General Relativity: The Science of Interstellar

ExCo ###, 2 Credits

Fall 2024

Instructor

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Class Meetings

- Time: Wednesdays, 7-9 pm
- Location: Wright 114

Course Overview

In the early twentieth century, Einstein revolutionized the study of gravity by connecting spacetime geometry with physical dynamics. As John Wheeler says, "Spacetime tells matter how to move; matter tells spacetime how to curve". This started the branch of physics currently known as General Relativity. Despite being a very complex theory, it leads to many intriguing results that are especially highlighted by the famous Christopher Nolan's movie "Interstellar". In this course, I aim to use these results to discuss General Relativity in a beginner-friendly manner.

Prerequisites

This course is aimed at students who have previously taken introductory Physics courses (PHYS 110, 111, 103, or 104). That said, everyone is welcome to join. The level of complexity might be adjusted depending on the background of who demonstrates interest.

Textbooks

- Kip Thorne's "The Science of Interstellar" (KT)

  This will be the main textbook for this course. Kip Thorne is a renowned physicist in the field (and my academic grandparent) who was deeply involved in the creation

of Interstellar. In this book, he uses a general-audience language to explain some parts of the movie.

- James Hartle's "Gravity: An Introduction to Einstein's General Relativity" (JH)

  This is the standard textbook for anyone learning General Relativity for the first time. I will reference this book only a couple of times during this course, but I highly recommend it for anyone who is interested in a more formal introduction to this branch of Physics.

Readings & Assignments

All readings and assignments are due at the beginning of the respective class meeting.

- **Weekly readings**

  There will be readings for all lecture-based classes.

  For KT readings, I want you to feel intrigued by the topics presented. As this book is intended for a general audience, these readings should not be too complicated. In lecture, we will get deeper into the physics of such topics.

  For JH readings, I *do not* expect you to completely understand the content covered in the assigned chapters. This book can be quite advanced in some parts, as it is aimed at an advanced undergraduate level. Instead, my goal is that you skim these chapters so that you have an idea of what we will talk about in lecture.

- **2 Quizzes**

  As midterm evaluations, there will be two quizzes, each focused on three chapters of KT. These are meant to give you a break from readings and a chance to look back at the topics we have talked about in lecture. Both of them will be take-home.

  Immediately after you turn in your answers at the beginning of class, we will spend the class period going over the quiz and answering any questions you might have.

- **Presentation**

  At the end of the semester, you will present on a topic relevant to what we have discussed in the course. The presentations will be 10-minutes long, after which you will have 2 minutes to answer questions.

Evaluation

This is a Pass / No Pass course, and all assignments will be "graded" similarly. That is, as long as you demonstrate that you have made enough effort, you will get full credit. This course is meant to show you the beauty of General Relativity, not to push you away from it.

In order to pass the course, you must complete all assignments in a timely manner. Additionally, the ExCo **attendance policy** is that a student cannot miss 25% or more of

classes, which means you can miss at most 3 classes in the semester. Attendance will be taken at all class meetings.

Tentative Schedule

Week	Topics	Reading / Assignment
1 (09/04)	Course Overview	
2 (09/11)	I. Foundations	KT p. vii–53
3 (09/18)	Differential Geometry	JH ch. 2 & 7–8
4 (09/25)	II. Gargantua	KT p. 57–102
5 (10/02)	IV. The Wormhole	KT p. 127–157
6 (10/09)	Review	**Quiz 1**
7 (10/16)	V. Exploring Gargantua's Environs	KT p. 161–182
	Fall break	
8 (10/30)	VI. Extreme Physics	KT p. 185–234
9 (11/06)	VII. Climax	KT p. 237–275
10 (11/13)	Review	**Quiz 2**
11 (11/20)	Einstein's Equations	JH ch. 20–23
	Thanksgiving break	
12 (12/04)	In-class Presentations	**Presentation**
13 (12/11)	In-class Presentations	**Presentation**