UCL SUMMER SCHOOL

ASTROPHYSICS AND COSMOLOGY

Key Information

Module code       ISSU0066
Taught during     Session One: Monday 1 July - Friday 19 July 2019
Module workload   45 teaching hours plus approximately 100 study hours
Module leader     Dr Ioannis Koutsonas
Department        Centre for Languages and International Education
Credit            15 UCL credits, 7.5 ECTS, 4 US
Level             Level 1, first year undergraduate
Pre-requisites    Standard entry requirements
Assessment        Weekly coursework (30%), Presentation (20%), Exam (50%)

Module Overview

Astrophysics and Cosmology provide the most fascinating and far reaching endeavours of human intellect. As the title suggest this intensive course is to provide a sound introduction to the main concepts and body of evidence that underlie our current understanding of the origin, structure and evolution of the Universe. The course in its scope, aims to offer exposure to the fundamental principles of special and general relativity and their significance to the evolution of the Cosmos. Topics such as stellar interiors, classification and evolution along with galaxy dynamics will be discussed in some detail. The course will culminate with descriptions of current cosmological models and touch up on recent developments of the much discussed dark matter and dark energy mysteries and what they entail to the evolution of the Universe.

Week One
- The Newtonian Universe and the Law of Gravitation
- Einstein’s Universe: Special and General Relativity
- Key Observational methods in Astrophysics

Week Two
- Star birth, life and death. The Hertzsprung – Russell diagram
- Equations of Stellar Structure and Stability
- Exotic objects: Magnetars, Pulsars and Black holes.
- Galaxies and their dynamics. The case for Dark Matter

Week Three
- Newtonian Cosmology and the Cosmological Principle
- The Scale factor of the Universe, Cosmological Redshift and Hubble’s Law
- Relativistic Cosmology and the Friedman model as a Paradigm

Please note that this module description is indicative and may be subject to change.
Module Aims
In the rapid scientific revolutions that we experienced in the 20th century (and in our century) the most groundbreaking were in the fields of Physics and its various branches such as Astrophysics and Cosmology. Hence no university graduate who consider themselves educated should live in dark about this seminal body of knowledge. This module aims to introduce students of various backgrounds to some of the key aspects of modern astrophysics and cosmology. Students will develop critical thinking and mathematical skills in conjunction to being able to understand some of the physical processes that underlie the formation of stars and galaxies and the evolution of the Universe as a whole. Hence the course can provide a bridge to either undertake further studies in the field of Astrophysics or be able to connect and understand scientific developments as they appear in modern books, articles and documentaries.

Teaching Methods
This intensive course will be delivered in lectures and small classes in over 45-50 teaching hours. A day trip visit to the Greenwich observatory and planetarium will be organised half way through the course. Moodle will be used to post lecture materials coursework questions and their answers following the assessment of these. Self-study and group study will be encouraged throughout this course. A total of 100 hours of personal input is expected.

Learning Outcomes
Upon successful completion of this module, students will:
- Acquire working knowledge of the law of gravitation in order to be able to draw conclusions about stellar structure and simple cosmological models.
- Appreciate the fact that concepts such as space and time are not absolute but relative and matter and energy are equivalent forms to each other. Become comfortable in using these concepts to a reasonable extent.
- Appreciate that the constituents of matter were created at the cores of stars.
- Develop an understanding of the scale of the Universe from very small to very large.
- Become philosophically enquiring.

Assessment Methods
- Weekly coursework (30%)
- Oral presentation (20%)
- Final Exam (50%)

Module Leader
Dr Ioannis Koutsonas formative education is in Physics with Astrophysics (B.Sc. Hons - University of Birmingham) and in Quantum Fields and Fundamental Forces (M.Sc - Imperial College London). He conducted research in Nanotechnology and Micro-devices at the University of Birmingham from where he obtained his Ph.D. in 2009. Dr Koutsonas has taught Physics and Engineering for over ten years, in various contexts and levels at the Universities of Birmingham, Queen Mary University as well as a number of six form colleges. He has been a lecturer in Physics at the UPCSE program since 2010. His research interests fall in the frame of Particle Theory, Cosmology and up to date applications of Nanotechnology.

Key Texts


