FLAVOR PHYSICS EFFECTS
ON
BEYOND THE STANDARD MODEL PHYSICS

Abstract

by

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The Standard Model (SM) has been extremely well tested on a large number of fronts. There remains only one particle left to discover, the Higgs boson, and the newest collider, the Large Hadron Collider (LHC), is being built expressly for that purpose. Once the LHC is running, physicists will have access to new levels of energy (and hence distance scales) never before attained. However, there are problems with the SM, both experimental and theoretical, that leave many convinced it is not the final theory.

The LHC is not the only experiment capable of probing such high energy scales. A consequence of many models of new physics is that quantum loop corrections generated by new states can generate sizeable effects in the quark flavor sector. With more precise measurements and predictions of the flavor sector, one may be able to tease out signs of new physics indirectly. Individually, these two methods of searching for new physics (direct and indirect) have their own strengths and weaknesses, it is by combining the two that will give the clearest picture. In this thesis, I give a few examples of this interplay.

First, I derive a set of sum rules that relate flavor-changing supersymmetric (SUSY) amplitudes to physical SUSY masses. SUSY is the theory of extending the SM by introducing a symmetry between bosons and fermions. There are several reasons to believe that SUSY

appears near the TeV scale and therefore might be tested at the LHC. These sum rules are derived in minimally flavor-violating models of SUSY. I then show how these sum rules can help disentangle the various SUSY contributions to $b \rightarrow s\gamma$.

Second, I determine the true lower mass bound on the SUSY charged Higgs. By applying several electroweak and flavor constraints, including those from $b \rightarrow s\gamma$, $B_s \rightarrow \mu\mu$, $B \rightarrow \tau\nu$ and $B \rightarrow D\tau\nu$, I find that the charged Higgs boson can be as light as 140 GeV. This is with a focus on two conventional SUSy scenarios, the "Max-mixing" and "No-mixing" scenarios. A charged Higgs below 150 Gev is allowed in both these scenarios, though for different ranges of tan β.

Finally, I will examine how quark flavor physics affects the lepton sector, particularly its effect on neutrinoless double beta decay experiments. Though these experiments are run in order to test the Majorana nature of the neutrino, they are also a test of new lepton number-violating operators. For generic coupling constants, current experiments probe scales far above that of the LHC. I will show, however, if one imposes minimal flavor violation on the quark sector, these experiments see their sensitivity reduced to an energy scale similar to that of the LHC's. After taking account that these operators themselves can induce neutrino masses, I find that there are only four neutrinoless double beta operators exist which both pass neutrino mass bounds and can be probed by both the LHC and current neutrinoless double beta decay experiments.