

Advanced Quantum Mechanics

Course Information

Fa Wang¹

¹International Center for Quantum Materials, School of Physics, Peking University, Beijing 100871, China

Fall 2018

Course Logistics

- Instructor: Fa Wang, wangfa@pku.edu.cn.
 - When contacting the instructor about this course, please indicate the course name in email subject, like “[AdvQM]...”
- Lectures: 1-2:50pm, Mon. & 10:10-12am, Wed.,
Room 309, Science Classroom Building.
- Office: West Physics Building, Room W571.
- Office Hours: 3-5pm, Fri.
- TA: TBA.
- Mass communication options: email and “course.pku.edu.cn”
 - Send an email to wangfa@pku.edu.cn if you are not enrolled yet.
 - Check course.pku.edu.cn (need to login by PKU ID).
- Course grades (tentative plan):
 - Homeworks: 40%, about seven homework sets, due time TBA.
 - Final Exam: 40%. Date TBA.
 - Midterm Exam: 20%, expected to happen around 8-9th week.

Reference Materials

Textbook

- J. J. Sakurai, *Modern Quantum Mechanics*, Addison-Wesley (1994). Reprinted in China.

Resources on Internet

- Prof. Littlejohn's lecture notes, <http://bohr.physics.berkeley.edu/classes/221/1011/221a.html>
- Prof. Murayama's lecture notes, <http://hitoshi.berkeley.edu/221A/>, <http://hitoshi.berkeley.edu/221B/>
- MIT OpenCourseWare, <http://ocw.mit.edu/courses/physics/>

And many more reference materials for later lectures...

Requirements

- Undergraduate quantum mechanics and related math courses.
- Diligence: how much you can learn depends mostly on yourself.
- Honesty: cheating on homeworks or exams will not be tolerated. Homeworks must be hand-written unless specified otherwise.
- Be interactive: you are encouraged to ask (reasonable amount of) questions in class, and to use my office hours.

WARNINGS!!!

- You shall NOT enroll in this course, if you do not want to
 - spend several hours on each homework set, or
(NOTE: you will not find ready solutions on internet or anywhere else.)
 - go through intense exams which may require a lot of calculation, or
(Certain tricks may simplify the calculations)
 - read many reference materials for understanding the course content, or
(Reading just those brief notes I'll provide is certainly not enough.)
 - suffer unexpected decline of your GPA.
- NOTE: I will not write recommendation letters for those who have taken my course(s) but have not done substantial research with me.
- NOTE: graduates in ICQM *can* choose the parallel Chinese class instead of this one. Ask your advisor to change your course program.
- **Thou shalt not complain of not being warned beforehand.**
勿谓言之不预。

Brief (Tentative) Syllabus (page 1/2)

- 1. Fundamental concepts (~ 3 lectures): Hilbert space and operators, observables and measurements, density matrix & entanglement.
- 2. Identical particles (~ 3 lectures): bosons and fermions, coherent state, Slater determinant, the BCS state, second quantization.
- 3. Quantum dynamics (~ 3 lectures): the Schrödinger and Heisenberg picture, propagators, path integral, geometric phase.
- 4. Symmetry in general (~ 2 lectures): degeneracy and conservation laws, selection rules.
- 5. $SO(3)$ and $SU(2)$ symmetry (~ 3 lectures): angular momentum, spin-1/2 systems, addition of angular momenta.

Brief (Tentative) Syllabus (page 2/2)

- 6. Time reversal symmetry (~ 1 lecture): Kramers theorem.
- 7. Approximation methods (~ 7 lectures): formal perturbation theory, time-dependent perturbation theory, variational method.
- 8. Scattering theory (~ 3 lectures): Lippman-Schwinger equation, Born approximation, optical theorem, partial wave method.
- 9. Relativistic quantum mechanics (~ 2 lectures): Dirac equation.