

Summary

In this thesis, we have focused on the studies of coupling constants of eta and eta-prime mesons with nucleons and electromagnetic transition form factors of eta and eta-prime. Phenomenology of eta and eta-prime mesons carry interesting physics due to their large masses, eta-eta-prime mixing, gluonic admixture, connection to $U(1)$ axial anomaly and contribution from heavy quarks.

In Chapter 1, the basic aspects of the physics of eta and eta-prime mesons are discussed.

In chapter 2, the coupling constants of eta and eta-prime mesons with nucleons are calculated. These calculations are done by using a well-known QCD sum rules approach. Using quark-flavor basis, coupling constants are calculated at physical points by linear extrapolation of results calculated at non-physical points. Light-cone expansion of a quark propagator contains anomalous glue which couple to eta, eta-prime mesons. By explicitly including this contribution, the effects are studied and analyzed. The reliable determination of these coupling constants have implications in understanding axial $U(1)$ dynamics of QCD, in the proton spin puzzle, in construction of realistic NN potential and in estimates of electric dipole moment of neutron.

In Chapter 3, The Transition Form Factors of eta and eta-prime mesons are studied and sub-leading power corrections to these TFFs from twist-six contributions are calculated. These corrections are calculated in standard collinear factorization approach. Meson mass corrections and quark mass corrections which give rise to $SU(3)$ flavor breaking effects are also taken into account. Obtained results are superimposed on the results of these TFFs up to twist-four available in the literature. TFFs act as the important tool to test some approaches of QCD. In the case of eta and eta-prime mesons, these TFFs have a special role in determining their quark-gluon structure and fixing their Distribution Amplitudes. These are essential inputs for the study of various exclusive processes.

In chapter 4, the summary of the present thesis is given. It highlights the main findings of the research and also inspires further study by stating hits and misses of the present study.