CHAPTER OVERVIEW

9: The Electronic States of the Multielectron Atoms

Multi-electron systems, including both atoms and molecules, are central to the study of chemistry. While we can write the Schrödinger equations for a two-electron atom and for many-electron atoms, the Schrödinger equations for atoms (and molecules too) with more than one electron cannot be solved because of electron-electron Coulomb repulsion terms in the Hamiltonian. These terms make it impossible to separate the variables and solve the Schrödinger equation. Fortunately, reasonably good approximate solutions can be found, and an active area of research for physical chemists involves finding methods to make them even better.

In this chapter you will learn several key techniques for approximating wavefunctions and energies, and you will apply these techniques to multi-electron atoms such as helium. You also will learn how to use the theoretical treatment of the electronic states of matter to account for experimental observations about multi-electron systems. For example, the periodic trends in ionization potential and atomic size that are presented in introductory chemistry texts and reproduced here in Figure 9.1 arise directly from the nature of the electronic states of the atoms in the periodic table.