## Studies of Models of Fermion Masses and Mixing

#### A THESIS

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Faculty of Science

by

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DEPARTMENT OF PHYSICS MOHANLAL SUKHADIA UNIVERSITY UDAIPUR Year of submission: 2011 To

# my family

## DECLARATION

I Mr. Kodrani Bhavikkumar Pravinkumar, S/o Mr. Kodrani Pravinkumar, resident of E-203, PRL residences, Navrangpura, Ahmedabad 380009, hereby declare that the work incorporated in the present thesis entitled, "Studies of Models of Fermion Masses and Mixing" is my own and original. This work (in part or in full) has not been submitted to any University for the award of a Degree or a Diploma.

Date :

(Kodrani Bhavikkumar Pravinkumar)

## CERTIFICATE

I feel great pleasure in certifying that the thesis entitled, "Studies of Models of Fermion Masses and Mixing" embodies a record of the results of investigations carried out by Mr. Kodrani Bhavikkumar Pravinkumar under my guidance.

He has completed the following requirements as per Ph.D. regulations of the University.

(a) Course work as per the university rules.

(b) Residential requirements of the university.

(c) Presented his work in the departmental committee.

(d) Published minimum of two research papers in a referred research journal.

I am satisfied with the analysis of data, interpretation of results and conclusions drawn.

I recommend the submission of thesis.

Date :

Anjan S. Joshipura Professor (Thesis Supervisor)

Countersigned by Head of the Department

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#### Abstract

In this thesis we consider two Higgs doublet model (2HDM) as physics beyond standard model (SM) and study various aspects of CP and flavor violation in it with a view to explain the deviations in CP violating observables in  $B_d^0 - \bar{B}_d^0$  and  $B_s^0 - \bar{B}_s^0$  mixing from SM predictions. 2HDM provide several new sources of CP and flavor violations which are not present in SM. These include flavor changing neutral current (FCNC) interactions, charged Higgs interactions and scalar-pseudoscalar mixing. We consider different variants of 2HDM which can be obtained by imposing some symmetry conditions or some other assumptions on the general 2HDM. These variants include

- 1. 2HDM with minimal flavor violation : In this model all the CP and flavor violations are described in terms of CKM matrix. Introduction of complex Higgs singlets can give rise to new phases to neutral mesons mixing. In this model new contribution to  $B_d^0 \bar{B}_d^0$  and  $B_s^0 \bar{B}_s^0$  mixing gets correlated for the case of neutral Higgs dominance.
- 2. 2HDM with suppressed FCNC : In this model spontaneous CP violation along with the presence of FCNC leads to complex CKM matrix. FCNC in this model are suppressed using 23 symmetry which exchanges quarks of second and third generations.
- 3. 2HDM without FCNC: In this model there are no FCNC. Charged Higgs interactions contains new phases not present type-I or type-II 2HDM and can give new phases to neutral meson mixing. NP contribution to  $B_d^0 \bar{B}_d^0$  and  $B_s^0 \bar{B}_s^0$  in this model gets correlated in the limit when masses and couplings of first and second generation of quarks vanishes.
- 4. 2HDM with general FCNC.

All these variants have different pattern for CP and flavor violations and lead to interesting phenomenological consequences. We make phenomenological analysis of above models and obtain constraints on new physics parameters subjected to constraints from processes such as  $B_d^0 - \bar{B}_d^0$  and  $B_s^0 - \bar{B}_s^0$  mixing,  $\bar{B}_s \to \mu^+ \mu^-$  and  $\bar{B}_d \to \bar{K} \mu^+ \mu^-$ 

# Contents

1	$\operatorname{Intr}$	Introduction			
	1.1	Standa	ard Model	2	
		1.1.1	Neutral current interaction	4	
		1.1.2	Charged current interaction	4	
	1.2	Parameterization of CKM matrix			
		1.2.1	Chau-Keung Parameterization	5	
		1.2.2	Wolfenstein parameterization	6	
	1.3	1.3 Establishment of CKM picture of CP violation			
		1.3.1	Measurement of angle $\gamma$ of unitarity triangle $\ldots \ldots \ldots$	8	
		1.3.2	Determination of CKM parameters in presence of new physics	11	
	1.4 Hints of physics beyond SM				
		1.4.1	Formalism for $B_q^0$ - $\overline{B}_q^0$ mixing $\ldots \ldots \ldots \ldots \ldots \ldots \ldots$	13	
		1.4.2	Hint of NP in $B_d^0 - \overline{B}_d^0$ mixing	14	
		1.4.3	Hint of NP in $B_s^0$ - $\overline{B}_s^0$ mixing	16	
	1.5	Motiva	ation and Outline of the thesis	18	
2	$2\mathrm{HI}$	ЭМ		20	
-	<b>-</b> 9 1	Scolor	Lagrangian	<b>-</b> 0	
	2.1	G		20	
	2.2	Coupli	ng of scalars to fermions	21	
	2.3	2HDM	with natural flavor conservation	23	
		2.3.1	Type - 1 2HDM	23	
		2.3.2	Type - 2 2HDM	24	
	2.4	Source	s of CP violation in General 2HDM	24	

3	2HDM with minimal flavor violation					
	3.1	Model and the structure of FCNC	30			
	3.2	Experimental constraints and their implications	35			
		3.2.1 Basic Results	35			
		3.2.2 Experimental Inputs	38			
	3.3	Charged Higgs dominance	40			
	3.4	Neutral Higgs dominance	42			
	3.5	Summary	45			
4	$2\mathrm{H}$	2HDM with suppressed FCNC 4'				
	4.1	Quark mass matrices and consequences of 23 symmetry	52			
	4.2	FCNC and neutral meson mixing	54			
	4.3	Numerical analysis	58			
	4.4	Summary	61			
<b>5</b>	$2\mathrm{H}$	2HDM without FCNC 6				
	5.1	Mass matrix symmetries and 2HDM	65			
	5.2	Modeling the symmetries:	68			
	5.3	Neutral meson mixing	72			
	5.4	Numerical analysis				
		5.4.1 $B_s^0 - \overline{B}_s^0$ mixing	77			
		5.4.2 Like-sign dimuon charge asymmetry of semileptonic b-hadron				
		decays	79			
	5.5	Summary	81			
6	$2\mathrm{H}$	2HDM with General FCNC 82				
	6.1	FCNC: Structure and examples	85			
	6.2	Effective Hamiltonian for the $b \leftrightarrow s$ transitions	90			
		6.2.1 $B_s^0 - \overline{B}_s^0$ mixing	90			
		6.2.2 $\Delta B = 1$ transitions	92			
	6.3	Constraining the FCNC couplings	94			
	6.4	Conclusion	101			

#### 7 Summary

104

$\mathbf{A}$	Calculation of Wilson coefficients for $B^0_q$ - $ar{B}^0_q$ mixing in 2HDM with-						
	out FCNC 11						
	A.1	Calculation of new contribution to $B_q^0 - \overline{B}_q^0$ mixing $\ldots \ldots \ldots$					
		A.1.1	Box diagram with $W^+, H^-$ in the loop $\ldots \ldots \ldots \ldots$	113			
		A.1.2	Box diagram with $H^+, H^-$ in the loop $\ldots \ldots \ldots \ldots$	116			
		A.1.3	Box diagram with $H^+, G^-$ in the loop	119			
		A.1.4	Total new contribution	121			
в	B List of publications 123						
Bibliography 1							