PH5002 - Foundations of Quantum Mechanics

Credits: 15.0  Semester: 1
Number of Lectures: 27  Lecturer: Dr K K Wan
Academic Year: 2016-17

Overview
This introduces students to the modern Hilbert space formulation of quantum mechanics and to relativistic quantum mechanics.

Aims & Objectives
The emphasis is on developing a good understanding of the mathematical and conceptual foundations of the subject. To achieve this the module is presented in several parts: Part 1 introduces Hilbert spaces, operators and the spectral theorem. Part 2 sets out the basic postulates of quantum mechanics. Part 3 discusses operator theory of angular momentum, including orbital and spin angular momentum and their addition. Part 4 consists of an introduction of relativistic quantum mechanics.

Learning Outcomes
Having taken the module students should have gained a good knowledge of the mathematical techniques employed in modern physics and a good understanding of quantum mechanics in an axiomatic manner. In particular students should have a good knowledge of

- operator theory in Hilbert space, particularly selfadjoint and unitary operators, projectors and the spectral theorem for selfadjoint operators and properties of commuting selfadjoint operators,
- the basic postulates on quantum statics and dynamics, including the working of various Pictures to describe quantum evolution,
- the use of creation and annihilation operators,
- quantum entanglement,
- operator theory of angular momentum and their addition,
- Charged spin-half particle in external magnetic field,
- Klein-Gordan and the Dirac equations and the relativistic origin of spin.

Synopsis
The module is presented in several parts:
Part 1 introduces Hilbert spaces, starting from finite-dimensional vector spaces, and operators in Hilbert space, including selfadjoint operators, unitary operators, projectors, and the spectral theorem. Part 2 sets out the basic postulates of quantum mechanics, illustrated by many examples and applications, including of quantum measurement problems, use of creation and annihilation operators, quantum evolution in terms Schrodinger, Heisenberg and Interaction pictures, quantum statistical ensembles and quantum entanglement.
Part 3 discusses operator theory of angular momentum, including orbital and spin angular momentum and their addition and application to the Zeeman effect.
Part 4 consists of an introduction of relativistic quantum mechanics, including the Klein-Gordan and the Dirac Equations and the relativistic origin of spin.

Pre-requisites
PH2011, PH2012, MT2001 or (MT2501 and MT2503), (PH3081 or PH3082 or [MT2003 or (MT2506 and MT2507)]), PH3061 and PH3062

Anti-requisites
None

Assessment
2 Hour Examination = 100%

Recommended Books
Please view University online record:
http://resourcelists.st-andrews.ac.uk/modules/ph5002.html
General Information
Please also read the general information in the School's honours handbook.