LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

Module Catalogue

Master's Programme: Astrophysics

(Master of Science, M.Sc.)

(120 ECTS credits)

Based on the *Prüfungs- und Studienordnung*

adopted by the Senate of LMU Munich on June 22, 2023

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Abbreviations and annotations

CP	Credit Points, ECTS credits
ECTS	European Credit Transfer and Accumulation System
h	hours
SoSe	summer semester
SWS	contact hours
WiSe	winter semester
WP	compulsory elective course/module
P	mandatory course/module

1. The ECTS credits assigned in the Module Catalogue are designated as follows: Credit Points not listed in parentheses are awarded when the pertinent examination of the module or module parts have/has been completed successfully. Credit Points in parentheses are listed for calculatory purposes only.

2. The semester for taking a module can either be binding or may be considered as a recommendation, depending on the applicable data in Anlage 2 of the Prüfungs- und Studienordnung for your Programme. In this Module catalogue, the options are indicated as „scheduled semester“ and „recommended semester“.

3. Please note: The Module Catalogue is merely intended to serve as an orientation whereas the provisions of the applicable version of the Prüfungs- und Studienordnung (in German only) of your Programme are legally binding. See: www.lmu.de/studienangebot and select your Programme.

Module: P 1 Introduction to Advanced Astrophysics

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	P 1.1 Introduction to Advanced Astrophysics (Lecture)	WiSe and SoSe	60 h (4 SWS)	120 h	(6)
Exercise course	P 1.2 Introduction to Advanced Astrophysics (Exercise Course)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

For successful completion of the module, 9 ECTS credits have to be acquired. Class attendance averages about 6 contact hours. Including time for self-study, 270 hours have to be invested.

Module type	Mandatory module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	None
Entry requirements	None
Semester	Recommended semester: 1
Duration	The successful completion of the module takes 1 semester.
Content	The module comprises a first basic lecture on fundamental and advanced astrophysics and an overview of corresponding concepts, experimental and theoretical methods, with an associated exercise course. ***Lecture: Introduction to Advanced Astrophysics (P1.1):*** The lecture introduces the most important concepts and methods of fundamental and advanced astrophysics, and an understanding of the interplay of the various astrophysical processes controlling the evolution of our Universe. Major topics of the lecture are: Basic concepts related to radiation, radiative transfer, observational methods and devices, solar and exo-planets, stellar atmospheres, structure and evolution, stellar remnants, the interstellar medium and star formation. Basic concepts of chemical evolution, stellar and galaxy dynamics, dark matter, active galactic nuclei and massive black holes, large-scale structures, the spatial distribution of galaxies and galaxy clusters, cosmology, the early universe, and the formation and evolution of galaxies.

	The basic astrophysical processes are motivated and underpinned with scientific concepts. ***Exercise course: Introduction to Advanced Astrophysics (P1.2):*** The content discussed in the lecture will be practised using typical applications.
Learning outcomes	The aim of this module is to provide students with a deep understanding of the fundamental knowledge, concepts and methods of astrophysics and concrete applications to typical situations. Students are enabled to solve astrophysical problems on the basis of understanding the complex interrelation between the different astrophysical branches. ***Lecture: Introduction to Advanced Astrophysics (P1.1):*** By providing the students with the fundamental knowledge and insights into astrophysical processes and procedures as well as their concrete applications, students should gain a detailed overview of the different areas of astrophysics. In particular, students should learn to recognise interrelationships across topics. ***Exercise course: Introduction to Advanced Astrophysics (P1.2):*** Simple problem solutions are to be developed, specified and implemented independently. Students should learn to apply the content discussed in the lecture to practical tasks.
Type of examination	Written exam or oral examination
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Thomas Preibisch
Language(s)	English
Additional information	None

Module: P 2 Astrophysical Basic Lab

Programmew	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lab course	P 2.1 Astrophysical Basic Lab (Lab Course)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)
Exercise course	P 2.2 Astrophysical Basic Lab (Exercise Course)	WiSe and SoSe	60 h (4 SWS)	120 h	(6)

For successful completion of the module, 9 ECTS credits have to be acquired. Class attendance averages about 6 contact hours. Including time for self-study, 270 hours have to be invested.

Module type	Mandatory module with mandatory courses
Usability of the module in other programmes	None
Elective guidelines	None
Entry requirements	None
Semester	Recommended semester: 1
Duration	The successful completion of the module takes 1 semester.
Content	The module comprises an astrophysical lab course with exercises, aiming at practicing basic astrophysical methods. Various experiments from a pool of experiments shall be performed: Interpretation and analysis of spectra from stellar and exoplanetary atmospheres, and from gaseous nebulae, galaxies and quasars, analysis of Lyman-alpha forest systems, search for extrasolar planets, strong and weak lensing, photometric observations of galaxies, stars, star clusters and planets. The specific experiments are updated and/or exchanged from time to time, following the astrophysical progress and change of focus.
Learning outcomes	The aim of this module is to provide students with a deep understanding of the fundamental methods of astrophysics and their applications. Students will acquire skills in the verification and application of astrophysical relations on the basis of fundamental experiments and observations. The handling of observational data, scientific

	documentation and critical evaluation of experimental results will be practised. This is the first step in introducing students to scientific working.
Type of examination	Scientific protocol and presentation
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Dr. Stella Seitz
Language(s)	English
Additional information	None

Module: P 3 Basic Research Methods and Tools of Advanced Astrophysics

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	P 3.1 Basic Research Methods and Tools of Advanced Astrophysics (Lecture)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)
Exercise course	P 3.2 Basic Research Methods and Tools of Advanced Astrophysics (Exercise Course)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

For successful completion of the module, 6 ECTS credits have to be acquired. Class attendance averages about 4 contact hours. Including time for self-study, 180 hours have to be invested.

Module type	Mandatory module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	None
Entry requirements	None
Semester	Recommended semester: 1
Duration	The successful completion of the module takes 1 semester.
Content	The module provides an overview of concepts and experimental and/or theoretical basic research methods and tools of advanced astrophysics, by means of a lecture from the fields of statistics, hydrodynamics, plasma physics, radiative transfer, observational methods, or applied quantum mechanics (with focus on atomic and molecular physics), as well as a corresponding exercise course. ***Lecture from the field of statistics, hydrodynamics, plasma physics, radiative transfer, observational methods , or applied quantum mechanics (P3.1)*** The lecture provides an overview of the concepts of statistical methods and their application to (observational) data analysis, or of concepts and methods of hydrodynamics (including numerical aspects), or of plasma physics, or of concepts and methods of radiative transfer in different astrophysical environments and wavelength domains, or of concepts and methods of observational methods and the design and operation of instruments and telescopes, or of concepts

	and methods of applied quantum mechanics, with focus on atomic and molecular physics. ***Corresponding exercise course, supplementing the lecture from the field of statistics, hydrodynamics, plasma physics, radiative transfer, observationsl methods, or applied quantum mechanics (P3.2)*** The contents discussed in the lecture are practised using corresponding applications, including numerical methods.
Learning outcomes	The aim of this module is to provide students with a deep understanding of the fundamental knowledge and procedures of specific fields that are essential for astrophysical work. Students are enabled to solve corresponding problems on the basis of understanding the inherent, complex interrelations. ***Lecture from the field of statistics, hydrodynamics, plasma physics, radiative transfer, observational methods, or applied quantum mechanics (P3.1)*** By providing basic knowledge and insights into the procedures of statistical methods, or hydrodynamics, or plasma physics, or radiative transfer, or observational methods, or applied quantum mechanics, as well as their specific applications, students should develop a thorough understanding of these topics that are essential tools for current astrophysical research. Moreover, they are also enabled to transfer the lecture content to current problems. ***Corresponding exercise course, supplementing the lecture from the field of statistics, hydrodynamics, plasma physics, radiative transfer, observationsl methods, or applied quantum mechanics (P3.2)*** Simple problem solutions shall be independently developed, specified and implemented. Students should learn to apply the content discussed in the lecture to practical tasks, also (if applicable), by means of numerical methods.
Type of examination	Written exam or oral examination
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Klaus Dolag
Language(s)	English
Additional information	None

Module: WP 1 Current Research Topics in Advanced Biophysics

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 1.1 Current Research Topics in Advanced Biophysics (Lecture)	WiSe and SoSe	45 h (3 SWS)	75 h	(4)
Exercise course	WP 1.2 Current Research Topics in Advanced Biophysics (Exercise Course)	WiSe and SoSe	15 h (1 SWS)	45 h	(2)

For successful completion of the module, 6 ECTS credits have to be acquired. Class attendance averages about 4 contact hours. Including time for self-study, 180 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 1 to WP 14, one compulsory elective module must be chosen.
Entry requirements	None
Semester	Recommended semester: 1
Duration	The successful completion of the module takes 1 semester.
Content	The module provides an in-depth discussion of current topics in advanced biophysics. Special attention is paid to recent developments in research.
Learning outcomes	Students acquire in-depth knowledge and gain an understanding of current research topics in advanced biophysics.
Type of examination	Written exam or oral examination
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Joachim Rädler

Language(s)	English
Additional information	None

Module: WP 2 Current Research Topics in Advanced Solid State Physics and Nanophysics

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 2.1 Current Research Topics in Advanced Solid State Physics and Nanophysics (Lecture)	WiSe and SoSe	45 h (3 SWS)	75 h	(4)
Exercise course	WP 2.2 Current Research Topics in Advanced Solid State Physics and Nanophysics (Exercise Course)	WiSe and SoSe	15 h (1 SWS)	45 h	(2)

For successful completion of the module, 6 ECTS credits have to be acquired. Class attendance averages about 4 contact hours. Including time for self-study, 180 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 1 to WP 14, one compulsory elective module must be chosen.
Entry requirements	None
Semester	Recommended semester: 1
Duration	The successful completion of the module takes 1 semester.
Content	The module provides an in-depth discussion of current topics in advanced solid state physics and nanophysics. Special attention is paid to recent developments in research.
Learning outcomes	Students acquire in-depth knowledge and gain an understanding of current research topics in advanced solid state physics and nanophysics.
Type of examination	Written exam or oral examination
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.

