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Longitudinal structure of the proton and neutron[1]

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Lepton scattering has been utilized for more than four decades to study the substructure of protons and neutrons, both free and bound in nuclei. The F_2 structure function extracted from such experiments has now been determined over many orders of magnitude in both Bjorken x and the 4-momentum transfer squared, Q^2, and such data have been an invaluable tool for the testing and study of Quantum Chromodynamics (QCD) in the perturbative regime. In addition, new precision data on F_2 from Jefferson Lab in the region of the nucleon resonances has opened up many new studies of the transition from perturbative to non-perturbative QCD. This includes the nature of quark-hadron (Q-H) duality, in which the resonances seem to average to a smooth scaling curve, similar to the that of deep inelastic scattering. In contrast, the longitudinal structure function, F_L, has been measured with much poorer precision and over a much more limited kinematic range. This is due to both the high precision required and the need for measurements at fixed x and Q^2 with multiple beam energies for the separation of longitudinal and transverse structure. Such measurements are critical for a full picture of nucleon structure. For instance, in deep inelastic scattering F_L is directly sensitive to the gluon content of the nucleon, unlike F_2, which is only sensitive through pQCD evolution. We will present the current experimental status of F_L for both free protons and from nucleons in nuclei and discuss some of the physics which can be addressed with such measurements. In particular, studies of Q-H duality and the determination of the structure function moments will be discussed.

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