



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 88/528/---/M0/H/2023

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Index

Abbreviations and annotations	4
Module: P 1 Introduction to Advanced Astrophysics	5
Module: P 2 Astrophysical Basic Lab	7
Module: P 3 Basic Research Methods and Tools of Advanced Astrophysics	9
Module: WP 1 Current Research Topics in Advanced Biophysics	11
Module: WP 2 Current Research Topics in Advanced Solid State Physics and Nanophysics	13
Module: WP 3 Current Research Topics in Advanced Elementary Particle Physics	15
Module: WP 4 Current Research Topics in Advanced Artificial Intelligence	17
Module: WP 5 Current Research Topics in Advanced Laser Physics	19
Module: WP 6 Current Research Topics in Advanced Medical Physics	21
Module: WP 7 Current Research Topics in Advanced Quantum Physics	23
Module: WP 8 Prospective Advanced Research Topics in Modern Experimental Physics	25
Module: WP 9 Advanced Research Topics in Advanced and Applied Quantum Mechanics	27
Module: WP 10 Advanced Research Topics in Quantum Field Theory and Gauge Theories	29
Module: WP 11 Advanced Research Topics in Cosmology, General Relativity, and Differential	
Geometry	31
Module: WP 12 Advanced Research Topics in String Theory and Geometry	33
Module: WP 13 Advanced Research Topics in Statistical Physics and Stochastics	35
Module: WP 14 Prospective Advanced Research Topics in Theoretical and Mathematical Physics	37
Module: WP 15 Presentation of Basic Concepts and Methods of Advanced Astrophysics	39
Module: WP 16 Instrumental Methods of Advanced Astrophysics in Practice	41
Module: WP 17 Numerical Methods of Advanced Astrophysics in Practice	43
Module: WP 18 Current Research Approaches in Advanced Astrophysics I	45
Module: WP 19 Basic Research Concepts of Advanced Astrophysics I	48
Module: WP 20 Current Research Approaches in Advanced Astrophysics II	50
Module: WP 21 Basic Research Concepts of Advanced Astrophysics II	53
Module: WP 22 Stars, Planets, Star Formation I	55
Module: WP 23 Circumstellar Disks and Planet Formation I	57
Module: WP 24 Radiative Processes in the Atmospheres of Planets, Stars, and the Interstellar Medium I	59
Module: WP 25 Structure and Evolution of Galaxies I	61
Module: WP 26 Cosmology and Large Scale Structures I	63
Module: WP 27 Specific Research Approaches in the Application of Experimental and Observational Methods I	65
Module: WP 28 Specific Research Approaches in the Application of Theoretical and Numerical Methods I	67
Module: WP 29 Stars, Planets, Star Formation II	69

Module: WP 30 Circumstellar Disks and Planet Formation II	.71
Module: WP 31 Radiative Processes in the Atmospheres of Planets, Stars, and the Interstellar Medium II	.73
Module: WP 32 Structure and Evolution of Galaxies II	.75
Module: WP 33 Cosmology and Large Scale Structures II	.77
Module: WP 34 Specific Research Approaches in the Application of Experimental and Observational Methods II	.79
Module: WP 35 Specific Research Approaches in the Application of Theoretical and Numerical Methods II	.81
Module: WP 36 Research Project: Introduction to Scientific Working Methods in the Area of Experimental Working and Instrument Development in Astronomy	.83
Module: WP 37 Research Project: Introduction to Scientific Working Methods in the Area of Development and Application of Theoretical and Numerical Methods in Astrophysics	.86
Module: WP 38 Research Project: Scientific Project Planning in the Area of Experimental Workin and Instrument Development in Astronomy	ng .89
Module: WP 39 Research Project: Scientific Project Planning in the Area of Development and Application of Theoretical and Numerical Methods in Astrophysics	.92
Module: WP 40 Final Module in the Area of Experimental Working and Instrument Development Astronomy	t in .95
Module: WP 41 Final Module in the Area of Development and Application of Theoretical and Numerical Methods in Astrophysics	.97

Abbreviations and annotations

СР	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
Р	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

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

Related module parts

Course type	Course (mandatory)	Rota- tion	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)

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 correspond- ing concepts, experimental and theoretical methods, with an associated exercise course.	
	<i>Lecture: Introduction to Advanced Astrophysics (P1.1):</i> 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, ob- servational methods and devices, solar and exo-planets, stellar atmospheres, structure and evolution, stellar rem- nants, the interstellar medium and star formation.	
	Basic concepts of chemical evolution, stellar and galaxy dy- namics, dark matter, active galactic nuclei and massive black holes, large-scale structures, the spatial distribution of galaxies and galaxy clusters, cosmology, the early uni- verse, and the formation and evolution of galaxies.	

	The basic astrophysical processes are motivated and under- pinned with scientific concepts.
	<i>Exercise course: Introduction to Advanced Astrophysics</i> <i>(P1.2):</i> 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 typi- cal situations. Students are enabled to solve astrophysical problems on the basis of understanding the complex inter- relation between the different astrophysical branches.
	<i>Lecture: Introduction to Advanced Astrophysics (P1.1):</i> 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 interrelation- ships across topics.
	<i>Exercise course: Introduction to Advanced Astrophysics</i> <i>(P1.2):</i> 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 com- pleted 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)	Rota- tion	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)

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 meth- ods. Various experiments from a pool of experiments shall be performed:
	Interpretation and analysis of spectra from stellar and exo- planetary atmospheres, and from gaseous nebulae, galax- ies 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 re- sults 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 examina- tion (or the examination of pertinent mandatory and poten- tial elective compulsary module parts) has/have been com- pleted successfully.
Responsible contact	Dr. Stella Seitz
Language(s)	English
Additional information	None

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

Programme		er's Programn er of Science,	ne: Astrophysics , M.Sc.)		
Related mo	odule parts				
Course type	Course (mandatory)	Rota- tion	Contact hours	Self-study hours	ECTS
Lecture	P 3.1 Basic Research Method and Tools of Advanced Astro physics (Lecture)	ds WiSe - and SoSe	30 h (2 SWS)	60 h	(3)
Exercise course	P 3.2 Basic Research Method and Tools of Advanced Astro physics (Exercise Course)	ls WiSe - and SoSe	30 h (2 SWS)	60 h	(3)

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 experi- mental and/or theoretical basic research methods and tools of advanced astrophysics, by means of a lecture from the fields of statistics, hydrodynamics, plasma physics, radia- tive 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 meth- ods, or applied quantum mechanics (P3.1) The lecture provides an overview of the concepts of statisti- cal methods and their application to (observational) data analysis, or of concepts and methods of hydrodynamics (in- cluding numerical aspects), or of plasma physics, or of con- cepts and methods of radiative transfer in different astro- physical environments and wavelength domains, or of con- cepts 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 lec- ture from the field of statistics, hydrodynamics, plasma physics, radiative transfer, observationsl methods, or ap- plied 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 proce- dures of specific fields that are essential for astrophysical work. Students are enabled to solve corresponding prob- lems on the basis of understanding the inherent, complex interrelations.
	Lecture from the field of statistics, hydrodynamics, plasma physics, radiative transfer, observational meth- ods, or applied quantum mechanics (P3.1) By providing basic knowledge and insights into the proce- dures of statistical methods, or hydrodynamics, or plasma physics, or radiative transfer, or observational methods, or applied quantum mechanics, as well as their specific appli- cations, students should develop a thorough understanding of these topics that are essential tools for current astrophys- ical research. Moreover, they are also enabled to transfer the lecture content to current problems.
	Corresponding exercise course, supplementing the lec- ture from the field of statistics, hydrodynamics, plasma physics, radiative transfer, observationsl methods, or ap- plied quantum mechanics (P3.2) Simple problem solutions shall be independently devel- oped, 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 com- pleted successfully.
Responsible contact	Prof. Dr. Klaus Dolag
Language(s)	English
Additional information	None

Course

Lecture

Exercise

type

Module: WP 1 Current Research Topics in Advanced Biophysics

course in Advanced Biophysic cise Course)	cs (Exer- and SoSe			
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 follow- ing 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 top- ics in advanced biophysics. Special attention is paid to re- cent developments in research.			
Learning outcomes	Students acquire in-depth knowledge and gain an under- standing 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 com- pleted successfully.			
Responsible contact	Prof. Dr. Joachim Rädler			

Contact

45 h (3 SWS)

15 h (1 SWS)

hours

Rota-

tion

WiSe

SoSe

WiSe

and

Related module parts

ture)

Course (mandatory)

WP 1.1 Current Research Topics

WP 1.2 Current Research Topics

in Advanced Biophysics (Lec-

Self-study ECTS

hours

75 h

45 h

(4)

(2)

Language(s) English

None

Additional information

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

Programme	e Master's P (Master of	Master's Programme: Astrophysics (Master of Science, M.Sc.)			
Related mo	odule parts				
Course type	Course (mandatory)	Rota- tion	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)

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 follow- ing 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 top- ics 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 under- standing 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 com- pleted successfully.

Responsible contactPD Dr. Theobald LohmüllerLanguage(s)EnglishAdditional informationNone

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

Programm	e Master's F (Master of	Programn Science,	ne: Astrophysics M.Sc.)		
Related mo	odule parts				
Course type	Course (mandatory)	Rota- tion	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)

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 follow- ing 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 top- ics in advanced elementary particle physics. Special atten- tion is paid to recent developments in research		
Learning outcomes	Students acquire in-depth knowledge and gain an under- standing 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 com- pleted 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

Programm	e Master's F (Master of	Master's Programme: Astrophysics (Master of Science, M.Sc.)			
Related mo	dule parts				
Course type	Course (mandatory)	Rota- tion	Contact hours	Self-study hours	ECTS
Lecture	WP 4.1 Current Research Topics in Advanced Artificial Intelli- gence (Lecture)	WiSe and SoSe	45 h (3 SWS)	75 h	(4)
Exercise course	WP 4.2 Current Research Topics in Advanced Artificial Intelli- gence (Exercise Course)	WiSe and SoSe	15 h (1 SWS)	45 h	(2)

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 follow- ing 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 top- ics in advanced artificial intelligence. Special attention is paid to recent developments in research. Theoretical as- pects and their practical implementation are covered.
Learning outcomes	Students acquire in-depth knowledge and gain an under- standing of current research topics in advanced artificial in- telligence. 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 com- pleted successfully.
Responsible contact	Prof. Dr. Daniel Grün
Language(s)	English
Additional information	None

Course

Lecture

type

Module: WP 5 Current Research Topics in Advanced Laser Physics

WP 5.1 Current Research Topics

in Advanced Laser Physics (Lec-

Course (mandatory)

Exercise course	WP 5.2 Current Resea in Advanced Laser Ph ercise Course)	arch Topics nysics (Ex-	WiSe and SoSe	15 h (1 SWS)	45 h	(2)
For success averages ab	ful completion of the m bout 4 contact hours. In	odule, 6 EC ⁻ cluding time	TS credit for self-	s have to be acquired study, 180 hours have	l. Class attendar e to be invested	ıce
Module typ	e	Compulso	ry electiv	e module with manda	atory courses	
Usability of programme	f the module in other es	MSc Phys	ics			
Elective gu	idelines	The modu ing rules: WP 1 to W chosen.	le can be With reg /P 14, on	selected in complian ard to the compulsory e compulsory elective	nce with the follo y elective modu e module must l	ow- les ce
Entry requi	irements	None				
Semester		Recomme	nded sen	nester: 1		
Duration		The succe	ssful con	pletion of the module	e takes 1 semes	ter.
Content		The modu ics in adva recent dev	le provid anced las velopmen	es an in-depth discus er physics. Special at ts in research.	sion of current tention is paid t	top- :o
Learning o	utcomes	Students a standing c ics.	acquire in of current	-depth knowledge ar research topics in ac	nd gain an unde dvanced laser pl	r- hys-
Type of exa	amination	Written ex	am or or	al examination		
Type of ass	sessment	The succe	ssful com	pletion of the modul	e will be gradec	1.
Requireme ECTS credi	nts for the gain of ts	ECTS crec (or the exa	lits will b aminatior	e granted when the n n of pertinent mandat	nodule examina ory and potenti	ition al

pleted successfully.