Responsible contact	PD Dr. Theobald Lohmüller
Language(s)	English
Additional information	None

Module: WP 3 Current Research Topics in Advanced Elementary Particle Physics

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 3.1 Current Research Topics in Advanced Elementary Particle Physics (Lecture)	WiSe and SoSe	45 h (3 SWS)	75 h	(4)
Exercise course	WP 3.2 Current Research Topics in Advanced Elementary Particle Physics (Exercise Course)	WiSe and SoSe	15 h (1 SWS)	45 h	(2)

For successful completion of the module, 6 ECTS credits have to be acquired. Class attendance averages about 4 contact hours. Including time for self-study, 180 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 1 to WP 14, one compulsory elective module must be chosen.
Entry requirements	None
Semester	Recommended semester: 1
Duration	The successful completion of the module takes 1 semester.
Content	The module provides an in-depth discussion of current topics in advanced elementary particle physics. Special attention is paid to recent developments in research
Learning outcomes	Students acquire in-depth knowledge and gain an understanding of current research topics in advanced elementary particle physics.
Type of examination	Written exam or oral examination
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.

Responsible contact	Prof. Dr. Otmar Biebel, Prof. Dr. Thomas Kuhr
Language(s)	English
Additional information	None

Module: WP 4 Current Research Topics in Advanced Artificial Intelligence

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 4.1 Current Research Topics in Advanced Artificial Intelligence (Lecture)	WiSe and SoSe	45 h (3 SWS)	75 h	(4)
Exercise course	WP 4.2 Current Research Topics in Advanced Artificial Intelligence (Exercise Course)	WiSe and SoSe	15 h (1 SWS)	45 h	(2)

For successful completion of the module, 6 ECTS credits have to be acquired. Class attendance averages about 4 contact hours. Including time for self-study, 180 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 1 to WP 14, one compulsory elective module must be chosen.
Entry requirements	None
Semester	Recommended semester: 1
Duration	The successful completion of the module takes 1 semester.
Content	The module provides an in-depth discussion of current topics in advanced artificial intelligence. Special attention is paid to recent developments in research. Theoretical aspects and their practical implementation are covered.
Learning outcomes	Students acquire in-depth knowledge and gain an understanding of current research topics in advanced artificial intelligence. They gain an understanding of the theoretical background and how to apply such methods in practice.
Type of examination	Written exam or oral examination
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential

	elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Daniel Grün
Language(s)	English
Additional information	None

Module: WP 5 Current Research Topics in Advanced Laser Physics

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 5.1 Current Research Topics in Advanced Laser Physics (Lecture)	WiSe and SoSe	45 h (3 SWS)	75 h	(4)
Exercise course	WP 5.2 Current Research Topics in Advanced Laser Physics (Exercise Course)	WiSe and SoSe	15 h (1 SWS)	45 h	(2)

For successful completion of the module, 6 ECTS credits have to be acquired. Class attendance averages about 4 contact hours. Including time for self-study, 180 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 1 to WP 14, one compulsory elective module must be chosen.
Entry requirements	None
Semester	Recommended semester: 1
Duration	The successful completion of the module takes 1 semester.
Content	The module provides an in-depth discussion of current topics in advanced laser physics. Special attention is paid to recent developments in research.
Learning outcomes	Students acquire in-depth knowledge and gain an understanding of current research topics in advanced laser physics.
Type of examination	Written exam or oral examination
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.

Responsible contact	Apl. Prof. Dr. Vladislav Yakovlev
Language(s)	English
Additional information	None

Module: WP 6 Current Research Topics in Advanced Medical Physics

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 6.1 Current Research Topics in Advanced Medical Physics (Lecture)	WiSe and SoSe	45 h (3 SWS)	75 h	(4)
Exercise course	WP 6.2 Current Research Topics in Advanced Medical Physics (Exercise Course)	WiSe and SoSe	15 h (1 SWS)	45 h	(2)

For successful completion of the module, 6 ECTS credits have to be acquired. Class attendance averages about 4 contact hours. Including time for self-study, 180 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 1 to WP 14, one compulsory elective module must be chosen.
Entry requirements	None
Semester	Recommended semester: 1
Duration	The successful completion of the module takes 1 semester.
Content	The module provides an in-depth discussion of current topics in advanced medical physics. Special attention is paid to recent developments in research, including possibilities of practical insights.
Learning outcomes	Students acquire in-depth knowledge and gain an understanding of current research topics in advanced medical physics. Moreover, they acquire practical skills relevant to such recent research areas.
Type of examination	Written exam or oral examination
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential

	elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Katia Parodi
Language(s)	English
Additional information	None

Module: WP 7 Current Research Topics in Advanced Quantum Physics

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 7.1 Current Research Topics in Advanced Quantum Physics (Lecture)	WiSe and SoSe	45 h (3 SWS)	75 h	(4)
Exercise course	WP 7.2 Current Research Topics in Advanced Quantum Physics (Exercise Course)	WiSe and SoSe	15 h (1 SWS)	45 h	(2)

For successful completion of the module, 6 ECTS credits have to be acquired. Class attendance averages about 4 contact hours. Including time for self-study, 180 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 1 to WP 14, one compulsory elective module must be chosen.
Entry requirements	None
Semester	Recommended semester: 1
Duration	The successful completion of the module takes 1 semester.
Content	The module provides an in-depth discussion of current topics in advanced quantum physics. Special attention is paid to recent developments in research.
Learning outcomes	Students acquire in-depth knowledge and gain an understanding of current research topics in advanced quantum physics.
Type of examination	Written exam or oral examination
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.

Responsible contact	Prof. Dr. Immanuel Bloch
Language(s)	English
Additional information	None

Module: WP 8 Prospective Advanced Research Topics in Modern Experimental Physics

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 8.1 Prospective Advanced Research Topics in Modern Experimental Physics (Lecture)	WiSe and SoSe	45 h (3 SWS)	75 h	(4)
Exercise course	WP 8.2 Prospective Advanced Research Topics in Modern Experimental Physics (Exercise Course)	WiSe and SoSe	15 h (1 SWS)	45 h	(2)

For successful completion of the module, 6 ECTS credits have to be acquired. Class attendance averages about 4 contact hours. Including time for self-study, 180 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 1 to WP 14, one compulsory elective module must be chosen.
Entry requirements	None
Semester	Recommended semester: 1
Duration	The successful completion of the module takes 1 semester.
Content	The module provides an in-depth discussion of prospective advanced topics in modern experimental physics. Special attention is paid to recent developments in research.
Learning outcomes	Students acquire in-depth knowledge and gain an understanding of prospective advanced topics in modern experimental physics.
Type of examination	Written exam or oral examination
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.

Responsible contact	Dean of Studies
Language(s)	English
Additional information	None

Module: WP 9 Advanced Research Topics in Advanced and Applied Quantum Mechanics

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 9.1 Advanced Research Topics in Advanced and Applied Quantum Mechanics (Lecture)	WiSe and SoSe	45 h (3 SWS)	75 h	(4)
Exercise course	WP 9.2 Advanced Research Topics in Advanced and Applied Quantum Mechanics (Exercise Course)	WiSe and SoSe	15 h (1 SWS)	45 h	(2)

For successful completion of the module, 6 ECTS credits have to be acquired. Class attendance averages about 4 contact hours. Including time for self-study, 180 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 1 to WP 14, one compulsory elective module must be chosen.
Entry requirements	None
Semester	Recommended semester: 1
Duration	The successful completion of the module takes 1 semester.
Content	The module provides an in-depth discussion of advanced research topics in advanced and applied quantum mechanics. Special attention is paid to recent developments in research.
Learning outcomes	Students acquire in-depth knowledge and gain an understanding of the discussed topics.
Type of examination	Written exam or oral examination
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.

Responsible contact	Prof. Dr. Jan von Delft
Language(s)	English
Additional information	None

Module: WP 10 Advanced Research Topics in Quantum Field Theory and Gauge Theories

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 10.1 Advanced Research Topics in Quantum Field Theory and Gauge Theories (Lecture)	WiSe and SoSe	45 h (3 SWS)	75 h	(4)
Exercise course	WP 10.2 Advanced Research Topics in Quantum Field Theory and Gauge Theories (Exercise Course)	WiSe and SoSe	15 h (1 SWS)	45 h	(2)

For successful completion of the module, 6 ECTS credits have to be acquired. Class attendance averages about 4 contact hours. Including time for self-study, 180 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 1 to WP 14, one compulsory elective module must be chosen.
Entry requirements	None
Semester	Recommended semester: 1
Duration	The successful completion of the module takes 1 semester.
Content	The module provides an in-depth discussion of advanced research topics in quantum field theory and gauge theories. Special attention is paid to recent developments in research.
Learning outcomes	Students acquire in-depth knowledge and gain an understanding of the discussed topics.
Type of examination	Written exam or oral examination
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.

Responsible contact	Prof. Dr. Georgi Dvali
Language(s)	English
Additional information	None

Module: WP 11 Advanced Research Topics in Cosmology, General Relativity, and Differential Geometry

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 11.1 Advanced Research Topics in Cosmology, General Relativity, and Differential Geometry (Lecture)	WiSe and SoSe	45 h (3 SWS)	75 h	(4)
Exercise course	WP 11.2 Advanced Research Topics in Cosmology, General Relativity, and Differential Geometry (Exercise Course)	WiSe and SoSe	15 h (1 SWS)	45 h	(2)

For successful completion of the module, 6 ECTS credits have to be acquired. Class attendance averages about 4 contact hours. Including time for self-study, 180 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 1 to WP 14, one compulsory elective module must be chosen.
Entry requirements	None
Semester	Recommended semester: 1
Duration	The successful completion of the module takes 1 semester.
Content	The module provides an in-depth discussion of advanced research topics in cosmology, general relativity and differential geometry. Special attention is paid to recent developments in research.
Learning outcomes	Students acquire in-depth knowledge and gain an understanding of the discussed topics.
Type of examination	Written exam or oral examination
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential

	elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Viatcheslav Mukhanov
Language(s)	English
Additional information	None

Module: WP 12 Advanced Research Topics in String Theory and Geometry

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 12.1 Advanced Research Topics in String Theory and Geometry (Lecture)	WiSe and SoSe	45 h (3 SWS)	75 h	(4)
Exercise course	WP 12.2 Advanced Research Topics in String Theory and Geometry (Exercise Course)	WiSe and SoSe	15 h (1 SWS)	45 h	(2)

For successful completion of the module, 6 ECTS credits have to be acquired. Class attendance averages about 4 contact hours. Including time for self-study, 180 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 1 to WP 14, one compulsory elective module must be chosen.
Entry requirements	None
Semester	Recommended semester: 1
Duration	The successful completion of the module takes 1 semester.
Content	The module provides an in-depth discussion of advanced research topics in string theory and geometry. Special attention is paid to recent developments in research.
Learning outcomes	Students acquire in-depth knowledge and gain an understanding of the discussed topics.
Type of examination	Written exam or oral examination
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Dieter Lüst

Language(s)	English
Additional information	None

Module: WP 13 Advanced Research Topics in Statistical Physics and Stochastics

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 13.1 Advanced Research Topics in Statistical Physics and Stochastics (Lecture)	WiSe and SoSe	45 h (3 SWS)	75 h	(4)
Exercise course	WP 13.2 Advanced Research Topics in Statistical Physics and Stochastics (Exercise Course)	WiSe and SoSe	15 h (1 SWS)	45 h	(2)

For successful completion of the module, 6 ECTS credits have to be acquired. Class attendance averages about 4 contact hours. Including time for self-study, 180 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 1 to WP 14, one compulsory elective module must be chosen.
Entry requirements	None
Semester	Recommended semester: 1
Duration	The successful completion of the module takes 1 semester.
Content	The module provides an in-depth discussion of advanced research topics in statistical physics and stochastics. This includes topics from the fields of quantum systems, complex many-body systems, soft and living matter, and biological systems. Special attention is paid to recent developments in research.
Learning outcomes	Students acquire in-depth knowledge and gain an understanding of the discussed topics.
Type of examination	Written exam or oral examination
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential

	elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Erwin Frey
Language(s)	English
Additional information	None

Module: WP 14 Prospective Advanced Research Topics in Theoretical and Mathematical Physics

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 14.1 Prospective Advanced Research Topics in Theoretical and Mathematical Physics (Lecture)	WiSe and SoSe	45 h (3 SWS)	75 h	(4)
Exercise course	WP 14.2 Prospective Advanced Research Topics in Theoretical and Mathematical Physics (Exercise Course)	WiSe and SoSe	15 h (1 SWS)	45 h	(2)

For successful completion of the module, 6 ECTS credits have to be acquired. Class attendance averages about 4 contact hours. Including time for self-study, 180 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 1 to WP 14, one compulsory elective module must be chosen.
Entry requirements	None
Semester	Recommended semester: 1
Duration	The successful completion of the module takes 1 semester.
Content	The module provides an in-depth discussion of prospective advanced research topics in theoretical and mathematical physics. Special attention is paid to recent developments in research.
Learning outcomes	Students acquire in-depth knowledge and gain an understanding of the discussed topics.
Type of examination	Written exam or oral examination
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential

	elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Jan von Delft
Language(s)	English
Additional information	None

Module: WP 15 Presentation of Basic Concepts and Methods of Advanced Astrophysics

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Seminar	WP 15.1 Presentation of Basic Concepts and Methods of Advanced Astrophysics (Seminar)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

For successful completion of the module, 3 ECTS credits have to be acquired. Class attendance averages about 2 contact hours. Including time for self-study, 90 hours have to be invested.

Module type	Compulsory elective module with mandatory course
Usability of the module in other programmes	MSc Physics
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 15 to WP 28, compulsory elective modules amounting to 30 ECTS credits must be selected. Students who choose the compulsory elective module WP 16 may not choose the compulsory elective module WP 17. Students who choose the compulsory elective module WP 17 may not choose the compulsory elective module WP 16.
Entry requirements	None
Semester	Recommended semester: 2
Duration	The successful completion of the module takes 1 semester.
Content	The module provides an overview of basic concepts and methods of advanced astrophysics. The students will present seminar talks, selected from a variety of topics covered by the working groups of the University Observatory and collaborating institutes. In this respect, the seminar talks also offer an opportunity to become familiar with the various research activities of the University Observatory, and to facilitate the choice of a topic for the upcoming Master's thesis.
Learning outcomes	Participating students will learn how specific astrophysical concepts and methods can be used to investigate a wide range of current astrophysical questions. The presentations will be prepared by the students supported by experienced

	supervisors, and they will learn (besides the actual topic of the talk) how to give a scientific presentation, and how to use modern visual media.
Type of examination	Presentation
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Daniel Grün
Language(s)	English
Additional information	None

Module: WP 16 Instrumental Methods of Advanced Astrophysics in Practice

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lab course	WP 16.1 Instrumental Methods of Advanced Astrophysics in Practice (Lab Course)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)
Exercise course	WP 16.2 Instrumental Methods of Advanced Astrophysics in Practice (Exercise Course)	WiSe and SoSe	60 h (4 SWS)	120 h	(6)

For successful completion of the module, 9 ECTS credits have to be acquired. Class attendance averages about 6 contact hours. Including time for self-study, 270 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	None
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 15 to WP 28, compulsory elective modules amounting to 30 ECTS credits must be selected. Students who choose the compulsory elective module WP 16 may not choose the compulsory elective module WP 17. Students who choose the compulsory elective module WP 17 may not choose the compulsory elective module WP 16.
Entry requirements	None
Semester	Recommended semester: 2
Duration	The successful completion of the module takes 1 semester.
Content	Content of this module is a lab course and practical exercises on instrumental methods of advanced astrophysics. The corresponding experiments can be (i) either performed as a one-semester lab project within the observationally/instrumentally oriented working groups at the USM or collaborating groups in Garching, supervised by experienced scientists, or (ii) as a series of different lab-courses and exercises conducted at the USM. In case (i), the experiments will be designed by the individual working groups, whilst in case (ii) they will be selected from a pool of topics:

	Photometric and/or spectroscopic observations at the USM Mount Wendelstein Observatory, with follow-up data reduction and analysis, observations and analysis of the Galactic 21 cm line with our 2-m radio telescope, and lab-experiments covering interferometry, adaptive optics, and spectroscopy. The various topics might be updated and/or exchanged from time to time, following the astrophysical progress and change of focus.
Learning outcomes	The aim of this module is to practise various observational/instrumental techniques and methods, the handling of observational/instrumental data (reduction and analysis), and the critical evaluation and scientific documentation of corresponding results. This is a first introduction to working methods based on observational instruments and techniques.
Type of examination	Scientific protocol and presentation
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Dr. Arno Riffeser
Language(s)	English
Additional information	None

Module: WP 17 Numerical Methods of Advanced Astrophysics in Practice

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lab course	WP 17.1 Numerical Methods of Advanced Astrophysics in Practice (Lab Course)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)
Exercise course	WP 17.2 Numerical Methods of Advanced Astrophysics in Practice (Exercise Course)	WiSe and SoSe	60 h (4 SWS)	120 h	(6)

For successful completion of the module, 9 ECTS credits have to be acquired. Class attendance averages about 6 contact hours. Including time for self-study, 270 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	None
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 15 to WP 28, compulsory elective modules amounting to 30 ECTS credits must be selected. Students who choose the compulsory elective module WP 16 may not choose the compulsory elective module WP 17. Students who choose the compulsory elective module WP 17 may not choose the compulsory elective module WP 16.
Entry requirements	None
Semester	Recommended semester: 2
Duration	The successful completion of the module takes 1 semester.
Content	Content of this module is a lab course and practical exercises on numerical methods of advanced astrophysics. The corresponding experiments can be (i) either performed as a one-semester lab project within the theoretically/numerically oriented working groups at the USM or collaborating groups in Garching, supervised by experienced scientists, or (ii) as a series of different lab-courses and exercises conducted at the USM. In case (i), the numerical experiments (related to prototypical astrophysical problems) will be

	designed by the individual working groups, whilst in case (ii) they will be selected from a pool of topics: Integration methods, linear equation systems and matrix inversion, differential equations, N-body simulations, Monte Carlo simulations (random numbers and radiative transfer), MCMC (Monte Carlo Markov Chain) methods. These topics might be updated and/or exchanged from time to time, following the astrophysical progress and change of focus. All numerical methods will be used to solve prototypical astrophysical problems.
Learning outcomes	The aim of the course is to understand and to apply numerical algorithms, procedures, and methods. Students will practise the use of operating systems, the coding of computer programs, and the visualization and critical evaluation and documentation of numerical results. This is a first step to introduce students to scientific numerical working methods.
Type of examination	Scientific protocol and presentation
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Klaus Dolag
Language(s)	English
Additional information	None

Module: WP 18 Current Research Approaches in Advanced Astrophysics I

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 18.1 Current Research Approaches in Advanced Astrophysics 1 (Lecture)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)
Exercise course	WP 18.2 Current Research Approaches in Advanced Astrophysics 1 (Exercise Course)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)
Seminar	WP 18.3 Current Research Approaches in Advanced Astrophysics 1 (Seminar)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

For successful completion of the module, 9 ECTS credits have to be acquired. Class attendance averages about 6 contact hours. Including time for self-study, 270 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 15 to WP 28, compulsory elective modules amounting to 30 ECTS credits must be selected. Students who choose the compulsory elective module WP 16 may not choose the compulsory elective module WP 17. Students who choose the compulsory elective module WP 17 may not choose the compulsory elective module WP 16.
Entry requirements	None
Semester	Recommended semester: 2
Duration	The successful completion of the module takes 1 semester.
Content	The module comprises a lecture covering current research in one of the major astrophysical branches, and a corresponding seminar and exercise course. During the lecture, fundamental concepts and methods of the field will be discussed, whilst during the seminar, specific

	aspects of current research will be detailed by participating students. ***Lecture: Current Research Approaches in Advanced Astrophysics 1 (WP 18.1)*** In this lecture, the most important concepts and methods of one of the major branches of astrophysics are outlined, leading also to an understanding of the interplay of the corresponding astrophysical processes. ***Exercise course: Current Research Approaches in Advanced Astrophysics 1 (WP 18.2)*** The contents discussed in the lecture and seminar will be practised using typical applications. ***Seminar: Current Research Approaches in Advanced Astrophysics 1 (WP 18.3)*** In this seminar, specific aspects of current research in the field covered by the lecture will be presented by participating students, both with respect to concepts and methods, as well as with respect to examples for typical applications. The seminar is particularly intended to cover those details which are not discussed in the lecture.
Learning outcomes	The aim of this module is to provide students with a deep understanding of the fundamental knowledge, concepts and methods of current research in one of the major branches of astrophysics, as well as to become familiar with concrete applications to typical situations. In the seminar, participating students will present additional material and/or important details not covered in the lecture, and in the exercise course they will be enabled to solve corresponding problems (referring to the contents of both lecture and seminar), on the basis of understanding the complex interrelation between the involved astrophysical processes. This module, if chosen, will substantially facilitate an understanding of the scientific background of the upcoming Master's thesis, when conducted on a similar topic as covered here. ***Lecture: Current Research Approaches in Advanced Astrophysics 1 (WP 18.1)*** Students should gain an overview on the current research status of a specific, important branch of astrophysics, by providing them with the fundamental knowledge and insights into corresponding astrophysical processes and procedures as well as their concrete applications. In particular, students should learn to recognise interrelationships across topics. ***Exercise course: Current Research Approaches in Advanced Astrophysics 1 (WP 18.2)*** Students should learn to apply the contents discussed in the lecture and seminar to practical tasks. Simple problem

	solutions are to be developed, specified and implemented independently. ***Seminar: Current Research Approaches in Advanced Astrophysics 1 (WP 18.3)*** Participating students will present additional material and/or important details about the current research status of the specific field that are not covered in the lecture. They should learn how specific concepts and methods can be used to investigate corresponding current astrophysical questions. The presentations will be prepared by the students under the guidance of experienced supervisors, and they will learn (besides the actual topic of the talk) how to give a scientific presentation, and how to use modern visual media.
Type of examination	Presentation
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Kevin Heng
Language(s)	English
Additional information	None

Module: WP 19 Basic Research Concepts of Advanced Astrophysics I

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 19.1 Basic Research Concepts of Advanced Astrophysics 1 (Lecture)	WiSe and SoSe	60 h (4 SWS)	120 h	(6)
Exercise course	WP 19.2 Basic Research Concepts of Advanced Astrophysics 1 (Exercise Course)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

For successful completion of the module, 9 ECTS credits have to be acquired. Class attendance averages about 6 contact hours. Including time for self-study, 270 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 15 to WP 28, compulsory elective modules amounting to 30 ECTS credits must be selected. Students who choose the compulsory elective module WP 16 may not choose the compulsory elective module WP 17. Students who choose the compulsory elective module WP 17 may not choose the compulsory elective module WP 16.
Entry requirements	None
Semester	Recommended semester: 2
Duration	The successful completion of the module takes 1 semester.
Content	The module comprises a lecture concentrating on one of the major astrophysical branches, and a corresponding exercise course. During the lecture, fundamental concepts and methods of the field will be discussed in detail. ***Lecture: Basic Research Concepts of Advanced Astrophysics 1 (WP 19.1)*** In this 4-SWS lecture, the most important concepts and methods of one of the major branches of astrophyiscs are

	discussed in detail, leading to an understanding of the interplay of the corresponding astrophysical processes. ***Exercise course: Basic Research Concepts of Advanced Astrophysics 1 (WP 19.2)*** The contents discussed in the lecture will be practised using typical applications.
Learning outcomes	The aim of this elective module is to provide students with a detailed understanding of the concepts and research methods in one of the major branches of astrophysics, as well as to become familiar with concrete applications to typical situations. Both objectives will be reached on the basis of understanding the complex interrelation between the involved astrophysical processes. This module, if chosen, will substantially facilitate an understanding of the scientific background of the upcoming Master's thesis, when conducted on a similar topic as covered here. ***Lecture: Basic Research Concepts of Advanced Astrophysics 1 (WP 19.1)*** Students should gain a detailed overview on the current research status of a specific, important branch of astrophysics, by providing them with the fundamental knowledge and insights into field-related astrophysical processes and procedures as well as their concrete applications. In particular, students should learn how specific research concepts and methods can be used to investigate corresponding astrophysical questions, and to recognise interrelationships across topics. ***Exercise course: Basic Research Concepts of Advanced Astrophysics 1 (WP 19.2)*** Students should learn to apply the contents discussed in the lecture to practical tasks. Simple problem solutions are to be developed, specified and implemented independently.
Type of examination	Written exam or oral examination
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Thomas Preibisch
Language(s)	English
Additional information	None

Module: WP 20 Current Research Approaches in Advanced Astrophysics II

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 20.1 Current Research Approaches in Advanced Astrophysics 2 (Lecture)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)
Exercise course	WP 20.2 Current Research Approaches in Advanced Astrophysics 2 (Exercise Course)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)
Seminar	WP 20.3 Current Research Approaches in Advanced Astrophysics 2 (Seminar)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

For successful completion of the module, 9 ECTS credits have to be acquired. Class attendance averages about 6 contact hours. Including time for self-study, 270 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 15 to WP 28, compulsory elective modules amounting to 30 ECTS credits must be selected. Students who choose the compulsory elective module WP 16 may not choose the compulsory elective module WP 17. Students who choose the compulsory elective module WP 17 may not choose the compulsory elective module WP 16.
Entry requirements	None
Semester	Recommended semester: 2
Duration	The successful completion of the module takes 1 semester.
Content	The module comprises a lecture covering current research in one of the major astrophysical branches, and a corresponding seminar and exercise course. During the lecture, fundamental concepts and methods of the field will be discussed, whilst during the seminar, specific

	aspects of current research will be detailed by participating students. ***Lecture: Current Research Approaches in Advanced Astrophysics 2 (WP 20.1)*** In this lecture, the most important concepts and methods of one of the major branches of astrophysics are outlined, leading also to an understanding of the interplay of the corresponding astrophysical processes. ***Exercise course: Current Research Approaches in Advanced Astrophysics 2 (WP 20.2)*** The contents discussed in the lecture and seminar will be practised using typical applications. ***Seminar: Current Research Approaches in Advanced Astrophysics 2 (WP 20.3)*** In this seminar, specific aspects of current research in the field covered by the lecture will be presented by participating students, both with respect to concepts and methods, as well as with respect to examples for typical applications. The seminar is particularly intended to cover those details which are not discussed in the lecture.
Learning outcomes	The aim of this elective module is to provide students with a deep understanding of the fundamental knowledge, concepts and methods of current research in one of the major branches of astrophysics, as well as to become familiar with concrete applications to typical situations. In the seminar, participating students will present additional material and/or important details not covered in the lecture, and in the exercise course they will be enabled to solve corresponding problems (referring to the contents of both lecture and seminar), on the basis of understanding the complex interrelation between the involved astrophysical processes. This module, if chosen, will substantially facilitate an understanding of the scientific background of the upcoming Master's thesis, when conducted on a similar topic as covered here. ***Lecture: Current Research Approaches in Advanced Astrophysics 2 (WP 20.1)*** Students should gain an overview on the current research status of a specific, important branch of astrophysics, by providing them with the fundamental knowledge and insights into corresponding astrophysical processes and procedures as well as their concrete applications. In particular, students should learn to recognise interrelationships across topics. ***Exercise course: Current Research Approaches in Advanced Astrophysics 2 (WP 20.2)*** Students should learn to apply the contents discussed in the lecture and seminar to practical tasks. Simple

	problem solutions are to be developed, specified and implemented independently. ***Seminar: Current Research Approaches in Advanced Astrophysics 2 (WP 20.3)*** Participating students will present additional material and/or important details about the current research status of the specific field that are not covered in the lecture. They should learn how specific concepts and methods can be used to investigate corresponding current astrophysical questions. The presentations will be prepared by the students under the guidance of experienced supervisors, and they will learn (besides the actual topic of the talk) how to give a scientific presentation, and how to use modern visual media.
Type of examination	Presentation
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Kevin Heng
Language(s)	English
Additional information	None

Module: WP 21 Basic Research Concepts of Advanced Astrophysics II

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 21.1 Basic Research Concepts of Advanced Astrophysics 2 (Lecture)	WiSe and SoSe	60 h (4 SWS)	120 h	(6)
Exercise course	WP 21.2 Basic Research Concepts of Advanced Astrophysics 2 (Exercise Course)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

For successful completion of the module, 9 ECTS credits have to be acquired. Class attendance averages about 6 contact hours. Including time for self-study, 270 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 15 to WP 28, compulsory elective modules amounting to 30 ECTS credits must be selected. Students who choose the compulsory elective module WP 16 may not choose the compulsory elective module WP 17. Students who choose the compulsory elective module WP 17 may not choose the compulsory elective module WP 16.
Entry requirements	None
Semester	Recommended semester: 2
Duration	The successful completion of the module takes 1 semester.
Content	The module comprises a lecture concentrating on one of the major astrophysical branches, and a corresponding exercise course. During the lecture, fundamental concepts and methods of the field will be discussed in detail. ***Lecture: Basic Research Concepts of Advanced Astrophysics 2 (WP 21.1)*** In this 4-SWS lecture, the most important concepts and methods of one of the major branches of astrophyiscs are

	discussed in detail, leading to an understanding of the interplay of the corresponding astrophysical processes. ***Exercise course: Basic Research Concepts of Advanced Astrophysics 2 (WP 21.2)*** The contents discussed in the lecture will be practised using typical applications.
Learning outcomes	The aim of this elective module is to provide students with a detailed understanding of the concepts and research methods in one of the major branches of astrophysics, as well as to become familiar with concrete applications to typical situations. Both objectives will be reached on the basis of understanding the complex interrelation between the involved astrophysical processes. This module, if chosen, will substantially facilitate an understanding of the scientific background of the upcoming Master's thesis, when conducted on a similar topic as covered here. ***Lecture: Basic Research Concepts of Advanced Astrophysics 2 (WP 21.1)*** Students should gain a detailed overview on the current research status of a specific, important branch of astrophysics, by providing them with the fundamental knowledge and insights into field-related astrophysical processes and procedures as well as their concrete applications. In particular, students should learn how specific research concepts and methods can be used to investigate corresponding astrophysical questions, and to recognise interrelationships across topics. ***Exercise course: Basic Research Concepts of Advanced Astrophysics 2 (WP 21.2)*** Students should learn to apply the contents discussed in the lecture to practical tasks. Simple problem solutions are to be developed, specified and implemented independently.
Type of examination	Written exam or oral examination
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Thomas Preibisch
Language(s)	English
Additional information	None

Module: WP 22 Stars, Planets, Star Formation I

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 22.1 Stars, Planets, Star Formation 1 (Lecture)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)
Exercise course	WP 22.2 Stars, Planets, Star Formation 1 (Exercise Course)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

