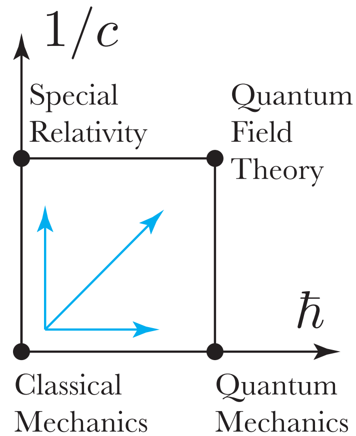
Class Meeting: **M**, **W** & **F** 1:30-2:50pm
Class Location: Heg 106
Lab Meeting: **W** 3-4pm
Lab Meeting Location: Heg 107

Email: haggard@bard.edu
Office: Rose 112
Office Hours: **TBD**
Office Phone: (845) 758-7302

Course Description — There was an explosion in our understanding of physics at the turn of the 20th century. Einstein imagined riding along with a light wave and realized as a consequence that parts of the foundation of our understanding of physics, e.g. our notion of time, need to be revised when we take into account objects moving near the speed of light. Thus began special relativity. Simultaneously, a collection of physicists realized together that some physical observables, like the energies of an electron orbiting the nucleus, are not well described by a continuum of values, but rather by discrete quantum jumps. Incorporating this discreteness into physical models also required an upheaval of the bedrock of physics, classical mechanics, and led to the invention of quantum mechanics.



In retrospect, one way to capture these two revolutions is to say that they each introduced a new fundamental physical scale, captured by a constant of nature. These are the speed of light, c, and Planck's constant, $\hbar$. As you turn on these constants you move from classical mechanics to special relativity and quantum mechanics respectively, see the Figure. If you do an experiment where they are both relevant at once you move towards the upper right corner of the Figure and the end of the modern physics era, the discovery of quantum field theory.

A third revolution, which built more slowly but with inexorable strength, was statistical mechanics. Unlike relativity and quantum mechanics, which changed what we think of as making up the world, statistical mechanics was a change in how we approach the description and quantification of the world. We leave the detailed understanding of a few objects behind for a much broader understanding of a great many objects. The advent of these three theories opened up a vast array of applications to physics and we will touch on many of these. A major focus will be understanding classical and quantum waves, but there will also be overviews of particle physics, nuclear physics, optical and molecular physics, condensed matter physics, astronomy, and cosmology.

Text: *Class notes* & *A Practical Guide to Data Analysis for Physical Science Students*, by L. Lyons. But, also check out the additional references on p 3.

Take homes — Twice during the semester I will give you take home exams. These will be 4 hour, open note, 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. 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 Fridays)	25%
Labs	25%
Quizzes	5%
Take home 1	15%
In-class exam	15%
Take home 2	15%

Week	Topics	Lab	Recommended Reading
8/31	Special Relativity: Space & Time	Measurements & Statistics	Hartle Ch. 4
9/7	Special Relativity: Energy & Momentum	Speed of Light	Hartle Ch. 5
9/14	Classical Waves in Matter	Michelson Interferometer	Hecht Ch. 2 (Ch. 1 opt.)
9/21	Electromagnetic Waves & Matter	Electron Charge-Mass Ratio	*Notes*
9/28	Classical Thermodynamics	No Lab **Take home 1**	Schroeder Ch. 1
10/5	Kinetic Theory	Brownian Motion	& Ch. 2
10/12	*(10/12 & 10/13 Fall Break)* Statistical Mechanics	Blackbody radiation	Einstein paper
10/19	Blackbody radiation	Spectrum of Mercury	*Notes*
10/26	Quantum Theory	Rydberg Constant	Tipler &
11/2	Quantum Mechanics in 1D	No Lab **In-class exam**	Llewellyn Ch. 4
11/9	Quantum Mechanics in 3D & Degeneracy	Photoelectric Effect	Einstein paper
11/16	Nuclear Physics	Millikan Oil Drop	Krane 1, 3, 6
11/23	Subatomic Particles *(Thanksgiving 11/26-27)*	No Lab	Griffiths
11/30	The Standard Model	Radioactivity	Chs. 1 & 2
12/7	(**Wed. 12/9 Adv. day**) The Solid State	No Lab	*Notes*
12/14	Cosmology **Completion days begin 12/14**	**Take home 2**	*Notes*

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

Course website: `http://bohr.physics.berkeley.edu/hal/teaching/phys241Fa15/`

Labs — I ask that you keep a meticulous lab notebook. Every time you add notes you should enter the date and indicate what they pertain to with a heading. You should collect all data in tables. Feel free to make sketches and tape in any cutout photographs. You should also always include written summaries of what you are doing, even if these are brief. You want to be able to reconstruct what you were doing years from now. In addition to the lab notebooks, lab write-ups will be due at 5pm each Monday for every lab. To make these as useful as possible most of them will not be full reports; instead, I will ask you to write two or three parts of a full report and will give you specific feedback on these parts. Writing physics is invaluable for the same reason as any written account—it allows you to think through writing.

Homework — There will be homework due every Friday in class. Complete solutions will be posted. I will grade a portion of the problems on a 0-5 scale. These scores mean roughly the following: 5=clear and complete solution, 4=good solution missing one conceptual point or calculation, 3=clear attempt but with substantive flaw, 2=effort made but incomplete plan, 1=little effort, 0=nothing appearing. I care most about the effort you invest and you can receive credit on this basis. 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 discuss. 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, which is worth looking up). I will always answer any questions in class, as well. Please do not use the internet as a resource for anything but physics books.

Lateness and Other Anomalies — I will usually grade your homework over the weekend and return it to you in class on Mondays. Late work will be accepted before I have graded that week's assignment with a 20% deduction on the graded score. After a set has been graded I will no longer accept late work. If you tell me about something ahead of time, almost any situation can be accommodated.
Quizzes — Sporadic brief (10-15min) quizzes will help you keep track of what you should know and the equations you should memorize.

Recommended References:
Gravity: An Introduction to Einstein's General Relativity, by J. B. Hartle
Optics, by E. Hecht
An Introduction to Thermal Physics, by D. V. Schroeder
Modern Physics, by P. A. Tipler & R. Llewellyn
Introductory Nuclear Physics, by K. S. Krane
Introduction to Elementary Particles, by D. J. Griffiths

Original Papers:
A. Einstein, "On the Movement of Small Particles Suspended in Stationary Liquids Required by the Molecular-Kinetic Theory of Heat," *Annalen der Physik (ser. 4)* **17** (1905) 549. [Translation]
A. Einstein, "Concerning an Heuristic Point of View Toward the Emission and Transformation of Light," *Annalen der Physik* **17** (1905) 132. [Translation]

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 and stay within the allotted time.

Signed: Date: