SH2372 General Relativity 6.0 credits

Allmän relativitetsteori

This is a translation of the Swedish, legally binding, course syllabus.

Establishment

The course syllabus is valid from Spring 2022 according to the school principal's decision: S-2022-0529 Decision date: 2022-02-24

Grading scale

A, B, C, D, E, FX, F

Education cycle

Second cycle

Main field of study

Engineering Physics

Specific prerequisites

SI2371 Special relativity and good knowledge of multivariable differential calculus. SI2371 may be studied in parallel.

English B / English 6

Language of instruction

The language of instruction is specified in the course offering information in the course catalogue.

Intended learning outcomes

After completing the course you should be able to:

- Use differential geometry to describe the properties of a curved space and compute basic quantities in differential geometry.
- Derive and use Einstein's field equations and describe the definition and role of the energy-momentum tensor in those, account for the physical interpretation of its components, and prove that Newton's theory of gravity is recovered in the non-relativistic limit.
- Compute physical quantities for test particles in a given solution to Einstein's field equations, e.g., particle trajectories and proper times.
- Give an account of the experiments with which the general theory of relativity has been tested and compare with predictions from Newton's theory of gravity.
- Use the Friedmann–Lemaître–Robertson–Walker metric to describe the different possibilities for how a homogeneous universe develops with time as well as describe the ideas behind cosmological inflation and dark energy.

Course contents

Basic differential geometry: Local coordinates on manifolds. Covariant and contravariant vector and tensor fields. (Pseudo-) Riemann metric. Covariant differentiation (Christoffel symbols, Levi-Civita connection). Parallel transport. Curved spaces. Lie derivatives and Killing vector fields.

General theory of relativity: Basic concepts in general relativity. Schwarzschild spacetime. Einstein's field equations. The energy-momentum tensor. Weak field limit. Experimental tests of general relativity. Gravitational lensing. Gravitational waves. Introductory cosmology (including the Friedmann–Lemaître–Robertson–Walker metric), including inflation and dark energy.

Examination

- TEN1 - Written exam, 6.0 credits, grading scale: A, B, C, D, E, FX, F

Based on recommendation from KTH's coordinator for disabilities, the examiner will decide how to adapt an examination for students with documented disability.

The examiner may apply another examination format when re-examining individual students.

If the course is discontinued, students may request to be examined during the following two academic years.

The course is examined through an exam, which normally is a written exam.

Ethical approach

- All members of a group are responsible for the group's work.
- In any assessment, every student shall honestly disclose any help received and sources used.
- In an oral assessment, every student shall be able to present and answer questions about the entire assignment and solution.