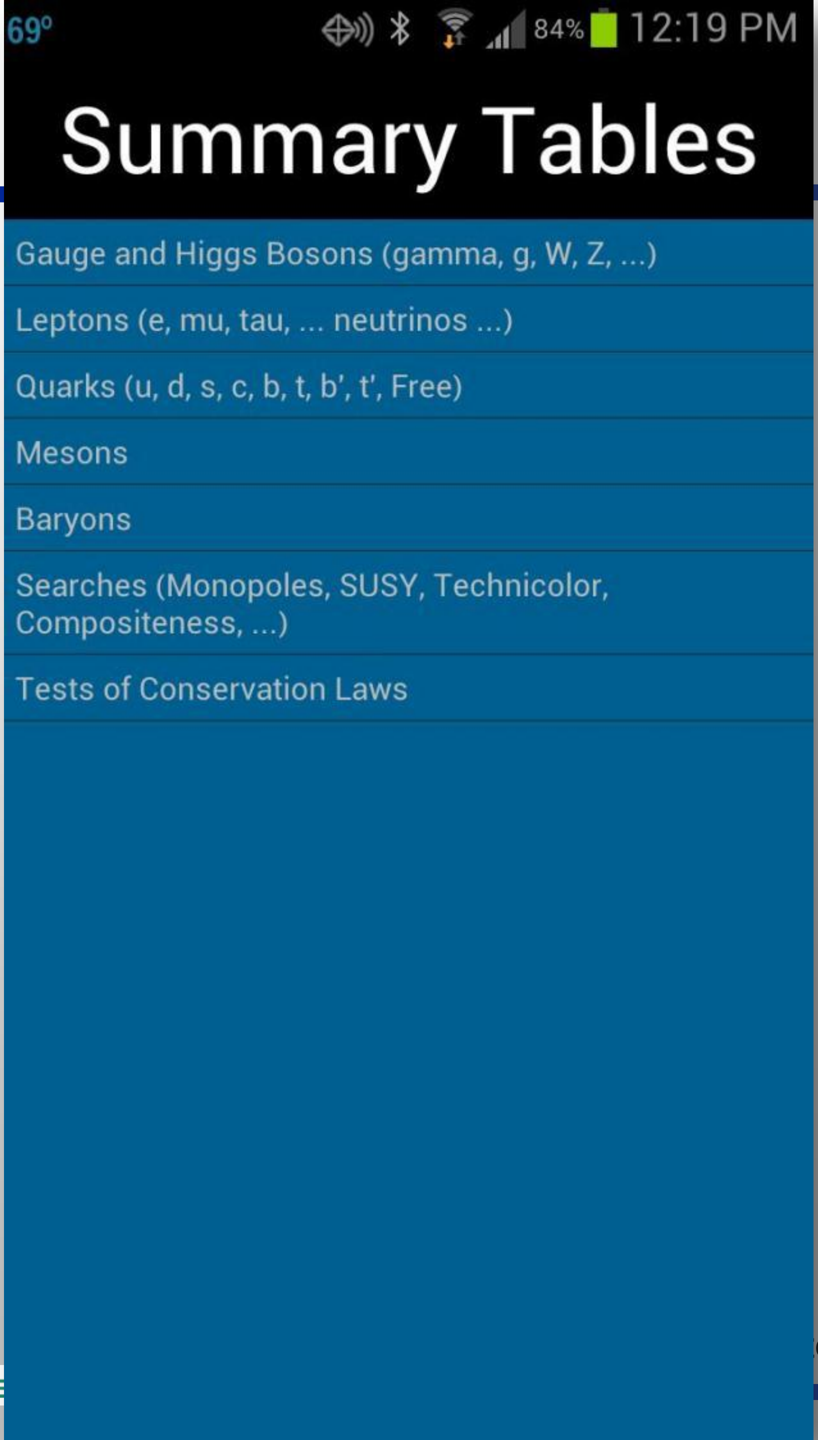
PDG App for Smartphones

iPhone and Android

In progress

Summary Tables



Summary Tables

SUMMARY TABLES OF PARTICLE PROPERTIES

Extracted from the Particle Listings of the
Review of Particle Physics
J. Beringer *et al.*(PDG), PR **D86**, 010001 (2012)
Available at `http://pdg.lbl.gov`

(Approximate closing date for data: January 15, 2012)

