FSI3035 General Relativity and Cosmology 7.5 credits

Allmän relativitetsteori och kosmologi

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

Course syllabus for FSI3035 valid from Spring 2014

Grading scale

Education cycle

Third cycle

Specific prerequisites

Enrolled as PhD student

Language of instruction

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

Intended learning outcomes

Acquire active knowledge about GR and its applications in cosmology. Be able to use the mathematical formalism; know the physics ideas and important successes.

Course contents

Advanced course on GR and its applications in cosmology. It is intended for PhD students who have a knowledge ofrelativity theory on the level of an undergraduate course but want to know more about the subject. The aim is to attract students working on different subjects in theoretical physics and mathematics who want to improve their general education in theoretical physics.

Disposition

Lectures and exercise classes; homework problems

Introduction
Equivalence principle (1.2.1, 3.2)
Recap of special relativity (2.3.3, 10.2)
Geometry
Curvilinear coordinates (4.2, 11.1.1)
Tensor calculus (11.1.1)
Covariant differentiation (11.1.2, 11.1.3, 11.2.1)
Curvature (4.3.3, 11.3)
Particle in gravitational field
Twin paradox and action principle in Special Relativity (A.1)
Geodesic motion (4.2.1, 5.2, 11.2.2, 12.1.1)
Einstein's equations
Conservation laws and continuity equation (10.3.2)
Energy-momentum tensor (10-4)
Einstein's equations (12.2)
Newton's constant, Planck mass and the cosmological constant (12-4.3)
Black holes
Schwarzschild solution of Einstein's equations (6.1.1, 12.3)
Event horizon (6-4.1, 6-4.3)
Celestial mechanics (6.3)
Planetary orbits in GR (6-4.4)
Falling into black hole (6-4.2, 6-4.3)
Cosmology
Hubble law (7.1.1, 7.1.2, 7.1.3)
Friedmann-Robertson-Walker metric (7.3)
Friedmann equations (12-4.2, 8.1)
Big Bang (8.2)
Brief history of the Universe (8.3.2)
Physical processes in the expanding Universe
Thermal history (8.3.1, 8.3.2)
Expansion rate and age of the Universe (8.2)
Neutrino decoupling (8.5.3)
Nucleosynthesis (8-4)
Recombination (8.5.1)
Jeans instability and structure formation (9.2.3)
The numbers in brackets indicate sections in the main course textbook

Course literature

Ta-Pei Cheng Relativity, Gravitation and Cosmology. A Basic
Introduction (Oxford University Press, 2005).
The course will loosely follow this book, but any other textbook that covers similar material would do. Here is a small selection of somewhat more advanced introductory books on General Relativity and Cosmology:
D.S. Gorbunov and V.A. Rubakov Introduction to the Theory of the Early Universe:
Hot Big Bang Theory (World Scientific, 2011).
J.B. Khriplovich General Relativity (Springer, 2005).
C.W. Misner, K.S. Thorne and J.A. Wheeler Gravitation (W.H. Freeman, 1973). B.F. Schutz A First Course in General Relativity (Cambridge University Press, 2004). S. Weinberg Cosmology (Oxford University Press, 2008).

Examination

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.

Solving homework problems and/or oral exam

Other requirements for final grade

Approved on Solving homework problems and/or oral 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.