For successful completion of the module, 6 ECTS credits have to be acquired. Class attendance averages about 4 contact hours. Including time for self-study, 180 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 15 to WP 28, compulsory elective modules amounting to 30 ECTS credits must be selected. Students who choose the compulsory elective module WP 16 may not choose the compulsory elective module WP 17. Students who choose the compulsory elective module WP 17 may not choose the compulsory elective module WP 16.
Entry requirements	None
Semester	Recommended semester: 2
Duration	The successful completion of the module takes 1 semester.
Content	The module (lecture plus exercise course) provides the students with an overview of concepts and methods used within the research of stellar and/or planetary structure and evolution and/or of star formation. The contents discussed in the lecture are practised by means of typical applications.
Learning outcomes	The lecture shall provide the students with basic knowledge and insights into the properties of stars and/or planets, and/or into the various processes controlling and affecting the formation of stars. From this knowledge, and the concrete interpretation of corresponding theoretical predictions, students should develop the ability to transfer the

	content presented in the lecture to current astrophysical problems and questions. During the exercise course, simple problem solutions shall be independently developed, specified and implemented, both using analytic and, if required, computational approaches. In this way, students should learn to apply the content discussed in the lecture to practical tasks.
Type of examination	Written exam or oral examination
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Thomas Preibisch
Language(s)	English
Additional information	None

Module: WP 23 Circumstellar Disks and Planet Formation I

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 23.1 Circumstellar Disks and Planet Formation 1 (Lecture)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)
Exercise course	WP 23.2 Circumstellar Disks and Planet Formation 1 (Exercise Course)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

For successful completion of the module, 6 ECTS credits have to be acquired. Class attendance averages about 4 contact hours. Including time for self-study, 180 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 15 to WP 28, compulsory elective modules amounting to 30 ECTS credits must be selected. Students who choose the compulsory elective module WP 16 may not choose the compulsory elective module WP 17. Students who choose the compulsory elective module WP 17 may not choose the compulsory elective module WP 16.
Entry requirements	None
Semester	Recommended semester: 2
Duration	The successful completion of the module takes 1 semester.
Content	The module (lecture plus exercise course) provides the students with an overview of concepts and methods used within the research of circumstellar disks and the formation of planets. The contents discussed in the lecture are practised by means of typical applications.
Learning outcomes	The lecture shall provide the students with basic knowledge and insights into the properties and evolution of circumstellar disks, and the formation of planets. From this knowledge, and the concrete interpretation of corresponding theoretical predictions, students should develop the ability to transfer the content presented in the lecture to

	current astrophysical problems and questions. During the exercise course, simple problem solutions shall be independently developed, specified and implemented, both using analytic and, if required, computational approaches. In this way, students should learn to apply the content discussed in the lecture to practical tasks.
Type of examination	Written exam or oral examination
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Til Birnstiel
Language(s)	English
Additional information	None

Module: WP 24 Radiative Processes in the Atmospheres of Planets, Stars, and the Interstellar Medium I

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 24.1 Radiative Processes in the Atmospheres of Planets, Stars, and the Interstellar Medium 1 (Lecture)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)
Exercise course	WP 24.2 Radiative Processes in the Atmospheres of Planets, Stars, and the Interstellar Medium 1 (Exercise Course)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

For successful completion of the module, 6 ECTS credits have to be acquired. Class attendance averages about 4 contact hours. Including time for self-study, 180 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 15 to WP 28, compulsory elective modules amounting to 30 ECTS credits must be selected. Students who choose the compulsory elective module WP 16 may not choose the compulsory elective module WP 17. Students who choose the compulsory elective module WP 17 may not choose the compulsory elective module WP 16.
Entry requirements	None
Semester	Recommended semester: 2
Duration	The successful completion of the module takes 1 semester.
Content	The module (lecture plus exercise course) provides the students with an overview of concepts and methods used within the research of radiative processes in astrophysics, particularly in the atmospheres of planets, stars, and in the Interstellar Medium. The contents discussed in the lecture are practised by means of typical applications.
Learning outcomes	The lecture shall provide the students with basic knowledge and insights into the the approaches and methods of

	radiative transfer in astrophysics. Important radiative processes and their effects within the atmospheres of planets, stars, and in the Interstellar Medium should be understood. From this knowledge, and the concrete interpretation of corresponding theoretical predictions, students should develop the ability to transfer the content presented in the lecture to current astrophysical problems and questions. During the exercise course, simple problem solutions shall be independently developed, specified and implemented, both using analytic and, if required, computational approaches. In this way, students should learn to apply the content discussed in the lecture to practical tasks.
Type of examination	Written exam or oral examination
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Kevin Heng
Language(s)	English
Additional information	None

Module: WP 25 Structure and Evolution of Galaxies I

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 25.1 Structure and Evolution of Galaxies 1 (Lecture)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)
Exercise course	WP 25.2 Structure and Evolution of Galaxies 1 (Exercise Course)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

For successful completion of the module, 6 ECTS credits have to be acquired. Class attendance averages about 4 contact hours. Including time for self-study, 180 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 15 to WP 28, compulsory elective modules amounting to 30 ECTS credits must be selected. Students who choose the compulsory elective module WP 16 may not choose the compulsory elective module WP 17. Students who choose the compulsory elective module WP 17 may not choose the compulsory elective module WP 16.
Entry requirements	None
Semester	Recommended semester: 2
Duration	The successful completion of the module takes 1 semester.
Content	The module (lecture plus exercise course) provides the students with an overview of concepts and methods used within the research on the structure and evolution of galaxies. The contents discussed in the lecture are practised by means of typical applications.
Learning outcomes	The lecture shall provide the students with basic knowledge and insights into the structure and evolution of galaxies. From this knowledge, and the concrete interpretation of corresponding theoretical predictions, students should develop the ability to transfer the content presented in the lecture to current astrophysical problems and questions.

	During the exercise course, simple problem solutions shall be independently developed, specified and implemented, both using analytic and, if required, computational approaches. In this way, students should learn to apply the content discussed in the lecture to practical tasks.
Type of examination	Written exam or oral examination
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Klaus Dolag
Language(s)	English
Additional information	None

Module: WP 26 Cosmology and Large Scale Structures I

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 26.1 Cosmology and Large Scale Structures 1 (Lecture)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)
Exercise course	WP 26.2 Cosmology and Large Scale Structures 1 (Exercise Course)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

For successful completion of the module, 6 ECTS credits have to be acquired. Class attendance averages about 4 contact hours. Including time for self-study, 180 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 15 to WP 28, compulsory elective modules amounting to 30 ECTS credits must be selected. Students who choose the compulsory elective module WP 16 may not choose the compulsory elective module WP 17. Students who choose the compulsory elective module WP 17 may not choose the compulsory elective module WP 16.
Entry requirements	None
Semester	Recommended semester: 2
Duration	The successful completion of the module takes 1 semester.
Content	The module (lecture plus exercise course) provides the students with an overview of concepts and methods used within the research on Cosmology, as well as studies of the design and properties of large-scale structures. The contents discussed in the lecture are practised by means of typical applications.
Learning outcomes	The lecture shall provide the students with basic knowledge and insights into Cosmology and Large Scale Structures. From this knowledge, and the concrete interpretation of corresponding theoretical predictions, students should develop the ability to transfer the content presented in the

	lecture to current astrophysical problems and questions. During the exercise course, simple problem solutions shall be independently developed, specified and implemented, both using analytic and, if required, computational approaches. In this way, students should learn to apply the content discussed in the lecture to practical tasks.
Type of examination	Written exam or oral examination
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Jochen Weller
Language(s)	English
Additional information	None

Module: WP 27 Specific Research Approaches in the Application of Experimental and Observational Methods I

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 27.1 Specific Research Approaches in the Application of Experimental and Observational Methods 1 (Lecture)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)
Exercise course	WP 27.2 Specific Research Approaches in the Application of Experimental and Observational Methods 1 (Exercise Course)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

For successful completion of the module, 6 ECTS credits have to be acquired. Class attendance averages about 4 contact hours. Including time for self-study, 180 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 15 to WP 28, compulsory elective modules amounting to 30 ECTS credits must be selected. Students who choose the compulsory elective module WP 16 may not choose the compulsory elective module WP 17. Students who choose the compulsory elective module WP 17 may not choose the compulsory elective module WP 16.
Entry requirements	None
Semester	Recommended semester: 2
Duration	The successful completion of the module takes 1 semester.
Content	The module (lecture plus exercise course) provides the students with an overview of concepts and applications of selected experimental and observational methods in astrophysics. The contents discussed in the lecture are practised by means of typical examples.
Learning outcomes	By providing basic knowledge and insights into experimental and observational methods in astrophysics as well as their concrete applications, students should develop the

	ability to transfer the content presented in the lecture to current problems and questions. During the exercise course, simple problem solutions shall be independently developed, specified and implemented, both using analytic and, if required, computational approaches. In this way, students should learn to apply the content discussed in the lecture to practical tasks.
Type of examination	Written exam or oral examination
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Joseph Mohr
Language(s)	English
Additional information	none

Module: WP 28 Specific Research Approaches in the Application of Theoretical and Numerical Methods I

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 28.1 Specific Research Approaches in the Application of Theoretical and Numerical Methods 1 (Lecture)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)
Exercise course	WP 28.2 Specific Research Approaches in the Application of Theoretical and Numerical Methods 1 (Exercise Course)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

For successful completion of the module, 6 ECTS credits have to be acquired. Class attendance averages about 4 contact hours. Including time for self-study, 180 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 15 to WP 28, compulsory elective modules amounting to 30 ECTS credits must be selected. Students who choose the compulsory elective module WP 16 may not choose the compulsory elective module WP 17. Students who choose the compulsory elective module WP 17 may not choose the compulsory elective module WP 16.
Entry requirements	None
Semester	Recommended semester: 2
Duration	The successful completion of the module takes 1 semester.
Content	The module (lecture plus exercise course) provides the students with an overview of concepts and applications of selected theoretical and numerical methods in astrophysics. The contents discussed in the lecture are practised by means of typical examples. This module is recommended to be selected if its contents comply with the focus of the students' forthcoming Master's Thesis.

