Nuclear Theory

The Time-Reversal- and Parity-Violating Nuclear Potential in Chiral Effective Theory

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We derive the parity- and time-reversal-violating nuclear interactions stemming from the QCD theta term and quark/gluon operators of effective dimension 6: quark electric dipole moments, quark and gluon chromo-electric dipole moments, and two four-quark operators. We work in the framework of two-flavor chiral perturbation theory, where a systematic expansion is possible. The different chiral-transformation properties of the sources of time-reversal violation lead to different hadronic interactions. For all sources considered the leading-order potential involves known one-pion exchange, but its specific form and the relative importance of short-range interactions depend on the source. For the theta term, the leading potential is solely given by one-pion exchange, which does not contribute to the deuteron electric dipole moment. In subleading order, a new two-pion-exchange potential is obtained. Its short-range component is indistinguishable from one of two undetermined contact interactions that appear at the same order and represent effects of heavier mesons and other short-range QCD dynamics. One-pion-exchange corrections at this order are discussed as well.

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