GAUGE AND HIGGS BOSONS

γ $I(J^{PC}) = 0,1(1^{--})$

Mass $m < 1 \times 10^{-18}$ eV
Charge $q < 1 \times 10^{-35}$ e
Mean life τ = Stable

g or gluon $I(J^P) = 0(1^-)$

Mass $m = 0$ [a]
SU(3) color octet

graviton $J = 2$

Mass $m < 7 \times 10^{-32}$ eV

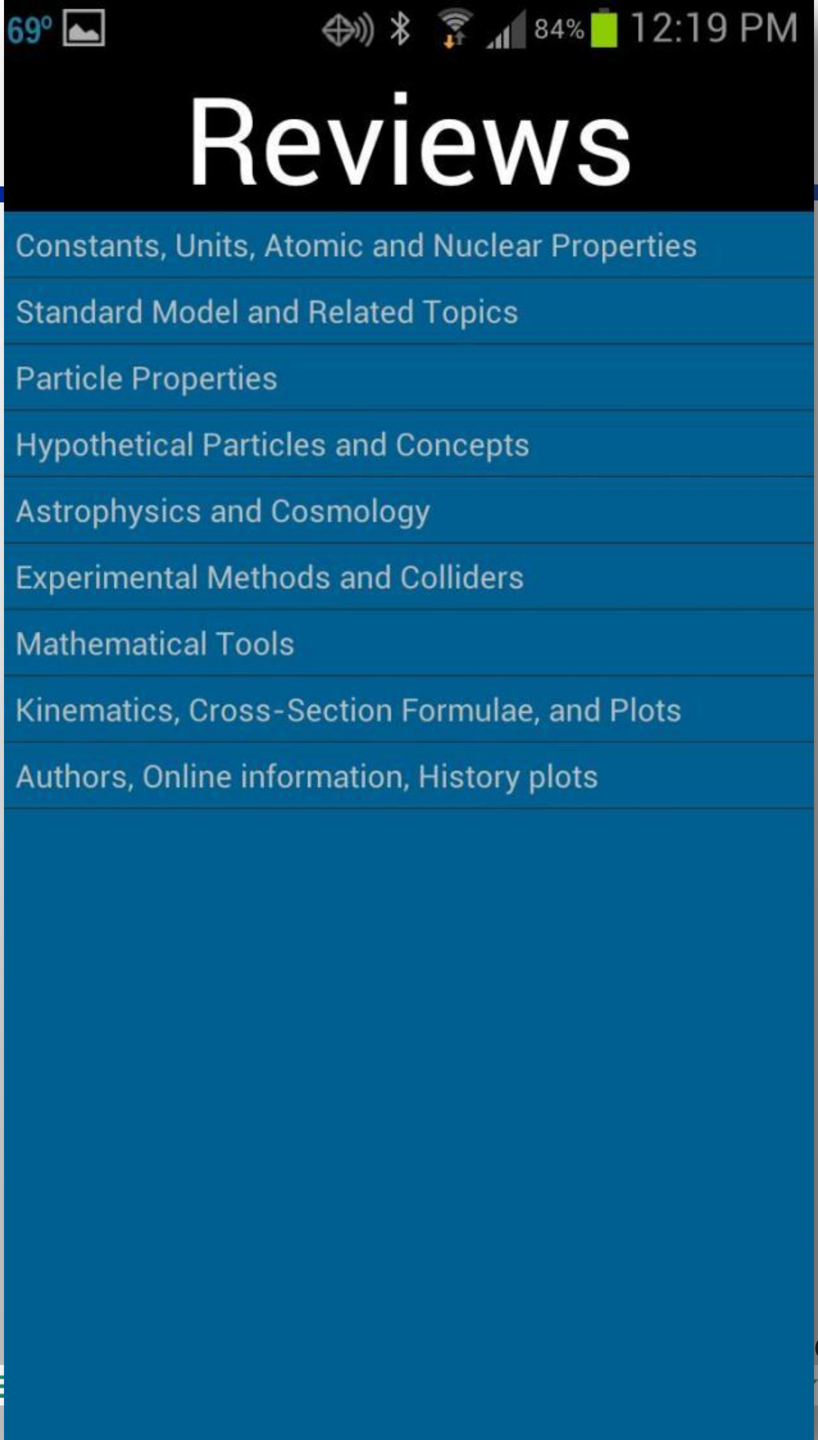
W $J = 1$

Charge = ± 1 e
Mass $m = 80.385 \pm 0.015$ GeV
$m_Z - m_W = 10.4 \pm 1.6$ GeV
$m_{W^+} - m_{W^-} = -0.2 \pm 0.6$ GeV
Full width $\Gamma = 2.085 \pm 0.042$ GeV
$\langle N_{\pi^\pm} \rangle = 15.70 \pm 0.35$
$\langle N_{K^\pm} \rangle = 2.20 \pm 0.19$
$\langle N_p \rangle = 0.92 \pm 0.14$
$\langle N_{\text{charged}} \rangle = 19.39 \pm 0.08$

W^- modes are charge conjugates of the modes below.

