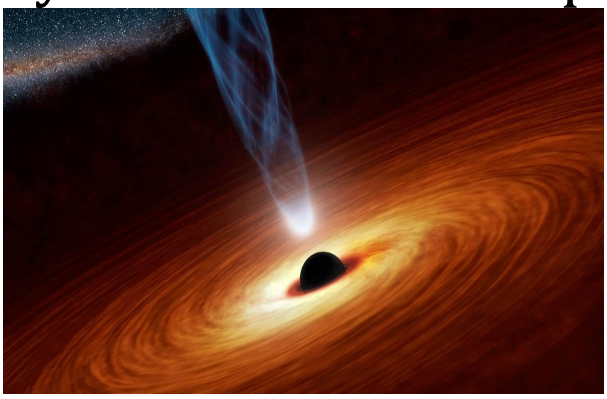
Syllabus Astro 350 Spring 2020



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No Textbook

Tues/Thursday 11:00am-12:15 pm
Room 2400 ATL
Course description
Black holes are the most exotic prediction of Einstein's Theory of General Relativity and, amazingly, the Universe seems to manufacture these bizarre objects in copious numbers. As well as being the ultimate laboratory for studying the nature of space and time, they drive some of the most energetic and extreme phenomena known to astronomers (with quasars and gamma-ray bursts being just a couple of examples). In this introduction to the physics and astrophysics of black holes, we start by examining the basic physics of black holes, which fundamentally means understanding gravity. We then look at the nature of stellar-mass black holes and supermassive black holes. We will discuss the fairly recent realization that black holes may be crucial agents for regulating the growth of galaxies. Finally, we dive into the realm of theoretical physics and probe how black holes may provide a route for uncovering new laws of physics governing the structure of space and time.

Course Prerequisites
It is assumed that you have some knowledge of astronomy at the ASTR100 or ASTR101 level. In addition, some mathematics (high-school level algebra, trigonometry and geometry) will be required for the classes, homeworks and examinations. Simple calculus will be used in a few of the classes, and may be

needed to answer a small number of the homework questions. However, no calculus will be required for the examinations.

Course expectations
Attendance: In order to successfully complete this course, I expect you to attend class 2 times a week. If you have to miss a lecture, please be sure to obtain a copy of the notes (either from another student, the web-site, or from me) and make sure that you understand what you missed. There will also be times when I will ask for class participation.

Preparation: I expect you to be prepared to work. We will be covering some fascinating but very challenging concepts - you will understand this material much more easily if you review your class notes sometime before the next lecture to make sure everything is clear. I encourage you to ask questions in the lectures or during my office hours.

Study Habits: It is better to keep up with the material on a daily basis than cram the night before the exam. I encourage you to chat about problems with your friends and classmates – you will learn a huge amount from trying to explain confusing issues to each other Please ask for help if you need it.. However, all graded materials, including class assignments and homeworks, must be your own thoughts in your own words.

Grading
Grades are based on a point scale with different assignments weighted as shown below.
Assignments:
Homework: 30%
Midterm: 30%
Final: 40%
TOTAL: 100%
Class participation is encouraged but not graded
Letter grades will be assigned based upon your cumulative score. The exam grades will be renormalized.

Midterm exam
There will be one in-class examination on the 12 March 2020. This exam will be closed book and will consist of a section of short answer questions, with essay and problem solving questions. University regulations will apply regarding academic honesty and excused absences. Please see the Schedule of Classes for these policies. If you are not able to take an exam due to illness or other legitimate reasons, you must contact me on or before the day of the exam either by email or voice mail. In addition, you must document the reason for your absence. A make up exam must be taken promptly.
If, for whatever reason, the University is officially closed on the day of the exam, the exam will be rescheduled for the next lecture date.

Final exam
As per the University examination schedule, the final exam for this course will be held on **Thursday, May 14 8:00-10:00am**, in room CSS2400. The final exam is cumulative in the sense that it will cover all material discussed in this course, but stress the second half. The format of the final exam will be the same as the midterm exam, with a section of short answer questions and a section of longer essay or problem solving questions.

Homeworks
There will be something almost every week. On the due date, homeworks should be handed in at the front of the class. Homeworks will be considered late by the end of class. If you cannot make it to class, you should either ask a friend/classmate to hand it in for you, or make sure that it gets to me or Alex before the time that it is due. Late assignments will be accepted for *up to* 50% credit if the assignment is turned in late, but before grading has started (Ask Alex for timing).

If you have a valid emergency, you should send me an email or voice mail message before the due date telling me the nature of the emergency.
Please document all such emergencies.
If, for whatever reason, the University is officially closed on the day of the due date, the due date will be moved to the next lecture.

Academic Integrity
The University's policies and rules on academic integrity are laid out in the Schedule of Classes. You must never engage in acts of academic dishonesty at any time. Acts of academic dishonest include cheating, fabrication, plagiarism, or helping any other person to do these things. These rules apply to homeworks and quizzes as well as exams. As a part of these rules, you must give credit to any book, published article or web-page that you have used to help you with a particular assignment. The University and I take these issues extremely seriously.
To underscore the need for academic integrity, the University asks you to write the Following pledge on any assignment or exam:
"I pledge on my honor that I have not given or received any unauthorized assistance on this assignment/examination."

Course Outline
Section I Classical Physics of Black Holes
Theories of gravity, from Newton to Einstein
Einstein's Theory of General Relativity, horizons, and black holes
Structure of a (rotating) black hole in GR

This section is Primarily Theoretical

Section II Stellar-Mass Black holes
Black holes (and pulsars) from stellar death

Discovery of the first black hole
Accretion – how black holes shine!

Primarily involves interpretation and analysis of observations
why do we think these objects are Black holes, how did they get that way, how do we observe BHs ?

Section III Supermassive black holes
Quasars and active galactic nuclei
'Dead' quasars and the center of our Galaxy
Black holes and their role in galaxy formation
Origin of supermassive black holes

Interpretation and analysis of observations
why do we think these objects are Black holes
the surprising connection between black holes and their 'host' galaxy

Section IV Black holes and the frontiers of physics
Tests of General Relativity
Gravitational radiation
Hawking radiation, firewalls & the Information Paradox
Imaging a black hole

Connection between theory and observation-pushing physics to the limit