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

Contact

45 h (3 SWS)

elective compulsary module parts) has/have been com-

hours

Self-study ECTS hours

75 h

(4)

Rota-

tion

WiSe

SoSe

and

Related module parts

ture)

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

Related module parts

Module: WP 6 Current Research Topics in Advanced Medical Physics

Course type	Course (mandatory)		Rota- tion	Contact hours	Self-study hours	ECTS
Lecture	WP 6.1 Current Research Topics in Advanced Medical Physics		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 success averages ab	ful completion of the m out 4 contact hours. Inc	odule, 6 ECT cluding time	TS credits for self-s	have to be acquire tudy, 180 hours ha	ed. Class attend ve to be investe	lance ed.
Module typ	e	Compulso	ry elective	e module with man	datory courses	
Usability of programme	the module in other s	MSc Physi	ics			
Elective gu	idelines	The modu ing rules: ' WP 1 to W chosen.	le can be With rega /P 14, one	selected in complia rd to the compulso compulsory electi	ance with the fo ry elective moo ve module mus	ollow- dules st be
Entry requi	rements	None				
Semester		Recomme	nded sem	ester: 1		
Duration		The successful completion of the module takes 1 semest		ester.		
Content		The modu ics in adva	le provide inced mee	es an in-depth discu dical physics. Speci	ussion of currential attention is p	nt top- paid to

Master's Programme: Astrophysics

(Master of Science, M.Sc.)

	practical insights.
Learning outcomes	Students acquire in-depth knowledge and gain an under- standing 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.

recent developments in research, including possibilities of

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

Module: WP 7 Current Research Topics in Advanced Quantum Physics

(Master of Science, M.Sc.)					
Related mo	odule parts				
Course type	Course (mandatory)	Rota- tion	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)

Master's Programme: Astrophysics

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 follow- ing 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 top- ics in advanced quantum physics. Special attention is paid to recent developments in research.
Learning outcomes	Students acquire in-depth knowledge and gain an under- standing 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 com- pleted successfully.

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

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

(Master of Science, M.Sc.)					
Related mo	odule parts				
Course type	Course (mandatory)	Rota- tion	Contact hours	Self-study hours	ECTS
Lecture	WP 8.1 Prospective Advanced Research Topics in Modern Ex- perimental Physics (Lecture)	WiSe and SoSe	45 h (3 SWS)	75 h	(4)
Exercise course	WP 8.2 Prospective Advanced Research Topics in Modern Ex- perimental Physics (Exercise Course)	WiSe and SoSe	15 h (1 SWS)	45 h	(2)

Master's Programme: Astrophysics

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 follow- ing 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 under- standing of prospective advanced topics in modern experi- mental 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 com- pleted 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 mo	odule parts				
Course type	Course (mandatory)	Rota- tion	Contact hours	Self-study hours	ECTS
Lecture	WP 9.1 Advanced Research Top- ics in Advanced and Applied Quantum Mechanics (Lecture)	WiSe and SoSe	45 h (3 SWS)	75 h	(4)
Exercise course	WP 9.2 Advanced Research Top- ics in Advanced and Applied Quantum Mechanics (Exercise Course)	WiSe and SoSe	15 h (1 SWS)	45 h	(2)

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 follow- ing 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 under- standing 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 com- pleted 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 F (Master of		Programn f Science,	ne: Astrophysics M.Sc.)		
Related module parts					
Course type	Course (mandatory)	Rota- tion	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)

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 follow- ing 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 under- standing 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 com- pleted 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

(Master of Science, M.Sc.)					
Related mo	odule parts				
Course type	Course (mandatory)	Rota- tion	Contact hours	Self-study hours	ECTS
Lecture	WP 11.1 Advanced Research Topics in Cosmology, General Relativity, and Differential Ge- ometry (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 Ge- ometry (Exercise Course)	WiSe and SoSe	15 h (1 SWS)	45 h	(2)

Master's Programme: Astrophysics

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 follow- ing 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 under- standing 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 com- pleted successfully.
Responsible contact	Prof. Dr. Viatcheslav Mukhanov
Language(s)	English
Additional information	None

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

J	(Master of	Science,	M.Sc.)		
Related mo	Related module parts				
Course type	Course (mandatory)	Rota- tion	Contact hours	Self-study hours	ECTS
Lecture	WP 12.1 Advanced Research Topics in String Theory and Ge- ometry (Lecture)	WiSe and SoSe	45 h (3 SWS)	75 h	(4)
Exercise course	WP 12.2 Advanced Research Topics in String Theory and Ge- ometry (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					

Master's Programme: Astrophysics

F 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 follow- ing 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 under- standing 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 com- pleted successfully.
Responsible contact	Prof. Dr. Dieter Lüst

Language(s) English

None

Additional information

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

Programme Master's (Master		Programm f Science,	ne: Astrophysics M.Sc.)		
Related mo	odule parts				
Course type	Course (mandatory)	Rota- tion	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)

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 follow- ing 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, com- plex many-body systems, soft and living matter, and biolog- ical systems. Special attention is paid to recent develop- ments in research.
Learning outcomes	Students acquire in-depth knowledge and gain an under- standing 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 com- pleted successfully.
Responsible contact	Prof. Dr. Erwin Frey
Language(s)	English
Additional information	None
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Module: WP 14 Prospective Advanced Research Topics in Theoretical and Mathematical Physics

(Master of Science, M.Sc.)					
Related mo	odule parts				
Course type	Course (mandatory)	Rota- tion	Contact hours	Self-study hours	ECTS
Lecture	WP 14.1 Prospective Advanced Research Topics in Theoretical and Mathematical Physics (Lec- ture)	WiSe and SoSe	45 h (3 SWS)	75 h	(4)
Exercise course	WP 14.2 Prospective Advanced Research Topics in Theoretical and Mathematical Physics (Ex- ercise Course)	WiSe and SoSe	15 h (1 SWS)	45 h	(2)

Master's Programme: Astrophysics

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 follow- ing 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 under- standing 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 com- pleted 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	e Master (Maste	Master's Programme: Astrophysics (Master of Science, M.Sc.)			
Related mo	dule parts				
Course type	Course (mandatory)	Rota- tion	Contact hours	Self-study hours	ECTS
Seminar	WP 15.1 Presentation of Basic Concepts and Methods of Ad- vanced Astrophysics (Seminar)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

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 follow- ing 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 pre- sent 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 vari- ous 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 com- pleted successfully.
Responsible contact	Prof. Dr. Daniel Grün
Language(s)	English
Additional information	None

Module: WP 16 Instrumental Methods of **Advanced Astrophysics in Practice**

Programm	e Master's (Master o	Master's Programme: Astrophysics (Master of Science, M.Sc.)			
Related mo	odule parts				
Course type	Course (mandatory)	Rota- tion	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 follow- ing 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 exer- cises on instrumental methods of advanced astrophysics. The corresponding experiments can be (i) either performed as a one-semester lab project within the observationally/in- strumentally oriented working groups at the USM or collab- orating groups in Garching, supervised by experienced sci- entists, or (ii) as a series of different lab-courses and exer- cises 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 re- duction and analysis, observations and analysis of the Ga- lactic 21 cm line with our 2-m radio telescope, and lab-ex- periments 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 observa- tional/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 work- ing methods based on observational instruments and tech- niques.
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 com- pleted successfully.
Responsible contact	Dr. Arno Riffeser
Language(s)	English
Additional information	None

