Hadronic CP violation from strangeness and constraints on CP phases

Ken-ichi Hikasa, Yasuhiro Shimizu, Takeo Moroi, Masahiro Yamaguchi

Department of Physics, Tohoku University, Sendai 980-8578, Japan

The origin of CP violation in nature is a very important issue in particle physics since CP violation is indispensable for the baryon asymmetry in universe. In the standard model (SM), there are two CP violating parameters; the phase of the Cabibbo-Kobayashi-Maskawa (CKM) matrix and the QCD theta (θ) parameter. The former induces CP violation in flavor violating process, such as CP violating K, B decays while the latter induces flavor conserving CP violation, such as neutron electric dipole moment (EDM). The experimental upper bound on the neutron EDM gives strong constraint on θ, ($|\theta| < 10^{-10}$). On the other hand, the recent measurements of CP asymmetry in B decays at Babar and Belle confirm that the phase of the CKM matrix is the dominant source of the CP violation in K and B decays. It is known that the phase of the CKM matrix is not enough to explain the baryon asymmetry in universe. Therefore, it is very important to search for new CP violating phases.

We consider hadronic CP violation induced by chromoelectric dipole moments (CEDMs) of light quarks and the QCD theta parameter ($\bar{\theta}$). We concentrate on the strange quark CEDM. We derive effective CP violating nucleon interactions induced by the CEDMs and $\bar{\theta}$ with the SU(3) chiral Lagrangian technique. From the effective interactions, we calculate the EDMs for the ^{199}Hg atom, neutron and deuteron. Using these results, it is possible to put constraints on the quark CEDMs from the experimental upper bounds on the EDMs of ^{199}Hg atom, neutron.

In order to demonstrate an implication of our results on the supersymmetric (SUSY) models, we calculate the gluino contributions to the quark CEDMs with the flavor violating mass insertion approximations. It is usually considered that the EDMs are sensitive to the flavor diagonal CP phases. However, when both left-handed and right-handed quark mixing exist, the CEDMs can be enhanced by the left-right squark mixings. Since the typical SUSY models have the left-handed squark mixing, the EDMs can give strong constraints on the flavor dependent SUSY phases. These constraints on the CP phases can give important implications to other SUSY phenomenology, including the B physics. As an example, we show that there is a strong correlation between the strange quark CEDM and the CP asymmetry in $B \to \phi K_s$ ($S_{\phi K_S}$). The current bounds on the strange quark CEDM from ^{199}Hg atomic and the neutron EDMs imply that the deviation of $S_{\phi K_S}$ from the SM should be strongly suppressed.