ASTR 2030: Black Holes
Course Syllabus, Fall 2019

DESCRIPTION
The aim of this course is to provide an introduction to black holes, largely as a vehicle for understanding modern concepts of space, time, and gravity. In order we will explore i) the properties of black holes, ii) the evidence for their existence, and iii) their role as laboratories for extreme Physics experiments. I will emphasize recent discoveries to highlight the scientific process as used in Astronomy. I hope to convince you that, via a combination of careful observation and theory, science allows us to confidently answer some questions that lie far outside the realm of everyday experience. You can expect this course to be conceptually challenging but rewarding.

PREREQUISITES: You will need to be proficient in high school math for this course. This includes scientific notation, unit analysis and conversions, ratios, and algebra. No previous Astronomy courses are required.

PROFESSOR: Jason Dexter
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Office: JILA Tower A909
Office hours: TTh 11:00-12:00, and by appointment

TEACHING ASSISTANT: Hannalore Gerling-Dunsmore
Email: gerlingd@colorado.edu
Office: JILA Tower A905
Office hours: W 4:00-5:00pm in the office and T 4:00-5:00pm, Th 3:00-4:00pm in the AHR, and by appointment

ASTRONOMY HELP ROOM (AHR):
Get free Astronomy help from graduate students Tuesdays, Wednesdays, and Thursdays 2–6pm in Duane D220

CLASS TIME AND LOCATION
Lecture: 9:30-10:45 TTh, Duane G1B20

TEXTBOOK
Gravity's Fatal Attraction: Black Holes in the Universe, Second Edition, Begelman & Rees
A copy is on reserve at the Norlin Library.

COURSE WEBSITE
On Canvas (`http://canvas.colorado.edu/`)

YOUR GRADE

(30%) HOMEWORKS (5). There will be 5 homeworks in this class, each due at the beginning of class (i.e., 9:30am sharp) on the dates listed below. Only the best 4/5 homework scores will count towards your grade, and *no late homeworks will be accepted.*

Homework 1: due 9:30am on Thursday, September 12
Homework 2: due 9:30am on Thursday, September 26
Homework 3: due 9:30am on Thursday, October 17
Homework 4: due 9:30am on Thursday, November 7
Homework 5: due 9:30am on Thursday, December 5

(15%) IN CLASS GROUP PROJECTS (3). We will do 3 small group projects in class. The principle goal of the projects is to work together with your peers in groups of 3 or 4 to think through conceptual questions related to black holes. You must work in a group, and the group must discuss and solve the project together.

One member of the group should be assigned as the Scribe, who is responsible for writing up and submitting the group's work. Only one submission will be accepted from each group, and it must have the names of all members of the group. You are encouraged to serve as the Scribe for one project during the semester.

The lowest project score will be dropped from your grade, including cases where you cannot attend class due to circumstances outside your control.

In class projects will be on Sept 26, Oct 24, and Nov 7 (at Fiske planetarium).

(5%) IN CLASS CLICKER QUESTIONS. We will use clickers in class every day to help you practice the material. Your 4 days with the lowest clicker scores will be dropped, including any days when you are not able to attend class.

(40%) EXAMS (2). There will be 2 in-class exams during the semester. Notes, books, and calculators are not allowed at exams, and an equation sheet will be provided to you for the exams. The exams are mandatory and *there are no makeup exams.*

Exam 1: in class on Thursday, October 3
Exam 2: in class on Thursday, November 14

(30%) FINAL EXAM (1). The final exam is mandatory and there will be no makeup final exam. The final will be a comprehensive exam of the entire course. Notes, books, and calculators are not allowed, and an equation sheet will be provided to you.

Final Exam date/time TBD

The total comes to 120%. To bring it to 100%, your lowest exam score or 2/3 of the final will be dropped, whichever is lower. TA Hannalore Gerling-Dunsmore will be calculating grades, and is generally the person to ask about them.

REVIEW SESSIONS

We will hold review sessions for the exams and Final. Times and locations are to be determined.

