APR15-2015-000929

Abstract for an Invited Paper
for the APR15 Meeting of
the American Physical Society

Measurement of parity-violating asymmetry in deep inelastic scattering at Jefferson Lab[1]

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Symmetry permeates nature and is fundamental to all laws of physics. One example is mirror symmetry, also called "parity symmetry". It implies that flipping left and right does not change the laws of physics. Laws for electromagnetism, gravity and the subatomic strong force respect parity symmetry, but the subatomic weak force does not. Historically, parity violation in electron scattering played a key role in establishing, and now testing, the Standard Model of particle physics. One particular set of the quantities accessible through measurements of parity-violating electron scattering are the vector-electron axial-vector-quark weak couplings, called C_{2q}'s, measured directly only once in the past 40 years. We report here on a new measurement of the parity-violating asymmetry in electron-quark scattering, that has yielded a specific combination $2C_{2u} - C_{2d}$ five times more precise than the earlier result. (Here u and d stand respectively for the up and the down quarks.) These results are the first evidence, at more than the 95% confidence level, that the C_{2q}'s are non-zero as predicted by the electroweak theory. They lead to constraints on new interactions beyond the Standard Model, particularly on those whose laws change when the quark chirality is flipped between left and right. In today's particle physics research that is focused on colliders such as the LHC, our results provide specific chirality information on electroweak theory that is difficult to obtain at high energies. In addition to deep inelastic scattering, we will report on measurement of the asymmetry in the nucleon resonance region. These data exhibit for the first time that the quark-hadron duality may work for electroweak observables at the $(10-15)\%$ level throughout the whole resonance region. At the end I will give a brief outlook on the future PVDIS program using the Jefferson Lab 12 GeV beam, which will not only provide more precise measurement of C_{2q}, but also for $\sin^2\theta_W$ and for studying unique features of the nucleon structure and that of the strong interaction.

[1]for the Jefferson Lab PVDIS Collaboration