UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Stellar Astrophysics

2425-1-F5802Q002

Aims

The course provides an introduction of the physics of stars, their formation and evolution. Stellar astrphysics is at the foundations of astronomy and serves as the cornerstone of astronomy, forming the basis for understanding galaxies and the role of gravity in shaping the Universe.

Contents

Key areas of study within stellar astrophysics include:

Stellar Formation: investigating how interstellar gas clouds cool down, collapse and fragment into stellar clusters
Stellar Structure: studying the internal layers of stars and the role of gravity, thermodynamics, quantum mechanics and radiation in shaping their equilibrium properties
Stellar Evolution: understanding how stars change over time and evolve into their eventual fate, such as becoming white dwarfs, neutron stars, or black holes; understanding the origin of the chemical elements and metal enrichment
Stellar Populations: studying how the metallicity content shapes the overall properties of stars and how these properties affect galaxy evolution due to stellar feedbacks.

Detailed program

I. BASIC CONCEPT

- Stellar equilibria and stability, virial theorem, stellar timescales
- Light from stars: black body radiation, opacity and radiative transport

- Classical and quantum gases
- Nuclear reactions: Gamov’s energy, synthesis of the heavy elements
  II. STARS ON GTHE MAIN SEQUENCE
- Stars on the main sequence: scaling relations
- Maximum and minimum mass of stars and mass funciton
  III. STELLAR EVOLUTION
- The role of gravity in driving stellar evolution
- Degenerate stars: the Chandrasekhar mass limit
- Red giants, Horizonthal Branch, AGB and supernovae
- Gravitational collapse: neutrino emission and deleptonisation
- Compact objects as relics of stars: white dwarfs, neutron stars and black holes
- Stellar evolution in binary systems
  IV. STAR FORMATION
- Star formation: Jean’s mass, protostars and the Hayashi track
- Population III stars

Prerequisites

Basic classes of the bachelor in Physics, including:
Calculus
Classical Mechanics
Electromagnetism
Condensed Matter
Quantum Mechanics

Teaching form

42 hours of frontal lectures, mostly at the blackboard, occasionally with the support of slides (6 credits)
20 hours of exercises and supporting activities (2 credits)

Lectures are in English.

Lectures from the previous years are made available to meet the needs of students who might be impeded in personally attending classes.

Textbook and teaching resource

Books:

Prialnik, “Stellar structure and evolution” - the reference book
Phillips, “The Physics of Stars” - complete and exhaustive text of the course
Kippenhahn and Weigert, “Stellar structure and evolution” - key text for understanding stellar evolution and star's formation
Stahler and Palla, “The formation of stars” - advanced text
Shapiro and Teukolsky, “Black holes, white dwrafs and neutron stars” - the classic text on compact objects

Selected reviews and selected papers provided during the lectures
Selection of recorded lectures

Semester

First semester

Assessment method

Oral exam: The first question will focus on one of the most fundamental concepts of stellar physics highlighted during the course. The examination continues on topics treated in the course to evaluate the:

- acquired knowledge of stellar astrophysics
- ability to perform analytical derivations
- ability to critically address problems related to the material studied in class Segi
  The examination ends with a short slide-presentation (or printed figures) on a selected topic of stellar evolution or star formation (10 minutes) at the student's discretion.

There will be no intermediate examinations nor homework.

Office hours

Upon appointment via email

Sustainable Development Goals

QUALITY EDUCATION