

PH2500

A Crash Course in Modern Mathematical Physics

Professor: Igor Kornev

Language of instruction: English – **Number of hours:** 36 – **ECTS:** 3

Prerequisites: PH1100 or equivalent. Basics in quantum mechanics, topology and linear algebra.

Period: S8 Elective 11 March to June IN28IE4, SEP8IE4

Course Objectives

The fundamental laws of nature are geometrical rather than algebraic. This course introduces students to some of the key concepts of modern theoretical physics. The aim of this course is to achieve an understanding and appreciation of geometrical methods in physics.

On completion of the course, students should be able to

- ✧ Understand the concepts of geometrical methods and their role in modern physics.
- ✧ Analyse physics problems using appropriate techniques from group theory and differential geometry.
- ✧ Apply their knowledge to diverse situations in physics and engineering

Course Contents

Topics include a selection from advanced topics in group theory and differential geometry.

- ✧ Introduction: Discrete and continuous symmetries; Mathematical background for groups. (6hrs)
- ✧ Quantum mechanics and rotation invariance (3hrs).
- ✧ The group of rotations. Angular momentum and ladder operators. (6hrs)
- ✧ Spin. How quantum mechanics leads to the use of $SU(2)$. (6hrs)
- ✧ Riemannian metrics, connections, geodesics, curvature. (6hrs)
- ✧ General Relativity; Einstein's Theory of Gravitation. (6hrs)

Course Organization

Lectures and weekly homework assignments.

Teaching Material and Textbooks

- ✧ Geometrical Methods of Mathematical Physics by Bernard Schutz
- ✧ General Relativity by R.M. Wald
- ✧ Auxiliary references: Riemannian Geometry by Manfredo do Carmo

Evaluation

- ✧ Homework: there will be, on average, one homework assignment every week - 40%
- ✧ Final exam - 60%