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Module: WP 17 Numerical Methods of Advanced Astrophysics in Practice

tice (Exercise Course)

Programm	e Master's (Master o	Master's Programme: Astrophysics (Master of Science, M.Sc.)		
Related module parts				
Course type	Course (mandatory)	Rota- tion	Contact hours	Self-study hours
Lab course	WP 17.1 Numerical Methods of Advanced Astrophysics in Prac- tice (Lab Course)	WiSe and SoSe	30 h (2 SWS)	60 h
Exercise course	WP 17.2 Numerical Methods of Advanced Astrophysics in Prac-	WiSe and	60 h (4 SWS)	120 h

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.

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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 follow- ing 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 exer- cises on numerical methods of advanced astrophysics. The corresponding experiments can be (i) either performed as a one-semester lab project within the theoretically/numeri- cally 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 con- ducted at the USM. In case (i), the numerical experiments (related to prototypical astrophysical problems) will be

ECTS

(3)

(6)

	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 as- trophysical problems.
Learning outcomes	The aim of the course is to understand and to apply numer- ical algorithms, procedures, and methods. Students will practise the use of operating systems, the coding of com- puter programs, and the visualization and critical evalua- tion 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 com- pleted successfully.
Responsible contact	Prof. Dr. Klaus Dolag
Language(s)	English
Additional information	None

Module: WP 18 Current Research Approaches in Advanced Astrophysics I

Programme		er's Program er of Scienc	nme: Astrophysics e, M.Sc.)		
Related mo	odule parts				
Course type	Course (mandatory)	Rota- tion	Contact hours	Self-study hours	ECTS
Lecture	WP 18.1 Current Research Ap- proaches in Advanced Astro- physics 1 (Lecture)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)
Exercise course	WP 18.2 Current Research Approaches in Advanced Astro- physics 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)

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 fol- lowing 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 semes- ter.
Content	The module comprises a lecture covering current re- search 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 examina- tion (or the examination of pertinent mandatory and po- tential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Kevin Heng
Language(s)	English
Additional information	None

Related module parts

Module: WP 19 Basic Research Concepts of Advanced Astrophysics I

Course type	Course (mandatory)		Rota- tion	Contact hours	Self-study hours	ECTS
Lecture	WP 19.1 Basic Research Con- cepts of Advanced Astrophysics		WiSe and SoSe	60 h (4 SWS)	120 h	(6)
Exercise course	WP 19.2 Basic Research Con- cepts of Advanced Astrophysics 1 (Exercise Course)		WiSe and SoSe	30 h (2 SWS)	60 h	(3)
For success averages ab	ful completion of the mod out 6 contact hours. Inclu	dule, 9 EC ⁻ uding time	TS credits for self-s	have to be acquire tudy, 270 hours ha	d. Class attend ve to be investe	ance ed.
Module typ	e	Compuls	sory electi	ve module with ma	ndatory course	es
Usability of programme	the module in other s	MSc Phy	ysics			
Elective gu	idelines	The moo lowing r	dule can b ules:	e selected in comp	liance with the	fol-
		With reg WP 28, o ECTS cr	gard to the compulso edits mus	e compulsory electi ry elective modules t be selected.	ve modules WF amounting to	P 15 to 30
		Students 16 may 1 17. Stud WP 17 n WP 16.	s who cho not choos ents who nay not ch	ose the compulsory e the compulsory e choose the compul loose the compulso	/ elective modu lective module sory elective m ry elective mod	ile WP WP iodule dule
Entry requi	rements	None				
Semester		Recomm	nended se	mester: 2		
Duration		The suco ter.	cessful co	mpletion of the mo	dule takes 1 se	mes-

Master's Programme: Astrophysics

(Master of Science, M.Sc.)

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 examina- tion (or the examination of pertinent mandatory and po- tential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Thomas Preibisch
Language(s)	English
Additional information	None

Related module parts

Module: WP 20 Current Research Approaches in Advanced Astrophysics II

Course type	Course (mandatory)	Rota- tion	Contact hours	Self-study hours	ECTS
Lecture	WP 20.1 Current Research Ap- proaches in Advanced Astro- physics 2 (Lecture)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)
Exercise course	WP 20.2 Current Research Approaches in Advanced Astro- physics 2 (Exercise Course)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)
Seminar	WP 20.3 Current Research Approaches in Advanced Astro- physics 2 (Seminar)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)
For success averages ab	ful completion of the module, 9 EC out 6 contact hours. Including time	CTS credit e for self-	s have to be acquire study, 270 hours ha	ed. Class attend ive to be investe	lance ed.

Master's Programme: Astrophysics

(Master of Science, M.Sc.)

Module type	Compulsory elective module with mandatory courses
Usability of the module in other pro- grammes	MSc Physics
Elective guidelines	The module can be selected in compliance with the fol- lowing 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 semes- ter.
Content	The module comprises a lecture covering current re- search 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 partici- pating students.
	Lecture: Current Research Approaches in Advanced Astrophysics 2 (WP 20.1) In this lecture, the most important concepts and meth- ods of one of the major branches of astrophysics are outlined, leading also to an understanding of the inter- play of the corresponding astrophysical processes.
	<i>Exercise course: Current Research Approaches in Ad- vanced Astrophysics 2 (WP 20.2)</i> 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 in- tended 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 (refer- ring to the contents of both lecture and seminar), on the basis of understanding the complex interrelation be- tween the involved astrophysical processes. This mod- ule, if chosen, will substantially facilitate an understand- ing of the scientific background of the upcoming Mas- ter's thesis, when conducted on a similar topic as cov- ered here.
	Lecture: Current Research Approaches in Advanced Astrophysics 2 (WP 20.1) Students should gain an overview on the current re- search status of a specific, important branch of astro- physics, by providing them with the fundamental knowledge and insights into corresponding astrophysi- cal processes and procedures as well as their concrete applications. In particular, students should learn to rec- ognise interrelationships across topics.
	<i>Exercise course: Current Research Approaches in Ad-</i> <i>vanced Astrophysics 2 (WP 20.2)</i> Students should learn to apply the contents discussed in the lecture and seminar to practical tasks. Simple

	/ -
	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 sta- tus of the specific field that are not covered in the lec- ture. They should learn how specific concepts and methods can be used to investigate corresponding cur- rent astrophysical questions. The presentations will be prepared by the students under the guidance of experi- enced supervisors, and they will learn (besides the ac- tual topic of the talk) how to give a scientific presenta- tion, 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 examina- tion (or the examination of pertinent mandatory and po- tential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Kevin Heng
Language(s)	English
Additional information	None

problem solutions are to be developed, specified and implemented independently.

