

WÜRZBURG

Module Catalogue

for the Subject

Physics International

as a Master's with 1 major with the degree "Master of Science" (120 ECTS credits)

Examination regulations version: 2020 Responsible: Faculty of Physics and Astronomy

JMU Würzburg • generated 19-Apr-2025 • exam. reg. data record 88|j44|-|-|H|2020



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The subject is divided into

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Learning Outcomes

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After having successfully completed their studies the graduates safulfil the following requirements:

- The graduates are highly skilled in abstract thinking, they are able to think analytically, they have a high problem-solving competence and are able to structure complex interrelations.
- The graduates have a wide overview of the different areas of physics and of connections to other sciences.
- They have profound knowledge of the mathematical and theoretical basics of physics as well as profound knowledge of the theoretical and experimental methods to gain new insights.
- They are able to transfer their abilities and expertise to research projects and know the current state of research in at least one speciality.
- With the help of primary literature, especially in English, they are able to become acquainted with the current state of research in a speciality .
- They have the ability to independently apply physical and mathematical methods to concrete experimental or theoretical physical tasks, to develop solutions and to interpret and assess the results.
- Even with incomplete information they are in a position to work independently on physical problems, applying scientific methods and following the rules of good scientific practice, and to present, assess and attend to the results and consequences of their work.
- They are able to discuss physical topics on the current state of research with other physicists and also to explain connections to physics to non-scientists.
- As physicists they are able to work in or even lead interdisciplinary and international teams with (natural) scientists and/or engineers in research, industry and economy.

Scientific qualification

- The graduates have profound knowledge of the mathematical, experimental and theoretical basics of physics
- The graduates can resort to profound knowledge of the theoretical and experimental methods to gain new insights
- The graduates have a wide overview of the different areas of physics
- The graduates know scientific areas adjacent to physics and realise interdisciplinary connections .
- The graduates have are highly skilled in abstract thinking, they are able to think analytically, they have a high problem-solving competence and are in a position to structure complex interrelations
- The graduates transfer their abilities and expertise to research projects and know the current state of research in at least one speciality .
- The graduates are able to discuss physical topics on the current state of research with other physicists.
- The graduates are in a position to independently apply physical and mathematical methods to concrete experimental or theoretical physical tasks, to develop solutions and to interpret and assess the results.
- With the help of primary literature, especially in English, the graduates are able to become acquainted with the current state of research in a speciality.

Qualification to start a job

- Even with incomplete information the graduates are in a position to work independently on physical problems, following the rules of good scientific practice, and to present, assess and attend to the results and consequences of their work.
- As physicists the graduates are able to work in or even lead interdisciplinary and international teams with (natural) scientists and/or engineers in research, industry and economy.

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- The graduates have the ability to independently apply physical and mathematical methods to concrete experimental or theoretical physical tasks, to develop solutions and to interpret and assess the results.
- The graduates are able to transfer their abilities and expertise to research projects and know the current state of research in at least one speciality.

Self-development

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- Even with incomplete information the graduates are in a position to work independently on physical problems, and to present, assess and attend to the results and consequences of their work.
- The gradues know the rules of good scientific practice and take them into account

Qualification for social commitment

- The graduates are able to critically reflect scientific developments and to capture their impact on economy, society and environment. (technological impact assessment)
- The graduates have enlargened their knowledge concerning economic, social, natural scientific or cultural questions (to name but a few) and are able to attend to their views reasonably.
- The graduates are able to discuss physical topics on the current state of research with other physicists and also to explain physical correlations to non-scientists.
- The graduates have developped the willingness and ability to show their skills in participative processes and actively contribute to decisions.

Abbreviations used

Course types: \mathbf{E} = field trip, \mathbf{K} = colloquium, \mathbf{O} = conversatorium, \mathbf{P} = placement/lab course, \mathbf{R} = project, \mathbf{S} = seminar, \mathbf{T} = tutorial, $\ddot{\mathbf{U}}$ = exercise, \mathbf{V} = lecture

Term: **SS** = summer semester, **WS** = winter semester

Methods of grading: **NUM** = numerical grade, **B/NB** = (not) successfully completed

Regulations: **(L)ASPO** = general academic and examination regulations (for teaching-degree programmes), **FSB** = subject-specific provisions, **SFB** = list of modules

Other: **A** = thesis, **LV** = course(s), **PL** = assessment(s), **TN** = participants, **VL** = prerequisite(s)

Conventions

Unless otherwise stated, courses and assessments will be held in German, assessments will be offered every semester and modules are not creditable for bonus.

Notes

Should there be the option to choose between several methods of assessment, the lecturer will agree with the module coordinator on the method of assessment to be used in the current semester by two weeks after the start of the course at the latest and will communicate this in the customary manner.

Should the module comprise more than one graded assessment, all assessments will be equally weighted, unless otherwise stated below.

Should the assessment comprise several individual assessments, successful completion of the module will require successful completion of all individual assessments.

In accordance with

the general regulations governing the degree subject described in this module catalogue:

ASPO2015

associated official publications (FSB (subject-specific provisions)/SFB (list of modules)):

06-Feb-2020 (2020-16) 09-Jun-2021 (2021-63) 06-Sep-2022 (2022-55) 12-Jun-2024 (2024-75) 14-Nov-2024 (2024-97)

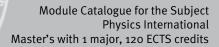
This module handbook seeks to render, as accurately as possible, the data that is of statutory relevance according to the examination regulations of the degree subject. However, only the FSB (subject-specific provisions) and SFB (list of modules) in their officially published versions shall be legally binding.

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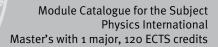
In the case of doubt, the provisions on, in particular, module assessments specified in the FSB/SFB shall prevail.





Electives Field (60 ECTS credits)





Subfield Physics (55 ECTS credits)

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Advanced Laboratory Courses

(9 ECTS credits)

Advanced Laboratory Course Master Part 1 11-P.F.M1-Int-2o1-m01 Managing Director of the Institute of Applied Physics Faculty of Physics and Astronomy ECTS Method of grading Only after succ. comp L. of module(3) 3 (not) successfully completed	Module title				Abbreviation	
Managing Director of the institute of Applied Physics Faculty of Physics and Astronomy ECTS Method of grading Only after succ. compl. of module(s) 3 (not) successfully completed Duration Module level Other prerequisites 1 semester graduate Preparation and safety briefing. Contents Foundations of particle, atomic and molecular physics, low-temperature experiments and correlated systems, solid state properties, surfaces and interfaces. Experiments covering the topics x-ray radiation, nuclear magnetic resonance (NMR), quantum Hall effect, optical pumping and spectroscopy with visible light, Hall effect, super-conductivity, lasers, solid state optics Intended learning outcomes Solid skills in performing an experiment and analyzing and documenting the experimental outcome. Basic know-ledge of how to prepare a scientific publication, of performing and evaluating an experiment, and presenting and discussing the results in the form of a scientific publication. Courses (uper, number of weeky contact hours, language – if other than German) P(3) Module taught in: English Method of assessment (type, scope, language – if other than German, examination offered – if not every semester, information on whether module is creditable for bonus) practical examination Students must successfully prepare, perform, document (lab notebook) and evaluate (in the form of a scientific publication) practical examination	Advanced Laboratory Course Master Part 1				11-P-FM1-Int-201-m01	
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	Adule title Abbreviation					
Advanced Laboratory Course Master Part 2 11-P-FM2-Int-201-m01					11-P-FM2-Int-201-m01	
Module	e coord	inator		Module offered by		
Managing Director of the Institute of Applied Physics				Faculty of Physics a	and Astronomy	
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)		
3	(not) s	successfully completed				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	graduate	Preparation and saf	ety briefing.		
Conten	ts		•			
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Intende	ed lear	ning outcomes				
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Course	S (type, r	umber of weekly contact hours, I	anguage — if other than Gei	rman)		
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fic publ success regulat	sfully c ions ar	omplete two experiment	nsidered to have suc s to be considered to	cessfully completed have successfully c	this experiment. Students must	
fic publ success regulat	sfully c ions ar ge of a	omplete two experiment e laid down in the respec ssessment: English	nsidered to have suc s to be considered to	cessfully completed have successfully c	this experiment. Students must	
fic publ success regulat Langua	sfully c ions ar ge of a	omplete two experiment e laid down in the respec ssessment: English	nsidered to have suc s to be considered to	cessfully completed have successfully c	this experiment. Students must	
fic publ success regulat Langua Allocat	sfully c ions ar ige of a ion of f	omplete two experiment e laid down in the respec ssessment: English	nsidered to have suc s to be considered to	cessfully completed have successfully c	this experiment. Students must	
fic publ success regulati Langua Allocat Additio	sfully c ions ar ge of a ion of p nal inf	omplete two experiments e laid down in the respec ssessment: English blaces	nsidered to have suc s to be considered to	cessfully completed have successfully c	this experiment. Students must	
fic publ success regulat Langua Allocat	sfully c ions ar ge of a ion of p nal inf	omplete two experiments e laid down in the respec ssessment: English blaces	nsidered to have suc s to be considered to	cessfully completed have successfully c	this experiment. Students must	
fic publ success regulat Langua Allocat Additio Worklo 90 h	sfully c ions ar ge of a ion of p nal info ad	omplete two experiments e laid down in the respect ssessment: English olaces	nsidered to have suc s to be considered to	cessfully completed have successfully c	this experiment. Students must	
fic publ success regulati Langua Allocat Additio Worklo	sfully c ions ar ge of a ion of p nal info ad	omplete two experiments e laid down in the respect ssessment: English olaces	nsidered to have suc s to be considered to	cessfully completed have successfully c	this experiment. Students must	
fic publ success regulat Langua Allocat Additio Worklo 90 h	sfully c ions ar ge of a ion of p nal info ad	omplete two experiments e laid down in the respect ssessment: English olaces	nsidered to have suc s to be considered to	cessfully completed have successfully c	this experiment. Students must	
fic publ success regulati Langua Allocat Additio 90 h Teachin 	sfully c ions ar ige of a ion of p mal info ad	omplete two experiments e laid down in the respect ssessment: English olaces	nsidered to have suc s to be considered to ctive module descript	cessfully completed have successfully co ion.	this experiment. Students must	
fic publ success regulati Langua Allocati Additio Boh Teachin Referre	sfully c ions ar ige of a ion of p mal info ad ng cycl	omplete two experiments e laid down in the respects ssessment: English places ormation e LPO I (examination regulation	nsidered to have suc s to be considered to ctive module descript	cessfully completed have successfully co ion.	this experiment. Students must	
fic publ success regulati Langua Allocat Additio 90 h Teachin Referre Module	sfully c ions ar ige of a ion of p mal inf ad ng cycl ed to in	omplete two experiments e laid down in the respect ssessment: English places ormation e LPO I (examination regulation ars in	nsidered to have suc s to be considered to ctive module descript	cessfully completed have successfully co ion.	this experiment. Students must	
fic publ success regulati Langua Allocat Additio Worklo 90 h Teachin Referre Module	sfully c ions ar ige of a ion of p mal info ad ad ad ad ad ad ad ad ad ad ad ad ad	e LPO I (examination regulation urs in e (1 major) Physics Inter	nsidered to have suc s to be considered to ctive module descript s for teaching-degree progra	cessfully completed have successfully co ion.	this experiment. Students must	
fic publ success regulati Langua Allocat Additio Worklo 90 h Teachin Referre Module Master Master	sfully c ions ar ige of a ion of p onal info ad ad ad ad ad ad ad ad ad ad ad ad ad	omplete two experiments e laid down in the respect ssessment: English places ormation e LPO I (examination regulation urs in ee (1 major) Physics Inter ee (1 major) Quantum En	nsidered to have suc s to be considered to ctive module descript s for teaching-degree progra	cessfully completed have successfully co ion.	this experiment. Students must	
fic publ success regulati Langua Allocat Additio 90 h Teachir Referre Master Master exchan	sfully c ions ar ige of a ion of p mal info ad ad ad ad ad ad ad ad ad ad ad ad ad	e LPO I (examination regulation urs in e (1 major) Physics Inter	nsidered to have suc s to be considered to ctive module descript s for teaching-degree progra mational (2020) gineering (2020)	cessfully completed have successfully co ion.	this experiment. Students must	

Module title				Abbreviation	
Advanced Laboratory Course Master Part 3					11-P-FM3-Int-201-m01
Module coordinator				Module offered by	
Managi	ng Dire	ector of the Institute of Ap	plied Physics	Faculty of Physics a	nd Astronomy
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)	
3	(not) s	successfully completed			
Duratio	n	Module level	Other prerequisites		
1 semes	ster	graduate	Preparation and safe	ety briefing.	
Content	ts				
solid st tic reso	ate pro nance	perties, surfaces and int	erfaces. Experiments	covering the topics	nents and correlated systems, x-ray radiation, nuclear magne- th visible light, Hall effect, super-
Intende	ed learn	ning outcomes			
ledge o ge of ex	f how t cperime	o prepare a scientific pub	olication and use stat cientific publications	e-of-the-art analysis , of performing and	perimental outcome. Basic know- s systems and software. Knowled- evaluating an experiment, and
Courses	S (type, n	umber of weekly contact hours, l	anguage — if other than Ger	man)	
P (3) Module	taugh	t in: English			
		s essment (type, scope, langua ₎ le for bonus)	ge — if other than German, e	examination offered — if no	t every semester, information on whether
fic publ success regulati	ts mus ication sfully c ions ar	t successfully prepare, pe) an experiment to be co	nsidered to have suc to be considered to	cessfully completed have successfully co	aluate (in the form of a scienti- this experiment. Students must ompleted this module. Detailed
Allocati	ion of p	olaces			
Additio	nal inf	ormation			
Worklo	ad				
90 h					
Teaching cycle					
-					
Referred to in LPO I (examination regulations for teaching-degree programmes)					
Module appears in					
	-	ee (1 major) Physics Inter ee (1 major) Quantum Eng			
	-	gram Physics (2023)	5meening (2020)		
	Master's degree (1 major) Quantum Engineering (2024)				
Master'	Master's degree (1 major) Physics International (2024)				

Module	Module title Abbreviation				
Advanc	ed Lab	oratory Course Master Pa	art 4		11-P-FM4-Int-201-m01
Module coordinator				Module offered by	
Managi	ng Dire	ector of the Institute of Ap	plied Physics	Faculty of Physics a	and Astronomy
ECTS	Metho	od of grading	Only after succ. com	npl. of module(s)	
3					
Duratio	n	Module level	Other prerequisites		
1 seme	ster	graduate	Preparation and safe	ety briefing.	
Conten	ts				
solid st tic reso	ate pro nance	perties, surfaces and int	erfaces. Experiments	covering the topics	nents and correlated systems, x-ray radiation, nuclear magne- ith visible light, Hall effect, super
Intende	ed learr	ning outcomes			
ledge o ge of e>	f how t kperime	o prepare a scientific pul	olication and use stat cientific publications	te-of-the-art analysis , of performing and	perimental outcome. Basic know s systems and software. Knowled evaluating an experiment, and
Course	S (type, n	umber of weekly contact hours, l	anguage — if other than Ger	rman)	
P (3) Module	taugh	t in: English			
		le for bonus)	ge — If other than German, e	examination offered — if no	ot every semester, information on whether
Studen fic publ success regulat	ts mus lication sfully c ions ar) an experiment to be co	nsidered to have suc to be considered to	cessfully completed have successfully co	aluate (in the form of a scienti- this experiment. Students must ompleted this module. Detailed
Allocat	ion of p	olaces			
Additio	nal inf	ormation			
Worklo	ad				
90 h					
Teachir	ng cycl	e			
Referred to in LPO I (examination regulations for teaching-degree programmes)					
Module					
	-	ee (1 major) Physics Inter			
	-	ee (1 major) Quantum Eng	gineering (2020)		
		gram Physics (2023)	ringering (agg ()		
	-	ee (1 major) Quantum Eng ee (1 major) Physics Inter			
mastel	5 uegle	ee (1 major) Enysics miler	national (2024)		



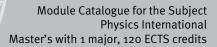
Advanced Seminar

(5 ECTS credits)

Module	Module title Abbreviation					
Advanc	ed Sen	ninar Physics A			11-OSP-A-Int-201-m01	
Module coordinator Module offered by					<u> </u>	
Manag	ing Dire	ector of the Institute of Ap	oplied Physics	Faculty of Physics a	ind Astronomy	
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)		
5	nume	rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	ts					
Semina	ar on cu	irrent topics in theoretica	l and experimental p	hysics		
Intende	ed lear	ning outcomes				
		/ledge about a current to rizing them and presentir			. Ability to read scientific publica-	
Course	S (type, r	number of weekly contact hours, l	anguage — if other than Ger	man)		
S (2) Module	e taugh	t in: English				
		sessment (type, scope, langua le for bonus)	ge — if other than German, e	examination offered — if no	ot every semester, information on whether	
		ussion (30 to 45 minutes) ssessment: English				
Allocat	ion of p	olaces				
Additio	nal inf	ormation				
Worklo	ad					
150 h						
Teachi	ng cycl	e				
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module	Module appears in					
	Master's degree (1 major) Physics International (2020)					
		gram Physics (2023) ee (1 major) Physics Inter	national (2024)			

Module	Module title Abbreviation					
Advanc	ed Sen	ninar Physics B			11-OSP-B-Int-201-m01	
Module coordinator Module offered by					<u> </u>	
Manag	ing Dire	ector of the Institute of Ap	plied Physics	Faculty of Physics a	and Astronomy	
ECTS	Metho	od of grading	Only after succ. con	pl. of module(s)		
5	nume	rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	ts					
Semina	ar on cu	irrent topics in theoretica	l and experimental p	hysics.		
Intende	ed lear	ning outcomes				
		/ledge about a current to rizing them and presentir			Ability to read scientific publica-	
Course	S (type, r	number of weekly contact hours, l	anguage — if other than Ger	man)		
S (2) Module	e taugh	t in: English				
		sessment (type, scope, langua le for bonus)	ge — if other than German, o	examination offered — if no	ot every semester, information on whether	
		ussion (30 to 45 minutes) ssessment: English				
Allocat	ion of p	olaces				
Additio	nal inf	ormation				
Worklo	ad					
150 h						
Teachi	ng cycl	e				
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module	Module appears in					
Master	Master's degree (1 major) Physics International (2020)					
		gram Physics (2023) ee (1 major) Physics Inter	national (2024)			



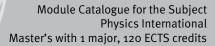


Experimental Physics

(10 ECTS credits)

Module title					Abbreviation		
Image and Signal Processing in Physics					11-BSV-Int-201-m01	L	
Module	coord	inator		Module offered by			
Managi	ng Dire	ector of the Institute of	Applied Physics	Faculty of Physics a	nd Astronomy		
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)			
6	nume	rical grade					
Duratio	n	Module level	Other prerequisites				
1 seme	ster	graduate					
Conten	ts						
of the d rem, co	ligital s rrelatio	periodic signals; basic ignal and image proces on and energy consider el and Radon transform	ssing; discretization of ation; statistical signal	signals/Shannon sa	impling theorem; Pa	rsival theo-	
Intende	ed lear	ning outcomes					
process	sing an	wledge about digital in d various methods of s ng them to tomography	ignal processing. Capa				
Course	S (type, r	umber of weekly contact hours	, language — if other than Ger	man)			
V (2) + I Module	• •	t in: English					
		s essment (type, scope, lang le for bonus)	uage — if other than German, e	examination offered — if no	t every semester, informat	ion on whether	
 a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English 							
Allocati		ffered: In the semester blaces					
	•						
Additio	nal inf	ormation					
Worklo	ad						
180 h							
Teaching cycle							
Referred to in LPO I (examination regulations for teaching-degree programmes)							
Module	appea	irs in					
Master' Master'	Module appears inMaster's degree (1 major) Physics International (2020)Master's degree (1 major) Quantum Engineering (2020)exchange program Physics (2023)						
Master's wi	th 1 majo	Physics International (2020)		generated 19-Apr-2025 • exa r (120 ECTS) Physics Internati		page 21 / 196	





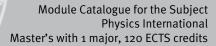
Master's degree (1 major) Quantum Engineering (2024) Master's degree (1 major) Physics International (2024)

Module title					Abbreviation	
Organic Semiconductors					11-OHL-Int-201-m01	
Module	coord	nator		Module offered by		
Managi	ng Dire	ctor of the Institute of Ap	plied Physics	Faculty of Physics a	nd Astronomy	
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)		
6	nume	rical grade				
Duratio	n	Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	ts					
Fundan ons.	nentals	of organic semiconducto	ors, molecular and po	lymer electronics ar	nd sensor technology, applicati-	
Intende	ed learr	ning outcomes				
In-dept	h know	ledge of the properties o	f organic semicondu	ctor materials and th	eir applications.	
Course	S (type, n	umber of weekly contact hours, l	anguage — if other than Ger	man)		
V (3) + I Module		t in: English				
		essment (type, scope, langua; le for bonus)	ge — if other than German, e	examination offered — if no	t every semester, information on whether	
c) oral e d) proje e) prese If a writ stead ta of asse nation Langua	 b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes) If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English Assessment offered: In the semester in which the course is offered and in the subsequent semester 					
Additio	nal info	ormation				
Worklo	ad					
180 h						
Teachir	ng cycle	2				
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)					
Module appears in						
	-	ee (1 major) Physics Inter				
	-	ee (1 major) Quantum Eng	gineering (2020)			
		gram Physics (2023) ee (1 major) Quantum Eng	vineering (2024)			
	-	ee (1 major) Physics Inter				

Module title					Abbreviation	
Physics of Advanced Materials					11-PMM-Int-201-m01	
Module	coord	inator		Module offered by		
Managi	ng Dire	ector of the Institute of Ap	plied Physics	Faculty of Physics a	nd Astronomy	
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)		
6	nume	rical grade				
Duratio	n	Module level	Other prerequisites			
1 semes	ster	graduate				
Content	ts					
als and	super		eterostructures and si		d polymers; magnetic materi- Is to characterize these material	
Intende	ed lear	ning outcomes				
Familia	rity wit	h the properties and cha	racterization methods	s of various groups o	of modern materials.	
Courses	S (type, r	number of weekly contact hours, l	anguage — if other than Ger	man)		
V (3) + F Module		t in: English				
		essment (type, scope, langua le for bonus)	ge — if other than German, e	examination offered — if no	t every semester, information on whether	
c) oral e d) proje e) prese If a writ stead ta of asses nation o Langua	 a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English Assessment offered: In the semester in which the course is offered and in the subsequent semester 					
Allocati	ion of p	olaces				
Additio	nal inf	ormation				
Worklo	ad					
180 h						
Teachin	ıg cycl	e				
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module	Module appears in					
Master's degree (1 major) Physics International (2020) Master's degree (1 major) Quantum Engineering (2020) exchange program Physics (2023) Master's degree (1 major) Quantum Engineering (2024) Master's degree (1 major) Physics International (2024)						

Module title					Abbreviation	
Spintronics 11-SPI-Int-201-mc				11-SPI-Int-201-m01		
Module	e coord	inator		Module offered by		
Manag	Managing Director of the Institute of Applied Physics Fa			Faculty of Physics a	nd Astronomy	
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)		
6	nume	rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	ts					
giant m current	agneto	the basic principles of presistance and tunnel r ed spin phenomena are	nagnetoresistance. Ne			
Intende	ed learr	ning outcomes				
	. Overvi	basic principles of spin ew over the state-of-the	•		•	
Course	S (type, n	umber of weekly contact hours	, language — if other than Gei	rman)		
V (3) + Module	• •	t in: English				
		s essment (type, scope, langu le for bonus)	uage — if other than German,	examination offered — if no	t every semester, informati	on on whether
 a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English Assessment offered: In the semester in which the course is offered and in the subsequent semester 						
Allocat	ion of p	olaces				
Additio	nal info	ormation				
Worklo	ad					
180 h						
Teachi	ng cycl	e				
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module appears in						
Master exchan	's degre ge prog	ee (1 major) Physics Inte ee (1 major) Quantum E gram Physics (2023) ee (1 major) Quantum E	ngineering (2020)			
Master's wi	ith 1 major	Physics International (2020)	-	generated 19-Apr-2025 • exa r (120 ECTS) Physics Internation	-	page 25 / 196





Master's degree (1 major) Physics International (2024)

Module title					Abbreviation	
Solid State Physics 2					11-FK2-Int-201-m01	
Module	coord	inator		Module offered by		
Managi	ng Dire	ector of the Institute of Ap	plied Physics	Faculty of Physics a	nd Astronomy	
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)		
8		rical grade				
Duratio		Module level	Other prerequisites			
1 seme	ster	graduate		ination committee re	equired.	
Conten	ts					
a. Elect b. Block c. Elect 2. Semi a. Elect b. Ferm c. Elect d. Boltz 3. The c a. Macr b. Polar plasmo c. Ferro 4. Semi a. Chara b. Intrir c. Dope d. Phys e. Hetel 5. Magr a. Atom b. Dia- c. Ferro 6. Supe	1 semester graduate Approval from examination committee required. Contents . 1. Electrons in a periodic potential – the band structure . a. Electrical and thermal transport b. Bloch theorem c. Electrons . 2. Semi-classical models of dynamic processes . a. Electrical transport in partially and completely filled bands . b. Fermi surfaces; measurement techniques . c. Electrical transport in external magnetic fields . d. Boltzmann-equations of transport . 3. The dielectric function and ferroelectrics . a. Macroscopic electrodynamics and microscopic theory . b. Polarizability of solids, of lattices, of valence electrons and quasi-free electrons; optical phonons, polaritons, plasmons, inter-band transitions, Wannier-Mott excitons c. Ferromagnetism . 4. Semiconductors . c. Doped semiconductors . d. Physics and applications of p-n junctions . e. Heterostructures . 5. Magnetism . a. Atomic dia- and paramagnetism . b. Dia- and paramagnetism . b. Dia- and paramagnetism <t< td=""></t<>					
		ning outcomes	dols in advanced col	id state physics. Far	niliarity with the theoretical prin	
		effects, concepts and mo h applications of experim		iu state physics. Fan	niliarity with the theoretical prin-	
· · · · · ·		umber of weekly contact hours, l	anguage — if other than Ger	man)		
V (4) + l Module		t in: English				
			ge — if other than German. 6	examination offered — if no	t every semester, information on whether	
					, ,	
b) oral (c) oral (d) proje	a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes).					

UNIVERSITÄT WÜRZBURG

If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.

Language of assessment: English

Assessment offered: In the semester in which the course is offered and in the subsequent semester

Allocation of places

Additional information

--

Workload

240 h

Teaching cycle

Referred to in LPO I (examination regulations for teaching-degree programmes)

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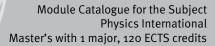
Module appears in

Master's degree (1 major) Physics International (2020) Master's degree (1 major) Quantum Engineering (2020) exchange program Physics (2023) Master's degree (1 major) Quantum Engineering (2024) Master's degree (1 major) Physics International (2024)

Module title				Abbreviation		
Solid State Spectrocopy					11-FKS-Int-201-m01	
Module	e coord	inator		Module offered by		
Manag	ing Dire	ector of the Institute of	Applied Physics	Faculty of Physics a	nd Astronomy	
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)		
6	nume	rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	ts					
		ny particle picture of e X-ray spectroscopies.	lectrons in solids, Ligh	t-matter interaction,	Optical spectroscop	y, Electron
Intend	ed lear	ning outcomes				
	their a		solid-sate spectroscopy ding of the theoretical			
Course	S (type, r	number of weekly contact hour	s, language — if other than Gei	rman)		
V (3) + Module		t in: English				
		sessment (type, scope, lang le for bonus)	uage — if other than German,	examination offered — if no	t every semester, informati	on on whether
e) pres If a writ stead t of asse nation Langua	entatio tten exa ake the essmen date at age of a ment o	e form of an oral examin t is changed, the lectur the latest. ssessment: English ffered: In the semester		e each or an oral exam s about this by four	mination in groups. weeks prior to the or	If the method riginal exami-
Allocal		Jaces				
Additio	onal inf	ormation				
 Worklo	ad					
180 h	<u>au</u>					
	ng cycl	۹	_			
	is cyce					
Roforro	d to in	IPOI (ovamination regulation	one for toaching dogroo progra	mmos)		
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module appears in						
Master Master exchan Master	's degr 's degr ige prog	ee (1 major) Physics Int ee (1 major) Quantum E gram Physics (2023) ee (1 major) Quantum E ee (1 major) Physics Int	ingineering (2020) Ingineering (2024)			
Master's w	ith 1 majo	r Physics International (2020)		generated 19-Apr-2025 • exa r (120 ECTS) Physics Internation	-	page 29 / 196
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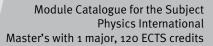
Module title Abbr					Abbreviation	
Magnetism					11-MAG-Int-201-mo	1
Module	e coord	inator		Module offered by		
Managi	ng Dire	ector of the Institute of A	pplied Physics	Faculty of Physics a	nd Astronomy	
ECTS	Metho	od of grading	Only after succ. con	pl. of module(s)		
6	nume	rical grade				
Duratio	n	Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	ts					
		nagnetism, Exchange in gnetism, Superparamag				
Intende	ed leari	ning outcomes				
measur to apply	re them y these	the basic terminology, o . Skills in constructing s skills to the mentioned ability of assessing the p	simple models and de fields of magnetism.	scribing the mathem Competence to inde	atical formalism, an pendently solve prol	d the ability
Course	S (type, n	umber of weekly contact hours,	language — if other than Ger	man)		
V (3) + I Module		t in: English				
		s essment (type, scope, langu le for bonus)	age — if other than German, o	examination offered — if no	t every semester, informati	ion on whether
 a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English 						
Allocati		ffered: In the semester i blaces			issequent semester	
Additio	nal inf	ormation				
Worklo	ad					
180 h						
Teaching cycle						
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module	appea	rs in				
Master' Master'	's degre 's degre	ee (1 major) Physics Inte ee (1 major) Quantum Er gram Physics (2023)				
Master's wi	th 1 majoı	Physics International (2020)		generated 19-Apr-2025 • exa (120 ECTS) Physics Internati		page 30 / 196





Master's degree (1 major) Quantum Engineering (2024) Master's degree (1 major) Physics International (2024)

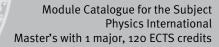
Module	Module title Abbreviation						
Optical Properties of Semiconductor Nanostructures					11-HNS-Int-201-mo:	1	
Module	e coord	inator		Module offered by			
Manag	ing Dire	ector of the Institute of	Applied Physics	Faculty of Physics a	and Astronomy		
ECTS	Meth	od of grading	Only after succ. cor	mpl. of module(s)			
6	nume	rical grade					
Duratio	on	Module level	Other prerequisites	5			
1 seme	ster	graduate					
Conten	ts						
or mach ging the tures o with a f of nove for qua	roscop eir size f varyir focus o el optoe ntum c	or Nanostructures are f ic crystals, their electro . The lecture addresses og dimensions (2D, 1D, n optical properties an electronic and quantum ommunication and quantum	nic, optical and magnes s technological challen oD). It provides the ba d light-matter coupling n photonic devices bas	etic properties can be ages in the preparatic sic theoretical conce g. Moreover, it discus ed on such nanostru	e systematically tailo on of semiconductor pts to describe their ses the challenges a	ored via chan- nanostruc- properties, and concepts	
		ning outcomes					
founda	tions. I	h the fundamental pro Knowledge of the techr c devices.					
Course	S (type, r	number of weekly contact hour	s, language — if other than Ge	erman)			
V (3) + Module		t in: English					
		s essment (type, scope, lang le for bonus)	guage — if other than German,	examination offered — if no	ot every semester, informat	ion on whether	
 a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English Assessment offered: In the semester in which the course is offered and in the subsequent semester 							
Allocat	ion of _l	olaces					
 Additio 	Additional information						
Worklo	ad						
180 h							
Teachi	ng cycl	e					
Referre	ed to in	LPO I (examination regulation	ons for teaching-degree progr	ammes)			
Module	e appea	ars in					
Master's wi	ith 1 majo	r Physics International (2020)	-	• generated 19-Apr-2025 • exa er (120 ECTS) Physics Internati	-	page 32 / 196	



Master's degree (1 major) Physics International (2020) Master's degree (1 major) Quantum Engineering (2020) exchange program Physics (2023) Master's degree (1 major) Quantum Engineering (2024) Master's degree (1 major) Physics International (2024)

