Physics 661: Quantum Mechanics I

Fall 2020

General Information

Course Time and Place: Tues. and Thurs. 9:30AM-10:50AM in Physics 202/204 (for the first few weeks) and via Zoom
Instructor: Professor J. M. Schwarz, aka Professor Jen
Office: 229a Physics Building
Phone: 607-342-0876
E-mail: quantummech.fall2020@yahoo.com
Course webpage: jmschwarztheorygroup.org/phy661
Office Hours: Tuesdays 4:00-5:00PM or by appt.

Professor Jen's Top 5 Reasons to Take This Course

We live in a quantum world. We are quantum creatures built out of atoms. Hence, the need to properly understand our world, and even ourselves, compels us to learn about quantum mechanics (Reason 5). In fact, it was my own learning of quantum mechanics that inspired me on to pursue a doctorate in physics (as opposed to a doctorate in history). There are other perhaps less obvious reasons for taking this course, such as the following:
(4) So you can learn the mathematics behind the article in Forbes Magazine entitled, "Six things everyone should know about quantum physics".
(3) You will ultimately be able to work for companies such as IBM or Google or Rigetti Computing or IonQ to help build a quantum computer.
(2) So you can determine whether or not the human eye is capable of detecting a single photon.
(1) You can come out with yet another interpretation of quantum mechanics—beyond the Copenhagan interpretation, the many worlds interpretation, quantum logic, and QBism—and write about it on social media and become the new darling of the internet.

On a more serious note, all of you have taken some sort of quantum mechanics course before. We will revisit many of the same topics and analyze them at a slightly deeper level. I hope to cover such things as the need for quantum mechanics, the mathematics of vector spaces, the postulates of quantum mechanics, one-dimensional problems, including the harmonic oscillator using creation and annihilation operators, path integrals, and angular momentum, spin, and Bell's inequality. If time permits, we may be able to cover some aspects of quantum computation.

Textbook

Much of the material presented is covered in the first three chapters of *Modern Quantum Mechanics, 2nd edition* by J. J. Sakurai and Jim Napolitano, so it would be a good idea to find a copy of this book and read these chapters. I will cite the relevant sections in this book as we go along. There is another graduate quantum mechanics textbook that we will use, namely *Principles of Quantum Mechanics'* by R. Shankar. We will toggle back and forth between the two. You may also want to skim a few others if the ones by Sakurai and Napolitano and by Shankar not speak to

you, though the hope is that these two books combined with lectures/discussion should be sufficient. Also, a good fraction of the homework problems will be assigned from *Modern Quantum Mechanics*, which is yet another reason to obtain a copy.

In addition, we will supplement our investigations with original papers by the authors that created the field. While sometimes the material in an original paper is presented in an outdated manner, you will get a glimpse of the inner workings of the minds of some of the best physicists.

Assessment of Your Work

(1) Homework (40 percent): There will be approximately 10 homework assignments. Each one will be handed out in class and due at some future lecture at the beginning of class. Some assignments will be a little more involved than others. I encourage you to talk to me about them and each other, especially if you are having problems getting started. *In the end, however, each person should write up their own solutions in the solitude of their own office and/or home.* If you have used any resources other than your brain, which has been nourished by the textbooks, to complete the assignment, please cite them. (I must also remind you that the Syracuse University Academic Integrity Policy holds students accountable for the integrity of the work they submit. For the complete policy, see http://academicintegrity.syr.edu.) Finally, after the solutions have been handed out, late homeworks will no longer be accepted.

(2) Class participation (10 percent): Not only are you encouraged to ask questions in class and via e-mail, I may ask each of you for a consultation when preparing some of the final lectures in terms of pinpointing what is confusing to you, etc.

(3) In-class, mid-term examination (20 percent): While the exam will be closed book, you will be allowed to bring a page of handwritten notes that must be turned in with your exam. The mid-term duration will be one class lecture.

(4) Final Examination (30 percent): The protocol will be the same as the mid-term examination, only it will take up 2 hours. Please stay tuned for the final exam date and time.

Prerequisites

Aside from an earlier, undergraduate quantum mechanics course, I presume that everyone knows a bit of classical and quantum mechanics. However, if there are terms that I casually invoke and you have not heard before and/or do not understand, please stop me and ask. This course should be as self-contained as possible.

Meeting Logistics

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For the first few weeks, we will meet in PB202/204. We will eventually switch to on-line via Zoom. Since some international graduate students were not able to make it to the US, we will be recording all of the lectures via Zoom. If you are able to attend class in-person for the first few weeks and

adhere to the public health guidelines discussed below, I encourage you to do so. To access the homework and additional reading material, please visit the course webpage. I will also be sending a weekly email to keep you up to date with the course.

