APPROUVED:

DEAN:
/ Prof. Dsc G. Rainovski/

Sofia University "St. Kliment Ohridski"
Faculty of Physics
Department of Astronomy

SYNOPSIS

Topics for examination of candidates for PhD students
Specialty 4.1 Physical sciences (Astronomy and Astrophysics)

1. Astrophysical information

Astronomical sources: point sources, extended sources. Basic photometric quantities: intensity, flux, incidence, surface brightness. Photons and electromagnetic spectrum. Sources of thermal radiation. Sources and mechanisms of non-thermal radiation. Cosmic objects, observable in different spectral ranges.

2. Telescopes: main astronomical instruments

Basics of telescope optics. Reflectors: two-mirror systems, systems of Cassegrain and Ritchie-Cretien. Focuses of Coude and Nasmyth. Catadioptric systems: Schmidt cameras, systems of Maksutov. Mounting of telescopes: types. Large contemporary telescopes. Active and adaptive optics.

3. Astronomical observations

Panoramic detection and spatial resolution. Trigonometric paralaxes. Receivers of radiation: human eye, photo emulsion, CCD matrices. Conditions for observation. Transparency of the Earth atmosphere. Observations in different spectral ranges: ground-based, stratospheric, satellite-born.

4. Methods of astrophysical research

Stellar magnitude scale. Absolute stellar magnitude. Photometric systems: broad-band, intermediate-band, narrow-band. Color index and color temperature. Spectral series. Forbidden spectral lines. Spectral continuum. Absorption and emission spectra. Spectral lines: profile and widening effects.

5. Planetary physics

Solar system: formation, structure and evolution. Planet types. Exoplanets: observations, methods of detection and classification.

6. Stellar radiation

Black body. Planck function and its approximations. Wien's law. Local thermodynamical equilibrium in stars. Bolometric magnitude and bolometric correction. Stellar luminosity. Effective temperature. Brightness temperature.

7. Interaction between radiation and matter

Equation of radiative transfer: differential and integral form. Source function. Scattering and absorption processes. Interstellar extinction. Reddening and color excess. Color-color diagram.

8. Fundamental parameters of stars

Effective temperature. Harvard classification of stellar spectra. Hertzsprung-Russell diagram. Luminosity classes. Main sequence. Sizes and masses of stars: methods for their derivation. The mass-luminosity-radius relation.

9. Stellar structure

Estimates of pressure, temperature and density in stellar interiors. Conditions for hydrostatic equilibrium. Energy transfer: radiative transfer and convection. Sources of energy in stars. Stellar model: basics.

10. Stellar atmospheres

Modeling of stellar atmosphere: parameters. Local thermodynamical equilibrium: conditions. Solution of the radiative transfer equation. Mean absorption coefficient. Grey atmosphere. Law of limb darkening of stellar disks. Theoretical approximation of photospheres with frequency-dependent absorption coefficient.

11. Stellar evolution

Early evolutionary stages. Gravitational contraction. Protostellar evolution. Main-sequence evolution. Evolution after the Main-sequence stage: low-mass stars and massive stars.

12. Compact cosmic objects

White dwarfs: equation of state and mass-radius relation. Chandrasekhar mass. Neutron stars. Black holes of stellar and non-stellar origin.

13. Physically variable stars

Pulsating variables: evolutionary statuses and pulsation mechanism. Eruptive variables. Low-mass variables at protostellar stage. Bursts in close binaries: novae. Accretion in close binaries: bursters and X-ray pulsars. Supernovae and radiopulsars.

14. Insterstellar medium

Components: gas, dust, magnetic fields, cosmic rays. Phase model, phases. Balance of energies. Heating and cooling of H II regions. Cascade transitions and forbidden lines.

15. Fundamentals of stellar astronomy

Positions, intrinsic motions and radial velocities of stars. Spatial velocities of stars. Centroid, peculiar and paralactic motion. Apex and antiapex. Spherical and ellipsoidal velocity distribution. Motion of the Sun relative to nearby stars: measured through their spatial velocities and their intrinsic motions. Oort theory of arbitrary plain-parallel motion. Rotation curve of the Galaxy.

16. Extragalactic astronomy

General physical properties of galaxies and their classification. Integral luminosities and colors. Diameters. Photometric studies of galaxies. Distributions of surface brightness and of color indices. Spectra of galaxies. Rotation and masses of galaxies.

17. Galaxies with active nuclei

Active galactic nuclei: types and subtypes. Criteria for division into subtypes. Connection between subtypes. Unified model and arguments for unification. Spectral pecularities. Ly-alpha forest. Spectral „bumps“. Variability. Reflection cartography.

18. Basics of cosmology

Large-scale structure of the Universe. Cosmological principle and observational basis of contemporary cosmology. Newton approximation, scale factor, co-moving reference frame. Non-relativistic cosmological equations. Parameters of the Standard cosmological model.

Recommended literature

Encyclopedia of astronomy and astrophysics, Murdin P: Ed. in chief, 2001, London: Nature Publishing Group/Institute of Physics Publishing

Carroll B.W., Ostlie D.A., *An Introduction to Modern Astrophysics,* 2007, Pearson Addison Wesley, 2nd ed., ISBN 0321442849

Lequeux, J., *The interstellar medium*, 2005, Berlin-Heidelberg, Springer

Bradley M. Peterson."An Introduction to Active Galactic Nuclei",CAMBRIDGE UNIVERSITY PRESS 1997

Steve B. Howell..„Handbook of CCD astronomy“ by, second edition, CAMBRIDGE UNIVERSITY PRESS 2006

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