2.S: Foundations of Quantum Mechanics (Summary)

Around 1900 several experimental observations were made that could not be explained, not even qualitatively, by existing physical laws. It therefore was necessary to invent (create) new concepts: quantization of energy and momentum, and a momentum-wavelength relation. In 1900 Planck proposed that electron oscillations in matter were quantized, and their energy was related by E = hν to the frequency of radiation emitted by a hot object. In 1905 Einstein proposed that electromagnetic radiation, light, also was quantized, consisting of photons, each with energy E = hν. In 1914 Bohr used this energy-frequency relationship together with the quantization of angular momentum, $M = n\hbar$, to construct a model of the hydrogen atom that was consistent with its luminescence spectrum. In 1922 Compton explained the inelastic scattering of x-rays by matter by treating the x-rays as particles with momentum p = h/λ. In 1924 de Broglie argued that particles should then have the properties of waves with a wavelength λ. This suggestion led Schrödinger to develop the general underlying theory of Quantum Wave Mechanics in 1925. The wave-like properties of electrons and the validity of the de Broglie relationship were demonstrated directly by Thomson's and Davisson and Germer's diffraction experiments in 1926 and 1927.