W^+ DECAY MODES		Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$\ell^+ \nu$	[b]	(10.80 ± 0.09) %		–
$e^+ \nu$		(10.75 ± 0.13) %		40192
$\mu^+ \nu$		(10.57 ± 0.15) %		40192
$\tau^+ \nu$		(11.25 ± 0.20) %		40173
hadrons		(67.60 ± 0.27) %		–

Reviews


69°
84%
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Reviews
Constants, Units, Atomic and Nuclear Properties
Standard Model and Related Topics
Particle Properties
Hypothetical Particles and Concepts
Astrophysics and Cosmology
Experimental Methods and Colliders
Mathematical Tools
Kinematics, Cross-Section Formulae, and Plots
Authors, Online information, History plots

Reviews

11. THE CKM QUARK-MIXING MATRIX

Revised March 2012 by A. Ceccucci (CERN), Z. Ligeti (LBNL), and Y. Sakai (KEK).

11.1. Introduction

The masses and mixings of quarks have a common origin in the Standard Model (SM). They arise from the Yukawa interactions of the quarks with the Higgs condensate. When the Higgs field acquires a vacuum expectation value, quark mass terms are generated. The physical states are obtained by diagonalizing the up and down quark mass matrices by four unitary matrices, $V_{L,R}^{u,d}$. As a result, the charged current $W^{\pm}$ interactions couple to the physical up and down-type quarks with couplings given by

$$V_{\rm CKM} \equiv V_L^u V_L^{d\dagger} = \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix}. \qquad (11.2)$$

This Cabibbo-Kobayashi-Maskawa (CKM) matrix [1,2] is a 3×3 unitary matrix. It can be parameterized by three mixing angles and a CP-violating phase,

$$V = \begin{pmatrix} c_{12}c_{13} & s_{12}c_{13} & s_{13}e^{-i\delta} \\ -s_{12}c_{23}-c_{12}s_{23}s_{13}e^{i\delta} & c_{12}c_{23}-s_{12}s_{23}s_{13}e^{i\delta} & s_{23}c_{13} \\ s_{12}s_{23}-c_{12}c_{23}s_{13}e^{i\delta} & -c_{12}s_{23}-s_{12}c_{23}s_{13}e^{i\delta} & c_{23}c_{13} \end{pmatrix}, \qquad (11.3)$$

where $s_{ij} = \sin\theta_{ij}$, $c_{ij} = \cos\theta_{ij}$, and δ is the phase responsible for all CP-violating phenomena in flavor changing processes in the SM. The angles θ_{ij} can be chosen to lie in the first quadrant.

It is known experimentally that $s_{13} \ll s_{23} \ll s_{12} \ll 1$, and it is convenient to exhibit this hierarchy using the Wolfenstein parameterization. We define [4–6]

$$s_{12} = \lambda = \frac{|V_{us}|}{\sqrt{|V_{ud}|^2 + |V_{us}|^2}}, \qquad s_{23} = A\lambda^2 = \lambda \left| \frac{V_{cb}}{V_{us}} \right|,$$

$$s_{13}e^{i\delta} = V_{ub}^* = A\lambda^3(\rho + i\eta) = \frac{A\lambda^3(\bar\rho + i\bar\eta)\sqrt{1-A^2\lambda^4}}{\sqrt{1-\lambda^2}[1 - A^2\lambda^4(\bar\rho + i\bar\eta)]}. \qquad (11.4)$$

These ensure that $\bar\rho + i\bar\eta = -(V_{ud}V_{ub}^*)/(V_{cd}V_{cb}^*)$ is phase-convention independent and the CKM matrix written in terms of λ, A, $\bar\rho$ and $\bar\eta$ is unitary to all orders in λ. To $\mathcal{O}(\lambda^4)$,

