



**Universität Ulm**

Master of Science Physics (PO 2019)

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## Cosmology

**Code** 8812873066

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**ECTS credits** 6

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**Attendance time** 5

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**Language of instruction** German

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**Duration** 1

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**Cycle** irregular

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**Coordinator** Dean of Physics Studies

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**Instructor(s)** Dr. Ralf Aurich

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**Allocation of study programmes** Physics M.Sc., elective module, 1<sup>st</sup> or 2<sup>nd</sup> semester

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**Recommended prerequisites** Fundamentals in optics, thermodynamics and astrophysics

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**Learning objectives** Students who successfully passed this module

- understand the current cosmological models.
- know the most important results that lead to the modern cosmological view of the world.
- have the tools to analyse new models.

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**Syllabus**

- Time evolution of the universe
- Fundamentals of general relativity
- The cosmological principle, curved spaces with constant curvature and the Robertson-Walker metric
- The Friedmann equations, expansion of the universe, red shift, Hubble diagram
- The energy budget of the universe: radiation, barionic and dark matter, the energy-momentum tensor
- Dark energy: Einstein's cosmological constant

- Solutions of the Friedmann equations, models of the universe, calculation of the cosmic scale factor and age of the world, Horizon
- Observable parameters in cosmology: age and distance estimations, distance factors, supernovas, cosmic microwave background radiation
- Basics of the hot big bang model

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**Literature**

- J.A.Peacock: Cosmological Physics (1999)
- P.Schneider: Einführung in die Extragalaktische Astronomie und Kosmologie (2007)
- S.Weinberg: Cosmology (2008)
- E.W.Kolb and M.S.Turner: The early Universe (1993)
- A.Liddle: Einführung in die moderne Kosmologie (2008)
- H.Goenner: Einführung in die Kosmologie (1994)
- S.Dodelson: Modern Cosmology (2003)

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**Teaching and learning methods**

Lecture (3 hours per week)  
Tutorials (2 hours per week)

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**Workload**

45 hours lecture (attendance)  
30 hours tutorials (attendance)  
105 hours self-study and exam preparation  
Total: 180 hours

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**Assessment**

The module examination consists of a graded written or oral examination, depending on the number of participants. Participation in the examination requires an ungraded study achievement. If a specified academic work is achieved, a grade bonus is awarded in accordance with §17 (3a) of the General Examination Regulations at the immediately following examination. The examination grade is improved by one grade level, but not better than 1.0. An improvement from 5.0 to 4.0 is not possible. The type, content and scope of the study achievement[s] will be announced in good time in the course information and the course catalogue. The examination form will be announced in good time before the examination is held - at least 4 weeks before the examination date.

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**Grading procedure**

The module grade is equal to the examination grade.

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**Basis for**

Specialization in cosmology and astrophysics

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