Learning outcomes	By providing basic knowledge and insights into theoretical and numerical methods in astrophysics as well as their concrete applications, students should develop the ability to transfer the content presented in the lecture to current problems and questions. During the exercise course, simple problem solutions shall be independently developed, specified and implemented, both using analytic and, if required, computational approaches. In this way, students should learn to apply the content discussed in the lecture to practical tasks.
Type of examination	Written exam or oral examination
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Klaus Dolag
Language(s)	English
Additional information	none

Module: WP 29 Stars, Planets, Star Formation II

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 29.1 Stars, Planets, Star Formation 2 (Lecture)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)
Exercise course	WP 29.2 Stars, Planets, Star Formation 2 (Exercise Course)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

For successful completion of the module, 6 ECTS credits have to be acquired. Class attendance averages about 4 contact hours. Including time for self-study, 180 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 29 to WP 35, one compulsory elective module must be chosen.
Entry requirements	None
Semester	Recommended semester: 3
Duration	The successful completion of the module takes 1 semester.
Content	The module (lecture plus exercise course) provides the students with an overview of concepts and methods used within the research of stellar and/or planetary structure and evolution and/or of star formation. The contents discussed in the lecture are practised by means of typical applications. This module is recommended to be selected if its contents comply with the focus of the students' forthcoming Master's Thesis.
Learning outcomes	The lecture shall provide the students with basic knowledge and insights into the properties of stars and/or planets, and/or into the various processes controlling and affecting the formation of stars. From this knowledge, and the concrete interpretation of corresponding theoretical predictions, students should develop the ability to transfer the content presented in the lecture to current astrophysical problems and questions. During the exercise course, simple problem solutions shall be independently

	developed, specified and implemented, both using analytic and, if required, computational approaches. In this way, students should learn to apply the content discussed in the lecture to practical tasks.
Type of examination	Written exam or oral examination
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Thomas Preibisch
Language(s)	English
Additional information	none

Module: WP 30 Circumstellar Disks and Planet Formation II

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 30.1 Circumstellar Disks and Planet Formation 2 (Lecture)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)
Exercise course	WP 30.2 Circumstellar Disks and Planet Formation 2 (Exercise Course)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

For successful completion of the module, 6 ECTS credits have to be acquired. Class attendance averages about 4 contact hours. Including time for self-study, 180 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 29 to WP 35, one compulsory elective module must be chosen.
Entry requirements	None
Semester	Recommended semester: 3
Duration	The successful completion of the module takes 1 semester.
Content	The module (lecture plus exercise course) provides the students with an overview of concepts and methods used within the research of circumstellar disks and the formation of planets. The contents discussed in the lecture are practised by means of typical applications. This module is recommended to be selected if its contents comply with the focus of the students' forthcoming Master's Thesis.
Learning outcomes	The lecture shall provide the students with basic knowledge and insights into the properties and evolution of circumstellar disks, and the formation of planets. From this knowledge, and the concrete interpretation of corresponding theoretical predictions, students should develop the ability to transfer the content presented in the lecture to current astrophysical problems and questions. During the exercise course, simple problem solutions shall be independently developed, specified and implemented, both

	using analytic and, if required, computational approaches. In this way, students should learn to apply the content discussed in the lecture to practical tasks.
Type of examination	Written exam or oral examination
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Til Birnstiel
Language(s)	English
Additional information	none

Module: WP 31 Radiative Processes in the Atmospheres of Planets, Stars, and the Interstellar Medium II

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 31.1 Radiative Processes in the Atmospheres of Planets, Stars, and the Interstellar Medium 2 (Lecture)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)
Exercise course	WP 31.2 Radiative Processes in the Atmospheres of Planets, Stars, and the Interstellar Medium 2 (Exercise Course)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

For successful completion of the module, 6 ECTS credits have to be acquired. Class attendance averages about 4 contact hours. Including time for self-study, 180 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 29 to WP 35, one compulsory elective module must be chosen.
Entry requirements	None
Semester	Recommended semester: 3
Duration	The successful completion of the module takes 1 semester.
Content	The module (lecture plus exercise course) provides the students with an overview of concepts and methods used within the research of radiative processes in astrophysics, particularly in the atmospheres of planets, stars, and in the Interstellar Medium. The contents discussed in the lecture are practised by means of typical applications. This module is recommended to be selected if its contents comply with the focus of the students' forthcoming Master's Thesis.
Learning outcomes	The lecture shall provide the students with basic knowledge and insights into the the approaches and methods of radiative transfer in astrophysics. Important radiative processes and their effects within the atmospheres of planets, stars, and in the Interstellar Medium

	should be understood. From this knowledge, and the concrete interpretation of corresponding theoretical predictions, students should develop the ability to transfer the content presented in the lecture to current astrophysical problems and questions. During the exercise course, simple problem solutions shall be independently developed, specified and implemented, both using analytic and, if required, computational approaches. In this way, students should learn to apply the content discussed in the lecture to practical tasks.
Type of examination	Written exam or oral examination
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Kevin Heng
Language(s)	English
Additional information	none

Module: WP 32 Structure and Evolution of Galaxies II

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 32.1 Structure and Evolution of Galaxies 2 (Lecture)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)
Exercise course	WP 32.2 Structure and Evolution of Galaxies 2 (Exercise Course)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

For successful completion of the module, 6 ECTS credits have to be acquired. Class attendance averages about 4 contact hours. Including time for self-study, 180 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 29 to WP 35, one compulsory elective module must be chosen.
Entry requirements	None
Semester	Recommended semester: 3
Duration	The successful completion of the module takes 1 semester.
Content	The module (lecture plus exercise course) provides the students with an overview of concepts and methods used within the research on the structure and evolution of galaxies. The contents discussed in the lecture are practised by means of typical applications. This module is recommended to be selected if its contents comply with the focus of the students' forthcoming Master's Thesis.
Learning outcomes	The lecture shall provide the students with basic knowledge and insights into the structure and evolution of galaxies. From this knowledge, and the concrete interpretation of corresponding theoretical predictions, students should develop the ability to transfer the content presented in the lecture to current astrophysical problems and questions. During the exercise course, simple problem solutions shall be independently developed, specified and implemented, both using analytic and, if required, computational approaches.

	In this way, students should learn to apply the content discussed in the lecture to practical tasks.
Type of examination	Written exam or oral examination
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Klaus Dolag
Language(s)	English
Additional information	none

Module: WP 33 Cosmology and Large Scale Structures II

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 33.1 Cosmology and Large Scale Structures 2 (Lecture)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)
Exercise course	WP 33.2 Cosmology and Large Scale Structures 2 (Exercise Course)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

For successful completion of the module, 6 ECTS credits have to be acquired. Class attendance averages about 4 contact hours. Including time for self-study, 180 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 29 to WP 35, one compulsory elective module must be chosen.
Entry requirements	None
Semester	Recommended semester: 3
Duration	The successful completion of the module takes 1 semester.
Content	The module (lecture plus exercise course) provides the students with an overview of concepts and methods used within the research on Cosmology, as well as studies of the design and properties of large-scale structures. The contents discussed in the lecture are practised by means of typical applications. This module is recommended to be selected if its contents comply with the focus of the students' forthcoming Master's Thesis.
Learning outcomes	The lecture shall provide the students with basic knowledge and insights into Cosmology and Large Scale Structures. From this knowledge, and the concrete interpretation of corresponding theoretical predictions, students should develop the ability to transfer the content presented in the lecture to current astrophysical problems and questions. During the exercise course, simple problem solutions shall be independently developed, specified and implemented, both using analytic and, if required, computational approaches.

	In this way, students should learn to apply the content discussed in the lecture to practical tasks.
Type of examination	Written exam or oral examination
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Jochen Weller
Language(s)	English
Additional information	none

Module: WP 34 Specific Research Approaches in the Application of Experimental and Observational Methods II

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 34.1 Specific Research Approaches in the Application of Experimental and Observational Methods 2 (Lecture)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)
Exercise course	WP 34.2 Specific Research Approaches in the Application of Experimental and Observational Methods 2 (Exercise Course)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

For successful completion of the module, 6 ECTS credits have to be acquired. Class attendance averages about 4 contact hours. Including time for self-study, 180 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 29 to WP 35, one compulsory elective module must be chosen.
Entry requirements	None
Semester	Recommended semester: 3
Duration	The successful completion of the module takes 1 semester.
Content	The module (lecture plus exercise course) provides the students with an overview of concepts and applications of selected experimental and observational methods in astrophysics. The contents discussed in the lecture are practised by means of typical examples. This module is recommended to be selected if its contents comply with the focus of the students' forthcoming Master's Thesis.
Learning outcomes	By providing basic knowledge and insights into experimental and observational methods in astrophysics as well as their concrete applications, students should develop the ability to transfer the content presented in the lecture to current problems and questions. During the exercise course, simple problem solutions shall be independently developed, specified and implemented, both using analytic and, if required, computational approaches. In this way,

	students should learn to apply the content discussed in the lecture to practical tasks.
Type of examination	Written exam or oral examination
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Joseph Mohr
Language(s)	English
Additional information	none

Module: WP 35 Specific Research Approaches in the Application of Theoretical and Numerical Methods II

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Lecture	WP 35.1 Specific Research Approaches in the Application of Theoretical and Numerical Methods 2 (Lecture)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)
Exercise course	WP 35.2 Specific Research Approaches in the Application of Theoretical and Numerical Methods 2 (Exercise Course)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

For successful completion of the module, 6 ECTS credits have to be acquired. Class attendance averages about 4 contact hours. Including time for self-study, 180 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	MSc Physics
Elective guidelines	The module can be selected in compliance with the following rules: With regard to the compulsory elective modules WP 29 to WP 35, one compulsory elective module must be chosen.
Entry requirements	None
Semester	Recommended semester: 3
Duration	The successful completion of the module takes 1 semester.
Content	The module (lecture plus exercise course) provides the students with an overview of concepts and applications of selected theoretical and numerical methods in astrophysics. The contents discussed in the lecture are practised by means of typical examples. This module is recommended to be selected if its contents comply with the focus of the students' forthcoming Master's Thesis.
Learning outcomes	By providing basic knowledge and insights into theoretical and numerical methods in astrophysics as well as their concrete applications, students should develop the ability to transfer the content presented in the lecture to current problems and questions. During the exercise course, simple problem solutions shall be independently developed, specified and implemented, both using analytic and, if required, computational approaches. In this way, students should

	learn to apply the content discussed in the lecture to practical tasks.
Type of examination	Written exam or oral examination
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Klaus Dolag
Language(s)	English
Additional information	None

Module: WP 36 Research Project: Introduction to Scientific Working Methods in the Area of Experimental Working and Instrument Development in Astronomy

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Seminar	WP 36.1 Scientific Working Methods in the Area of Experimental Working and Instrument Development in Astronomy (Project Seminar)	WiSe and SoSe	60 h (4 SWS)	120 h	(6)
Colloquium	WP 36.2 Scientific Working Methods in the Area of Experimental Working and Instrument Development in Astronomy (Colloquium)	WiSe and SoSe	60 h (4 SWS)	120 h	(6)

For successful completion of the module, 12 ECTS credits have to be acquired. Class attendance averages about 8 contact hours. Including time for self-study, 360 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	None
Elective guidelines	The module can be selected in compliance with the following rules: There must be taken exactly one of the compulsory elective areas "Experimental Working and Instrument Development in Astronomy" and "Development and Application of Theoretical and Numerical Methods in Astrophysics". By doing so, the following compulsory elective modules must be selected from the compulsory elective modules WP 36 to WP 41: 1. For the compulsory elective area "Experimental Working and Instrument Development in Astronomy", the compulsory elective modules WP 36, WP 38 and WP 40 must be chosen. 2. For the compulsory elective area "Development and Application of Theoretical and Numerical Methods in Astrophysics", the compulsory elective modules WP 37, WP 39 and WP 41 must be chosen.