Module: WP 21 Basic Research Concepts of Advanced Astrophysics II

Related mo	dule parts						
Course type	Course (mandatory)		Rota- tion	Contact hours	Self-study hours	ECTS	
Lecture	WP 21.1 Basic Research Con- cepts of Advanced Astrophysics		WiSe and SoSe	60 h (4 SWS)	120 h	(6)	
Exercise course	2 (Lecture) WP 21.2 Basic Research Con- cepts 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.			lance ed.				
Module type		Compuls	Compulsory elective module with mandatory courses				
Usability of the module in other programmes		MSc Phy	/sics				
Elective guidelines		The moo lowing r	The module can be selected in compliance with the fol- lowing rules:				
		With reg WP 28, o ECTS cr	ard to the compulso edits mus	e compulsory electi ry elective modules t be selected.	ve modules Wf amounting to	P 15 to 30	
		Students 16 may 1 17. Stud WP 17 n	s who cho not choos ents who nay not ch	ose the compulsory e the compulsory e choose the compul noose the compulso	velective modu lective module sory elective m ry elective mod	ile WP WP nodule dule	

Master's Programme: Astrophysics

(Master of Science, M.Sc.)

	WP 16.
Entry requirements	None
Semester	Recommended semester: 2
Duration	The successful completion of the module takes 1 semes- ter.
Content	The module comprises a lecture concentrating on one of the major astrophysical branches, and a corresponding exercise course. During the lecture, fundamental con- cepts and methods of the field will be discussed in detail.
	Lecture: Basic Research Concepts of Advanced Astro- physics 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 examina- tion (or the examination of pertinent mandatory and po- tential 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

Exercise course	mation 1 (Lecture) WP 22.2 Stars, Planet mation 1 (Exercise Co	ts, Star For- burse)	and SoSe WiSe and SoSe	30 h (2 SWS)	60 h	(3)
For success averages ab	ful completion of the m out 4 contact hours. In	odule, 6 EC ⁻ cluding time	TS credits for self-s	s have to be acquired. tudy, 180 hours have	Class attendar to be invested	ıce
Module typ	e	Compulsory elective module with mandatory courses				
Usability of programme	f the module in other es	MSc Physi	CS			
Elective gu	idelines	The modul ing rules:	le can be	selected in complianc	e with the follo	ow-
		With regar WP 28, co credits mu	d to the o mpulsory st be sele	compulsory elective m elective modules amo ected.	odules WP 15 ounting to 30 E	to ECTS
		Students w 16 may no Students w 17 may no	vho choos t choose vho choos t choose	se the compulsory elect the compulsory electiv se the compulsory elect the compulsory electiv	ctive module V ve module WP ctive module V ve module WP	VP 17. VP 16.
Entry requi	irements	None				
Semester		Recommended semester: 2				
Duration		The succes	ssful com	pletion of the module	takes 1 semes	ter.
Content		The modul dents with within the evolution a in the lectu	le (lecture an overv research and/or of ure are pr	e plus exercise course, iew of concepts and m of stellar and/or plane star formation. The co ractised by means of ty) provides the nethods used etary structure ntents discuss ypical applicat	stu- and sed ions.
Learning o	utcomes	The lectury and insigh and/or into the format crete inter tions, stud	e shall protest into the state of the variation of state pretation entry should be sho	ovide the students wit e properties of stars ar ous processes controll rs. From this knowled of corresponding the ild develop the ability	h basic knowle nd/or planets, ing and affecti ge, and the co pretical predic to transfer the	edge ing n- -

Programme

Course

Lecture

type

Related module parts

Course (mandatory)

WP 22.1 Stars, Planets, Star For-

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

Rotation

WiSe

Contact

30 h (2 SWS)

hours

Self-study ECTS

hours

60 h

(3)

	content presented in the lecture to current astrophysical problems and questions. During the exercise course, simple problem solutions shall be independently developed, speci- fied 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 practi- cal 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 com- pleted successfully.
Responsible contact	Prof. Dr. Thomas Preibisch
Language(s)	English
Additional information	None

Module: WP 23 Circumstellar Disks and Planet Formation I

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

Related module parts

Course type	Course (mandatory)	Rota- tion	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)

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 follow- ing 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 stu- dents 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 prac- tised by means of typical applications.
Learning outcomes	The lecture shall provide the students with basic knowledge and insights into the properties and evolution of circumstel- lar disks, and the formation of planets. From this knowledge, and the concrete interpretation of correspond- ing 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 inde- pendently developed, specified and implemented, both us- ing analytic and, if required, computational approaches. In this way, students should learn to apply the content dis- cussed 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 com- pleted 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

(Master of Science, M.Sc.)					
Related mo	odule parts				
Course type	Course (mandatory)	Rota- tion	Contact hours	Self-study hours	ECTS
Lecture	WP 24.1 Radiative Processes in the Atmospheres of Planets, Stars, and the Interstellar Me- dium 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 Me- dium 1 (Exercise Course)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

Master's Programme: Astrophysics

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 follow- ing 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 stu- dents 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 pro- cesses 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 de- velop the ability to transfer the content presented in the lec- ture to current astrophysical problems and questions. Dur- ing 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 dis- cussed 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 com- pleted successfully.
Responsible contact	Prof. Dr. Kevin Heng
Language(s)	English
Additional information	None

Module: WP 25 Structure and Evolution of Galaxies I

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

Related module parts

Course type	Course (mandatory)	Rota- tion	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)

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 follow- ing 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 stu- dents with an overview of concepts and methods used within the research on the structure and evolution of galax- ies. 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 de- velop the ability to transfer the content presented in the lec- ture 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 ap- proaches. 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 com- pleted successfully.
Responsible contact	Prof. Dr. Klaus Dolag
Language(s)	English
Additional information	None

