Syllabus for Physics 212C

Spring 2009, Physics Department, UCSD

INSTRUCTOR: Congjun Wu (5611 MHA)

Time/Place: 12:30 - 1:50pm, TUTH, Thurgood Marshall 102.

Office hour: Fri: 12:50 pm - 1:50pm

Books:

1. Sakurai *Modern Quantum Mechanics*, Publisher: Addison Wesley; Rev Sub edition (September 10, 1993).
2. L. D. Landau & E. M. Lifshitz, *Quantum Mechanics: Non-relativistic Theory*, Vol 3 of Landau's theoretical physics course, Butterworth-Heinemann; 3 edition (January 1, 1981).
3. L. I. Schiff, *Quantum Mechanics*, McGraw-Hill Companies; 3 edition (June 1968)
4. G. Baym, *Lectures on Quantum Mechanics*.

Grade:

We will decide the policy during the first class. Basically it will depend on your homework, midterm and the final project.

Homework Assignments:

Homework will be assigned every one or two weeks. Since it is unlikely to find a TA, I will not actually grade the homework. But I will do collect homework and keep a record.

Class Schedule

1. Second quantization

   Lect 1. Description of the quantum states of indistinguishable particles, occupation number representation

   Lect 2. Second quantization representation for single body and two-body operators of bosons and fermions

   Lect 3. Applications: exchange energy, Cooper problem.

2. Scattering theory

   Lect 5. Description of scattering problem

   Lect 6. Partial Waves: phase shifts

   Lect 7. Low energy scattering, bound states, resonace

   Lect 8. The Born Approximation and Optical Theorem

3. Symmetries

   Lect 9. Symmetries and conservation laws;

   Lect 10. Theory of angular momentum: Euler angles, SU(2) v.s. O(3);

   Lect 11. Theory of angular momentum: D-matrix, Schwinger boson;

   Lect 12. Discrete symmetries: parity, time reversal, Kramer degeneracy

4. Berry phases

   Lect 13. Berry phases and parallel transport;

   Lect 14. Magnetic Monopoles;

   Lect 15. Aharanov-Bohm scattering (partial wave analysis);

   Lect 16. Topological insulators and Chern numbers;

5. Relativistic Quantum Mechanics

   Lect 17. Dirac Equation; square root of operators; γ-matrices;

   Lect 18. Plane wave solution of Dirac equation; helicity eigen states; Dirac v.s Weyl fermions

   Lect 19. Symmetry propertis of Dirac equation: U(1) gauge symmetry,

   rotation symmetry, parity, time reversal

   Lect 20. Non-relativistic approximation of the Dirac equation: Pauli's equation and spin-orbit coupling