Final Report

DOE Award:	DE- FG02-08ER41531
Institution:	University of Wisconsin-Madison
Project Title:	Fundamental Interactions in Nuclei
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The funding awarded during the grant period provided summer salary and travel support for the PI; support (partial or full) support for six post-doctoral researchers, and partial support for seven Ph.D students. The research covered the following topics: electroweak baryogenesis; electroweak symmetry-breaking and its implications for dark matter; fundamental symmetry tests; applications of perturbative QCD and effective field theories to nuclear physics symmetry tests and precise QCD studies. The research resulted in approximately 50 publications and numerous invited talks at major conferences and workshops.

Primary accomplishments include:

1. Development of a gauge invariant method for computing the properties of the electroweak phase transition in beyond Standard Model scenarios and applications to several novel scenarios for electroweak symmetry-breaking.

2. Demonstration that flavor changing CP-violation can be responsible for the observed baryon asymmetry and can be tested with CP-violating observables in heavy flavor physics.

3. Computation of the impact of the pion polarizability on the hadronic light by light contribution to the muon anomalous magnetic moment, indicating a possible greater discrepancy between the experimental result and Standard Model expectation than previously thought

4. Analysis of twist-four contributions to the parity violating asymmetry in deep inelastic electron-deuteron scattering and demonstration of its unique sensitivity to a leptophobic Z' boson

5. Completion of the first comprehensive computation of logarithmic scaling of twist four, isovector leading moment of the F2 structure function.

6. Completion of a major review of electric dipole moments of nucleons, neutral atoms, and nuclei and quantification of the theoretical uncertainties associated with non-perturbative QCD and many-body nuclear physics.

7. Completion of a major review of electroweak baryogenesis.

8. Completion of several studies of precision neutron decay, including new analyses of electroweak corrections in the Standard Model, of radiative corrections in the Minimal Supersymmetric Standard Model, and of the complementarity between the LHC and neutron decay probes of new scalar and tensor interactions.

9. Completion of a comprehensive study of dark matter in a complex scalar gauge singlet extension of the Standard Model scalar sector.

10. Completion of the first computation of the quark chromo-electric dipole moment and CPV four quark operator contributions to the rho-meson EDM in the Dyson Schwinger framework.

Note the projects 1, 3, 4, 5, 9, and 10 have formed components of the PhD research of five students. Of graduating PhD students, two went on to post-doctoral appointments and one entered a masters in computer science program. Of the post-docs, five have gone on to other academic appointments and one has entered private employment.