Module: WP 26 Cosmology and Large Scale Structures I

Exercise course	WP 26.2 Cosmology 3 Scale Structures 1 (E Course)	and Large xercise	WiSe and SoSe	30 h (2 SWS)	60 h	(3)
For succes averages a	sful completion of the m bout 4 contact hours. In	nodule, 6 EC cluding tim	CTS credit e for self-	s have to be acquired. study, 180 hours have	Class attendat to be invested	nce I.
Module ty	ре	Compulso	ory electiv	e module with mandat	tory courses	
Usability o programm	of the module in other les	MSc Phys	sics			
Elective gu	uidelines	The moduing rules:	ule can be	selected in complianc	e with the foll	ow-
		With rega WP 28, co credits m	ard to the ompulsory ust be sel	compulsory elective m v elective modules amo ected.	odules WP 15 ounting to 30 I	to ECTS
		Students 16 may n Students 17 may n	who choo ot choose who choo ot choose	se the compulsory ele the compulsory electi se the compulsory ele the compulsory electi	ctive module V ve module WP ctive module V ve module WP	VP ' 17. VP ' 16.
Entry requ	iirements	None				
Semester		Recomme	ended sem	nester: 2		
Duration		The succe	essful com	pletion of the module	takes 1 semes	ster.
Content		The modu dents with within the design an tents disc ical applie	ule (lectur h an overv e research nd propert cussed in t cations.	e plus exercise course view of concepts and n on Cosmology, as we ies of large-scale struc he lecture are practise	 provides the nethods used as studies of ctures. The cor by means of 	stu- ີ the າ- f typ-
Learning o	outcomes	The lectu and insig From this correspor	re shall pr hts into Co knowledo nding theo	rovide the students wit osmology and Large S ge, and the concrete ir pretical predictions, stu	th basic knowl cale Structure nterpretation o udents should	edge s. f de-

Programme

Course

Lecture

type

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

Contact

30 h (2 SWS)

velop the ability to transfer the content presented in the

hours

Rota-

tion

WiSe

and SoSe

Related module parts

Course (mandatory)

WP 26.1 Cosmology and Large

Scale Structures 1 (Lecture)

Self-study ECTS

hours

60 h

(3)

	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 ap- proaches. 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 com- pleted 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

Related module parts					
Course type	Course (mandatory)	Rota- tion	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)

Master's Programme: Astrophysics

(Master of Science, M.Sc.)

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 follow- ing 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 stu- dents with an overview of concepts and applications of se- lected experimental and observational methods in astro- physics. The contents discussed in the lecture are practised by means of typical examples.
Learning outcomes	By providing basic knowledge and insights into experi- mental 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 com- pleted successfully.
Responsible contact	Prof. Dr. Joseph Mohr
Language(s)	English
Additional information	none

Related module parts

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

Course type	Course (mandatory)		Rota- tion	Contact hours	Self-study hours	ECTS
Lecture	WP 28.1 Specific Rese proaches in the Applic Theoretical and Nume Methods 1 (Lecture)	arch Ap- ation of rical	WiSe and SoSe	30 h (2 SWS)	60 h	(3)
Exercise course	WP 28.2 Specific Rese proaches in the Applic Theoretical and Nume Methods 1 (Exercise C	arch Ap- ation of rical 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	2	Compulsor	y elective	module with man	datory courses	
Usability of programme	the module in other s	MSc Physic	CS			
Elective gui	delines	The modul ing rules:	e can be s	selected in complia	ance with the fo	llow-

Master's Programme: Astrophysics

(Master of Science, M.Sc.)

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

Learning outcomes	By providing basic knowledge and insights into theoretical and numerical methods in astrophysics as well as their con- crete 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, speci- fied 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 practi- cal 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 com- pleted successfully.
Responsible contact	Prof. Dr. Klaus Dolag
Language(s)	English
Additional information	none

Module: WP 29 Stars, Planets, Star Formation II

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

Related module parts

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

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 fol- lowing rules: With regard to the compulsory elective mod- ules 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 semes- ter.
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 dis- cussed in the lecture are practised by means of typical ap- plications. This module is recommended to be selected if its contents comply with the focus of the students' forth- coming 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 astrophysi- cal problems and questions. During the exercise course, simple problem solutions shall be independently

	developed, specified and implemented, both using ana- lytic 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 examina- tion (or the examination of pertinent mandatory and po- tential 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

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

Related module parts

Course type	Course (mandatory)	Rota- tion	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)

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 fol- lowing rules: With regard to the compulsory elective mod- ules 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 semes- ter.
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 for- mation of planets. The contents discussed in the lecture are practised by means of typical applications. This mod- ule is recommended to be selected if its contents comply with the focus of the students' forthcoming Master's The- sis.
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 corre- sponding 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 in- dependently 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 examina- tion (or the examination of pertinent mandatory and po- tential elective compulsary module parts) has/have been completed successfully.
Responsible contact	Prof. Dr. Til Birnstiel
Language(s)	English
Additional information	none
Programme

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

5	(Master of Science, M.Sc.)				
Related mo	odule parts				
Course type	Course (mandatory)	Rota- tion	Contact hours	Self-study hours	ECTS
Lecture	WP 31.1 Radiative Processes in the Atmospheres of Planets, Stars, and the Interstellar Me- dium 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 Me- dium 2 (Exercise Course)	WiSe and SoSe	30 h (2 SWS)	60 h	(3)

Master's Programme: Astrophysics

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 fol- lowing rules: With regard to the compulsory elective modules WP 29 to WP 35, one compulsory elective mod- ule must be chosen.
Entry requirements	None
Semester	Recommended semester: 3
Duration	The successful completion of the module takes 1 semes- ter.
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 astro- physics, particularly in the atmospheres of planets, stars, and in the Interstellar Medium. The contents discussed in the lecture are practised by means of typical applica- tions. This module is recommended to be selected if its contents comply with the focus of the students' forth- coming 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 atmos- pheres of planets, stars, and in the Interstellar Medium

	should be understood. From this knowledge, and the concrete interpretation of corresponding theoretical pre- dictions, students should develop the ability to transfer the content presented in the lecture to current astro- physical problems and questions. During the exercise course, simple problem solutions shall be independently developed, specified and implemented, both using ana- lytic and, if required, computational approaches. In this way, students should learn to apply the content dis- cussed 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 examina- tion (or the examination of pertinent mandatory and po- tential 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

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

Related module parts

Course type	Course (mandatory)	Rota- tion	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)

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 follow- ing 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 stu- dents with an overview of concepts and methods used within the research on the structure and evolution of galax- ies. 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 de- velop the ability to transfer the content presented in the lec- ture to current astrophysical problems and questions. Dur- ing 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 dis- cussed 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 com- pleted successfully.
Responsible contact	Prof. Dr. Klaus Dolag
Language(s)	English
Additional information	none

Module: WP 33 Cosmology and Large Scale Structures II

(Master of Science, M.Sc.)					
Related mo	odule parts				
Course type	Course (mandatory)	Rota- tion	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)

Master's Programme: Astrophysics

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 follow- ing 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 stu- dents 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 con- tents discussed in the lecture are practised by means of typ- ical applications. This module is recommended to be se- lected 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 de- velop the ability to transfer the content presented in the lec- ture to current astrophysical problems and questions. Dur- ing the exercise course, simple problem solutions shall be independently developed, specified and implemented, both using analytic and, if required, computational approaches.

