(*)}$



CP VIOLATION
PROVEN IN THE SM !!

SM	→	SM+NP
$(V_{ub}/V_{cb})^{SM}$ γ^{SM}	**tree level**	$(V_{ub}/V_{cb})^{SM}$ γ^{SM}
β^{SM} α^{SM} Δm_d	***Bd Mixing***	$\beta^{SM}+\phi_{Bd}$ $\alpha^{SM}-\phi_{Bd}$ $C_{Bd}\Delta m_d$
Δm_s^{SM} $-\beta_s^{SM}$	***Bs Mixing***	$C_{Bs}\Delta m_s^{SM}$ $-\beta_s^{SM}+\phi_{Bs}$
ε_K^{SM} Δm_K^{SM}	***K Mixing***	$C_{\varepsilon_K}\,\varepsilon_K^{SM}$ $C_{\Delta mK}\,\Delta m_K^{SM}$

Physical observables

$$\Delta m_s = |A_s| = C_{B_s} \Delta m_s^{SM}$$

$$2\phi_s = -\arg A_s = 2\left(\beta_s - \phi_{B_s}\right)$$

$$A_{SL}^s = \frac{\Gamma(\bar{B}_s \to l^+ X) - \Gamma(B_s \to l^- X)}{\Gamma(\bar{B}_s \to l^+ X) + \Gamma(B_s \to l^- X)} = Im\left(\frac{\Gamma_{12}^s}{A_s}\right)$$

$$A_{SL}^{\mu\mu} = \frac{f_d \chi_{d0} A_{SL}^d + f_s \chi_{s0} A_{SL}^s}{f_d \chi_{d0} + f_s \chi_{s0}}$$

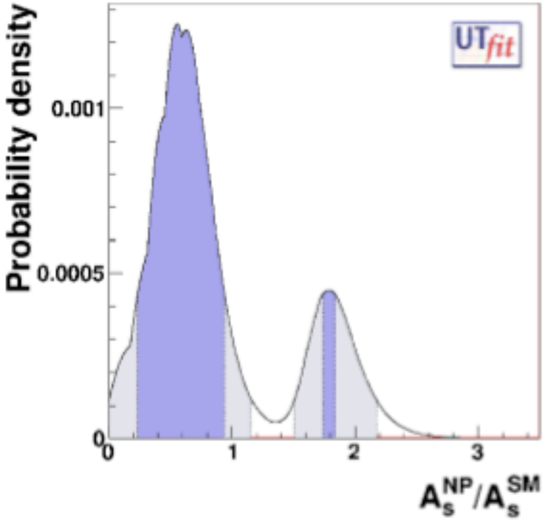
$$\frac{\Delta\Gamma_s}{\Delta m_s} = Re\left(\frac{\Gamma_{12}^s}{A_s}\right) \qquad \tau_{B_s}^{FS} = \frac{1}{\Gamma_S} \frac{1 + (\Delta\Gamma_s/2\Gamma_s)^2}{1 - (\Delta\Gamma_s/2\Gamma_s)^2}$$

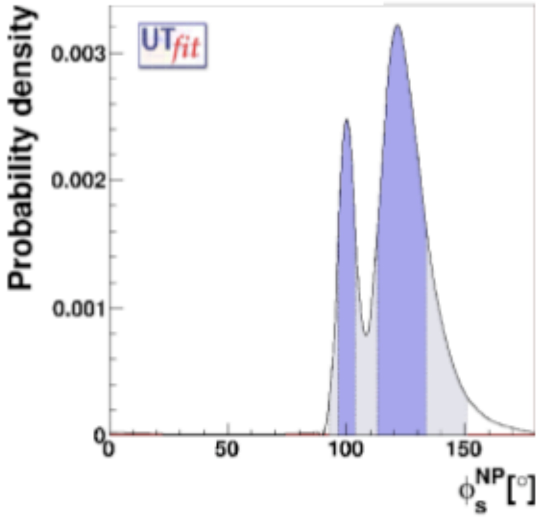
The two solutions for ϕ_s correspond to two regions for A_s^{NP} and ϕ_s^{NP}:

