

Philosophy of Quantum Mechanics

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Intersession 2022

Course Details

Email: carledg1@jhu.edu
Course Number: AS.150.266.13
Time: MWTH 9:00am - 12:00pm
Room: Online

Course Description

Quantum Mechanics (QM) is an extraordinarily successful physical theory. Not only are the predictions of the theory remarkably well-confirmed, but the theory has led to concrete applications to communication that promise to revolutionize the world. In spite of this, the interpretation of QM has proven to be very difficult. An understanding of the theory seems to indicate that a number of our deeply held beliefs about the nature of reality are wrong. In this course we will survey some interpretive issues in the foundations of QM. Topics will include the measurement problem, non-locality, interpretations of quantum mechanics (Bohmian mechanics, collapse theories, many-worlds), quantum computation, quantum cryptography and quantum teleportation. The emphasis will be placed on conceptual understanding rather than mathematical rigor.

Learning Outcomes

By the end of the course students should have a basic understanding of quantum mechanics. Students should also be able to articulate some of the primary philosophical problems that arise in the interpretation of quantum theory. Students should also have a familiarity with applications of quantum theory including quantum teleportation, computation, and cryptography. More broadly students should acquire a greater understanding of the interplay between philosophy and physics.

Requirements

Students will be required to attend each class and contribute to the discussion. This means that students must do the readings beforehand. Students will be required to post one substantive (a couple of paragraphs) comment or question on the discussion board before each class. If students attend each class and participate, then no final or paper will be required. If, however, a student misses more than one class or fails to participate via discussion posts and in class participation, then the student may submit a final paper on a topic to be assigned on a case-by-case basis.

Reading List

Raymer, M.G. *Quantum Physics: What Everyone Needs to Know*. Oxford: Oxford University Press. 2017.

Zubairy, M.S. *Quantum Mechanics for Beginners: with applications to quantum communication and quantum computation*. Oxford: Oxford University Press. 2020.

Additional readings will be distributed on an as-needed basis.

Schedule

Week 1

1/5 - Introduction to philosophy of physics; mathematical background for quantum theory.

1. Zubairy Ch. 1; linear algebra handout
2. Rickles, Dean. Chapters 1 and 2 of *Philosophy of Physics*.

1/6 - Introduction to quantum mechanics

1. Raymer Ch.1
2. Zubairy Ch. 5 and 10.

Week 2

1/10 - The measurement problem

1. Raymer Ch. 2, 4, 6
2. Optional: Zubairy Ch. 8

1/12 - Non-locality

1. Raymer Ch. 8
2. Zubairy Ch. 12

1/13 - Interpretations of QM

1. Readings to be distributed

Week 3

1/17 - MLK Day - No class

1/19 - Quantum Entanglement, Teleportation, and Computing

1. Raymer Ch. 9, 10
2. Optional: Zubairy Ch. 15, 16

1/20 - Quantum Computing Cont., Quantum Cryptography

1. Raymer Ch. 3
2. Zubairy Ch. 13

Academic Integrity

From the University: "The strength of the university depends on academic and personal integrity. In this course, you must be honest and truthful. Ethical violations include cheating on exams, plagiarism, reuse of assignments, improper use of the Internet and electronic devices, unauthorized collaboration, alteration of graded assignments, forgery and falsification, lying, facilitating academic dishonesty, and unfair competition. Report any violations you witness to the instructor. You may consult the associate dean of students and/or the chairman of the Ethics Board beforehand. See the guide on "Academic Ethics for Undergraduates" and the Ethics Board web site <http://ethics.jhu.edu> for more information."

Accommodation

If you are a student with a disability or believe that you might have a disability that requires special accommodations, please contact Student Disability Services to obtain a letter from a specialist: Garland 385; (410) 516 4720; studentdisabilityservices@jhu.edu