UCLouvain

lphys2122

2019

Cosmology

In view of the health context linked to the spread of the coronavirus, the methods of organisation and evaluation of the learning units could be adapted in different situations; these possible new methods have been - or will be - communicated by the teachers to the students.

5 credits	30.0 h	Q1

Teacher(s)	Ringeval Christophe ;
Language :	English
Place of the course	Louvain-la-Neuve
Main themes	This teaching unit introduces the students to current cosmological observations and to the Friedmann-Lemaître model at the root of physical cosmology. In particular, we show how the expansion of the Universe and the relative abundances of the light nuclei can be predicted from the laws of physics. The agreement between these predictions and the actual measurements have been the first validation of the hot Big-Bang model, but they also support the existence of new forms of matter and energy, referred to as "dark".
Aims	**a. Contribution of the teaching unit to the learning outcomes of the programme (PHYS2M and PHYS2M1)** 1.1, 1.2, 2.1, 3.1, 3.2, 3.3, 4.1, 5.3, 7.3. **b. Specific learning outcomes of the teaching unit** At the end of this teaching unit, the student will be able to : 1 1. check and derive cosmological results assuming a homogeneous Universe ; 2. calculate distances and angles in Friedmann-Lemaître metrics ; 3. write down and solve Boltzmann equations in Friedmann-Lemaître metrics ; 4. correctly estimate relic abundances for hot or cold relics, given a cross-section ; 5. tackle down basic calculations in general relativity in highly symmetric space-times. - - - - *The contribution of this Teaching Unit to the development and command of the skills and learning outcomes of the programme(s) can be accessed at the end of this sheet, in the section entitled "Programmes/courses offering this Teaching Unit".*
Evaluation methods	**Due to the COVID-19 crisis, the information in this section is particularly likely to change.** Evaluation is based on a 2 hours long written exam that is focused on solving typical problems in homogeneous cosmology with some amount of guidance. The problems require to be able to extend the techniques presented in the teaching unit to original and new questions, as well as abilities to correctly perform basic calculations in general relativity.
Teaching methods	**Due to the COVID-19 crisis, the information in this section is particularly likely to change.** Teaching activities are alternating between traditional lecturing and guided learning. Calculations are detailed on the black board, in interacting style, while multimedia support is provided for numerical and data analysis results.
Content	The content of the teaching unit provides all the tools needed to understand the homogeneous cosmology of the last century. This includes the theoretical foundations of the Big-Bang model of Friedmann and Lemaître, propagation of photons in homogeneous space-times, decoupling of hot and cold relics from the primordial plasma, as well as details of Big-Bang nucleosynthesis processes. Lectures start from the following tree : • The observed Universe • Cosmological principle and kinematics • Dynamics of Friedmann-Lemaître space-times • Thermal history of the Universe • Kinetic theory in curved space-time • Freeze-out of interactions and relics • Big-Bang nucleosynthesis • Predicting the abundance of light elements • Yet another evidence for dark matter

Bibliography	• • “Fundamentals of Cosmology”, Rich. • “Primordial Cosmology”, premiers chapitres, Peter & Uzan. • “The Early Universe”, Kolb & Turner. • “Principles of Physical Cosmology”, premiers chapitres, Peebles. • “A First Course in General Relativity”, Schutz.
Faculty or entity in charge	PHYS

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Aims
Master [60] in Physics	PHYS2M1	5		
Master [120] in Physics	PHYS2M	5		