Effective Chiral Theory for Pseudoscalar and Vector Mesons

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Abstract

An extended $U(3)_L \otimes U(3)_R$ chiral theory which includes pseudoscalar and vector meson nonets as dynamic variables is presented. We combine the hidden symmetry approach with a general procedure of including the η' meson into chiral theory to construct a most general chiral effective Lagrangian with broken $U(3)_L \otimes U(3)_R$ local symmetry. In analogy with QCD, symmetry breaking terms are included for each of the unbroken Lagrangian densities through a mechanism based on the quark mass matrix. These are taken to be (i) Hermitian, (ii) proportional to the quark mass matrix and, (iii) recover the unbroken Lagrangian smoothly in the limit of vanishing symmetry breaking parameters. The Lagrangian describes, amongst other issues, state mixing and the mass splitting of the pseudoscalar and vector mesons. In the presence of symmetry breaking the kinetic and mass terms of the pseudoscalar particles are both nondiagonal, giving rise to a general and well defined mixing pattern. In the special case of, η_8-η_0 mixing, the mixing pattern involves two mixing angles and two field rescaling parameters. Under simplifying assumptions, this mixing pattern reduces to single mixing angle schemes. Through orthogonalization of particle states and taking the calculated masses to be equal to their experimental values, the number of free parameters is reduced to three, measuring $SU(3)$ flavor and nonet symmetry breaking. We apply our theory to study anomalous radiative decays of pseudoscalar and vector mesons. The value of these free parameters are determined from global fit of decay width data. Based on quality of fit to data, our applications to anomalous radiative decays requires both direct and indirect symmetry breaking. Best agreement to data is obtained within the framework of a single mixing angle pattern.