

ENTRANCE EXAM FOR PhD. STUDY

field of study: ASTROPHYSICS

specialization: STELLAR ASTRONOMY

Topics from the field: ASTRONOMICAL DEVICES

1. Astronomical telescope

Refractor, reflector, ocular; aberrations of telescope, resolution of telescope. Earth's atmosphere and telescope.

2. Dispersion of light

Dispersion of light, dispersive prism, examples of usage – spectroscopy.

3. Interference of light

Interference of light. Fabry-Perot and Michaelson interferometer, interference filters.

4. Diffraction

Diffraction of light, diffraction grating – description, physics, properties, modes of exploitation in astronomy – spectroscopy.

5. Polarization

Polarized light, its origin and modes of exploitation in astrophysics. Measuring of polarized light.

Topics from the field: ASTROPHYSICS

1. Internal structure of stars

Fundamental equations of internal structure of stars. Sources of the star energy. Energy transfer from the star's core to its surface. Star structure depending on its evolutionary stage.

2. Theory of stellar atmospheres

Description of radiation in stellar atmospheres, excitation and ionization of atoms, absorption and emission coefficient, optical thickness, radiative transfer equation and its solution, local thermodynamic equilibrium, Saha (ionization) equation, Boltzmann equation, statistical equilibrium, models of stellar atmospheres. Analysis of chemical composition of atmospheres.

3. Radiation of the cosmic objects

Thermal and non-thermal radiation, nebular radiation, radiation in lines. Atomic spectra and molecular spectra. Stellar spectrum – continuum and line spectrum. Absorption and emission lines, profiles of spectral lines. Broadening of spectral lines: collisional, Doppler and rotational. Physical processes involved in formation of continuous and line spectra, curve of growth.

4. Basic characteristics of stars

Apparent and absolute magnitude, bolometric magnitude. Luminosity, radius, temperature, spectral type. Ranges of star characteristics depending on their evolutionary stage. Mutual relationships between basic characteristics, Stefan-Boltzmann law. HR diagram, mass-luminosity diagram, evolutionary passes of stars.

5. Observational methods in astrophysics.

Spectroscopy, spectrophotometry, photometry (visual, photographic, photoelectric, CCD). Color index, excess, polarimetry.

Topics from the field: VARIABLE AND BINARY STARS

1. Observational methods of variable and binary stars

Photometry and photometric systems, light-curve, broad-band UBVRIJHKL photometry, narrow-band photometry. Photographic, photoelectric and CCD photometry, spectroscopy, determining the spectral type, determining radial velocities, astrometry (satellite's astrometry), interferometry.

2. Types of variable stars

Geometric (rotating stars: magnetic and spotted, binary stars: eclipsing and interacting). Physical: changes in the star's environment, in the surface and subsurface layers and in the nucleus, shaping of the light-curves, catalogues of variable stars.

3. Pulsating variables and supernovae

Radial and non-radial pulsations, modes of pulsations. Position of variable stars in the H-R diagram, instability belt and its explanation. Cepheids: the period-luminosity dependence, oscillations, astroseismology, long-period variables, evolution of massive stars and supernovae of type II, evolution of binaries and supernovae of type I (Ia, Ib, Ic).

4. Definition, classification and abundance of binary stars

Visual, spectroscopic and eclipsing binary stars. Abundance of binary stars among the main sequence stars. Abundance of binary stars among peculiar and physically variable stars, binaries in star clusters, catalogues of binary stars, Roche model and evolution of binary stars, mass transfer, Algol paradox, final stages of binary stars' evolution.

5. Visual, eclipsing and spectroscopic binary stars

Optical binaries and temporary binary stars, relative motions of components in the visual binary star. Light-curve types of eclipsing binary stars (Algol, Beta Lyrae, W UMa), geometric and photometric

elements. Spectroscopic binaries - radial velocity curve. Absolute parameters of a binary star.

RECOMMENDED LITERATURE

- Gray, D.F.: The observation and analysis of stellar photospheres. A Whilley Interscience Publication, New York, 1976.
- de Loore, C.W.H., Doom, C.: Structure and Evolution of Single and Binary Stars. Kluwer Acad. Publ., Dordrecht, 1992.
- Kourganoff, V.: Introduction to Advanced Astrophysics. Reidel Publ., Dordrecht, 1980. Hiltitch, R.W.: ●An introduction to close binary stars. Cambridge University Press, 2001. Warner, B.: ●Cataclysmic variables. Cambridge University Press, 1995.