

# Universo Primordial 2026-2027 (1º Semestre)

Mestrado em Física e Astrofísica

## Universo Primordial / Primordial Universe

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Regent:

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Teórica: T11

Teórico-Prática: TP11

UC information and contents:

**Fenix:** <https://fenix.ciencias.ulisboa.pt/courses/up-847504421687569>

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## HORÁRIO

|       | Seg 9/16 | Ter 9/17                     | Qua 9/18 | Qui 9/19 | Sex 9/20                      | Sáb 9/21 |
|-------|----------|------------------------------|----------|----------|-------------------------------|----------|
| 07:00 |          |                              |          |          |                               |          |
| 08:00 |          |                              |          |          |                               |          |
| 09:00 |          |                              |          |          |                               |          |
| 10:00 |          |                              |          |          |                               |          |
| 11:00 |          |                              |          |          |                               |          |
| 12:00 |          |                              |          |          |                               |          |
| 13:00 |          |                              |          |          |                               |          |
| 14:00 |          |                              |          |          | 14:00 - 15:00<br>T<br>8.2.03  |          |
| 15:00 |          | 15:00 - 16:00<br>T<br>8.2.04 |          |          | 15:00 - 16:00<br>TP<br>8.2.03 |          |
| 16:00 |          |                              |          |          |                               |          |



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## OBJECTIVES

This course explores the physics of the **Primordial Universe** within the framework of the **Standard Model of Cosmology**, based on the **Hot Big Bang theory**.

Students will be introduced to the model's key concepts and will learn how to apply them to problems in **early-universe physics**, **cosmology**, and **astroparticle physics**.

TP sessions are primarily intended to discussion/presentation of exercises and support students' independent study. They may also provide further insight into topics introduced during the T lectures.



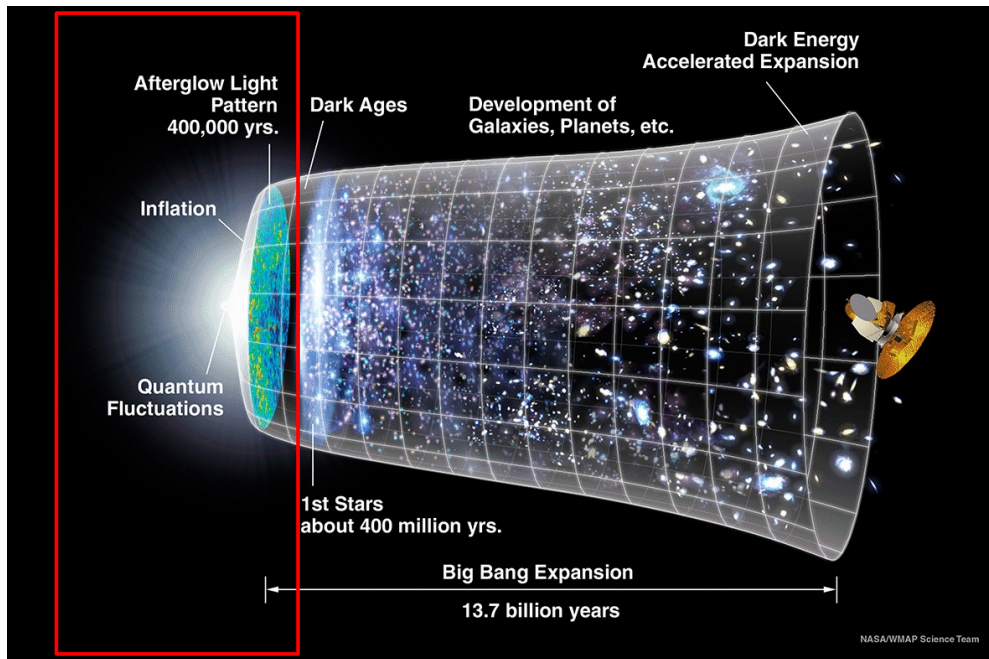
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What do we know about the universe?...  
How confident are we in that knowledge?

