PHYSICS 3650 Quantum Physics I

Lecturer	Olivier Pfister. 135 Physics. 4-7956. opfister@virginia.edu
	Office hours TBA and by appointment
Grader	TBA; Office hours TBA
Class times	MWF 11:-11:50. 204 Physics

Course description

As it nears a century of existence, quantum physics is arguably the most successful scientific theory ever formulated. Initially created to explain atoms whose dimensions are of the order of the angstrøm and whose energies are of the order of the electron-volt, quantum mechanics still holds valid for elementary particles over distances a million times smaller and energies ten trillion times larger. It unifies all physical forces except gravitation—which is, as we know, by far the weakest of all.

Quantum physics may be viewed as an "extension" of classical physics[1] that relies heavily on a nontrivial mathematical formalism, the complex algebra of Hilbert space. As powerful as the formalism is, the necessary task of its integration to the theory becomes a temporary hindrance to developing a physical intuition for quantum physics.

The goal of this course is to develop such an intuition before, and as we are, introducing the formalism. This approach quite contrasts with a number of quantum physics textbooks, such as the one by Griffiths.

To do so, we'll follow, in the first half of the semester, the approach adopted by J.-M. Lévy-Leblond and F. Balibar in their book "Quantics. Rudiments of Quantum Physics." This approach uses very little of the mathematical machinery at first, to better introduce the essential concepts. Although this book is designed to be studied over one semester, we'll branch out to the fully fledged formalism in the second half of the semester in order to seamlessly—or so your instructor hopes—mesh with the Quantum II course taught out of the Griffiths text in the spring.

On our journey toward discovering and understanding the quantum world, we'll also stop and consider cases which had the founding fathers scratch their heads and argue for a long time, such as the Einstein-Podolsky-Rosen paradox and entanglement, now known as the cornerstone of quantum computing.

Text

We'll use 3 textbooks (which you may find second-hand, and which the library and I will provide).

[1] "Quantics. Rudiments of Quantum Physics," by Jean-Marc Lévy-Leblond and Françoise Balibar.
[2] "Introduction to Quantum Mechanics," by David J. Griffiths.
[3] "Quantum Mechanics," by Bernard Diu, Claude Cohen-Tannoudji, and Franck Laloë.

[1] albeit questionably, since it's really classical physics that is a particular case of quantum physics

Syllabus

A. The concepts of quantum physics [1]

Chap. 1. The quantum regime
Chap. 2. Quantons
Chap. 3. Quantum magnitudes and the Heisenberg inequalities
Chap. 4. Probabilities and quantum amplitudes
Chap. 5. Quantons in space and time
Chap. 7. Collective behavior: identical quantons

B. The formalism of quantum physics and some applications [2,3]

The postulates of quantum mechanics
Measurement and entanglement
The Schrödinger equation
Applications of the Schrödinger equation:
- Tunneling through potential barriers. Potential wells
- The quantum harmonic oscillator
- The hydrogen atom
- "Quantum technologies:" from entanglement and Schrödinger's cat to quantum computing

Details, details, details

Prerequisites	PHYS 2620, MATH 3255 or 3250, or instructor permission	
Grading	Prelecture assignments	15%
	Homework ($\sim$ 1 problem set/week. NO LATE HOMEWORK)	25%
	Clicking in class (participation always, accuracy sometimes)	5%
.	Midterm exam	20%
	Final exam	35%
Exam schedule	Midterm: Monday, October 24, 2016, class time. Final: Friday, December 16, 2016, 9am-12n. 204 Physics	
Voting remote (required)	*iClicker2* **Note:** Register your clicker asap using the "i>clicker" left tab of the Collab course page.	
Library reserve	Relevant books can be found on the "Physics 3650" reserve shelf in the Physics Library.	

Course Policies

- **The course's web site** (grades, info, teaching evaluations) is on your UVa Collab.
- **Homework policy:** LATE HOMEWORK IS NOT ACCEPTED.

- **Attendance** is not taken at lectures. However, students are responsible for all material taught and all announcements made therein. Graded iClicker questions will often be given at lectures.

- **Cell phone policy:** All cell phones must be silenced before entering the classroom and be unused until the end of lecture, problem sessions, and exams, unless an emergency occurs.

- **Class Honor ("pledge") Policy Statement:** I trust every student in this course to fully comply with all of the provisions of the UVa honor system. In addition to pledging that you have neither received nor given aid while taking your exams, your signature also affirms that you have not accessed any notes, study outlines, problem sets, old exams, answer keys, or the textbooks, while taking a closed-book exam. Alleged honor violations brought to my attention may be forwarded to the Honor Committee. If, in my judgment, it is beyond a reasonable doubt that a student has committed an honor violation with regard to an exam, that student will receive an immediate score of zero, or grade of 'F,' for that exam, irrespective of any subsequent action taken by the Honor Committee.