

RETROSPECTIVE RESULTS ON THE CKM MATRIX AND THE UNITARITY TRIANGLE

Based on results available
around 2009

P r e l i m i n a r y

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The CKMfitter Group

Abstract

This document provides a retrospective collection of inputs to the global CKM analysis, and numerical results obtained with the use of the CKMfitter fit package. Experimental and theoretical information available by fall 2009, are used. These include for the first time constraints on the CKM angle α . The statistical method employed is the frequentist approach *Rfit*. Detailed background information on the methodology and the treatment of experimental and theoretical uncertainties is provided in:

CP VIOLATION AND THE CKM MATRIX:
ASSESSING THE IMPACT OF THE ASYMMETRIC *B* FACTORIES

By CKMfitter Group

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Parameter	Value \pm Error(s)	Reference	Errors	
			GS	TH
$ V_{ud} $ (nuclei)	0.97425 ± 0.00022	[1]	*	-
$ V_{us} $ ($K_{\ell 3}$)	0.2246 ± 0.0012	[2]	*	-
$ V_{ub} $	$(3.79 \pm 0.09 \pm 0.41) \times 10^{-3}$	[3, 4]	*	*
$ V_{cb} $	$(40.59 \pm 0.37 \pm 0.58) \times 10^{-3}$	[3]	*	*
$ \varepsilon_K $	$(2.229 \pm 0.010) \times 10^{-3}$	[5]	*	-
Δm_d	$(0.507 \pm 0.005) \text{ ps}^{-1}$	[3]	*	-
Δm_s	$(17.77 \pm 0.12) \text{ ps}^{-1}$	[6]	*	-
$\sin(2\beta)_{[c\bar{c}]}$	0.671 ± 0.023	[3]	*	-
$S_{\pi\pi}^{+-}, C_{\pi\pi}^{+-}, C_{\pi\pi}^{00}$	Inputs to isospin analysis	[3]	*	-
$\mathcal{B}_{\pi\pi}$ all charges	Inputs to isospin analysis	[3]	*	-
$S_{\rho\rho,L}^{+-}, C_{\rho\rho,L}^{+-}, S_{\rho\rho}^{00}, C_{\rho\rho}^{00}$	Inputs to isospin analysis	[3]	*	-
$\mathcal{B}_{\rho\rho,L}$ all charges	Inputs to isospin analysis	[3]	*	-
$B^0 \rightarrow (\rho\pi)^0 \rightarrow 3\pi$	Time-dependent Dalitz analysis	[7, 8]	*	-
$B^- \rightarrow D^{(*)}K^{(*)-}$	Inputs to GLW analysis	[3]	*	-
$B^- \rightarrow D^{(*)}K^{(*)-}$	Inputs to ADS analysis	[3]	*	-
$B^- \rightarrow D^{(*)}K^{(*)-}$	GGSZ Dalitz analysis	[3]	*	-
$\mathcal{B}(B^- \rightarrow \tau^- \bar{\nu}_\tau)$	$(1.73 \pm 0.35) \times 10^{-4}$	[9]	*	-
$\bar{m}_c(m_c)$	$(1.286 \pm 0.013 \pm 0.040) \text{ GeV}$	[12]	*	*
$\bar{m}_t(m_t)$	$(165.02 \pm 1.16 \pm 0.11) \text{ GeV}$	[10]	*	*
B_K	$0.721 \pm 0.005 \pm 0.040$	[16]	*	*
$\alpha_s(m_Z^2)$	0.1176 ± 0.0020	[5]	-	*
η_{cc}	Calculated from $\bar{m}_c(m_c)$ and α_s	[17]	-	*
η_{ct}	0.47 ± 0.04	[18]	-	*
η_{tt}	0.5765 ± 0.0065	[17, 18]	-	*
$\eta_B(\overline{\text{MS}})$	0.551 ± 0.007	[19]	-	*
f_{B_s}	$(228 \pm 3 \pm 17) \text{ MeV}$	[16]	*	*
B_s	$1.23 \pm 0.03 \pm 0.05$	[16]	*	*
f_{B_s}/f_{B_d}	$1.199 \pm 0.008 \pm 0.023$	[16]	*	*
B_s/B_d	$1.05 \pm 0.02 \pm 0.05$	[16]	*	*

Table 1: *Inputs to the standard CKM fit. If not stated otherwise: for two errors given, the first is statistical and accountable systematic and the second stands for systematic theoretical uncertainties. The last two columns indicate Rfit treatment of the input parameters: measurements or parameters that have statistical errors (we include here experimental systematics) are marked in the “GS” column by an asterisk; measurements or parameters that have systematic theoretical errors are marked in the “TH” column by an asterisk. Upper part: experimental determinations of the CKM matrix elements. Middle upper part: CP-violation and mixing observables. Middle lower part: parameters used in SM predictions that are obtained from experiment. Lower part: parameters of the SM predictions obtained from theory.*

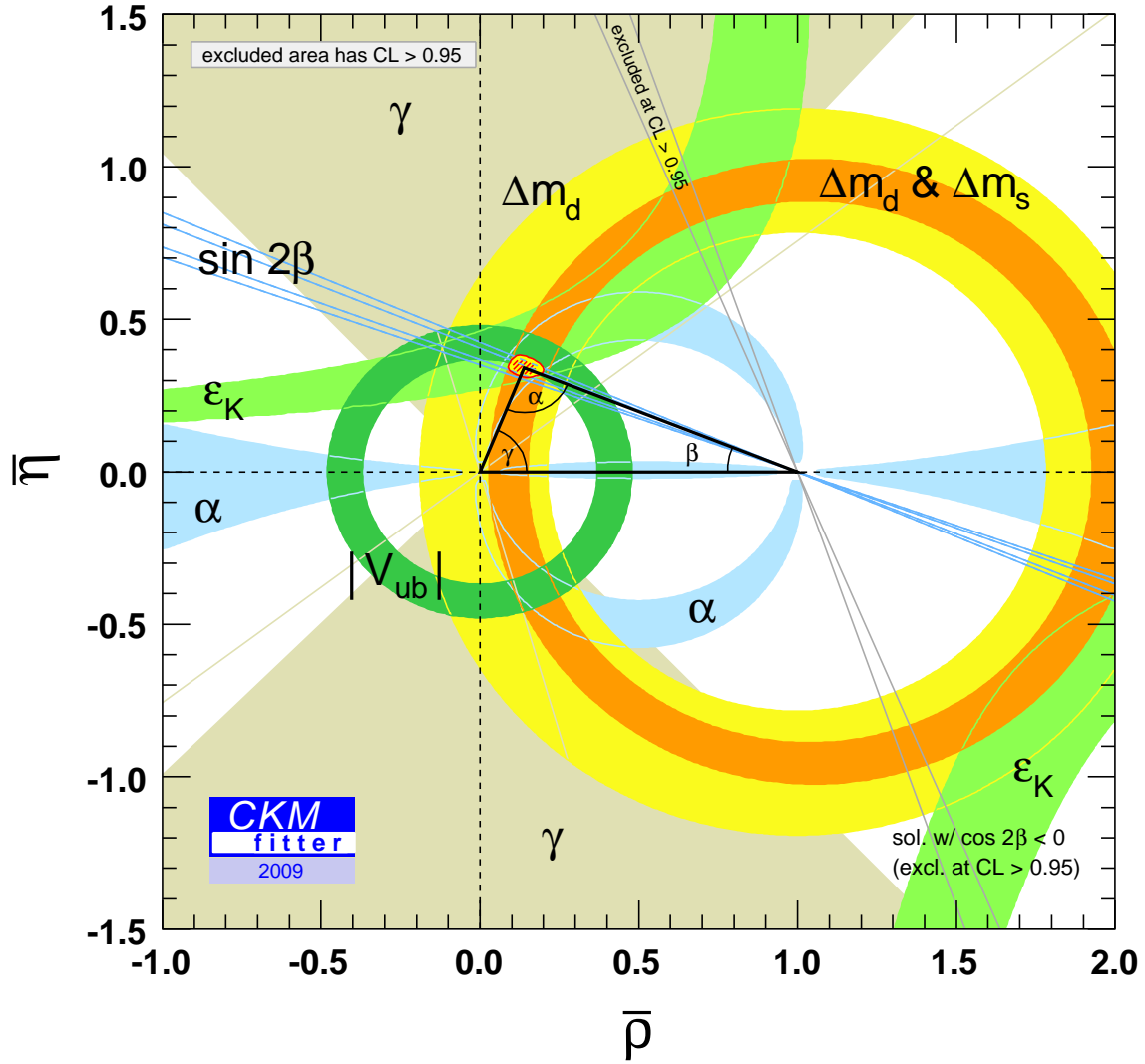


Figure 1: Constraints on the $(\bar{\rho}, \bar{\eta})$ plane including results available by 2006 in the global CKM fit. The experimental inputs correspond to all information, including the first results on CP violation from the B-factories, with numerical values summarised in Table 1. The red hashed region of the global combination corresponds to 68%CL.

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