Relat

Programme

	In this way, students should learn to apply the content dis- cussed 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 com- pleted successfully.
Responsible contact	Prof. Dr. Jochen Weller
Language(s)	English
Additional information	none

Programme

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

Related mo	odule parts				
Course type	Course (mandatory)	Rota- tion	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)

Master's Programme: Astrophysics

(Master of Science, M.Sc.)

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 follow- ing 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 stu- dents with an overview of concepts and applications of se- lected experimental and observational methods in astro- physics. The contents discussed in the lecture are practised by means of typical examples. This module is recom- mended 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 experi- mental 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 com- pleted successfully.
Responsible contact	Prof. Dr. Joseph Mohr
Language(s)	English
Additional information	none

Programme

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

Related mo	odule parts				
Course type	Course (mandatory)	Rota- tion	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)

Master's Programme: Astrophysics

(Master of Science, M.Sc.)

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 follow- ing 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 stu- dents with an overview of concepts and applications of se- lected 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 stu- dents' forthcoming Master's Thesis.
Learning outcomes	By providing basic knowledge and insights into theoretical and numerical methods in astrophysics as well as their con- crete 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, speci- fied 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 practi- cal 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 com- pleted 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

Programm	e Master (Master	's Progra r of Scier	mme: Astrophysics nce, M.Sc.)		
Related mo	odule parts				
Course type	Course (mandatory)	Rota- tion	Contact hours	Self-study hours	ECTS
Seminar	WP 36.1 Scientific Working Methods in the Area of Experi- mental Working and Instrument Development in Astronomy (Pro- iect Seminar)	WiSe and SoSe	60 h (4 SWS)	120 h	(6)
Collo- quium	WP 36.2 Scientific Working Methods in the Area of Experi- mental Working and Instrument Development in Astronomy (Col- loquium)	WiSe and SoSe	60 h (4 SWS)	120 h	(6)

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 fol- lowing rules:
	There must be taken exactly one of the compulsory elec- tive areas "Experimental Working and Instrument Devel- opment in Astronomy" and "Development and Applica- tion of Theoretical and Numerical Methods in Astro- physics".
	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 semes- ter.
Content	The core content of the module is the preparation of a scientific research project, with focus on the required scientific <i>working methods</i> , 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 meth- ods from one of the main areas of research in astron- omy, and comprises a preparatory project split into dif- ferent tasks.
	By working on such preparatory tasks/sub-projects, stu- dents should familiarise with the area-specific experi- mental 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, discuss- ing the astronomical background, and outlining current problems.
	The corresponding colloquium is aimed at reflecting on and discussing fundamental issues in the chosen sub- ject, particularly regarding its current state of research and related observations and instruments. Morevoer, the colloquium should clarify the student's progress in un- derstanding 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/astro- nomical fields central to their future Master's thesis. The focus is here on the scientific <i>working methods</i> in the area of "Experimental Working and Instrument Develop- ment in Astronomy". Particularly, the students should acquire the necessary knowledge and theoretical and practical skills to such an extent that they can success- fully 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. Stu- dents 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 fo- rum 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 examina- tion (or the examination of pertinent mandatory and po- tential 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

Programm	e Master's F (Master of	Programn Science,	ne: Astrophysics M.Sc.)		
Related mo	odule parts				
Course type	Course (mandatory)	Rota- tion	Contact hours	Self-study hours	ECTS
Seminar	WP 37.1 Scientific Working Methods in the Area of Develop- ment and Application of Theo- retical and Numerical Methods in Astrophysics (Project Semi- nar)	WiSe and SoSe	60 h (4 SWS)	120 h	(6)
Collo- quium	WP 37.2 Scientific Working Methods in the Area of Develop- ment and Application of Theo- retical and Numerical Methods in Astrophysics (Colloquium)	WiSe and SoSe	60 h (4 SWS)	120 h	(6)

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 follow- ing rules:
	There must be taken exactly one of the compulsory elective areas "Experimental Working and Instrument Development in Astronomy" and "Development and Application of Theo- retical 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 compul- sory 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 sci- entific research project, with focus on the required scien- tific <i>working methods</i> , and regarding the area of the "De- velopment and Application of Theoretical and Numerical Methods in Astrophysics". A project seminar and a collo- quium 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 in- separable unit and must therefore be taken in the same working group in which the Master's thesis is to be con- ducted. The module contains concepts and methods from one of the main areas of research in astrophysics, and com- prises a preparatory project split into different tasks.
	By working on such preparatory tasks/sub-projects, stu- dents should familiarise with the area-specific theoretical and numerical methods. The lecturer/supervisor will organ- ise the sub-projects under individual guidance and give ad- vice 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 re- lated to the astrophysical area of their future Master's the- sis, 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 pro- gress 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 lit- erature study, which is intensified by working on case stud- ies. The aim is, among others, to create an oral and/or poster-presentation, as well as an essay that might be valu- able for the introduction of the written version of the Mas- ter's thesis.
Learning outcomes	The aim of this module is to familiarise students with the current state of research in those astrophysical fields cen- tral to their future Master's thesis. The focus is here on the scientific <i>working methods</i> 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 suc- cessfully 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. Stu- dents 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 re- veal the students' progress in understanding all relevant topics and issues.
Type of examination	Presentation
Type of examination Type of assessment	Presentation The successful completion of the module will not be graded.
Type of examination Type of assessment Requirements for the gain of ECTS credits	PresentationThe successful completion of the module will not be graded.ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been com- pleted successfully.
Type of examination Type of assessment Requirements for the gain of ECTS credits Responsible contact	PresentationThe successful completion of the module will not be graded.ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been com- pleted successfully.Prof. Dr. Thomas Preibisch
Type of examination Type of assessment Requirements for the gain of ECTS credits Responsible contact Language(s)	PresentationThe successful completion of the module will not be graded.ECTS credits will be granted when the module examination (or the examination of pertinent mandatory and potential elective compulsary module parts) has/have been com- pleted successfully.Prof. Dr. Thomas PreibischEnglish

