

Syllabus for Physics 220

Group Theoretical Method in Physics

Spring 2016-2017, Physics Department, UCSD

INSTRUCTOR: Congjun Wu (5430 MH)

Email: wucj@physics.ucsd.edu, Tel: 858-5343325

Time/Place: MW 9:30am - 10:50am, MH 5301

Instructor Office hour: Monday 1:00pm-2:00pm

Text Books:

1. M. S. Dresselhaus, G. Dresselhaus, A. Jorio, *Group Theory, Application to the Physics of Condensed Matter* Springer-Verlag Berlin Heidelberg (2008).
2. M. Lax, *Symmetry Principles in Solid State and Molecular Physics*, Dover Publications (March 14, 2012).
3. Howard Georgi *Lie Algebras In Particle Physics: from Isospin To Unified Theories*, Westview Press; 1 edition (October 24, 1999).

Class Schedule

1. Elements

Lecture 1: symmetry and group, fundamental concepts, examples

Lecture 2: Representation, linear space, Schur's Lemma

Lecture 3: Character and the orthogonality theorem

2. Point group

Lecture 4: Classification of point groups

Lecture 5: Applications: C_{60} , crystal field splitting (e_g , t_{2g})

3. Angular momentum and 3D rotation group

Lecture 6: Rotation the D-matrix

Lecture 7: Clebsch-Gordan coefficient, spherical tensors, spinors, Wigner-Eckart theorem

4. Symmetry of crystals

Lecture 8: Crystalline point group

Lecture 9: Crystalline systems and Bravais lattice

Lecture 10: Space group

Lecture 11: Representations of space group and its application in solid state band structure

5. Permutation group S_N

Lecture 12: General properties of permutation group

Lecture 13: Young pattern and Young tableaux, representations of permutation group

6. $SU(N)$ group

Lecture 14: Weights, roots, Dynkin diagram

Lecture 15: Gell-Mann matrices, representations of $SU(3)$

Lecture 16: Tensors, dimensions, Young tableaux for $SU(N)$

Lecture 17: 3D harmonic oscillator, Landau level, quarks