

PHILOSOPHY AND BLACK HOLES

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Office Hours: Monday 1:30-3:30pm

Semester: Spring 2025
Time: Wednesday 1:30-4:00pm
Classroom: 112 Miner Hall
Course Website: Canvas

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Course Description

From *Interstellar* to the 2019 photo splashed across the front of newspapers, black holes have captured the popular imagination. But what are these mysterious objects, and how do we know? In this course, we will explore diverse philosophical issues related to the study of black holes: how should we understand ideas like “event horizon” or “singularity”?; how can we make sense of scientists claiming to “observe” objects that emit no light?; and what does the study of black holes reveal about the nature of scientific inquiry? We will begin by demystifying black holes: what they are, how they form, and the groundbreaking discoveries that have led to our current understanding of them. Together, we will grapple with the epistemic challenges presented by black holes, and examine the innovative methods that scientists use to investigate them: gravitational waves, the Event Horizon Telescope, so-called “analog experiments”, and more! As we delve deeper, we will engage with the broader philosophical questions that emerge concerning the nature of scientific representation; the use of models and simulations in empirical science; the differences between “experimental” and “observational” or “historical” sciences; and the social responsibilities of scientists.

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1 Learning Outcomes

By the end of this course you will:

- Have a good (non-technical) understanding of terms like ‘event horizon’, ‘singularity’, and ‘Schwarzschild solution’ and ‘Kerr solution’ used when talking about black holes.
- Be able to explain the key evidence for the existence of astrophysical black holes and some of their key properties.
- Be able to appreciate how black holes enter into philosophical debates about scientific realism, the nature of time, and more.

2 Text(s)

There are **no required textbooks**. All required course readings will be uploaded to Canvas or will be freely available online.

In some cases, you may need to use your Tufts credentials to access something through the Tufts library. Please feel free to ask me if you need help accessing any of the readings.

3 Course Requirements

All written assignments should be submitted via Canvas.

3.1 Summary of Assignments:

Assignment:	Percentage:
Meaningful Participation:	15%
Short Reaction Paper:	15%
Presentation on Final Paper:	15%
Final Paper:	55%

Meaningful Participation (15%):

Philosophy is a group activity. With this in mind, students are expected to carefully study all required readings for each week and come prepared to discuss them, raise questions about them, and draw attention to their strengths and weaknesses.

From time to time I will also ask you to do short in-class writing assignments reflecting on the readings and class discussions. These will not themselves be graded but will contribute to your participation grade.

Attendance: You should attend every class but extenuating circumstances arise that can make this difficult. If you have to miss a class, please contact me so that we can come up with a plan for you to catch up on what you missed.

Short Reaction Paper (15%)

For this assignment, you will write a short (2 page) reaction paper responding to an aspect of the readings, and/or something that came up in class discussion.

Presentation on Final Paper (15%)

The final two class sessions will be allotted for presentations in which each student will present (using slides, a handout, poster, etc.) on their work to date on the final paper. In these presentations, you should (where possible) give a statement of the central question under investigation and some context for why this question is important; an indication of what literature there already is on the topic and what you intend to focus on/add to the existing literature. If you are far enough along you should also offer a statement of their thesis and central argument.

Final Paper (55%)

You will write a final paper (approx. 3000-4000 words). The topic should relate directly to issues considered in the course. Your paper should be detailed and highly focused. Considering an argument for or against a specific thesis, and/or adjudicating a specific debate between two or three authors in the literature, is better than a sweeping or general treatment of a large issue involving many arguments or people. You are strongly encouraged to meet with me individually to discuss your topic.

3.2 Letter Grade Conversion

≥ 93.00	A	73.00 - 76.99	C
90.00 - 92.99	A-	70.00 - 72.99	C-
87.00 - 89.99	B+	67.00 - 69.99	D+
83.00 - 86.99	B	63.00 - 66.99	D
80.00 - 82.99	B-	60.00 - 62.99	D-
77.00 - 79.99	C+	≤ 59.99	F

4 Course Outline

This schedule is flexible and subject to change (e.g., if we want to spend more time on a particular topic, I will adjust accordingly). The current version of this document will always be available on [Canvas](#).

4.1 Topic Overview

Week	Date	Topic
Week 1	15 January	Introduction to Black Holes
-	22 January	No Class (Tufts Monday)
Week 2	29 January	The Schwarzschild and Kerr Solutions
Week 3	5 February	Many Definitions of Black Holes
Week 4	12 February	Epistemic Peculiarities of Black Hole Astrophysics
Week 5	19 February	The Evidence for Supermassive Black Holes
Week 6	26 February	The Evidence for Black Hole Binaries
Week 7	5 March	Visualization and Directness
Week 8	12 March	Analogue Experiments
<i>Spring Break</i>		
Week 9	26 March	Scientific Realism
Week 10	2 April	Philosophy of Time
Week 11	9 April	TBA: Student Choice!
Week 12	16 April	Presentations
Week 13	23 April	Presentations

4.2 Reading Schedule

Week 1: Introduction to Black Holes

Watch: Galison (2020) *Black Holes: The Edge of All We Know*

Read: Hawking (1988) *A Brief History of Time*, Chapters 6-7

Week 2: The Schwarzschild and Kerr Solutions

Read: Gubser and Pretorius (2017) *The Little Book of Black Holes* Chapters 3 & 4 (Optional background: Chapters 1 & 2)

Read: Cartwright (1983) *How the Laws of Physics Lie*, Essay 7: ‘Fitting Facts to Equations’

Week 3: Many Definitions of Black Holes

Read: Curiel (2019) ‘The many definitions of a black hole’

Read: Doboszewski and Lehmkuhl (2023) ‘On the Epistemology of Observational Black Hole Astrophysics’, Section 3

Week 4: Epistemic Peculiarities of Black Hole Astrophysics

Read: Doboszewski and Lehmkuhl (2023) ‘On the Epistemology of Observational Black Hole Astrophysics’ (the rest).

Read: Boyd (2023) ‘Laboratory Astrophysics: Lessons for Epistemology of Astrophysics’

Week 5: The Evidence for Supermassive Black Holes

Read: Eckart et al. (2017) ‘The Milky Way’s Supermassive Black Hole: How Good a Case Is It? A Challenge for Astrophysics & Philosophy of Science’

Read: Doboszewski and Elder (2024) ‘Robustness and the Event Horizon Telescope: the case of the first image of M87*’

Week 6: The Evidence for Black Hole Binaries

Read: Elder (2023) ‘Black Hole Coalescence: Observation and Model Validation’

Read: Patton (2020) ‘Expanding Theory Testing in General Relativity: LIGO and parametrized theories’

Week 7: Visualization and Directness

Read: Skulberg and Sparre (2023) ‘A Black Hole in Ink: Jean-Pierre Luminet and “Realistic” Black Hole Imaging’

Read: Skulberg and Elder (Forthcoming) ‘What is a “direct” image of a shadow?: A history and epistemology of “directness” in black hole research’

Week 8: Confirmation from Analogue Experiments

Read: Dardashti, Thébault and Winsberg (2017) ‘Confirmation via Analogue Simulation: What Dumb Holes Could Tell Us about Gravity’

Read: Crowther, Linnemann, and Wüthrich (2019) ‘What we cannot learn from analogue experiments’

(Optional: Watch Grace Field (2022) ‘Analogue Black Holes’)

***** Friday, 14 March 2025: Submit Short Reaction Paper by 5:00pm (via Canvas)**

*** SPRING BREAK ***

Week 9: Scientific Realism

Read: Hacking (1989) 'Extragalactic reality: The case of gravitational lensing'

Read: Allzén (2023) Extragalactic Reality Revisited: Astrophysics and Entity Realism

Week 10: Philosophy of Time

Read: Baron and Le Bihan (2023) 'Trouble on the horizon for presentism'

Week 11: TBA

We will decide together what topic to cover this week. (Some options: Singularities, Black holes and determinism, black hole thermodynamics, the information loss paradox, social dimensions of black hole research, digging deeper on a previous topic, etc.)

Week 12: Student Presentations

Order TBA

Week 13: Student Presentations

Order TBA

***** Friday, 2 May 2025: Submit Final Research Paper by 5:00pm (via Canvas).**

5 Course Policies

5.1 Late or Incomplete Work

We all live busy lives outside of the classroom and we each face our own unique challenges. I understand that these challenges will sometimes make it difficult to complete class assignments on time.

Please let me know as soon as possible (and ideally before the deadline) if you know that you will struggle to meet a deadline. When you do, we can determine a reasonable timeline for you to complete the assignment or, under some circumstances, an alternative way for you to demonstrate your learning.

Extensions: All students are entitled to a no-questions-asked 24-hour extension for each written assignment. You still need to let me know if you want to use one of these extensions! Further extensions are at my discretion, but I promise to be as flexible as possible in offering reasonable extensions.

Late work without such an extension will be penalized by 1/3 of a letter grade per day (so, e.g., an A- handed in one day late would become a B+).

6 Other Policies and Resources

6.1 Tufts Academic Resources

The StAAR Center offers a variety of FREE resources, available to *all students*. Students may make an appointment to work on any writing-related project or assignment, attend subject tutoring in a variety of disciplines, or meet with an academic coach to hone fundamental academic skills like time management or overcoming procrastination. Students can make an appointment for any of these services by visiting go.tufts.edu/TutorFinder, or by visiting their website: <https://students.tufts.edu/staar-center>

6.2 Accommodations

Tufts is committed to providing equal access and support to all qualified students through the provision of reasonable accommodations. If you have a disability that requires reasonable accommodations, you are encouraged to contact the StAAR Center at:

- StaarCenter@tufts.edu or
- 617-627-4539.

Please be aware that accommodations cannot be enacted retroactively, making timeliness a critical aspect for their provision.

In addition, students with or without a formally documented disability are warmly encouraged to contact me about accommodations. I am committed to collaborating with students to ensure that my course does not present unreasonable or inequitable barriers to their success.

6.3 Religious Accommodations

Tufts University faculty, staff, and administration highly value and acknowledge the religious diversity of its student body. Students seeking religious accommodations related to their holy days are encouraged to collaborate with faculty to make arrangements during the first week of each semester. The religious holy days calendar, including the holy days policy from the Faculty Handbook, is available [here](#) for your reference. Students seeking additional support may refer to the University Religious Accommodations Policy, available [here](#). The University Chaplaincy is also available to respond to questions on religious observances; their contact information is available [here](#).

6.4 Academic Integrity

All members of the Tufts community are responsible for integrity in their own behavior and for contributing to an overall environment of integrity at the university. You can find resources relating to academic integrity in the Tufts Academic Integrity handbook ([click here](#)). It is your responsibility to familiarize yourself with the requirements of ethical behavior and academic work as described in Tufts' Academic Integrity handbook.

If you ever have a question about the expectations concerning a particular assignment or project in this course, please ask me for clarification.

The Faculty of the School of Arts and Sciences and the School of Engineering are required to report suspected cases of academic integrity violations to the Dean of Student Affairs Office. If I suspect that you have cheated or plagiarized in this class, I must report the situation to the dean.

6.5 Guidelines for the use of AI

In this course, you may use AI tools for your learning, just as you can collaborate with your peers for things such as brainstorming, getting feedback, revising, or editing of your own work. However, you may not submit any work generated by an AI program as your own. This is a violation of Tufts Academic Integrity policies.

To help guide you in the use of AI in this course – consider the following guidelines:

- Familiarize yourself with AI tools, including that: Bias is embedded in the creation of these systems and in their output and you may encounter harmful language and ideas. AI platforms can produce inaccurate or false information with confidence (so called hallucinations, e.g, it frequently invent false references). Text from AI may closely mimic human knowledge, understanding and even human emotions. Many of these tools retain the rights to use your information and the content shared with them in a variety of ways.
- Cite all AI tools when used or referred to in assigned work. See *How to Cite ChatGPT* from the APA & *How to Cite Generative AI* from the MLA. Identify the way it contributed to your work. For example, you can include a statement that you asked an AI to “identify any grammatical or spelling errors” in your writing, or you used it to get started in thinking about topics for your paper. Any statement directly generated by an AI system should be in quotes.
- If you have questions please ask via email, in office hours or during class.

6.6 Student Support, Including Mental Health

As a student, there may be times when personal stressors or difficulties interfere with your academic performance or well-being. The **Dean of Student Affairs Office** offers support and care to undergraduates and graduate students who are experiencing difficulties, and can also aid faculty in their work with students. In addition, through Tufts’ **Counseling and Mental Health Service (CMHS)** students can access mental health support 24/7, and they can provide information on additional resources. CMHS also provides confidential consultation, brief counseling, and urgent care at no cost for all Tufts undergraduates as well as for graduate students who have paid the student health fee. To make an appointment, call 617-627-3360. Please visit the CMHS website: <http://go.tufts.edu/Counseling> to learn more about their services and resources.

7 Other Resources

7.1 The Stanford Encyclopedia of Philosophy

Find it online here: <https://plato.stanford.edu/>

The SEP is a good place to start when learning about a new philosophical topic. The SEP entries are written by experts in that area and generally provide a good overview of the issues.

A good next step is often to follow up by reading the sources that the SEP entry sites on a particular issue.

7.2 Writing Philosophy Papers

- Jim Pryor's guide to philosophical writing:
<http://www.jimpryor.net/teaching/guidelines/writing.html>
- Harvard guide to writing philosophy papers:
https://philosophy.fas.harvard.edu/files/phildept/files/brief_guide_to_writing_philosophy_paper.pdf