ECE770-T14/QIC 885: Quantum Electronics & Photonics

Lecture 1

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Abstract and Objectives of Lecture 1

After some introductory remarks and the motivation behind taking this course, the first lecture will be divided into two parts. First I will talk about the origin and brief history of quantum physics, emphasizing a series of experiments to probe the structure of matter in which classical physics failed to explain. Starting with discovery of electron, black body radiation, and photoelectric effect, we discuss briefly the spectra of Hydrogen atom, models of atom, Compton experiment and finally electron diffraction experiment. By highlighting the wave-particle duality of EM radiation and electron, the classical notion of particles and waves as two category of physical objects is modified. Wave-particle duality as the most remarkable conclusion from these experiments will be highlighted and set to be the starting point of our second part of lecture 1. Wave-particle duality states that all elementary objects share two distinct modes of behavior; particle-like and wave-like. In the second part, after introducing Planck-Einstein-de Broglie (PEdB) relation based on the wave-particle duality, the concept of a matter wave and wavefunction will be developed and the Schrodinger Equation (SE) is justified. By discussing the physical meaning associated with the wavefunction in SE via two-slit experiment, the Born statistical interpretation and collapse of wave function will be discussed. I will finally proceed by some remarks about normalization of $|\Psi|^2$ and the continuity equation for probability current density.

Topics of lecture 1

1-1 Introduction

1-2 Wave-Particle Duality of EM Radiation

1-3 Wave-Particle Duality of Massive Elementary Objects

1-4 Wave-Particle Duality of Elementary Objects

1-5 Wave Mechanics & Matter Waves

1-6 The Schrodinger Equation (SE)

1-7 Physical Meaning associated with Wavefunction

1-8 The collapse of Wavefunction

1-9 Normalization of $|\Psi|^2$ and Continuity Equation

References & Suggested Readings

1- S. Gasiriowicz, *Quantum Physics*, 3^{rd} ed., JW, 2003, Chapter 1.

2- N. Zettili, *Quantum Mechanics, Concepts and Applications*, 2^{nd} ed., JW, 2008, Chapter 1.

3- J. L. Pawel, and B. Craseman, *Quantum Mechanics*, AWP, 1961, Chapter 1.

4- A. Messiah, *Quantum Mechanics*, NHP, 1961.

5- H. Kroemer, *Quantum Mechanics: For engineering, material sciences and applied physics*, JWS, 1994, Chapter 1.

6- D.J. Griffith, *Introduction to Quantum Mechanics*, 2^{nd} ed., PH, 2005, Chapter 1.

7- J. L. Pawel, and B. Craseman, *Quantum Mechanics*, AWP, 1961, Chapter 2. (Excellent discussion of Wave Mechanics)

8- B.H. Bransden, C.J. Joachain, *Quantum Mechanics*,2^{nd} ed., Pearson/PH, 2000, chapters 1, 2 and 3.

9- W. Greiner, *Quantum Mechanics An Introduction*, 4^{th} ed., Springer, 2001, Chapters 1, 2 and 3.