

DNP07-2007-000222

Abstract for an Invited Paper
for the DNP07 Meeting of
the American Physical Society

Probing the TeV Scale with Parity-Violating Electron Scattering: New Opportunities with the 12 GeV Upgrade¹

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The technique of parity-violating electron scattering, involving measurements of the asymmetry in the scattering of longitudinally polarized electrons off fixed targets, has become increasingly precise and broad in its scope over the past two decades. Such asymmetries are sensitive to weak neutral current interactions between electrons and target particles, mediated by the Z^0 boson, and are being used to investigate the strangeness content of the nucleon, the neutron distribution in heavy nuclei and to probe for the limits of the validity of the electroweak theory in a manner complementary to direct searches for new physics at high energy scales at colliders. At Jefferson Laboratory, experimental techniques have now been developed, that allow for asymmetries to be measured with statistical and systematic errors approaching 1 part per billion. With the completion of the 12 GeV upgrade, further precise measurements become feasible, in parity-violating deep inelastic scattering and in electron-electron (Møller) scattering. In particular, the latter measurement could potentially lead to the best measurement of the electroweak mixing angle $\sin^2 \theta_W$ at low energy, with precision equal to or better than the two best collider measurements. In deep inelastic scattering, apart from testing the electroweak theory, the measurements would provide new precision probes of the high- x structure of the nucleon by testing for the onset of charge symmetry violation and allowing a clean and accurate measurement of $d(x)/u(x)$ as $x \rightarrow 1$. In this talk, we will first give an introduction to the experimental technique and report on recent developments. We will then elaborate on the physics motivation for the abovementioned program of new measurements in detail.

¹Research supported by the Department of Energy, Division of Nuclear Physics