

# Group Theory

First Term 2001

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Office Hours:

Tu 2-3, Fr 11-12 (Blackett 807)

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## 1. Introduction

- a. Symmetry in physics
- b. Discrete and continuous symmetries
- c. Symmetry in quantum mechanics

## 2. Mathematical Background for Discrete Groups

- a. Groups
- b. Subgroups
- c. Cosets
- d. Conjugacy classes

## 3. Representations of Groups

- a. Reducible and irreducible representations
- b. Schur's lemmas and the Great Orthogonality Theorem
- c. Character tables
- d. Direct products and their decomposition

## 4. Physical Applications of Discrete Groups

- a. The group of the Hamiltonian
- b. Eigenfunctions and irreducible representations
- c. Bloch's theorem
- d. Selection rules

## 5. Continuous Groups, Lie Groups, and Lie Algebras

- a. Linear transformation groups
- b. Infinitesimal generators
- c. Algebra of infinitesimal generators

## 6. Irreducible Representations of $SO(2)$ and $SO(3)$

- a. Orthogonality relations and the density function
- b. Basis functions for irreducible representations of  $SO(2)$
- c. Spherical Harmonics and characters for  $SO(3)$

## 7. Unitary Groups

- a. Unitary groups and particle physics
- b. Basis states for  $SU(N)$
- c. Multiparticle states and direct products
- d. Young tableaux

## Recommended Books

Basic course material:

H.F. Jones, *Groups, Representations and Physics* (Adam Hilger, Bristol, 1998)

M. Tinkham, *Group Theory and Quantum Mechanics* (McGraw-Hill, 1964)

Related and advanced treatments:

R. Hermann, *Lie Groups for Physicists* (Benjamin, 1966)

D.B. Lichtenberg, *Unitary Symmetry and Elementary Particles* (Academic, 1978)