

PHY305: Physics of Universe

Academic Year: 2023-2024; Semester I, 3-0-0-0 (9)

Objective: This course is intended towards undergraduate students to introduce the world of astrophysics. The course will emphasize on fundamentals of astrophysics starting from basic celestial mechanics to the interaction of radiation with matter, stellar structure, star formation, stellar evolution and extragalactic astronomy. A brief introduction to cosmology will also be covered.

Details of the Course-Content:

(1) Introduction, astronomical observations and instruments:

- celestial phenomena, their connection with established and new physics, typical physical scale/condition in astrophysics
- Astronomical observations: photometry, astrometry, astronomy in different bands of electromagnetic radiation, measurement of stellar parameters, stellar classification, earth vs space-based observations (ELT, TMT, HST, JWST)
- Interaction of radiation with matter, review of blackbody radiation

(2) Stellar structure and Stellar evolution:

- Basic equation of stellar structure, hydrostatic equilibrium and virial theorem, mass continuity, energy transport inside stars, convection inside stars
- Nuclear energy production, nuclear reaction rates, Nucleosynthesis
- Stellar evolution-main sequence, red giants and white dwarfs, Chandrasekhar mass limit, neutron star, blackhole, supernova, the Hertzsprung-Russel Diagram, evolution in binary systems, star clusters and binary stars, star-formation
- Mass loss from stars, accretion flows, stellar winds, exoplanets

(3) The Milky way and Other Galaxies

- Type of galaxies, structure of Milky way, Galaxy demographics, active galaxies and quasars, galactic center black hole

(4) Introduction to Cosmology

- The Olbers Paradox, Extragalactic distances, Hubble's law, age of the universe from Cosmic clocks, Isotropy of the Universe
- The Friedmann Equations, Big Bang model, early universe and Cosmic Microwave Background Radiation (CMBR).

Textbooks:

1. Astrophysics in a Nutshell, Dan Maoz, Princeton university press (2007)
2. Astrophysics for Physicists, Arnab Rai Choudhuri, Cambridge University Press (2010)
3. An Introduction to Modern Astrophysics, B. W. Carroll and D. A. Ostlie, Cambridge University Press
4. An Introduction to Astronomy and Astrophysics, Pankaj Jain, CRC press

Instructor: Prof. Gopal Hazra, Department of Physics, IIT Kanpur, Office: 604, ESB-II Building.

Phone: +91-512-679-2377; **Email:** hazra@iitk.ac.in

Lectures: 17:00-18:00 hrs on Monday, Wednesday and Friday, **Venue:** T211

Student TA: Arpan Hait (arpan20@iitk.ac.in)

Evaluation Scheme: Assignments (5%), 2-Quizzes (15/20%), Mid-Sem Examination (30/35%), End-Sem Examination (45%). Taking End-Sem examination is mandatory.

Course Policy:

1. Only SUGC sanctioned leaves will be considered as valid reasons for absences during lectures/quizzes/exams.
2. **DOAA guidelines** on use of unfair means will be strictly followed.