Physics 523; Quantum Mechanics I
Fall, 2009

Syllabus

Professor: Claude Bernard

Class Webpage: `http://physics.wustl.edu/cb/523/`

Office Hours: Mondays 1:30–2:30 PM, Tuesdays 2–3 PM, immediately after class, and by appointment.

Contact Info: Office: Compton 367, 5-6280, `cb@wustl.edu`

Class meetings: MWF, 10–11 AM, Crow 205.

TA: Zhenyu Zhou, `zzhou@physics.wustl.edu`, Compton 364, office hour Tuesdays 3–4 PM.

General course description: This is the first semester of a two-semester treatment of Quantum Mechanics. I plan to cover the fundamentals of quantum mechanics, basic examples including the harmonic oscillator and the hydrogen atom, symmetry transformations, the rotation group, angular momenta and Clebsch Gordon coefficients and series.

Prerequisites: An advanced undergraduate quantum mechanics course, such as 471. Familiarity with Lagrangians and Hamiltonians in classical mechanics will be helpful.

Books on reserve in physics library:

Textbook:

1. Abers, Ernest S., *Quantum Mechanics*. This is the text. A nice book, with a good balance between detail and overview. It covers the material at what seems to be an appropriate level for most students in the course. The main drawback is there are a lot of typos. It will be useful to you to go to the web page with corrections: `http://www.physics.ucla.edu/~abers/QMErrata3.html`. There is also a link to the errata page from the course web page. I suggest putting the corrections in your book immediately, at least for the those sections we will cover (see the schedule below). You may want to forget about the "minor errors" and just put in the "important and major errors" and the "errors of intermediate importance." It is also recommended that you get the "third printing," which has somewhat fewer errors. If you buy the book new you will automatically get the third printing. If you buy a used, earlier, printing, see `http://www.physics.ucla.edu/~abers/QMErrata12.html`.

Other useful books on library reserve:

2. Shankar, Ramamurti, *Principles of Quantum Mechanics* (2nd edition). This is a good book. It's a little "talky" and the organization is not ideal. But it's clear, and it carefully avoids complicated derivations when simpler and more physical ones will do. This book (and the next one, Gottfried) are listed as "recommended" at the book store, and they are stocking a few copies. One or both may be worth purchasing if you find them useful.

3. Gottfried, K and Yan, T.-M., *Quantum Mechanics: Fundamentals*, (2nd edition). This is an update of a classic book. Well written and very thorough; more detailed than I like in a text, but an excellent reference.

4. Sakurai, J.J., *Modern Quantum Mechanics* (2nd Edition). A standard text, and another useful reference. Sometimes gets overly technical (in my opinion) for the issues at hand.

5. Merzbacher, Eugen, *Quantum mechanics*, 3rd edition. A standard work. It's a little on the mathematical side and often too detailed for my taste, but at least it's complete and almost always correct. In principle, the first six chapters of the book could be used as a text for a (hard) undergraduate course, since it doesn't assume prior knowledge of quantum mechanics. You may want to read them, as they can serve as an excellent review, and may teach you many things you missed the first time around.

6. Messiah, Albert, *Quantum Mechanics*. Rather dense, but has *everything* in it.

7. Baym, Gordon, *Lectures on quantum mechanics*. Thoughtful and clear, with emphasis on the physics. It doesn't cover all topics, though.

8. Dirac, P.A.M., *The Principles of Quantum Mechanics*, 4th edition. A classic. Since he was writing in the days before students had any prior exposure to quantum physics, he had to make things very clear. Some of the notation and explanations are out of date, though.

9. Scheck, Florian, *Quantum Physics*. A relatively new book, which looks interesting and clear. I haven't read it carefully yet, though. Please let me know if you like it.

10. Griffiths *Introduction to Quantum Mechanics* (2nd Edition). A standard undergraduate text for backup.

The lecture notes by Jeff Greensite: `http://www.physics.sfsu.edu/~greensit/` are also recommended. They are for an undergraduate course, but the treatment is nice, and quite often sophisticated. For example, Greensite is one of the few that do all the uncertainty relations carefully (including time-energy). The notes are free, although the figures are not available online.

Grading: There will be 8 problem sets due during the semester, at approximately one- to two-week intervals. Help from me on the problems is freely available; make an appointment to see me if you are unable to come to office hours. You are also permitted, and even encouraged, to discuss problems with other students after you have made some effort to solve them by yourself. Needless to say, however, you *must* write up the solutions by yourself — copying is a very serious offense and will be dealt with severely (referral to the Graduare School Committee on Academic Integrity is automatic). A midterm is scheduled for **Friday, October 23**, and there will be a final exam during exam period (December 11–17), date and time to be arranged (December 15 might be a good choice). The breakdown of the final grade is:

Problem sets	25%
Midterm	30%
Final exam	45%

The following is a tentative course schedule. Note that there will be no classes on Friday, September 11 and Wednesday, November 4. I will try to schedule make-up lectures during the semester, but, in case we need it, I've also scheduled a lecture for December 9, which is during reading period.

Dates	**Topics**	**Relevant sections in Abers**
8/26—8/31	Basic QM features: Stern-Gerlach, and K-$\bar{K}$ examples	2.1
9/2—9/14	Relevant aspects of classical mechanics	1.1—1.2
9/11	*No Lecture*	
9/16—10/2	Fundamentals of QM; uncertainty principles	2.2—2.7
10/5—10/9	Harmonic oscillator	3.2
10/12—10/26	Angular momentum I	3.3
10/16	*Fall break*	
10/23	**Midterm**	
10/28—11/18	Spherically symmetric potentials; hydrogen atom	3.4—3.5
11/4	*No Lecture*	
11/20—12/9	Angular Momentum II: addition of angular momentum Clebsch-Gordon coefficients & series	4.1—4.5
11/25—11/29	*Thanksgiving*	

If time permits, I will cover some or all of tensor observables and the Wigner-Eckart theorem (Abers, sections 5.1—5.2).