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TITLE: THE MAGNETIC MOMENT OF THE NUCLEON: CHIRAL EFFECTIVE FIELD THEORY

Abstract: The magnetic moment of a particle is its tendency to align with a magnetic field, and depends on the total angular momentum of the particle. The magnetic moment of spin-1/2 nucleons such as the proton can be obtained from the Sachs magnetic form factor: commonly identified with the fourier transform of the electric current distribution. In a quantum field theory such as quantum chromodynamics (QCD), there is a anomalous component to the magnetic moment generated by quantum corrections.

These experimentally known effects have been calculated using lattice QCD (an approximation to QCD using a box of discrete momenta), but a simple linear extrapolation of these lattice QCD simulations results in a discrepancy with the experimental result of the magnetic moment of the nucleon. In chiral effective field theory, a low energy effective theory of QCD, so-called ‘self energy’ loops occur. A charged pion will surround the nucleon, and contribute to the angular momentum of the system, and thus to the magnetic moment. These loops modify the simple linear fit to include important non-analytic terms. In my presentation, lattice QCD simulations for the total magnetic moment are corrected to more realistic conditions, using chiral effective field theory. This is achieved by extrapolating to physical quark masses, and accounting for finite-volume corrections.

The exciting and highly significant conclusion of this research is the discovery that the quantum corrections calculated from chiral effective field theory resolve the discrepancy found in the lattice QCD simulations. Finite-volume corrections are significant even at 3 fm box sizes, but the infinite-volume extrapolation agrees with the experimental result for the magnetic moment of the nucleon.