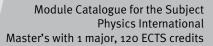
Module title				Abbreviation		
Semiconductor Physics					11-HPH-Int-201-m01	
Module	e coord	inator		Module offered by		
Managi	ing Dire	ector of the Institute of	Applied Physics	Faculty of Physics a	ind Astronomy	
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)		
6	nume	rical grade				
Duratio	n	Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	ts					
structu tronic p studies lowered	re, lead propert how tl d dime	als with the fundamen ling to methods for des ies of monolithic semic nese can be used to mo nsionality systems. Exa	cribing band structure onductors. It then turn odify and design optica	s. These form a basis s to examining semi l and electrical prop	s for discussing optic conductor heterostru erties, especially in f	cal and elec- ictures, and
		ning outcomes				
and ba	nd stru	e student with a working ctures, as well as elect eted specially lectures	rical and optical prope			
Course	S (type, r	number of weekly contact hour	s, language — if other than Gei	rman)		
V (3) + Module		t in: English				
		sessment (type, scope, lang le for bonus)	uage — if other than German,	examination offered — if no	ot every semester, informati	on on whether
 a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English Assessment offered: In the semester in which the course is offered and in the subsequent semester 						
Additio	nal inf	ormation				
Worklo	ad					
180 h						
Teaching cycle						
Referre	d to in	LPO I (examination regulati	ons for teaching-degree progra	mmes)		
Module appears in						
	-	ee (1 major) Physics Int ee (1 major) Quantum E				
Master's wi	ith 1 majo	r Physics International (2020)	-	generated 19-Apr-2025 • exa r (120 ECTS) Physics Internati	-	page 34 / 196





exchange program Physics (2023) Master's degree (1 major) Quantum Engineering (2024) Master's degree (1 major) Physics International (2024)

Module title					Abbreviation		
Quantum Transport					11-QTR-Int-201-m01		
Module	e coord	inator		Module offered by			
Managi	ing Dire	ector of the Institute of Ap	oplied Physics	Faculty of Physics a	nd Astronomy		
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)			
6	nume	rical grade					
Duratio	n	Module level	Other prerequisites				
1 seme	ster	graduate					
Conten	ts						
action a as well the qua of supe Low dir vant ma tals, an	The lecture addresses the fundamental transport phenomena of electrons in solids where Electron-electron inter- action and the wave nature are the determining factors. This includes the diffusive and ballistic transport regime as well as the Coulomb blockade. Observations of electron interference effects, conductance quantization and the quantum Hall effect will be discussed. Thermoelectric properties of electronic system and the phenomenon of superconductivity will be examined as well. Low dimensional electron systems and its quantum mechanical description are the basis of this lecture. Rele- vant material systems are semiconductor heterostructures as well as topological insulators, topological semime- tals, and topological superconductors. The content will be guided by actual research results. Intended learning outcomes						
		ults critical.					
		number of weekly contact hours, l	anguage — if other than Ger	man)			
V (3) +							
		t in: English					
		Sessment (type, scope, langua le for bonus)	ge — If other than German, e	examination offered — if no	t every semester, informat	ion on whether	
 module is creditable for bonus) a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English Assessment offered: In the semester in which the course is offered and in the subsequent semester 							
Allocat	ion of p	olaces					
Additio	nal inf	ormation					
Workload							
180 h							
Teachi	ng cycl	e					
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module	e appea	ars in					
Master's wi	ith 1 majo	r Physics International (2020)	JMU Würzburg •	generated 19-Apr-2025 • exa	am. reg. da-	page 36 / 196	



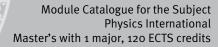
Module tit	le			Abbreviation
Advanced ⁻	Theory of Quantum Computi	ng and Quantum Info	ormation	11-QIC-Int-201-m01
Module co				
Managing and Astrop	Director of the Institute of Th hysics	eoretical Physics	Faculty of Physics	and Astronomy
ECTS Me	ethod of grading	Only after succ. con	npl. of module(s)	
6 nu	merical grade			
Duration	Module level	Other prerequisites	;	
1 semester	graduate			
Contents				
 3. Compos 4. Entangle 5. Quantun 6. Quantur 	n theory seen from the persp ite systems and the Schmidt ement measures n operations, POVMs, and th n gates and quantum compu s of the theory of decoheren	t decomposition ne theorems of Kraus uters		
	earning outcomes			
depth unde cepts of qu herence.	erstanding of the phenomen Jantum information theory. A	on of entanglement. Ability to assess the l	Knowledge of the fu imitations of quantu	ultipartite quantum systems. In- undamental mathematical con- um computing arising from deco-
	pe, number of weekly contact hours, l	anguage — if other than Ge	rman)	
V (3) + R (1) Module tai) ught in: English			
	assessment (type, scope, langua litable for bonus)	ge — if other than German,	examination offered — if n	ot every semester, information on whether
b) oral exa c) oral exa d) project r e) presenta If a written stead take of assessm nation date Language o	the form of an oral examination	ach (approx. 30 minu of 2, approx. 30 minu s) or es). method of assessm tion of one candidate must inform student	ites per candidate) c ent, this may be cha e each or an oral exa ts about this by four	anged and assessment may in- amination in groups. If the method weeks prior to the original exami-
Allocation	of places			
Additional	information			
Workload				
180 h				
Teaching c	ycle			

Referred to in LPO I (examination regulations for teaching-degree programmes)

Module appears in

Module	Module title Abbreviation					
Nano-O	Optics				11-NOP-Int-201-mon	L
Module	e coord	inator		Module offered by		
Managi	ing Dire	ector of the Institute of	Applied Physics	Faculty of Physics a	ind Astronomy	
ECTS Method of grading Only after succ.			Only after succ. con	npl. of module(s)		
6	nume	rical grade				
Duratio	on	Module level	Other prerequisites	i i		
1 semester graduate						
Conten	ts					
from th copy ar basis, c 2D, 1D tennas.	e discu re discu quantu and o c	ission of the focusing o issed. In the following, m emitters are introduc dimensions are introduc	amentals, experimenta of light. Based on this, t the near-field optical r ced and their light emis ced and discussed in c	the fundamentals of nicroscopy is introdu ssion in nano-enviror	modern far-field opt uced and discussed. nments is derived. Pl	ical micros- As a further asmons in
	-	ning outcomes				
			he topic of nano-optics ell as the current deve			escription
Course	S (type, r	number of weekly contact hour	s, language — if other than Ge	rman)		
V (3) + Module		t in: English				
Method	d of ass	sessment (type, scope, lang	uage — if other than German,	examination offered — if no	ot every semester, informati	on on whether
		le for bonus)				
 b) oral c) oral of d) projection e) pressent lf a write stead ta of assent Langua Assess 	examir examin ect repo entatio tten exa ake the ssmen date at ge of a ment o	ation in groups (group ort (approx. 8 to 10 pag n/talk (approx. 30 min amination was chosen e form of an oral examin t is changed, the lectur the latest. ssessment: English ffered: In the semester	e each (approx. 30 minu s of 2, approx. 30 minu es) or	tes per candidate) o ent, this may be cha e each or an oral exa s about this by four	nged and assessmer mination in groups. weeks prior to the or	If the method
Allocat	ion of p	olaces				
Additio	nal inf	ormation				
Worklo	ad					
180 h						
Teachi	ng cycl	e				
Referre	d to in	LPO I (examination regulation	ons for teaching-degree progra	ammes)		
	_					
Module						
	-	ee (1 major) Physics Int ee (1 major) Quantum I				
Master's wi	ith 1 majo	r Physics International (2020)	-	generated 19-Apr-2025 • exa r (120 ECTS) Physics Internati	-	page 40 / 196





exchange program Physics (2023) Master's degree (1 major) Quantum Engineering (2024) Master's degree (1 major) Physics International (2024)

Module	e title				Abbreviation
Phenor	menolo	gy and Theory of Superc	onductivity		11-PTS-Int-201-m01
Module	e coord	inator		Module offered by	
-	ing Dire	ector of the Institute of Ap ector of the Institute of Th sics	, ,	Faculty of Physics a	and Astronomy
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)	
6	nume	rical grade			
Duratio	on	Module level	Other prerequisites	i	
1 seme	ster	graduate			
Conten	ts		·		
vention superce grams a des, ph of the H	nal and onduct and fur nase flu Higgs m	unconventional superco ors. Extension of Ginzbur actional integrals. Theore actuations, and coupling	nductivity. Review of g-Landau theory to a tical formalism of Wa to the electromagnet nagnetism and conve	BCS theory and its a quantum field theor and identities and res ic field. Interpretatio ntional/unconventio	iew of the phenomenology of con- applicability for different types of ry formalism using Feynman dia- sponse functions. Goldstone mo- n of the Meissner effect in terms onal superconductivity. Discussi- ctivity.
Intende	ed lear	ning outcomes			
derstar arch. K as well	nding o nowled as the	f unconventional superco lge of BCS mean-field the	onductivity and its in ory, the quantum-fie Higgs mechanism. Ba	terplay with magneti ld theory methods n asic understanding o	Itum phenomenon. Profound un- sm in the context of current rese- ecessary to extend BCS theory, If unconventional superconduc-
Course	S (type, r	number of weekly contact hours, l	anguage — if other than Gei	rman)	
V (3) +					
	_	t in: English			
		sessment (type, scope, langua le for bonus)	ge — if other than German,	examination offered — if no	ot every semester, information on whether
a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may in- stead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original exami- nation date at the latest. Language of assessment: English Assessment offered: In the semester in which the course is offered and in the subsequent semester					
Allocat	ion of p	olaces			
Additio	nal inf	ormation			
	1				
Worklo	ad				
180 h					

Teaching cycle

Referred to in LPO I (examination regulations for teaching-degree programmes)

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Module appears in

Master's degree (1 major) Physics International (2020) Master's degree (1 major) Quantum Engineering (2020)

exchange program Physics (2023)

Master's degree (1 major) Quantum Engineering (2024)

Module coorlecturer of thECTSMeth5numDuration1 semesterContents	ctroscopy and quantum-o dinator e seminar "Nanoskalige A od of grading erical grade		Module offered by	08-PCM4-161-m01		
lecturer of th ECTS Meth 5 num Duration 1 semester Contents	e seminar "Nanoskalige N od of grading	Naterialien"	Module offered by			
ECTS Meth 5 num Duration 1 semester Contents	od of grading	Naterialien"		Module offered by		
ECTS Meth 5 num Duration 1 semester Contents	od of grading	Γ	Institute of Physical and Theoretical Chemistry			
5 num Duration 1 semester Contents						
Duration 1 semester Contents	encalgiaue					
1 semester Contents						
Contents	<u>-</u>	Other prerequisites				
	graduate	Prior completion of	modules o8-PCM1a	and o8-PCM1b recom	nmended.	
This module						
	discusses advanced topic time-resolved laser spect			control. It focuses of	n ultrashor	
Intended lea	rning outcomes					
plain the the principles an Courses (type, S (2) + Ü (1)	able to describe the gene ory of time-resolved laser d applications of quantum number of weekly contact hours,	spectroscopy and na n control.	ame experimental me			
	ht in: German or English					
module is credita	s essment (type, scope, langua ble for bonus)	age — If other than German,	examination offered — if no	it every semester, informati	ion on whether	
b) oral exami c) talk (appro Language of	amination (approx. 90 min nation of one candidate e ox. 30 minutes) assessment: German and	each (approx. 20 min	utes) or			
Allocation of	places					
Additional in	formation	_				
Workload						
150 h						
Teaching cyc	le					
Referred to i	LPO I (examination regulation	is for teaching-degree progra	ammes)			
Module appe	ars in					
	ree (1 major) Chemistry (2	2016)				
	ree (1 major) Mathematic					
-	ree (1 major) Physics (201					
-	ree (1 major) Nanostructu		1			
-	ree (1 major) Computation					
-	ching degree Gymnasium			ork Bavaria (ENB) (2	016)	
	ary course MINT Teacher E		Network Bavaria (EN	B) (2016)		
-	ree (1 major) Chemistry (2					
-	ree (1 major) Computation		19)			
-	ree (1 major) Mathematic	-	,			
waster's deg	ree (1 major) Nanostructu	re Technology (2020))			
	or Physics International (2020)	JMU Würzburg	• generated 19-Apr-2025 • exa	am, reg. da-	page 44 / 19	

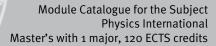


Master's degree (1 major) Physics (2020) Master's teaching degree Gymnasium MINT Teacher Education PLUS, Elite Network Bavaria (ENB) (2020) Supplementary course MINT Teacher Education PLUS, Elite Network Bavaria (ENB) (2020) Master's degree (1 major) Physics International (2020) Master's degree (1 major) Quantum Engineering (2020) Master's degree (1 major) Quantum Technology (2021) Master's degree (1 major) Computational Mathematics (2022) Master's degree (1 major) Functional Materials (2022) Master's degree (1 major) Mathematics (2022) Master's degree (1 major) Mathematics (2022) Master's degree (1 major) Quantum Engineering (2024) Master's degree (1 major) Physics International (2024) Master's degree (1 major) Computational Mathematics (2022) Master's degree (1 major) Physics International (2024) Master's degree (1 major) Computational Mathematics (2022)

Module	e title				Abbreviation			
Advanc	ed Top	ics in Solid State Phys	ics		11-CSFM-Int-201-m01			
Module	e coord	inator		Module offered by	l			
Managi and Asi		ector of the Institute of sics	Theoretical Physics	Faculty of Physics a	and Astronomy			
ECTS		od of grading	Only after succ. con	npl. of module(s)				
6	nume	rical grade		-				
Duration Module level Other prerequisites								
1 seme	ster	graduate	Approval from exam	nination committee r	equired.			
Conten	ts							
vered in	n any o		ese topics may relate		anced courses on topics not co- arch developments or to subjects			
Intende	ed lear	ning outcomes						
		/ledge and understandi teaching and research.	ng of an advanced top	ic in condensed mat	tter physics. Insight into the inter			
Course	S (type, r	number of weekly contact hours	s, language — if other than Ge	rman)				
V (3) + Module		t in: English						
		sessment (type, scope, lang le for bonus)	uage — if other than German,	examination offered — if no	ot every semester, information on whether			
		mination (approx. 90 to						
		ation of one candidate		utes) or				
		ation in groups (groups		tes per candidate) o	r			
		ort (approx. 8 to 10 pag n/talk (approx. 30 mini						
If a writ stead ta of asse nation	ten exa ake the ssmen date at	amination was chosen a form of an oral examin	as method of assessme nation of one candidate	e each or an oral exa	nged and assessment may in- mination in groups. If the metho weeks prior to the original exam			
Allocat								
		1465						
Additio	nal inf	ormation						
Worklo	ad							
180 h								
Teachi	ng cycl	e						
Referre	d to in	LPO I (examination regulation	ons for teaching-degree progra	ammes)				
Module								
		ee (1 major) Physics Int						
	-		ngineering (2020)					
	c dogr	Master's degree (1 major) Quantum Engineering (2020) Master's degree (1 major) Quantum Engineering (2024)						
	-	ee (1 major) Quantum E ee (1 major) Physics Int						

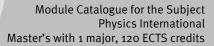
Metho	e title				Abbreviation	
	ds of O	bservational Astronomy			11-ASM-Int-201-m01	
Module	e coord	inator		Module offered by	l	
Managi and As		ector of the Institute of T sics	heoretical Physics	Faculty of Physics and Astronomy		
ECTS	Meth	od of grading	Only after succ. cor	npl. of module(s)		
6 numerical grade						
Duration Module level Other prerequisites						
1 seme	ster	graduate				
Conten	Its					
		oservational Astronomy a om radio, optical, X-ray a			action and reduction of o	bserva-
		ning outcomes		opes.		
	-			win various parts of	the electromagnetic spec	ctrum
(radio,	optica		energies). Knowledge		plications of these metho	
-		number of weekly contact hours,		rman)		
V (3) +		in the second contact nouls,	i other than de			
	• •	t in: English				
		s essment (type, scope, langu ole for bonus)	age — if other than German,	examination offered — if no	ot every semester, information on	whether
		mination (approx. 90 to	 120 minutes) or			
		nation of one candidate				
u) ural		iation of one canuluate i	each (approx. 30 mini	utes) or		
		nation in groups (groups			r	
c) oral	examir		of 2, approx. 30 minu		r	
c) oral d) proje e) pres	examir ect rep entatio	ation in groups (groups ort (approx. 8 to 10 page m/talk (approx. 30 minu	of 2, approx. 30 minu s) or tes).	ites per candidate) o		
c) oral (d) proje e) pres If a writ	examir ect rep entatio tten ex	aation in groups (groups ort (approx. 8 to 10 page on/talk (approx. 30 minu amination was chosen a	of 2, approx. 30 minu s) or tes). s method of assessm	ites per candidate) o ent, this may be cha	nged and assessment ma	
c) oral d) proje e) pres If a writ stead t	examir ect rep entatio tten ex ake the	nation in groups (groups ort (approx. 8 to 10 page on/talk (approx. 30 minu amination was chosen a e form of an oral examina	of 2, approx. 30 minu s) or tes). s method of assessm ation of one candidate	ites per candidate) o ent, this may be cha e each or an oral exa	nged and assessment ma mination in groups. If the	metho
c) oral (d) proje e) pres If a writ stead t of asse	examir ect rep entatio tten ex ake the essmen	nation in groups (groups ort (approx. 8 to 10 page on/talk (approx. 30 minu amination was chosen a e form of an oral examina t is changed, the lecture	of 2, approx. 30 minu s) or tes). s method of assessm ation of one candidate	ites per candidate) o ent, this may be cha e each or an oral exa	nged and assessment ma	metho
c) oral (d) proje e) pres If a writ stead t of asse nation	examir ect rep entatio tten ex ake the essmen date at	nation in groups (groups ort (approx. 8 to 10 page on/talk (approx. 30 minu amination was chosen a e form of an oral examina t is changed, the lecture t the latest.	of 2, approx. 30 minu s) or tes). s method of assessm ation of one candidate	ites per candidate) o ent, this may be cha e each or an oral exa	nged and assessment ma mination in groups. If the	metho
c) oral (d) proje e) pres If a writ stead t of asse nation Langua	examir ect rep entatio tten ex ake the essmen date at age of a	nation in groups (groups ort (approx. 8 to 10 page on/talk (approx. 30 minu amination was chosen a e form of an oral examina t is changed, the lecture t the latest. Issessment: English	of 2, approx. 30 minu s) or tes). s method of assessm ation of one candidate r must inform studen	ites per candidate) o ent, this may be cha e each or an oral exa ts about this by four	nged and assessment ma mination in groups. If the weeks prior to the origina	method
c) oral of d) proje e) pres If a writ stead t of asse nation Langua Assess	examir ect rep entatio tten ex ake the essmen date at age of a ment o	nation in groups (groups ort (approx. 8 to 10 page on/talk (approx. 30 minu amination was chosen a e form of an oral examina t is changed, the lecture t the latest. Issessment: English offered: In the semester i	of 2, approx. 30 minu s) or tes). s method of assessm ation of one candidate r must inform studen	ites per candidate) o ent, this may be cha e each or an oral exa ts about this by four	nged and assessment ma mination in groups. If the weeks prior to the origina	method
c) oral (d) proje e) press If a writ stead t of asse nation Langua	examir ect rep entatio tten ex ake the essmen date at age of a ment o	nation in groups (groups ort (approx. 8 to 10 page on/talk (approx. 30 minu amination was chosen a e form of an oral examina t is changed, the lecture t the latest. Issessment: English offered: In the semester i	of 2, approx. 30 minu s) or tes). s method of assessm ation of one candidate r must inform studen	ites per candidate) o ent, this may be cha e each or an oral exa ts about this by four	nged and assessment ma mination in groups. If the weeks prior to the origina	method
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c) oral d d) proje e) pres If a writ stead t of asse nation Langua Assess Allocat Morklo 180 h Teachin Referre Master Master	examir ect rep entatio tten ex- cake the essmen date at age of a ment o tion of [onal inf onal inf onal inf e appea d to in e appea	e LPO I (examination regulation e (1 major) Physics Inte e (1 major) Quantum Er	of 2, approx. 30 minus) or tes). s method of assessmation of one candidate r must inform student n which the course is	ent, this may be cha e each or an oral exa ts about this by four offered and in the su	nged and assessment ma mination in groups. If the weeks prior to the origina	metho
c) oral d d) proje e) pres If a writ stead t of asse nation Langua Assess Allocat Worklo 180 h Teachin Referre Module Master exchan	examir ect rep- entatio tten ex- cake the essmen date at age of a ment o tion of onal inf onal inf onal inf e appea d's degr d's degr	e LPO I (examination regulation e (1 major) Physics Inte e (1 major) Quantum Er gram Physics (2023)	of 2, approx. 30 minu s) or tes). s method of assessm ation of one candidate r must inform student n which the course is n which the course is n which the course is n which the course is n which the	ent, this may be cha e each or an oral exa ts about this by four offered and in the su	nged and assessment ma mination in groups. If the weeks prior to the origina	metho
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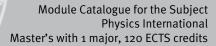
Module title					Abbreviation
Experin	nental	Particle Physics			11-TPE-Int-201-m01
Module	e coord	inator		Module offered by	
Managi	ing Dire	ector of the Institute of Ap	plied Physics	Faculty of Physics a	nd Astronomy
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)	
6	nume	rical grade			
Duratio	n	Module level	Other prerequisites		
1 seme	ster	graduate			
Conten	ts				
termina	ation of				Discovery of the Higgs Boson. De- del parameters. Search for phy-
Intende	ed lear	ning outcomes			
		•			ctor, and with modern data ana- ess their systematic uncertain-
Course	S (type, r	number of weekly contact hours, l	anguage — if other than Ger	man)	
V (3) + I Module		t in: English			
		Sessment (type, scope, langua le for bonus)	ge — if other than German, e	examination offered — if no	t every semester, information on whether
b) oral e c) oral e d) proje e) prese If a writ stead ta of asse nation e Langua	examir examin ect repo entatio ten exa ake the ssmen date at ge of a ment o	e form of an oral examina t is changed, the lecturer the latest. ssessment: English ffered: In the semester in	ach (approx. 30 minu of 2, approx. 30 minut of or es). method of assessme tion of one candidate must inform student	tes per candidate) or ent, this may be char e each or an oral exar s about this by four y	nged and assessment may in- mination in groups. If the method weeks prior to the original exami-
Allocat	ion of _l	olaces			
Additio	nal inf	ormation			
Worklo	ad				
180 h					
Teachir	ıg cycl	e			
Referre	d to in	LPOI (examination regulation	s for teaching-degree progra	mmes)	
Module	e appea	ars in			
Master'	's degr	ee (1 major) Physics Inter	national (2020)		
		gram Physics (2023)			
Master'	's degr	ee (1 major) Physics Inter	national (2024)		

Module title Abbreviation						
Introdu	ction to	o Space Physics			11-ASP-Int-201-m01	
Module	coord	inator		Module offered by		
Managi and Ast	-	ctor of the Institute of T ics	heoretical Physics	Faculty of Physics and Astronomy		
ECTS	Metho	od of grading	Only after succ. con	pl. of module(s)		
6	numei	rical grade				
Duratio	n	Module level	Other prerequisites			
1 semes	ster	graduate				
Conten	ts					
3. Elem 4. The s 5. Accel	mics of ents of sun and leratior	f charged particles in m space physics I heliosphere a and transport of energ to measure energetic p	etic particles in the he	liosphere		
Intende	d learr	ning outcomes				
	nd the	ge in space physics, in heliosphere. Knowledg ments.				
Courses	5 (type, n	umber of weekly contact hours,	language — if other than Ger	man)		
V (3) + F Module		tin: English				
Method	l of ass	essment (type, scope, langu	age — if other than German, o	examination offered — if no	t every semester, informati	on on whether
		le for bonus)				
b) oral e c) oral e d) proje e) prese If a writ stead ta of asses nation o Langua	examin examin ect repo entatio ten exa ake the ssment date at ge of a	nination (approx. 90 to ation of one candidate ation in groups (groups ort (approx. 8 to 10 page n/talk (approx. 30 minu mination was chosen a form of an oral examina is changed, the lecture the latest. ssessment: English ffered: In the semester i	each (approx. 30 minu of 2, approx. 30 minu (s) or tes) s method of assessme ation of one candidate or must inform student	tes per candidate) or ent, this may be char e each or an oral exar s about this by four y	nged and assessmer mination in groups. I weeks prior to the or	If the method riginal exami-
Allocati	ion of p	laces				
Additio	nal info	ormation				
Workloa	ad					
180 h						
Teachin	ig cycle	9				
Referre	d to in	LPO I (examination regulation	ns for teaching-degree progra	mmes)		
Module	appea	rs in				
Master's wit	th 1 major	Physics International (2020)	-	generated 19-Apr-2025 • exa (120 ECTS) Physics Internatio	_	page 50 / 196



Module title	9			Abbreviation		
Multi-wave	ength Astronomy			11-MAS-Int-201-mo	1	
Module coo	rdinator		Module offered by	<u> </u>		
	irector of the Institute of T	heoretical Physics	Faculty of Physics and Astronomy			
ECTS Method of grading Only after succ. compl. of module(s)						
6 numerical grade						
Duration Module level Other prerequisites						
1 semester graduate						
Contents						
2. Jet-emiss 3. VLBI obse 4. High-ene	nology of active galactic n ion processes ervations of jets rgy observations of jets senger signatures of jets	uclei and extragalacti	c jets			
Intended le	arning outcomes					
galactic jets	in multiwavelength astron Insight into a new not-ye	t solved astrophysica	l question. Practice i			
V (3) + R (1)	e, number of weekly contact hours, ght in: English	language — if other than Ge	rman)			
	ISSESSMENT (type, scope, langu	age — if other than German	examination offered — if no	nt every semester informat	ion on whether	
module is credi		age in other than German,		it every semester, mornat	ion on whether	
b) oral exan c) oral exan d) project re e) presenta If a written e stead take t of assessme nation date Language o Assessmen	kamination (approx. 90 to nination of one candidate nination in groups (groups eport (approx. 8 to 10 page tion/talk (approx. 30 minu examination was chosen a he form of an oral examina- ent is changed, the lecture at the latest. f assessment: English t offered: In the semester i	each (approx. 30 minu of 2, approx. 30 minu s) or tes) s method of assessm ation of one candidate r must inform studen	ites per candidate) o ent, this may be cha e each or an oral exa ts about this by four	nged and assessme mination in groups. weeks prior to the o	If the method riginal exami-	
Allocation of	of places					
Additional i	nformation	_				
Workload		_				
180 h Teaching cy						
Referred to	in LPO I (examination regulatio	hs for teaching-degree progr	ammes)			
Module app	ears in					
Master's de	gree (1 major) Physics Inte rogram Physics (2023)	rnational (2020)				
Master's with 1 m	Aaster's with 1 major Physics International (2020) JMU Würzburg • generated 19-Apr-2025 • exam. reg. da- ta record Master (120 ECTS) Physics International - 2020 page 52 / 196					





Modul	e title				Abbreviation
Advan	ced Top	ics in Astrophysics			11-CSAM-Int-201-m01
Modul	e coord	inator		Module offered by	
-	ging Dire strophys	ector of the Institute of Th ics	eoretical Physics	Faculty of Physics a	and Astronomy
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)	
6	nume	rical grade			
Durati	on	Module level	Other prerequisites	i	
1 seme	ester	graduate	Approval from exam	nination committee r	equired.
Conter	nts				
are rele dynam	evant to iics, hea	the following topics: Ste	ellar structure, star fo	rmation and develop	physics will be conveyed which oment, radiation transport, gas iistry, accretion and jets, galaxy
Intend	ed learı	ning outcomes			
		advanced skills in curren ndependently get acquai			pphysics.
Course	es (type, n	umber of weekly contact hours, l	anguage — if other than Ge	rman)	
V (3) + Modul		t in: English			
		essment (type, scope, langua le for bonus)	ge — if other than German,	examination offered — if no	ot every semester, information on whether
 b) oral c) oral d) proj e) pres lf a wri stead t of asse nation 	examin examin ect repo entatio tten exa take the essmen date at	form of an oral examina	ach (approx. 30 minu of 2, approx. 30 minu s) or es). method of assessm tion of one candidate	tes per candidate) o ent, this may be cha e each or an oral exa	r nged and assessment may in- mination in groups. If the method weeks prior to the original exami-
Allocat	tion of p	olaces			
Additio	onal inf	ormation			
Worklo	bad				
180 h					
Teachi	ng cycl	9			
Referre	ed to in	LPO I (examination regulation	s for teaching-degree progra	ammes)	
Modul	e appea	rs in			
	-	ee (1 major) Physics Inter ee (1 major) Physics Inter			
master	i s ucgli		national (2024)		

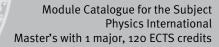
Module	title				Abbreviation
Advanc	ed Mag	gnetic Resonance Imagin	g		11-MRI-Int-201-m01
Module	coord	inator		Module offered by	
Managi	ng Dire	ector of the Institute of Ap	plied Physics	Faculty of Physics a	nd Astronomy
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)	
6	nume	rical grade			
Duratio	n	Module level	Other prerequisites		
1 seme	ster	graduate			
Conten	ts				
imaging the fun- course 1) the N 2) the p and me 3) the c 4) the p fields o Intende	Contents Nuclear magnetic resonance (NMR) is a quantum mechanical phenomenon that, through magnetic resonance imaging (MRI), has played a major role in the revolution in medical imaging over the last 30 years. Starting from the fundamentals of nuclear magnetic resonance (resonance principle, relaxation times, chemical shift) this course covers 1) the NMR signal theory and signal evolution (Bloch equations) 2) the principles of spatial encoding, magnetic resonance imaging (MRI) and corresponding imaging sequences and measurement parameters, 3) the concept of k-space and Fourier imaging, 4) the physical, methodological and technical possibilities and limitations of MRI. Finally, typical application fields of MRI in biomedical research, clinical imaging and non-destructive testing will be covered. Intended learning outcomes The students are familiar with the basics and the deepened aspects of NMR and MRI including the mathematical-theoretical description and the physical basics of modern MRI, MRI-instrumentation and image-formati-				
plinary	relatio	ns and applications.		-	
V (3) + I		umber of weekly contact nours, t		inany	
		t in: English			
		s essment (type, scope, langua le for bonus)	ge — if other than German, e	examination offered — if no	t every semester, information on whether
 b) oral e c) oral e d) proje e) prese lf a writ stead ta of asse nation e Langua 	 a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English Assessment offered: In the semester in which the course is offered and in the subsequent semester 				
Allocat					
Additio	nal info	ormation			
Worklo	ad				
180 h					
Teachir	ng cycl	e			
		e: In the semester in whic	h the course is offere	d and in the subseq	uent semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

Module appears in

Module	e title				Abbreviation	
Surface Science 11-SSC-Int-					11-SSC-Int-201-m01	
Module	e coord	inator		Module offered by		
Managi	ing Dire	ector of the Institute of A	pplied Physics	Faculty of Physics a	nd Astronomy	
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)		
6	nume	rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	ts					
Atomic surface	structu e, therm	surfaces and interfaces, ire: reconstructions and odynamics, adsorption al bonding, surface stat	adsorbates, surface of and desorption, Expe	prientation and symr rimental characteriz	netries, Microscopic ation, Electronic stru	processes at cture of sur-
Intende	ed leari	ning outcomes				
charact	teristic	nave an overview over th of surfaces and interfac of surfaces, as well as th	es. The students know	v the most important		
Course	S (type, n	umber of weekly contact hours,	language — if other than Ger	rman)		
V (3) + Module		t in: English				
		essment (type, scope, langu le for bonus)	age — if other than German,	examination offered — if no	ot every semester, informati	on on whether
 b) oral c) oral of d) projection e) pressent lf a write stead ta of assent Langua Assess 	examin examin ect repo entatio tten exa ake the essmen date at age of a ment o	mination (approx. 90 to lation of one candidate ation in groups (groups ort (approx. 8 to 10 page n/talk (approx. 30 minu amination was chosen a form of an oral examina- t is changed, the lecture the latest. ssessment: English ffered: In the semester i	each (approx. 30 minu of 2, approx. 30 minu s) or tes). s method of assessme ation of one candidate r must inform student	tes per candidate) o ent, this may be cha e each or an oral exa s about this by four	nged and assessmer mination in groups. weeks prior to the or	If the method iginal exami-
Allocat	ion of p	olaces				
Additio	nal inf	ormation				
 Worklo	ad					
180 h						
Teachi	ng cycl	٩				
	0 - 9 - 0					
Referre	d to in	LPO I (examination regulatio	ns for teaching-degree progra	mmes)		
				/		
Module	e appea	urs in				
		ee (1 major) Physics Inte	rnational (2020)			
	-	ee (1 major) Quantum Er				
Master's wi	ith 1 majoı	Physics International (2020)	-	generated 19-Apr-2025 • exa r (120 ECTS) Physics Internati	-	page 57 / 196

