PHY690C: Fundamentals of Astrophysics

Academic Year: 2024-2025; Semester I, 3-0-0-0 (9)

Objective: This course is intended to introduce astrophysical concepts to the master's and advanced undergraduate students with a background in basic physics. The course will emphasize on fundamentals of astrophysics starting from basic celestial mechanics to the interaction of radiation with matter. After introducing our nearest star, the Sun and its interior, the course will also focus on stellar structure, star formation, stellar evolution. Our solar system planets and recently detected exoplanets and their atmosphere will also be introduced. The milky way and structure of other galaxies also will be a significant part of the course. A brief introduction to cosmological principle will also be covered. Details of course structure is given below.

Pre-requisites: There is no strict pre-requisites for the course but physics one level courses (e.g., classical mechanics, electrodynamics, quantum mechanics) and basics of thermodynamics would be desirable.

Details of the Course-Content:

S. No.	Broad Title	Topics	No. of Lectures
1.	**Introduction to stars and their parameters**	Typical physical scale/condition in astrophysics, Astrophysics in different bands of electromagnetic radiation, celestial co-ordinates. Measurement of stellar parameters (Mass, Radius, Temperature) – visual, eclipsing, spectroscopic binaries Stellar classification, Effective temperature	**8**
2.	**Basic radiative transfer in astrophysics**	Specific intensity, luminosity/flux, Interaction of radiation with matter, review of blackbody radiation, Local Thermodynamic Equilibrium, Radiative transfer equations, Saha ionization equation; Sun as a star, limb darkening, photosphere, chromosphere, transition region, corona, Sunspots	**5**
3.	**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	**12**

		Mass loss from stars, accretion flows, stellar winds	
4.	**Solar system planets and exoplanets**	Physical Processes in the Solar System: The physics of atmospheres, Introduction to Terrestrial planets, The realm of Giant planets, Techniques to detect exoplanets, Exoplanet Atmospheres.	**6**
5.	**The Milky way, Other Galaxies and introduction to cosmological principle**	Type of galaxies, structure of Milky way, Galaxy demographics, active galaxies and quasars, galactic center black hole, The Olbers Paradox, Extragalactic distances, Hubble's law, age of the universe from Cosmic clocks, Isotropy of the Universe	**9**
		Total number of lectures:	**40**

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. Exoplanet Atmosphere: Physical Processes, Sara Seager, Princeton Series in Astrophysics

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Evaluation Scheme: Assignments (10%), 2-Quizzes (15/20%), Mid-Sem Examination (30/35%), End-Sem Examination (40%). 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.