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Nucleon Polarisabilities and Effective Field Theories[1]

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Low-energy Compton scattering probes the nucleon's two-photon response to electric and magnetic fields at fixed photon frequency and multipolarity. It tests the symmetries and strengths of the interactions between constituents, and with photons. For convenience, this energy-dependent information is often compressed into the two scalar dipole polarisabilities α_{E1} and β_{M1} at zero photon energy. These are fundamental quantities, and important for the proton charge radius puzzle and the Lamb shift of muonic hydrogen. Combined with emerging lattice QCD computations, they provide stringent tests for our understanding of hadron structure. Extractions of the proton and neutron polarisabilities from all published elastic data below 300 MeV in Chiral Effective Field Theory with explicit $\Delta(1232)$ are now available. This talk emphasises χEFT as natural bridge between lattice QCD and ongoing or approved efforts at HIγS, MAMI and MAX-lab. Chiral lattice extrapolations from $m_\pi > 200$ MeV to the physical point compare well to lattice computations. Combining χEFT with high-intensity experiments with polarised targets and polarised beams will extract not only scalar polarisabilities, but in particular the four so-far poorly explored spin-polarisabilities. These parametrise the stiffness of the spin in external electromagnetic fields (nucleonic bi-refringence/Faraday effect). New chiral predictions for proton, deuteron and ^{3}He observables show intriguing sensitivities on spin and neutron polarisabilities. Data consistency and a model-independent quantification of residual theory uncertainties by Bayesian analysis are also discussed. Proton-neutron differences explore the interplay between chiral symmetry breaking and short-distance Physics. Finally, I address their impact on the neutron-proton mass difference, big-bang nucleosynthesis, and their relevance for anthropic arguments.

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