

PHYS499G: An Introduction to General Relativity for Undergraduates

Lecturer: William DeRocco

January 2025

1 Logistics

- Textbook: *Spacetime and Geometry*, Sean Carroll. Available online at https://fma.if.usp.br/~mlima/teaching/PGF5292_2021/Carroll_SG.pdf
- Meeting time: M/W/F 11:00 AM - 12:40 PM (see below for full schedule)
- Meeting location: PHY 1402 (1/3 - 1/10), *PHY 1303 (1/13 - 1/22), possibly subject to change*
- Weather policy: Any notice of cancellation will be posted as an announcement on Canvas by 9 AM
- Grading:
 - Homework: 60%
 - Final presentation: 40%
- Contact: derocco@umd.edu

2 Schedule

2.1 Friday, January 3rd (PHY 1402)

- Introductions
- Brief review of special relativity
 - What is spacetime?
 - Space-time interval
 - Einstein summation convention
 - The metric
 - Special relativity postulates

- Lorentz transformations
- Homework: #1, #2

2.2 Monday, January 6th (PHY 1402)

- Introduction to GR
 - Principles of GR
- Differential Geometry I
 - Manifolds
 - Coordinates
 - Vectors
 - Dual vectors
 - Tensors
 - The metric
- Homework: #3, #4

2.3 Wednesday, January 8th (PHY 1402)

- Differential Geometry II
 - Covariant derivative
 - Connections
 - Christoffel symbols
 - Parallel transport
 - Curvature
- Homework: #5, #6

2.4 Friday, January 10th (PHY 1402)

- General Relativity
 - Geodesic equation
 - 4-velocity and 4-momentum
 - Locally inertial coordinates
 - Killing vectors
 - Newtonian limit
 - Einstein equation
- Homework: #7, #8

2.5 Monday, January 13th (PHY 1303)

- Schwarzschild solution
 - Weak-field limit
 - Gravitational redshift
 - Singularities
 - Eddington-Finkelstein coordinates
- Homework: #9, #10

2.6 Wednesday, January 15th

NO CLASS

2.7 Friday, January 17th (PHY 1303)

- Review / overflow day
- Homework: **Final presentation**

2.8 Monday, January 20th

NO CLASS

2.9 Wednesday, January 22nd (PHY 1303)

Final presentations