

Indian Institute of Technology, Kanpur Proposal for a New Course

1. Course No: SPA660A
2. Course Title: High Energy Astrophysics of Binary star systems
3. Lectures per week: 3 (L), Tutorial: 0 (T), Laboratory: 0 (P), Additional hours: (0-2): 0 (A), Credits $(3*L+0*T+P+A)$: 9, Duration of Course: Full Semester
4. Proposing Department: Space Science & Astronomy
5. Proposing Instructor: Pankaj Jain/J. S. Yadav

6. Course Description

(A) Objectives: This course will introduce students to the exciting world of High energy processes, which may involve very strong gravity, very high temperature (million degree) and/or high magnetic field in our Galaxy and beyond. Astrophysical sources which show such high energy phenomena are binary stars in which one of the partner is a black hole or a neutron star. These sources emit significant radiation in X-rays, gamma-rays as well as radio waves. This course will introduce the student to the structure of such sources and their emission characteristics. The student will also learn X-ray and gamma ray detection techniques, challenges faced while developing space X-ray detectors and the current state of space X-ray detectors worldwide. Students will have access to data to study galactic black hole X-ray binaries or neutron star X-ray binaries including pulsars and will learn techniques for analysing data from such sources.

(B) Contents (preferably in the form of 5 to 10 broad titles:

S. no.	Broad Title	Topics	No. of lectures
1.	Stars and stellar evolution	Brief review of stellar structure and evolution, Compact stars	4
2.	Basic Concepts	Basic equations of gas dynamics, sound waves, plasma oscillations, Debye length, viscosity, shock waves in plasmas	6
3.	Binary Stars	Introduction to binary star systems, mass transfer and formation of accretion disk, Roche lobe overflow, accretion through stellar wind	8
4.	Accretion Disks	Structure of accretion disks, viscous torques, steady thin disks, structure of α -disks, emitted spectrum, different X-ray states in compact star binaries, outbursts in X-ray binaries	9
5.	Detection of X-rays and gamma rays	Techniques for detection of X-rays and gamma rays; types of detectors; statistical and error analysis of data	5
6.	space X-ray detectors	Challenges faced in making space detectors; the Astrosat space observatory	5
7.	Observations	Observations of black hole X-ray binaries, Neutron star X-ray binaries and X-ray pulsar; accretion disk and radio jet connection	5

(C) pre-requisites: SPA6xx: Introduction to Astronomy and Astrophysics or an equivalent course

(D) Short summary for including in the Courses of Study Booklet: Review of stellar evolution and Compact stars, brief overview of Gas dynamics, plasma Physics and shock waves, binary stars, mass transfer through Roche lobe overflow and stellar wind, formation and structure

of accretion disks, steady α -disks, emitted spectrum, different X-ray states in compact star binaries, outbursts in X-ray binaries, detection of X-rays and gamma rays, space X-ray detectors, observations and study of X-ray binaries

7. Recommended Books:

- High Energy Astrophysics, Malcolm S. Longair
- Accretion Power in Astrophysics, J. Frank, A. King and D. Raine

8. Any other remarks:

Dated: Proposer:

Dated: DUGC/DPGC Convener:

The course is approved/not approved

Chairman, SUGC/SPGC

Dated: