

PHYS5007

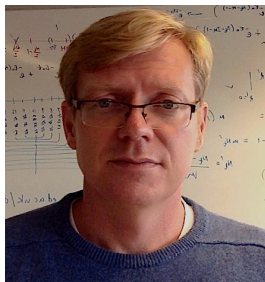
Groups and Symmetries

Course Information Guide

1 Course Details

PHYS5007 Groups and Symmetries is a level 5 Physics masters course. It is composed of 18 lectures, all given in Semester 1.

Lecturer:



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Recommended Texts:

Landau & Lifshitz – Mechanics

Goldstein – Mechanics

Sakurai – Quantum Mechanics

Zee – Group Theory in a Nutshell for Physicists

Course notes and Question Sheets will be made available on Moodle.

2 Assessment

The course will be assessed via an examination in the April/May diet. It provides 10 M-level credits.

3 Required Knowledge

Students are expected to be familiar with the motivations of quantum mechanics as well as mechanics. This course will have some overlap with Mathematical Methods I and II, as well as Dynamics, Electrodynamics and Relativity.

4 Intended Learning Outcomes

By the end of the course, students will be able to demonstrate a knowledge and broad understanding of the role of symmetries in physics. They should be able to define and describe various discrete and continuous groups, explain differences between Abelian and non-Abelian groups and the difference between reducible and irreducible representations. They should be able to specify the generators of $SU(2)$, $SO(3)$, $SU(3)$, as well as those of the Lorentz and Poincaré groups. They should be able to construct representations of $SU(N)$ groups, explain the meaning of Clebsch-Gordon coefficients and use them in physics applications. They should have an overview of the application of symmetry concepts to particle and solid state physics.

5 Course Outline

5.1 Fundamental concepts

We will review the mathematical concepts that underpin the remainder of this course. These are groups, rings, vector spaces and algebras. In order to bridge these mathematical concepts to physics applications we will introduce the Lagrangian Formalism and discuss Noether's Theorem.

5.2 Continuous and Discrete Groups

We will discuss examples of continuous and discrete groups and their application to particle and solid state physics.

5.3 Rotations and Representations

We will discuss rotations in detail as well as their formulation in terms of $SO(3)$ and $SU(2)$ Lie Algebras and their representations and will discuss their relevance for physics motivated from conservation laws and observed phenomena.

5.4 General Lie Algebras and Groups and their representations

An introduction to Lie Groups and Lie Algebras and their connection will be given. The example of $SU(3)$ will be discussed in detail; strategies to obtain irreducible representations will be introduced.

5.5 Lorentz and Poincaré Groups

We will investigate the symmetry groups that form the cornerstone of the theory of special relativity.