

# Gravitational Waves

Spring 2018

Lectures: T & F (occasionally) in H331/H239, 9:00-13:00  
Instructor: Dr. Sarah Caudill  
Assistant: Ka Wa Tsang  
Office: N353  
Email: [caudills@nikhef.nl](mailto:caudills@nikhef.nl)

## OBJECTIVES

To introduce students to current research topics in gravitational-wave theory, experiment, data science and astrophysics.

## COURSE CONTENT

The course starts with an introduction to general relativity (GR). The Einstein field equations and properties of black hole solutions are discussed. Next the linearized Einstein equations are derived, which lead to the prediction of gravitational waves. We will also explore how numerical relativity is used in this field. Interesting sources of gravitational radiation are discussed, such as two black holes spiraling towards each other and colliding. Experimental efforts to gain access to the strong-field regime of GR through direct observation of gravitational waves are explained. We then turn to data analysis of the recent gravitational-wave detections: how they were discovered and how their parameters were measured. The emphasis throughout is how these observations allow us to address fundamental problems in physics.

## SCHEDULE

This schedule may be subject to change but the changes will be announced in advance.

Dates	Topics	Rooms
3 - 4 - 2018	Overview of the Field	H331 9-11: lecture H239 11-13: computer lab
10 - 4 - 2018	General Relativity Review GW Derivation	H331 9-11: lecture H331 11-13: lecture
17 - 4 - 2018	Numerical Relativity	H331 9-11: lecture H239 11-13: computer lab

Dates	Topics	Rooms
24 - 4 - 2018	Detectors	H331 9-11: lecture H239 11-13: computer lab
1 - 5 - 2018	Astrophysical Sources	H331 9-11: lecture H239 11-13: computer lab
8 - 5 - 2018	GW Data Analysis	H331 9-11: lecture H239 11-13: computer lab
15 - 5 - 2018	Bayesian Model Selection & Parameter Estimation I	H331 9-11: lecture H239 11-13: computer lab
18 - 5 - 2018	Bayesian Model Selection & Parameter Estimation II	H239 9-13: computer lab
25 - 5 - 2018	Astrophysics & Rates with GWs	H239 11-13: computer lab

## ASSESSMENT

Assignment	Percentage of final grade
Weekly exercises	20%
Final exam	70%
Visualization project	10%

## EXAM SCHEDULE

Final: 11:00-14:00 Wednesday May 30, 2018 in H331

The final exam will be cumulative with emphasis on the material in the exercises. **There will be no make up of the final exam except in cases of emergency or by prior arrangement.**

## POLICIES

- Feel free to work on weekly exercises with other students but exams **must be your own work**.
- **Please feel free to ask questions in class.**