Study programmes: Mathematics – PhD studies

Course name: General relativity theory and cosmological models

Teacher or teachers: Jovana Nikolić, Igor Uljarević, Aleksandra Marinković

Status: Optional

ECTS credits: 9

Requirements: none

Course objective: Obtaining advance knowledge 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 description:

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. Schwarschild'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.

Recommended 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.*

Total number of classes: 10	**Total number of classes**: 10	**Total number of classes**: 10

Teaching methods: group or individual

Grading system (maximum number of points: 100)

Pre-exam requirements	points	Final exam	points
Activity in class	20	Written exam	
Practical work		Oral exam	60
Colloquia			

Seminars	20		