# PHYS S102E

# Hollywood Astrophysics

# Summer Session B

## Course Description

In this online summer course, students learn how to critically evaluate Hollywood's representation of modern physics (relativity, quantum mechanics and modern day climate change). After being given the background physics and quantitative training required to understand a particular topic, students will typically be shown a movie clip and asked to quantitatively judge the veracity of the physics in the scene. Is it a good or bad representation of what actually happens according to the laws of physics? Assignments will involve both solving physics word problems and evaluating movie clips such as a scene in 'Interstellar' or a 'doomsday scenario' (e.g. abrupt onset of an ice age triggered by changes in the ocean currents).

If you claim a movie violates the laws of physics, you need to be able to back up that claim with sound physical reasoning. This is what students learn to do in Hollywood Astrophysics.

## Instructor and Teaching Fellow


Instructor: Frank Robinson

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Teaching Fellow: Iver Warburton

- Office Hours: Schedule via email
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## General Course Information

Online Virtual Classroom Meeting: Monday & Wednesday 10:00am-11:30am (EST)

Students are required to participate in two online section meetings per week in our "virtual classroom". During these virtual classroom sections, students will participate in open discussions with Professor Robinson and the TF. It is expected that you will have already watched and made your own notes from the lectures before each online classroom meeting begins.

Lectures: Before each "Virtual Classroom Meeting" you will be required to watch a set of online lecture videos (each 5-20 minutes long) on your own. You are expected to **watch and take notes** from the lectures needed for each online discussion before the online meeting time. Note that some weeks, you will be expected to watch over an hour of lecture videos before a meeting, so do plan your schedule so that you can keep up with lecture viewing. Much of the information on the exams will come directly from what is presented in the lectures. *It is your responsibility to put together a set of detailed notes based on the lectures*.

## Grading Breakdown

Your final grade in the course will be based on:

- 20% Exam 1 composed of a written test (15%) and an oral test (5%)
- 20% Exam 2 composed of a written test (15%) and an oral test (5%)
- 20% Exam 3 composed of a written test (15%) and an oral test (5%)
- 20% Homework assignments (3 problem sets)
- 20% Participation in online section discussion (10%) and lecture mini-quiz participation (10%)

Exam 1: Scheduled to be taken at 10 am on July 9

Exam 2: Scheduled to be taken at 10 am on July 21

Exam 3: Scheduled to be taken at 10 am on July 30

You must take each exam during this timeslot (we will not be using Examity). After finishing the exam, students will have a 5-10 minute one on one oral test with one of the instructors (typically they will be asked to either one of their answers in the exam or describe how they would solve a similar problem).

Attendance: Class will meet on Zoom twice a week to discuss the material and work through example problems. Attendance is mandatory.

Online Discussion Section Participation: You will also receive a grade based on your online section participation. The goal of these discussions is to develop good problem-solving skills required to solve homework problems, answer exam questions and understand lecture material.

Homework: During the course students will receive homework problems approximately once a week. Typically, a homework will be assigned on Monday and be due the following Friday at 12 am EST (midnight). We will provide hints on how to do these types of problems during the discussion section, but it's ideal if you try do these problems on your own (or in groups) before class. Late homeworks will be given a maximum of 50 % for one day late and 25 % for 2 days late. You will scan your written homework and upload it to Canvas. You will be responsible for the legibility of your work, which includes handwriting *and* scanning. You may also typeset your homework, in which case you are only responsible for typos.

Academic Honesty: All the exams are closed book, which means the use of any written material or any form of collaboration is forbidden. For a short but useful discussion, see: http://yalecollege.yale.edu/faculty-staff/faculty/handbook-instructors-undergraduates-yale-college/teaching/academic-dishonesty. All suspected cases of cheating will be reported to the Yale College Executive Committee.

AI Statement: Before collaborating with an AI chatbot on your work for this course, please request permission by sending me a note that describes (a) how you intend to use the tool and (b) how using it will enhance your learning. Any use of AI to complete an assignment must be acknowledged in a citation that includes the prompt you submitted to the bot, the date of access, and the URL of the program.

## Learning goals

- Develop analytic and numerical problem-solving skills including the ability to make useful approximations.
- Improve scientific literacy
- Expose students to developments in modern physics and astrophysics.

**Dates, Topics, Lectures and Exams**

**Class 1: Review of classical physics.**

The very fast, the very big and the very small. An overview of modern physics.

Monday June 30: Open questions and discussion.

*Introduction and orientation.*

*Review of classical physics that will be used in this class.*

**Class 2: Special Theory of Relativity (very fast)**

Wednesday July 2: Open questions and discussion of problem set 1.

*Introduction to relativity.*

*Time dilation and length contraction in movies. Simultaneity, events and space-time.*

*Relativistic momentum and energy*

**Class 3: Gravitation, black holes, intro. to relativity (very big)**

Monday July 7: Open questions and discussion.

*Newton vs Einstein's gravity.*

*Space-time, Black-holes and the physics of "Interstellar"*

**Class 4: Exam 1 (Relativity)**

Wednesday July 9: Exam1.

**Class 5: Waves, particles and an introduction to Quantum Mechanics (very small)**

Monday July 14: Open questions and discussion.

*Intro. to waves, properties of waves. Combining waves. Sound. Electromagnetic spectrum.*
*Waves vs particles: the photoelectric effect and the double slit experiment.*

**Class 6: Quantum Mechanics**

Wednesday July 16: Open questions and discussion of problem set 2.

*Interpretations of the double slit experiment (Dr. Quantum video), Schrodinger equation, Heisenberg's uncertainty principle, scattering and tunneling.*

**Class 7: Exam 2 (Quantum Mechanics and Relativity)**

Monday July 21: Exam2.

**Class 8: Historical climate change**

Wednesday July 23: Open questions and discussion of problem set 3.

*Disaster movies – asteroid impacts and extinction events. "The Day after Tomorrow"*

*Radiation and steady state. Absorption spectra. Global energy budget.*

**Class 9: Modern day climate change**

Monday July 28: open questions and discussion.

*Radiative forcing, climate sensitivity, forcings and feedback. Geoengineering (e.g. Solar Radiation Management).*

**Class 10: Exam 3 (Climate Change, Quantum Mechanics and Relativity)**

Wednesday July 30: Exam 3