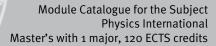




exchange program Physics (2023) Master's degree (1 major) Quantum Engineering (2024) Master's degree (1 major) Physics International (2024)

Module title Abbreviation								
Basic Ir	Basic Imaging Concepts 11-BIC-Int-201-m01							
Module coordinator				Module offered by				
Managing Director of the Institute of Applied Ph			Applied Physics	s Faculty of Physics and Astronomy				
ECTS	Metho	od of grading	Only after succ. cor	Only after succ. compl. of module(s)				
6	nume	rical grade						
Duratio	n	Module level	Other prerequisites	;				
1 seme	ster	graduate						
Conten	ts							
across tion, ce spread vanced ties in b	Introduction to generic imaging concepts and physical imaging methods covering the most central aspects across all imaging modalities, including 1) the concept of Fourier imaging, 2) tomography (Radon-Transformation, central-slice- theorem), 3) the system theory of imaging systems, and 4) issues of image quality (point-spread function, modulation transfer function, spatial resolution, contrast, noise). During the course different advanced methods for image acquisition will be covered and a comprehensive overview of modern imaging modalities in biomedicine, material science and astrophysics will be given.							
		ning outcomes						
		know the physical foun mage formation and ar						
Course	S (type, n	umber of weekly contact hour	s, language — if other than Ge	rman)				
V (3) + Module		t in: English						
Method	l of ass	essment (type, scope, lang	guage — if other than German,	examination offered — if no	t every semester, informati	on on whether		
		le for bonus)						
 a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English Assessment offered: In the semester in which the course is offered and in the subsequent semester 								
Allocat	ion of p	olaces						
Additio	nal inf	ormation						
Worklo	ad							
180 h								
Teaching cycle								
Teaching cycle: every year, after announcement								
Referre	d to in	LPO I (examination regulati	ons for teaching-degree progra	ammes)				
Module appears in								
	-	ee (1 major) Physics Int gram Physics (2023)	ernational (2020)					
Master's wi	th 1 majoı	Physics International (2020)	-	• generated 19-Apr-2025 • exa er (120 ECTS) Physics Internati	-	page 59 / 196		





Module	title		Abbreviation				
Basic Ir	naging	Reconstruction and Pro		11-IRP-Int-201-m01			
Module coordinator				Module offered by			
Managing Director of the Institute of Applied Physics			plied Physics	Faculty of Physics a	nd Astronomy		
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)			
6 numerical grade							
Duratio	n	Module level	Other prerequisites				
1 semes	ster	graduate					
Conten	ts						
duced i ging ap code. Ir cessing in the fi CT data	This training course uses the fundamentals of modern signal processing and imaging concepts, which are intro- duced in the corresponding lecture. Starting with the different categories of signals and transferring them to ima- ging applications, the students can test Fourier transform properties first hand by developing Matlab or Python code. Image convolution and de-convolution techniques are addressed in particular with respect to image pro- cessing tasks in modern physics (e.g. denoising). The Radon-Transform, which takes an outstanding im-portance in the field of computed tomography is demonstrated by the three-dimensional image reconstruction from real CT data whereby different sources of error can be tested. The theoretical part on discrete signals and their Fouri- er transform properties as well as different ways of image compression will also be further developed during this						
	d lear	ning outcomes					
respect problen	to ima ns, suc	ging applications. They a h as image reconstructio	re able to devise a st n, denoising, Fourier	rategy /toolchain fo analysis and freque	al processing in particular with r basic and advanced imaging ncy decomposition. By using entific images, such as SNR.		
Courses (type, number of weekly contact hours, language — if other than German)							
V (3) + R (1) Module taught in: English							
		essment (type, scope, langua le for bonus)	ge — if other than German, e	examination offered — if no	t every semester, information on whether		
 a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English 							
		ffered: In the semester in	which the course is	offered and in the su	ıbsequent semester		
Allocati	ion of p	olaces					
Additio	Additional information						
Workload							
180 h							
Teachir							
Teaching cycle: every year, after announcement							

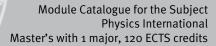
Referred to in LPO I (examination regulations for teaching-degree programmes)

Module appears in

Master's degree (1 major) Physics International (2020) exchange program Physics (2023)

Module title					Abbreviation		
Contemporary Astrophysics					11-CAP-Int-201-m01		
Module coordinator				Module offered by			
Managing Director of the Institute of Theoretical Physics and Astrophysics				Faculty of Physics and Astronomy			
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)			
6 numerical grade							
Duratio	n	Module level	Other prerequisites				
1 semes	emester graduate						
Conten	ts						
Telesco Mediun	pes an n, Mole	d Detectors, Stellar Struc	ture and Atmospher of the Milky Way, the	es, Stellar Evolution	oplanets, Astronomical Scales, and their End Stages, Interstellar xpanding Universe, Galaxies, Ac-		
Intende	ed leari	ning outcomes					
of astro	physic		ole to plan and interp	oret his/her own obse	s the methods and instruments ervations. He/She is familiar with 's and galaxies.		
Courses	S (type, n	number of weekly contact hours, l	anguage — if other than Gei	rman)			
V (3) + I Module		t in: English					
		sessment (type, scope, langua le for bonus)	ge — if other than German,	examination offered — if no	t every semester, information on whether		
 a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English Assessment offered: In the semester in which the course is offered and in the subsequent semester 							
Allocati	ion of p	olaces					
Additio	nal inf	ormation					
Worklo	ad						
180 h							
Teachir	Teaching cycle						
Teachir	ng cycle	e: every year, after annou	ncement				
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module appears in							
	Master's degree (1 major) Physics International (2020)						
	•	gram Physics (2023)	(2020)				





Module title					Abbreviation	
Advanc	Advanced Astro Imaging 11-AAI-Int-201-m01					
Module coordinator				Module offered by		
Managing Director of the Institute of Theoretical Physics Faculty of Physics and Astronom and Astrophysics					nd Astronomy	
ECTS Method of grading Only after succ. compl. of module(s)						
6	6 numerical grade					
Duratio	n	Module level	Other prerequisites			
1 semes	ster	graduate				
Conten	ts					
ric Tran Detecto 2) Imag c) Basic Algorith 3) Adva try; e) M	 Image Acquisition: a) Motivation: History of Astronomical Imaging - From the Eye to the Detector; b) Atmospheric Transmission: Ground Based vs. Space Based Imaging; c) Observing Techniques and Instruments; d) Optical Detector Types and CCD Properties; e) Imaging in Other Bands of the Electromagnetic Spectrum Image Processing: a) Data Formats and Imaging Software; b) Basic Methods: Pixel Operations and Statistics; c) Basic Methods II: Image Operations; d) Image Reduction- / Calibration; e) Imaging in Color f) Image Processing Algorithms Advanced Processing: a) FITS File Format; b) Image Reconstruction; c) Fourier Analysis; d) Speckle Interferometry; e) Maximum Entropy Methods; f) Interferometry; g) Image Classification, Machine Learning Methods 					
to Gam	ma-ray	s; c) Imaging in Other Sci		ruments / Data Proce	essing; b) Future Facilities Radio	
		ning outcomes				
dern as re the fo analysis	tronon ollowin s, appl	ny, incorporating measure g qualifications: ability to	ements from ground- o process and interp of processing algori	and space-based in ret raw-image data, t	thods using examples from mo- struments. The students acqui- o perfom data reduction, image and methods are not limited to	
Course	S (type, n	umber of weekly contact hours, l	anguage — if other than Ger	man)		
V (3) + I Module		t in: English				
		essment (type, scope, langua le for bonus)	ge — if other than German, o	examination offered — if no	t every semester, information on whether	
a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may in- stead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original exami- nation date at the latest. Language of assessment: English Assessment offered: In the semester in which the course is offered and in the subsequent semester Allocation of places						
Additio	Additional information					

Workload

180 h

Teaching cycle

Referred to in LPO I (examination regulations for teaching-degree programmes)

Module appears in

Master's degree (1 major) Physics International (2020) exchange program Physics (2023)

Module title					Abbreviation		
Advanced Computer Tomography				11-CTA-Int-201-m01			
Module	coord	inator		Module offered by			
Managing Director of the Institute of Applied Physics			plied Physics	Faculty of Physics a	nd Astronomy		
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)			
6 numerical grade							
Duratio	n	Module level	Other prerequisites				
1 seme	ster	graduate					
Conten	ts						
medica on to va ting the ty of sta gebraic ny thes ror sour images watersh Intende The stu basic ir solution firm im	This advanced course focuses on the details of modern computed tomography (CT), which is employed both in medical and industrial imaging applications. In addition to the technicalities of CT systems and their application to various tasks in engineering and medical science, this lecture emphasizes on the mathematics of "inverting the Radon transform". Starting with the simple Filtered Back Projection method which is applied to a variety of standard recording geometries (parallel, fan, cone, helix) the advanced course lays out the strategies for algebraic reconstruction techniques (ART) along with many types of regularization schemes which may accompany these methods. Students will have the opportunity to see how Radon data is recorded and how different error sources as well as the corresponding correction schemes influence the outcome of the reconstructed volume images. Finally the most common tools for volume image analysis are presented, such as distance transforms, watersheds, labelling and fiber orientation analysis. Intended learning outcomes The student know the concept of Computed tomography (CT) and its applications. From the formulation of the basic inverse problem posed by this technique the students are able to derive strategies for different numerical solutions, based on Fourier analysis and/or based on probability theory. Most importantly the students have a						
		ared reconstruction. umber of weekly contact hours, la	anguage — if other than Ger	man)			
V (3) + I	R (1)	t in: English					
		essment (type, scope, langua le for bonus)	ge — if other than German, e	examination offered — if no	t every semester, information on whether		
 a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English Assessment offered: In the semester in which the course is offered and in the subsequent semester 							
· · · · · ·	Allocation of places						
Additional information							
Workload							
180 h							

Teaching cycle

Teaching cycle: every year, after announcement

Referred to in LPO I (examination regulations for teaching-degree programmes)

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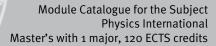
Module appears in

Master's degree (1 major) Physics International (2020) exchange program Physics (2023)

Module title A					Abbreviation		
Electro	Electron and Ion Microscopy 11-EIM-Int-201-m01						
Module coordinator			Module offered by				
Managing Director of the Institute of Applied Physics			Applied Physics	Faculty of Physics and Astronomy pl. of module(s) charged particles, interaction of matter with elec- bles: SEM, STEM, TEM, sample preparation, advan-			
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)			
6	nume	rical grade					
Duratio	n	Module level	Other prerequisites				
1 seme	ster	graduate					
Conten	ts						
trons a	nd chai		s, measurement princi	ples: SEM, STEM, TE			
Intende	ed learr	ning outcomes					
and ins	trumer	ital basics and principle	es of detectors and con	ntrast mechanisms. I	He/she knows differe		
Course	S (type, n	umber of weekly contact hours	, language — if other than Ger	rman)			
V (3) + I Module		t in: English					
		essment (type, scope, langule for bonus)	uage — if other than German,	examination offered — if no	t every semester, informati	on on whether	
 a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes) If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English Assessment offered: In the semester in which the course is offered and in the subsequent semester 							
Allocat	ion of p	olaces					
			_				
Additio	nal info	ormation					
Worklo	ad		_				
180 h							
Teachir	ng cycl	9					
Teachir	ng cycle	e: annually, after annou	ncement				
Referred to in LPO I (examination regulations for teaching-degree programmes)							
Module appears in							
exchan Master'	ge prog 's degre	ee (1 major) Physics Inte gram Physics (2023) ee (1 major) Quantum E ee (1 major) Physics Inte	ngineering (2024)				
	-	Physics International (2020)	JMU Würzburg •	generated 19-Apr-2025 • exa r (120 ECTS) Physics Internation	-	page 69 / 196	

Module	title		Abbreviation				
Scannii	ng Prol	be Technologies	11-SPT-Int-201-m01				
Module coordinator A				Module offered by			
Managing Director of the Institute of App			plied Physics	Faculty of Physics and Astronomy			
ECTS Method of grading Only after succ. compl. of module(s)							
6	nume	rical grade					
Duratio	n	Module level	Other prerequisites				
1 seme	ster	graduate					
Conten	ts						
surface enginee basic p	scienc ering; r rinciple	e; tip-sample interaction neasurement modes, e.g	s; design principles a ., contact and non-co	and material conside ntact, Kelvin probe,	nicroscopy; basic principles of erations; fundamentals of control friction force microscopy, etc; chniques and their application:		
Intende	ed leari	ning outcomes					
les, is a	ware o	f basic design principles	, knows pros and con	s of various materia	ows the basic theoretical princip- ls, and is familiar of measure- cent development in the field.		
Course	S (type, n	number of weekly contact hours, l	anguage — if other than Ger	man)			
V (3) + I Module		t in: English					
			ge — if other than German, e	examination offered — if no	t every semester, information on whether		
		le for bonus)					
 b) oral e c) oral e d) proje e) prese lf a writ stead ta of asse nation e Langua 	 a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English Assessment offered: In the semester in which the course is offered and in the subsequent semester 						
Allocat	ion of p	olaces					
Additio	nal inf	ormation					
Worklo	ad						
180 h							
Teachir	Teaching cycle						
		e: every year, after annou					
Referred to in LPO I (examination regulations for teaching-degree programmes)							
Module appears in							
Master's degree (1 major) Physics International (2020)							
	exchange program Physics (2023)						





Module title Abbreviation							
Visiting Rese	Visiting Research 11-FPA-Int-201-m01						
Module coord	linator		Module offered by				
			Faculty of Physics a	and Astronomy			
ECTS Meth	TS Method of grading Only after succ. compl. of module(s)						
10 nume	rical grade						
Duration Module level Other prerequisites							
1-2 semester	graduate	Approval from exam	ination committee r	equired.			
Contents	•						
	documentation of the res			sics. Experimental work including visits to other universities or re-			
Intended lear	ning outcomes						
	th current research topics yze and document scient		neoretical physics. W	/ithin experimental physics, the			
Courses (type,	number of weekly contact hours, I	language — if other than Gei	man)				
R (o) Module taugł	it in: English						
Method of as module is credita		ge — if other than German,	examination offered — if no	ot every semester, information on whether			
	(approx. 10 to 20 pages) assessment: English						
Allocation of	places						
Additional in	ormation						
Workload							
300 h							
Teaching cyc	e						
Referred to in	LPOI (examination regulation	s for teaching-degree progra	mmes)				
Module appe	Module appears in						
-	ree (1 major) Physics Inter						
-	Master's degree (1 major) Quantum Engineering (2020)						
-	Master's degree (1 major) Quantum Engineering (2024) Master's degree (1 major) Physics International (2024)						
waster's deg	ee (1 major) Physics Inter	national (2024)					

Module title				Abbreviation		
Current	Current Topics in Experimental Physics 11-EXE5-Int-201-m01					
Module	coord	inator		Module offered by		
chairpe	erson of	f examination committee		Faculty of Physics a	nd Astronomy	
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)		
5	nume	rical grade				
Duratio	n	Module level	Other prerequisites			
1 seme	ster	graduate	Approval from exam	ination committee re	equired.	
Conten	ts					
Current study a		in experimental physics,	Credited academic a	chievements, e.g. in	a case of change of university or	
Intende	ed learr	ning outcomes				
Master' suring a	's level and eva	. He/She commands kno	wledge in a current fi are necessary to acqu	eld in experimental	ule in experimental physics on physics and insight into the mea- He/She is able to classify and to	
Course	S (type, n	umber of weekly contact hours, l	anguage — if other than Ger	man)		
V (2) + I Module	• •	t in: English				
			ge — if other than German, e	examination offered — if no	t every semester, information on whether	
· · · · · · · · · · · · · · · · · · ·		le for bonus) nination (approx. 90 to 1				
 b) oral e c) oral e d) proje e) prese If a writ stead ta of asse nation e Langua 	examin examin ect repo entatio ten exa ake the ssmen date at ge of a	ation of one candidate e ation in groups (groups c ort (approx. 8 to 10 pages n/talk (approx. 30 minut amination was chosen as form of an oral examina t is changed, the lecturer the latest. ssessment: English	ach (approx. 30 minu of 2, approx. 30 minu) or es). method of assessme tion of one candidate	es per candidate) or ent, this may be char each or an oral exar	r nged and assessment may in- mination in groups. If the method weeks prior to the original exami-	
Allocat	ion of p	olaces				
Additio	nal inf	ormation				
Worklo	Workload					
150 h						
Teaching cycle						
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)					
Module	Module appears in					
	-	ee (1 major) Physics Inter				
Master'	Master's degree (1 major) Physics International (2024)					

Module title				Abbreviation		
Current Topics in Experimental Physics					11-EXE6-Int-201-m01	
Module	coord	inator		Module offered by		
chairpe	rson o	f examination committee		Faculty of Physics a	nd Astronomy	
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)		
6	nume	rical grade				
Duratio	n	Module level	Other prerequisites			
1 seme	ster	graduate	Approval from exam	ination committee re	equired.	
Conten	ts					
Current study a	•	in experimental physics.	Credited academic a	chievements, e.g. ir	a case of change of university or	
Intende	ed leari	ning outcomes				
Master' suring a	s level and eva	. He/She commands kno	wledge in a current fi are necessary to acqu	eld in experimental	ule in experimental physics on physics and insight into the mea- He/She is able to classify and to	
Course	S (type, n	umber of weekly contact hours, l	anguage — if other than Ger	man)		
V (3) + I Module	• •	t in: English				
		s essment (type, scope, langua le for bonus)	ge — if other than German, e	examination offered — if no	t every semester, information on whether	
b) oral e c) oral e d) proje e) prese If a writ stead ta of asse nation e	examin examin ect repo entatio ten exa ake the ssmen date at	form of an oral examina	ach (approx. 30 minu of 2, approx. 30 minut o) or es). method of assessme tion of one candidate	es per candidate) of ent, this may be char each or an oral exa	r nged and assessment may in- mination in groups. If the method weeks prior to the original exami-	
Allocat						
Additio	nal inf	ormation				
Worklo	ad					
180 h						
Teaching cycle						
Referre	d to in	LPO I (examination regulations	s for teaching-degree progra	mmes)		
Module	Module appears in					
	-	ee (1 major) Physics Inter				
Master'	s degr	ee (1 major) Physics Inter	national (2024)			

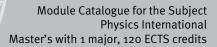
Module title				Abbreviation		
Current	Current Topics in Experimental Physics 11-EXE7-Int-201-m01					
Module	coord	inator		Module offered by		
chairpe	erson of	examination committee		Faculty of Physics a	nd Astronomy	
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)		
7	numei	rical grade				
Duratio	n	Module level	Other prerequisites			
1 seme	ster	graduate	Approval from exam	ination committee re	equired.	
Conten	ts					
Current study a		in experimental physics.	. Credited academic a	achievements, e.g. ir	n case of change of university or	
Intende	ed learr	ning outcomes				
Master' suring a	's level. and eva	. He/She commands kno	wledge in a current fi are necessary to acqu	eld in experimental	ule in experimental physics on physics and insight into the mea- He/She is able to classify and to	
Course	S (type, n	umber of weekly contact hours, l	anguage — if other than Ger	man)		
V (3) + I Module		t in: English				
Method	l of ass	essment (type, scope, langua	ge — if other than German, e	examination offered — if no	t every semester, information on whether	
		le for bonus)				
 b) oral e c) oral e d) proje e) prese lf a writ stead ta of asse nation e Langua 	examin examin ect repo entatio ten exa ake the ssment date at ge of a	form of an oral examina t is changed, the lecturer the latest. ssessment: English	ach (approx. 30 minu of 2, approx. 30 minu o) or es). method of assessme tion of one candidate	tes per candidate) of ent, this may be char e each or an oral exa	r nged and assessment may in- mination in groups. If the method weeks prior to the original exami-	
Allocat	ion of p	olaces				
Additio	nal info	ormation				
	Workload					
	210 h					
Teaching cycle						
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)					
 Module appears in						
			national (acca)			
	-	ee (1 major) Physics Inter ee (1 major) Physics Inter				
master	Master's degree (1 major) Physics International (2024)					

Module title				Abbreviation		
Current Topics in Experimental Physics					11-EXE8-Int-201-m01	
Module	coord	inator		Module offered by		
chairpe	erson of	f examination committee	_	Faculty of Physics a	nd Astronomy	
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)		
8	nume	rical grade				
Duratio	n	Module level	Other prerequisites			
1 seme	ster	graduate	Approval from exam	ination committee re	equired.	
Conten						
Current study a		in experimental physics.	Credited academic a	chievements, e.g. in	a case of change of university or	
Intende	ed learr	ning outcomes				
Master' suring a	's level and eva	. He/She commands kno	wledge in a current fi are necessary to acqu	eld in experimental	ule in experimental physics on physics and insight into the mea- He/She is able to classify and to	
Course	S (type, n	umber of weekly contact hours, l	anguage — if other than Ger	man)		
V (4) +						
		t in: English				
		s essment (type, scope, langua le for bonus)	ge — if other than German, e	examination offered — if no	t every semester, information on whether	
b) oral e c) oral e d) proje e) prese If a writ stead ta of asse nation	examin examin ect repo entatio ten exa ake the ssment date at	form of an oral examina	ach (approx. 30 minu of 2, approx. 30 minu o) or es). method of assessme tion of one candidate	es per candidate) or ent, this may be char each or an oral exar	r nged and assessment may in- mination in groups. If the method weeks prior to the original exami-	
Allocat	ion of p	olaces				
Additio	nal inf	ormation				
Worklo	Workload					
240 h						
Teachir	Teaching cycle					
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)					
Module						
	-	ee (1 major) Physics Inter				
master	Master's degree (1 major) Physics International (2024)					

Module title Abbreviation				Abbreviation		
Current Topics in Experimental Physics 11-EXE6A-Int-201-m01				11-EXE6A-Int-201-m01		
Module	coord	inator		Module offered by		
chairpe	rson o	f examination committee		Faculty of Physics a	nd Astronomy	
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)		
6	nume	rical grade				
Duratio	n	Module level	Other prerequisites			
1 seme	ster	graduate	Approval from exam	ination committee re	equired.	
Conten						
Current study a		in experimental physics,	, credited academic a	chievements, e.g. in	a case of change of university or	
Intende	ed learn	ning outcomes				
Master' suring a	s level and eva	. He/She commands kno	wledge in a current fi are necessary to acqu	eld in experimental	dule in experimental physics on physics and insight into the mea- He/She is able to classify and to	
Course	S (type, n	umber of weekly contact hours, l	anguage — if other than Ger	man)		
V (3) + I Module	• •	t in: English				
Method	l of ass	essment (type, scope, langua	ge — if other than German, e	examination offered — if no	t every semester, information on whether	
		le for bonus)				
b) oral e c) oral e d) proje e) prese If a writ stead ta of asse nation e Langua	examin examin ect repo entatio ten exa ake the ssmen date at ge of a	form of an oral examina t is changed, the lecturer the latest. ssessment: English	ach (approx. 30 minu of 2, approx. 30 minut o) or es). method of assessme tion of one candidate	es per candidate) of ent, this may be char each or an oral exa	r nged and assessment may in- mination in groups. If the method weeks prior to the original exami-	
Allocat	ion of p	olaces				
Additio	nal inf	ormation				
Worklo	ad					
180 h						
Teachir	Teaching cycle					
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)					
	Module appears in Master's degree (1 major) Physics International (2020)					
	-					
master	Master's degree (1 major) Physics International (2024)					

Module title				Abbreviation		
Current To	opics in Physics			11-EXP6-Int-201-m01		
Module co	oordinator		Module offered by			
chairperso	on of examination committee		Faculty of Physics a	nd Astronomy		
ECTS M	lethod of grading	Only after succ. com	pl. of module(s)			
6 ni	umerical grade					
Duration	Module level	Other prerequisites				
1 semeste	er graduate	Approval from exam	ination committee re	equired.		
Contents						
	ppics in experimental or theory or study abroad.	etical physics. Credite	ed academic achieve	ements, e.g. in case of change of		
Intended	learning outcomes					
physics or a current f	n Master's level in the study p	programme Nanostructor	cture Technology. He calculating method	ule in theoretical or experimental e/She commands knowledge in s which are necessary to acquire about fields of application.		
Courses (t	ype, number of weekly contact hours, la	anguage — if other than Ger	man)			
V (3) + R (1)					
module is cre a) written b) oral exa c) oral exa d) project	f assessment (type, scope, language editable for bonus) examination (approx. 90 to 1 amination of one candidate e amination in groups (groups of report (approx. 8 to 10 pages tation/talk (approx. 30 minute	20 minutes) or ach (approx. 30 minu If 2, approx. 30 minut) or	tes) or	t every semester, information on whether		
If a writter stead take of assess nation dat	n examination was chosen as e the form of an oral examinat	method of assessme tion of one candidate	each or an oral exam	nged and assessment may in- mination in groups. If the method weeks prior to the original exami-		
Allocation	n of places					
Additiona	l information					
Workload						
180 h						
Teaching	Teaching cycle					
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module a						
Master's o Master's o	degree (1 major) Physics Inter degree (1 major) Quantum Eng degree (1 major) Quantum Eng degree (1 major) Physics Inter	gineering (2020) gineering (2024)				





Theoretical Physics

(10 ECTS credits)

Module title					Abbreviation		
Quantu	Quantum Mechanics II 11-QM2-Int-201-m01					1	
Module coordinator Module offered by				Module offered by			
Managing Director of the Institute of Theoretical Physics Faculty of Physics and Astronomy and Astrophysics							
ECTS	Metho	od of grading	Only after succ. com	npl. of module(s)			
8	numer	rical grade					
Duratio	n	Module level	Other prerequisites				
1 semes	ster	undergraduate					
Content	!	5	<u>.</u>				
"Quantum mechanics 2" constitutes the central theoretical course to be taken within the international Master's program in physics. While the specific emphasis can be adjusted individually, the core topics that are supposed to be covered should include: Second quantization: fermions and bosons Band structures of particles in a crystal Angular momentum, symmetry operators, Lie Algebras Scattering theory: potential scattering, partial wave expansion Relativistic quantum mechanics: Klein-Gordon equation, Dirac equation, Lorentz group, fine structure splitting of atomic spectra Quantum entanglement Canonical formalism Indepth knowledge of advanced quantum mechanics. Thorough understanding of the mathematical and theoretical concepts of the listed topics. Ability to describe or model problems of modern theoretical quantum physics mathematically, to solve problems analytically or using approximation methods and to interpret the results phy-							
matter/	solid s	urse is pivotal to subseq tate physics. The course	is mandatory for all N	Master's students.			
		umber of weekly contact hours, l	anguage — if other than Ger	man)			
V (4) + I Module		tin: English					
		essment (type, scope, langua le for bonus)	ge — if other than German, e	examination offered — if no	t every semester, informati	on on whether	
a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may in- stead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original exami- nation date at the latest. Language of assessment: English Assessment offered: In the semester in which the course is offered and in the subsequent semester							
Allocati	Allocation of places						
Additio	nal info	ormation					
Workload							
240 h							
Master's wit	h 1 major	Physics International (2020)		generated 19-Apr-2025 • exa r (120 ECTS) Physics Internatio	-	page 80 / 196	

Referred to in LPO I (examination regulations for teaching-degree programmes)

Module appears in

Master's degree (1 major) Physics International (2020) Master's degree (1 major) Quantum Engineering (2020)

exchange program Physics (2023)

Master's degree (1 major) Quantum Engineering (2024)

Master's degree (1 major) Physics International (2024)

Module title Abbreviation				Abbreviation	
Theoretical Quantum Optics					11-TQO-Int-221-m01
Module coordinator Module offered by					
Managi and Ast		ector of the Institute of Th ics	eoretical Physics	Faculty of Physics a	nd Astronomy
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)	
8	numei	rical grade			
Duratio	n	Module level	Other prerequisites		
1 semes	ster	graduate			
Content	ts				
2. Intera 3. Mast 4. Cohe 5. Cohe 6. Photo	action o er equa rence a rent lig on stati	cal atom-field interaction of atoms with quantized l ation and open systems and interference effects th propagation in resona istics and correlations otics of many-body system	ight fields and dress nt media	ed-atom model	
		ning outcomes			
cal leve ln-dept tistics a Lindbla on effec	l. Knov h unde and cor d supe cts in re	vledge of density matrix f rstanding of quantum pro relations. Knowledge of t roperators. Understandir	ormalism for quantu operties of light and t he theory of open sys ng and modeling the nowledge of cooperat	m systems and the re heir experimental sig stems and master eq role of coherence an	with atoms at the microscopi- elated mathematical concepts. gnatures, including photon sta- juation description involving d interference in light propagati- body systems: super- and subra-
Courses	5 (type, n	umber of weekly contact hours, la	anguage — if other than Ger	man)	
V (4) + F Module		t in: English			
		essment (type, scope, languag le for bonus)	ge — if other than German, e	examination offered — if no	t every semester, information on whether
 a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English Assessment offered: In the semester in which the course is offered and in the subsequent semester 					
Allocati	ion of p	laces			
Additio	nal info	ormation			
Worklo	ad				
240 h					

Referred to in LPO I (examination regulations for teaching-degree programmes)

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Module appears in

Module title Abb				Abbreviation			
Theory of Relativity					11-RTT-Int-201-m01		
Module coordinator Module offered by							
Managir and Astr		ector of the Institute of Th ics	eoretical Physics	Faculty of Physics a	nd Astronomy		
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)			
6	numer	rical grade					
Duratio	n	Module level	Other prerequisites				
1 semes	ster	graduate					
Content	S						
 2. Differ 3. Brief 2 4. Eleme 5. Electr 6. Field 7. Stella 	ential Summ ents of odyna equati ir equil	al Foundations forms ary of the special relativit differential geometry mics as an example of a ons of the fundamental s librium and other astroph to cosmology	relativistic gauge the structure of general re				
		ning outcomes					
of the fo and the	ormula theory	tion in terms of differenti	al forms. Understand wing both of them as	ling of the formal sim gauge theories. App	ity. Mathematical understanding nilarity between electrodynamics lication of the theory to simple		
Courses	(type, n	umber of weekly contact hours, l	anguage — if other than Ger	man)			
V (3) + R Module		t in: English					
		essment (type, scope, langua; le for bonus)	ge — if other than German, e	examination offered — if no	t every semester, information on whether		
 b) oral e c) oral e d) proje e) prese lf a writt stead ta of asses 	 a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. 						
		ffered: In the semester in	which the course is	offered and in the su	bsequent semester		
Allocati	on of p	olaces					
Addition	nal info	ormation					
Workloa	ad						
180 h							
Teachin	g cycle	9					

Module appears in

Module title				Abbreviation	
Renormalization Group Methods in Field Theory					11-RMFT-Int-201-m01
Module coordinator Module offered by					
Managi and Ast	-	ector of the Institute of Th lics	eoretical Physics	Faculty of Physics a	nd Astronomy
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)	
8	nume	rical grade			
Duratio	n	Module level	Other prerequisites		
1 semes	ster	graduate			
Conten	ts				
se "Ren lation o stems, the cou 1. Wilso 2. Path 3. Betho 4. RG flo 5. Comp mation 6. RG flo Intende Familia of the t	This course is complementary to the discussion of Wilson's renormalizationg group (RG) as covered in the cour- se "Renormalization Group and Critical Phenomena" (11-CRP). This course focuses on the diagrammatic formu- lation of RG flow equations and its relation to diagrammatic perturbation expansions. For interacting fermion sy- stems, this is of particular relevance in the context of the functional renormalization group. A possible outline of the course is: 1. Wilson's RG 2. Path integral formulation of interacting fermions 3. Bethe-Salpeter-equation 4. RG flow equations for the one-particle and the two-particle vertex 5. Comparison of flow equations with diagrammatic resummation schemes (such as the "random phase approxi- mation") 6. RG flow equations for spin systems Intended learning outcomes Familiarity with modern diagram based techniques for interacting many-body systems. In-depth understanding				
		charge and spin density v umber of weekly contact hours, la			
V (4) + I	R (2)				
		t in: English			t en
		le for bonus)	ge — If other than German, e	examination offered — If no	t every semester, information on whether
a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may in- stead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original exami- nation date at the latest. Language of assessment: English Assessment offered: Once a year as announced Allocation of places					
Addítio	nal info	ormation			
	- J				
Worklo	aQ				
240 h					

