ME-615

Introduction to earthquake source physics

Lecampion Brice, Momeni Seyyedmaalek

Cursus	Sem.	Type
Mechanics		Opt.

Language of teaching	English
Credits	2
Session	
Exam	Project report
Workload	60h
Hours	**27**
Lecture	13
Project	14
Number of positions	

Frequency

Every 2 years

Remark

Next time TBD

Summary

This course presents the classical and new approaches required to study the source mechanisms of earthquakes, combining theory and observations in a unified methodology, with a key focus on the mechanics governing fault ruptures highlighting novel developments in the field.

Content

This course presents the classical and new approaches required to study the source mechanisms of earthquakes, combining theory and observation in a unified methodology, with a key focus on the mechanics governing fault ruptures highlighting novel developments in the field. It will cover source mechanisms by building from fundamental concepts such as the equations of elastodynamic theory to more advanced problems including dislocation theory, kinematic models, and fracture dynamics. The theory is presented in a student-friendly form using consistent notation throughout, and with full, detailed mathematical derivations that enable students to follow each step. Later courses explain the widely-used practical modeling methods for source mechanism determination from observations, linking clearly to the theoretical foundations, and highlighting the practical processing of digital seismological data. Providing a unique balance between application techniques and theory, this should serve as a practical introduction for graduate students interested in seismology, tectonophysics, geodynamics, and geomechanics, as well as a valuable practical resource for professionals working in seismic hazard assessment and seismic engineering.

This course will consist of a total of 13 lectures and a project. It will follow roughly the structure of the book Source mechanisms of earthquakes: theory and practice by A. Udias, A. U. Vallina, R. Madariaga, and E. Buforn. Cambridge University Press, 2014.

- Lecture #1: Earthquakes and fault motion
- Lecture #2: Processing and analysis of recorded seismic signals
- Lectures #3&#4: Mathematical representation of the source
- Lecture #5: Point source models
- Lecture #6: The seismic moment tensor
- Lectures #7&8: Determination of point source mechanisms
- Lectures #9&10: Kinematics of extended sources
- Lectures #11&12: Determination of source dimensions
- Lecture # 13: Introduction to dynamics of earthquake ruptures

An introduction, in which very basic concepts are explained (Lecture #1), is followed by a presentation of the basis of

digital data processing, an often-neglected subject (Lecture #2). The fundamentals of the elastodynamic theory of earthquake source representation are given in details in lectures #3-4. In the following, two types of source representation or model are considered. These are point sources, including the first-order moment tensor (lectures #5 and #6), and extended kinematic sources (lectures #7&8).
After the presentation of each type of source model, some methods used for determination of the corresponding model parameters from seismic wave observations are discussed, namely, point source inversion, including fault-plane solutions and moment tensor inversion (lectures #9&10), and the determination of source dimensions and slip distribution on the fault plane (lectures #11&12).
In these courses, the methods are explained in detail and references are given to web addresses where computer programs for them can be found.

The first part of the semester will be dedicated to lectures while in the later part, the students will be given a real earthquake to invert starting from localization and point source inversion.

Note

A project will be given half-way through the semester - in a team of 2/3 students. It is expected that the student(s) will have to code their solutions. The project delivery will therefore be a git repo.

Keywords

earthquake, seismology, elastodynamics, inversion theory, faults

Learning Prerequisites

Important concepts to start the course

Continuum mechanics, computational thinking

Resources

Bibliography

A. Udias, A. U. Vallina, R. Madariaga, and E. Buforn. Source mechanisms of earthquakes: theory and practice. Cambridge University Press, 2014.
A. Udias and E. Buforn. Principles of seismology. Cambridge University Press, 2018.

Ressources en bibliothèque

- Source mechanisms of earthquakes: theory and practice
- Principles of seismology