Philosophy 3930 Special Topics: Philosophy of Quantum Mechanics
Syllabus

Spring 2022
M/W/F 11:45am - 12:35pm
Matherly Hall, Room 115

Instructor Information
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Course Description and Objectives
Quantum mechanics provides us with a spectacularly successful recipe for making predictions about the outcomes of a wide variety of physical experiments. While the intricacies of this recipe are well understood, the implications of its success for the nature of physical reality are not. What must the world be like such that the quantum recipe generates such accurate and reliable predictions of it? To answer this question is to provide an “interpretation” of quantum mechanics, and it will be our central concern in this course. We will begin by examining the basics of quantum mechanics, with an emphasis on its general structure as opposed to the mathematical details. Then we will explore its possible ontological implications, examining interpretations such as spontaneous collapse theories, the Many Worlds Interpretation, and Bohmian Mechanics. No prior background in physics is required, though students should be willing to engage with a modicum of formalism.

General Education Objectives and Learning Outcomes
This course is a Humanities (H) subject area course in the UF General Education Program. Humanities courses provide instruction in the history, key themes, principles, terminology, and theory or methodologies used within a humanities discipline or the humanities in general. Students will learn to identify and to analyze the key elements, biases and influences that shape thought. These courses emphasize clear and effective analysis and approach issues and problems from multiple perspectives. A minimum grade of C is required for general education credit.

PHI 3930 accomplishes these goals by familiarizing students with some key philosophical topics and arguments concerning science: its methods, aims, presuppositions, and justification. Students will become adept at thinking critically, analyzing arguments, and writing clearly and persuasively.

The General Education Student Learning Outcomes (SLO's) divide into three areas: CONTENT—students demonstrate competence in the terminology, concepts, theories and methodologies used within the discipline; COMMUNICATION—students communicate

knowledge, ideas and reasoning clearly and effectively in written and oral forms appropriate to the discipline; and CRITICAL THINKING—students analyze information carefully and logically from multiple perspectives, using discipline-specific methods, and develop reasoned solutions to problems.

Students will satisfy the CONTENT SLO by demonstrating a mastery of some key philosophical concepts as well as central arguments in the discipline. The COMMUNICATION SLO will be achieved by two papers, take-home midterm and final exams, and regular participation in class. Students will be required to explain and evaluate various views in the philosophy of science. Students will also demonstrate achievement of the CRITICAL THINKING SLO through the papers and exams, which will be on assigned topics designed to test students' critical thinking abilities. These assignments will be graded on the basis of a student's comprehension of the relevant issues, development and cogent defense of her or his position, clarity of expression, and mechanics.

In short, at the end of the course, students will be able to:

- Explain the basic structure of quantum mechanics
- Summarize the results of some important quantum experiments
- Articulate what is meant by "quantum non-locality" and the "measurement problem"
- Explain some of the most prominent interpretations of quantum mechanics and problems facing each of them

Academic Honesty

UF students are bound by The Honor Pledge, which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: 'On my honor, I have neither given nor received unauthorized aid in doing this assignment.'"

The Honor Code (http://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor. Plagiarism on any assignment will automatically result in a grade of "E" for the course. Plagiarism is defined in the University of Florida's Student Honor Code as follows: "A student shall not represent as the student's own work all or any portion of the work of another. Plagiarism includes (but is not limited to): a. Quoting oral or written materials, whether published or unpublished, without proper attribution. b. Submitting a document or assignment which in whole or in part is identical or substantially identical to a document or assignment not authored by the student." Students found guilty of academic misconduct will be prosecuted in accordance with the procedures specified in the UF honesty policy.

In-Class Expectations

In response to COVID-19, the following practices are in place to maintain your learning environment, to enhance the safety of our in-classroom interactions, and to further the health and safety of ourselves, our neighbors, and our loved ones.