Referred to in LPO I (examination regulations for teaching-degree programmes)

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Module appears in

Module title					Abbreviation		
Physics of Complex Systems 11-PKS-Int-201-m01							
Module coordinator Module offered by							
Managing Director of the Institute of Theoretical Physics Faculty of Physics and Astronomy and Astrophysics							
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)			
6	nume	rical grade					
Duratio	n	Module level	Other prerequisites				
1 semes	ster	graduate					
Content	ts						
 2. Introd 3. Entrod 4. Phas 5. Unive 6. Spin 	ductior py pro- e trans ersality glasse		equilibriumt t				
-		ning outcomes					
In-dept na in co univers	h know omplex ality. A	ledge of concepts and r many-body systems. Th bility to appreciate the c ex systems.	orough understandin	g of the concepts of e	entropy, entropy pro	duction and	
Courses	5 (type, n	umber of weekly contact hours,	language — if other than Ge	rman)			
V (2) + F Module		t in: English					
		essment (type, scope, langu le for bonus)	age — if other than German,	examination offered — if no	t every semester, informati	on on whether	
b) oral e c) oral e d) proje e) prese If a writ stead ta of asses nation o	 module is creditable for bonus) a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English 						
Allocati	ion of p	laces					
Additio	nal info	ormation					
Worklo	Workload						
180 h							
Teachin	ig cycl	2					
Referred to in LPO I (examination regulations for teaching-degree programmes)							
Master's wit	th 1 major	Physics International (2020)		generated 19-Apr-2025 • exa r (120 ECTS) Physics Internatio	-	page 88 / 196	

Module appears in

Module title Abbreviation					
Advanced Theory of Quantum Computing and Quantum Information11-QIC-Int-201-m01					
Module coordinator		Module offered by			
Managing Director of the Institute of T and Astrophysics	heoretical Physics	Faculty of Physics a	and Astronomy		
ECTS Method of grading	Only after succ. con	npl. of module(s)			
6 numerical grade					
Duration Module level	Other prerequisites	;			
1 semester graduate					
Contents					
 Quantum theory seen from the pers Composite systems and the Schmid Entanglement measures Quantum operations, POVMs, and the Schmid set of the theory of decohere 	It decomposition the theorems of Kraus puters				
Intended learning outcomes					
Comprehensive understanding of qua Knowledge of handling tensor product depth understanding of the phenome cepts of quantum information theory. herence.	ts and dealing with qu non of entanglement.	uantum effects in mu Knowledge of the fu	Iltipartite quantum systems. In- Indamental mathematical con-		
Courses (type, number of weekly contact hours	, language — if other than Ge	rman)			
V (3) + R (1) Module taught in: English					
Method of assessment (type, scope, langumodule is creditable for bonus)	age — if other than German,	examination offered — if n	ot every semester, information on whether		
 a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English Assessment offered: In the semester in which the course is offered and in the subsequent semester 					
Allocation of places					
Additional information					
Workload					
180 h					
Teaching cycle					
	,				

Module appears in

Module title					Abbreviation		
Theore	tical So	lid State Physics			11-TFK-Int-201-m01		
Module	e coord	inator		Module offered by			
-	Managing Director of the Institute of Theoretical Physics and Astrophysics			Faculty of Physics a	nd Astronomy		
ECTS	Metho	od of grading	Only after succ. con	compl. of module(s)			
8	nume	rical grade					
Duration Module level Other prerequisites							
1 seme	ster	graduate					
Conten	ts						
bus wh A possi 1. Band pologic 2. Elect theory, 3. Appl 4. BCS Intende	The contents of this two-term course will depend on the choice of the lecturer, and may include parts of the syllabus which could alternatively be offered as "Quantum Many Body Physics" (11-QVTP). A possible syllabus may be: 1. Band structure (Sommerfeld theory of metals, Bloch theorem, k.p approach and effective Hamiltonians for to- pological insulators (TIs), bulk-surface correspondence, general properties of TIs) 2. Electron–electron interactions in solids (path integral method for weakly interacting fermions, mean field theory, random phase approximation (RPA), density functional theory) 3. Application of mean field theory and the RPA to magnetism 4. BCS theory of superconductivity Intended learning outcomes In-depth knowledge of the topics listed above. In-depth understanding of the concepts involved and ability to						
standa	rd text	umber of weekly contact hours, l	state physics.				
V (4) +	R (2)	t in: English					
		e essment (type, scope, langua le for bonus)	ge — if other than German, o	examination offered — if no	t every semester, information on whether		
 a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English Assessment offered: In the semester in which the course is offered and in the subsequent semester 							
Allocat	ion of p	olaces					
Additio	nal inf	ormation					
Worklo	ad						
240 h							
Teachi	ng cycl	e					

Module appears in

Module title					Abbreviation	
Theore	tical So	olid State Physics 2			11-TFK2-Int-201-mo	1
Module	coord	inator		Module offered by		
Managi and Ast	-	ector of the Institute of sics	Theoretical Physics	Faculty of Physics and Astronomy		
ECTS Method of grading Only after succ. compl. of module(s)						
8	nume	rical grade				
Duratio	n	Module level	Other prerequisites	;		
1 seme	ster	graduate				
Conten	ts					
 A possible continuation of "11-TFK" is the following syllabus: 5. Advanced topics of the theory of superconductivity (Bogoliubov-de Gennes equations, effective field theory, Anderson-Higgs description of the Meissner effect) 6. Unconventional superconductors (e.G. copper-oxide high-Tc superconductors) 7. Green's function methods and Feynman diagrammatic technique 8. The Kondo Effect (Anderson's "poor mans scaling", renormalization group) 						
		ning outcomes				
ty to ap	ply the	methods listed. This p	sted above. In-depth u provides a thorough wo ical solid state physics	orking knowledge of a		
Course	S (type, n	umber of weekly contact hour	s, language — if other than Ge	rman)		
V (4) + I Module		t in: English				
Method	l of ass	essment (type, scope, lang	guage — if other than German,	examination offered — if no	ot every semester, informat	ion on whether
		le for bonus)				
b) oral of c) oral of d) project e) prese If a writ stead ta of asse nation of	 a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English 					
Allocati	ion of p	olaces				
Additio	nal inf	ormation				
Worklo	ad					
240 h						
Teachir	ng cycl	e				
Referre	d to in	LPO I (examination regulation	ons for teaching-degree progra	ammes)		
Module	e appea	urs in				
Master's wi	th 1 majoi	r Physics International (2020)	_	• generated 19-Apr-2025 • exa r (120 ECTS) Physics Internati	-	page 94 / 196

Module title				Abbreviation	
Topological E	ffects in Solid State Phys	ics		11-TEFK-Int-201-m01	
Module coord	inator		Module offered by	<u> </u>	
Managing Director of the Institute of Theoretical Physics and Astrophysics			Faculty of Physics a	and Astronomy	
ECTS Metho	5 Method of grading Only after succ. compl. of module(s)				
8 nume	rical grade				
Duration	n Module level Other prerequisites				
1 semester	graduate				
Contents					
 Mathematical basics of topology Time-reversal symmetry Hall conductance and Chern numbers Bulk-boundary correspondence Graphene (as a topological insulator) Quantum Spin Hall insulators Z2 invariants Topological superconductors 					
	ning outcomes				
stems. Ability				sics related to solid state sy- e Department of Physics and	
Courses (type, r	number of weekly contact hours, l	anguage — if other than Ge	rman)		
V (4) + R (2) Module taugh	t in: English				
Method of ass module is creditab		ge — if other than German,	examination offered — if no	ot every semester, information on whether	
 a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English Assessment offered: In the semester in which the course is offered and in the subsequent semester 					
Allocation of	olaces				
Additional inf	ormation				
Workload					
240 h					
Teaching cycl	e				

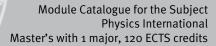
Module appears in

Module title					Abbreviation	
Field Th	eory ir	n Solid State Physics			11-FFK-Int-201-m01	
Module	coord	inator		Module offered by		
Managi and Ast	-	ector of the Institute of T ics	heoretical Physics	Faculty of Physics and Astronomy		
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)		
8	numer	rical grade				
Duratio	n	Module level	Other prerequisites	;		
1 semes	ster	graduate				
Conten	ts					
This will usually be a course on quantum many particle physics approached by the perturbative methods using Green's functions An outline could be: 1. Single-particle Green's function 2. Review of second quantization 3. Diagrammatic method using many particle Green's functions at temperature T=0 4. Diagrammatic method for finite T 5. Landau theory of Fermi liquids 6. Superconductivity 7. One-dimensional systems and bosonization						
-		ning outcomes				
ties of F	ermi li	ledge of the methods o quids (and bosonic sys understanding the effe	tems) beyond the one	-particle picture. Acq	uisition of methods	which are es-
Courses	5 (type, n	umber of weekly contact hours	, language — if other than Ge	rman)		
V (4) + F Module		t in: English				
		essment (type, scope, langule for bonus)	age — if other than German,	examination offered — if no	t every semester, informati	ion on whether
 a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English Assessment offered: In the semester in which the course is offered and in the subsequent semester 						
Allocati	on of p	olaces				
Additio	nal info	ormation				
Worklo	ad					
240 h						
Teachin	ig cycl	9				
Master's wit	th 1 major	Physics International (2020)		• generated 19-Apr-2025 • exa r (120 ECTS) Physics Internati		page 98 / 196

Module appears in

	e title				Abbreviation	
Select	ed Topi	ics of Theoretical Solid	State Physics		11-AKTF-Int-201-mc)1
Modul	e coord	linator		Module offered by		
	ing Dir	ector of the Institute of	Theoretical Physics	Faculty of Physics a	nd Astronomy	
ECTS	T	od of grading	Only after succ. cor	npl. of module(s)		
6	1	erical grade				
Duratio		Module level	Other prerequisites	6		
1 seme	ester	graduate	, ,			
Conter	nts] 0				
ments	to brin		ndensed matter theory with actual research to			
Intend	ed lear	ning outcomes				
theore	tical po	oint of view. This happe	condensed matter systeens on the basis of anal ts to the next step of be	ytical and numerical	methods. Therefore	
Course	es (type,	number of weekly contact hou	rs, language — if other than Ge	rman)		
V (3) +						
		nt in: English				
		sessment (type, scope, lan ble for bonus)	guage — if other than German,	examination offered — if no	ot every semester, informat	tion on whether
b) oral c) oral d) proj e) pres lf a wri stead t of asse nation Langua Assess	examin examin ect rep sentatio tten ex cake the essmen date a age of a sment o	nation in groups (group ort (approx. 8 to 10 pay on/talk (approx. 30 mir amination was chosen e form of an oral exami nt is changed, the lectu t the latest. assessment: English offered: In the semeste	e each (approx. 30 min os of 2, approx. 30 minu ges) or	ites per candidate) o ent, this may be cha e each or an oral exa ts about this by four	nged and assessme mination in groups. weeks prior to the o	If the method
Allocat	tion of	places			sobequent semester	r
Allocal						r
						r
	onal inf	formation				r
 Additic		formation				r
 Additio Worklo		formation				r
 Additic Worklc 180 h	oad					r
 Additio Worklo	oad					r
 Additio Worklo 180 h Teachi 	oad ng cycl	le				r
 Additic Worklc 180 h Teachi Referre	oad ng cycl	le	ions for teaching-degree progra			r
 Additio 180 h Teachi Referre	ng cycl ed to in	le I LPO I (examination regulat	ions for teaching-degree progra			r
 Additic 180 h Teachi Referre Module	oad ng cycl ed to in e appe	le I LPO I (examination regulat ars in				r
 Additic 180 h Teachi Referre Module	ng cycl ed to in e appe	le I LPO I (examination regulat	ternational (2020)			r
 Additic 180 h Teachi Referre Module Master Master	oad ng cycl ed to in e appe r's degr	le I LPO I (examination regulat ars in ree (1 major) Physics In	ternational (2020) Engineering (2020)			r





Master's degree (1 major) Physics International (2024)

Module title					Abbreviation	
Compu	Itationa	l Materials Science (DFT)		11-CMS-Int-201-m01	
Modul	e coord	inator		Module offered by	<u> </u>	
	ing Dire trophys	ector of the Institute of Th sics	neoretical Physics	Faculty of Physics a	and Astronomy	
ECTS	Metho	od of grading	Only after succ. con	ompl. of module(s)		
8	nume	rical grade				
Duratio	on	Module level	Other prerequisites	quisites		
1 semester graduate						
Conter	nts					
4. Hart 5. Man 6. And 7. Dyna 8. DFT 9. Stro Intend	ree-Foc y-body erson ir amical r + DMFT ngly cor ed learr	evaluation of topological k and static mean-field t methods for solid state p npurity model (AIM) and nean-field theory (DMFT) methods for realistic mo rrelated electrons hing outcomes eatment of the above top	heory ohysics Kondo physics odeling of solids	v hands-on tutorials :	to be held in the CIP-Pool. Fami-	
ctions tions o based stency Course V (4) +	by proje of the AI on exac equation es (type, n R (2)	ecting DFT results onto a M and explore some of it at diagonalization or con	tomic orbitals using v ts limiting cases such tinuous-time quantur	wannier90. Knowledg a as the Kondo regim m Monte Carlo for the	maximally localized Wannier fun- ge how to obtain many-body solu- e. Ability to use impurity solvers e solution of the DMFT self-consi-	
Metho	d of ass		age — if other than German,	examination offered — if no	ot every semester, information on whether	
 b) oral c) oral d) proj e) pressification lf a wristead to fasse nation Langua 	examin examin ect repo sentatio tten exa take the essmen date at age of a	form of an oral examina	each (approx. 30 minu of 2, approx. 30 minu s) or ees). s method of assessm ition of one candidate r must inform student	ites per candidate) o ent, this may be cha e each or an oral exa ts about this by four	nged and assessment may in- mination in groups. If the methoc weeks prior to the original exami-	
	tion of p					
Additio	onal inf	ormation				
Worklo	oad					

Referred to in LPO I (examination regulations for teaching-degree programmes)

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Module appears in

Module title					Abbreviation	
Confor	mal Fie	ld Theory			11-KFT-Int-201-m01	
Module	e coord	inator		Module offered by		
Manag and As	-	ector of the Institute of ⁻ sics	Theoretical Physics	Faculty of Physics a	nd Astronomy	
ECTS	Metho	od of grading	Only after succ. cor	npl. of module(s)		
6	nume	rical grade				
Duratio	on	Module level	Other prerequisites	;		
1 seme	ster	graduate				
Conten	ts					
dimensi tricritic riance i der con sional s terestir states (mensio topolog their na course o Introo point) 1 Confo tions) 2 Confo tion an on, the 3 The c lian) bo and ou duality 4 Kac d	sional s al Ising is eleva formal system ng area (where onal CF gical qu ames to is: duction ormal th ormal th free bo entral to psoniza t-states and th letermi	d theory (CFT), as devel statistical mechanics, w g, 3-state Potts, etc.) car sted from a global to a le transformations. This, s (either two space or o s of condensed matter p the bulk wave function Ts), the two-channel Ko iantum computing invo the fusion rules of the d (scale and conformal i neories in D=2 (primary her's theorem, radial qu boson and vertex operato charge and the Virasoro tion, mode expansions s, highest weight states e bootstrap) nant and unitarity (Verm ds, minimal models in g	here critical exponents be calculated exactly ocal invariance, which in turn, yields a rich ar ne time and one space physics, including Abe is described in terms ndo effect, fractional t lving non-Abelian any associated conformal nvariance, critical expo s (conformal group, con fields and correlation uantization and Polyak ors, conformal Ward id algebra (central charg and the Virasoro alge , descendant fields an	s and correlation fun The physical idea is for reasons of consis- nd fascinating mathe e dimension). CFT ha- clian and non-Abeliar of conformal correlat opological insulators ons (Ising and Fibona fields.) A potential s onents, the transverse nformal algebra in 20 functions, quantum tov's theorem, time of entities) ge, the Schwarzian de bra, the cylinder geo id operator product e	ctions for many modes that the principle of stency amounts to in matical structure for s become relevant to n bosonization, quan ors, and the edge in s, and in particular fa acci anyons, for exar yllabus for the first to se Ising model at the D, constraints on cor field theory, canonia rdering and function erivative, the free fer metry and the Casim expansions, conform	lels (Ising, of scale inva- nvariance un- r two dimen- o many in- ntized Hall terms 1+1 di- ault-tolerant nple, owe term of the e self-dual rrelation func- cal quantiza- nal integrati- rmion, (Abe- nir effect, in- al blocks,
	-	ning outcomes				
derstar standir	nding o ng in pa	both practical and con f critical phenomena, q irticular for students of ontemporary condense	uantum field theory, a theoretical physics by	nd functional integra	ition. Enhanced leve	l of under-
Course	S (type, r	umber of weekly contact hours	, language — if other than Ge	rman)		
V (3) + Module		t in: English				
		sessment (type, scope, lang le for bonus)	uage — if other than German,	examination offered — if no	t every semester, informat	ion on whether
b) oral c) oral d) proje	examir examin ect repo	mination (approx. 90 to nation of one candidate ation in groups (groups ort (approx. 8 to 10 page n/talk (approx. 30 minu	each (approx. 30 minu s of 2, approx. 30 minu es) or		r	
Master's wi	ith 1 majo	r Physics International (2020)	-	• generated 19-Apr-2025 • exa r (120 ECTS) Physics Internati	-	page 104 / 196

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If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.

Language of assessment: English

Assessment offered: In the semester in which the course is offered and in the subsequent semester

Allocation of places

Additional information

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Workload

180 h

Teaching cycle

Referred to in LPO I (examination regulations for teaching-degree programmes)

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Module appears in

Master's degree (1 major) Physics International (2020) exchange program Physics (2023)

Master's degree (1 major) Physics International (2024)

Module title					Abbreviation	
Conform	nal Fie	ld Theory 2			11-KFT2-Int-201-mo	1
Module	coord	inator		Module offered by		
Managi and Ast		ector of the Institute of	Theoretical Physics	Faculty of Physics a	nd Astronomy	
ECTS		od of grading	Only after succ. con	nnl of modulo(c)		
6 Duratio		rical grade Module level	 Other prerequisites	•		
			Other prerequisites			
1 semes		graduate				
Contents5 Minimal models (critical statistical mechanics models (Ising, tricritical Ising, 3 state Potts model, restricted so- lid-on-solid models), correlation functions of the critical Ising model, fusion rules and the Verlinde algebra, Land- au-Ginzburg description of minimal models, modified Coulomb gas method and its application to the Ising mo- del, superconformal models)6 Free bosons and fermions (mode expansions, twist fields, fermionic zero modes and fermion parity) 7 Free fermions on the torus (operator implementation of the partition function, vacuum energies, representati- ons of Virasoro algebra, the modular group and fermionic spin structures, Virasoro characters, critical Ising mo- del on the torus, Jacobi theta function identities)8 Free bosons on the torus (Lagrangian formulation of the partition function, fermionization, orbifolds in general, S1/Z2 orbifold, Gaussian and Askhin-Teller models, duality between original and orbifold theories, marginal ope- rators, the space of c=1 theories)Intended learning outcomesAcquisition of both practical and conceptional familiarity with the methods of conformal field theory. Basic un- derstanding of critical phenomena, quantum field theory, and functional integration. Enhanced level of under- standing in particular for students of theoretical physics by exposure to an ambitious method with significant ap-						algebra, Land- ne Ising mo- ty) epresentati- al Ising mo- ds in general, marginal ope- y. Basic un- el of under-
		ontemporary condense umber of weekly contact hour		rman)		
V (3) + I Module		t in: English				
Method	l of ass	eessment (type, scope, lang le for bonus)	uage — if other than German,	examination offered — if no	t every semester, informati	ion on whether
 a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English Assessment offered: In the semester in which the course is offered and in the subsequent semester 						
Allocat	ion of p	olaces				
Additio	nal inf	ormation				
Worklo	ad					
180 h						
Master's wi	th 1 majoı	Physics International (2020)		• generated 19-Apr-2025 • exa er (120 ECTS) Physics Internati		page 106 / 196

Referred to in LPO I (examination regulations for teaching-degree programmes)

Module appears in

Master's degree (1 major) Physics International (2020) Master's degree (1 major) Physics International (2024)

Module title					Abbreviation	
Group 1	Theory				11-GRTM-Int-201-mo	01
Module	coord	inator		Module offered by		
Managi and Ast	-	ector of the Institute of sics	Theoretical Physics	Faculty of Physics a	nd Astronomy	
ECTS Method of grading Only after succ. compl. of module(s)						
6	nume	rical grade				
Duratio	n	Module level	Other prerequisites			
1 semester graduate Approval from examination committee required.						
Conten	ts					
German contents available but not translated yet. Gruppentheorie. Endliche Gruppen. Lie-Gruppen. Lie-Algebren. Darstellungen. Tensoren. Klassifikationstheorem. Anwendungen						
Intende	ed leari	ning outcomes				
Die Stu der Lag	dieren e, Prob	den beherrschen die G Ilemstellungen der Gru	available but not trans rundlagen der Gruppen ppentheorie zu erkenn ulierung und Bearbeitu	theorie, insbesonde en und mit Hilfe der	erlernten Methoden	
Courses	5 (type, n	umber of weekly contact hour	s, language — if other than Ge	rman)		
V (3) + I Module		t in: English				
Method	l of ass	essment (type, scope, lang	guage — if other than German,	examination offered — if no	t every semester, informat	ion on whether
		le for bonus)				
 a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English Assessment offered: In the semester in which the course is offered and in the subsequent semester 						If the method riginal exami-
Allocati						
Additio	nal inf	ormation				
Worklo	ad					
180 h	au					
Teachir		0				
reaciiii	is tyte					
Poforro	d to in		ons for teaching-degree progra	ummoc)		
Referre		LFVI (examination regulation	uns for teaching-degree progra	unines)		
Module	appea	irs in				
Master's wi	th 1 majoı	Physics International (2020)	-	generated 19-Apr-2025 • exa r (120 ECTS) Physics Internati	-	page 108 / 196

Module title				Abbreviation		
Particle Physics (Standard Model)				11-TPSM-Int-201-m01		
Module coordinator			Module offered by			
Managing Directors o the Institute of Theore			Faculty of Physics a	nd Astronomy		
ECTS Method of gra	ading	Only after succ. con	npl. of module(s)			
6 numerical gra	ade					
Duration Modul	e level	Other prerequisites				
1 semester gradua	ate	Approval from exam	ination committee re	equired.		
Contents						
Electroweak symmetr parity Violation Bhabha scattering Z-Line Shape and forv Higgs production and Experimental setup a ters Search for the Higgs b	ward / reverse asy l decay nd results of key e	mmetry		nd for determining its parame-		
Intended learning out						
have established and	l confirmed the sta	andard model. They I	nave basic knowledg	cle and the key experiments that ge in order to interpret experimen- its significance and limitations.		
Courses (type, number of	weekly contact hours, l	anguage — if other than Ger	rman)			
V (3) + R (1) Module taught in: Eng	glish					
Method of assessmen module is creditable for bon		ge — if other than German, o	examination offered — if no	t every semester, information on whether		
 a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English Assessment offered: In the semester in which the course is offered and in the subsequent semester 						
Allocation of places				·		
Additional information						
Workload						
180 h						
Teaching cycle						

Referred to in LPO I (examination regulations for teaching-degree programmes)

Module appears in

Master's degree (1 major) Physics International (2020) exchange program Physics (2023)

Module title Ab				Abbreviation	
Renormalization Group and Critical Phenomena			enomena		11-CRP-Int-201-m01
Module coordinator				Module offered by	
		ector of the Institute of Th	eoretical Physics	Faculty of Physics a	ind Astronomy
	trophys			,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	· · · · · · · · · · · · · · · · · · ·
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)	
6		rical grade			
Duratio	on	Module level	Other prerequisites		
1 seme	ester	graduate			
Conter					
2. Mea 3. The 4. Phas 5. Pertu 6. Low	se diagi urbatioi -dimens				
Intend	ed lear	ning outcomes			
sics. U	ndersta				on group (RG) in statistical phy- theories in both statistical and
Course	S (type, r	number of weekly contact hours, l	anguage — if other than Ge	rman)	
V (3) +					
	_	t in: English			
		sessment (type, scope, langua le for bonus)	ge — if other than German,	examination offered — if no	ot every semester, information on whether
 a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English Assessment offered: In the semester in which the course is offered and in the subsequent semester 					
Allocat	tion of p	olaces			
Additio	onal inf	ormation			
Workload					
180 h					
Teachi	ng cycl	e			
Referre	ed to in	LPO I (examination regulation	s for teaching-degree progra	immes)	

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Module appears in

Module title				Abbreviation		
Bosoni	sation	and Interactions in One	Dimension		11-BWW-Int-201-m01	
Module	coord	inator		Module offered by	Module offered by	
Managing Director of the Institute of Theoretical Physics Faculty of Physics and Astronomy and Astrophysics			nd Astronomy			
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)		
6	nume	rical grade				
Duratio	n	Module level	Other prerequisites			
1 semes	ster	graduate				
Conten						
2. Abeli	ian bos	f Fermi systems in one d conisation and Luttinger oup, and the sine-Gordor	liquids (spinless ferm	nions, correlation fun	actions, models with spin, renor-	
3. Intera 4. Beth 5. Spin- 6. Disor 7. Non-a	acting f e ansat 1/2 ch rdered abeliar	ains systems	ıbbard model, t/J moc NZW model (Kac-Moo	lel, transport propert	ies) ra construction, Knizhnik-Zamo-	
		ning outcomes				
Familia	rity wit				uisition of the theoretical tools to sport in 1D.	
		umber of weekly contact hours,				
V (3) + I Module		t in: English				
Method	l of ass	essment (type, scope, langu	age — if other than German,	examination offered — if no	t every semester, information on whether	
		le for bonus)				
 a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English Assessment offered: In the semester in which the course is offered and in the subsequent semester 						
Allocati	ion of p	olaces				
Additio	nal inf	ormation				
Workload						
180 h						
Teachir	ıg cycl	9				
Master's wi	th 1 majoı	Physics International (2020)	-	generated 19-Apr-2025 • exa r (120 ECTS) Physics Internation		

Referred to in LPO I (examination regulations for teaching-degree programmes)

Module appears in

Module t	itle				Abbreviation	
Introduction to Gauge/Gravity Duality				11-GGD-Int-201-mo	L	
	oordinator			Module offered by		
Managing and Astro	-	f the Institute of Th	eoretical Physics	Faculty of Physics a	nd Astronomy	
ECTS N	Aethod of g	rading	Only after succ. con	npl. of module(s)		
8 n	iumerical gr	rade				
Duration	Modu	le level	Other prerequisites			
1 semest	er gradu	late				
Contents	;		·			
 Qu Inta Rer Gai Coi Lar Sup 2. Elemer Ma Bla 3. Elemer Op Stri Op Stri Op Eterner Op Stri Typ D-E 4. The Ad Sta Nea Fie Tes Hol Strision Hol Extens Hol Strision Qu Bla Hol Extens Hol Extens Hol Extens Hol Extens Hol Extens Hol Ent 8. Applica Gra Qu 	antisation o eractions normalisatic uge Fields nformal Sym ge N expans persymmetr nts of gravity nifolds, coo mann curva ximally sym ick holes nts of string en and clos ings in back be IIB String Branes IS/CFT corre itement of th ar-horizon li Id-operator ists of the co lographic pr ions to non- lographic re lographic re lographic re lographic I in nsport coeffi ations I: The antum field ick holes lographic lir nsport coeffi ations II: Co ite charge d antum critic lographic fe lographic fe canglement ations III: Pa avity dual of ark-gluon pl	nmetry sion y y ordinate covariance ature metric spacetimes theory ed strings ground fields Theory espondence he correspondence imit of D3-Branes correspondence: Co- rinciple -conformal theorie enormalisation gro Theorem ermo- and hydrody theory at finite ter near response form ficients: Shear vis- ondensed matter p lensity and Reissn cal behaviour ermions uperconductors entropy atticle physics f confinement f chiral symmetry b lasma	e rrelation functions nformal anomaly es up namics nperature nalism cosity and conductivi hysics er-Nordström black h	oles		2200 116 / 106
		lasma International (2020)		generated 19-Apr-2025 • exa r (120 ECTS) Physics Internati	-	page 116 / 196

Intended learning outcomes

Thorough understanding of the foundations of gauge/gravity duality and the ability to carry out basic tests. Working knowledge of essential applications. Knowledge of quantum mechanics and classical electrodynamics is a prerequisite for this course. Knowledge of quantum field theory and general relativity will be useful, however is not a prerequisite.

Courses (type, number of weekly contact hours, language — if other than German)

V (4) + R (2)

Module taught in: English

Method of assessment (type, scope, language – if other than German, examination offered – if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 90 to 120 minutes) or

b) oral examination of one candidate each (approx. 30 minutes) or

c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or

d) project report (approx. 8 to 10 pages) or

e) presentation/talk (approx. 30 minutes).

If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.