ANTICIPATED COURSE SCHEDULE

This is a rough guide to the topics we will cover this semester. It will likely evolve as the semester progresses. The exam and project dates and homework due dates will not change. The reading assignments from our textbook, Gravity's Fatal Attraction: Black Holes in the Universe by Begelman & Rees (BR), are given for each week.

Week	Tuesday	Thursday
1 (Aug. 27, 29) *Reading: BR Chapter 1*	Introduction	Gravity and forces
2 (Sep. 3, 5)	Dark stars	Special relativity HW1 assigned
3 (Sep. 10, 12)	Special relativity	General relativity **HW1 due**
4 (Sep. 17, 19)	General relativity	General relativity HW2 assigned
5 (Sep. 24, 26) *Reading: BR Chapter 2*	Black holes in general relativity	**project 1** **HW2 due**
6 (Oct. 1, 3) *Reading: BR Chapter 3*	Fates of stars	**Exam 1**
7 (Oct. 8, 10) *Reading: BR Chapter 4-5*	Formation of black holes	X-ray binaries and quasars HW3 assigned
8 (Oct. 15, 17) *Reading: BR Chapter 6*	Accretion power	**Fiske planetarium** **HW3 due**
9 (Oct. 22, 24) *Reading: BR Chapter 8-9*	Accretion disks	**project 2**
10 (Oct. 29, 31) *Reading: BR Chapter 10*	Supermassive black holes in galaxies	Imaging black holes HW4 assigned
11 (Nov. 5, 7)	Imaging black holes	**project 3 at Fiske** **HW4 due**
12 (Nov. 12, 14)	TBD	**Exam 2**
13 (Nov. 19, 21)	Gravitational waves	Gravitational waves HW5 assigned
14 (Nov. 26, 28)	*Fall Break*	*Fall Break*
15 (Dec 3, 5) *Reading: BR Chapter 7*	Hawking radiation	Information paradox **HW5 due**
16 (Dec 10, 12) *Reading: BR Chapter 11*	TBD	Inside black holes

COURSE POLICIES

Collaboration: I encourage you to work together on homeworks, as this is the way scientists most successfully tackle problems. However, be sure that what you turn in is *your own*. Instances of copying or cheating will be referred to the Honor Council for non-academic sanctions. Any degree of copying or cheating will result in the following academic sanctions: zero credit for the work, for all parties involved, and that assignment cannot be dropped. If you have any questions about the line between collaboration and cheating, don't hesitate to come and talk to me.

Clickers: Bring your clicker to class every day.

Phones, laptops, and tablets: Must be turned off during class, unless you make arrangements with me to take notes on these devices.

End of class: Please don't start packing up your belongings until class is dismissed. You can expect class to finish on time.

Accommodation for disabilities: If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the Disability Services website. Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance. If you have a temporary medical condition or injury, see Temporary Medical Conditions under the Students tab on the Disability Services website.

Classroom behavior: Students and faculty each have responsibility for maintaining an appropriate learning environment. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. Class rosters are provided to the instructor with the student's legal name. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records. For more information, see the policies on classroom behavior and the Student Code of Conduct.

Honor code: All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code. Violations of the policy may include: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code (honor@colorado.edu); 303-492-5550). Students who are found responsible for violating the academic integrity policy will be subject to non-academic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found at the Honor Code Office website.

Sexual misconduct, discrimination, harassment and/or related retaliation: The University of Colorado Boulder (CU Boulder) is committed to fostering a positive and welcoming learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct intimate partner abuse (including dating or domestic violence), stalking, protected-class discrimination or harassment by members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or cureport@colorado.edu. Information about the OIEC, university policies, anonymous reporting, and the campus resources can be found on the OIEC website.

Please know that faculty and instructors have a responsibility to inform OIEC when made aware of incidents of sexual misconduct, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about options for reporting and support resources.

Religious holidays: Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. See the campus policy regarding religious observances for full details. Please notify me as far in advance as possible if you have a religious conflict with any scheduled class activity and I will try to accommodate your needs.