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Research Interest

The subject of my Ph.D. work is B physics at the LHC and future B-factories which provides a unique window to CP violation. All the experimental facts so far point to the validity of the standard Cabibbo-Kobayashi-Maskawa (CKM) paradigm of CP violation; however, we know that the amount of CP violation provided by this mechanism is at least 9 orders of magnitude smaller than that needed to explain the observed baryon asymmetry. So, there must be some new source of CP violation, which is a subdominant effect in the experiments performed so far. In my thesis, I concentrated on an otherwise sacred symmetry- CPT and violation of it. Though it is under stood that all local axiomatic quantum field theories(LAQFT) must conserve CPT and the assumption of Lorentz invariance is required for the CPT theorem. The reverse is not true: Lorentz violation only allows for, but does not require, CPT violation, even if the other properties of standard quantum field theory are assumed.

The study for CPT violation has threefold reasons. First, like all symmetries, it requires a thorough scrutiny and we might be surprised as history has taught us before. Secondly, for the bound systems like mesons, asymptotic states, whose existence is a prerequisite for the CPT theorem, are not uniquely defined. Quarks and gluons are bound inside the hadrons and cannot be considered, in a true sense, asymptotic states. Thirdly, some nonlocal and nonrenormalizable string-theoretic effects may also appear at the Planck scale with a possible effect at the weak scale through the effective Hamiltonian. CPTV through such non-local interacting QFT does not necessarily lead to the violation of Lorentz symmetry.

Beside this, I also did some model independent studies to reconcile some anomalous data from Tevatron regarding semileptonic B-decay and tried to fit New physics(NP) models and constraint them.

In the future, along with works in this path, I intend to study various possible new physics scenarios in the light of upcoming and constantly upgrading experimental results from LHC and other experiments. There are some plans regarding checking some specific decays, data from which will be able to shed light on various NP parameters, both in model specific (like models with one or more compactified extra dimensions) and model independent way. These may include novel CP violating effects, abnormal enhancement or suppression of branching ratios, deviation of the decay distributions from the Standard Model expectations, etc. Let us note that a direct detection of new physics may not explore the underlying flavor dynamics and it will be left to these indirect search experiments to pin down that sector.

Currently, I am completing a comprehensive study of true Triple product asymmetries in B going to two vector mesons(specifically $Bs \to \phi\phi$) decays and the effect of possible CPTV on decay and mixing. As immediate work plan, there is an ongoing plan to work on 'clean tests' of NP effects and hadronic form factor uncertainties of B decays via virtual processes which offer a multitude of observables free from form factors via angular analysis, the violation of whose relation with Wilson coefficients unambiguously signals the presence of NP.

Though my main focus has been calculational work in B physics, I am also interested in collider studies and the computational studies that are needed for that.