Language of assessment: English

Assessment offered: In the semester in which the course is offered and in the subsequent semester

Allocation of places

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Additional information

Workload

240 h

Teaching cycle

Referred to in LPO I (examination regulations for teaching-degree programmes)

Module appears in

Master's degree (1 major) Physics International (2020)

exchange program Physics (2023)

Module title			Abbreviation		
Cosmology				11-AKM-Int-201-m01	
Module	coord	inator		Module offered by	
Managi and Ast	-	ector of the Institute of Th iics	eoretical Physics	Faculty of Physics a	nd Astronomy
ECTS	Metho	od of grading	Only after succ. com	ıpl. of module(s)	
6	nume	rical grade			
Duratio	n	Module level	Other prerequisites		
1 semes	ster	graduate			
Conten	ts				
Matter,	Primor		smic Microwave Bac		he Early Universe, Inflation, Dark ormation, Galaxies and Galaxy
Intende	d learı	ning outcomes			
		lge of cosmology. Knowle ions. Insight into current			logy and the ability to relate tho- ientific questions.
Courses	5 (type, n	umber of weekly contact hours, la	anguage — if other than Ger	man)	
V (3) + I Module		t in: English			
		s essment (type, scope, langua; le for bonus)	ge — if other than German, e	examination offered — if no	t every semester, information on whether
b) oral e c) oral e d) proje e) prese If a writ stead ta of asses nation o Langua	examin examin ect repo entatio ten exa ake the ssmen date at ge of a	form of an oral examinat	ach (approx. 30 minu of 2, approx. 30 minu) or es). method of assessme tion of one candidate must inform student	tes per candidate) or ent, this may be char e each or an oral exar s about this by four y	nged and assessment may in- mination in groups. If the method weeks prior to the original exami-
Allocati					
Additio	nal inf	ormation			
Worklo	ad				
180 h					
Teachir	ig cycl	e			
Referre	d to in	LPO I (examination regulations	for teaching-degree progra	mmes)	
Module	appea	irs in			
exchan	ge prog	ee (1 major) Physics Inter gram Physics (2023) ee (1 major) Physics Inter			

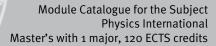
Modul	e title				Abbreviation	
Theoretical Astrophysics					11-AST-Int-201-m01	
Modul	e coord	inator		Module offered by		
	ging Dire strophys	ector of the Institute of Th sics	eoretical Physics	Faculty of Physics a	and Astronomy	
ECTS	Meth	od of grading	Only after succ. con	npl. of module(s)		
6	nume	rical grade				
Durati	on	Module level	Other prerequisites			
1 seme	ester	graduate				
Conter	nts					
		retical astrophysics such jets, shock waves, radiat			black holes, supernovae, pulsars,	
Intend	ed lear	ning outcomes				
Knowl	edge of	basic processes and met	hods of theoretical a	strophysics. Ability	to formulate theoretical models.	
Course	es (type, r	number of weekly contact hours, l	anguage — if other than Ge	rman)		
V (2) + Modul		t in: English				
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus) a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may in- stead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original exami- nation date at the latest. Language of assessment: English Assessment offered: In the semester in which the course is offered and in the subsequent semester Allocation of places						
Additio	onal inf	ormation				
Workle	oad					
180 h						
Teaching cycle						
-						
Referred to in LPO I (examination regulations for teaching-degree programmes)						
	e appea		national (casa)			
exchar	Master's degree (1 major) Physics International (2020) exchange program Physics (2023) Master's degree (1 major) Physics International (2024)					

Module	title				Abbreviation	
Introduction to Plasma Physics					11-EPP-Int-201-m01	
Module	coord	nator		Module offered by		
		ector of the Institute of Th	eoretical Physics	Faculty of Physics a	ind Astronomy	
and Ast						
ECTS		d of grading	Only after succ. con	npl. of module(s)		
6 Duratio		ical grade Module level				
			Other prerequisites			
1 semes		graduate				
Transpo thin the celerati	ort equa solar on and	ations for energetic parti	cles, Properties of ma n via shock waves a	agnetic turbulence, F nd via interaction wit	Ids, Magnetohydrodynamics, Propagation of solar particles wi- th plasma turbulence, Particle ac- liation.	
		fundamental processes i	n plasma astrophysi	cs.		
		umber of weekly contact hours, l				
V (2) + I	R (2)	tin: English				
a) writte b) oral e c) oral e d) proje e) prese If a writ stead ta of asses nation o Langua	Method of assessment (type, scope, language – if other than German, examination offered – if not every semester, information on whether module is creditable for bonus) a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may in- stead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original exami- nation date at the latest.					
		ffered: In the semester in	which the course is	offered and in the su	ubsequent semester	
Allocati						
Additio	nal info	ormation				
Worklo	ad					
180 h						
Teachir	ng cycl	2				
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)					
Module	appea	rs in				
Master' exchan	s degre ge prog	ee (1 major) Physics Inter gram Physics (2023) ee (1 major) Physics Inter				

Module title	Abbreviation				
High-Energy Astrophysics		11-APL-Int-201-m01			
Module coordinator	Module offered by				
Managing Director of the Institute of Theoretical Physics and Astrophysics	Faculty of Physics a	nd Astronomy			
ECTS Method of grading Only after succ. co	mpl. of module(s)				
6 numerical grade					
Duration Module level Other prerequisite	5				
1 semester graduate					
Contents					
Astrophysical sources of high-energy emission, radiative p celeration processes, pair creation, nuclear processes, pio equations					
Intended learning outcomes					
The student gains knowledge in fundamentals of high-ene non-thermal radiative processes in astrophysical	rgy astrophysics, such	n as particle acceleration and			
Courses (type, number of weekly contact hours, language — if other than Ge	erman)				
V (3) + R (1) Module taught in: English					
Method of assessment (type, scope, language — if other than German, module is creditable for bonus)	examination offered — if no	t every semester, information on whether			
 a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 min c) oral examination in groups (groups of 2, approx. 30 min d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessm stead take the form of an oral examination of one candidat of assessment is changed, the lecturer must inform studen nation date at the latest. Language of assessment: English Assessment offered: In the semester in which the course is 	utes per candidate) or nent, this may be char te each or an oral exam ts about this by four o	nged and assessment may in- mination in groups. If the method weeks prior to the original exami-			
Allocation of places					
Additional information					
Workload					
180 h					
Teaching cycle					
Referred to in LPO I (examination regulations for teaching-degree programmes)					
Module appears in					
Master's degree (1 major) Physics International (2020)					
exchange program Physics (2023)					
exchange program Physics (2023) Master's degree (1 major) Physics International (2024)					

Module title			Abbreviation				
Computational Astrophysics			11-NMA-Int-201-mo	1			
Module	coord	inator		Module offered by	Module offered by		
Managi and Ast		ector of the Institute of sics	Theoretical Physics	Faculty of Physics a	nd Astronomy		
ECTS	Metho	od of grading	Only after succ. cor	npl. of module(s)			
6	nume	rical grade		-			
Duratio		Module level	Other prerequisites	5			
1 semes	ster	graduate					
Conten	ts						
rithms Lattice-	(tree- a Boltzm	ods used in astrophysic nd polynomial codes). ann). Hyperbolic conso s of high-performance	Particle-mesh method ervation laws (fluid dyr	s (particle-in-cell me namics, finite differer	thods). Vlasow meth nce method, Rieman	nods (e.g., n solver,	
Intende	ed leari	ning outcomes					
		e problems and equations. Capability to choose					
Course	S (type, n	umber of weekly contact hour	s, language — if other than Ge	rman)			
V (3) + I							
		t in: English					
		s essment (type, scope, lang le for bonus)	uage — if other than German,	examination offered — if no	ot every semester, informati	ion on whether	
		mination (approx. 90 to	 120 minutes) or				
b) oral (examin	ation of one candidate	each (approx. 30 min				
		ation in groups (groups ort (approx. 8 to 10 pag		ites per candidate) o	r		
		n/talk (approx. 3 to 10 pag					
If a writ	ten exa	amination was chosen	as method of assessm				
		e form of an oral examin t is changed, the lectur					
_		the latest.	er must morm studen	is about this by four	weeks phot to the of		
		ssessment: English					
		ffered: In the semester	in which the course is	offered and in the su	ibsequent semester		
Allocat	ion of p	Diaces					
	nal i-f	ormation					
Adaltio	nat inf	uniation	_				
Worklo							
	au						
	180 h						
Teaching cycle							
Referro	d to in	IPOI (avamination togetati	ons for teaching degree progr	ammes)			
Referred to in LPO I (examination regulations for teaching-degree programmes)							
Module	 Module appears in						
		ee (1 major) Physics Int	ernational (2020)				
	-	gram Physics (2023)	(2020)				
Master's wi	th 1 majoı	Physics International (2020)	-	• generated 19-Apr-2025 • exa er (120 ECTS) Physics Internati	-	page 122 / 196	





Module title			Abbreviation			
Quantu	m Field	Theory I			11-QFT1-Int-201-m01	
Module	coordi	nator		Module offered by		
Managi and Ast	-	ctor of the Institute of Th ics	eoretical Physics	Faculty of Physics a	nd Astronomy	
ECTS	Metho	d of grading	Only after succ. com	pl. of module(s)		
8	numer	ical grade				
Duratio	n	Module level	Other prerequisites			
1 semes	ster	graduate	Approval from exam	ination committee re	equired.	
Conten	ts					
 Lagra Field Asym Gaug Pertu Feynr Quar 	 Symmetries. Lagrange formalism for fields. Field quantisation. Asymptotic states, scattering theory and S-matrix Gauge principle and interaction. Perturbation theory. Feynman rules. Quantum elektrodynamical processees in Born approximation. Radiative corrections (optional) 					
		ling outcomes				
They kn process	ow hov ses in tl	v to use perturbation the	ory and how to apply n electrodynamics in	Feynman rules. The	vistic quantum field theories. y are able to calculate basics over, they have a basic under-	
Courses	5 (type, n	umber of weekly contact hours, la	anguage — if other than Ger	man)		
V (4) + F Module		in: English				
		essment (type, scope, langua; e for bonus)	ge — if other than German, e	examination offered — if no	t every semester, information on whether	
 a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English Assessment offered: In the semester in which the course is offered and in the subsequent semester 						
Allocati	ion of p	laces				
Additio	nal info	ormation				
Worklo	ad					
240 h						

Teaching cycle

Referred to in LPO I (examination regulations for teaching-degree programmes)

Module appears in

Master's with 1 major Physics International (2020)

Module	title				Abbreviation
Quantum Field Theory II					11-QFT2-Int-201-m01
Module	coord	inator		Module offered by	
Managi and Ast		ector of the Institute of Th sics	eoretical Physics	Faculty of Physics a	nd Astronomy
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)	
8	nume	rical grade			
Duratio	n	Module level	Other prerequisites		
1 semes	ster	graduate			
Conten	ts				
2. Path 3. Reno 4. Reno 5. Gaug 6. Spon	Integra rmaliza rmaliza e theo itaneou	ation ation group			
-		ning outcomes			
In-dept zation a	h know and of g	ledge of the concepts an			ding the principles of renormali- ory and to solve them using the
Courses	5 (type, n	number of weekly contact hours, l	anguage — if other than Ger	man)	
V (4) + I Module		t in: English			
		sessment (type, scope, langua le for bonus)	ge — if other than German, e	examination offered — if no	t every semester, information on whether
 a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English Assessment offered: In the semester in which the course is offered and in the subsequent semester 					
Allocati	ion of p	olaces			
Additio	nal inf	ormation			
Worklo	ad				
240 h					
Teachir	ng cycl	e			
Referre	d to in	LPO I (examination regulations	for teaching-degree progra	mmes)	

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Module appears in

Module title			Abbreviation				
Theoretical Elementary Particle Physics				11-TEP-Int-201-m01			
Module	coordinator		Module offered by				
-	ng Director of the Institute of Th rophysics	eoretical Physics	Faculty of Physics a	nd Astronomy			
ECTS	Method of grading	Only after succ. com	npl. of module(s)				
8	numerical grade						
Duratio	n Module level	Other prerequisites					
1 seme	ster graduate						
Conten	ts						
2. Grou 3. Quar 4. Parto 5. Basic 6. Gaug 7. Spon 8. Elect	 Fundamental Forces and Particles Groups and Symmetries Quark Model of Hadrons Parton Model and Deep Inelastic Scattering Basics of Quantum Field Theory Gauge Theories Spontaneous Symmetry Breaking Electro-Weak Standard Model Quantum Chromo Dynamics 						
	ed learning outcomes						
standaı calcula		om symmetry princip nd decay processes, t	les and experimenta	rstanding of the structure of the l observations. Knowledge of the models and there are limitati-			
Course	S (type, number of weekly contact hours, l	anguage — if other than Ger	rman)				
V (4) + I Module	R (2) e taught in: English						
	l of assessment (type, scope, langua creditable for bonus)	ge — if other than German, e	examination offered — if no	t every semester, information on whether			
 a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English Assessment offered: In the semester in which the course is offered and in the subsequent semester 							
Allocat	ion of places						
Additio	nal information						
Worklo	ad						
240 h							

Teaching cycle

Referred to in LPO I (examination regulations for teaching-degree programmes)

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Module appears in

	e title			_	Abbreviation		
Selecte	ed Topi	cs of Theoretical Eleme	ntary Particle Physics	;	11-ATTP-Int-201-m01		
Module	e coord	inator		Module offered by			
Managing Director of the Institute of Theoretical Physics and Astrophysics				Faculty of Physics a	and Astronomy		
ECTS		od of grading	Only after succ. co	mpl. of module(s)			
6	nume	rical grade					
Duratio	on	Module level	Other prerequisites	ner prerequisites			
1 seme	ster	graduate					
Conten	Its						
1. Adva 2. Pher 3. Higg	anced T nomen s Phys	topics from the followin rechniques for Precision plogy of Collider Experir ics Physics	Calculations of Scatt				
Intende	ed lear	ning outcomes					
		y advanced computatic e of current trends in pa			of particle physics ph	enomenolo	
Course	S (type, 1	number of weekly contact hours	s, language — if other than Ge	erman)			
V (3) + Module		t in: English					
		sessment (type, scope, lang ble for bonus)	uage — if other than German,	examination offered — if no	ot every semester, informatio	on on whether	
		nation of one candidate	cucii (upprova je min				
d) proje e) prese If a writ stead ta of asse nation Langua	ect rep entatic tten ex ake the essmen date at age of a	nation in groups (groups ort (approx. 8 to 10 pag on/talk (approx. 30 minu amination was chosen a e form of an oral examin t is changed, the lectur t the latest. assessment: English offered: In the semester	utes). as method of assessm lation of one candidat er must inform studen	utes per candidate) o ent, this may be cha e each or an oral exa ts about this by four	nged and assessmen mination in groups. If weeks prior to the ori	f the method	
d) proje e) prese If a writ stead ta of asse nation Langua	ect rep entation tten ex cake the essmen date at age of a ment o	ort (approx. 8 to 10 pag on/talk (approx. 30 minu amination was chosen a e form of an oral examin t is changed, the lectur t the latest. Issessment: English offered: In the semester	es) or utes). as method of assessm ation of one candidat er must inform studen	utes per candidate) o ent, this may be cha e each or an oral exa ts about this by four	nged and assessmen mination in groups. If weeks prior to the ori	f the method	
d) proje e) prese If a writ stead ta of asse nation Langua Assess	ect rep entation tten ex cake the essmen date at age of a ment o	ort (approx. 8 to 10 pag on/talk (approx. 30 minu amination was chosen a e form of an oral examin t is changed, the lectur t the latest. Issessment: English offered: In the semester	es) or utes). as method of assessm ation of one candidat er must inform studen	utes per candidate) o ent, this may be cha e each or an oral exa ts about this by four	nged and assessmen mination in groups. If weeks prior to the ori	f the method	
d) proje e) prese If a writ stead ta of asse nation Langua Assess Allocat	ect rep entatic tten ex ake the essmen date at age of a ment c :ion of	ort (approx. 8 to 10 pag on/talk (approx. 30 minu amination was chosen a e form of an oral examin t is changed, the lectur t the latest. Issessment: English offered: In the semester	es) or utes). as method of assessm ation of one candidat er must inform studen	utes per candidate) o ent, this may be cha e each or an oral exa ts about this by four	nged and assessmen mination in groups. If weeks prior to the ori	f the method	
d) proje e) prese If a writ stead ta of asse nation Langua Assess Allocat	ect rep entatic tten ex ake the essmen date at age of a ment c :ion of	ort (approx. 8 to 10 pag on/talk (approx. 30 minu amination was chosen a e form of an oral examin t is changed, the lectur t the latest. assessment: English offered: In the semester places	es) or utes). as method of assessm ation of one candidat er must inform studen	utes per candidate) o ent, this may be cha e each or an oral exa ts about this by four	nged and assessmen mination in groups. If weeks prior to the ori	f the method	
d) proje e) prese If a writ stead ta of asse nation Langua Assess Allocat	ect rep entatic tten ex cake the essmen date at age of a ment c cion of	ort (approx. 8 to 10 pag on/talk (approx. 30 minu amination was chosen a e form of an oral examin t is changed, the lectur t the latest. assessment: English offered: In the semester places	es) or utes). as method of assessm ation of one candidat er must inform studen	utes per candidate) o ent, this may be cha e each or an oral exa ts about this by four	nged and assessmen mination in groups. If weeks prior to the ori	f the method	
d) proje e) prese If a writ stead ta of asse nation Langua Assess Allocat Additio	ect rep entatic tten ex cake the essmen date at age of a ment c cion of	ort (approx. 8 to 10 pag on/talk (approx. 30 minu amination was chosen a e form of an oral examin t is changed, the lectur t the latest. assessment: English offered: In the semester places	es) or utes). as method of assessm ation of one candidat er must inform studen	utes per candidate) o ent, this may be cha e each or an oral exa ts about this by four	nged and assessmen mination in groups. If weeks prior to the ori	f the method	
d) proje e) prese If a writ stead ta of asse nation Langua Assess Allocat Additio Worklo	ect rep entatic tten ex cake the essmen date at age of a ment c ion of	ort (approx. 8 to 10 pag on/talk (approx. 30 minu amination was chosen a e form of an oral examin t is changed, the lectur t the latest. assessment: English offered: In the semester places	es) or utes). as method of assessm ation of one candidat er must inform studen	utes per candidate) o ent, this may be cha e each or an oral exa ts about this by four	nged and assessmen mination in groups. If weeks prior to the ori	f the method	
d) proje e) prese If a writ stead ta of asse nation Langua Assess Allocat Additio 180 h Teachin 	ect rep entatic tten ex cake the essmen date at age of a ment c tion of onal inf	ort (approx. 8 to 10 pag on/talk (approx. 30 minu amination was chosen a e form of an oral examin t is changed, the lectur t the latest. assessment: English offered: In the semester places formation	es) or utes). as method of assessm nation of one candidat er must inform studen in which the course is	utes per candidate) o eent, this may be cha e each or an oral exa ts about this by four offered and in the su	nged and assessmen mination in groups. If weeks prior to the ori	f the method	
d) proje e) prese If a writ stead ta of asse nation Langua Assess Allocat Additio 180 h Teachin 	ect rep entatic tten ex cake the essmen date at age of a ment c tion of onal inf	ort (approx. 8 to 10 pag on/talk (approx. 30 minu amination was chosen a e form of an oral examin t is changed, the lectur t the latest. assessment: English offered: In the semester places	es) or utes). as method of assessm nation of one candidat er must inform studen in which the course is	utes per candidate) o eent, this may be cha e each or an oral exa ts about this by four offered and in the su	nged and assessmen mination in groups. If weeks prior to the ori	f the metho	
d) proje e) prese If a writ stead ta of asse nation Langua Assess Allocat Worklo 180 h Teachin Referre 	ect rep entatic tten ex cake the essmen date at age of a ment o ion al inf onal inf oad	e LPO I (examination regulation (approx. 8 to 10 pag (approx. 30 minutation) (approx. 30 min	es) or utes). as method of assessm nation of one candidat er must inform studen in which the course is	utes per candidate) o eent, this may be cha e each or an oral exa ts about this by four offered and in the su	nged and assessmen mination in groups. If weeks prior to the ori	f the metho	
d) proje e) prose if a writ stead ta of asse nation - Langua Assess Allocat Worklo 180 h Teachin Referre Module	ect rep entatic tten ex ake the essmen date at age of a ment c ion of onal inf onal inf onal inf ead	e LPOI (examination regulation ars in	es) or utes). as method of assessm action of one candidat er must inform studen in which the course is	utes per candidate) o eent, this may be cha e each or an oral exa ts about this by four offered and in the su	nged and assessmen mination in groups. If weeks prior to the ori	f the metho	
d) proje e) prese If a writ stead ta of asse nation Langua Assess Allocat Worklo 180 h Teachin Referre Module	ect rep entatic tten ex ake the essmen date at age of a ment c ion of onal inf onal inf onal inf ed to in e appea	e LPO I (examination regulation (approx. 8 to 10 pag (approx. 30 minutation) (approx. 30 min	es) or utes). as method of assessm ation of one candidat er must inform studen in which the course is not the course is cons for teaching-degree progree ernational (2020)	utes per candidate) o eent, this may be cha e each or an oral exa ts about this by four offered and in the su	nged and assessmen mination in groups. If weeks prior to the ori	f the metho	

	e			Abbreviation					
Models Be	yond the Standard Model o	f Elementary Particle	Physics	11-BSM-Int-201-m01					
Module co	ordinator		Module offered by	/					
Managing Director of the Institute of Theoretical Physics and Astrophysics			Faculty of Physics	and Astronomy					
ECTS Me	thod of grading	Only after succ. con	compl. of module(s)						
6 nu	nerical grade								
Duration Module level Other prerequisite			;						
1 semester	graduate								
Contents									
 3. Neutrino Physics 4. Higgs Physics A selection of topics from the following fields will covered: Phenomenology of Experiments at the LHC Particle Cosmology Extended Gauge Theories Models with Extended Higgs Sectors Supersymmetry Models with Extra Dimension of Space-Time Intended learning outcomes Familiarity with tests of the standard model and their limitations. Knowledge in the description of elementary particle phenomenology, in particular Higgs and neutrino physics. Ability to construct extensions of the standard 									
			model and understand how to test these extensions in low energy experiments, at high energy colliders and in cosmology.						
Courses (type, number of weekly contact hours, language — if other than German)									
V (3) + R (1)		language — if other than Ge	rman)						
	ght in: English	language — if other than Ge	rman)						
Module tau Method of	ght in: English			not every semester, information on whether					
Module tau Method of module is cred a) written e b) oral exar c) oral exar d) project r e) presenta If a written stead take of assessm nation date Language of Assessment	ight in: English assessment (type, scope, langua itable for bonus) xamination (approx. 90 to a nination of one candidate e nination in groups (groups o eport (approx. 8 to 10 pages tion/talk (approx. 30 minut examination was chosen as the form of an oral examina ent is changed, the lecturer e at the latest. of assessment: English it offered: In the semester in	age — if other than German, 220 minutes) or 2ach (approx. 30 minu of 2, approx. 30 minu 5) or 2es). 3 method of assessm 2 tion of one candidato 7 must inform student	examination offered — if r utes) or Ites per candidate) ent, this may be cha e each or an oral ex ts about this by fou	or anged and assessment may in- amination in groups. If the method r weeks prior to the original exami-					
Module tau Method of module is cred a) written e b) oral exar c) oral exar d) project r e) presenta If a written stead take of assessm nation date Language of	ight in: English assessment (type, scope, langua itable for bonus) xamination (approx. 90 to a nination of one candidate e nination in groups (groups o eport (approx. 8 to 10 pages tion/talk (approx. 30 minut examination was chosen as the form of an oral examina ent is changed, the lecturer e at the latest. of assessment: English it offered: In the semester in	age — if other than German, 220 minutes) or 2ach (approx. 30 minu of 2, approx. 30 minu 5) or 2es). 3 method of assessm 2 tion of one candidato 7 must inform student	examination offered — if r utes) or Ites per candidate) ent, this may be cha e each or an oral ex ts about this by fou	or anged and assessment may in- amination in groups. If the method r weeks prior to the original exami-					
Module tau Method of module is cred a) written e b) oral exar c) oral exar d) project r e) presenta If a written stead take of assessm nation date Language of Assessmer Allocation	ight in: English assessment (type, scope, langua itable for bonus) xamination (approx. 90 to a nination of one candidate e nination in groups (groups o eport (approx. 8 to 10 pages tion/talk (approx. 30 minut examination was chosen as the form of an oral examina ent is changed, the lecturer e at the latest. of assessment: English it offered: In the semester in	age — if other than German, 220 minutes) or 2ach (approx. 30 minu of 2, approx. 30 minu 5) or 2es). 3 method of assessm 2 tion of one candidato 7 must inform student	examination offered — if r utes) or Ites per candidate) ent, this may be cha e each or an oral ex ts about this by fou	or anged and assessment may in- amination in groups. If the method r weeks prior to the original exami-					

Workload

180 h

Teaching cycle

Referred to in LPO I (examination regulations for teaching-degree programmes)

Module appears in

Master's degree (1 major) Physics International (2020) exchange program Physics (2023)

Module title	Abbreviation				
String Theory 1			11-STRG1-Int-201-m01		
Module coordinator		Module offered by			
Managing Director of the Institute of Tl and Astrophysics	neoretical Physics	Faculty of Physics a	nd Astronomy		
ECTS Method of grading Only after succ. compl. of module(s)					
8 numerical grade					
Duration Module level	Other prerequisites				
1 semester graduate					
Contents					
Classical and quantum theory of the re action, Quantization of the closed bos dimension, Quantization of the open b Conformal Field Theory, String Path Int ty.	onic string and emerg oosonic string, D-Bran	ent graviton, Quantu es, Gauge Fields and	um Lorentz invariance and critical I Yang-Mills Theories, Relativistic		
Intended learning outcomes					
Familiarity with the classical and quan sical actions for relativistic bosonic str the closed bosonic string and to under sed bosonic string. Knowledge of the t of the bosonic string. Understanding o nes. Knowledge of open string quantiz fields for coincident branes. In-depth I its BRST quantization and the calculat tive actions in target space and the em	ings, the Nambu-Goto rstand the emergence he quantum Lorentz a f the boundary condit ation and the spectru knowledge of relativis ion of string interaction pergence of Einstein g	o action and the Poly of the massless gra- anomaly and the deri- tions for the open str m of massless gaug- tic conformal field th ons. Thorough under- ravity.	vakov action. Ability to quantize viton in the spectrum of the clo- ivation of the critical dimension ring and its connection to D-bra- e fields, as well as of Yang-Mills neory, the string path integral and		
Courses (type, number of weekly contact hours,	language — if other than Ger 	man)			
V (4) + R (2) Module taught in: English					
Method of assessment (type, scope, langua module is creditable for bonus)	age — if other than German, e	examination offered — if no	t every semester, information on whether		
a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may in- stead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original exami- nation date at the latest. Language of assessment: English Assessment offered: In the semester in which the course is offered and in the subsequent semester Allocation of places					
Additional information					
Workload					
240 h					

Teaching cycle

Referred to in LPO I (examination regulations for teaching-degree programmes)

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Module appears in

Module title					Abbreviation	
String Theory 2					11-STRG2-Int-201-m01	
Module coordinator				Module offered by		
Managing Director of the Institute of Theoretical Physics and Astrophysics				Faculty of Physics a	nd Astronomy	
ECTS Method of grading Only after succ. compl.				npl. of module(s)		
6	nume	rical grade		-		
Duratio	n	Module level	Other prerequisites			
1 semester graduate						
Conten	ts					
and hig A/B Su pe 1 Su ween th ge theo Intende	gher dir perstrin perstrin ne five pries, su ed learn	nensions, the classical and ngs, the Gliozzi-Scherck-C ng, heterotic string theori superstring theories as w upergravity and the AdS/ hing outcomes	nd quantum version Dlive Projection and S es, anomaly cancella rell as their relation to CFT Correspondence.	of the Ramond-Neve Space-Time Supersyn ation and restrictions o M Theory in 11D, D-	view of supersymmetry in two au-Schwarz Superstring, type 2 mmetry in 10 dimensions, the ty- s on gauge groups, dualities bet- Branes and supersymmetric gau-	
nic strin dimens superst perstrin Projecti tic supe the allo to M Th	In-depth knowledge of supersymmetric string theories and M Theory. Familiarity with the main features of boso- nic string theory, as well as withthe theory of fermionic fields and representations of Clifford algebra in different dimensions. Knowledge of supersymmetry in two and higher dimensions, as relevant for the understanding of superstring theory. Working knowledge of the classical and quantum version of the Ramond-Neveau-Schwarz Su- perstring. Understanding of the emergence of type II A/B Superstrings upon imposing the Gliozzi-Scherck-Olive Projection, which in particular enforces Space-Time Supersymmetry in 10D. Familiarity with the type 1 and hetero- tic superstring theories, as well as with anomaly cancellation in these theories and the restrictions it imposes on the allowed gauge groups. Knowledge of dualities between the five superstring theories as well as their relation to M Theory in 11D. Knowledge of the properties of D-Branes in type I and II superstring theories and the super- symmetric gauge theories they carry, of the supergravity actions in ten and eleven dimensional space-time and					
Course	S (type, n	umber of weekly contact hours, l	anguage — if other than Ger	man)		
V (3) + Module		t in: English				
		essment (type, scope, langua; le for bonus)	ge — if other than German, e	examination offered — if no	t every semester, information on whether	
 a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English 						
		ffered: In the semester in	which the course is	offered and in the su	Ibsequent semester	
Allocat	ion of p	olaces				
Additio	nal inf	ormation				

Workload

180 h

Teaching cycle

Referred to in LPO I (examination regulations for teaching-degree programmes)

Module appears in

Master's degree (1 major) Physics International (2020) exchange program Physics (2023)

Module title			ŀ	Abbreviation			
Radio Astro	nomical Interferometry		1	11-RAI-Int-211-m01			
Module coo	rdinator		Module offered by				
		f Theoretical Division	Faculty of Physics an	dActronomi			
and Astroph	irector of the Institute o lysics	a Astronomy					
ECTS Met	hod of grading	Only after succ. compl. of module(s)					
6 nun	6 numerical grade						
Duration Module level Other prerequisites							
1 semester	graduate						
Contents							
a) History of b) The role a c) Application d) Summary II) Fundame 1. Fourier op a) The conco b) Convolution c) (Radio) te 2. Interferor a) The Miche b) The two-e c) The visibin d) The influe f) Coordinat 3. Aperture S a) The conco b) Simple co c) Tracking a d) VLBI array e) Antennas 4. Receiver R a) Heterody b) Interferor c) Sampling d) Bandwidt c) Calibration 5. Image de c) Seif calib 6. Digital Be II I. Special Be II I. Special Be c) Spectroso d) Polarisati e) Time-Don f) Low-frequ g) Big Data i h) Interferor	ept of telescope apertur on and Fourier Theorem lescopes as spatial filte netry elson interferometer element interferometer lity function ence of limited bandwid e systems synthesis by Radio Interfer ept of (u ,v) coverage onfigurations and transit arrays and Earth-rotation vs separations and geomet esponse ne frequency conversion neter sensitivity , weighting, gridding th smearing n onstruction d alternative imaging al fects ration	try and scientific topics in radio astronomy e e is ers th e) Spatial frequencie ferometric Arrays t arrays n synthesis try n gorithms nges y etry try terferometry rometry	s in interferometry				
		· _					
	ajor Physics International (2020)	IMIL Mürzburg	 generated 19-Apr-2025 exam 	rog do	page 137 / 196		

1. Low-frequency arrays: LOFAR, GMRT, ASKAP, APERTIF/WSRT, LWA, MWA

- 2. Centimeter-Band Arrays: JVLA, MERLIN, ATCA, MeerKAT, VLBA, EVN, LBA, JVN, VERA, AVN
- 3. (Sub-) Mill imeter Arrays: ALMA, NOEMA, GMVA, EHT

4. The Future: SKA

Intended learning outcomes

The goal of the course is the transfer of knowwledge and competence in the radio interferometrical method, providing a foundation for independent research.

Concepts are taught in connection to practical examples from modern astronomy including recent measurements of radio interferometers.

Students shall gain the following specific competences: Understanding of the concept of radio interferometrical observations and their calibration.

Processing and interpretation of raw data. data reduction and analysis, applications and understanding of established algorithms.

Handling of large data volumes. The course makes use of general concepts and teaches special programming concepts that are of wide use beyond astronomy.

Courses (type, number of weekly contact hours, language – if other than German)

V (3) + R (1)

Module taught in: English

Method of assessment (type, scope, language – if other than German, examination offered – if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 90 to 120 minutes) or

b) oral examination of one candidate each (approx. 30 minutes) or

c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or

d) project report (approx. 8 to 10 pages) or

e) presentation/talk (approx. 30 minutes).

If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest.

