

Physics 662: Quantum Mechanics II

Spring 2023

General Information

Course Time and Place: Tues. and Thurs. 2PM-3:20PM EST in Physics 106
 Instructor: Professor J. M. Schwarz, aka Professor Jen
 Office: TBD, though temporarily PB229a
 Phone: 607-342-0876
 Slack Page: Please check your SU email for an invite
 Course webpage: jmschwarztheorygroup.org/phy662
 Office Hours: TBD

Professor Jen's Top 5 Reasons to Take This Course

We live in a fundamentally quantum world. We are quantum creatures built out of atoms. Hence, the need to properly understand our world, including 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 Copenhagen 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 PHY661: Quantum Mechanics I that presumably began with the fundamentals of quantum mechanics and ended with the beloved hydrogen atom. Since path integrals nor the addition of angular momentum have not yet been discussed, we are going to begin with those topics, as well as briefly revisit the hydrogen atom, and then forge onwards to discuss to symmetries in quantum mechanics, several different approximation methods such as time-independent perturbation theory, scattering theory, including the Born approximation, and finishing with multiple, identical particles.

Textbook

Much of the material presented is covered in the Chapters 3-7 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 the relevant sections in the relevant chapters. I will cite the relevant sections in this book as we go along. There is another graduate quantum mechanics textbook that we may look at as well, namely *Principles of Quantum Mechanics* by R. Shankar. You may want to find a

copy of this book as well. You may also want to skim a few others, such as the book by Eugene Commins and a two volume series by Cohen-Tannoudji, if the ones by Sakurai and Napolitano and by Shankar do not speak to you, though the hope is that these two books combined with class meets (and perhaps some recitation times should be sufficient. Also, a good fraction of the homework problems will be assigned from *Modern Quantum Mechanics, Second Edition*, which is yet another reason to obtain a copy.

In addition, we will sometimes 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 creative 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 the beginning of some future 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 class meets 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 meet.

(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

I will assume that everyone knows a bit of classical and quantum mechanics (having taken various physics courses prior to SU and given your coursework from last semester). 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.

Class Meet Logistics

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Our class meets will in person on Tuesday and Thursday afternoons, as specified above. If you are not able to attend class, please let me know via our course Slack page.

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). So, if you are not feeling well, one of the most important things you can do is to stay home. Many 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 reach out to me so that I can make accommodations. We often have a culture of trying to “push through” when we are 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 you’re sick puts other people’s health at risk. So, if you have any symptoms at all, stay home. Moreover, 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. Additionally, 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 summer, 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.

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://syracuseuniversity.qualtrics.com/jfe/form/SV9pORpTKnq6pLeyF>.

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 for a second semester in a row, where **fun** means that the learning experience should be enjoyable and inspiring.