

The QCD vacuum is populated by localized nonperturbative fluctuations of the gauge fields (instantons), which carry topological charge and cause the dynamical breaking of the chiral symmetry of fermions through zero modes of the Dirac operator. An effective description of low-energy QCD abstracted from this picture (instanton vacuum) describes the basic features of hadronic correlation functions and has been extensively used in studies of meson and baryon structure (masses, form factors, etc). The picture also predicts the gluonic structure of hadrons at low scales ($\mu \sim 1/\rho \sim 0.6$ GeV). We review a method for evaluating hadronic matrix elements of gluon operators in the instanton vacuum, based on a systematic expansion in the instanton packing fraction ("diluteness") [1]. We apply this method to several gluonic operators of interest: (i) hadronic matrix elements of F^2 and $F\text{-}F_{\text{dual}}$ (low-energy theorems from scale and axial anomaly); (ii) leading-twist gluon density in hadrons (partonic momentum sum rule); (iii) higher-twist quark-gluon operators appearing in DIS processes. As a recent application, we discuss a calculation of the nucleon matrix element of the dimension-6 CP-odd gluon operator $F\text{-}F_{\text{dual}}$ (Weinberg operator), which appears in a scenario of hadronic CP-violation and the neutron electric dipole moment [2].

[1] D. Diakonov, M.V. Polyakov and C. Weiss, Nucl. Phys. B 461, 539 (1996)

[2] C. Weiss, Phys. Lett. B 819, 136447 (2021)