Class Meeting: **M**, **W** & **F** 10:10-11:30am
Class Location: **MW**: Heg 106, **F**: Heg 201
Office Hours: **TBD**

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Course Description — Quantum mechanics was discovered in the context of atomic physics, but unlike many of the named classes in our curriculum it is not a subfield of physics in the same way that atomic physics or optics or particle physics are. Instead, it encompasses (almost) all the known subfields of physics and provides a new understanding of two of the pillars of physics: what it means to describe a physical system (a system's configuration, or more formally its state) and what is possible when you measure a system (its measurement outcomes). The exception to this statement is gravity; many researchers, myself included, are trying to fathom how gravity fits in. Perhaps gravity is even pointing us towards a need for reimagining quantum mechanics?

I quite like Scott Aaronson's analogy that quantum mechanics is like a computer's operating system (OS). You can run optics or atomic physics as software on this OS, but fundamentally, it determines what is possible. It determines what you can compute and measure. It is a new framework. Think about what it was like when you learned Newtonian mechanics for the first time. Forces are by no means intuitive and they don't help you think about every physical scenario or solve every problem. Nonetheless, the Newtonian framework provides an irreplaceable perspective on how to predict and understand physical motions. Quantum mechanics revolutionizes this understanding and framework.

The analogy with an operating system is also useful in thinking about the sort of mental shift you need to make as a student of quantum mechanics. If you pick up a friend's computer running an unfamiliar OS you will often find it challenging to do simple operations. Despite these difficulties you know quite well what a computer does; similarly, you know quite well what quantum mechanics does—it provides a quantitative framework for predicting the outcomes of measurements—so don't lose track of this picture as you are familiarizing yourself with its operational procedures.

Many people bring a great attitude to learning a new computer OS; they simply muck around with it until they get the hang of it. When they screw up, they simply say "oops" and try again. I strongly encourage you to bring this mindset to learning quantum. After all, it's a new OS, you should expect to turn many wrong nobs and totally misinterpret some relationships until you are more familiar with it. Don't believe the hype—quantum mechanics is not overly difficult, just unfamiliar and surprising at times.

Text: *Introduction to Quantum Mechanics* 3rd ed., by D. J. Griffiths & D. F. Schroeter (Cambridge University Press, 2018)

Take homes — Twice during the semester I will give you take home exams. These will be 4 hour, open book, self-timed exams. You can study as much as you like using any resource up to opening the exam. However, once you have opened the exam I ask that you only refer to your class notes and our primary text. I ask that you honor your peers and the effort that we all put into the class by not going over time or referencing any outside materials.

Grading Structure

Weekly Homework (due on Wednesdays)	35%
Student lectures	10%
In-class Exam	15%
Take home 1	20%
Take home Final	20%

Week	Topics	Chap.
1/27	What is quantum mechanics? Probabilities & Qubits	Notes, 1.1-3
2/3	Classical origins, Wave equations, & Continuum probabilities	Notes, 1.1-3
2/10	Operators, Eigenvalues, & Eigenfunctions	3
2/17	Time-independent Schrödinger equation	2.1-2
2/24	Quantum Harmonic Oscillator & Free Particle (**In-class Exam**)	2.3-4
3/2	Wave packets & Uncertainty relations, Momentum representation	2.4, 1.5-6
3/9	Uncertainty, 1D potentials	3.5, 2.5-6
3/16	**Spring Recess**	
3/23	Quantized angular momentum	4.3
3/30	Spin (**1st take home due 4/3, 5pm**)	4.4.1-2
4/6	Three-dimensional potentials & Degeneracy	4.1 & 6.6
4/13	Hydrogen atom	4.2
4/20	Addition of angular momenta, Multiparticle systems	4.4.3,
4/27	(**Mon. Tues. Advising days**) Quantum Particle Statistics	5
5/4	Symmetries & Quantum Chaos	6
5/11	Chaos Conclusion **Completion days begin 5/13**	Exam will focus on
5/18	**2nd take home due 5/19, 5pm**	topics post 3/16

Note: I reserve the right to adjust this syllabus during the semester

Course website: `faculty.bard.edu/hhaggard/teaching/phys321Sp20/`

Homework — There will be homework due every ??? at ???. The goal of the homework is for us to engage each other in a discussion of physics regularly, please come and visit as often as you like to chat. Along these lines, I recommend that you work together; this is invaluable in learning physics. Please write things up yourself to show me *and you* that you understand it (this helps battle the illusion of explanatory depth, or knowledge illusion). Please do not use the internet as a resource for anything but definitions of terms; if ever you are in doubt about the appropriateness of a resource, just ask me.

Homework Feedback — In the spirit of promoting discussion, I would like to go through and score homework together in small group or individual meetings. I believe that most of you did this last semester (or in a previous semester) with Paul. Let's discuss this option together on the first day of class and finalize how we will proceed with it.

Student Lectures — I would like each of you to give a guest lecture once during the semester. It has always been my belief that teaching is one of the best ways to learn and if it weren't so much work for you, I would have you do every lecture. These guest lectures will be 25 minutes, with 5-10 minutes set aside for us to discuss afterwards. I will meet with you twice before you lecture, once briefly to discuss what material you will cover, and then again to do a mock run through of the lecture. In previous years students have really enjoyed this opportunity, I hope you will too!

Further recommended books:
Quantum Processes, Systems, and Information, by B. Schumacher & M. Westmoreland
A Modern Approach to Quantum Mechanics, by J. Townsend
Principles of Quantum Mechanics, by R. Shankar
Quantum Mechanics for Scientists and Engineers, by D. A. B. Miller
Modern Quantum Mechanics, by J.J. Sakurai & J. J. Napolitano

I have read over this syllabus. I agree not to look at solutions manuals or use the internet for anything other than looking up reference information. Finally, I commit to stick to the parameters of the take home exams. I agree to these commitments freely and completely.

Signed: Date: