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Strangeness-conserving effective weak chiral Lagrangian

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Abstract. We consider the strangeness–conserving effective weak chiral Lagrangian based on the nonlocal chiral quark model from the instanton vacuum. We incorporate the effect of the strong interaction by the gluon into the effective Lagrangian. The effect of the Wilson coefficients on the weak pion–nucleon coupling constant is discussed briefly.

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In this work, we briefly illustrate the $\Delta S = 0$ effective weak chiral Lagrangian from the instanton vacuum, which is essential to study the weak interaction of hadrons at low-energy regions. Since parity violation (PV) can provide high–precision tests of the electro–weak standard model (SM) [1], a great deal of attention has been paid to PV in the SM. It is known that there is discrepancy in the weak charge between measurements in atomic physics and the prediction from the SM [2]. Moreover, it is well known that there is still disagreement theoretically as well as experimentally [3] in determining the weak pion-nucleon coupling constant h^1_π.

Recently, Meissner et al. [4] studied h^1_π within the SU(3) Skyrme model, based on the effective current–current interaction which is equivalent to a factorization scheme at the leading order in N_c. However, processes such as nonleptonic weak processes defy any explanation from the factorization. Therefore, we first derive the $\Delta S = 0$ effective weak chiral Lagrangian, incorporating the effective Hamiltonian [5] within the nonlocal chiral quark model from the instanton vacuum. Using the derivative expansion, we obtain the effective weak Lagrangian to order $\mathcal{O}(p^2)$ and to the next–to–leading order (NLO) in N_c. We will use this derived effective weak chiral Lagrangian as a starting point for investigating h^1_π.

We include two effects from the strong interaction in the effective Lagrangian : The first one is the QCD vacuum effect which is implemented in the chiral quark model from the instanton vacuum, and the other is the perturbative gluon effect (the strong enhancement effect) which is encoded in the Wilson coefficients [5]. The terms at the leading order of N_c in the effective Lagrangian are expressed in terms of the current–current interactions which correspond to the factorization scheme. It can be easily shown that they are identical to those in [4] when the perturbative gluon effect is turned off. On the other hand, the NLO terms from the non–factorization scheme have a more complicated form. The explicit form of the $\Delta S = 0$ effective weak Lagrangian with the Wilson coefficients to the NLO can be found in [6].

The role of the Wilson coefficients can be investigated by calculating h^1_π from the effective weak chiral Lagrangian. As done in [4], we employ the chiral soliton with the zero-mode quantization. The pion which couples to the nucleon can be introduced from the meson fluctuation around the soliton field. When the perturbative gluon effect is turned off and NLO terms are not considered, h^1_π turns out to be the same as that in [4]. On the other hand, if the strong enhancement effect is taken into account at the leading order in N_c, a rough estimation of the effect shows that h^1_π is enhanced by 20 %, compared to that without the Wilson coefficients. However, it should be noted that if we restrict ourselves to SU(2), h^1_π vanishes anyway. The investigation in the SU(3) flavor space is under progress.

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