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Novel loop-diagrammatic approach to QCD θ parameter and application to the left-right model

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When the QCD axion is absent in full theory, the strong CP problem has to be explained by an additional mechanism, e.g., the left-right symmetry. Even though tree-level QCD θ̄ parameter is restricted by the mechanism, radiative corrections to θ̄ are mostly generated, which leads to a dangerous neutron electric dipole moment (EDM). The ordinary method for calculating the radiative θ̄ utilizes an equation θ̄ = −arg det mloop based on the q chiral rotations of complex quark masses. In this paper, we point out that when full theory includes extra heavy quarks, the ordinary method is unsettled for the extra quark contributions and does not contain its full radiative corrections. We formulate a novel method to calculate the radiative corrections to θ̄ through a direct loop-diagrammatic approach, which should be more robust than the ordinary one. As an application, we investigate the radiative θ̄ in the minimal left-right symmetric model. We first confirm a seminal result that two-loop level radiative θ̄ completely vanishes (corresponding to one- loop corrections to the quark mass matrices). Furthermore, we estimate the size of a non- vanishing radiative θ̄ at three-loop level. It is found that the resultant induced neutron EDM is comparable to the current experimental bound, and the expected size is restricted by the perturbative unitarity bound in the minimal left-right model.

Abstract for a poster

all program topics can be contemplated

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