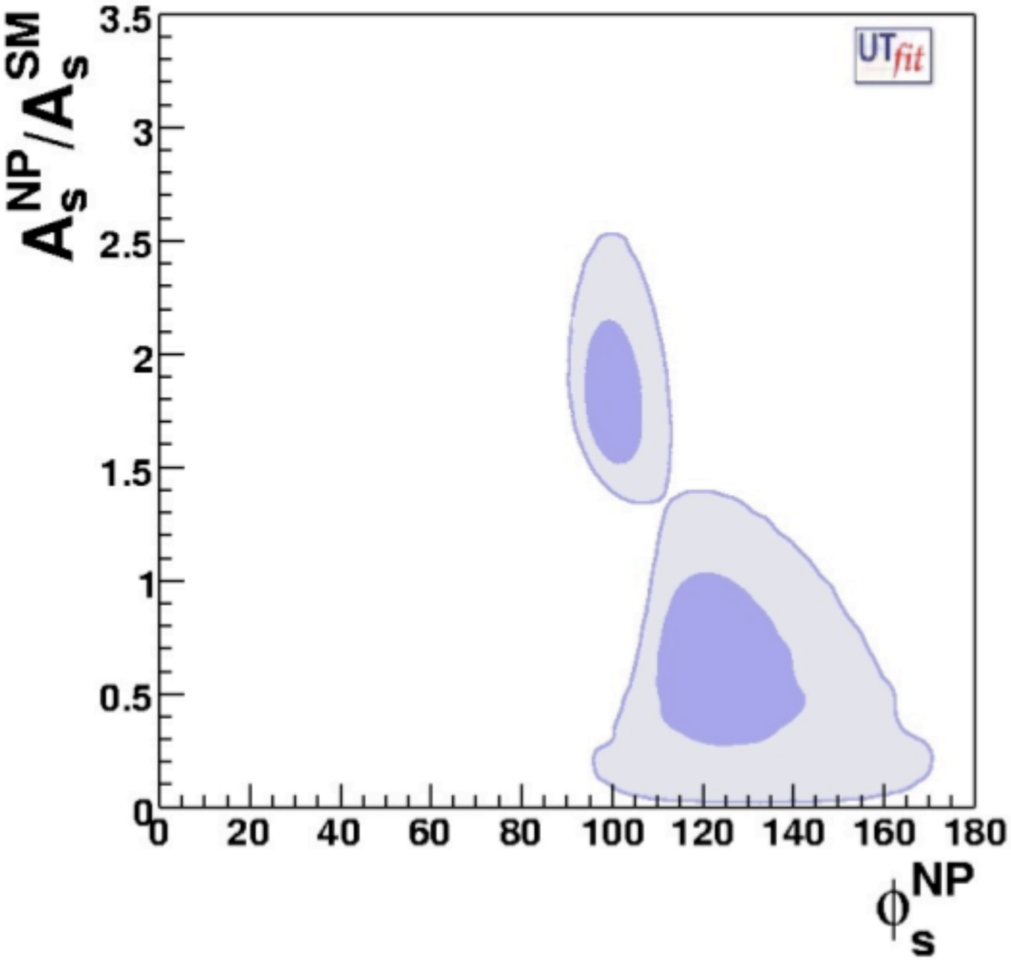
$A_s^{NP}/A_s^{SM}=0.6\pm0.4$ & $\phi_{NP}=(123\pm10)^\circ$

$A_s^{NP}/A_s^{SM}=1.8\pm0.1$ & $\phi_{NP}=(100\pm3)^\circ$

requires NP with new sources of CP violation!







We find non standard CP violation in Bs mixing @ 2.9 σ ➔ New Physics

A pattern of NP contributions to flavour violation emerges:

1 <-> 2 suppressed

1 <-> 3 ≤ O(10%)

2 <-> 3 O(1)

CKMFitter 2.5 σ 0810.3139

HFAG 2.2 σ 0808.1297 CDF 1.5 σ -> 1,7 σ

1. *We expect a correlation between b <->s mixing and b -> s penguin transitions (this could be helpful for S_{peng} or $A_{k\pi}$ [Beneke,Buchalla et al.; Buras et al; London et al; Lunghi & Soni, Feldmann et al.])*
2. *If confirmed MFV models, including the simplest realizations of the MSSM, are ruled out*
3. *Large NP contributions to b <->s transitions can be accomodated in non abelian flavour models - SU(3)- given the large breaking due to the top quark mass*
4. *GUT's correlate a large mixing in ν oscillations with a large b <->s mixing*