Entry requirements	None
Semester	Recommended semester: 3
Duration	The successful completion of the module takes 1 semester.
Content	The core content of the module is the preparation of a scientific research project, with focus on the required scientific *working methods*, and regarding the area of "Experimental Working and Instrument Development in Astronomy". A project seminar and a colloquium serve as an introduction to the Master's thesis in terms of subject specialisation. Together with the module on scientific project planning and the final (thesis) module, the current module forms an inseparable unit and must therefore be taken in the same working group in which the Master's thesis is to be conducted. The module contains concepts and methods from one of the main areas of research in astronomy, and comprises a preparatory project split into different tasks. By working on such preparatory tasks/sub-projects, students should familiarise with the area-specific experimental and observational methods and instrumental techniques. The lecturer/supervisor will organise the sub-projects under individual guidance and give advice on how to work on them. Students should outline the knowledge they have acquired by regularly reporting on their progress (in oral or written form). In a **project seminar**, students will give a presentation related to the astrophysical/astronomical area of their future Master's thesis, demonstrating which scientific methods and techniques (experimental, observational, and instrumental) are relevant in this context, discussing the astronomical background, and outlining current problems. The corresponding **colloquium** is aimed at reflecting on and discussing fundamental issues in the chosen subject, particularly regarding its current state of research and related observations and instruments. Morevoer, the colloquium should clarify the student's progress in understanding all relevant topics and issues, and to guide the students in improving potential shortcomings. The above two courses shall be tightly connected with a literature study, which is intensified by working on case studies. The aim is, among others, to create an oral and/or poster-presentation, as well as an essay that might be valuable for the introduction of the written version of the Master's thesis.

Learning outcomes	The aim of this module is to familiarise students with the current state of research in those astrophysical/astronomical fields central to their future Master's thesis. The focus is here on the scientific *working methods* in the area of "Experimental Working and Instrument Development in Astronomy". Particularly, the students should acquire the necessary knowledge and theoretical and practical skills to such an extent that they can successfully apply them in their Master's thesis work. To this end, they are individually supported by supervisors. The aim of the **project seminar** is to impart specific knowledge from the above-mentioned special field. Students should be able to transfer the content covered in the course – and leading up to the Master's thesis -- to current scientific problems. The aim of the **colloquium** is to serve as a working forum for analysing the current state of research, as well as to reveal the students' progress in understanding all relevant topics and issues.
Type of examination	Presentation
Type of assessment	The successful completion of the module will not be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Thomas Preibisch
Language(s)	English
Additional information	None

Module: WP 37 Research Project: Introduction to Scientific Working Methods in the Area of Development and Application of Theoretical and Numerical Methods in Astrophysics

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Seminar	WP 37.1 Scientific Working Methods in the Area of Development and Application of Theoretical and Numerical Methods in Astrophysics (Project Seminar)	WiSe and SoSe	60 h (4 SWS)	120 h	(6)
Colloquium	WP 37.2 Scientific Working Methods in the Area of Development and Application of Theoretical and Numerical Methods in Astrophysics (Colloquium)	WiSe and SoSe	60 h (4 SWS)	120 h	(6)

For successful completion of the module, 12 ECTS credits have to be acquired. Class attendance averages about 8 contact hours. Including time for self-study, 360 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	None
Elective guidelines	The module can be selected in compliance with the following rules: There must be taken exactly one of the compulsory elective areas "Experimental Working and Instrument Development in Astronomy" and "Development and Application of Theoretical and Numerical Methods in Astrophysics". By doing so, the following compulsory elective modules must be selected from the compulsory elective modules WP 36 to WP 41: 1. For the compulsory elective area "Experimental Working and Instrument Development in Astronomy", the compulsory elective modules WP 36, WP 38 and WP 40 must be chosen. 2. For the compulsory elective area "Development and Application of Theoretical and Numerical Methods in Astrophysics", the compulsory elective modules WP 37, WP 39 and WP 41 must be chosen.

Entry requirements	None
Semester	Recommended semester: 3
Duration	The successful completion of the module takes 1 semester.
Content	The core content of the module is the preparation of a scientific research project, with focus on the required scientific *working methods*, and regarding the area of the "Development and Application of Theoretical and Numerical Methods in Astrophysics". A project seminar and a colloquium serve as an introduction to the Master's thesis in terms of subject specialisation. Together with the module on scientific project planning and the final (thesis) module, the current module forms an inseparable unit and must therefore be taken in the same working group in which the Master's thesis is to be conducted. The module contains concepts and methods from one of the main areas of research in astrophysics, and comprises a preparatory project split into different tasks. By working on such preparatory tasks/sub-projects, students should familiarise with the area-specific theoretical and numerical methods. The lecturer/supervisor will organise the sub-projects under individual guidance and give advice on how to work on them. Students should outline the knowledge they have acquired by regularly reporting on their progress (in oral or written form). In a **project seminar**, students will give a presentation related to the astrophysical area of their future Master's thesis, demonstrating which scientific methods (theoretical and numerical) are relevant in this context, discussing the physical and numerical background, and outlinining current problems. The corresponding **colloquium** is aimed at reflecting on and discussing fundamental issues in the chosen subject, particularly regarding its current state of research. Morevoer, the colloquium should clarify the student's progress in understanding all relevant topics and issues, and to guide the students in improving potential shortcomings. The above two courses shall be tightly connected with a literature study, which is intensified by working on case studies. The aim is, among others, to create an oral and/or poster-presentation, as well as an essay that might be valuable for the introduction of the written version of the Master's thesis.
Learning outcomes	The aim of this module is to familiarise students with the current state of research in those astrophysical fields central to their future Master's thesis. The focus is here on the scientific *working methods* in the area of "Development and Application of Theoretical and Numerical Methods".

	Particularly, the students should acquire the necessary knowledge and skills to such an extent that they can successfully apply them in their Master's thesis work. To this end, they are individually supported by supervisors. The aim of the **project seminar** is to impart specific knowledge from the above-mentioned special field. Students should be able to transfer the content covered in the course – and leading up to the Master's thesis -- to current scientific problems. The aim of the **colloquium** is to serve as a working forum for analysing the current state of research, as well as to reveal the students' progress in understanding all relevant topics and issues.
Type of examination	Presentation
Type of assessment	The successful completion of the module will not be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Thomas Preibisch
Language(s)	English
Additional information	None

Module: WP 38 Research Project: Scientific Project Planning in the Area of Experimental Working and Instrument Development in Astronomy

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Seminar	WP 38.1 Scientific Project Planning in the Area of Experimental Working and Instrument Development in Astronomy (Project Seminar)	WiSe and SoSe	60 h (4 SWS)	120 h	(6)
Tutorial	WP 38.2 Scientific Project Planning in the Area of Experimental Working and Instrument Development in Astronomy (Tutorial)	WiSe and SoSe	60 h (4 SWS)	120 h	(6)

For successful completion of the module, 12 ECTS credits have to be acquired. Class attendance averages about 8 contact hours. Including time for self-study, 360 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	None
Elective guidelines	The module can be selected in compliance with the following rules: There must be taken exactly one of the compulsory elective areas "Experimental Working and Instrument Development in Astronomy" and "Development and Application of Theoretical and Numerical Methods in Astrophysics". By doing so, the following compulsory elective modules must be selected from the compulsory elective modules WP 36 to WP 41: 1. For the compulsory elective area "Experimental Working and Instrument Development in Astronomy", the compulsory elective modules WP 36, WP 38 and WP 40 must be chosen. 2. For the compulsory elective area "Development and Application of Theoretical and Numerical Methods in Astrophysics", the compulsory elective modules WP 37, WP 39 and WP 41 must be chosen.
Entry requirements	None

Semester	Recommended semester: 3
Duration	The successful completion of the module takes 1 semester.
Content	The core content of the module is the preparation of a scientific research project, with focus on the required scientific *project planning*, and regarding the area of "Experimental Working and Instrument Development in Astronomy". A project seminar and a tutorial serve as an introduction and guidance towards this focus, respectively, and shall be related to potential topics of the future Master's thesis. Together with the module on scientific working methods and the final (thesis) module, the current module forms an inseparable unit and must therefore be taken in the same working group in which the Master's thesis is to be conducted. The module contains general and astrophysical/astronomical area-specific concepts, and comprises a preparatory project related to the area of the future Master's thesis. By working on such a preparatory project, students should familiarise with scientific project planning, such that they can successfully apply the acquired knowledge and concepts to other projects (e.g., but not exclusively, related to their future Master's thesis). The lecturer will organise the preparatory project under individual guidance and, if necessary, will help with advice. Students should regularly outline their progress in form of oral or written reports. In a **project seminar**, students will give a presentation on scientific project planning, by means of a case-study related to the astrophysical/astronomical area of their future Master's thesis. In particular, they should stress the importance of defining the scope, allocating resources efficiently, establishing realistic timelines and milestones, implementing robust data management strategies, and conducting thorough risk assessments, exemplified for the above case-study. The corresponding **tutorium** is aimed at identifying and discussing fundamental issues related to the chosen subject. Particular topics (for the considered area of experimental working and instrument development in Astronomy) are time-lines, resource allocation and collaboration, data-management strategies, and risk assessments, and the tutorium should serve to help the student in establishing these issues for the considered preparatory project.
Learning outcomes	The aim of this module is to familiarise students with scientific *project planning*, particularly in the area of "Experimental Working and Instrument Development in

	Astronomy", and related to topics central to their future Master's thesis. The students should acquire the necessary background, knowledge, and skills to such an extent that they can successfully apply them in their Master's thesis project and in their subsequnt working career, be it inside or outside sience. To this end, they are individually supported by supervisors. The aim of the **project seminar** is to teach students with the specific background, knowledge, and skills required to successfully plan and conduct a scientific project that either has an experimental/observational character, or concentrates on the development of instruments, by means of presenting a field-typical case-study. Students should be able to transfer the content covered in the course – and leading up to the Master's thesis -- to the planning of other (scientific and non-scientific) projects. The aim of the **tutorium** is to help students in identifying and discussing fundamental issues related to the chosen subject, particular those which have been mentioned in the above content section. Moreover, the tutorium will enable the supervisors to evaluate the students' progress in understanding and considering all relevant topics and issues, and to guide the students in improving potential shortcomings.
Type of examination	Presentation
Type of assessment	The successful completion of the module will not be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Thomas Preibisch
Language(s)	English
Additional information	None

Module: WP 39 Research Project: Scientific Project Planning in the Area of Development and Application of Theoretical and Numerical Methods in Astrophysics

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Seminar	WP 39.1 Scientific Project Planning in the Area of Development and Application of Theoretical and Numerical Methods in Astrophysics (Project Seminar)	WiSe and SoSe	60 h (4 SWS)	120 h	(6)
Tutorial	WP 39.2 Scientific Project Planning in the Area of Development and Application of Theoretical and Numerical Methods in Astrophysics (Tutorial)	WiSe and SoSe	60 h (4 SWS)	120 h	(6)

For successful completion of the module, 12 ECTS credits have to be acquired. Class attendance averages about 8 contact hours. Including time for self-study, 360 hours have to be invested.

