PH3062 - Quantum Mechanics 2

Credits:	10.0	**Semester:**	2
Number of Lectures:	18	**Lecturer:**	Dr Antje Kohnle
Academic Year:	2018-19		

Overview
To expand students' basic knowledge gained in PH3061 Quantum Mechanics 1 particularly in approximation methods, time-dependent effects, intrinsic angular momentum ("spin"), and many-particle systems.

Aims & Objectives
- To expand the student's abilities to deal with realistic quantum mechanical problems, in particular (a) those where the single-particle problem does not admit of exact solution, and (b) those where the number of particles is large.
- To reinforce the example cases covered in PH3061 (Quantum Mechanics 1) by using them for practical calculations, particularly in the perturbation theory section of the course.
- To use the language of Dirac notation, and to enable the students to translate freely between it and the more familiar position-basis notation.
- To emphasise the applicability of the methods to common examples of quantum phenomena, e.g. the properties of atoms when irradiated by light.

Learning Outcomes
By the end of the module, the student should:
- be able to use Dirac notation fluently in the context of practical calculations;
- be well acquainted with some approximation methods commonly used in quantum mechanics; - be able to select which method is appropriate for a given problem, and apply it;
- be familiar with the phenomenon of intrinsic angular momentum ("spin"), and the basic mathematical methods used to describe it;
- be able to construct the ground-state wave functions of simple non-interacting many-particle systems as a determinant or permanent of the single-particle wave functions;
- be able to solve simple problems involving the Heisenberg coupling of a small number of spins.

Synopsis
Recap of basic principles, Dirac notation, and maximal sets of mutually commuting operators.
Time-independent perturbation theory (non-degenerate).
Time-independent perturbation theory (degenerate).
Time-dependent perturbation theory; the Fermi golden rule.
The Stern-Gerlach apparatus.
Hilbert space; Matrix representation for spin-1/2; the Pauli matrices. Coupling spins: the two-site Heisenberg model, and how to solve it.
Qubits; Introduction to quantum information.
Indistinguishable particles; symmetries of the wave function; fermionic and bosonic statistics; the Pauli exclusion principle.
Wave functions for particles that don't interact with each other: Slater determinants and permanents.

Pre-requisites
PH3061

Anti-requisites
none

Assessment
Continuous Assessment (class test 15%, successful engagement with web-based question system 5%) = 20%, 2 Hour Examination = 80%

Additional information on continuous assessment etc.

Please note that the definitive comments on continuous assessment will be communicated within the module. This section is intended to give an indication of the likely breakdown and timing of the continuous assessment.

This module is part of the core JH programme, and as such there is a summary of deadlines etc on the School's Students and Staff web pages. There is one class test, contributing 15% to the module mark, likely to be in week eight. Successful engagement with a web-based question system (Peerwise) counts for 5% of the module mark. Students have compulsory tutorials every two weeks.

Accreditation Matters
This module contains material that is or may be part of the IOP "Core of Physics". This includes
First order time independent perturbation theory
Pauli exclusion principle, fermions, bosons, and elementary particles
Electron theory of solids to the level of simple band structure

Recommended Books
Please view University online record: http://resourcelists.st-andrews.ac.uk/modules/ph3062.html

General Information
Please also read the general information in the School's honours handbook.