SI151V Introductory Relativity Theory 6.0 credits

Inledande relativitetsteori

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

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

Establishment

The course plan is valid from and including VT 2024 according to the headmaster's decision: S-2023-1475. Decision date: 2023-09-21

Grading scale

P, F

Education cycle

First cycle

Main field of study

Physics,Technology

Specific prerequisites

Basic qualification and qualification in the following subjects: Mathematics D/Mathematics 3c, Physics B/Physics 2.

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, the student must be able to:

- Explain the starting points of the theory of relativity and how these revise basic concepts in physics such as space, time and simultaneity.
- Describe how the concepts of future, past and present must be changed to make sense within the special theory of relativity and determine if and how two given events can affect each other.
- Transform time and space between different observers moving relative to each other and show how these transformations lead to length contraction and time dilation.
- Formulate the paradoxes of relativity and solve them using Lorentz transformations, the Doppler effect and other tools from special relativity.
- Handle the relationship between energy and mass, $E=mc^2$, in both conceptual and mathematically formulated problems, as well as perform simpler kinematic calculations.
- Apply the theory of relativity to everyday phenomena and technology, where it plays a decisive role, and also calculate the size of the relativistic effects.

Course contents

Einstein's theory of relativity consists of two parts, firstly the special theory of relativity whose formulation and most important results are dealt with in this course, and secondly the general theory of relativity which is not part of the course and which deals with the law of gravitation. The special theory of relativity leads to new ways of looking at the fundamental concepts of space and time, leading to a drastic revision of central parts of Newton's classical physics. The classical physics view of time and space is discussed and specifically demonstrated how the classical physics formulation leads to errors at speeds close to the speed of light. Furthermore, the basic assumption of the special theory of relativity is formulated that the speed of light in a vacuum is a constant, an assumption that has very far-reaching consequences. The experimental basis for the theory of relativity is discussed. The most important results in the theory of relativity are treated: time dilation, length contraction, simultaneity, relativistic Doppler effect as well as the twin paradox and other paradoxes. Furthermore, relativity theory's extension of classical mechanics and Einstein's famous formula E=mc2 are discussed.

Mathematical treatment of coordinate transformations (Lorentz transformations) and space-time diagrams are included as well as relativistic collisions and decays. The course includes many important practical applications and phenomena where the theory of relativity plays a decisive role, such as maintaining a time standard with atomic clocks, GPS, the creation of new particles such as the Higgs particle at CERN and conditions for human space travel.

Examination

- TEN1 - Homework examination 1, 2.0 credits, grading scale: P, F

- TEN2 - Homework examination 2, 2.0 credits, grading scale: P, F
- TEN3 - Homework examination 3, 2.0 credits, grading scale: P, 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.

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.