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

Programme N ('s Program r of Scienc	nme: Astrophysics e, M.Sc.)		
Related mo	dule parts				
Course type	Course (mandatory)	Rota- tion	Contact hours	Self-study hours	ECTS
Seminar	WP 38.1 Scientific Project Plan- ning in the Area of Experimenta Working and Instrument Devel- opment in Astronomy (Project Seminar)	WiSe I and SoSe	60 h (4 SWS)	120 h	(6)
Tutorial	WP 38.2 Scientific Project Plan- ning in the Area of Experimenta Working and Instrument Devel- opment in Astronomy (Tutorial)	WiSe I and SoSe	60 h (4 SWS)	120 h	(6)

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 fol- lowing rules:
	There must be taken exactly one of the compulsory elec- tive areas "Experimental Working and Instrument Devel- opment 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 Work- ing and Instrument Development in Astronomy", the com- pulsory 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 semes- ter.		
Content	The core content of the module is the preparation of a sci- entific research project, with focus on the required scien- tific <i>project planning</i> , and regarding the area of "Experi- mental Working and Instrument Development in Astron- omy". A project seminar and a tutorial serve as an intro- duction and guidance towards this focus, respectively, and shall be related to potential topics of the future Mas- ter'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 con- ducted. The module contains general and astrophysi- cal/astronomical area-specific concepts, and comprises a preparatory project related to the area of the future Mas- ter'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 guid- ance 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 re- lated to the astrophysical/astronomical area of their future Master's thesis. In particular, they should stress the im- portance of defining the scope, allocating resources effi- ciently, establishing realistic timelines and milestones, im- plementing robust data management strategies, and con- ducting 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 sci- entific <i>project planning</i> , particularly in the area of "Exper- imental Working and Instrument Development in		

	Astronomy", and related to topics central to their future Master's thesis. The students should acquire the neces- sary 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 ei- ther has an experimental/observational character, or con- centrates 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 en- able the supervisors to evaluate the students' progress in understanding and considering all relevant topics and is- sues, 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 examina- tion (or the examination of pertinent mandatory and po- tential 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 Maste (Mast		er's Programme: Astrophysics ter of Science, M.Sc.)			
Related mo	odule parts				
Course type	Course (mandatory)	Rota- tion	Contact hours	Self-study hours	ECTS
Seminar	WP 39.1 Scientific Project Plan- ning in the Area of Development and Application of Theoretical and Numerical Methods in As- trophysics (Project Seminar)	WiSe and SoSe	60 h (4 SWS)	120 h	(6)
Tutorial	WP 39.2 Scientific Project Plan- ning in the Area of Development and Application of Theoretical and Numerical Methods in As- trophysics (Tutorial)	WiSe and SoSe	60 h (4 SWS)	120 h	(6)

Module type	Compulsory elective module with mandatory courses
Usability of the module in other pro- grammes	None
Elective guidelines	The module can be selected in compliance with the fol- lowing 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 mod- ules 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 se- mester.
Content	The core content of the module is the preparation of a scientific research project, with focus on the required scientific <i>project planning</i> , 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 meth- ods 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 in- dividual guidance and, if necessary, will help with ad- vice. 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 Mas- ter's thesis. In particular, they should stress the im- portance of defining the scope, allocating resources ef- ficiently, 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 cho- sen subject. Particular topics (for the considered area of development and application of theoretical and nu- merical methods in Astrophysics) are time-lines, data- management strategies, and risk assessments, and the tutorium should serve to help the student in establish- ing these issues for the considered preparatory project.

Learning outcomes	The aim of this module is to familiarise students with scientific <i>project planning</i> , particularly in the area of "Development and Application of Theoretical and Nu- merical 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 re- quired to successfully plan and conduct a theoretical or computational scientific project, by means of present- ing 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 identify- ing and discussing fundamental issues related to the chosen subject, particular those which have been men- tioned in the above content section. Moreover, the tu- torium will enable the supervisors to evaluate the stu- dents' 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 exami- nation (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 (Master		er's Progran ter of Scienc	nme: Astrophysic e, M.Sc.)	CS		
Related mo	Related module parts					
Course type	Course (mandatory)	Rota- tion	Contact hours	Self-study hours	ECTS	
Master's thesis	WP 40.1 Master's Thesis in th Area of Experimental Working and Instrument Development Astronomy	e WiSe g and in SoSe	-	900 h	(30)	

Module type	Compulsory elective module	
Usability of the module in other programmes	None	
Elective guidelines	The module can be selected in compliance with the fol- lowing rules:	
	There must be taken exactly on of the compulsory elective areas "Experimental Working and Instrument Develop- ment 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 Work- ing and Instrument Development in Astronomy", the com- pulsory 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 semes- ter.	

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 con- text) 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, stu- dents should at first plan the steps that lead to a success- ful 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 scien- tific 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 conse- quences) in the written version of the Master's Thesis. The introduction of the Master's Thesis (mostly, the sci- entific context) might lean on the essay formulated in the module on working methods.
Learning outcomes	Under supervision, students should apply the content-re- lated 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 examina- tion (or the examination of pertinent mandatory and po- tential 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 Maste (Maste		Programn of Science,	ne: Astrophysics , M.Sc.)		
Related mo	odule parts				
Course type	Course (mandatory)	Rota- tion	Contact hours	Self-study hours	ECTS
Master's thesis	WP 41.1 Master's Thesis in the Area of Development and Appli- cation of Theoretical and Nu- merical Methods in Astrophysics	WiSe and SoSe	-	900 h	(30)

Module type	Compulsory elective module
Usability of the module in other programmes	None
Elective guidelines	The module can be selected in compliance with the follow- ing rules:
	There must be taken exactly on of the compulsory elective areas "Experimental Working and Instrument Development in Astronomy" and "Development and Application of Theo- retical 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 compul- sory 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 Numeri- cal 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 As- trophysics/Astronomy. Subsequently, the students will de- scribe 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, stu- dents should at first plan the steps that lead to a successful completion of the topic, following the knowledge and strat- egies 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-re- lated and methodological skills acquired during their stud- ies 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 scien- tific 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 com- pleted successfully.
Responsible contact	Prof. Dr. Thomas Preibisch
Language(s)	English
Additional information	None

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