CHAPTER OVERVIEW

7: Matter Waves

We begin our study of quantum mechanics by discussing the diffraction undergone by X-rays and electrons when they interact with a crystal. X-rays are a form of electromagnetic radiation with wavelengths comparable to the distances between atoms. Scattering from atoms in a regular crystalline structure results in an interference pattern which is in many ways similar to the pattern from a diffraction grating. We first develop Bragg’s law for diffraction of X-rays from a crystal. Two practical techniques for doing X-ray diffraction are then described.

It turns out that electrons have wave-like properties and also undergo Bragg diffraction by crystals. Bragg diffraction thus provides a crucial bridge between the worlds of waves and particles. With this bridge we introduce the classical ideas of momentum and energy by relating them to the wave vector and frequency of a wave. The properties of waves also give rise to the Heisenberg uncertainty principle.

Table 7.1 shows a table of the Nobel prizes associated with the ideas presented in this chapter. This gives us a feel for the chronology of these discoveries and indicates how important they were to the development of physics in the early 20th century.

Table 7.1: Selected Nobel prize winners, year of award, and contribution.

Year	Recipient	Contribution
1901	W. K. Röntgen	Discovery of X-rays
1906	J. J. Thomson	Discovery of electron
1914	M. von Laue	X-ray diffraction in crystals
1915	W. and L. Bragg	X-ray analysis of crystal structure
1918	M. Planck	Energy quantization
1921	A. Einstein	Photoelectric effect
1922	N. Bohr	Structure of atoms
1929	L.-V. de Broglie	Wave nature of electrons
1932	W. Heisenberg	Quantum mechanics
1933	Schrödinger and Dirac	Atomic theory
1937	Davisson and Thomson	Electron diffraction in crystals

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