Universitat Autònoma de Barcelona

2022/2023

Cosmology

Code: 42858
ECTS Credits: 6

Degree	Type	Year	Semester
4313861 High Energy Physics, Astrophysics and Cosmology	OT	0	2

Contact

Name: Enrique Gaztañaga Balbas

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Use of Languages

Principal working language: english (eng)

Teachers

Hector Croce

Diego Blas Temiño

Pablo Fosalba Vela

Prerequisites

Introduction to the Physics of the Cosmos

Objectives and Contextualisation

The course is intended to provide students with a introductory lectures to Cosmology. The standard Cosmological model, the open questions and the current research lines in the field.

Competences

- Formulate and tackle problems, both open and more defined, identifying the most relevant principles and using approaches where necessary to reach a solution, which should be presented with an explanation of the suppositions and approaches.
- Understand the bases of advanced topics selected at the frontier of high energy physics, astrophysics and cosmology and apply them consistently.

Learning Outcomes

1. Apply the theory of cosmic perturbation to the problem of the formation of the structure of the universe.
2. Distinguish and analyse the problems of the classic Big Bang theory.
3. Recognise the basics of the theory of cosmic perturbation theory.

Content

1. Introduction to Cosmology: the Big Bang theory, Hubble's law, nucleosynthesis. Cosmic background radiation.
2. Cosmic Expansion: models, scale factors, redshift, measurements of H.

3. Cosmological equations: continuity equation and state equation,
4. Friedmann equation, acceleration, cosmological parameters, dark matter and energy.
5. Spacetime measurements: cosmic distances, horizons, age and volume.
6. Problems with the Big Bang theory: baryogenesis, inflation, dark matter, origen of structures.
7. Structure formation: gravitational collapse, instability hierarchical, power spectrum, acoustic oscillations, galaxy formation, numerical simulations, halo models.

Methodology

Theory lectures and exercises.

Classwork and Homework.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Lectures on basic concepts	45	1.8	1, 2, 3
Type: Supervised			
Home problems	39	1.56	1, 2, 3
Type: Autonomous			
Class Projects	39	1.56	1, 2, 3

Assessment

Assistance to classes is a requirement.

Some parts of the class will require class projects and some other parts to present problems.

This can be both writen or oral presentation to a total value of 50%.

The other 50% is a written exam.

There will be a resit exam for 50% of the grade.

In order to take part in the resit exam you must have obtained a mark of 3.5 or higher.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Class Project & Problems	50%	21	0.84	1, 2, 3
Exam	50%	3	0.12	1, 2, 3
Resit Exam	50%	3	0.12	1, 2, 3

Bibliography

- An introduction to Moderm Cosmology, A.Liddle, Horizon P&D (1999, 2003)
- Cosmological Physics, J.A.Peacock, Cambridge U. Press (1999)
- Extragalactic Astronomy and Cosmology, Peter Schneider, (2010)
- Introduction to Cosmology, Barbara Sue Ryden (2010)

Software

Course coordinator: Prof. Enrique Gaztanaga <gazta@ice.cat>
== Part I Introduction days: 18/3, 13/4 and 21-28/4 =====
Teacher: Prof. Enrique Gaztanaga <gazta@ice.cat>
Introduction to the metric, the Friedman equations and measurements
Practical projects.
== Part II. PROBLEMS WITH THE BIGBANG: days: 19-25/3 =====
teacher: Prof. Diego Blas <dblas@ifae.es>

- BARYOGENESIS
- INFLATION
- DARK MATTER

== Part III Large Scale Structure: 6-12/4 ==========
Teacher: Prof. Martin Crocce martincrocce@gmail.com

1) Evolution of density perturbations / Vlasov Eqs.
2) Linear Theory - evolution during radiation domination, evolution during matter domination
3) Power spectrum - main observational characteristics / connection to cosmology (large scales, early universe)
4) Two-point Correlation Function
5) Baryon Acoustic Oscillations.
6) Next-to-leading order : onset of nongaussianity

== Part IV. Structure Formation: Advanced Topics, (10h): 14-20/4 ==========
Teacher: Prof. Pablo Fosalba fosalba@gmail.com

1)- Galaxy formation: mass function, galaxy bias, halo model (4h)
2)- Gravitational Lensing (2h)
3)- Numerical simulations (2h)
4)- CMB (2h)