Master Physique fondamentale et applications
Cosmologie - cosmology

Informations

Composante : Faculté des Sciences

Langue(s) d'enseignement

Anglais

Contenu

This UE aims to reveal the major issues related to the origin of the Universe. The course aims to describe the universe using the standard cosmological model based on general relativity and numerous observational pillars such as the expansion of the universe, primordial nucleosynthesis and the cosmic microwave background.

Compétences à acquérir

Understand the origin, formation and evolution of the universe.

Understand what the universe is made of in terms of its large structures and its elementary "bricks" that are galaxies.
Understand the observational issues, understand and know the major observables of the universe.
Know how to write the equations of general relativity and deduce their expression within the framework of the Friedmann-Lemaître model.
Know how to deduce the equations of standard cosmology in the Robertson-Walker metric.
Know how to solve these equations and extract the properties of the universe that they describe.
Know how to make the link between the observables and the predictions of the model.

Modalités d'organisation

The course is composed of three parts: a part dealing with cosmological observables, another with the Friedmann-Lemaître cosmological model and a project part.

1. The observables

1.1. Objects and structures in the universe
Objects: Galaxies (individual and collectives properties) + QSO + CGM/IGM
1.2. Hierarchical structures

Groups of galaxies (including the Local Group) - Clusters of galaxies - Superclusters - Large scales structures (Voids – Filaments – redshift space)
1.3. The pillars of cosmology
The Hubble Law (expansion) + Distant SN (acceleration of the expansion)
The Cosmic Microwave Background
Primordial nucleo-synthesis + Current issues

2. Friedmann-Lemaître models

2.1. Introduction to general relativity (RG)
Tensor calculus - Curved spacetime – Energy-momentum tensors – Equivalence, RG and covariance principles – Formal Einstein equations.
2.2. Friedmann–Lemaître–Robertson–Walker (FLRW)
Einstein Eq. in the Friedman-Lemaître model for the Robertson-Walker metric: Calculus of the Christoffel symbols – Ricci tensors – Scalar Curvature – Einstein and energy-momentum tensors – Einstein equations.
2.3. Homogeneous universe
Scale factor equation – Densities - First and second equation of cosmologies – Hubble law – Deceleration parameter – Lookback time - Models without and with cosmological constant – Einstein-de Sitter models.
2.4. Properties of FLRW models
Density parameters – Galaxy luminosity function – Universe Mass-to-Light ratio - Evolution parameters – Radial trajectory of photons – Cosmic time - Proper and comoving distances – Redshift-apparent magnitude relation – deceleration parameter from distant supernovae.
2.5. Introduction to Inflationary models - adiabatic and isothermal density fluctuations

Bibliographie, lectures recommandées

Astrophysics Processes - Hale Bradt - Cambridge Ed. U. Press
Fondamental Astronomy - H. Karttunen et al. - Ed. Springer
Astrophysics - J.A. Irwin - Wiley
Astronomy & Astrophysics - M. Gregory & S.A. Gregory - Ed. Brooks/Cole.
An Introduction to Modern Astrophysics - B.W. Carroll & D. Ostlie - Ed. Person New International Edition. Astrophysics for Physicists - A.R. Choudhuri - Ed. Cambridge U. Press
Astrophysical Concepts - M. Harwit - Ed. Springer Astronomy Today - E. Chaisson & S. McMillan
Galaxies
Galactic Astronomy - J. Binney & S. Tremaine - Ed. Princeton
Galactic Dynamics - J. Binney & S. Tremaine - Ed. Princeton
A Panchromatic View of Galaxies - A. Boselli - Ed. Wiley-VCH
Galaxies Formation and Evolution - H. Mo, F. van den Bosch & S. White- Ed. Cambrigde U.. Press Galaxies and Cosmology - M.H. Jones & R.J.A. Lambourne - Ed. Cambridge U. Press Extragalactic Astronomy and Cosmology - P. Schneider - Ed. Springer
Galaxies in the Universe - L.S. Sparke & J.S. Gallagher, III - Ed. Cambridge U. Press The structure and Evolution of Galaxies - S. Phillips - Ed. Wiley.
Galaxies and Cosmology - F. Combes et al. - Ed. Springer
Cosmology
Principles of Physical Cosmology - P.J.E. Peebles - Ed. Princeton U. Press
Cosmological Physics - J. A. Peacock - Ed. Cambridge U. Press
The Inflationary Universe - A.H. Guth - Ed. Princeton U. Press
Foundations of Modern Cosmology - J.F. Hawley & K. A. Holcomb - Ed. Oxford U. Press Cosmology - M. Rowan-Robinson - Ed. Clarendon Press, Oxford
The Expanding Universe - W.D. Heacox - Ed. Cambridge U. Press The Big Bang - J. Silk, Joseph - Ed. W. H. Freeman
Other :
Gravitation and Cosmology - Weinberg. Modern Cosmology - Dodelson. Structure Formation - Padmanabhan.

Prérequis recommandés

Knowledge of tensor calculus, differential calculus, differential equation resolution, changes of bases, spherical harmonics, dimensional equations.

Knowledge of statistical physics, mechanics, electromagnetism, quantum physics, thermodynamics.

VOLUME HORAIRE

- Volume total: 40 heures
- Cours magistraux: 17 heures
- Travaux dirigés: 17 heures
- Travaux pratiques: 6 heures

Codes Apogée

- SPFBU13C [ELP]

Pour plus d'informations

Aller sur le site de l'offre de formation...