For those joining the class on-line, please keep your microphone muted unless you are actively talking to your colleagues; this is especially important if you are in a noisy place or if you are using a built-in microphone on a laptop or cellphone. Please introduce yourself before speaking.

Public Health

While we have discussed the nuts and bolts of the course, my highest priority this semester is the preservation of your health (and mine). The University has already sent you the general things we expect students to do to protect public health. While on campus, I ask that:

(1) you to wear a face covering when indoors or when interacting with others outdoors,

(2) stay at least six feet from others when at all possible, indoors and outdoors,

(3) do not share pencils, computers, etc., with your classmates, unless they have been cleaned beforehand with sanitizer or alcohol.

These guidelines may change during the semester to reflect changing conditions and knowledge; I will let you know if any changes in guidelines are about to occur. If you have a medical reason that you cannot wear a mask, please notify me ASAP. If you forget your mask, I will likely have one or two extras; ask me, and I may have one for you. If a student is unwilling to do their part to preserve public health in in-person classes, then I will ask them to leave and complete their work online. If they do not comply, I will have to cancel the in-person class.

For the in-person classes, if you are not feeling well, one of the most important things you can do is to stay home. All of the components of our class can be done remotely, and if you are feeling unwell – particularly if your symptoms involve nausea, cough, fever, or others common in COVID-19 – you should connect to our class remotely, and inform us that you are working remotely because you are ill. We often have a culture of trying to push through when we axre not feeling well, saying things like Yeah, I am sick, but I will be okay – I can still go to class. While this sort of perseverance in general is a good thing, coming to class when youre sick puts other peoples health at risk. So, if you have any symptoms at all, stay home.

If you have an illness or injury that interferes with your ability to do work in our class, i.e. you are seriously sick, please communicate with me! The Center for Disability Resources also helps students with short-term injuries and illnesses – concussions, broken bones, etc. If you are sick or hurt, I will work with you and with CDR to do whatever I can to accommodate your condition.

If you are too sick to participate in class, even remotely, do not worry! I want you to focus on taking care of yourself rather than on physics classes. If you are sick and miss things, I will be flexible with deadlines to allow you to catch up. If you miss a large amount of class (two weeks or more), you may be eligible to take an incomplete grade in the course. This is a grade pending status that means that you were not able to finish all your work during the semester. Once you finish up your work in the spring, I can go back and give you your final grade. If you think you might need to use this option, it is important to talk to me as early as possible so we can discuss arrangements. In general, only students who have completed a meaningful amount of classwork with a passing grade are eligible to take an incomplete.

What happens if your instructors get sick? If any of your instructors contract COVID-19, we will do our best to get a substitute instructor for you as soon as possible. If this happens, however, we cannot risk a spreading set of cases in our class. In this case, it is likely that the remainder of our class will transition to being fully online.

Equality and Inclusiveness

Everyone in this class is an equally-valued member of this university and our community. I expect you to treat your classmates as honored colleagues in the collective endeavor we are all involved in: to understand the natural world and use that understanding to improve our society.

In particular, bias against or denigration of anyone in our class because of their gender or how they express it, their sexual orientation, their religion, their national origin, their race or ethnicity, or a disability they may have will not be tolerated. If you are the target of this sort of bias or if you witness it, please report it directly to me and I will take swift action. If you don't feel comfortable talking to me, you may report it anonymously to the Physics Department at:
https://docs.google.com/forms/d/e/
1FAIpQLScNduLL1hc9fJu5MRaKjajJFnlTDiDio0xvqprn9kCXDpS2Cg/viewform.

Syllabus Statement Regarding Disability-Related Accommodations

Students who are in need of disability-related academic accommodations must register with the Office of Disability Services (ODS), 304 University Avenue, Room 309, 315-443-4498. Students with authorized disability-related accommodations should provide a current Accommodation Authorization Letter from ODS to the instructor and review those accommodations with the instructor. Accommodations, such as exam administration, are not provided retroactively; therefore, planning for accommodations as early as possible is necessary. For further information, see the ODS website, Office of Disability Services http://disabilityservices.syr.edu/.

SU Religious Observances Policy

The policy, found at http://supolicies.syr.edu/emp_ben/religious_observance.htm, recognizes the diversity of faiths represented among the campus community and protects the rights of students, faculty, and staff to observe religious holydays according to their tradition. Under the policy, students are provided an opportunity to make up any examination, study, or work requirements that may be missed due to a religious observance provided they notify their instructors before the end of the second week of classes. For both fall and spring semesters, an online notification process is available through MySlice/Student Services/Enrollment/My Religious Observances from the first day of class until the end of the second week of class.

Secret Course Objective

To have **fun** learning about the "mysteries" of quantum mechanics, where **fun** means that the learning experience should be enjoyable and inspiring.