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Vector mesons and chiral perturbation theory

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We present an extended version of chiral perturbation theory that incorporates vector mesons in addition to pions and nucleons. This extension establishes a consistent framework by treating the mass of vector mesons as heavy and their associated momentum as light, thereby defining a well-defined power counting rule.

In our proposed theory, contrary to the typical vector-meson dominance (VMD) model, vector mesons are introduced as auxiliary fields that can be entirely integrated out at the leading order. The genuine contributions of vector mesons are taken into account as loop corrections at higher orders.

Through our analysis, we demonstrate that the extended theory significantly improves the description of electromagnetic form factors of pions and nucleons compared to conventional Chiral Perturbation Theory (ChPT). This achievement enables the systematic incorporation of vector-meson dominance. Additionally, we derive the chiral nuclear force up to next-to-next-to-leading order (N²LO) and apply it to NN phase shifts, resulting in enhanced accuracy when compared to conventional ChPT forces. Our findings shed light on the role of vector mesons in low-energy nuclear dynamics.

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