Module type	Compulsory elective module with mandatory courses
Usability of the module in other programmes	None
Elective guidelines	The module can be selected in compliance with the following rules: There must be taken exactly one of the compulsory elective areas "Experimental Working and Instrument Development in Astronomy" and "Development and Application of Theoretical and Numerical Methods in Astrophysics". By doing so, the following compulsory elective modules must be selected from the compulsory elective modules WP 36 to WP 41: 1. For the compulsory elective area "Experimental Working and Instrument Development in Astronomy", the compulsory elective modules WP 36, WP 38 and WP 40 must be chosen. 2. For the compulsory elective area "Development and Application of Theoretical and Numerical Methods in Astrophysics", the compulsory elective modules WP 37, WP 39 and WP 41 must be chosen.

Entry requirements	None
Semester	Recommended semester: 3
Duration	The successful completion of the module takes 1 semester.
Content	The core content of the module is the preparation of a scientific research project, with focus on the required scientific *project planning*, and regarding the area of the "Development and Application of Theoretical and Numerical methods in Astrophysics". A project seminar and a tutorial serve as an introduction and guidance towards this focus, respectively, and shall be related to potential topics of the future Master's thesis. Together with the module on scientific working methods and the final (thesis) module, the current module forms an inseparable unit and must therefore be taken in the same working group in which the Master's thesis is to be conducted. The module contains general and astrophysical area-specific concepts, and comprises a preparatory project related to the area of the future Master's thesis. By working on such a preparatory project, students should familiarise with scientific project planning, such that they can successfully apply the acquired knowledge and concepts to other projects (e.g., but not exclusively, related to their future Master's thesis). The lecturer will organise the preparatory project under individual guidance and, if necessary, will help with advice. Students should regularly outline their progress in form of oral or written reports. In a **project seminar**, students will give a presentation on scientific project planning, by means of a case-study related to the astrophysical area of their future Master's thesis. In particular, they should stress the importance of defining the scope, allocating resources efficiently, establishing realistic timelines, implementing robust data management strategies, and conducting thorough risk assessments, exemplified for the above case-study. The corresponding **tutorium** is aimed at identifying and discussing fundamental issues related to the chosen subject. Particular topics (for the considered area of development and application of theoretical and numerical methods in Astrophysics) are time-lines, data-management strategies, and risk assessments, and the tutorium should serve to help the student in establishing these issues for the considered preparatory project.

Learning outcomes	The aim of this module is to familiarise students with scientific *project planning*, particularly in the area of "Development and Application of Theoretical and Numerical Methods in Astrophysics", and related to topics central to their future Master's thesis. The students should acquire the necessary background, knowledge, and skills to such an extent that they can successfully apply them in their Master's thesis project and in their subsequent work, be it inside or outside sience. To this end, they are individually supported by supervisors. The aim of the **project seminar** is to teach students with the specific background, knowledge, and skills required to successfully plan and conduct a theoretical or computational scientific project, by means of presenting a field-typical case-study. Students should be able to transfer the content covered in the course – and leading up to the Master's thesis -- to the planning of other (scientific and non-scientific) projects. The aim of the **tutorium** is to help students in identifying and discussing fundamental issues related to the chosen subject, particular those which have been mentioned in the above content section. Moreover, the tutorium will enable the supervisors to evaluate the students' progress in understanding and considering all relevant topics and issues, and to guide the students in improving potential shortcomings.
Type of examination	Presentation
Type of assessment	The successful completion of the module will not be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Thomas Preibisch
Language(s)	English
Additional information	None

Module: WP 40 Final Module in the Area of Experimental Working and Instrument Development in Astronomy

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Master's thesis	WP 40.1 Master's Thesis in the Area of Experimental Working and Instrument Development in Astronomy	WiSe and SoSe	-	900 h	(30)

For successful completion of the module, 30 ECTS credits have to be acquired. Class attendance averages about 0 contact hours. Including time for self-study, 900 hours have to be invested.

Module type	Compulsory elective module
Usability of the module in other programmes	None
Elective guidelines	The module can be selected in compliance with the following rules: There must be taken exactly on of the compulsory elective areas "Experimental Working and Instrument Development in Astronomy" and "Development and Application of Theoretical and Numerical Methods in Astrophysics". By doing so, the following compulsory elective modules must be selected from the compulsory elective modules WP 36 to WP 41: 1. For the compulsory elective area "Experimental Working and Instrument Development in Astronomy", the compulsory elective modules WP 36, WP 38 and WP 40 must be chosen. 2. For the compulsory elective area "Development and Application of Theoretical and Numerical Methods in Astrophysics", the compulsory elective modules WP 37, WP 39 and WP 41 must be chosen.
Entry requirements	Successful participation in WP 36 and WP 38
Semester	Recommended semester: 4
Duration	The successful completion of the module takes 1 semester.

Content	The module comprises the Master's thesis in the area of "Experimental Working and Instrument Development in Astronomy". Under the guidance of the supervisor of the Master's Thesis, the students will solve a specific problem (or several problems) from this area that should be related to one of the main research fields in Astronomy Astrophysics. Subsequently, the students will describe and discuss their solution (including the scientific context) and potential consequences in the written version of the Master's Thesis. Together with the module on scientific working methods and scientific project planning, this final module forms an inseparable unit, and thus all three modules must be taken in the same working group. Under the guidance of the Master's thesis supervisor, students should at first plan the steps that lead to a successful completion of the topic, following the knowledge and strategies acquired in the module on scientific project planning. Thereafter, they should work on the solution of the concrete problem(s), using theoretical and practical methods and techniques studied in the module on scientific working methods. After having solved the problem(s) -- completely or in part, depending on the complexity and the available time frame --, the students should finally present their results (together with potential consequences) in the written version of the Master's Thesis. The introduction of the Master's Thesis (mostly, the scientific context) might lean on the essay formulated in the module on working methods.
Learning outcomes	Under supervision, students should apply the content-related and methodological skills acquired during their studies to conducting a larger scientific project, solving related problems, and thereby advancing the skills they have learnt. By producing the written version of their Master's Thesis, students should learn how to formulate and present a scientific publication independently.
Type of examination	Master's thesis
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Thomas Preibisch
Language(s)	English
Additional information	None

Module: WP 41 Final Module in the Area of Development and Application of Theoretical and Numerical Methods in Astrophysics

Programme	Master's Programme: Astrophysics (Master of Science, M.Sc.)

Related module parts

Course type	Course (mandatory)	Rotation	Contact hours	Self-study hours	ECTS
Master's thesis	WP 41.1 Master's Thesis in the Area of Development and Application of Theoretical and Numerical Methods in Astrophysics	WiSe and SoSe	-	900 h	(30)

For successful completion of the module, 30 ECTS credits have to be acquired. Class attendance averages about 0 contact hours. Including time for self-study, 900 hours have to be invested.

Module type	Compulsory elective module
Usability of the module in other programmes	None
Elective guidelines	The module can be selected in compliance with the following rules: There must be taken exactly on of the compulsory elective areas "Experimental Working and Instrument Development in Astronomy" and "Development and Application of Theoretical and Numerical Methods in Astrophysics". By doing so, the following compulsory elective modules must be selected from the compulsory elective modules WP 36 to WP 41: 1. For the compulsory elective area "Experimental Working and Instrument Development in Astronomy", the compulsory elective modules WP 36, WP 38 and WP 40 must be chosen. 2. For the compulsory elective area "Development and Application of Theoretical and Numerical Methods in Astrophysics", the compulsory elective modules WP 37, WP 39 and WP 41 must be chosen.
Entry requirements	Successful participation in WP 37 and WP 39
Semester	Recommended semester: 4
Duration	The successful completion of the module takes 1 semester.
Content	The module comprises the Master's thesis in the area of

	"Development and Application of Theoretical and Numerical Methods in Astrophysics". Under the guidance of the supervisor of the Master's Thesis, the students will solve a specific problem (or several problems) from this area that should be related to one of the main research fields in Astrophysics/Astronomy. Subsequently, the students will describe and discuss their solution (including the scientific context) and potential consequences in the written version of the Master's Thesis. Together with the module on scientific working methods and scientific project planning, this final module forms an inseparable unit, and thus all three modules must be taken in the same working group. Under the guidance of the Master's thesis supervisor, students should at first plan the steps that lead to a successful completion of the topic, following the knowledge and strategies acquired in the module on scientific project planning. Thereafter, they should work on the solution of the concrete problem(s), using theoretical and numerical/computational methods and techniques studied in the module on scientific working methods. After having solved the problem(s) -- completely or in part, depending on the complexity and the available time frame --, the students should finally present their results (together with potentiall consequences) in the written version of the Master's Thesis. The introduction of the Master's Thesis (mostly, the scientific context) might lean on the essay formulated in the module on working methods.
Learning outcomes	Under supervision, students should apply the content-related and methodological skills acquired during their studies to conducting a larger scientific project, solving related problems, and thereby advancing the skills they have learnt. By producing the written version of their Master's Thesis, students should learn how to formulate and present a scientific publication independently.
Type of examination	Master's thesis
Type of assessment	The successful completion of the module will be graded.
Requirements for the gain of ECTS credits	ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Thomas Preibisch
Language(s)	English
Additional information	None