Language of assessment: English

Assessment offered: In the semester in which the course is offered and in the subsequent semester

Allocation of places

Additional information

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Workload

180 h

Teaching cycle

Teaching cycle: every year, after announcement

Referred to in LPO I (examination regulations for teaching-degree programmes)

Module appears in

Master's degree (1 major) Physics International (2020)

exchange program Physics (2023)

Module title					Abbreviation			
Black H	Black Holes 11-SLQ-Int-241-mo1							
Module	e coord	inator		Module offered by				
Managi and Ast		ector of the Institute of sics	Theoretical Physics	Faculty of Physics and Astronomy				
ECTS	CTS Method of grading Only after succ. compl. of module(s)							
6	nume	rical grade						
Duratio	n	Module level	Other prerequisites	5				
1 seme	ster	graduate						
Contents								
 Vacu kelst catio Gravi Charj ADM Blacl PART 2 Spin Blacl Gravi PART 3 Intro Deriv Hawl 	 PART 1 - Classical solutions 1. Vacuum solutions of Einstein's equation - the Schwarzschild solution, Birkhoff's theorem, the Eddington-Finkelstein coordinates, Kruskal extension and eternal black holes, the Penrose diagram, conformal compactification and Carter-Penrose diagram 2. Gravitational collapse - the Oppenheimer-Snyder solution 3. Charged and rotating black holes - Cauchy horizons, ergosphere 4. ADM formalism - energy and angular momentum 5. Black hole thermodynamics PART 2 - Astrophysical observations of black holes 1. Spin and mass measurements of black holes 2. Black hole electromagnetism 3. Gravitational waves and their measurement PART 3 - Quantum aspects of black hole 1. Introduction to QFT on curved spacetime: Rindler spacetime, Unruh effect 2. Derivation of Hawking radiation 3. Hawking's original formulation of the information paradox 4. The "holography of information" - information paradox in AdS/CFT, the Page curve and Islands 							
		•						
This co ons in t Throug connec	Intended learning outcomes This course plays a bridging role joining the basics on GR learnt in the GR I course and the active research directi- ons in the fields of Astronomy, Astrophysics, General Relativity, String Theory and Gauge/Gravity Duality. Through this course, the students will gain sufficient commands over the applications of general relativity in connection with research directions in this area. This in turn will motivate them to pursue careers as a researcher in the aforementioned directions and help them to successful begin their Master and PhD projects.							
Course	S (type, r	number of weekly contact hours	s, language — if other than Ge	rman)				
V (3) + Module		t in: English						
			uage — if other than German,	examination offered — if no	t every semester, informat	ion on whether		
b) oral c) oral d d) proje e) prese If a writ stead ta of asse nation	Method of assessment (type, scope, language – if other than German, examination offered – if not every semester, information on whether module is creditable for bonus) a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may in- stead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original exami- nation date at the latest.							
Master's wi	th 1 majo	r Physics International (2020)	-	 generated 19-Apr-2025 exact exact exact	-	page 139 / 196		

Julius-Maximilians-UNIVERSITÄT WÜRZBURG

Language of assessment: English

Assessment offered: In the semester in which the course is offered and in the subsequent semester

Allocation of places

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Additional information

Workload

180 h

Teaching cycle

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Referred to in LPO I (examination regulations for teaching-degree programmes)

Module appears in

Master's degree (1 major) Physics International (2020) Master's degree (1 major) Physics International (2024)

Module title Abbreviation						
Particle Physic	cs (Standard Model)			11-TPSM-Int-211-m01		
Module coordi	nator		Module offered by			
Managing Dire	ctors of the Institute of A	pplied Physics and	Faculty of Physics a	ind Astronomy		
the Institute of	Theoretical Physics and	Astrophysics				
ECTS Metho	d of grading	Only after succ. con	ompl. of module(s)			
	ical grade					
	Duration Module level Other prerequisit					
I	graduate	Approval from exam	ination committee r	equired.		
Contents Theoretical description of the Standard Model Electroweak symmetry breaking through the Higgs mechanism parity Violation Bhabha scattering Z-Line Shape and forward / reverse asymmetry Higgs production and decay Experimental setup and results of key experiments to test the Standard Model and for determining its parameters Search for the Higgs boson Intended learning outcomes Students know the theoretical fundamental laws of the standard model of particle and the key experiments that have established and confirmed the standard model. They have basic knowledge in order to interpret experiment						
	umber of weekly contact hours, l	-		its significance and limitations.		
	essment (type, scope, langua	ge — if other than German, o	examination offered — if no	ot every semester, information on whether		
 a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English Assessment offered: In the semester in which the course is offered and in the subsequent semester 						
Allocation of p	laces					
Additional info	ormation					
Workload						
240 h						
Teaching cycle	2					

Referred to in LPO I (examination regulations for teaching-degree programmes)

Module appears in

Master's degree (1 major) Physics International (2020) Master's degree (1 major) Physics International (2024)

Module title Abbreviation					
Visiting	g Resea	urch			11-FPA-Int-201-m01
Module coordinator				Module offered by	
chairpe	airperson of examination committee			Faculty of Physics a	and Astronomy
ECTS	Method of grading Only after succ. compl. of module(s)				
10	nume	rical grade			
Duratio	uration Module level Other prerequisites				
1-2 sem	nester	graduate	Approval from exam	ination committee r	equired.
Conten	ts				
	s and c	locumentation of the res			sics. Experimental work including visits to other universities or re-
Intende	ed leari	ning outcomes			
		h current research topics yze and document scient		neoretical physics. V	Vithin experimental physics, the
Course	S (type, n	umber of weekly contact hours, l	anguage — if other than Gei	rman)	
R (o) Module	e taugh	t in: English			
		s essment (type, scope, langua le for bonus)	ge — if other than German,	examination offered — if no	ot every semester, information on whether
		(approx. 10 to 20 pages) ssessment: English			
Allocat	ion of p	olaces			
Additio	nal inf	ormation			
Worklo	ad		·		
300 h					
Teachi	ng cycl	e			
Referre	d to in	LPO I (examination regulation	s for teaching-degree progra	immes)	
Module	e appea	irs in			
		ee (1 major) Physics Inter	national (2020)		
	-	ee (1 major) Quantum En			
	-	ee (1 major) Quantum Eng	·		
Master	's degr	ee (1 major) Physics Inter	national (2024)		

Module	title			Abbreviation		
Current Topics of Theoretical Physics					11-EXT5-Int-201-m01	
Module	coord	inator		Module offered by		
chairperson of examination committee				Faculty of Physics a	nd Astronomy	
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)		
5	nume	rical grade				
Duratio	n	Module level	Other prerequisites			
1 semes	ster	graduate	Approval from exam	ination committee re	equired.	
Conten	ts					
Current study a		in theoretical physics. C	redited academic ach	ievements, e.g. in ca	ase of change of university or	
Intende	ed learn	ning outcomes				
ster's le	evel. He	e/She commands advanc	ed technical knowled	ge in a current field	ule in theoretical physics on Ma- in theoretical physics and ma- problems in theoretical physics.	
Courses	S (type, n	umber of weekly contact hours, l	anguage — if other than Ger	man)		
V (2) + I Module		t in: English				
		s essment (type, scope, langua le for bonus)	ge — if other than German, e	examination offered — if no	t every semester, information on whether	
b) oral o c) oral o d) proje e) prese If a writ stead ta of asses nation o	 a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. 					
Allocati		ssessment: English				
Additio	nal info	ormation				
Worklo	ad					
150 h Teachir		<u>a</u>				
	ig tyti	5				
Referre	d to in	LPO I (examination regulations	for teaching-degree progra	mmes)		
Module	appea	irs in				
	-	ee (1 major) Physics Inter				
Master'	s degre	ee (1 major) Physics Inter	national (2024)			

Current Topics of Theoretical Physics 11-EXT6-Int-201-m01 Module coordinator Module offered by chaitperson of examination committee Faculty of Physics and Astronomy ECTS Method of grading Only after succ. compl. of module(S) 6 numerical grade 1 semester graduate Approval from examination committee required. Contents Current topics in theoretical physics. Credited academic achievements, e.g. In case of change of university or study abroad. Intended learning outcomes Intended learning outcomes The student posseses deepened knowledge meeting the requirements of a module in theoretical physics on Master's level. He/She commands advanced technical knowledge in a current field in theoretical physics on Master's level. He/She commands advanced technical knowledge in a current field in theoretical physics on Master's level. He/She commands on paper and the semand to or current problems in theoretical physics. Outge at (i) Module taught in: English Method of gracesesment (tops, scope, language – if other than German, examination offered – if not every sensetie, infomation on whether medule is cereinable for bonus) a) written examination of one candidate each (approx. 30 minutes) or or or al examination of no candidate each (approx. 30 minutes) or e) or el examination in groups. Scope, language – if other than German, examination of a dasessment may in-stead take the form of an oral examination of one candidate each or an oral examination in	Module	title				Abbreviation
chairperson of examination committee Faculty of Physics and Astronomy ECTS Method of grading Only after succ. compl. of module(s) 6 numerical grade Duration Module level Other prerequisites 1 semester graduate Approval from examination committee required. Contents	Current	Topics	s of Theoretical Physics			11-EXT6-Int-201-m01
ECTS Method of grading Only after succ. compl. of module(s) 6 numerical grade - Duration Module level Other prerequisites 1 semester graduate Approval from examination committee required. Contents - - Current topics in theoretical physics. Credited academic achievements, e.g. in case of change of university or study abroad. - Intended learning outcomes - - The student posseses deepened knowledge meeting the requirements of a module in theoretical physics on Master's level. He/She is able to apply these methods to current problems in theoretical physics. Or Master's level. He/She is able to apply these methods to current problems in theoretical physics. Courses Uype, number of weekly contact hours, language – if other than German) V V (3) + R (1) Module taught in: English Method of assessment (type, scope, language – if other than German, examination offered – if not every semester, information on whether module is creditable for bonus) a) written examination (approx. 90 to 120 minutes) or or or al examination of one candidate each (approx. 30 minutes) or or or al examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination at the latest. Language of assessment: English Allocation of places	Module	coord	inator		Module offered by	
6 numerical grade Duration Module level Other prerequisites 1 semester graduate Approval from examination committee required. Contents Current topics in theoretical physics. Credited academic achievements, e.g. in case of change of university or study abroad. Intended learning outcomes Intended learning outcomes The student posseses deepened knowledge meeting the requirements of a module in theoretical physics on Master's level. He/She commands advanced technical knowledge in a current field in theoretical physics. Courses (type, number of weekly contact hours, language – if other than German) V (3) + R (1) Module taught In: English Method of assessment (type, scope, language – if other than German, examination offered – if not every semester, information on whether module is creditable for hours) a) written examination (approx. 90 to 120 minutes) or b) oral examination in groups (groups of 2, approx. 30 minutes) or b) oral examination in groups (groups of 2, approx. 30 minutes) or c) oral examination may chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English Melocation of places	chairpe	rson o	f examination committee		Faculty of Physics a	nd Astronomy
Duration Module level Other prerequisites 1 semester graduate Approval from examination committee required. Contents Current topics in theoretical physics. Credited academic achievements, e.g. in case of change of university or study abroad. Intended learning outcomes Intended learning outcomes The student posseses deepened knowledge meeting the requirements of a module in theoretical physics on Master's level. He/She commands advanced technical knowledge in a current field in theoretical physics and master's level. He/She commands advanced technical knowledge in a current field in theoretical physics and master's level. He/She commands advanced technical knowledge in a current problems in theoretical physics. Courses (type, number of weekly contact hours, language – if other than German) V (3) + R (1) Module taught in: English Method of assessment (type, scope, language – if other than German, examination offered – if not every semester, information on whether module is creditable for hours) a) written examination (approx. 90 to 120 minutes) or b) oral examination in groups (groups of 2, approx. 30 minutes) or b) oral examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination take at the latest. Language of assessment: English Method of places <td>ECTS</td> <td>Metho</td> <td>od of grading</td> <td>Only after succ. com</td> <td>pl. of module(s)</td> <th></th>	ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)	
1 semester graduate Approval from examination committee required. Contents Current topics in theoretical physics. Credited academic achievements, e.g. in case of change of university or study abroad. Intended learning outcomes Intended learning outcomes Intended learning outcomes Courses (type, number of weekly contact hours, language – if other than German) V (3) + R (1) Module taught in: English Method of assessment (type, scope, language – if other than German) V (3) + R (1) Module taught in: English Method of assessment (type, scope, language – if other than German, examination offered – if not every semester, information on whether module is creditable for bonus) a) written examination (approx. 90 to 120 minutes) or b) oral examination in groups (groups of 2, approx. 30 minutes) or b) oral examination in groups (groups of 2, approx. 30 minutes) or c) are examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination of places - - Morkload - 180 h - - - - <td>6</td> <td>nume</td> <td>rical grade</td> <td></td> <td></td> <th></th>	6	nume	rical grade			
Contents Current topics in theoretical physics. Credited academic achievements, e.g. in case of change of university or study abroad. Intended learning outcomes The student posseses deepened knowledge meeting the requirements of a module in theoretical physics on Master's level. He/She commands advanced technical knowledge in a current field in theoretical physics and masters the respective methods. He/She is able to apply these methods to current problems in theoretical physics. Courses (type, number of weekly contact hours, language – if other than German) V (3) + R (1) Module taught in: English Method of assessment (type, scope, language – if other than German, examination offered – if not every senester, information on whether module is creditable for bonus) a) written examination (approx. 90 to 120 minutes) or b) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or c) oral examination on one candidate each (approx. 30 minutes) or b) oral examination on fone candidate each (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may in- stead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original exami- nation date at the latest. Language of assessment: English Allocation of places	Duratio	n	Module level	Other prerequisites		
Current topics in theoretical physics. Credited academic achievements, e.g. in case of change of university or study abroad. Intended learning outcomes The student posseses deepened knowledge meeting the requirements of a module in theoretical physics on Master's level. He/She commands advanced technical knowledge in a current field in theoretical physics and masters the respective methods. He/She is able to apply these methods to current problems in theoretical physics. Courses (type, number of weekly contact hours, language – if other than German) V (3) + R (1) Module taught in: English Method of assessment (type, scope, language – if other than German, examination offered – if not every semester, information on whether module is creditable for bonus) a) written examination (approx. 90 to 120 minutes) or b) oral examination (approx. 30 to 120 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 30 to 120 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may in- stead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original exami- nation date at the latest. Language of assessment: English Allocation of place	1 semes	ster	graduate	Approval from exam	ination committee re	equired.
study abroad. Intended learning outcomes The student posseses deepened knowledge meeting the requirements of a module in theoretical physics on Master's level. He/She commands advanced technical knowledge in a current field in theoretical physics and masters the respective methods. He/She is able to apply these methods to current problems in theoretical physics. Courses (type, number of weekly contact hours, language – if other than German) V (3) + R (1) Module taught in: English Method of assessment (type, scope, language – if other than German, examination offered – if not every semester, information on whether module is creditable for bonus) a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes) or c) oral examination in groups. St to 120 minutes). If a written examination approx. 90 minutes). If a written examination of one candidate each (approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination and examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. Language of assessment: English Allocation of places	Conten	ts				
The student possesses deepened knowledge meeting the requirements of a module in theoretical physics on Ma- ster's level. He/She commands advanced technical knowledge in a current field in theoretical physics and ma- sters the respective methods. He/She is able to apply these methods to current problems in theoretical physics. Courses (type, number of weekly contact hours, language – if other than German) V (3) + R (1) Module taught in: English Method of assessment (type, scope, language – if other than German, examination offered – if not every semester, information on whether module is creditable for bonus) a) written examination (approx. 9 to 120 minutes) or b) oral examination one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes) or c) oral examination more candidate each (approx. 30 minutes) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may in- stead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original exami- nation date at the latest. Language of assessment: English Allocation of places 		•	in theoretical physics. C	redited academic ach	ievements, e.g. in ca	ase of change of university or
ster's level. He/She commands advanced technical knowledge in a current field in theoretical physics and ma- sters the respective methods. He/She is able to apply these methods to current problems in theoretical physics. Courses (type, number of weekly contact hours, language – if other than German) V (3) + R (1) Module taught in: English Method of assessment (type, scope, language – if other than German, examination offered – if not every semester, information on whether module is creditable for bonus) a) written examination (approx. 9 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes) or c) oral examination may be changed and assessment may in- stead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original exami- nation date at the latest. Language of assessment: English Allocation of places Additional information Workload 180 h Teaching cycle Referred to in LPO 1 (examination for teaching-degree programmes) Module appears in Master's degree (1 major) Physics International (2020)	Intende	ed learr	ning outcomes			
V (3) + R (1) Module taught in: English Method of assessment (type, scope, language – if other than German, examination offered – if not every semester, information on whether module is creditable for borus) a) written examination (approx. 90 to 120 minutes) or b) oral examination in groups (groups of 2, approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may in- stead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original exami- nation date at the latest. Language of assessment: English Allocation of places Morkload 180 h Teaching cycle Referred to in LPO I (examination regulations for teaching-degree programmes) Module appears in Master's degree (1 major) Physics International (2020)	ster's le	evel. He	e/She commands advanc	ed technical knowled	ge in a current field	in theoretical physics and ma-
Module taught in: English Method of assessment (type, scope, language – if other than German, examination offered – if not every semester, information on whether module is creditable for bonus) a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may in- stead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original exami- nation date at the latest. Language of assessment: English Allocation of places Morkload 180 h Teaching cycle Referred to in LPO I (examination regulations for teaching-degree programmes) Module appears in Master's degree (1 major) Physics International (2020)	Courses	5 (type, n	umber of weekly contact hours, l	anguage — if other than Ger	man)	
module is creditable for bonus) a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may in- stead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original exami- nation date at the latest. Language of assessment: English Allocation of places Additional information Workload 180 h Teaching cycle Referred to in LPO I (examination for teaching-degree programmes) Module appears in Master's degree (1 major) Physics International (2020)			t in: English			
b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may in- stead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original exami- nation date at the latest. Language of assessment: English Allocation of places Additional information Workload 180 h Teaching cycle Referred to in LPO I (examination regulations for teaching-degree programmes) Module appears in Master's degree (1 major) Physics International (2020)				ge — if other than German, e	examination offered — if no	t every semester, information on whether
Allocation of places Additional information Workload 180 h Teaching cycle Referred to in LPO I (examination regulations for teaching-degree programmes) Module appears in Master's degree (1 major) Physics International (2020)	b) oral e c) oral e d) proje e) prese If a writ stead ta of asse nation o	examin examin ect repo entatio ten exa ake the ssment date at	ation of one candidate e ation in groups (groups c ort (approx. 8 to 10 pages n/talk (approx. 30 minute amination was chosen as form of an oral examinat t is changed, the lecturer the latest.	ach (approx. 30 minu of 2, approx. 30 minut) or es). method of assessme tion of one candidate	tes per candidate) or ent, this may be char e each or an oral exar	nged and assessment may in- mination in groups. If the method
Additional information Additional information Additional information Additional information Additional information Vorkload 180 h Teaching cycle Referred to in LPO I (examination regulations for teaching-degree programmes) Module appears in Master's degree (1 major) Physics International (2020)						
 Workload 180 h Teaching cycle Referred to in LPO I (examination regulations for teaching-degree programmes) Module appears in Master's degree (1 major) Physics International (2020)						
180 h Teaching cycle Referred to in LPO I (examination regulations for teaching-degree programmes) Module appears in Master's degree (1 major) Physics International (2020)	Additio	nal info	ormation			
180 h Teaching cycle Referred to in LPO I (examination regulations for teaching-degree programmes) Module appears in Master's degree (1 major) Physics International (2020)						
Teaching cycle Referred to in LPO I (examination regulations for teaching-degree programmes) Module appears in Master's degree (1 major) Physics International (2020)	Worklo	ad				
Referred to in LPO I (examination regulations for teaching-degree programmes) Module appears in Master's degree (1 major) Physics International (2020)	180 h	180 h				
Module appears in Master's degree (1 major) Physics International (2020)	Teachir	Teaching cycle				
Module appears in Master's degree (1 major) Physics International (2020)						
Master's degree (1 major) Physics International (2020)	Referre	d to in	LPO I (examination regulations	s for teaching-degree progra	mmes)	
Master's degree (1 major) Physics International (2020)	Module	apnea	irs in			
• · · · · ·				national (2020)		
אומטובר א עבצובע (דווומוטו) דוואטוט ווונדוומנוטוומו (2024)		-				

Module title				Abbreviation	
Current Topic	s of Theoretical Physics			11-EXT7-Int-201-m01	
Module coord	inator		Module offered by		
chairperson o	f examination committee		Faculty of Physics a	nd Astronomy	
ECTS Metho	od of grading	Only after succ. com	pl. of module(s)		
7 nume	rical grade				
Duration	Module level	Other prerequisites			
1 semester	graduate	Approval from exam	ination committee re	equired.	
Contents					
Current topics study abroad.		redited academic ach	nievements, e.g. in ca	ase of change of university or	
Intended lear	ning outcomes				
ster's level. H	e/She commands advanc	ed technical knowled	ge in a current field	ule in theoretical physics on Ma- in theoretical physics and ma- problems in theoretical physics.	
Courses (type, r	number of weekly contact hours, l	anguage — if other than Ger	man)		
V (3) + R (1) Module taugh	t in: English				
Method of ass module is creditab		ge — if other than German, e	examination offered — if no	t every semester, information on whether	
 b) oral examin c) oral examin d) project repues e) presentation If a written example stead take the of assessmen nation date at 	e form of an oral examina t is changed, the lecturer	ach (approx. 30 minu of 2, approx. 30 minu of or es). method of assessme tion of one candidate	tes per candidate) or ent, this may be char e each or an oral exar	r nged and assessment may in- mination in groups. If the method weeks prior to the original exami-	
Allocation of					
Additional inf	ormation				
Workload					
210 h					
Teaching cycl	Teaching cycle				
Referred to in	LPO I (examination regulations	s for teaching-degree progra	mmes)		
Module appea	ars in				
	ee (1 major) Physics Inter	national (2020)			
Master's degr	ee (1 major) Physics Inter	national (2024)			

Module	title				Abbreviation
Current	Topics	s of Theoretical Physics			11-EXT8-Int-201-m01
Module	coord	inator		Module offered by	
chairpe	rson o	f examination committee		Faculty of Physics a	nd Astronomy
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)	
8	nume	rical grade			
Duratio	n	Module level	Other prerequisites		
1 seme	ster	graduate	Approval from exam	ination committee re	equired.
Conten	ts				
Current study a		in theoretical physics. C	redited academic ach	ievements, e.g. in ca	ase of change of university or
Intende	ed learr	ning outcomes			
ster's le	evel. He	e/She commands advanc	ed technical knowled	ge in a current field	ule in theoretical physics on Ma- in theoretical physics and ma- problems in theoretical physics.
Course	5 (type, n	umber of weekly contact hours, l	anguage — if other than Ger	man)	
V (4) + I Module		t in: English			
		s essment (type, scope, langua ₎ le for bonus)	ge — if other than German, e	examination offered — if no	t every semester, information on whether
b) oral o c) oral o d) proje e) prese If a writ stead ta of asse nation o	examin examin ect repo entatio ten exa ake the ssment date at	form of an oral examinat	ach (approx. 30 minu of 2, approx. 30 minut) or es). method of assessme tion of one candidate	tes per candidate) or ent, this may be char each or an oral exar	nged and assessment may in- mination in groups. If the method weeks prior to the original exami-
Allocat					
Additio	nal inf	ormation			
 Worklo	ad				
	au				
· ·	240 h				
reaciiii	Teaching cycle				
Referre	d to in	LPO I (examination regulations	for teaching degree progra	mmec)	
			s for reacting-degree progra	inities)	
Module	appea	irs in			
Master'	s degre	ee (1 major) Physics Inter	national (2020)		
Master'	Master's degree (1 major) Physics International (2024)				

Module	title				Abbreviation
Current	Topics	of Theoretical Physics			11-EXT6A-Int-201-m01
Module	coord	inator		Module offered by	
chairpe	rson o	f examination committee		Faculty of Physics a	nd Astronomy
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)	
6	nume	rical grade			
Duratio	n	Module level	Other prerequisites		
1 seme	ster	graduate	Approval from exam	ination committee re	equired.
Conten	ts				
Current study a		in theoretical physics. C	redited academic ach	ievements, e.g. in ca	ase of change of university or
Intende	ed learr	ning outcomes			
ster's le	evel. He	e/She commands advanc	ed technical knowled	ge in a current field	ule in theoretical physics on Ma- in theoretical physics and ma- problems in theoretical physics.
Courses	5 (type, n	umber of weekly contact hours, l	anguage — if other than Ger	man)	
V (3) + I Module		t in: English			
		s essment (type, scope, langua ₎ le for bonus)	ge — if other than German, e	examination offered — if no	t every semester, information on whether
b) oral o c) oral o d) proje e) prese If a writ stead ta of asse nation o	examin examin ect repo entatio ten exa ake the ssment date at	form of an oral examinat	ach (approx. 30 minu of 2, approx. 30 minut) or es). method of assessme tion of one candidate	tes per candidate) or ent, this may be char e each or an oral exar	r nged and assessment may in- mination in groups. If the method weeks prior to the original exami-
Allocat					
Additio	nal info	ormation			
 Worklo	ad				
180 h	au				
	Teaching cycle				
Referre	d to in	LPOI (examination regulations	s for teaching-degree progra	mmes)	
Referred to in LPO I (examination regulations for teaching-degree programmes)					
Module	appea	irs in			
Master'	s degre	ee (1 major) Physics Inter	national (2020)		
Master'	Master's degree (1 major) Physics International (2024)				

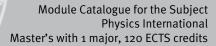
Module	title				Abbreviation	
Current	Topics	s in Physics			11-EXP6A-Int-201-m01	
Module	e coord	inator		Module offered by		
chairpe	erson o	f examination committee		Faculty of Physics a	nd Astronomy	
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)		
6	nume	rical grade				
Duratio	n	Module level	Other prerequisites			
1 seme	ster	graduate	Approval from exam	ination committee re	equired.	
Conten	ts					
	•	in experimental or theor tudy abroad.	etical physics. Credit	ed academic achieve	ements, e.g. in case of change of	
Intende	ed lear	ning outcomes				
physics a currei	s on Ma nt field	aster's level in the study p in physics and insight in	programme Nanostrue to the measuring and	cture Technology. He I calculating method	ule in theoretical or experimental e/She commands knowledge in Is which are necessary to acquire about fields of application.	
Course	S (type, r	number of weekly contact hours, l	anguage — if other than Ger	man)		
V (3) + I Module		t in: English				
		eessment (type, scope, langua le for bonus)	ge — if other than German, e	examination offered — if no	t every semester, information on whether	
b) oral c c) oral c d) proje e) prese If a writ stead ta of asse nation	examir examin ect repo entatio ten exa ake the ssmen date at	e form of an oral examina	ach (approx. 30 minu of 2, approx. 30 minu of or es). method of assessme tion of one candidate	tes per candidate) of ent, this may be char e each or an oral exam	r nged and assessment may in- mination in groups. If the method weeks prior to the original exami-	
Allocat	ion of p	olaces				
Additio	nal inf	ormation				
Worklo	ad					
180 h						
Teachir	ıg cycl	e				
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)					
Module	appea	ars in				
Master Master Master	's degr 's degr 's degr	ee (1 major) Physics Inter ee (1 major) Quantum Eng ee (1 major) Quantum Eng ee (1 major) Physics Inter	gineering (2020) gineering (2024)			

Module	title				Abbreviation	
Astrophysics 11-APM-Int-241-mo1				1		
Module	coord	inator		Module offered by		
Managi and Ast		ector of the Institute of Tl sics	neoretical Physics	Faculty of Physics a	nd Astronomy	
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)		
6	nume	rical grade				
Duratio	n	Module level	Other prerequisites			
1 semes	ster	graduate				
Conten	ts					
Telesco Mediun	pes an 1, Mole	onomy, Coordinates and d Detectors, Stellar Stru cular Clouds, Structure uclei, Large-Scale Struct	cture and Atmospher of the Milky Way, the	es, Stellar Evolution	and their End Stages	s, Interstellar
Intende	d lear	ning outcomes				
of astro	physic	familiar with the moder al research. He/She is a ad evolution of the most	ble to plan and interp	oret his/her own obse	ervations. He/She is	
Courses	5 (type, n	umber of weekly contact hours,	language — if other than Ge	rman)		
V (2) + I Module		t in: English				
Method	l of ass	essment (type, scope, langua	age — if other than German,	examination offered — if no	t every semester, informati	ion on whether
		le for bonus)				
b) oral e c) oral e d) proje e) prese lf a writ stead ta of asses nation o Langua	examin examin ect repo entatio ten exa ake the ssmen date at ge of a ment o	nination (approx. 90 to a ation of one candidate e ation in groups (groups ort (approx. 8 to 10 page n/talk (approx. 30 minut amination was chosen as form of an oral examina t is changed, the lecture the latest. ssessment: English ffered: In the semester in	each (approx. 30 minu of 2, approx. 30 minu s) or ees). s method of assessme ition of one candidate r must inform student	tes per candidate) or ent, this may be char e each or an oral exar s about this by four v	nged and assessmer mination in groups. weeks prior to the or	If the method riginal exami-
Allocati	ion of p	olaces				
 Additio	nal info	ormation				
Worklo	ad					
180 h						
Teachin	ng cycl	a				
	3 -)	-				
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)					
		•				
Module Master			rnational (asca)			
	-	ee (1 major) Physics Inte ee (1 major) Physics Inte				
Master's wit	th 1 major	Physics International (2020)		generated 19-Apr-2025 • exa r (120 ECTS) Physics Internatio	-	page 150 / 196

Module title				Abbreviation	
Atmospheric Physics				11-ATP-Int-241-m01	
Module	e coord	inator		Module offered by	
Managi and Ast		ector of the Institute of Th sics	eoretical Physics	Faculty of Physics a	nd Astronomy
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)	
6	nume	rical grade			
Duratio	n	Module level	Other prerequisites		
1 seme	ster	graduate			
Conten	ts				
mics. R and Ru	adiativ naway.	e transfer and radiative b	alance. Fluid mecha ic and magnetic field	nics. Greenhouse eff	l composition and thermodyna- Tect. Climate Models: Equilibrium terplanetary medium. Meteorites,
Intende	ed lear	ning outcomes			
ar-Earth ration c	n space of exop	e. They are able to use the	e acquired knowledge	e in the planning of s	ne Earth's atmosphere and ne- space missions and in the explo- restrial climate and interpret the
Course	S (type, r	number of weekly contact hours, l	anguage — if other than Gei	rman)	
V (2) + Module		t in: English			
		Sessment (type, scope, langua le for bonus)	ge — if other than German,	examination offered — if no	t every semester, information on whether
 b) oral e c) oral e d) proje e) prese If a writ stead ta of asse nation e Langua 	examir examin ect repo entatio ten exa ake the ssmen date at ge of a	e form of an oral examina	ach (approx. 30 minu of 2, approx. 30 minu) or es). method of assessme tion of one candidate must inform student	tes per candidate) or ent, this may be char e each or an oral exar is about this by four y	nged and assessment may in- mination in groups. If the method weeks prior to the original exami-
Allocat					
Additio	nal inf	ormation			
Worklo	ad				
180 h					
Teachir	ıg cycl	e			
Referre	d to in	LPO I (examination regulations	for teaching-degree progra	immes)	
Module	e appea	ars in			
Master	's degr	ee (1 major) Physics Inter	national (2020)		

Master's with 1 major Physics International (2020)





Master's degree (1 major) Physics International (2024)

Module (itle			Abbreviation	
Open Qu	antum Systems			11-0QS-Int-241-m01	
Module	coordinator		Module offered by		
Managin and Astr		ute of Theoretical Physics	Faculty of Physics a	nd Astronomy	
ECTS I	Method of grading	Only after succ. co	npl. of module(s)		
6 r	numerical grade				
Duration	Module level	Other prerequisites	5		
1 semest	er graduate				
Contents	i				
density r cesses	natrix theory, stochas	tic processes in Hilbert space	e, non-Markovian pro	cesses, relativistic quantum pro-	
Intended	l learning outcomes				
developr	ment of a theoretical ι	nderstanding of quantum sy	stem coupled to thei	r environment	
Courses	(type, number of weekly cont	act hours, language — if other than Ge	erman)		
V (3) + R					
	aught in: English				
	of assessment (type, sco reditable for bonus)	ppe, language — if other than German,	examination offered — if no	ot every semester, information on whether	
c) oral ex d) project e) presen If a writte stead tal of assess nation d Languag Assessm	amination in groups t report (approx. 8 to ntation/talk (approx. 2 en examination was cl ke the form of an oral sment is changed, the ate at the latest. e of assessment: Engl	go minutes). hosen as method of assessm examination of one candidat lecturer must inform studen	ent, this may be char ent, this may be char e each or an oral exa ts about this by four	nged and assessment may in- mination in groups. If the methoo weeks prior to the original exami	
 Addition	al information				
Audition					
Workloa	d				
180 h	-				
Teaching	g cvcle				
Referred to in LPO I (examination regulations for teaching-degree programmes)					
Module a	appears in				
		sics International (2020)			
Master's	degree (1 major) Phys	sics International (2024)			



Subfield Non-Physical Minors

(ECTS credits)

Module	e title				Abbreviation
Operat	ions Re	esearch for students	of other subjects		10-M-ORSaf-152-m01
Module	e coord	inator		Module offered by	
Dean o	f Studi	es Mathematik (Math	nematics)	Institute of Mathen	natics
ECTS	Methe	od of grading	Only after succ. con	npl. of module(s)	
10	nume	rical grade			
Duratio	on .	Module level	Other prerequisites		
1 seme	ster	undergraduate			
Conten					
		mming duality theor	v transport problems int	egral linear program	ming, graph theoretic problems.
		ning outcomes		egiat ancar program	
for solv	ing ma		s especially in economic		h, as required as a central tool apply these methods to practical
Course	S (type, r	number of weekly contact h	ours, language — if other than Ge	rman)	
V (4) +	Ü (2)				
		Sessment (type, scope, la ble for bonus)	anguage — if other than German,	examination offered — if no	ot every semester, information on whether
credita Allocat	ble for	bonus	er in which the course is		
Additio	nal inf	ormation			
Worklo	ad				
300 h					
Teachi	ng cycl	е			
Referre	ed to in	LPOI (examination regu	lations for teaching-degree progra	ammes)	
Module	e appea	ars in			
Bachel	or's de	gree (1 major) Compi	uter Science (2015)		
Master's degree (1 major) Physics (2016)					
		gree (1 major) Comp			
		gree (1 major) Compi	ter Calenaa (aata)		
Master	's degr		-		
		ee (1 major) Physics	(2020)		
Master	's degr	ee (1 major) Physics	(2020)	ability (2024)	

