Flavor and Higgs Physics in Randall-Sundrum Models

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Abstract. We want to evaluate the three-body flavor-violating Higgs decays, i.e. $h^0 \to cW^-\bar{b}$, which could compete with the two-body decays $h^0 \to b\bar{b}$, $c\bar{c}$, $\tau^+\tau^-$, below the threshold for the mode $h^0 \to c\bar{t}$. Here we evaluate the mode $h^0 \to c\bar{t}$; this mode would require $m_{h^0} > m_t + m_c$, which may be in conflict with Electro-Weak precision tests. We work within the Randall-Sundrum set up, which is known to offer an alternative solution to the hierarchy problem.

Keywords: Randall-Sundrum Models, Flavor Physics, Higgs-Fermions Interactions.
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INTRODUCTION

The Randall-Sundrum model (RS) considers a 5D space-time, with anti de-Sitter geometry (AdS_5); the fifth dimension is compactified on an orbifold. A slide of this AdS_5 has boundaries two 4D-branes: the UV-brane (M_p, Planck Scale), and the IR-brane (TeV's scale) [1].

The 5D RS scenario considers that the Higgs is localized at the IR-brane, in order to explain the hierarchy problem. The first and the second generation of fermions are localized near the UV-brane, and the third generation is localized near the IR-brane, this localization explains the hierarchy of the Yukawa Couplings [2].

FLAVOR-CHANGING INTERACTION

LFV interactions of the Higgs boson where shown to appear in the RS scenario [3]. Studies of the general features involving flavor physics in the RS models are in [3]. In particular we would like to study a three body Higgs decay. The general expression for the Higgs-fermions (up-type quark) interactions is:

$$L_Y^{4D} \propto -\sum_{i,j} (g_h^u)_{ij} h \bar{u}_L^i u_R^j + h.c. \qquad (1)$$

The couplings describing the flavor-changing interactions, $(g_h^u)_{ij}$, are expressed in terms of the fermionic profiles evaluated at the IR-brane, the Yukawa matrices and a mixture of eigenvectors in the flavor space [3]. Both, the contribution from the SM and for the RS are included at the coupling constant.

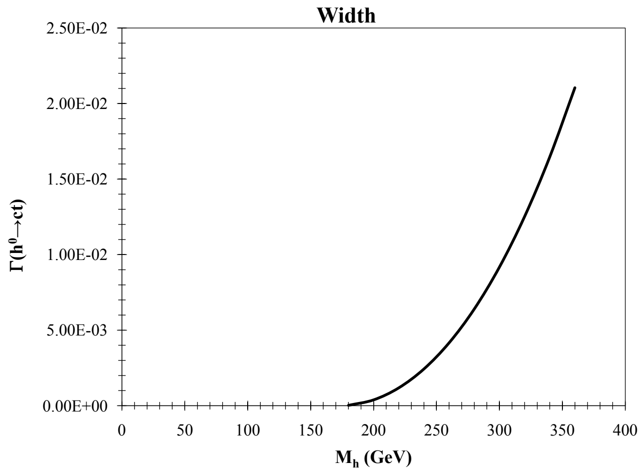

FIGURE 1. 2-body decay $h^0 \to c\bar{t}$ width

Higgs Decays in the RS Model

Equation (1) describes the interactions of the different Kaluza-Klein modes (KK) with the Higgs boson. We will consider only the interaction of the Higgs boson with the zero mode KK fermions. Here we will evaluate the amplitude for the two body decay including only the FCNC Higgs contributions (the three body decay have another SM contribution, and it will be included in a fourthcoming publication). We consider the two body decay: $h^0 \to c\bar{t}$, whose amplitude is:

$$iM = \bar{u}(p_2)[\frac{i}{2}(g_h^u)_{c^{(0)}t^{(0)}}(1+\gamma^5)]v(p_1) \tag{2}$$

where the $c^{(0)}$ and the $t^{(0)}$ indicate the zero KK modes, and the coupling constant is of the form,

$$(g_h^u)_{c^{(0)}t^{(0)}} = \frac{\sqrt{m_{c^{(0)}}m_{t^{(0)}}}}{v}\chi_{c^{(0)}t^{(0)}}e^{i\theta_{c^{(0)}t^{(0)}}} \tag{3}$$

in this model $v \sim 246GeV$. To evaluate the 2-body width decay, shown in Fig.1, we include the expression for 2-body phase space, namely [4]:

$$d\Gamma(Y \to fg) = \frac{1}{32\pi^2}|\bar{M}|^2\frac{|p_1|}{m^2}\sin\theta d\theta d\phi \tag{4}$$

in our case:

$$|\bar{M}|^2 \sim \frac{m_{c^{(0)}}m_{t^{(0)}}}{v}\chi_{c^{(0)}t^{(0)}}p_1 \cdot p_2 \tag{5}$$

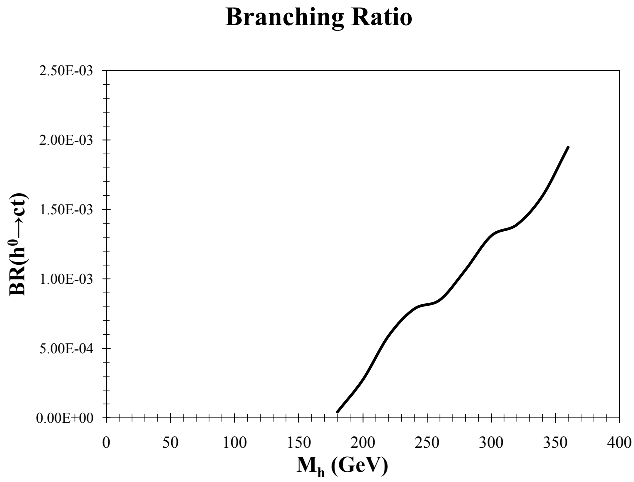

FIGURE 2. Branching Ratio for the 2-body decay $h^0 \to c\bar{t}$

Results

Using for the total decay width of the Higgs, the SM aproximation, we found the Branching Ratio shown in Fig.2, where we have to consider the process above the threshold $\sim 175GeV$, in order to be consistent with the theory, $m_h > m_t + m_c$.

Taking a mass range for the Higgs between $180 - 360GeV's$ we obtain (in the context of the RS model) a Branching Ratio of the order of $\sim 10^{-3} - 10^{-4}$, which is consistent with another calculations (THDM II and III)[5].

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