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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. One of the recent focal points is their behavior at large values of the momentum transfer Q^2, where one expects to observe transition from nonperturbative to perturbative QCD dynamics and detect effects of quark orbital angular momenta and diquark correlations. Multiple experiments at JLab and elsewhere are focussing on the momentum region up to $Q^2 = 18$ GeV^2 for the proton and up to 14 GeV^2 for the neutron. A theoretical study of these form factors is possible using nonperturbative QCD on the lattice, thanks to considerable increase in the efficiency of the techniques and computing resources. I am going to report our recent lattice QCD calculations of the G_E and G_M nucleon form factors performed with momenta up to $Q^2 = 12\,\mathrm{GeV}^2$, 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 remarkable qualitative agreement of our ab initio theory calculations with experiment. However, one of our intriguing findings is that the proton GE/GM ratio does not appear to cross zero near the $Q^2 = 8$ GeV^2 point, unlike extrapolated experimental data suggest. Comparison of our calculations and upcoming JLab experimental results will be an important test of nonperturbative QCD methods in the almost-perturbative regime.

In-person participation

No

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