Module title				Abbreviation	
Advanced Analysis					10-M-VAN-152-m01
Module	e coord	inator		Module offered by	
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathem	atics
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)	
7	nume	rical grade			
Duratio		Module level	Other prerequisites		
1 seme	ster	undergraduate			
Conten	ts				
-		of analysis in several vari	ables, integration the	orems.	
		ning outcomes			
The stu	ident is				of the Lesbegue integral, he or
		number of weekly contact hours, l	· · ·	· ·	
V (4) +		iumber of weekly contact hours, t	anguage — If other than den		
Metho	d of ass		ge — if other than German, e	examination offered — if no	t every semester, information on whether
		le for bonus)			
b) oral c) oral	examir examin age of a	mination (approx. 90 to 1 nation of one candidate e nation in groups (groups c ssessment: German and, bonus	ach (15 to 30 minutes of 2, 10 to 15 minutes	s) or	
Allocat	ion of _l	olaces			
Additio	onal inf	ormation			
Worklo	ad				
210 h					
Teachi	ng cvcl	e			
Referre	ed to in	LPO I (examination regulations	s for teaching-degree progra	mmes)	
	<u></u>				
Module	e appea	ars in			
Bachel Bachel Bachel Master Master Master Master Master	or's de or's de or's degr 's degr 's degr 's degr 's degr 's degr	gree (1 major) Mathemati gree (1 major) Mathemati gree (1 major) Computatio gree (1 major) Mathemati ee (1 major) Physics (2010 ee (1 major) Nanostructur ee (1 major) Nanostructur ee (1 major) Physics (202 ee (1 major) Physics Inter ee (1 major) Quantum Eng	cal Physics (2015) onal Mathematics (20 cal Physics (2016) 6) re Technology (2016) re Technology (2020) o) national (2020) gineering (2020)	915)	
	-	ee (1 major) Quantum Teo gree (1 major) Mathemati			
Bachet	5, 5 uc	aree (1 major) matricillati	··· (202)		

Module title Abbreviation						
Applied Analysis 10-M=AAANin-152-mot					n01	
Module	e coord	inator		Module offered by		
Dean o	f Studi	es Mathematik (Mathen	natics)	Institute of Mathem	atics	
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)		
10	nume	rical grade				
Duratio	n	Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	ts					
theory particu theory Recomi	of Hilbo lar FEN of ellip mende	y of functional analysis ert spaces and Fourier a I methods), principles o tic, parabolic and hyper d previous knowledge: h the contents of the m	nalysis, spectral theor f functional analysis, f bolic partial differenti	y and quantum mech unction spaces, emb al equations with me	hanics, numerical m bedding theorems, c thods from function	ethods (in ompactness,
		ning outcomes			Jiimended.	
The stu to esta	dent is blish a	acquainted with the fu connection between his ther natural and engine	s/her acquired skills a			
Course	S (type, r	number of weekly contact hours	, language — if other than Gei	rman)		
V (4) + Module		t in: English				
		sessment (type, scope, langu le for bonus)	uage — if other than German,	examination offered — if no	t every semester, informati	on on whether
b) oral c) oral (Langua	examir examin ge of a ment o	mination (approx. 90 to nation of one candidate ation in groups (groups ssessment: English ffered: In the semester bonus	each (approx. 20 minu of 2, 15 minutes per c	utes) or andidate)	ıbsequent semester	
Allocat						
Additio	nal inf	ormation				
 Worklo	ad					
300 h						
Teachi	ng cycl	e				
Referre	d to in	LPO I (examination regulation	ns for teaching-degree progra	mmes)		
Module	e appea	ars in				
Master Master Master Master	Module appears in Master's degree (1 major) Mathematics International (2015) Master's degree (1 major) Physics International (2020) Master's degree (1 major) Mathematics International (2021) Master's degree (1 major) Mathematics International (2022) Master's degree (1 major) Physics International (2024) Master's with 1 major Physics International (2020) JMU Würzburg • generated 19-Apr-2025 • exam. reg. da-					
		,	_	r (120 ECTS) Physics Internati	-	page 157 / 196



Module title Abbreviation						
Differential Geometry 10-M=ADGMin-152-mo1					m01	
Modul	e coord	inator		Module offered by		
Dean o	fStudi	es Mathematik (Mather	natics)	Institute of Mathem	atics	
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)		
10	nume	rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	graduate				
Conter	Its					
folds. Recom Basic k	mende	dvanced results in diffe d previous knowledge: lge from the modules "I s" is recommended.				
		ning outcomes				
The stu	ıdent is	acquainted with conce hese methods and kno				
Course	S (type, n	umber of weekly contact hours	, language — if other than Gei	rman)		
V (4) + Module		t in: English				
		eessment (type, scope, lang le for bonus)	uage — if other than German,	examination offered — if no	t every semester, informati	on on whether
b) oral c) oral Langua Assess	examin examin age of a	nination (approx. 90 to ation of one candidate ation in groups (groups ssessment: English ffered: In the semester bonus	each (approx. 20 minu of 2, 15 minutes per c	utes) or andidate)	ıbsequent semester	
Allocat	ion of p	olaces				
Additio	onal inf	ormation				
Worklo	ad					
300 h						
Teachi	ng cycl	e				
Referre	ed to in	LPO I (examination regulation	ons for teaching-degree progra	immes)		
Modul	e appea	irs in				
Master's degree (1 major) Mathematics International (2015) Master's degree (1 major) Physics International (2020) Master's degree (1 major) Mathematics International (2021) Master's degree (1 major) Mathematics International (2022) Master's degree (1 major) Physics International (2024) Master's degree (1 major) Mathematics International (2025) Master's with 1 major Physics International (2020) Master's with 1 major Physics International (2020)						
			-	r (120 ECTS) Physics Internation	-	190

Module title Abbre					Abbreviation	
Comple	ex Anal	ysis		10-M=AFTHin-152-m	101	
Module	e coord	inator		Module offered by		
Dean o	f Studi	es Mathematik (Mathem	natics)	Institute of Mathem	atics	
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)		
10	nume	rical grade				
Duratio	on	Module level	Other prerequisites	i i i i i i i i i i i i i i i i i i i		
1 seme	ster	graduate				
Conten	ts					
geome ons (e. Recom	tric met g. ellip mende	y of mapping properties thods. Structural proper tic functions). d previous knowledge: lge of the contents of th	ties of families of hold	omorphic and merom	orphic functions. Sp	pecial functi-
Intende	ed lear	ning outcomes				
ticular	the (ge	acquainted with the fur ometric) mapping prope ner acquired skills and o	erties of holomorphic f	unctions. He/She is	able to establish a c	onnection
Course	S (type, r	number of weekly contact hours,	language — if other than Ger	rman)		
V (4) + Module		t in: English				
Metho	d of ass	Sessment (type, scope, langu	age — if other than German,	examination offered — if no	t every semester, informati	on on whether
		le for bonus)				
b) oral c) oral Langua	examir examin Ige of a ment o	mination (approx. 90 to nation of one candidate ation in groups (groups ssessment: English ffered: In the semester i bonus	each (approx. 20 minu of 2, 15 minutes per c	utes) or andidate)	ıbsequent semester	
Allocat	ion of p	olaces				
Additio	nal inf	ormation				
Worklo	ad					
300 h						
Teachi	ng cycl	e				
Referre	d to in	LPO I (examination regulation	ns for teaching-degree progra	ummes)		
Module	e appea	urs in				
Module appears inMaster's degree (1 major) Mathematics International (2015)Master's degree (1 major) Physics International (2020)Master's degree (1 major) Mathematics International (2021)Master's degree (1 major) Mathematics International (2022)Master's degree (1 major) Physics International (2024)Master's degree (1 major) Mathematics International (2025)Master's with 1 major Physics International (2020)JMU Würzburg • generated 19-Apr-2025 • exam. reg. da-page 160 / 196						
			ta record Maste	r (120 ECTS) Physics Internati	onal - 2020	

Module title					Abbreviation		
Lie Theory					10-M=ALTHin-152-n	101	
Module	e coord	inator		Module offered by			
Dean o	fStudi	es Mathematik (Mathen	natics)	Institute of Mathem	atics		
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)			
10	nume	rical grade					
Duratio	on	Module level	Other prerequisites				
1 seme	ster	graduate					
Conten	ts						
examp Recom Basic k	Linear Lie groups and their Lie algebras, exponential function, structure and classification of Lie algebras, classic examples, applications, e. g. in physics and control theory. Recommended previous knowledge: Basic knowledge of the contents of the modules "Functional Analysis" and "Introduction to Topology" is recom- mended. Furthermore, basic knowledge of the contents of the module "Introduction to Differential Geometry" is						
Intende	ed lear	ning outcomes					
The stu	ident is hese to	acquainted with the fu common problems, an			, , ,		
Course	S (type, r	umber of weekly contact hours	, language — if other than Ge	rman)			
V (4) + Module		t in: English					
Metho	d of ass	essment (type, scope, langu	uage — if other than German,	examination offered — if no	t every semester, informati	on on whether	
		le for bonus)					
b) oral c) oral Langua	examir examin Ige of a ment o	nination (approx. 90 to ation of one candidate ation in groups (groups ssessment: English ffered: In the semester bonus	each (approx. 20 minu of 2, 15 minutes per c	utes) or andidate)	ıbsequent semester		
Allocat	ion of p	olaces					
Additio	onal inf	ormation					
Worklo	ad						
300 h							
Teachi	ng cycl	e					
Referre	ed to in	LPO I (examination regulation	ns for teaching-degree progra	immes)			
Module	e appea	urs in					
Master	's degr	ee (1 major) Mathematio	-				
	-	ee (1 major) Physics Inte					
	-	ee (1 major) Mathematio ee (1 major) Mathematio					
	-	ee (1 major) Physics Inte					
	-	Physics International (2020)		generated 19-Apr-2025 • exa	ım. reg. da-	page 161 / 196	
			ta record Maste	r (120 ECTS) Physics Internati	onal - 2020		



Module	title				Abbreviation
Τοροίο	зу				10-M=ATOPin-152-m01
Module	coord	inator		Module offered by	
Dean of	Studie	es Mathematik (Mathema	atics)	Institute of Mathem	natics
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)	
10	nume	rical grade			
Duratio	n	Module level	Other prerequisites		
1 semes	ster	graduate			
Conten	ts				
		opology, topological inva ng spaces.	ariants (e. g. fundame	ental group, connect	ion), construction of topological
Intende	d learr	ning outcomes			
		acquainted with the fund non problems.	damental results, the	orems and methods	in topology and is able to apply
Courses	5 (type, n	umber of weekly contact hours, l	anguage — if other than Ger	man)	
V (4) + Í Module		t in: English			
		e essment (type, scope, langua; le for bonus)	ge — if other than German, e	examination offered — if no	ot every semester, information on whether
b) oral (c) oral (Langua	examin examin ge of a ment o	nination (approx. 90 to 1 ation of one candidate e ation in groups (groups c ssessment: English ffered: In the semester in bonus	ach (approx. 20 minu of 2, 15 minutes per ca	ites) or andidate)	ıbsequent semester
Allocati	ion of p	olaces			
Additio	nal inf	ormation			
Worklo	ad				
300 h					
Teachir	ig cycl	e			
Referre	d to in	LPOI (examination regulations	s for teaching-degree progra	mmes)	
Module					
	-	ee (1 major) Mathematics			
	-	ee (1 major) Physics Inter ee (1 major) Mathematics			
	-	ee (1 major) Mathematics			
	-	ee (1 major) Physics Inter			
	-	ee (1 major) Mathematics	•		

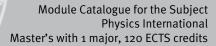
Module title Abbreviation							
Number Theory					10-M=AZTHin-152-n	101	
Module	e coord	inator		Module offered by			
Dean o	f Studi	es Mathematik (Mathem	natics)	Institute of Mathem	atics		
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)			
10	nume	rical grade					
Duratio	n	Module level	Other prerequisites				
1 seme	ster	graduate					
Conten	ts						
applica overvie Recomi Basic k	Number-theoretic functions and their associated Dirichlet series resp. Euler products, their analytic theory with applications to prime number distribution and diophantine equations; discussion of the Riemann hypothesis, overview of the development of modern number theory. Recommended previous knowledge: Basic knowledge of algebra and number theory is assumed, such as can be acquired in the modules "Introduction to Algebra", "Introduction to Number Theory" and "Applied Algebra".						
		ning outcomes		0			
The stu structu	dent is res in r	acquainted with the fur number theory and know evelopments in number	s methods for the sol				
Course	S (type, r	umber of weekly contact hours,	, language — if other than Gei	rman)			
V (4) + Module		t in: English					
Method	d of ass	essment (type, scope, langu	age — if other than German,	examination offered — if no	t every semester, informati	on on whether	
		le for bonus)					
b) oral c) oral (Langua	examir examin ge of a ment o	mination (approx. 90 to ation of one candidate ation in groups (groups ssessment: English ffered: In the semester i bonus	each (approx. 20 minu of 2, 15 minutes per c	utes) or andidate)	ıbsequent semester		
Allocat	ion of p	olaces	_				
Additio	nal inf	ormation					
Worklo	ad						
300 h			_				
Teachi	ng cycl	e					
Referre	a to in	LPO I (examination regulatio	ns for teaching-degree progra	mmes)			
		•					
Module			a Interneticial ()				
	-	ee (1 major) Mathematic ee (1 major) Physics Inte					
	-	ee (1 major) Mathematic					
	-	ee (1 major) Mathematic					
Master	's degr	ee (1 major) Physics Inte	ernational (2024)				
Master's wi	ith 1 majo	Physics International (2020)	-	generated 19-Apr-2025 • exa r (120 ECTS) Physics Internati	-	page 164 / 196	



Module title Abbreviation						
Groups and their Representations					10-M=VGDSin-152-r	n01
Module	e coord	inator		Module offered by		
Dean o	fStudi	es Mathematik (Mathem	atics)	Institute of Mathem	atics	
ECTS	Metho	od of grading	Only after succ. con	pl. of module(s)		
10	nume	rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	its					
the S-r Recom Basic k	ings of mende	d previous knowledge: Ige of algebra is assume				
		ning outcomes				
The stu	ıdent m	asters advanced algebra questions in group theor				
Course	S (type, n	umber of weekly contact hours,	language — if other than Ger	rman)		
V (4) + Module		t in: English				
		s essment (type, scope, langu le for bonus)	age — if other than German,	examination offered — if no	t every semester, informati	on on whether
b) oral c) oral Langua Assess	examin examin age of a	mination (approx. 90 to ation of one candidate e ation in groups (groups ssessment: English ffered: In the semester i bonus	each (approx. 20 minu of 2, 15 minutes per c	utes) or andidate)	ıbsequent semester	
Allocat	ion of p	olaces				
Additio	onal inf	ormation				
Worklo	ad					
300 h						
Teachi	ng cycl	e				
Referre	ed to in	LPO I (examination regulation	ns for teaching-degree progra	mmes)		
Module	e appea	nrs in				
Master Master Master Master Master	Master's degree (1 major) Mathematics International (2015) Master's degree (1 major) Physics International (2020) Master's degree (1 major) Mathematics International (2021) Master's degree (1 major) Mathematics International (2022) Master's degree (1 major) Physics International (2024) Master's degree (1 major) Mathematics International (2025) Master's with 1 major Physics International (2020) Master's with 1 major Physics International (2020)					
		,	-	r (120 ECTS) Physics Internatio	-	

Module	title				Abbreviation		
Geometrical Mechanics					10-M=VGEMin-152-	m01	
Module	e coord	inator		Module offered by			
Dean of	fStudi	es Mathematik (Mathen	natics)	Institute of Mathem	atics		
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)			
10	nume	rical grade					
Duratio	n	Module level	Other prerequisites				
1 semes	ster	graduate					
Conten	ts						
tic geor phase s Recomr Advanc Geomet	The module builds on the topics covered in module 10-M=ADGM and discusses these in more detail: symplec- tic geometry, cotangent bundles and other examples of symplectic manifolds, symmetries and Noether theorem, phase space reduction, normal forms, introduction to Poisson geometry. Recommended previous knowledge: Advanced knowledge of differential geometry is required, such as can be acquired in the module "Differential Geometry". Knowledge of the contents of the module "Introduction to Topology" is also recommended. Knowled-						
		al mechanics can also					
The stu He/She	dent is e is able	acquainted with select e to establish a connect s in physics.					
Courses	S (type, n	umber of weekly contact hours	, language — if other than Ger	rman)			
V (4) + Í Module		t in: English					
		essment (type, scope, langule for bonus)	uage — if other than German,	examination offered — if no	t every semester, informati	on on whether	
b) oral (c) oral (Langua	examin examin ge of a ment o	nination (approx. 90 to ation of one candidate ation in groups (groups ssessment: English ffered: In the semester bonus	each (approx. 20 minu of 2, 15 minutes per c	utes) or andidate)	ıbsequent semester		
Allocati	ion of p	olaces					
Additio	nal inf	ormation					
Worklo	ad						
300 h							
Teachir	ıg cycl	e					
Referred to in LPO I (examination regulations for teaching-degree programmes)							
Module	e appea	nrs in					
Master' Master'	's degro 's degro	ee (1 major) Mathematic ee (1 major) Physics Inte ee (1 major) Mathematic	ernational (2020) cs International (2021)				
	-	ee (1 major) Mathematio					
Master's wi	th 1 major	Physics International (2020)		generated 19-Apr-2025 • exa r (120 ECTS) Physics Internati		page 167 / 196	





Master's degree (1 major) Physics International (2024) Master's degree (1 major) Mathematics International (2025)

Module	e title				Abbreviation
Numeric of Partial Differential Equations10-M=VNPEin					
Module	e coord	inator		Module offered by	<u> </u>
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics
ECTS		od of grading	Only after succ. com		
		rical grade			
10		-			
Duratio	n	Module level	Other prerequisites		
1 seme	ster	graduate			
Conten	ts				
(numer discont Recomi	ical me tinuous mende	ethods for elliptic, parabo Gelerkin finite elements d previous knowledge:	olic and hyperbolic pa method, finite differ	artial differential equ ences and finite volu	finite elements, error estimates lations; finite elements method ume methods). equations, such as can be acqui
		lules "Introduction to Fur			
		ning outcomes			
		acquainted with advanc			ential equations.
		number of weekly contact hours, l	anguage — if other than Ger	man)	
V (4) +					
Module	e taugh	t in: English			
a) writte b) oral c) oral	en exa en exa examir examin	^{le for bonus)} mination (approx. 90 to 1 lation of one candidate e ation in groups (groups c	20 minutes, usually (ach (approx. 20 minu	chosen) or utes) or	ot every semester, information on whether
	ment o	ssessment: English ffered: In the semester in bonus	which the course is	offered and in the s	ubsequent semester
Allocat	ion of p	olaces			
Additio	nal inf	ormation			
Worklo	ad				
300 h					
Teachi	ng cycl	e			
	0 -) - (-		
Pafarra	d to in	LPOI (examination regulations	c fortoaching dagge	mmoc)	
Referre		LE VI (examination regulation:	s ior teaching-degree progra	iiiiiles <i>)</i>	
Module	annos	ors in			
		ee (1 major) Mathematics	International (2015)		
	-	ee (1 major) Mathematics ee (1 major) Physics Inter			
	-	ee (1 major) Mathematics			
	-	ee (1 major) Mathematics			
	-				
Master	's degr	ee (1 major) Physics Inter	national (2024)		
	-	ee (1 major) Physics Inter ee (1 major) Mathematics	-		

Module title					
	10-M=VDIMin-152-m01				
Module offered by	·				
Institute of Mathem	natics				
ompl. of module(s)					
es					
	coding theory, cryptography, matics" is required.				
cted topic in discrete ı	mathematics.				
German)					
n, examination offered — if no	ot every semester, information on whether				
utes per candidate)	ubsequent semester				
grammes)					
Module appears in					
1) 2)					
	Institute of Mathem ompl. of module(s) es rete mathematics (e. g. tion to Discrete Mathem ected topic in discrete in German)				

Module	e title				Abbreviation
Selecte	ed Topi	cs in Mathematical Phys	ics		10-M=VMPHin-152-m01
Module	e coord	inator		Module offered by	
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)	
10		rical grade			
Duratio	n	Module level	Other prerequisites	5	
1 seme	ster	graduate			
Conten	ts				
terial se Recom	ciences mende	s, geometric field theory, d previous knowledge:	advanced topics in q	quantum theory.	uid dynamics, mathematical ma- of analysis is required. In case o
		commended to consult th			
		ning outcomes			
					She is able to establish a a and questions in physics.
Course	S (type, r	number of weekly contact hours, I	anguage — if other than Ge	rman)	
V (4) +	Ü (2)				
Module	e taugh	t in: English			
		essment (type, scope, langua le for bonus)	ge — if other than German,	examination offered — if no	ot every semester, information on whether
b) oral c) oral Langua	examir examin ge of a ment o	mination (approx. 90 to 1 nation of one candidate e ation in groups (groups o ssessment: English ffered: In the semester ir bonus	ach (approx. 20 min of 2, 15 minutes per c	utes) or :andidate)	ubsequent semester
Allocat					
Additio	nal inf	ormation			
 Worklo	ad				
300 h					
Teachi	ng cycl	e			
	-3 -9 -0	-			
Dofo	d to !=		- Contraction 1		
Kererre	u to in	LPO I (examination regulation	s for teaching-degree progra	ammes)	
 Module	e appea	irs in			
		ee (1 major) Mathematics	International (2015)		
Master	-	ee (1 major) Physics Inter			
	Jucan	ee (I major) i mystes meet			
Master	-	ee (1 major) Mathematics)	
Master Master	's degr		International (2021)		
Master Master Master Master	's degr 's degr 's degr	ee (1 major) Mathematics	s International (2021) s International (2022) mational (2024))	

Modul	e title				Abbreviation	
Partial	Differe	ntial Equations of Math	ematical Physics		10-M=VPDPin-152-1	m01
Modul	e coord	inator		Module offered by	<u> </u>	
Dean c	of Studi	es Mathematik (Mathem	atics)	Institute of Mathem	natics	
ECTS	1	od of grading	Only after succ. con			
	1	rical grade				
10 Duratio		Module level	Other prerequisites			
		-				
1 seme		graduate				
Conter						
examp ons an Recom	les; init d gener mende	olic, and hyperbolic equ tial and boundary value ralisations; Hilbert space d previous knowledge: dge from the modules "C	problems; well-posed e methods; Sobolev s	and ill-posed proble paces and Fourier tra	ems; solution metho ansforms.	ods; extensi-
		recommended, as well a				Terentiat
Intend	ed lear	ning outcomes				
equati	ons, as	acquainted with fundar well as standard examp ner acquired skills and o	les from mathematica	ll physics. He/She is	able to establish a	
Course	S (type, r	number of weekly contact hours,	language — if other than Ger	rman)		
V (4) + Moduli		t in: English				
		sessment (type, scope, langu	ago if other than Cormon	avamination offered if no	at avan comostar informat	ion on whothor
		le for bonus)	age — II other than German, i	examination onered — if no	ot every semester, mormat	ion on whether
b) oral c) oral Langua Assess	examir examin age of a	mination (approx. 90 to nation of one candidate nation in groups (groups ssessment: English ffered: In the semester i bonus	each (approx. 20 minu of 2, 15 minutes per c	utes) or andidate)	ubsequent semester	
	tion of p					
Additid	nal inf	ormation				
Worklo	ad					
	au					
300 h		_	_			
reachi	ng cycl	e				
Referre	ed to in	LPO I (examination regulation	ns for teaching-degree progra	mmes)		
	e appea	ars in				
Modul		ee (1 major) Mathematic	s International (2015)			
	's degr					
Master	-	ee (1 major) Physics Inte	rnational (2020)			
Master Master	's degr	-				
Master Master Master Master	's degr 's degr 's degr	ee (1 major) Physics Inte ee (1 major) Mathematic ee (1 major) Mathematic	s International (2021) s International (2022)			
Master Master Master Master Master	f's degr f's degr f's degr f's degr	ee (1 major) Physics Inte ee (1 major) Mathematic	s International (2021) s International (2022)			



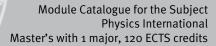
Module title				Abbreviation		
Pseudo Riemannian and Riemannian Geometry				10-M=VPRGin-152-r	no1	
Module	e coord	inator		Module offered by		
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics	
ECTS	Meth	od of grading	Only after succ. com	pl. of module(s)		
10	nume	rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	Its					
nian ar map, Ja Laplace theory. Recom Advance Geome	nd pseu acobi fi e opera mende ced kno etry". Kr	uilds on the topics cover ido-Riemannian manifold elds, comparison theorem tors, causal structure of d previous knowledge: wwledge of differential ge nowledge of the contents also recommended.	ls, Levi-Civita connec ns in Riemannian geo Lorenz manifolds, Ein ometry is required, su	tion and curvature, g ometry, submanifold stein equations and uch as can be acquir	geodesics and the ex ls, integration, d'Aler l applications in gen red in the module "D	(ponential mbert and eral relativity ifferential
		ning outcomes				
The stu manifo	ident is Ids. He	acquainted with advance /She is able to establish d questions in physics.				
Course	S (type, r	number of weekly contact hours,	anguage — if other than Ger	man)		
V (4) + Module		t in: English				
		sessment (type, scope, langua le for bonus)	ge — if other than German, e	examination offered — if no	ot every semester, informati	ion on whether
b) oral c) oral Langua	examir examin age of a ment o	mination (approx. 90 to 1 nation of one candidate e ation in groups (groups o ssessment: English ffered: In the semester ir bonus	ach (approx. 20 minu of 2, 15 minutes per ca	ites) or andidate)	ubsequent semester	
Allocat	ion of _l	olaces				
Additio	onal inf	ormation				
	-					
Worklo	ad					
300 h	300 h					
Teachi	ng cycl	e				
Referre	ed to in	LPO I (examination regulation	s for teaching-degree progra	mmes)		
Module						
	-	ee (1 major) Mathematics ee (1 major) Physics Inter	_			
Master's w	ith 1 majo	r Physics International (2020)		generated 19-Apr-2025 • exa (120 ECTS) Physics Internati		page 174 / 196

Julius-Maximilians-UNIVERSITÄT WÜRZBURG

Master's degree (1 major) Mathematics International (2021) Master's degree (1 major) Mathematics International (2022) Master's degree (1 major) Physics International (2024) Master's degree (1 major) Mathematics International (2025)

Module title					Abbreviation	
Databases 1					10-I=DB-161-m01	
Module	e coord	inator		Module offered by		
Dean o	f Studi	es Informatik (Compute	er Science)	Institute of Comput	er Science	
ECTS	Meth	od of grading	Only after succ. co	mpl. of module(s)		
5		rical grade		•		
Duratio		Module level	Other prerequisites	5		
1 seme		graduate		-		
Conten		0	1			
Relatio	nal alg	ebra and complex SQL anagement.	statements; database	planning and norma	l forms, XML data mo	odelling;
Intende	ed lear	ning outcomes				
The stu	ıdents	possess knowledge ab g in XML.	out data modelling and	d queries in SQL, trar	sactions as well as	about easy
Course	S (type, r	number of weekly contact hour	s, language — if other than Ge	erman)		
V (2) +	Ü (2)					
		Sessment (type, scope, lang ole for bonus)	uage — if other than German,	examination offered — if no	ot every semester, informat	ion on whether
examin prox. 1 <u>9</u> Separa	nation o 5 minut te writt age of a	by the lecturer at the bo of one candidate each (tes per candidate). ten examination for Ma ssessment: German an bonus	approx. 20 minutes) o ster's students.			
Allocat	ion of	places				
Additio	onal inf	ormation				
	s avail	able for students of the	Master's programme	Informatik (Compute	r Science, 120 ECTS o	credits): SE,
Worklo	ad					
150 h						
Teachi	ng cycl	e				
Referre	ed to in	LPO I (examination regulati	ons for teaching-degree progr	ammes)		
Module	e appea	ars in				
	-	ee (1 major) Computer S				
	Master's degree (1 major) Physics (2016)					
	Master's degree (1 major) Digital Humanities (2016) Master's degree (1 major) Computer Science (2017)					
	-	ee (1 major) Computer : ee (1 major) Computer :				
	-	ee (1 major) Computer : ee (1 major) Physics (20				
	-	ee (1 major) Physics (20				
	-	ee (1 major) Quantum E				
		ee (1 major) Quantum E				
Master's wi	ith 1 majo	r Physics International (2020)	-	 generated 19-Apr-2025 exa er (120 ECTS) Physics Internati 	-	page 176 / 196





Master's degree (1 major) Physics International (2024)

Module	e title		Abbreviation							
Analysis and Design of Programs 10-I=PA-161-m01										
Module	e coord	inator		Module offered by						
holder of the Chair of Computer Scienc		nce II	Institute of Comput	er Science						
ECTS			Only after succ. compl. of module(s)							
5 Duratia			Other prerequisites							
Duration Module level		Other prerequisites								
1 semester graduate										
Contents										
Program analysis, model creation in software engineering, program quality, test of programs, process models.										
Intend	ed lear	ning outcomes								
The students are able to analyse programs, to use testing frameworks and metrics as well as to judge program quality.										
Courses (type, number of weekly contact hours, language — if other than German)										
	-		<u>, , , , , , , , , , , , , , , , , , , </u>							
$V(2) + \ddot{U}(2)$										
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)										
written examination (approx. 60 to 120 minutes).										
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (ap-										
		es per candidate).	,		5					
Language of assessment: German and/or English										
creditable for bonus										
Allocation of places										
Additio	onal inf	ormation								
Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): SE,IS,ES,GE										
Worklo										
150 h										
Teachi	ng cycl	e								
Referre	ed to in	LPO I (examination regulation	ons for teaching-degree progra	mmes)						
Module	e appea	nrs in								
Master	's degr	ee (1 major) Computer S	Science (2016)							
Master's degree (1 major) Mathematics (2016)										
Master's degree (1 major) Physics (2016)										
Master's degree (1 major) Nanostructure Technology (2016)										
Master's degree (1 major) Computational Mathematics (2016)										
Master's teaching degree Gymnasium MINT Teacher Education PLUS, Elite Network Bavaria (ENB) (2016)										
Supplementary course MINT Teacher Education PLUS, Elite Network Bavaria (ENB) (2016) Master's degree (1 major) Computer Science (2017)										
Master's degree (1 major) Computer Science (2017) Master's degree (1 major) Computer Science (2018)										
Master's degree (1 major) Computer Science (2010) Master's degree (1 major) Computational Mathematics (2019)										
	-	ee (1 major) Computati ee (1 major) Mathemati		7/						
Master's w	ith 1 majo	r Physics International (2020)	-	generated 19-Apr-2025 • exa r (120 ECTS) Physics Internati	-	page 178 / 196				

Master's degree (1 major) Information Systems (2019) Master's degree (1 major) Nanostructure Technology (2020) Master's degree (1 major) Physics (2020) Master's teaching degree Gymnasium MINT Teacher Education PLUS, Elite Network Bavaria (ENB) (2020) Supplementary course MINT Teacher Education PLUS, Elite Network Bavaria (ENB) (2020) Master's degree (1 major) Physics International (2020) Master's degree (1 major) Quantum Engineering (2020) Master's degree (1 major) Quantum Technology (2021) Master's degree (1 major) Computational Mathematics (2022)

Master's degree (1 major) Mathematics (2022)

