

Title: Theory and phenomenology of two-Higgs-doublet models

Author(s): Branco, G. C.^{2,3}; **Ferreira, P. M.**^{1,4}; Lavoura, L.^{2,3}; Rebelo, M. N.^{2,3}; Sher, Marc⁵; Silva, João P.^{4,3}

Source: Physics Reports-Review Section Of Physics Letters

Volume: 516 **Issue:** 1-2 **Pages:** 1-102 **DOI:** 10.1016/j.physrep.2012.02.002

Published: Jul 2012

Document Type: Review

Language: English

Abstract: We discuss theoretical and phenomenological aspects of two-Higgs-doublet extensions of the Standard Model. In general, these extensions have scalar mediated flavour changing neutral currents which are strongly constrained by experiment. Various strategies are discussed to control these flavour changing scalar currents and their phenomenological consequences are analysed. In particular, scenarios with natural flavour conservation are investigated, including the so-called type I and type II models as well as lepton-specific and inert models. Type III models are then discussed, where scalar flavour changing neutral currents are present at tree level, but are suppressed by either a specific ansatz for the Yukawa couplings or by the introduction of family symmetries leading to a natural suppression mechanism. We also consider the phenomenology of charged scalars in these models. Next we turn to the role of symmetries in the scalar sector. We discuss the six symmetry-constrained scalar potentials and their extension into the fermion sector. The vacuum structure of the scalar potential is analysed, including a study of the vacuum stability conditions on the potential and the renormalization-group improvement of these conditions is also presented. The stability of the tree level minimum of the scalar potential in connection with electric charge conservation and its behaviour under CP is analysed. The question of CP violation is addressed in detail, including the cases of explicit CP violation and spontaneous CP violation. We present a detailed study of weak basis invariants which are odd under CP. These invariants allow for the possibility of studying the CP properties of any two-Higgs-doublet model in an arbitrary Higgs basis. A careful study of spontaneous CP violation is presented, including an analysis of the conditions which have to be satisfied in order for a vacuum to violate CP. We present minimal models of CP violation where the vacuum phase is sufficient to generate a complex CKM matrix, which is at present a requirement for any realistic model of spontaneous CP violation. (C) 2012 Elsevier B.V. All rights reserved.

KeyWords Plus: Higgs-Doublet Models; Changing Neutral Currents; Spontaneous CP Violation; Electroweak Symmetry-Breaking; Minimal Flavor Violation; Rare B-Decays; Supersymmetric Standard Model; Grand Unified Theories; Effective-Field Theory; Large Hadron Collider

Reprint Address: Ferreira, PM (reprint author), Univ Lisbon, Ctr Fis Teor & Computac, P-1649003 Lisbon, Portugal.

Addresses:

1. Univ Lisbon, Ctr Fis Teor & Computac, P-1649003 Lisbon, Portugal
2. Univ Tecn Lisboa, Inst Super Tecn, Dept Fis, P-1049001 Lisbon, Portugal
3. Univ Tecn Lisboa, Inst Super Tecn, Ctr Fis Teor Partículas, P-1049001 Lisbon, Portugal
4. Inst Super Engn Lisboa, P-1959007 Lisbon, Portugal
5. Coll William & Mary, High Energy Theory Grp, Williamsburg, VA 23187 USA

E-mail

Address: gbranco@ist.utl.pt; pedromferreira@gmail.com; balio@cftp.ist.utl.pt; rebelo@ist.utl.pt; mtsher@wm.edu; jpsilva@cftp.ist.utl.pt

Funding:

Funding Agency	Grant Number
Portuguese Fundacao para a Ciencia e a Tecnologia (FCT)	CERN/FP/116328/2010 PTDC/FIS/098188/2008
CFTP-FCT Unit 777	
POCTI (FEDER)	
Marie Curie Initial Training Network 'UNILHC'	PITN-GA-2009-237920
FCT	PTDC/FIS/70156/2006
National Science Foundation	NSF-PHY-0757481

Publisher: Elsevier Science BV

Publisher Address: Po Box 211, 1000 AE Amsterdam, Netherlands

ISSN: 0370-1573

Citation: Branco G C, Ferreira P M, Lavoura L, Rebelo M N, Sher M, Silva J P. Theory and phenomenology of two-Higgs-doublet models. Physics Reports-Review Section Of Physics Letters. 2012; 1-2 (516): 1-102.