Abstract

Top quark is the only quark available within the Standard Model (SM) of particle physics, which decays before forming bound state with other quarks, including its anti-particle. This property of the top quark makes it unique as it provides a way to study the properties of a *bare quark*. The SM predicts branching ratio, BR($t \to Wb$)$\sim$100%. On the other hand, the *Flavor Changing Neutral Current* (FCNC) interactions are forbidden within the SM, with possible contributions arising at higher order corrections only.

In this thesis work we study three different processes of single top quark productions at proposed colliders such as the *Large Hadron Electron Collider* (LHeC), the *International Linear Collider* (ILC) and the *Future Circular Collider for Hadron and Electron* (FCC-he). The choice of the processes under study is advantageous at such colliders due to the fact that, (1) the process is forbidden in the SM, thus reduces the background considerably, (2) the associated production of electron or light quark (produced along with the top quark) provides a handle in disentangling the *Lorentz structure* of the new physics (NP) couplings. We choose SM Effective Field Theory (SMEFT) as the theoretical framework. We consider both vector and tensor structure of their couplings with left- or right-chirality separately. Assuming simultaneous presence of relevant FCNC couplings, we obtain the reach of each of the couplings at 95% C.L., through the processes considered in each of the colliders. Suitable observables related to the top quark polarization and angular distributions of the final state particles are appropriately exploited to disentangle the effects of different couplings. We have also demonstrated the utility of electron beam polarization in obtaining better reach, and further as a tool to discriminate different couplings wherever possible. Our study predicts the limits on the couplings with their simultaneous presence.

The details of the study is given in Chapters 3 to 5 of the thesis.