INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

This thesis focuses on the study of the semileptonic B meson decays via the neutral and charged current exchanges. The charged current transitions occur at tree level in the Standard Model (SM) and the branching fractions of the semileptonic decays of B mesons to lighter leptons (electron and muon) in the final state as considered in this thesis have been determined to be mostly SM-like. In such cases, the charged current transitions provide an important avenue for the clean extraction of the Cabibbo-Kobayashi-Maskawa (CKM) matrix elements which is very crucial for understanding the CKM structure of the Standard Model and for precise theoretical predictions of several observables. In this thesis, we have studied the extraction of the CKM elements |Vub|, |Vcb|, and the ratio |Vub|/|Vcb| which are relatively less precisely known.

It has been observed that the extracted values of |Vub| and |Vcb| from the inclusive decays are larger as compared to those extracted from the corresponding exclusive decays. The discrepancy between the exclusive and inclusive determinations is more for |Vub|. Explaining this discrepancy with new physics is difficult as pointed out in some of the earlier analyses in the literature. These are the long standing puzzles, so far no convincing arguments addressing these puzzles are available in the literature. This could be due to our lack of understanding of the non-perturbative unknowns. Also the methodology adopted by the Heavy Flavor Averaging Group (HFLAV) for the exclusive determination from B -> πlν decays is not very clean. In this thesis, we have studied this decay modes reconsidering other possible ways of analyzing the available data and pin-point the source of the discrepancy as mentioned above. We have utilized the newly available inputs on the form-factors from Light Cone Sum Rules (LCSR) approach along with the Lattice QCD computations. It has been found that the BaBar 2011 dataset is in tension with the other datapoints and it is also influential in the extraction of |Vub| and could be the probable source of discrepancy between the exclusive and inclusive determinations. We have also considered other exclusive b -> ulν channels for eg. B -> ρ(w)lν for a combined extraction of |Vub| and the exclusive b -> clν channels for combined extraction of |Vcb|. We have obtained the ratio |Vub|/|Vcb| from the experimental measurements and form factor inputs in the mesonic b -> c(u)lν decays independently and also after incorporating the ratio of the branching fractions in the two bins of Bs -> K momentum transfer measured by LHCb. Our value for |Vub|/|Vcb| is consistent with the determination from the ratio of partial rates of baryonic decays from LHCb.

Apart from the charged current transitions, we have also studied the Flavor Changing Neutral Current (FCNC) transitions which being loop-suppressed in the SM are highly sensitive to new physics (NP) effects at higher energy scales and any deviation of the experimental measurements from the SM predictions signify the possibility of beyond SM (BSM) particles. Over the last few years, the low-energy experiments in B physics have shown some anomalous results indicating an indirect hint of new physics. In the neutral current sector in the B(Bs) -> (K,K*) (Φ) modes, the various experimental collaborations have measured several observables, such as the Lepton Flavor Universality Violating observables and a plenty of angular observables, out of which some have shown deviation from their respective SM expectations. This thesis addresses this issue by extending the SM framework with dimension six operators in a model-independent effective field theory approach to find out the operator or sets of operators which can provide plausible explanation to the present data. In general in a NP model, besides the one-operator scenarios, some multi operator scenarios may also contribute to the processes under study and may provide possible explanation to the observed anomalous results which necessitates the role of model selection. In this regard, we have employed Akaike Information Criterion and Cross-Validation to select the best possible combinations of operators most compatible with the available data in this channel. In addition to the b -> sll channels, we have also analysed the exclusive b -> dll transitions in this thesis which may offer another window to look for beyond SM phenomenon. The non-vanishing direct CP asymmetry and low branching ratios of these decay modes in the SM further motivates a systematic analysis of these modes within the framework of the SM and also in some NP scenarios. We have predicted several observables in these channels for eg. the branching fractions, direct CP asymmetries, isospin asymmetry and various angular observables in the SM and also compared the sensitivities of these observables towards the different NP scenarios. If the future measurements report a deviation with respect to the SM predictions in these channels, it will be possible to identify the type of new physics interaction from the pattern of the results.