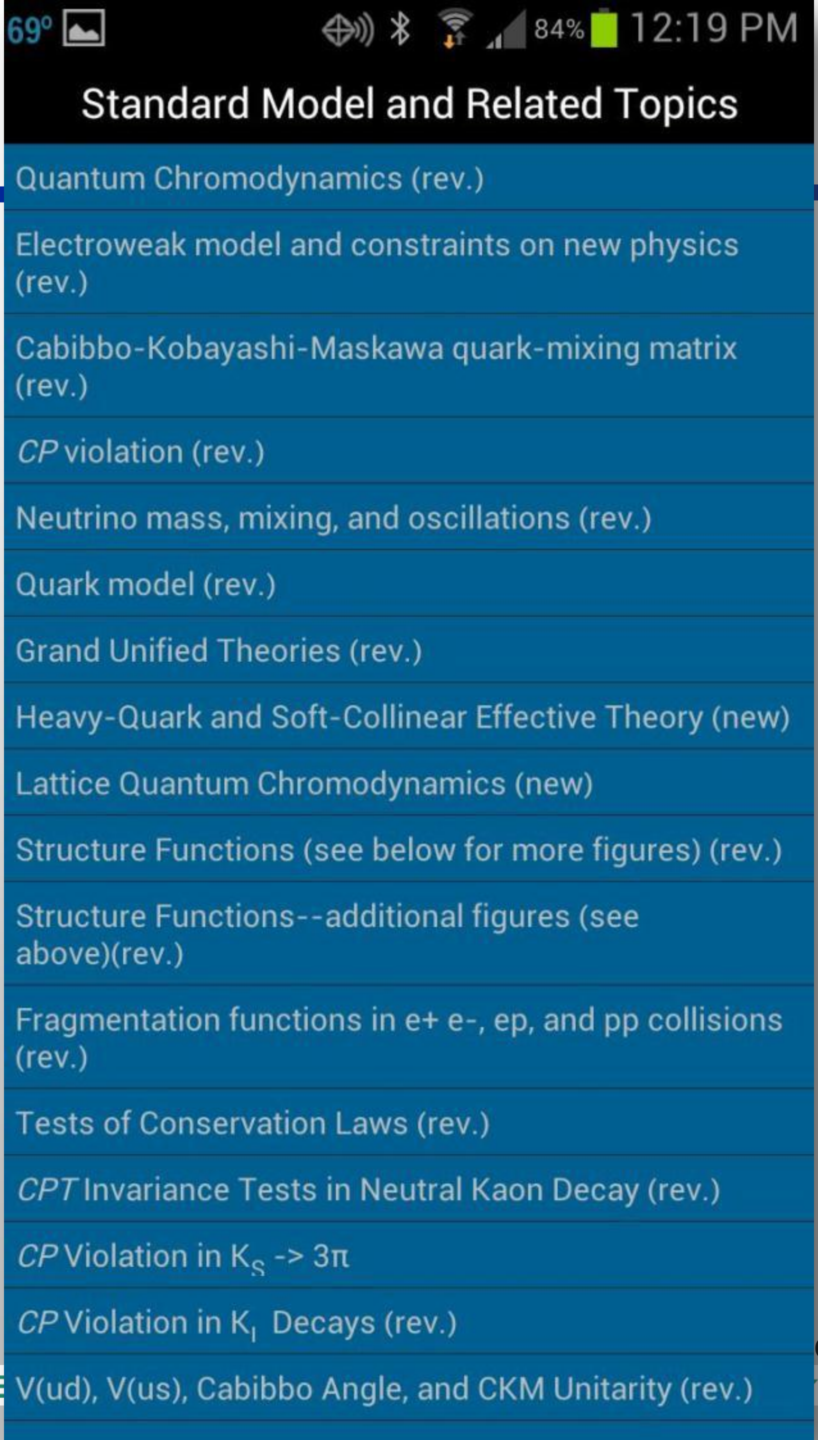
$$V = \begin{pmatrix} 1-\lambda^2/2 & \lambda & A\lambda^3(\rho - i\eta) \\ -\lambda & 1-\lambda^2/2 & A\lambda^2 \\ A\lambda^3(1-\rho-i\eta) & -A\lambda^2 & 1 \end{pmatrix} + \mathcal{O}(\lambda^4). \qquad (11.5)$$

Unitarity implies $\sum_i V_{ij}V_{ik}^* = \delta_{jk}$ and $\sum_j V_{ij}V_{kj}^* = \delta_{ik}$. The six vanishing combinations can be represented as triangles in a complex plane. The most commonly used unitarity triangle arises from

$$V_{ud}V_{ub}^* + V_{cd}V_{cb}^* + V_{td}V_{tb}^* = 0, \qquad (11.6)$$

by dividing each side by $V_{cd}V_{cb}^*$ (see Fig. 1). The vertices are exactly $(0,0)$, $(1,0)$ and, due to the definition in Eq. (11.4), $(\bar\rho, \bar\eta)$. An important goal of flavor physics is to overconstrain the CKM elements, many of which can be displayed and compared in the $\bar\rho, \bar\eta$ plane.

Can fill the screen



particle data group

BERKELEY LAB

Deployment in a few months?