Relativistic-Many-Body Theory and QED

These theories underpin our understanding of: the atomic structure of few-electron heavy ions, the inner shells of heavy neutral atoms, and molecules containing these elements. They form the basis for our understanding of ALL real-world problems involving these systems.

Connections:

- Theoretical-experimental synergy
- Terrestrial and astrophysical plasmas containing heavy elements.
- DOE cleanup mission - actinides and transuranics
- Testing the Standard Model (PNC, QED, EDM)
- Nuclear many-body theory

Scientific Issues

- Difficulties arise when both interelectron interactions and relativistic effects are important

- $\alpha Z \approx 1$ Non-perturbative - relativity must be treated exactly

- Eigenvalues have no lower bound due to negative energy states $\Rightarrow$ No-Virtual-Pair Approximation (Brown & Ravenhall, Sucher).

- QED is less well tested in the regime of intense electric field strength.