PHY484H1/1484H: Relativity Theory II

Winter 2017 — M/Th 10:10 a.m. — MP 1318A

Course Description

This course covers more advanced topics of general relativity. Given the groundbreaking discoveries of gravitational waves by LIGO in late 2015, this course will work toward an understanding of gravitational waves and the objects that generate them. As such, we will focus on black holes and neutron stars. And we will focus on *dynamical* situations, like two compact objects orbiting and coalescing into one, i.e. situations very different from the static/stationary spacetimes that can be studied so successfully by analytical calculations like those presented in the first part of this course (PHY483H1/1478H). We will also discuss gravitational wave detectors, the fundamentals of relativistic fluids, internal structure of relativistic stars, and precision timing of radio pulsars in relativistic binary stellar systems.

Course times

Two lectures per week M/Th 10:10 a.m. MP 1318A

Prerequisites

- Introductory course in general relativity (e.g. PHY483): Differential geometry, tensors, Einstein equations, Schwarzschild solution.
- Good grounding in mechanics and Newtonian gravity
- Useful to have some knowledge of partial differential equations

Instructors

Harald Pfeiffer
Office: McLennan Physical Laboratory, Room 1309, 13th floor, 60 St. George Street
Contact: pfeiffer@cita.utoronto.ca
Office hour: Monday 4:30-5:30pm

Chris Thompson
Office: McLennan Physical Laboratory, Room 1316, 13th floor, 60 St. George Street
Contact: thompson@cita.utoronto.ca

Course outline

Week of	Instructor	topics
Jan 9	HP	Recap Schwarzschild & Kerr solution
		Event horizons, singularity theorems, BH thermodymics
Jan 16	HP	Geodesics around black holes
	CT	Gravitational waves: linearized Einstein eqns
Jan 23	CT	Gravitational waves: polarization, energy flux, quadrupole formula
Jan 30	HP	post-Newtonian formalism
Feb 6	HP	Numerical relativity
Feb 13	HP	Numerical relativity
		Intro to GW detectors: ground-based, space-based, pulsar timing
Feb 20		Reading week
Feb 27	HP	LIGO: data-analysis & its gravitational wave discoveries
Mar 6	HP	implications of GW discoveries
Mar 6 ... Mar 20	CT	Relativistic fluids
Mar 20, Mar 27	CT	Degenerate stars
Mar 27, Apr 3	CT	Timing of relativistic binary stars
		(last day of classes: April 5)

Grading

There will be homework sets every two weeks, and a final exam. Weighting is 70% for homework, and 30% for final.