

PHY657: ADVANCED GENERAL RELATIVITY

INSTRUCTOR: ARJUN BAGCHI

Brief Summary. This is a second course on General Relativity, following PHY407A. This course aims to further the student's knowledge of Einstein's theory of general relativity. After mathematical preliminaries about more advanced aspects of Riemannian geometry, the course will delve into the details of the Lagrangian and Hamiltonian formulations of general relativity. A large part of the course would focus on black holes, covering the Schwarzschild, Reissner-Nordström and Kerr black holes and then general properties of black holes and black hole mechanics. Depending on the time available, we will then cover some or all of the additional topics listed below.

Prerequisites. Essential: PHY 407A - Special and General Relativity. Desirable: PHY 685 - Introduction to Quantum Field Theory.

Contents.

- (1) Introduction
- (2) Geometric preliminaries
- (3) More geometry: Geodesic congruences, Hypersurfaces
- (4) Lagrangian formulation of General Relativity
- (5) Hamiltonian formulation of General Relativity
- (6) Black holes
 - (a) Schwarzschild BH
 - (b) Reissner-Nordström BH
 - (c) Kerr BH
 - (d) General properties of BHs
 - (e) Laws of BH mechanics
- (7) Additional topics:
 - (a) Gravity in 2+1 dimensions
 - (b) Gravity as a gauge theory
 - (c) Quantum effects in gravity
- (8) Concluding remarks.

Grading policy. Assignments: 20%, Mid-Semester: 30%, End Semester: 50%.

This is subject to change depending on the strength of the class.