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Nucleon electromagnetic form factors at large momentum from Lattice QCD

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Proton and neutron electric and magnetic form factors are the primary characteristics of their spatial structure and have been studied extensively over the past half-century. At large values of the momentum transfer Q^2 they should reveal transition from nonperturbative to perturbative QCD dynamics and effects of quark orbital angular momenta and diquark correlations. Currently, these form factors are being measured at JLab at momentum transfer up to $Q^2 = 18$ GeV^2 for the proton and up to 14 GeV^2 for the neutron. We will report theoretical study of these form factors using nonperturbative QCD on the lattice, including G_E and G_M nucleon form factors with momenta up to $Q^2 = 12$ GeV^2, pion masses down to the almost-physical m_π=170 MeV, several lattice spacings down to $a = 0.073$ fm, and high $O(10^5)$ statistics. Specifically, we study the G_E/G_M ratios, asymptotic behavior of the F_2/F_1 ratios, and flavor dependence of contributions to the form factors. We observe qualitative agreement of our ab initio theory calculations with experiment. Comparison of our calculations and upcoming JLab experimental results will be an important test of nonperturbative QCD methods in the almost-perturbative regime.

Topical area

Structure of Hadrons and Nuclei

Primary authors: POCHINSKY, Andrew (MIT); NEGELE, John Negele (MIT); SYRITSYN, Sergey (Stony Brook University (SUNY)); GREEN, Jeremy (DESY, Zeuthen); ENGELHARDT, Michael (NMSU); KRIEG, Stefan (Forschungszentrum Jülich / Bonn University); MEINEL, Stefan (University of Arizona)

Presenter: SYRITSYN, Sergey (Stony Brook University (SUNY))

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