PHYS-643

Astrophysics VI : The variable Universe

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Cursus	Sem.	Type
Physics		Opt.

Language of teaching	English
Credits	3
Session	
Exam	Oral
Workload	90h
Hours	**42**
Courses	28
Exercises	14
Number of positions	**30**

Frequency

Every year

Summary

Introduction to time-variable astrophysical objects and processes, from Space weather to stars, black holes, and galaxies. Introduction to time-series analysis, instrumentation targeting variability, and the importance of the time domain for astronomy, cosmology, and fundamental physics.

Content

The Universe is bustling with variability. Variability denotes changes of observed properties as a function of time that can be detected on all observable timescales. From the millisecond pulsars to the billions of years of cosmic or stellar evolution, virtually all astronomical objects vary on some timescale. Importantly, variability allows us to unravel the physics of astronomical objects or even for testing fundamental physical concepts, such as general relativity. However, the realization that the Universe is not static also carries a profound philosophical insight for how humans engage with the Cosmos.

In this course, we dive into the fascinating subject of time-domain astronomy and time-variable astrophysical phenomena, ranging from "next-door" events to cosmological tests. Lectures will be 2 hours in duration, followed by 1h excerise sessions.

The exercises are structured around recent publications that match the week's topic and provide an opportunity for students to discuss recent literature on a variety of topics with each other and with the lecturer. Each student will lead the discussion of approximately 2 papers during the semester, depending on the number of participants (1 paper/week). All students read the papers to be discussed to allow for an interesting discussion and to clarify the different concepts and results described.

The goal of the exercises is to practice synthesizing complex information from a variety of fields, and students will have an opportunity to receive one-on-one feedback on their presentations. The presentations will be 15-min journal club-style presentations, followed by Q&A and open discussion. The presentations will prepare students for the oral exam, which will consist of a paper presentation with subsequent Q&A on course materials and count for 100% of the grade.

The lectures and exercises will cover the following topics:

1. From historical records to modern time-domain surveys (Lecture 1)

2. Variability in the Solar System (Lecture 2)

3. Extrinsic stellar variability (Lecture 3)

4. Intrinsic stellar variability (Lectures 4 & 5)

5. Searching for life in the Universe (Lecture 6)

6. Transient events (Lecture 7)

7. Degenerate objects (Lecture 8)

8. Active galaxies (Lecture 9)

9. Multi-messenger astronomy (Lecture 10 & 11)

10. Cosmic distances and expansion (Lecture 12)

11. Applications for fundamental physics and cosmology (Lectures 13 & 14)

Note

PHYS-439 (Introduction to astroparticle physics) provides high-energy and astroparticle complement to this course

Keywords

observational astrophysics, time-domain astronomy, variability, stars, galaxies, black holes, fundamental physics

Learning Prerequisites

Required courses

Bachelor in physics, astrophysics, or mathematics; Astrophysics I & II (PHYS-209 & PHYS-323)

Learning Outcomes

- Understand basic processes leading to varibility in astronomical sources
- understand the principles behind tests of fundamental physics based on time-domain observations