

Subdivided 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: 2024 Responsible: Faculty of Physics and Astronomy

JMU Würzburg • generated 21-Jun-2024 • exam. reg. data record 88|j44|-|-|H|2024

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Learning Outcomes

German contents and learning outcome available but not translated yet.

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.
- 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-Sep-2023 (2023-70)

12-Jun-2024 (2024-75)

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

Master's with 1 major Physics International (2024)

The subject is divided into

Abbreviation	Module title	ECTS credits	Method of grading	pag
Electives Field (60 ECTS cr	redits)			
Subfield Physics (55 ECT	S credits)			
Advanced Laboratory C	ourses (9 ECTS credits)			
11-P-FM1-Int-201-m01	Advanced Laboratory Course Master Part 1	3	B/NB	10
11-P-FM2-Int-201-m01	Advanced Laboratory Course Master Part 2	3	B/NB	10
11-P-FM3-Int-201-m01	Advanced Laboratory Course Master Part 3	3	B/NB	11
11-P-FM4-Int-201-m01	Advanced Laboratory Course Master Part 4	3	B/NB	11
Advanced Seminar (5 E	CTS credits)			
11-0SP-A-Int-201-m01	Advanced Seminar Physics A	5	NUM	10
11-0SP-B-Int-201-m01	Advanced Seminar Physics B	5	NUM	10
Experimental Physics (to ECTS credits)			
11-BSV-Int-201-m01	Image and Signal Processing in Physics	6	NUM	5
11-OHL-Int-201-m01	Organic Semiconductors	6	NUM	10
11-PMM-Int-201-m01	Physics of Advanced Materials	6	NUM	11
11-SPI-Int-201-m01	Spintronics	6	NUM	13
11-FK2-Int-201-m01	Solid State Physics 2	8	NUM	8
11-FKS-Int-201-m01	Solid State Spectrocopy	6	NUM	8
11-MAG-Int-201-m01	Magnetism	6	NUM	9
11-HNS-Int-201-m01	Optical Properties of Semiconductor Nanostructures	6	NUM	9
11-HPH-Int-201-m01	Semiconductor Physics	6	NUM	9
11-QTR-Int-201-m01	Quantum Transport	6	NUM	12
11-QIC-Int-201-m01	Advanced Theory of Quantum Computing and Quantum Infor- mation	6	NUM	12
11-NOP-Int-201-m01	Nano-Optics	6	NUM	10
11-PTS-Int-201-m01	Phenomenology and Theory of Superconductivity	6	NUM	11
08-PCM4-161-m01	Ultrafast spectroscopy and quantum-control	5	NUM	1
11-CSFM-Int-201-m01	Advanced Topics in Solid State Physics	6	NUM	6
11-ASM-Int-201-m01	Methods of Observational Astronomy	6	NUM	4
11-TPE-Int-201-m01	Experimental Particle Physics	6	NUM	14
11-ASP-Int-201-m01	Introduction to Space Physics	6	NUM	4
11-MAS-Int-201-m01	Multi-wavelength Astronomy	6	NUM	9
11-CSAM-Int-201-m01	Advanced Topics in Astrophysics	6	NUM	6
11-MRI-Int-201-m01	Advanced Magnetic Resonance Imaging	6	NUM	10
11-SSC-Int-201-m01	Surface Science	6	NUM	13
11-BIC-Int-201-m01	Basic Imaging Concepts	6	NUM	5
11-CAP-Int-201-m01	Contemporary Astrophysics	6	NUM	5
11-AAI-Int-201-m01	Advanced Astro Imaging	6	NUM	4
11-CTA-Int-201-m01	Advanced Computer Tomography	6	NUM	6
11-EIM-Int-201-m01	Electron and Ion Microscopy	6	NUM	6
11-SPT-Int-201-m01	Scanning Probe Technologies	6	NUM	13
11-FPA-Int-201-m01	Visiting Research	10	NUM	8
11-EXE5-Int-201-m01	Current Topics in Experimental Physics	5	NUM	6

Master's with 1 major Physics International (2024)

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11-EXE6-Int-201-m01	Current Topics in Experimental Physics	6	NUM	69
11-EXE7-Int-201-m01	Current Topics in Experimental Physics	7	NUM	70
11-EXE8-Int-201-m01	Current Topics in Experimental Physics	8	NUM	71
11-EXE6A-Int-201-m01	Current Topics in Experimental Physics	6	NUM	68
11-EXP6-Int-201-m01	Current Topics in Physics	6	NUM	74
Theoretical Physics (10	ECTS credits)			
11-QM2-Int-201-m01	Quantum Mechanics II	8	NUM	123
11-TQO-Int-221-m01	Theoretical Quantum Optics	8	NUM	152
11-RTT-Int-201-m01	Theory of Relativity	6	NUM	131
11-RMFT-Int-201-m01	Renormalization Group Methods in Field Theory	8	NUM	129
11-PKS-Int-201-m01	Physics of Complex Systems	6	NUM	112
11-QIC-Int-201-m01	Advanced Theory of Quantum Computing and Quantum Infor- mation	6	NUM	121
11-TFK-Int-201-m01	Theoretical Solid State Physics	8	NUM	147
11-TFK2-Int-201-m01	Theoretical Solid State Physics 2	8	NUM	146
11-TEFK-Int-201-m01	Topological Effects in Solid State Physics	8	NUM	142
11-FFK-Int-201-m01	Field Theory in Solid State Physics	8	NUM	80
11-AKTF-Int-201-m01	Selected Topics of Theoretical Solid State Physics	6	NUM	43
11-CMS-Int-201-m01	Computational Materials Science (DFT)	8	NUM	57
11-KFT-Int-201-m01	Conformal Field Theory	6	NUM	95
11-KFT2-Int-201-m01	Conformal Field Theory 2	6	NUM	93
11-GRTM-Int-201-m01	Group Theory	6	NUM	89
11-CRP-Int-201-m01	Renormalization Group and Critical Phenomena	6	NUM	59
11-BWW-Int-201-m01	Bosonisation and Interactions in One Dimension	6	NUM	54
11-GGD-Int-201-m01	Introduction to Gauge/Gravity Duality	8	NUM	87
11-AKM-Int-201-m01	Cosmology	6	NUM	42
11-AST-Int-201-m01	Theoretical Astrophysics	6	NUM	48
11-EPP-Int-201-m01	Introduction to Plasma Physics	6	NUM	66
11-APL-Int-201-m01	High-Energy Astrophysics	6	NUM	44
	Computational Astrophysics	6	NUM	103
11-QFT1-Int-201-m01	Quantum Field Theory I	8	NUM	105
11-QFT2-Int-201-m01	Quantum Field Theory II	8	NUM	119
11-TEP-Int-201-m01	Theoretical Elementary Particle Physics	8	NUM	144
11-ATTP-Int-201-m01	Selected Topics of Theoretical Elementary Particle Physics	6	NUM	49
11-BSM-Int-201-m01	Models Beyond the Standard Model of Elementary Particle Physics	6	NUM	51
11-STRG1-Int-201-m01	String Theory 1	8	NUM	138
	String Theory 2	6	NUM	130
11-RAI-Int-211-mo1	Radio Astronomical Interferometry	6	NUM	127
11-SLQ-Int-241-mo1	Black Holes	6	NUM	133
11-TPSM-Int-211-m01	Particle Physics (Standard Model)	8	NUM	150
11-FPA-Int-201-m01	Visiting Research	10	NUM	85
11-EXT5-Int-201-m01	Current Topics of Theoretical Physics	5	NUM	75
11-EXT6-Int-201-m01	Current Topics of Theoretical Physics	6	NUM	77
11-EXT7-Int-201-m01	Current Topics of Theoretical Physics	7	NUM	78
11-EXT8-Int-201-m01	Current Topics of Theoretical Physics	8	NUM	79
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	ta record Master (120 ECTS) Physics International		page	- , - , - , - , - , - , - , - , - , - ,

11-EXT6A-Int-201-m01	Current Topics of Theoretical Physics	6	NUM	76
11-EXP6A-Int-201-m01	Current Topics in Physics	6	NUM	73
Subfield Non-Physical Mi	nors			
10-M-OML-222-m01	Optimization for Machine Learning	10	NUM	38
10-M-VAN-222-m01	Advanced Analysis	10	NUM	39
10-M=AAANin-152-m01	Applied Analysis	10	NUM	24
10-M=ADGMin-152-m01	Differential Geometry	10	NUM	25
10-M=AFTHin-152-m01	Complex Analysis	10	NUM	26
10-M=ALTHin-152-m01	Lie Theory	10	NUM	27
10-M=ATOPin-152-m01	Topology	10	NUM	28
10-M=AZTHin-152-m01	Number Theory	10	NUM	29
10-M=VGDSin-152-m01	Groups and their Representations	10	NUM	31
10-M=VGEMin-152-mo1	Geometrical Mechanics	10	NUM	32
10-M=VNPEin-152-m01	Numeric of Partial Differential Equations	10	NUM	34
10-M=VDIMin-152-m01	Discrete Mathematics	5	NUM	30
10-M=VMPHin-152-m01	Selected Topics in Mathematical Physics	10	NUM	33
10-M=VPDPin-152-m01	Partial Differential Equations of Mathematical Physics	10	NUM	35
10-M=VPRGin-152-m01	Pseudo Riemannian and Riemannian Geometry	10	NUM	36
10-I=DB-161-m01	Databases	5	NUM	13
10-l=QC-221-m01	Quantum Communications	5	NUM	16
10-I-RAK-152-m01	Computer Architecture	5	NUM	22
10-I-APR-172-m01	Advanced Programming	5	NUM	18
10-I-BS-191-m01	Operating Systems	5	NUM	20
10-l=Kl1-212-m01	Artificial Intelligence 1	5	NUM	14
08-FU-SAM-161-m01	Sensor and Actor Materials - Functional Ceramics and Magne- tic Particles	5	NUM	10
08-FU-EEW-222-m01	Electrochemical Energy Storage and Conversion	5	NUM	8
08-FU-MW-222-m01	Structure-Properties Correlations of Light Materials - Experi- ments and Numerical Simulations	5	NUM	9
11-EXNP6-Int-201-m01	Nonphysical Minor Subject	6	NUM	72
Master Project Modules (6		1	-	, –
11-FS-P-Int-201-m01	Professional Specialization Physics International	15	B/NB	86
11-MP-P-Int-201-m01	Scientific Methods and Project Management Physics Interna- tional	15	B/NB	100
11-MA-P-Int-201-m01	Master Thesis Physics International	30	NUM	98
				<u> </u>

Module	title				Abbreviation			
Electroo	chemio	al Energy Storage and Co	onversion		08-FU-EEW-222-m01			
Module	coord	inator		Module offered by				
		Chair of Chemical Techno	logy of Material Syn-		echnology of Material Synthesis			
thesis	ortife		logy of material byn	chair of chemical i	centrology of material synthesis			
ECTS	CTS Method of grading Only after succ. compl. of module(s)							
5	5 numerical grade							
Duration Module level Other prerequisites								
1 semes	ster	undergraduate						
Content	ts							
nickel n layer ca	netal h ipacito	ydride, sodium sulfur, so	dium nickel chloride el cell systems (AFC, I	, lithium ion accumu	ms like lead, nickel cadmium and Ilators), electrochemical double , SOFC), Solar cells (Si, CIS, CIGS,			
Intende	ed lear	ning outcomes						
			vledge in the field of	electrochemical ene	ergy storage and transformation			
and are	able t	o apply this to scientific p	problems.		·			
Courses	s (type	, number of weekly conta	ct hours, language —	if other than Germa	in)			
V (2) + S	• •							
		t in: German or English						
		sessment (type, scope, la on on whether module ca			tion offered — if not every seme-			
b) talk (Langua	(appro: ge of a	mination (approx. 90 min x. 30 minutes); (weightec ssessment: German and, ffered: Once a year, sum	l 65:35) /or English	ation of one candida	te each (approx. 30 minutes) and			
Allocati	ion of _l	olaces						
Additio	nal inf	ormation						
Workloa	ad							
150 h								
Teachin	ıg cycl	e						
Referre	d to in	LPOI (examination regu	lations for teaching-o	legree programmes)				
			Ŭ					
Module	appea	ars in						
		ee (1 major) Functional M	aterials (2022)					
	-	ee (1 major) Quantum Eng						
Master'	Aaster's degree (1 major) Physics International (2024)							

Modul	e title				Abbreviation	
		perties Correlations of L	ight Materials - Exper	iments and Numeri-	08-FU-MW-222-m01	
cal Sin						
Modul	e coord	inator		Module offered by		
degree tional I		mme coordinator Funkti ials)	onswerkstoffe (Func-	Chair of Chemical T	echnology of Material Synthesis	
ECTS	Methe	od of grading	Only after succ. com	pl. of module(s)		
5	nume	erical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	Its					
Materia	al prop	erties of metals and cera	mics: Structur-proper	ty relationships thro	ugh experiments and simulatior	
Intend	ed lear	ning outcomes				
and hig sented sized.	gh perfo . The re	ormance ceramics. Analy elationship of mikro- and	rtical methods and pro nanoscopic structure	edictions through nu of materials and the	erials: aviation aluminum alloys Imerical simulations will be pre- e resulting properties are empha	
Course	s (type	, number of weekly cont	act hours, language —	· if other than Germa	n)	
V (2) + Module		t in: German or English				
		sessment (type, scope, la ion on whether module o			tion offered — if not every seme	
b) talk Langua	(appro: age of a	mination (approx. 90 mi x. 30 minutes); (weighte ssessment: German and ffered: Once a year, sum	d 60:40) I/or English	ation of one candida	te each (approx. 30 minutes) and	
Allocat		*				
Additic	nal inf	ormation				
Worklo	had					
150 h		-				
Teachi	ing cycl	e				
	1					
Referre	ed to in	LPO I (examination regu	ulations for teaching-c	legree programmes)		
Modul						
	-	ee (1 major) Functional A				
	-	ee (1 major) Quantum En				
master	s aegr	ee (1 major) Physics Inte	mational (2024)			

Module	e title				Abbreviation		
Sensor	r and A	ctor Materials - Functi	onal Ceramics and Mag	netic Particles	08-FU-SAM-161-m01		
Module	e coord	inator		Module offered by	/		
			ktionswerkstoffe (Func-	· · · ·	Technology of Material Synthesis		
-	Matrier		clionswerkstone (Func-		rechnology of Material Synthesis		
ECTS							
5							
Duratio	on	Module level	Other prerequisites	6			
1 seme	ster	graduate					
Conten	its						
		ffects and application	s of sensory and actuate	ny materials such a	as piezoelectrics, shape memory		
					ological fluids, magnetofluids.		
		ning outcomes					
			ntal knowledge in the ar	ea of sensory and	actuatory materials		
		•		•			
		, number of weekly co	ntact hours, language –	- II other than Germ	idii)		
V (2) +	· · ·						
					nation offered — if not every seme		
-			e can be chosen to earn	-	didate each (approx. 20 minutes)		
P: cred Allocat		or bonus places					
Additio	onal inf	ormation					
Worklo	oad						
150 h							
Teachi	ng cvcl						
	0.7	e					
		e					
 Referre	ed to in		egulations for teaching.	degree programme	5)		
 Referre 	ed to in		egulations for teaching-o	degree programme:	s)		
		LPOI (examination re	egulations for teaching-o	degree programme	s)		
 Module	e appea	LPOI (examination re		degree programme	s)		
 Module Master	e appe a 's degr	LPOI (examination re ars in ee (1 major) Physics (2			s)		
 Module Master Master	e appe a 's degr 's degr	LPOI (examination re ars in ee (1 major) Physics (2	:016) cture Technology (2016)		s)		
 Module Master Master Master Master	e appe a ''s degr ''s degr ''s degr	LPOI (examination re ars in ee (1 major) Physics (2 ee (1 major) Nanostruc ee (1 major) Functiona ee (1 major) Nanostruc	eo16) eture Technology (2016) l Materials (2016) eture Technology (2020)		5)		
 Module Master Master Master Master Master	e appea 's degr 's degr 's degr 's degr 's degr	LPO I (examination re ars in ee (1 major) Physics (2 ee (1 major) Nanostruc ee (1 major) Functiona ee (1 major) Nanostruc ee (1 major) Physics (2	eo16) eture Technology (2016) l Materials (2016) eture Technology (2020) e020)		5)		
 Master Master Master Master Master Master	e appea 's degr 's degr 's degr 's degr 's degr 's degr	LPO I (examination re ars in ee (1 major) Physics (2 ee (1 major) Nanostruc ee (1 major) Functiona ee (1 major) Physics (2 ee (1 major) Physics In	eo16) Eture Technology (2016) I Materials (2016) Eture Technology (2020) e020) ternational (2020)		s)		
 Module Master Master Master Master Master Master	e appea d's degr d's degr d's degr d's degr d's degr d's degr d's degr	LPO I (examination re ars in ee (1 major) Physics (2 ee (1 major) Nanostruc ee (1 major) Functiona ee (1 major) Nanostruc ee (1 major) Physics (2 ee (1 major) Physics In ee (1 major) Quantum	2016) 2016) 2 ture Technology (2016) 2 l Materials (2016) 2 ture Technology (2020) 2 2 00) 2 ternational (2020) 2 Engineering (2020)		5)		
 Module Master Master Master Master Master Master Master	e apper 's degr 's degr 's degr 's degr 's degr 's degr 's degr	LPO I (examination re ars in ee (1 major) Physics (2 ee (1 major) Nanostruc ee (1 major) Functiona ee (1 major) Nanostruc ee (1 major) Physics (2 ee (1 major) Physics In ee (1 major) Quantum ee (1 major) Quantum	2016) 2016) 2 ture Technology (2016) 2 ture Technology (2020) 2020) 2 ternational (2020) 2 Engineering (2020) Technology (2021)		s)		
 Master Master Master Master Master Master Master Master	e appea ''s degr ''s degr ''s degr ''s degr ''s degr ''s degr ''s degr	LPO I (examination re ars in ee (1 major) Physics (2 ee (1 major) Nanostruc ee (1 major) Functiona ee (1 major) Nanostruc ee (1 major) Physics (2 ee (1 major) Physics In ee (1 major) Quantum	2016) 2016) 2 ture Technology (2016) 2 ture Technology (2020) 2020) 2 ternational (2020) 2 Engineering (2020) 2 Technology (2021) 2 Engineering (2024)		s)		

Module	e title			Abbreviation			
Ultrafa	st spectroscopy and quantum	-control		08-PCM4-161-m01			
Module	e coordinator		Module offered by	<u> </u>			
		Matarialian"		l and Theoretical Ch	- mictur		
	r of the seminar "Nanoskalige			l and Theoretical Ch	emistry		
ECTS	Method of grading numerical grade	Only after succ. con	ipi. of module(s)				
5							
Duratio		Other prerequisites		and all DCMah rasan	mandad		
	1 semester graduate Prior completion of modules 08-PCM1a and 08-PCM1b recommended.						
Conten							
	odule discusses advanced top ulses, time-resolved laser spe			control. It focuses o	n ultrashort		
Intende	ed learning outcomes						
plain th	ts are able to describe the ger ne theory of time-resolved lase les and applications of quantu	er spectroscopy and na					
Course	s (type, number of weekly con	tact hours, language –	- if other than Germa	ın)			
S (2) +	Ü (1)						
Module	e taught in: German or English						
	d of assessment (type, scope, formation on whether module			tion offered — if not	every seme-		
	en examination (approx. 90 m		·	date each (approx. a	o minutes)		
	lk (approx. 30 minutes)				,		
Langua	ge of assessment: German an	d/or English					
Allocat	ion of places						
Additio	onal information						
Worklo	ad						
150 h							
-							
Teachi	ng cycle						
Referre	ed to in LPO I (examination reg	gulations for teaching-o	degree programmes)				
Module	e appears in						
Master	's degree (1 major) Chemistry ((2016)					
Master	's degree (1 major) Mathemati	cs (2016)					
	's degree (1 major) Physics (20						
	's degree (1 major) Nanostruct						
	's degree (1 major) Computatio						
	's teaching degree Gymnasiun				016)		
	mentary course MINT Teacher		vetwork Bavaria (EN	Б) (2016)			
	's degree (1 major) Chemistry ('s degree (1 major) Computatio		0)				
	's degree (1 major) Mathemati		<i>YI</i>				
	's degree (1 major) Nanostruct						
	's degree (1 major) Physics (20						
	's teaching degree Gymnasiun		ion PLUS, Elite Netw	ork Bavaria (ENB) (20	020)		
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Master's wi	ith 1 major Physics International (2024)			1111. Teg. ud-	page 11 / 153		

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) 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 (2024)

Module title					Abbreviation			
Databa	Databases 10-I=DB-161-m01							
Module	coord	nator		Module offered by				
			un Calanaa)	1				
		es Informatik (Compute	ï	Institute of Comput	ter Science			
ECTS		o d of grading rical grade	Only after succ. con	npl. of module(s)				
5	L							
Duration		Module level graduate	Other prerequisites	i				
	Contents							
Relatio	nal alge	-	statements; database	planning and norma	l forms, XML data m	odelling;		
		anagement.						
		ning outcomes						
		oossess knowledge ab g in XML.	out data modelling and	l queries in SQL, trar	isactions as well as	about easy		
Course	s (type,	number of weekly cor	tact hours, language –	- if other than Germa	an)			
V (2) +	Ü (2)							
			language — if other th can be chosen to earn		ition offered — if not	every seme-		
		nation (approx. 60 to 1						
			eginning of the course,	the written examina	tion may be replace	d by an oral		
			approx. 20 minutes) or					
		es per candidate).						
		en examination for Ma						
Langua credita		ssessment: German ar	id/or English					
Allocat								
		laces						
Additio	nal inf	ormation						
			Master's programme I	nformatik (Computa	r Science 120 ECTS	crodite), SE		
IS, HCI,	, GE.					creans): SE,		
Worklo	ad							
150 h								
Teachi	ng cycl	9						
Referre	ed to in	LPOI (examination re	gulations for teaching-	degree programmes)	1			
Module	e appea	rs in						
Master	's degre	ee (1 major) Computer	Science (2016)					
	-	ee (1 major) Physics (20						
Master	's degre	ee (1 major) Digital Hur	nanities (2016)					
Master	Master's degree (1 major) Computer Science (2017)							
Master	's degre	ee (1 major) Computer	Science (2018)					
Master	's degre	ee (1 major) Physics (20	020)					
	-	ee (1 major) Physics Int						
	-	ee (1 major) Quantum E						
Master	's degre	ee (1 major) Quantum E	Ingineering (2024)					
Master	's degre	ee (1 major) Physics Int	ernational (2024)					
Master's wi	ith 1 major	Physics International (2024)	-	• generated 21-Jun-2024 • ex r (120 ECTS) Physics Internat	-	page 13 / 153		

Module title					Abbreviation			
Artific	ial Intelli	gence 1			10-l=Kl1-212-m01			
Modul	le coordii	nator		Module offered by				
holder	r of the Cl	hair of Computer Scier	nce VI	Institute of Comput	er Science			
ECTS		d of grading	Only after succ. compl. of module(s)					
5		cal grade						
Durati		Module level	Other prerequisites					
	1 semester graduate							
Conte								
			euristic search, constra		, search with partial	information,		
		ing outcomes	d inference, knowledge	representation.				
			d practical knowledge a	about artificial intelli	gence in the area of	agents		
	•		ess possible applicatio			agents,		
Course	es (type,	number of weekly con	tact hours, language –	- if other than Germa	ın)			
V (2) +	- Ü (2)							
			language — if other th can be chosen to earn		ition offered — if not	every seme-		
		ation (approx. 60 to 12						
			eginning of the course,	the written examina	tion may be replace	d by an oral		
			approx. 20 minutes) or					
		s per candidate).			0			
	able for b							
Langu	age of as	sessment: German an	d/or English					
Alloca	tion of pl	aces						
Additi	onal info	rmation						
Focuse AT,SE,		ble for students of the	Master's programme I	nformatik (Compute	r Science, 120 ECTS (credits):		
Workl								
150 h								
Teach	ing cycle							
Referr	ed to in L	.POI (examination reg	gulations for teaching-	degree programmes)				
Modul	le appear	rs in						
Maste	r's degre	e (1 major) Computer S	Science (2021)					
	-		Computer Science (20					
	-		onal Mathematics (202	22)				
	-	e (1 major) Informatio	•					
	-	e (1 major) