Study programmes: Bachelor studies – Astronomy and Astrophysics
Course name: Physical principles of stellar structure
Lecturers: Bojan Arbutina
Status: Compulsory
ECTS: 6
Attendance prerequisites: enrolled in a fourth year of studies
Course aims: Acquiring general and specific knowledge in physical principles of stellar structure.
Course outcome: At the end of the course student has basic knowledge of physical principles of stellar structure and has skills for future research in this area.
Course content: Introduction. Topic and tasks of theory of stellar structure and evolution. Physical characteristics of stars from observations. Empirical relations and diagrams. General law of matter distribution. Distribution of gas particles and photons in thermodynamic equilibrium. Degenerated states. Local thermodynamic equilibrium (LTE). Ideal gas and radiation in LTE. Chemical composition, ionization, concentration of free electrons, mean molecular weight. Parameters of radiation field. Equation of state (gas + radiation). Polytropic processes. Adiabatic changes. Some thermodynamic relations (ideal gas, black-body radiation, complete (and partial) ionized ideal gas and black-body radiation). Mechanisms and processes of radiation absorption. Typical astrophysical conditions in stellar interiors. Atomic and mass monochromatic absorption coefficients (bound-free and free-free transitions). Tomson's scattering by free electrons. Total absorption. Roseland opacity. Approximate (Kramers') equations. Metal influence on opacity. Interpolation equation for opacity. Spherical symmetry of stars. Mass conservation law. Hydrostatical (gravitational) equilibrium. Integral equilibrium theorem. Sources of stellar energy. Thermonuclear reactions. Reactions of hydrogen and helium. Reaction of heavier isotopes. Reaction rate and amount of released energy. Interpolation equations. Neutrino energy and URCA process. Gravitational potential energy. Conditions for gravitational contraction. Amount of released energy by gravitational contractions. Energy transfer. Thermal (energetic) equilibrium. Radiative equilibrium (RE) and energy flux. Conditions for stable RE. Thermal conduction. Convection (temperature gradients in convective zone, mean convective element velocity and conditions for turbulence, energy flux in convective zone and methods of studies, convective efficiency). Virial theorem. Deriving theorem for continuous physical systems. Application on spherical symmetrical stars (internal and total stellar energy, gravitational contraction and dynamical stability).
Literature: Chandrasekhar S., 1939, *Stellar Structure*, University of Chicago Press. Schwarzshild M., 1958, *Structure and Evolution of the Stars,* Princeton Univ. Press. Cox J. P., Giuli R. T., 1968, *Principles of Stellar Structure, Vol. I,* Gordon and Breach, Sc. Publ. Hansen C. J., Kawaler S. D., Trimble V., 2004, *Stellar Interiors - Physical Principles, Structure, and Evolution,* New York: Springer **Exercises**: Hansen C. J., Kawaler S. D., Trimble V., 2004, *Stellar Interiors - Physical Principles, Structure, and Evolution,* New York: Springer

Number of hours: **4**	**Lectures**: **2**	**Tutorials**: **2**

Teaching and learning methods: Group work

Assessment (maximal 100 points)

Course assignments	points	Final exam	points
Lectures	30	Written exam	30
Exercises / Tutorials		Oral exam	40
Colloquia			
Essay / Project			