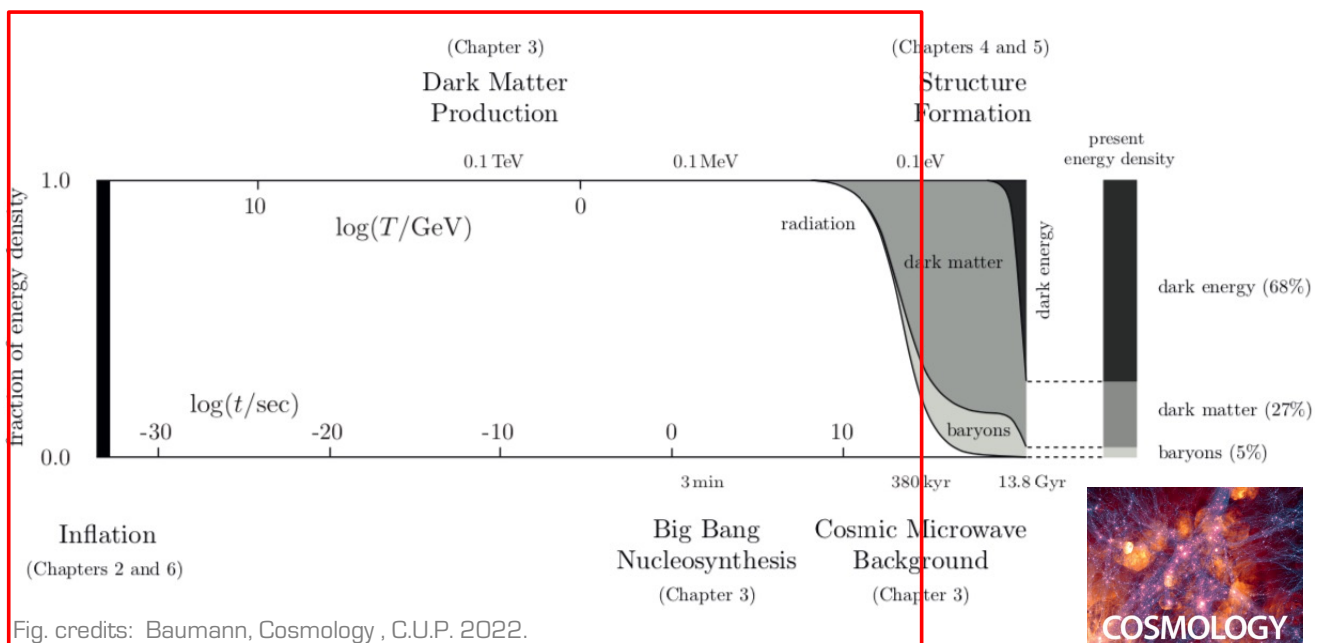


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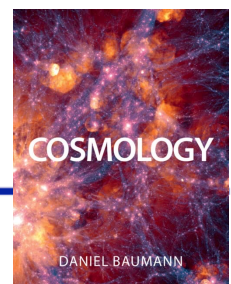
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What is our current understanding of the universe?...  
How confident are we in that understanding?



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## PROGRAMA

1. The observed Universe
2. The Standard Model of Cosmology
3. Thermodynamics in an expanding Universe
4. Neutrino Decoupling
5. Dark Matter and WIMP relics
6. Big-Bang Nucleosynthesis
7. Recombination and CMB decoupling
8. The theory of Inflation
9. Perturbation theory during inflation
10. Evolution of perturbations after inflation:  
CMB and matter power spectrum  
observables
11. Baryogenesis



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## BIBLIOGRAPHY

Main:

- **Daniel Boumann, Cosmology, Cambridge University Press, 2022.**
- **Edward Kolb and Michael Turner - 'The early universe' - Addison Wesley 1990.**
- Patrick Peter and Jean-Philippe Uzan, "Primordial Cosmology", Oxford U. Press, 2009;
- Scott Dodelson - 'Modern Cosmology' - Academic Press, Elsevier, 2003;

Other:

- Daniel Boumann, Cosmology, Part III Mathematical Tripos, Course Lectures
- A Liddle and D. Lyth - 'Cosmological inflation and large-scale structure' - CUP 2000
- Barbara Ryden - "Introduction to Cosmology" - Addison Wesley, 2003
- Inflation and the theory of Cosmological Perturbations, A. Riotto, Lectures on Astroparticle, Physics and Cosmology



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## EVALUATION

The final grade will be calculated as a **weighted average** of the grades obtained in the following assessment activities:

- **Submission of the Exercise Sheet (ES) solutions** (40%)
- **Individual research project presentation** (35%): The topic may be chosen from a list provided by the instructor or proposed by the student, subject to approval. One or more conference days will be scheduled for the presentations. Each presentation will typically last 30 minutes, followed by 15 minutes of discussion.
- **Black-Board presentation and discussion of Exercise Sheet problems** (15%): Each student will present their solutions to selected ES problems. The problems will be selected randomly and announced in advance.
- **Continuous assessment** (10 %): This includes participation in discussions during theoretical and practical classes, e.g. may include answers to “spontaneous quizzes”.

