Group Theory

Lecture 1, Group Theory, Prof. Daniel Roggenkamp

Lecture notes by Janosh Riebesell, 15.04.2015

No exam, no tutorial.
Problem sets (ca. every two weeks or so …)

Introduction

Symmetry

- guiding principle to devise models of physical systems.
- special/general relativity postulated from symmetry considerations
- particle spectrum of SM is governed by gauge group: $\mathrm{SU}(3) \times \mathrm{SU}(2) \times \mathrm{U}(1)$
- symmetries can be used to solve theories.

Noether theorem: continuous symmetries

$$\updownarrow$$

integrals of motion
conserved charges

example: spectrum of H-atom is fixed by representation theory

Mathematical tool to study symmetries:

Group + Representations

Aim: introduction to group theory/representation theory

Topics covered:
- Abstract groups
- Representation theory
- Finite groups (S_n)
- Lie groups/-algebras ($\mathrm{SU}(n)$, Poincaré group)
- Projective representations (central extension)
  $\rightarrow$ QM setup (explain occurrence of $\mathrm{SU}(2)$)
- (Clifford algebra)

Literature:
- Fulton, Harris. *Representation Theory.*
- Hamermesh. *Group Theory and its Application.*
- Ma. *Group Theory for Physicists.*
- Tung. *Group Theory in Physics.*
- Burns. *Introduction to Group Theory.*
- Fuchs, Schweigert. *Symmetries, Lie Algebras.*
- Knapp. *Lie Groups Beyond an Introduction.*