1 The historical development of the wave-particle duality concept

Although the wave-particle duality is one of the conceptual cornerstones of quantum mechanics, the wave-or-particle dillemma limited to light only is at least 250 years older than the quantum branch of physics. The question of the nature of light has been an important scientific issue since the 17th century, the same time when modern optics was born. One can easily discern three different stages in the evolution of this problem, and to each of these stages we can attach names of several famous physicists who contributed to our understanding of light. Their discussions and different explanations demonstrate how baffling the nature of light has seemed from the beginning, and how rich is the current of thoughts and ideas that it has stimulated. Only in the last century, thanks to the quantum theory, did the duality problem unexpectedly expand to embrace matter as well.

The first modern scientific inquiries into the realm of optics date back to ca. 1650. Isaac Newton stated that light was composed of particles emitted in all directions from a source, and it was this corpuscular view that became dominant in the 1700s (Ch. 1.1). The second of the aforementioned stages started in the early 19th century when Thomas Young conducted his famous slit experiment which unambiguously proved that light rays interfered just like water waves. Shortly afterwards Augustin-Jean Fresnel presented the wave theory of light grounded firmly within a mathematical framework, and in the 1870s James Clerk Maxwell explained light as propagation of electromagnetic waves (Ch. 1.2). However, in 1905 Albert Einstein, motivated by Max Planck's scheme of energy quantization, put forward an idea that that light itself propagated in space and interacted with matter as discrete particles (light quanta). Twenty years later Louis de Broglie advanced a hypothesis that all matter manifests a wavelike nature, even if under many experimental circumstances it also behaves as if it were consisted of particles. Quantum mechanics employed this conceptual breakthrough in order to united the wave and the particle views: Light and matter show both wavelike and particlelike properties, although not at the same time (Ch. 1.3).

In the following sections we will examine the development of the wave-particle duality concept in more detail, but still rather succinctly. We omit or relegate to later chapters the more detailed quantitative treatments of the presented phenomena, because right now our goal is only to look upon the *historical* evolution of the concept. Hence we can better appreciate the colossal amount of scientific research hidden behind and beneath it.