Study programme: Astronomy and Astrophysics – PhD Studies

Course: Stellar Physics

Teacher or teachers: Bojan Arbutina

Status: optional

ECTS credits: 9

Requirements: none

Course objective: Acquiring advanced knowledge about structure and evolution of non-rotating and rotating stars.

Course outcome: At the end of the course, student has enough skills to start a research on stellar structure and evolution, numerical modeling and stability problems concerning non-rotating and rotating stars.

Course description:

PHYSICAL PRINCIPLES OF STELLAR STRUCTURE.
Introduction. Structure of spherically symmetric stars. Stellar hydrodynamics. Euler and Lagrange variables, magnetohydrodynamics, virial theorem. Stationary rotation. Barotropes, pseudo-barotropes, baroclines, spheroidal stratification, outer gravitational field. Small oscillations and dynamical stability. Von Zeipel paradox. Solberg and Holland criterion. Thermal inbalance in baroclines. Meridional circulation. Circulation in radiative and convective zones, turbulent motions in stars. Uniform and differential rotation. Polytropic stars. Solar rotation.
METHODS IN STELLAR MODELING. MODELS. Complete set of equations. Differential equations and boundary conditions. Chandrasekhar-Milne model, quasi-spherical configurations, Kippenhahn and Thomas technique, self-consistent field method. Specific angular momentum distribution, mass loss and dynamical stability. Stellar evolution of spherical and rotating stars. Fragmentation and formation of binary and multiple stars, pre-main sequence evolution, main sequence and post-main sequence phases, pulsation instability, stationary rotating white dwarf models. Effects of rotation on observational characteristics of stars.

Recommended literature:

Chandrasekhar S., 1969, Ellipsoidal Figures of Equilibrium, New Haven, Yale Univ. Press.;
Cox J. P., Giuli R.T., 1968, Principles of Stellar Structure I & II, New York: Gordon and Breach;
Hansen C. J., Kawaler S. D., Trimble V., 2004, Stellar Interiors - Physical Principles, Structure, and Evolution, New York: Springer;
Tassoul J.-L., 1978, Theory of Rotating Stars, Princeton Univ.Press, Princeton, New Jersey;
Tassoul J.-L., 2004, Stellar Rotation, Cambridge: Cambridge University Press

Excercises: Hansen C. J., Kawaler S. D., Trimble V., 2004, Stellar Interiors - Physical Principles, Structure, and Evolution, New York: Springer;

Total number of classes: 10	**Theoretical classes**: 4	**Practical classes**: 6

Teaching methods:
Ex cathedra, group work, student research

Grading system (maximum number of points: 100)

Pre-exam requirements	points	**Final exam**	points
Activity in class		Written exam	
Practical work	30	Oral exam	70
Colloquia			
Seminars			