Module	e title		Abbreviation							
Computer Architecture 10-I-RAK-152-m01										
Module	e coord	inator		Module offered by						
Dean of Studies Informatik (Computer S			r Science)	Science) Institute of Computer Science						
ECTS	Metho	od of grading	Only after succ. compl. of module(s)							
5 numerical grade										
Duration Module level			Other prerequisites							
1 seme	ster	undergraduate								
Contents										
Instruction set architectures, command processing through pipelining, statical and dynamic instruction schedu- ling, caches, vector processors, multi-core processors.										
Intende	ed lear	ning outcomes								
The students master the most important techniques to design fast computers as well as their interaction with compilers and operating systems.										
Courses (type, number of weekly contact hours, language — if other than German)										
V (2) +	Ü (2)									
Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)										
written examination (approx. 60 to 120 minutes). If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (ap- prox. 15 minutes per candidate). Language of assessment: German and/or English creditable for bonus										
Allocation of places										
Additio	nal inf	ormation								
Worklo	ad									
150 h										
Teachir	ng cvcl	e								
	<u> </u>									
Referre	d to in	LPO I (examination regulation	ons for teaching-degree progra	ammes)						
Referred to in LPO I (examination regulations for teaching-degree programmes) § 22 II Nr. 3 b) § 69 I Nr. 1 c): Rechnerarchitektur										
Module appears in Bachelor's degree (1 major) Computer Science (2015)										
Bachelor's degree (1 major) Mathematics (2015)										
Bachelor's degree (1 major) Computational Mathematics (2015) Bachelor's degree (1 major) Aerospace Computer Science (2015)										
First state examination for the teaching degree Gymnasium Computer Science (2015)										
Master's degree (1 major) Physics (2016)										
Master's teaching degree Gymnasium MINT Teacher Education PLUS, Elite Network Bavaria (ENB) (2016)										
Bachelor's degree (1 major) Aerospace Computer Science (2017)										
		gree (1 major) Compute								
Bachelo	or's de	gree (1 major) Compute	r Science (2019)							
Master's wi	ith 1 majo	r Physics International (2020)		• generated 19-Apr-2025 • exa r (120 ECTS) Physics Internati		page 180 / 196				

UNIVERSITÄT WÜRZBURG

Master's degree (1 major) Physics (2020)

Master's teaching degree Gymnasium MINT Teacher Education PLUS, Elite Network Bavaria (ENB) (2020) Supplementary course MINT Teacher Education PLUS, Elite Network Bavaria (ENB) (2020) Master's degree (1 major) Physics International (2020)

Bachelor's degree (1 major) Aerospace Computer Science (2020)

Bachelor's degree (1 major) Computer Science und Sustainability (2021)

Bachelor's degree (1 major) Artificial Intelligence and Data Science (2022)

Bachelor's degree (1 major) Artificial Intelligence and Data Science (2023)

Bachelor's degree (1 major) Mathematics (2023)

Master's degree (1 major) Physics International (2024)

Bachelor's degree (1 major) Artificial Intelligence and Data Science (2024)

Master's teaching degree Gymnasium MINT Teacher Education PLUS, Elite Network Bavaria (ENB) (2025)

Bachelor's degree (1 major) Games Engineering (2025)

Module title					Abbreviation	
Advanced Programming					10-I-APR-172-m01	
Module coordinator				Module offered by		
holder of the Chair of Computer Science			e ll	Institute of Comput	er Science	
ECTS Method of grading			Only after succ. con	· · · ·		
5	1	rical grade				
Duratio		Module level	Other prerequisites			
1 seme		undergraduate				
Conten						
grams. and coo de a se cussed	If more de dup nsible	vledge of basic programm e complex problems are t licates occur. In this lectu structure. Also, further to	o be tackled, subopti ure, further knowledg	mal results like long e is to be conveyed o	, incomprehensible on how to give progr	functions ams and co-
Intende	ed lear	ning outcomes				
then im	npleme	n advanced programming nted in multiple languag ng concepts are introduce	es and their efficienc	y measured using sta	andard metrics. In ad	ddition, par-
Course	S (type, r	number of weekly contact hours, l	anguage — if other than Ger	rman)		
V (2) +	Ü (2)					
		sessment (type, scope, langua ole for bonus)	ge — if other than German, o	examination offered — if no	t every semester, informati	on on whether
lf anno examin prox. 1	unced ation c 5 minut ige of a	nation (approx. 60 to 120 by the lecturer at the beg of one candidate each (ap tes per candidate). ssessment: German and bonus	inning of the course, oprox. 20 minutes) or			
Allocat	ion of _l	places				
Additio	onal inf	ormation				
Worklo	ad					
150 h						
Teachi	ng cvcl	e				
Referred to in LPO I (examination regulations for teaching-degree programmes)						
§ 22 II Nr. 3 b)						
Module						
		gree (1 major) Computer :	Science (2017)			
		gree (1 major) Computer				
Module	e studie	es (Bachelor) Computer S	cience (2019)			
	-	ee (1 major) Nanostructu				
	-	ee (1 major) Physics (202				
		hing degree Gymnasium				020)
		ry course MINT Teacher E				
Master's wi	ith 1 majo	r Physics International (2020)		generated 19-Apr-2025 • exa r (120 ECTS) Physics Internati	-	page 182 / 196



Bachelor's degree (1 major) Business Information Systems (2020) Master's degree (1 major) Physics International (2020) Master's degree (1 major) Quantum Engineering (2020) Bachelor's degree (1 major) Computer Science und Sustainability (2021) Master's degree (1 major) Quantum Technology (2021) Bachelor's degree (1 major) Business Information Systems (2021) Bachelor's degree (1 major) Artificial Intelligence and Data Science (2022) Bachelor's degree (1 major) Artificial Intelligence and Data Science (2023) Bachelor's degree (1 major) Business Information Systems (2023) Master's degree (1 major) Quantum Engineering (2024) Master's degree (1 major) Physics International (2024) Bachelor's degree (1 major) Business Information Systems (2024) Bachelor's degree (1 major) Artificial Intelligence and Data Science (2024) Bachelor's degree (1 major) Digital Business & Data Science (2024) Master's teaching degree Gymnasium MINT Teacher Education PLUS, Elite Network Bavaria (ENB) (2025) Supplementary course MINT Teacher Education PLUS, Elite Network Bavaria (ENB) (2025) Bachelor's degree (1 major) Games Engineering (2025)

Module title					Abbreviation		
Operating Systems 10-I-BS-191-m01							
Module	e coord	inator		Module offered by			
holder of the Chair of Computer Science II			ce II	Institute of Comput	er Science		
			Only after succ. con	· · ·			
5	nume	rical grade		· · · · · · · · · · · · · · · · · · ·			
Duratio	on	Module level	Other prerequisites				
1 seme	ster	undergraduate					
Conten	ts		•				
sing in	operat	o computer systems, dev ing systems, processes a nt, device and file manag	and threads, CPU sch	eduling, synchronisa			
Intende	ed lear	ning outcomes					
The stu	Idents	possess knowledge and	practical skills in bui	ding and using esse	ntial parts of operat	ing systems.	
Course	S (type, r	number of weekly contact hours,	language — if other than Ge	rman)			
V (2) + Module		t in: English					
Method	d of ass	sessment (type, scope, langua	age — if other than German,	examination offered — if no	t every semester, informat	ion on whether	
module is	s creditab	ole for bonus)					
examin prox. 1	ation o 5 minut 1ge of a	by the lecturer at the beg of one candidate each (a tes per candidate). Issessment: German and bonus	pprox. 20 minutes) or				
Allocat	ion of _l	places					
Additio	onal inf	ormation					
Worklo	ad						
150 h							
Teachi	ng cycl	ρ					
	is cyci						
Referre	ed to in	LPO I (examination regulation	s for teaching-degree progra	immes)			
Bachel	or's de	gree (1 major) Computer	Science (2019)				
Master	's degr	ee (1 major) Nanostructu	re Technology (2020)				
	Master's degree (1 major) Physics (2020)						
		gree (1 major) Business I		(2020)			
	-	ee (1 major) Physics Inte					
	-	ee (1 major) Quantum En					
		gree (1 major) Aerospace					
		gree (1 major) Computer		ability (2021)			
		ee (1 major) Quantum Te gree (1 major) Business I		(2021)			
Master's wi	ith 1 majo	r Physics International (2020)	-	generated 19-Apr-2025 • exa r (120 ECTS) Physics Internation	-	page 184 / 196	

Julius-Maximilians-UNIVERSITÄT WÜRZBURG

Bachelor's degree (1 major) Artificial Intelligence and Data Science (2022) Bachelor's degree (1 major) Artificial Intelligence and Data Science (2023) Bachelor's degree (1 major) Mathematics (2023) Bachelor's degree (1 major) Business Information Systems (2023) Master's degree (1 major) Quantum Engineering (2024) Master's degree (1 major) Physics International (2024) Bachelor's degree (1 major) Artificial Intelligence and Data Science (2024)

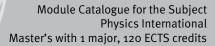
Module title					Abbreviation		
Artificial Intelligence 1 10-I=KI1-161-m01							
Module	e coord	inator		Module offered by			
holder of the Chair of Computer Science VI			ce VI	Institute of Computer Science			
ECTS	1	od of grading	Only after succ. con	1			
5	1	rical grade					
Duratio		Module level	Other prerequisites				
		-		•			
1 seme		graduate					
Conten							
		ents, uninformed and he and predicate logic and			, search with partial i	information,	
Intende	ed lear	ning outcomes					
		possess theoretical and gic and are able to asse			gence in the area of	agents,	
Course	S (type, r	number of weekly contact hours	, language — if other than Ge	rman)			
V (2) +							
Method	d of ass	sessment (type, scope, langu le for bonus)	lage — if other than German,	examination offered — if no	t every semester, informati	on on whether	
lf anno examin prox. 1 <u>9</u>	unced ation c 5 minut ge of a	nation (approx. 60 to 12 by the lecturer at the be of one candidate each (a tes per candidate). ssessment: German and bonus	ginning of the course, approx. 20 minutes) or				
Allocat							
πισται		Jaces					
		ormation					
	s availa	able for students of the	Master's programme l	nformatik (Computer	Science, 120 ECTS c	credits):	
Worklo							
	au						
150 h			_				
Teachi	ng cycl	e					
Referre	ed to in	LPO I (examination regulatio	ns for teaching-degree progra	ammes)			
Module	e appea	ars in					
	-	ee (1 major) Computer S					
	Master's degree (1 major) Mathematics (2016)						
		ee (1 major) Physics (20					
	-	ee (1 major) Nanostructi					
		ee (1 major) Computatio					
		hing degree Gymnasium				016)	
		ry course MINT Teacher		Network Bavaria (EN	В) (2016)		
		ee (1 major) Computer S					
	-	ee (1 major) Computer S		a)			
master	s aegr	ee (1 major) Computatio	mai mainematics (201	.9)		l	
Master's wi	ith 1 majo	r Physics International (2020)		• generated 19-Apr-2025 • exa r (120 ECTS) Physics Internati		page 186 / 196	

Master's degree (1 major) Mathematics (2019) Master's degree (1 major) Information Systems (2019) Master's degree (1 major) Nanostructure Technology (2020) Master's degree (1 major) Physics (2020) Master's teaching degree Gymnasium MINT Teacher Education PLUS, Elite Network Bavaria (ENB) (2020) Supplementary course MINT Teacher Education PLUS, Elite Network Bavaria (ENB) (2020) Master's degree (1 major) Aerospace Computer Science (2020) Master's degree (1 major) Physics International (2020) Master's degree (1 major) Quantum Engineering (2020) Master's degree (1 major) Quantum Technology (2021)

Module title Abbreviation					
Sensor	and Ac	tor Materials - Functio	nal Ceramics and Mag	netic Particles	08-FU-SAM-161-m01
Module	Module coordinator Module offered by				
	progra Natrieri	mme coordinator Funkt als)	tionswerkstoffe (Func-	Chair of Chemica	l Technology of Material Synthesis
ECTS	Metho	od of grading	Only after succ. con	pl. of module(s)	
5	1	rical grade			
<u>J</u> Duratio	·	Module level	Other prerequisites		
1 seme		graduate			
Conten	ts				
					as piezoelectrics, shape memory ological fluids, magnetofluids.
Intend	ed learı	ning outcomes			
Studen	its have	e developed fundament	al knowledge in the ar	ea of sensory and	actuatory materials.
Course	S (type, n	number of weekly contact hours	s, language — if other than Gei	man)	
V (2) +	P (2)				
Metho	d of ass	sessment (type, scope, lang	uage — if other than German,	examination offered — if	not every semester, information on whether
		le for bonus)			
P: cred		ffered: Once a year, sur or bonus blaces	mmer semester		
Allocal		Jaces			
Additio	onal info	ormation			
Worklo	ad				
150 h					
Teachi	ng cycl	e			
Referre	ed to in	LPO I (examination regulation	ons for teaching-degree progra	mmes)	
Module	e appea	ars in			
Master	's degr	ee (1 major) Physics (20	016)		
Master	's degr	ee (1 major) Nanostruct	ure Technology (2016)		
		ee (1 major) Functional			
	-	ee (1 major) Nanostruct			
	-	ee (1 major) Physics (20			
	-	ee (1 major) Physics Int			
	-	ee (1 major) Quantum E			
	-	ee (1 major) Quantum T			
		ee (1 major) Quantum E			
Master	's degre	ee (1 major) Physics Int	ernational (2024)		

Electro					Abbreviation	
	chemio	al Energy Storage and	Conversion		08-FU-EEW-152-mo)1
Module	e coord	inator		Module offered by		
		Chair of Chemical Techn	ology of Material Syn-		echnology of Materi	ial Synthesis
thesis			T			
ECTS	1	od of grading	Only after succ. con	npl. of module(s)		
5		rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	undergraduate				
	stry and	l application of: battery metal hydride, sodium				
cal dou	ıble lay	er capacitors, redox-flov GaAs, organic and dye	w batteries, fuel cell sy	stems (AFC, PEMFC,		
Intende	ed lear	ning outcomes				
Studen	its have	e developed a knowledg e to research problems		energy storage and c	onversion and are al	ble to apply
Course	S (type, r	number of weekly contact hours	, language — if other than Ge	rman)		
V (2) +	P (1) +	E (1)				
		sessment (type, scope, langu	lage — if other than German,	examination offered — if no	ot every semester, informat	tion on whether
		le for bonus)			· ·	
Langua	ige of a					
Assess Allocat	ment o	ssessment: German and ffered: Once a year, sun blaces	-			
Allocat 	ment o	ffered: Once a year, sun	-			
Allocat Additio 	ment o ion of p	ffered: Once a year, sun blaces	-			
Allocat 	ment o ion of p	ffered: Once a year, sun blaces	-			
Allocat Additio Worklo	ment o ion of p onal inf	ffered: Once a year, sun olaces ormation	-			
Allocat Additio Worklo 150 h	ment o ion of p onal inf	ffered: Once a year, sun olaces ormation	-			
Allocat Additio Worklo 150 h Teachin 	ment o ion of p onal inf ad	ffered: Once a year, sun olaces ormation	nmer semester	ımmes)		
Allocat Additio 150 h Teachin Referre	ment o ion of p onal inf ad ng cycl	ffered: Once a year, sun places ormation e LPOI (examination regulatio	nmer semester	ımmes)		
Allocat Additio Worklo 150 h Teachin Referre Module	ment o ion of p onal inf pad ng cycl ed to in e appea	ffered: Once a year, sun olaces ormation e LPOI (examination regulatio	nmer semester			
Allocat Additio Worklo 150 h Teachin Referre Bachele	ment o ion of p onal inf bad ng cycl ed to in e appea or's de	ffered: Once a year, sun olaces ormation e LPOI (examination regulatio urs in gree (1 major) Nanostrue	nmer semester			
Allocat Additio Worklo 150 h Teachin Referre Module Bachel Master	ment o ion of p onal inf ad ed to in e appea or's de 's degr	ffered: Once a year, sun places ormation e LPOI (examination regulation ars in gree (1 major) Nanostruce ee (1 major) Physics (20	nmer semester	5)		
Allocat Additio Worklo 150 h Teachin Referre Module Bachele Master Master	ment o ion of p onal inf onal inf orad ed to in e appea or's de 's degr 's degr	ffered: Once a year, sun places ormation e LPO I (examination regulation trs in gree (1 major) Nanostructure ee (1 major) Nanostructure ee (1 major) Nanostructure	nmer semester	5)		
Allocat Additio Worklo 150 h Teachin Referre Referre Bachele Master Master Master Master	ment o ion of p onal inf onal inf oad ed to in e appea or's de 's degr 's degr 's degr	ffered: Once a year, sun places ormation e LPO I (examination regulation ars in gree (1 major) Nanostructure ee (1 major) Physics (20 ee (1 major) Functional I	nmer semester	5)		
Allocat Additio Worklo 150 h Teachin Referre Bachele Master Master Master Master Master	ment o ion of p onal inf bad ng cycl ed to in e appea or's de 's degr 's degr 's degr 's degr	ffered: Once a year, sun places ormation e LPO I (examination regulation rrs in gree (1 major) Nanostructure ee (1 major) Physics (20 ee (1 major) Nanostructure ee (1 major) Functional I ee (1 major) Nanostructure	nmer semester ns for teaching-degree progra cture Technology (201) 16) ure Technology (2016) Waterials (2016) ure Technology (2020)	5)		
Allocat Additio Worklo 150 h Teachin Referre Bachel Master Master Master Master Master Master	ment o ion of j onal inf had ng cycl ed to in e appea or's de r's degr 's degr 's degr 's degr	ffered: Once a year, sun places ormation e LPO I (examination regulation ars in gree (1 major) Nanostructu ee (1 major) Physics (20	nmer semester ns for teaching-degree progra cture Technology (201) 16) ure Technology (2016) Materials (2016) ure Technology (2020) 20)	5)		
Allocat Additio Worklo 150 h Teachin Referre Module Bachele Master Master Master Master Master Master Master Master Master Master Master Master	ment o ion of p onal inf onal inf onal inf or of s det to in e appea or's degr 's degr 's degr 's degr 's degr	ffered: Once a year, sun places ormation e LPO I (examination regulation rrs in gree (1 major) Nanostructure ee (1 major) Physics (20 ee (1 major) Nanostructure ee (1 major) Functional I ee (1 major) Nanostructure	nmer semester ns for teaching-degree progra cture Technology (201 16) ure Technology (2016) Materials (2016) ure Technology (2020) 20) ernational (2020)	5)		
Allocat Additio Worklo 150 h Teachin Referre Bachel Master Master Master Master Master Master Master Master Master Master Master Master Master Master Master Master Master Master	ment o ion of p onal inf onal inf orad ed to in e appea or's degr 's degr 's degr 's degr 's degr 's degr 's degr	ffered: Once a year, sun places ormation e LPO I (examination regulation ars in gree (1 major) Nanostructu ee (1 major) Nanostructu ee (1 major) Nanostructu ee (1 major) Nanostructu ee (1 major) Physics (20 ee (1 major) Physics (20	nmer semester ns for teaching-degree progra cture Technology (201) 16) ure Technology (2016) Materials (2016) ure Technology (2020) 20) ernational (2020) ngineering (2020)	5)		



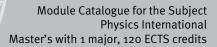


Bachelor's degree (1 major) Quantum Technology (2021) Master's degree (1 major) Quantum Technology (2021)

	e title				Abbreviation
Structu	ire and	Properties of Modern M	aterials: Experiments	s vs. Simulations	08-FU-MW-161-m01
Module coordinator Module offered by					
-		mme coordinator Funkti als)	onswerkstoffe (Func-	Chair of Chemical	Technology of Material Synthesis
ECTS	nal Matrierials) TS Method of grading Only after succ. compl. of module(s)				
		rical grade			
5 Duratio	•				
		Module level	Other prerequisites		
1 seme	ster	graduate			
Conten	ts		_		
Materia simula		erties of metals and cera	mics: correlation of s	tructure/property re	lations through experiments and
Intende	ed lear	ning outcomes			
mance	cerami pecial f	cs. They are introduced	to measuring method	s and calculation m	uminium alloys and high-perfor- ethods using numerical simulati of materials and the resulting pro
Course	S (type, r	number of weekly contact hours,	language — if other than Gei	rman)	
V (2) +	-				
		sessment (type scope langu	age — if other than German	examination offered — if r	ot every semester, information on whether
	s creditab		age in other than German,	examination offered in t	of every semester, mornation on whether
		·····,			
a) talk b) oral c) oral Langua	(approx examir examin age of a	x. 30 minutes) or nation of one candidate of ation in groups (groups ssessment: German and	of 2, approx. 30 minu I/or English		
a) talk b) oral c) oral Langua Assess	(appro) examir examin age of a ment o	k. 30 minutes) or nation of one candidate of ation in groups (groups ssessment: German and ffered: Once a year, win	of 2, approx. 30 minu I/or English		
a) talk b) oral c) oral Langua Assess	(appro) examir examin age of a ment o	k. 30 minutes) or nation of one candidate of ation in groups (groups ssessment: German and ffered: Once a year, win	of 2, approx. 30 minu I/or English		
a) talk b) oral c) oral Langua Assess Allocat 	(approx examir examin age of a ment o ion of p	k. 30 minutes) or nation of one candidate of ation in groups (groups ssessment: German and ffered: Once a year, wint blaces	of 2, approx. 30 minu I/or English		
a) talk b) oral c) oral Langua Assess Allocat 	(approx examir examin age of a ment o ion of p	k. 30 minutes) or nation of one candidate of ation in groups (groups ssessment: German and ffered: Once a year, win	of 2, approx. 30 minu I/or English		
a) talk b) oral c) oral Langua Assess Allocat Additio	(approx examir examin age of a ment o ion of p	k. 30 minutes) or nation of one candidate of ation in groups (groups ssessment: German and ffered: Once a year, wint blaces	of 2, approx. 30 minu I/or English		
a) talk b) oral c) oral Langua Assess Allocat Additio	(approx examir examin age of a ment o ion of p onal inf	k. 30 minutes) or nation of one candidate of ation in groups (groups ssessment: German and ffered: Once a year, wint blaces	of 2, approx. 30 minu I/or English		
a) talk b) oral c) oral Langua Assess Allocat Additio	(approx examir examin age of a ment o ion of p onal inf	k. 30 minutes) or nation of one candidate of ation in groups (groups ssessment: German and ffered: Once a year, wint blaces	of 2, approx. 30 minu I/or English		
a) talk b) oral c) oral Langua Assess Allocat Additio Worklo 150 h	(approx examir examin age of a ment o ion of p onal info pad	k. 30 minutes) or nation of one candidate of ation in groups (groups ssessment: German and ffered: Once a year, wint places ormation	of 2, approx. 30 minu I/or English		
a) talk b) oral c) oral Langua Assess Allocat Additio Worklo	(approx examir examin age of a ment o ion of p onal info pad	k. 30 minutes) or nation of one candidate of ation in groups (groups ssessment: German and ffered: Once a year, wint places ormation	of 2, approx. 30 minu I/or English		
a) talk b) oral c) oral Langua Assess Allocat Worklo 150 h Teachin 	(approx examir examin age of a ment o ion of p onal info pad	k. 30 minutes) or nation of one candidate of ation in groups (groups ssessment: German and ffered: Once a year, wint olaces ormation	of 2, approx. 30 minu l/or English ter semester	tes total)	
a) talk b) oral c) oral Langua Assess Allocat Worklo 150 h Teachin 	(approx examir examin age of a ment o ion of p onal info pad	k. 30 minutes) or nation of one candidate of ation in groups (groups ssessment: German and ffered: Once a year, wint places ormation	of 2, approx. 30 minu l/or English ter semester	tes total)	
a) talk b) oral c) oral Langua Assess Allocat Additio 150 h Teachin Referre	(approx examir examin age of a ment o ion of p onal info pad	k. 30 minutes) or nation of one candidate of ation in groups (groups ssessment: German and ffered: Once a year, wint places ormation	of 2, approx. 30 minu l/or English ter semester	tes total)	
a) talk b) oral c) oral Langua Assess Allocat Morklo 150 h Teachin Referre Module	(appro) examir examin age of a ment o ion of p onal inf pad ng cycl ed to in	k. 30 minutes) or nation of one candidate of ation in groups (groups ssessment: German and ffered: Once a year, wint olaces ormation e LPOI (examination regulation	of 2, approx. 30 minu l/or English ter semester	tes total)	
a) talk b) oral c) oral Langua Assess Allocat Modditio Teachin Referre Module	(appro) examin examin age of a ment o ion of p onal info pad ng cycl ed to in e appea	 a) ominutes) or lation of one candidate of ation in groups (groups ssessment: German and ffered: Once a year, winter olaces ormation e LPO I (examination regulation regulation are in the second sec	of 2, approx. 30 minu l/or English ter semester	tes total)	
a) talk b) oral c) oral Langua Assess Allocat Additio Teachin Referre Module Master Master	(approx examin examin age of a ment o ion of p onal info pad ad ed to in e appea 's degro	k. 30 minutes) or nation of one candidate of ation in groups (groups ssessment: German and ffered: Once a year, wint olaces ormation e LPOI (examination regulation	of 2, approx. 30 minu l/or English ter semester ns for teaching-degree progra 16) tre Technology (2016)	tes total)	
a) talk b) oral c) oral Langua Assess Allocat Morklo 150 h Teachin Referre Master Master Master Master	(approx examin examin age of a ment o ion of p onal inf pad ng cycl ed to in e appea 's degru 's degru	 a) ominutes) or lation of one candidate of ation in groups (groups ssessment: German and ffered: Once a year, winter olaces ormation e LPO I (examination regulation regilation regulati	of 2, approx. 30 minu l/or English ter semester ns for teaching-degree progra 16) ure Technology (2016) Materials (2016)	tes total)	
a) talk b) oral c) oral Langua Assess Allocat Modulio Referre Module Master Master Master Master	(approx examin examin age of a ment o ion of p onal info pad ng cycl ed to in e appea 's degru 's degru 's degru	 a) o minutes) or nation of one candidate of ation in groups (groups ssessment: German and ffered: Once a year, winto places ormation e LPO I (examination regulation regulati	of 2, approx. 30 minu l/or English ter semester ns for teaching-degree progra 16) Ire Technology (2016) Aaterials (2016) Ire Technology (2020)	tes total)	
a) talk b) oral c) oral Langua Assess Allocat Additio Worklo 150 h Teachin Referre Master Master Master Master Master Master	(approx examin examin age of a ment o ion of p onal info pad ng cycl ed to in e appea 's degru 's degru 's degru 's degru	 a) o minutes) or nation of one candidate of ation in groups (groups ssessment: German and ffered: Once a year, winto blaces ormation e LPO I (examination regulation regulation regulation regulation at a structure of the major) Physics (202) are (1 major) Functional Mee (1 major) Nanostructure (1 major) (1 major) Nanostructure (1 major) (1 major) (1 maj	of 2, approx. 30 minu l/or English ter semester ns for teaching-degree progra 16) tre Technology (2016) Aaterials (2016) tre Technology (2020) 20)	tes total)	
a) talk b) oral c) oral Langua Assess Allocat Modditio Teachin Referre Master Master Master Master Master Master Master Master	(approx examin examin age of a ment o ion of p onal info pad ad ed to in 's degru 's degru 's degru 's degru 's degru	k. 30 minutes) or nation of one candidate of ation in groups (groups ssessment: German and ffered: Once a year, wint olaces ormation e LPO I (examination regulation ars in ee (1 major) Physics (202 ee (1 major) Nanostructu ee (1 major) Nanostructu ee (1 major) Nanostructu ee (1 major) Physics (202	of 2, approx. 30 minu l/or English ter semester ns for teaching-degree progra 16) tre Technology (2016) Aaterials (2016) tre Technology (2020) 20) rnational (2020)	tes total)	

Module title					Abbreviation	
Nonphy	/sical N	Ainor Subject			11-EXNP6-Int-201-m01	
Module	coord	inator		Module offered by		
chairpe	rson o	f examination committee		Faculty of Physics a	nd Astronomy	
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)		
6	nume	rical grade				
Duratio	n	Module level	Other prerequisites			
1 seme	ster	graduate	Approval from exam	ination committee re	equired.	
Conten	ts					
Non-teo	chnical	minor. Crediting for acad	lemic achievements,	e.g. from university	change or study abroad	
Intende	ed learn	ning outcomes				
		osseses advanced knowl cal minor subject (mathe			rements of a module in the field	
Course	S (type, n	umber of weekly contact hours, la	anguage — if other than Ger	man)		
V (3) + Module		t in: English				
		s essment (type, scope, langua; le for bonus)	ge — if other than German, e	examination offered — if no	t every semester, information on whether	
b) oral e c) oral e d) proje e) prese If a writ stead ta of asse nation	 a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 8 to 10 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an oral examination of one candidate each or an oral examination in groups. If the method of assessment is changed, the lecturer must inform students about this by four weeks prior to the original examination date at the latest. 					
Allocat		ssessment: English blaces				
Additio	nal info	ormation				
Worklo	Workload					
180 h						
Teaching cycle						
Referre	d to in	LPO I (examination regulations	s for teaching-degree progra	mmes)		
Module	appea	in in				
Master	s degre	ee (1 major) Physics Inter	national (2020)			
Master	Master's degree (1 major) Physics International (2024)					





Master Project Modules

(60 ECTS credits)

Modul	e title			Abbreviation	
Professional Specialization Physics International 11-FS-P-Int-201-m01					
Module coordinator Module offered by					
chairpe	erson o	f examination committee		Faculty of Physics a	and Astronomy
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)	
15	(not) s	successfully completed			
Duratio	on	Module level	Other prerequisites		
1 seme	ster	graduate			
Conten	Its				
					es that are of particular relevance quired underlying fundamental to
Intend	ed lear	ning outcomes			
for the	master				of relevance to the topic chosen bility to present and convey this
Course	S (type, r	number of weekly contact hours, l	anguage — if other than Gei	rman)	
S (4) Module	e taugh	t in: English			
		Sessment (type, scope, langua Ile for bonus)	ge — if other than German,	examination offered — if no	ot every semester, information on whether
		ussion (30 to 45 minutes) ssessment: English			
Allocat	ion of j	olaces			
Additio	onal inf	ormation			
Worklo	ad				
450 h					
Teachi	ng cycl	e			
Referre	ed to in	LPOI (examination regulation	s for teaching-degree progra	immes)	
Module	e appea	ars in			
Master	's degr	ee (1 major) Physics Inter	national (2020)		
Master	's degr	ee (1 major) Physics Inter	national (2024)		

Module	e title		Abbreviation		
Scienti	fic Met	hods and Project Manag	11-MP-P-Int-201-m01		
Module coordinator Module offe					red by
chairpe	erson o	f examination committee		Faculty of Ph	ysics and Astronomy
ECTS	Metho	od of grading	Only after succ. con	•	
15	(not) s	successfully completed		-	
Duratio	on	Module level	Other prerequisites		
1 seme	ster	graduate			
Conten	its				
					nning within a current experimental or plan for the planned master thesis.
Intend	ed lear	ning outcomes			
retical	researc master	h topic of relevance to th	e topic chosen for th	e master thes	ning in a current experimental or theo- is. Ability to establish a research plan l work. Ability to present the project in a
Course	S (type, r	number of weekly contact hours, l	anguage — if other than Ger	rman)	
R (4) Module	e taugh	t in: English			
		sessment (type, scope, langua le for bonus)	ge — if other than German,	examination offere	ed — if not every semester, information on whether
		ussion (30 to 45 minutes) ssessment: English			
Allocat	ion of _l	olaces			
Additio	onal inf	ormation			
Worklo	ad				
450 h					
Teachi	ng cycl	e			
Referre	ed to in	LPOI (examination regulation	s for teaching-degree progra	immes)	
Module	e appea	ars in			
Master	's degr	ee (1 major) Physics Inter	national (2020)		
Master	's degr	ee (1 major) Physics Inter	national (2024)		

Module title Abbreviation						
Master Thesis Physics International 11-MA-P-Int-201-m01						
Modul	e coord	inator		Module offered by	1	
chairpe	erson o	f examination committee	2	Faculty of Physics	and Astronomy	
ECTS	Meth	od of grading	Only after succ. con	npl. of module(s)		
30	nume	rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	graduate				
Conter	Its		• •			
		work on an experimental nd according to scientifie			ics, in particular using state-of-the	
		ning outcomes	_			
Ability	to inde				, in particular according to state-	
		number of weekly contact hours,	-	•		
Course	S (type, r	lumber of weekly contact hours,	language — If other than Gel 	man)		
module i Master	s creditab 's thes	sessment (type, scope, langua ile for bonus) is (750 to 900 hours tota ssessment: English		examination offered — if r	not every semester, information on whether	
	tion of		-			
Additio	onal inf	ormation				
Time to	o comp	lete: 6 months				
Worklo		-				
900 h						
	ng cycl	e				
	- /					
Referre	ed to in	LPOI (examination regulation	s for teaching-degree progra	immes)		
			• • •			
Modul	e appea	ars in				
		ee (1 major) Physics Inter	rnational (2020)			
Master	's degr	ee (1 major) Physics Inter	rnational (2024)			