The Weird World of Quantum Mechanics

Are photons real? Can you change the past by doing an experiment in the present? Can you kill Schrodinger's cat by looking at it? Is it true that a watched pot never boils? Can you send quantum information faster than the speed of light? Quantum mechanics is so weird, what is reality really like? These and many related questions have intrigued scientists since the birth of quantum mechanics almost a century ago. Much progress has been made, but there is a sense that we must drastically revise our understanding of reality, and no one is quite sure how to do that. These questions are partly philosophical and partly technical, but the technical part can be understood with a minimum of math and physics. In this course we will review the most bizarre aspects of quantum mechanics, look at the experiments that have been done to elucidate them, and discuss the philosophical ramifications.

The textbook is *The Quantum Challenge* by George Greenfield and Arthur Zajonic. It's the perfect book for this class. Unfortunately, it is out of print. The book store was selling a few copies for several hundred dollars, but that seemed unreasonable. You can get used copies from Amazon for prices starting at $13.00 the last time I checked. There are two editions. The first edition in paperback is least expensive and fine for this course. You really should have a copy, and I would prefer if you would order one online. If you will have no interest in quantum mechanics beyond this class, I can loan you one of my own copies.

One of the nice things about these Honors seminars is that there will be freshmen as well as seniors in the class and students with many different academic backgrounds. That's great but it makes grading something of a challenge. As I see it, the only constructive role that grades play in this context is this; they tend to keep students engaged with the material. To this end I would like you to do some library research. During the quarter I would like you to write three brief papers. For each paper I would like you to choose one of the many experiments that are mentioned in the text, look up the original article or other articles describing the same experiment, and write a brief paper in which you explain the experiment in more detail. Some of the articles will have a lot of technical analysis which you are free to ignore if it's not within your sphere of competence. I would like you to concentrate on the experiment, the technology, and the significance of the results. I will be glad to help out if you get stuck on something. I know there is always a temptation to put these things off until the end of the quarter. To avoid this I would like to have your first paper by the end of the fourth week of class. The second before the end of the seventh week and the last paper at the end of the quarter. Please send me your paper by email. I will print out a copy, comment on it and hand it back in class.

It's important that you familiarize yourself with the course website. You should be able to reach it by going to the Physics Department website https://physics.oregonstate.edu and scrolling

down to PH407H under COURSES. That doesn't seem to be working at the moment so use the complete address:

http://physics.oregonstate.edu/~stetza/COURSES/ph407h/

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The Weird World of Quantum Mechanics: Schedule of Topics

Topic	Reading Assignment
Jan. 10: Welcome and introduction	
Jan. 17: Matter waves	Chapter 1
Jan. 24: Are photons real?	Chapter 2
Jan. 31: The uncertainty principle	Sections 3.1-3.4
Feb. 7: Complementarity	Chapter 4
Feb. 14: The EPR paradox and Bell's theorem	Chapter 5
Feb. 21: More on EPR	Chapter 6
Feb. 28: Schrodinger's cat	Sections 7.1 – 7.6
March 6: The measurement problem	Chapter 8
March 14: Other interpretations	My notes