$b \rightarrow s$ & $\tau \rightarrow \mu\gamma$ in SUSY GUTS

When SUSY is broken at a scale larger than M_{GUT} SQuark and SLepton masses unify including the non-diagonal coupling $(\delta_{ij})_{LL}$, $(\delta_{ij})_{RR}$

The following relations holds at M_Z (Ciuchini et al. hep-ph/0307191)

$$(\delta^d_{ij})_{RR} \simeq \frac{m^2_L}{m^2_D} (\delta^l_{ij})_{LL}$$

$$(\delta^{u,d}_{ij})_{LL} \simeq \frac{m^2_E}{m^2_Q} (\delta^l_{ij})_{RR}$$

$$(\delta^u_{ij})_{RR} \simeq \frac{m^2_E}{m^2_U} (\delta^l_{ij})_{LL}$$

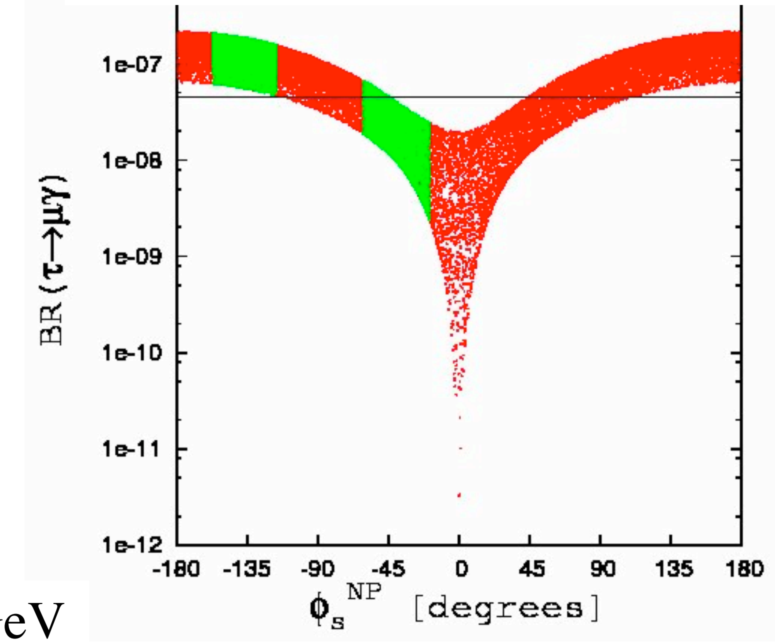
$$(\delta^d_{ij})_{LR} \simeq \frac{m^2_{L_{ave}}}{m^2_{Q_{ave}}} \frac{m_b}{m_\tau} (\delta^l_{ij})^*_{RL}$$

