Study programmes: Mathematics, Astronomy and Astrophysics - PhD studies

Course name: General theory of relativity and the cosmological models

Lecturers: Dr. Zarko Mijajlović, Darko Milinković, Jelena Katić

Status: Compulsory

ECTS: 9

Attendance prerequisites: None

Course aims: Obtaining advance knoledge from theory of relativity and cosmology

Course outcome: On course completion, the student has advanced knowledge of cosmology and the theory of relativity and the capability to independently engage in scientific research in these areas.

Course content:

Introduction: Inertial systems. The structure of the universe on a large scale. Tensor, metric tensor. Covariant differentiation. Christoffel symbols. Riemann geometry: Riemann geometry, Ricci tensor and the Einstein tensor. Geodesics.

The general theory of relativity: The metric of space-time continuum. The principle of equivalence (heavy and inertial masses). Space-time metrics and curvature.. Own time in general relativity. The paths of light rays, gravitational lenses. Energy tensor and principle of effect: energy and matter tensors, tensor of electromagnetic fields. Gravitational equations (Einstein's field equations). Spherically symmetric gravitational field and horizon spherically symmetric field. Švarcšvild's solution. Gravitational waves. Black holes. Gravitational time dilation. Experimental tests of the general theory of relativity.

Cosmology: Cosmological principle of homogeneity and isotropy. The big bang theory. Friedman equations and the Friedman model. Cosmological parameters, their evolution, the expansion of the universe and the redshift. The early universe, relics of the big bang and the thermodynamics of the early universe and bariogenesis. Cosmological constant and dark matter. Inflationary universe. Horizon of the visible universe. Age of the universe. Alternative cosmological models. The string theory. Experimental cosmology: astronomical observations and relevant measurements to cosmology. Open problems in cosmology: accelerated expansion of the universe, the problem of dark matter and dark energy.

Literature: 1. Jayant Vishnu Narlikar, *An Introduction to Cosmology*, 3rd ed., Cambridge Univ. Press, 2002

Additional literature:

1. A.Kostrikin, Yu. Manin, *Linear algebra and Geometry,*
2. I. Lukačević: *Osnove Teorije relativnosti*, Beograd, 1982.
3. M. Spivak, *Physics for Mathematicians*, Publish or Perish, 2010.
4. A. Liddle, *An Introduction to Modern Cosmology*, WILEY, 2nd edition, 2003.
5. A.Kostrikin, Yu. Manin, *Linear algebra and Geometry,*
6. *Sachs, Wu: General Relativity for Mathematicians, Springer 1977*
7. *Hawking, Ellis: The Large Scale Structure of Space-Time, Cambridge University Press 1975.*

Number of hours: 10	**Lectures: 4**	**Research: 6**

Teaching and learning method: group or individual

Assessment (maximal 100 points)

Course assignments	**points**	**Final exam**	**points**
Lectures	20	Written exam	-
Exercises / Tutorials	-	Oral exam	60
Colloquia	-	Written-oral exam	-
Essay / Project	20		