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Chapter 1

Theoretical Introduction

A. Kronfeld, Z. Ligeti, U. Nierste

This chapter provides a theoretical introduction to B physics, with special attention to hadron colliders.

1.1 Motivation

Goal: establish origin of CP violation and test the standard model.

1.2 General Formalism

Describe the neutreal meson system. Time evolution, including $\Delta\Gamma$. Formulae including width difference for time dependent and integrated asymmetries.

1.2.1 Mixing and Time Evolution

1.2.2 Time-dependent and time-integrated CP Asymmetries

1.2.3 Phase Conventions

1.3 Aspects of CP Violation

It's hard to say something new here, but we should still include this.

1.3.1 Types of CP Violation

There are three phase convention independent quantities...

1.3.1.1 CP Violation in Mixing

1.3.1.2 CP Violation in Decay

1.3.1.3 CP Violation in the Interference Between Decay with and without Mixing

1.3.2 $\Delta F = 2$ vs. $\Delta F = 1$ CP Violation

1.3.3 CP Violation in decays to non CP eigenstates

1.4 CP Violation in the SM

1.4.1 CKM Picture and Unitarity

Everything depends on one invariant, J. Define $\bar{\rho}$, $\bar{\eta}$, etc.

1.4.2 "Clean" Measurements

What can be done that follows from symmetries?

1.5 Theoretical Tools

Relevant model independent ways to get info on hadronic physics.

1.5.1 Effective Hamiltonians

1.5.2 Heavy Quark Expansion

1.5.3 Heavy Quark Effective Theory

1.5.4 Isospin and $SU(3)$ Symmetry

1.5.5 Lattice Gauge Theory

1.6 Input from Kaon Physics

1.6.1 ϵ_K

1.6.2 ϵ'

1.6.3 $K^+ \to \pi^+ \nu\bar{\nu}$ and $K^0 \to \pi^0 \nu\bar{\nu}$

1.7 Expected CP Asymmetries in the Standard Model

1.7.1 Present Constraints

Where we stand now:

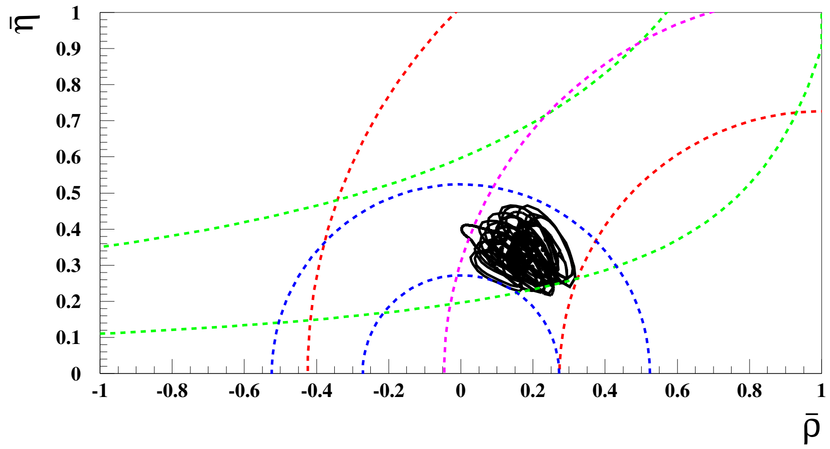

Figure 1.1: The 95% CL allowed region on the $\bar{\rho} - \bar{\eta}$ plane. Each contour corresponds to one theoretical model, and the envelope of all of them is the overall 95% CL allowed region. Also shown are the individual constraints. (From Ref. [1].)

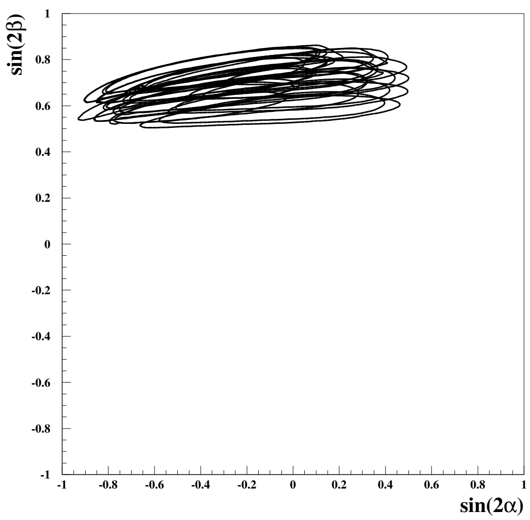

Figure 1.2: The 95% CL allowed region on the $\sin 2\alpha - \sin 2\beta$ plane. Each contour corresponds to one theoretical model, and the envelope of all of them is the overall 95% CL allowed region. (From Ref. [1].)

References

[1] S. Plaszczynski and M.H Schune, hep-ph/9911280.

[2] T. Affolder *et al.*, CDF Collaboration, hep-ex/9909003, to appear in Phys. Rev. D.

[3] N. Isgur and M.B. Wise, Phys. Lett. B232 (1989) 113; Phys. Lett. B237 (1990) 527.

[4] I.I. Bigi, M. Shifman, N.G. Uraltsev, and A. Vainshtein, Phys. Rev. Lett. 71 (1993) 496.

[5] A.V. Manohar and M.B. Wise, Phys. Rev. D49 (1994) 1310.

[6] G.C. Branco, L. Lavoura, and J.P. Silva, *CP Violation* (Clarendon Press, Oxford, 1999).

[7] The BaBar Physics Book, eds. P.F. Harrison and H.R. Quinn, SLAC Report SLAC-R-504 (1998).

[8] Y. Nir, Proceedings of the XXVII SLAC Summer Institute on Particle Physics, hep-ph/9911321.