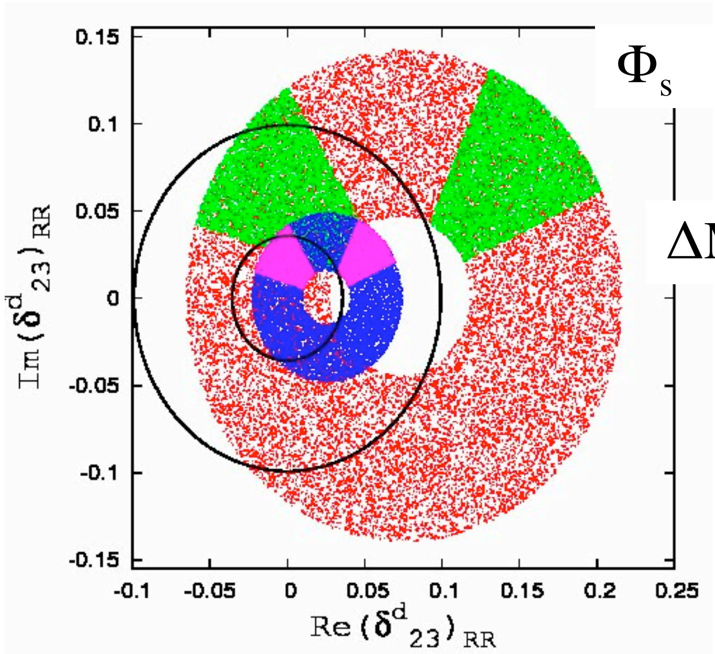
b → s & τ → μγ in SUSY GUTS

mass insertion analysis in a SUSY-GUT scheme

- RG-induced $(\delta_{23})_{LL}$
- explicit $(\delta_{23})_{RR}$

Limits from Belle and Babar < 4.5 & 6.8 10^{-8}





Φ_s

ΔM_s m_{sq}=500 GeV

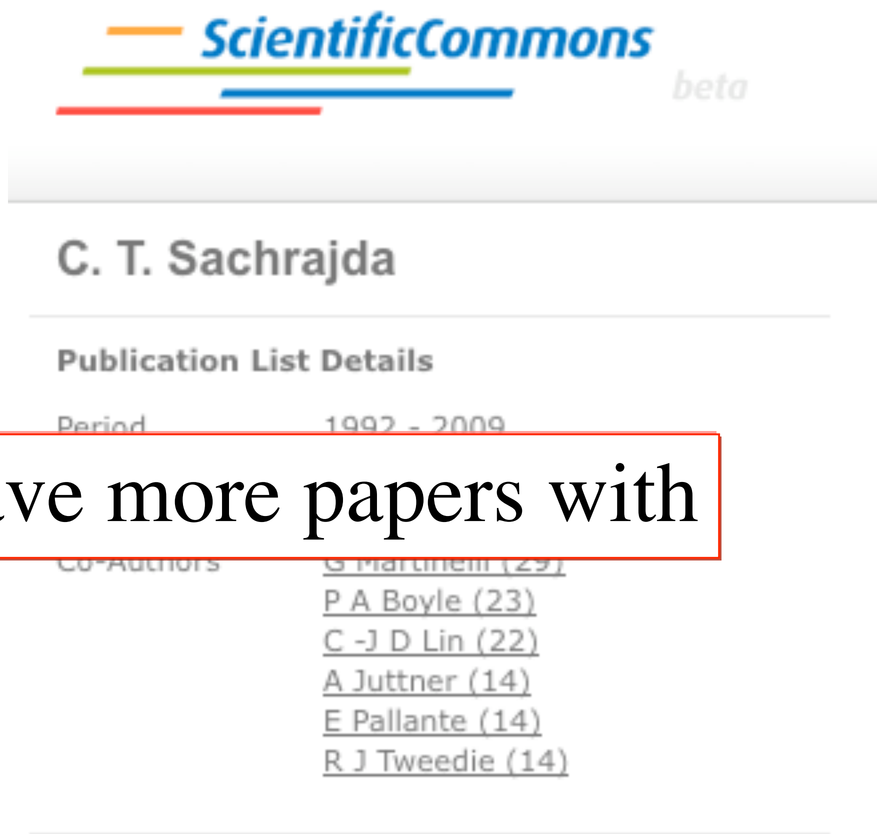
In the UTfit range for the B_s mixing phase:

$BR(\tau \to \mu\gamma) > 3 \times 10^{-9}$!!


2009
My dear Chris
we are here
to celebrate
your anniversary!

CONCLUSIONS

For 23 years I had the honour and the privilege to collaborate with a great scientist: Prof. Chris Sachrajda



He is the person I have more papers with

Chris is an exceptional scientific personality

His activity has marked the development
of particle phenomenology in the last 30 years or so
(perturbative QCD, lattice, heavy quarks)

He created a school, many of his students are
now professors/researches in several places around the world

He is a honest, wise and equilibrated person, and for this
reasons he was/is apponited to also important administrative
charges with success (director of the dep., scientific panels, etc.)

... but much more important

CHRIS IS A LOVELY PERSON AND
ONE OF MY BEST FRIENDS,
AND I AM HAPPY THAT
WE MET 23 YEARS AGO

HAPPY 60's (& 70's, 80s, 90s, 10000000..)