- If you are not vaccinated, get vaccinated. Vaccines are readily available at no cost and have been demonstrated to be safe and effective against the COVID-19 virus. Visit this link for details on where to get your shot, including options that do not require an appointment:
  https://coronavirus.ufhealth.org/vaccinations/vaccine-availability/.
  Students who receive the first dose of the vaccine somewhere off-campus and/or outside of Gainesville can still receive their second dose on campus.
- You are expected to wear approved face coverings at all times during class and within buildings even if you are vaccinated. Please continue to follow healthy habits, including best practices like frequent hand washing. Following these practices is our responsibility as Gators.
    - Sanitizing supplies are available in the classroom if you wish to wipe down your desks prior to sitting down and at the end of the class.
    - Hand sanitizing stations will be located in every classroom.
- If you are sick, stay home and self-quarantine. Please visit the UF Health Screen, Test & Protect website about next steps, retake the questionnaire and schedule your test for no sooner than 24 hours after your symptoms began. Please call your primary care provider if you are ill and need immediate care or the UF Student Health Care Center at 352-392-1161 (or email covid@shcc.ufl.edu) to be evaluated for testing and to receive further instructions about returning to campus. UF Health Screen, Test & Protect offers guidance when you are sick, have been exposed to someone who has tested positive or have tested positive yourself. Visit the UF Health Screen, Test & Protect website for more information.
    - Course materials will be provided to you with an excused absence, and you will be given a reasonable amount of time to make up work.
    - If you are withheld from campus by the Department of Health through Screen, Test & Protect you are not permitted to use any on campus facilities. Students attempting to attend campus activities when withheld from campus will be referred to the Dean of Students Office.
- Continue to regularly visit coronavirus.UFHealth.org and coronavirus.ufl.edu for up-to-date information about COVID-19 and vaccination.

HyFlex

Classes will take advantage of HyFlex, so that students have the option to participate remotely via Zoom. **The default expectation is that students show up in person and participate in the classroom during our class meetings.** However, if a student is either (1) withheld from campus on ONE.UF, or (2) is strongly opposed to participating in person because of concerns about COVID-19, that student may participate via Zoom instead. Please let me know by email if you will be participating on Zoom for either of these reasons.

Canvas e-Learning Environment
This course is supplemented by online content in the e-Learning environment known as "Canvas." To login to the e-Learning site for this course, go to https://lss.at.ufl.edu/, click the **e-Learning in Canvas** button, and on the next page enter your Gatorlink username and password. You can then access the course e-Learning environment by selecting PHIL 3930 from the **Courses** pull-down menu at the top of the page. If you encounter any difficulties logging in or accessing any of the course content, contact the UF Computing Help Desk at (352) 392-4537. Please do not contact the course instructor regarding computer issues.

Online Course Evaluation
Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via https://ufl.bluera.com/ufl/. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/.

Accommodation for Students with Disabilities
Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, www.dso.ufl.edu/drc/) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

Counseling and Wellness Center:
http://www.counseling.ufl.edu/cwc/Default.aspx, 392-1575
University Police Department:
392-1111 or 9-1-1 for emergencies.

Course Text
There is one required textbook for this course:

- *Quantum Mechanics and Experience*, by David Z. Albert, Cambridge: Harvard University Press.

This book is available from the bookstore and on Amazon. The majority of our readings will come from it; some other readings will be provided on Canvas.

Course Requirements
Discussion Questions: 10%
In-Class Activities: 10%
Take-Home Exam 1: 20%
Take-Home Exam 2: 20%
Take-Home Exam 3: 20%
Final Paper: 20%

Discussion Questions

The weekly schedule for this course will be primarily lectures on Mondays and Wednesdays, and primarily discussions on Fridays. The Friday discussions will be largely concerned with clarifying aspects of the readings or lectures from earlier in the week. In preparation for this, you will be asked to pick one topic, argument, or explanation from either the reading or lectures for the week that you have a question about. This can be something that you found confusing, or just something that you would like to hear more about. Once you have selected your question, you should post it in the Canvas discussion forum for that week. **Questions should be posted no later than 8:00pm on Thursdays.** We will then aim to answer these questions during class on Friday. **I will divide the class into groups, so that half of you will be responsible for posting discussion questions on any given week.**

In-Class Activities

In-class activities consist of reading quizzes and small group discussions.

- *Reading Quizzes:* To prepare for class, you will need to study the readings carefully. To reward you for doing this work, there will be occasional unannounced reading quizzes interspersed throughout the semester. Each quiz will contain two or three true-false, multiple-choice, or short answer questions about the required reading for that day's class.
- *Small Group Discussions:* Occasionally I will break the class up into small groups; each group's task will be to come up with an answer to a particular question relevant to that day's material. We will then reconvene to discuss our answers.

If you miss an in-class activity of either sort, you will not be able to make it up, but at the end of the semester I will drop your three lowest in-class activity grades. If you will miss an in-class activity for a religious holiday or another official university activity, you must notify me ahead of time; activities missed for these reasons will *not* count toward your three drops for the semester.

Take-Home Exams

There are three take-home exams on the schedule. For each one, the exam prompts will be provided at least a week before the due date. You will have to choose a subset of them, and answer each with either a short essay or algebraic manipulations of the quantum formalism. The questions will concern the readings and topics we have discussed in class, and will typically ask you to explain a given argument, position, or concept (i.e. your goal should be to illustrate your understanding of the relevant material). While you may discuss the question prompts with other students, *you may not work with anyone else on the preparation of your answers.* Late exams will be deducted 1/3 of a letter grade (i.e. a +/- increment) for each day past the due date.

Final Paper

At the end of the course you will be asked to write a final paper. You will have the option of several prompts to choose from, and will need to answer one of them with a sustained argument. In contrast to the take-home exams, the final paper is intended to give you a more significant opportunity to develop your own views and arguments.

Grading

The following grade scale will be used to assign final letter grades for the course. See UF grading policies for assigning grade points at: https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx.

Grade Scale	Grade Value
100-93=A	A=4.0
92-90=A-	A-=3.67
89-87=B+	B+=3.33
86-83=B	B=3.00
82-80=B-	B-=2.67
79-77=C+	C+=2.33
76-73=C	C=2.00
72-70=C-	C-=1.67
69-67=D+	D+=1.33
66-63=D	D=1.00
62-60=D-	D-=0.67
59-0=E	E=0.00

Course Schedule

The following is a tentative schedule for the course. Any changes to the schedule will be announced in class and over email. The syllabus is divided into weeks; the items listed for a given week are to be read before classes that week.

Week 1: January 5, 7

- Craig Callender, “Nothing to See Here: Demoting the Uncertainty Principle” (on Canvas)
- Craig Callender, “Return of the Stingy Oddsmaker: A Response” (on Canvas)

Week 2: January 10, 12, 14

- *Quantum Mechanics and Experience*, Chapter 1: Superposition, pp. 1-16
- Discussion Questions: Group A

Week 3: January 19, 21

- *Quantum Mechanics and Experience*, Chapter 2: The Mathematical Formalism, pp. 17-43
- Discussion Questions: Group B

Week 4: January 24, 26, 28

- *Quantum Mechanics and Experience*, Chapter 2: The Mathematical Formalism, pp. 43-60
- Discussion Questions: Group A
- **Take-Home Exam 1 due by Sunday, January 30 at 11:59pm (submit on Canvas)**

Week 5: January 31; February 2, 4

- *Quantum Mechanics and Experience*, Chapter 3: Nonlocality, pp. 61-72
- Tim Maudlin, *Quantum Non-Locality and Relativity*, pp. 12-19 (on Canvas)
- Discussion Questions: Group B

Week 6: February 7, 9, 11

- *Quantum Mechanics and Experience*, Chapter 4: The Measurement Problem, pp. 73-79
- Discussion Questions: Group A

Week 7: February 14, 16, 18

- *Quantum Mechanics and Experience*, Chapter 5: The Collapse of the Wavefunction, pp. 80-111
- Discussion Questions: Group B

Week 8: February 21, 23, 25

- Tim Maudlin, *Philosophy of Physics: Quantum Theory*, pp. 110-121 (on Canvas)
- Discussion Questions: Group A
- **Take-Home Exam 2 due by Sunday, February 27 at 11:59pm (submit on Canvas)**

Week 9: February 28; March 2, 4

- *Quantum Mechanics and Experience*, Chapter 6: The Dynamics by Itself, pp. 112-133
- Discussion Questions: Group B

Spring Break: March 7-11

Week 10: March 14, 16, 18

- Tim Maudlin, *Philosophy of Physics: Quantum Theory*, pp. 173-204 (on Canvas)
- Discussion Questions: Group A

Week 11: March 21, 23, 25

- *Quantum Mechanics and Experience*, Chapter 7: Bohm's Theory, pp. 134-155
- Discussion Questions: Group B

Week 12: March 28, 30; April 1

- *Quantum Mechanics and Experience*, Chapter 7: Bohm's Theory, pp. 155-179
- Discussion Questions: Group A
- **Take-Home Exam 3 due by Sunday, April 3 at 11:59pm (Submit on Canvas)**

Week 13: April 4, 6, 8

- Jill North, "The Structure of a Quantum World" (on Canvas)
- Tim Maudlin, "The Nature of the Quantum State" (on Canvas)
- Discussion Questions: Group B

Week 14: April 11, 13, 15

- Continued discussion of North and Maudlin
- Erik Deumens talk on the measurement problem

Week 15: April 18, 20

- TBD/Make-up Days

Final Paper due by Monday, April 25 at 11:59pm (submit on Canvas)