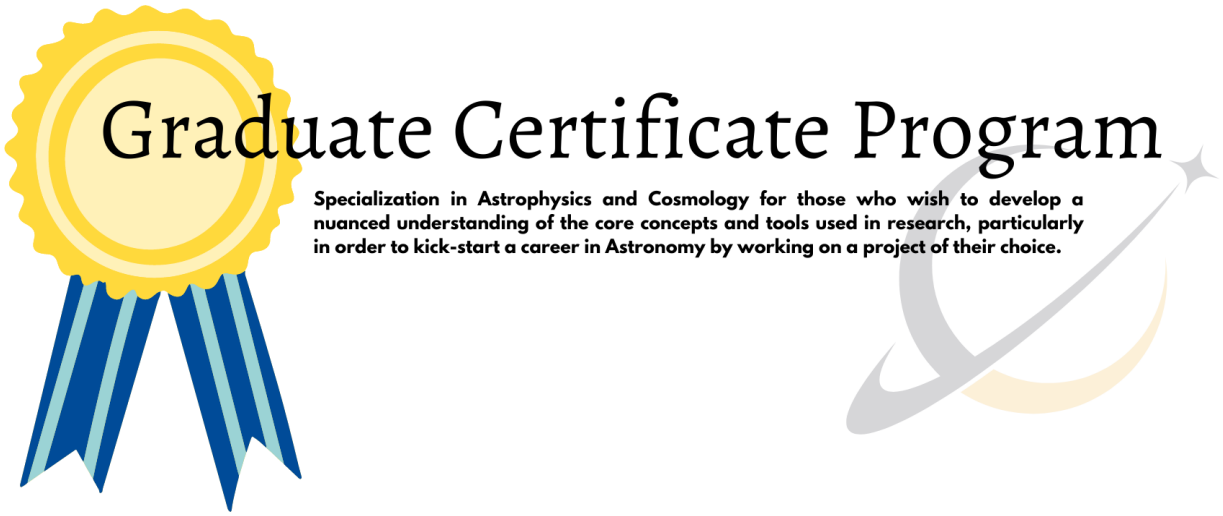
NAXXATRA
A CONSTELLATION OF CURIOUS MINDS

Graduate Certificate Program

Astrophysics and Cosmology Track



What is the Graduate Certificate Program?

1. The Graduate Certificate in Astrophysics and Cosmology is an **immersive three-month program with a guided mini-project.**
2. Undergraduate students and above are welcome to register. High school students with keen interest in Astronomy and some background experience will be accepted in special cases.
3. You can choose your domain for the final project from various streams like Observational Astrophysics, Astrobiology, Astroparticle Physics, or Theoretical Astrophysics.
4. A **40-hour program** to equip students with a comprehensive and in-depth understanding of the subject.

Why take the GCP?

1. The program is designed to introduce the core concepts which are essential to pursue advanced subjects in Astrophysics.
2. The lectures have significant mathematical rigor but are designed to gradually introduce the topics to keep the content suitable for both beginners and intermediate-level students.
3. A **complete toolkit** for a student to kick-off an active journey in exploring the subject, while being able to experience basic research methodologies through a practical approach.
4. The perfect stepping stone for students to pursue more advanced projects after completing the course, and connect with a diverse community of researchers.
5. GCP in Astrophysics and Cosmology will provide a framework that they can revisit and use in the future to revise their basics. The program offers **lifetime access to our bundle of resources, lectures and slides.**

Overview

Learning Outcomes

a. Familiarization with various concepts in Astrophysics and Cosmology.
b. Exploration of interesting topics such as Spectral classification of stars, Stellar Evolution, Galaxies, Binary systems, and Black holes.
c. Attain the knowledge of fundamentals of Astrophysics such as Distance measurement, Spectroscopy, and Formation of stars.
d. Understanding the Early stages of the Universe, its Evolution, and the future.
e. Introduction to trending concepts such as the Sunyaev-Zel'dovich effect, Cosmic acceleration, Dark matter, and Dark energy.
f. Problem-solving skills and application of concepts through activities and exact problems.
g. Ability to link the theoretical, observational, and computational aspects of the fields.
h. Ability to use basic knowledge of the fields, skills, and techniques learned during the program for research purposes. A complete toolkit to tackle projects in related fields.

Tentative timings and Days of Lectures: Classes will be held from **7:30 PM to 8:30 PM** on Mondays, Tuesdays, Thursdays, Fridays. Informal Discussions if needed will be held on the remaining days.

Module 1: Astrophysics

Lectures at 7:00 PM on Mondays, Tuesdays, Thursdays, and Fridays. Informal Discussions on the remaining days will be held on our Discord Server: Naxxatra Classroom.

Week 1 - The Basics

- Electromagnetic Spectrum
- Types of Telescopes for different Wavelengths
- Multi-Messenger Astronomy
- Astrometry, Photometry, and Spectroscopy

Week 2 - The Sun and the Star

- The Layers of Sun and Differential Rotation
- The Solar Neutrino Puzzle
- Stars: Spectral Classification, Blackbody Radiation, Luminosity, Distance Modulus
- Equation of Radiation Transfer

Week 3 - Variable Stars and Stellar Evolution

- Period-Luminosity Relation for Cepheid Variables
- Equation of State for Stellar Evolution
- H-R Diagram
- The Death of a Star and Supernovae

Week 4 - Galaxies and Cosmology

- Milky Way and other galaxies: Differential Rotation, 21-cm Line
- Interacting and Merging Galaxies
- Pulsars and Quasars
- Redshift, Expansion of the Universe, CMB, Cosmological Models

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Module 2: Cosmology

Tentative timings and Days of Lectures: Classes will be held from **7:30 PM to 8:30 PM** on Mondays, Tuesdays, Thursday, Fridays. Informal Discussions if needed will be held on the remaining days.

Week 1 - The Basics

- Spacetime Geometry
- Cosmological Redshift and Scale factor

Week 2 and Week 3 - Expanding Universe

- Expansion of the Universe, Hubble Law

- Dynamics of Expansion: Einstein Field equation, Friedmann Equation, Shapes of the Universe
- Age of expansion, Matter-domination, Radiation-domination, Dark energy-domination epoch
- Cosmological parameters and Cosmological probes

Week 4 - The Early Universe

- Stages of the Universe
- High energy particles and the Standard Model
- Cosmic microwave background, Temperature Fluctuation, Sunyaev Zeldovich effect with X-Ray Luminosity
- Dark Matter and Dark Energy
- Inflationary Cosmology and Future of the Universe

Module 3: Guided Mini-Project

- Submit your own proposal for your custom mini project idea.
- Join a team of like-minded peers or work independently once your proposal is approved.
- Get continued mentorship and guidance throughout the mini-project in finalizing problem statement, accessing data and general research process.
- Get access to our Technical Writing Course using LaTeX. Write a research report or a review paper using LaTeX software.
- Submit your report as well as get a chance to present your work in front of scientists and researchers.