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Nucleon Form Factors in Dispersively Improved Chiral Effective Theory

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We present a new method for calculating the nucleon electromagnetic form factors (EM FFs) combining Chiral Effective Field Theory (ChEFT) and dispersion analysis [1]. The FFs are expressed as dispersive integrals over the two-pion cut at timelike $t > 4M_\pi^2$. The spectral functions are computed using elastic unitarity, chiral pion-nucleon amplitudes (LO, NLO, partial N2LO), and timelike pion FF data. The method effectively includes $\pi\pi$ rescattering effects and the ρ resonance and leads to major improvements compared to traditional ChEFT calculations. Higher-mass isovector and isoscalar t-channel states are described by effective poles, whose strength is fixed by sum rules (charges, radii). We obtain excellent agreement with the spacelike proton and neutron FF data up to $Q^2 \sim 1$ GeV^2. We predict the values of the higher FF derivatives with minimal uncertainties and study their collective behavior (multiple dynamical scales, unnatural sizes). Our approach provides a FF parametrization with proper analyticity and theoretical uncertainty estimates, which can be used for analysis of low-Q^2 elastic scattering data and extraction of the proton radius [2].

[1] J.M. Alarcon, C. Weiss, Phys. Rev. C 97, 055203 (2018).

[2] J.M. Alarcon, C. Weiss, arXiv:1803.09748 [hep-ph].

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