18.1: Introduction to Quantum Physics

Classical mechanics, including extensions to relativistic velocities, embrace an unusually broad range of topics ranging from astrophysics to nuclear and particle physics, from one-body to many-body statistical mechanics. It is interesting to discuss the role of classical mechanics in the development of quantum mechanics which plays a crucial role in physics. A valid question is "why discuss quantum mechanics in a classical mechanics course?". The answer is that quantum mechanics supersedes classical mechanics as the fundamental theory of mechanics. Classical mechanics is an approximation applicable for situations where quantization is unimportant. Thus there must be a correspondence principle that relates quantum mechanics to classical mechanics, analogous to the relation between relativistic and non-relativistic mechanics. It is illuminating to study the role played by the Hamiltonian formulation of classical mechanics in the development of quantal theory and statistical mechanics. The Hamiltonian formulation is expressed in terms of the phase-space variables $\mathbf{q}, \mathbf{p}$ for which there are well-established rules for transforming to quantal linear operators.