INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

In this thesis we have presented a complete analysis of radiative correction to elastic lepton-proton scattering using effective field theory (EFT) keeping in mind the ongoing Muon Scattering Experiment (MUSE) at PSI. The MUSE seeks to find a resolution to the famous Proton Radius Puzzle, a serious discrepancies associated with the measured values of the proton's charge radius from different experiments, through a simultaneous study of very low-energy electron-proton and muon-proton scatterings with precedented accuracies. The work in the thesis encompasses three vital aspects associated with the systematic analysis of radiative corrections to the lepton-proton scattering process: 1) accounting for the inelastic radiative tail effects constituting the dominant background for the basic elastic process, 2) systematics associated with hadronic effects in the two-photon exchange (TPE) contributions to the elastic cross section, and 3) accurate estimate of the infrared divergence free radiative contributions incorporating dominant hadronic recoil effects. The EFT that we have used is the so-called Heavy Baryon Chiral Perturbation Theory (HBChPT), the non-relativistic analog of Baryon Chiral Perturbation Theory, which is tailor-made to ideally describe the dynamics of nucleon at low-energies. The first work of this thesis is a systematic calculation of the cross-section for the lepton-proton bremsstrahlung process in HBChPT at next-to-leading order (NLO). This process corresponds to an undetected background signal for the proposed MUSE experiment. In the second work, we evaluate the TPE corrections to the low-energy elastic lepton-proton scattering at NLO accuracy, including a non-zero lepton mass. We consider the elastic proton intermediate state in the two-photon exchange invoking soft photon approximation. The infrared singular contributions are projected out using dimensional regularization. In the final work, the full radiative correction to the elastic lepton proton scattering, including all the virtual and corresponding soft photon emission diagrams up to NLO in HBChPT, is taken into account. We demonstrate the systematic cancellation of the infrared singularities amongst the various diagrams contributing to the elastic cross-section.