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Electron correlation energies, atomic masses and their applications in the search for physics beyond the standard model

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Electron correlations play important roles in determining the structures and properties of atoms, molecules, and solid-state materials. However, due to complicated electron-electron interactions, it is challenging to accurately treat the correlation effects. In this contribution, we employ the *ab initio* fully relativistic multi-configuration Dirac-Hartree-Fock (MCDHF) and relativistic configuration interaction (RCI) methods to calculate the electron correlation energies and ionization potentials of complex atoms and ions. In collaboration with high-precision mass measurement of highly charged ions in Paul traps, our calculations would enable the determination of the absolute masses of neutral atoms with a relative accuracy of 10^{-12}, and have applications in measuring the neutrino mass and in constraining the hypothetical fifth force.

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