ECE770-T14/QIC 885: Quantum Electronics & Photonics

Lecture 2

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Abstract and Objectives of Lecture 2

We start by stating the linear superposition principle in Schrodinger Equation (SE) by focusing on the representation of a wavefunction in configuration space and reciprocal space. Having established the connection between these two spaces through the generalized Fourier Transform (FT) pair, we are able not only to construct any wave function as a solution to SE (linear superposition principle) but we can spectrally decompose any solution to its plane wave function ingredients (spectral decomposition technique). Following the Born statistical interpretation of $|\Psi|^2$, I will discuss how the other dynamical variables such as position, momentum and energy can be calculated. The concept of uncertainty in the dynamical variables will be introduced. Using the developed concepts we are now well-equipped to deal with the wave function description of a classical particle by introducing the concept of a wave packet. I will discuss the Gaussian wave packet representation of a classical particle and showing the minimum uncertainty in position-momentum. A free-space propagation of free object will be investigated in detail and by one example on electron free space propagation, I will briefly discuss the Bohr-Sommerfeld quantization. In the last part, I will talk about the time-independent Schrodinger equation as an introduction to solution of Schrodinger equation and mention about important properties of such solutions, known as energy eigenstates, such as orthonormality, completeness, and inversion symmetry.

Topics of lecture 2

1-10 Linear Superposition Principle in SE

1-11 Expectation Values of Physical Parameters & Operators

1-12 Wavefunction Description of a Free Oject in Free Space

1-13 Bohr-Sommerfeld Quantization

2- Solution of Schrodinger Equation (SE)

2-1 Properties of Wavefunction Solutions of Time-Independent (TI-SE)

2-2 Anatomy of TI-SE

References & Suggested Readings

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

2- A. Goswami, *Quantum Mechanics*, $2^{nd}ed.$, 1997, Chapter 2 and 3.

3- H. Kroemer, *Quantum Mechanics: For engineering, material sciences and applied physics*, JWS, 1994, Section 1-4 and Section 2-1.

4- A.F.J. Levi, *Applied quantum Mechanics*, $2^{nd}ed.$, Cambridge Press, 2006, section 2-2.

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

6- C. Cohen-Tannoudji, B. Diu, F. Laloe, *Quantum Mechanics*, Vol. 1, Wiley-VCH, 1977, Chapter I.