

## **I - MATHEMATICS AND PHYSICS**

Mean, variance, moments of a distribution  
Binomial distribution, Poisson distribution, and Gaussian distribution  
Least-squares method  
Taylor series  
Fourier series and transform  
Fundamental laws of Nature  
Physical quantities and units  
Kinetic energy, potential energy, thermal energy  
Angular momentum, orbital angular momentum, spin angular momentum  
Laws of thermodynamics  
Phase space  
Virial theorem  
Gravitational field, electromagnetic field  
Maxwell's equations  
Thomson and Compton scattering, synchrotron radiation, free-free absorption  
Blackbody radiation, Planck function  
Radiation pressure  
Reflection, refraction, interference, diffraction, aberrations  
Conduction, convection, radiation, diffusion  
Heisenberg's principle  
Bohr model of the atom  
Laser emission, maser emission  
Space and time in Galilean, Special and General  
Relativity Time dilation and Lorentz contraction in Special  
Relativity Classical and relativistic Doppler shift Aberration  
of the light  
Equivalence principle

## **II - ASTRONOMY**

Magnitudes and colors  
Photometric systems  
Surface brightness  
Isophotes, isophotal radii  
Parallax  
Distance modulus  
Cosmic distance scale  
Redshift  
Jeans criterion  
Eddington limit  
Fundamental and Local Standard of Rest  
Solar motion, Solar apex  
Stellar proper motions and radial velocities  
Velocity ellipsoid  
Differential rotation of the Milky Way, Oort constants  
Core and tidal radius of a stellar cluster  
Classification and physical interpretation of stellar spectra  
Stellar opacity, formation of spectral lines and continuum  
Emission and absorption spectral lines  
Molecular spectral lines  
21-cm spectral line  
Pressure, temperature, and gravity in stellar atmospheres  
Extinction, reddening  
Gravitational lensing  
X-ray, ultraviolet, optical, infrared, and radio telescopes

## **III - THE SOLAR SYSTEM AND EXTRASOLAR PLANETS**

Albedo

Kepler's laws  
Two-body problem  
Physical properties of the Sun and Solar System  
Roche model, Lagrangian points  
Oort cloud, Kuiper belt  
Escape velocity in planet atmospheres  
Detection of extrasolar planets

#### **IV - STARS AND INTERSTELLAR MEDIUM**

Perfect gas, degenerate gas  
Stefan's law, Wien's law  
Boltzmann's law, Saha's law  
Color temperature  
Thermonuclear reactions: proton-proton chain, CNO cycle, triple alpha reaction  
Initial mass function  
Stellar populations  
Globular clusters, open clusters  
Stability of the stars: radiative and convective transfer  
Stellar evolution, isochrones  
Hayashi line  
Properties of the color-magnitude diagram  
Properties of the stars on the main sequence  
RR Lyrae, cepheids, planetary nebulae, supernovae  
Chandrasekar mass, white dwarfs Oppenheimer-Volkoff mass, neutron stars, black holes  
Properties of the interstellar medium  
Binary stars

#### **V - GALAXIES AND INTERGALACTIC MEDIUM**

Properties of the galaxies  
Hubble sequence, de Vaucouleurs' classification, luminosity class of galaxies  
Active galactic nuclei: radio galaxies, Seyfert galaxies, blazars, quasars  
Dark matter in galaxies  
The Local Group  
Surface brightness profile of galaxies  
Rotation curve, velocity dispersion profile  
Galaxy mass  
Galaxy luminosity function  
Galaxy color-magnitude diagram  
Faber-Jackson law, Fundamental Plane, Tully-Fisher law  
Black hole mass-velocity dispersion relation  
Chemical evolution of galaxies

#### **VI - GALAXY CLUSTERS AND COSMOLOGY**

Properties and classification of galaxy clusters  
Galaxies, dark matter, and gas in galaxy clusters  
Free-fall time  
Galaxy cluster mass  
Matter and energy in the Universe  
Hubble's law  
Cosmic microwave background  
Cosmological principle, Robertson-Walker metric  
Standard Friedmann's models of the Universe  
Universe models with non-zero cosmological constant  
Cosmological parameters  
Cosmological horizon, event horizon  
Thermal history of the Universe  
Nucleosynthesis in the early Universe  
Inflation  
Correlation functions, spectrum of initial fluctuations

Fluctuations in the cosmic microwave background  
radiation Sunyaev-Zeldovich effect  
Gravitational waves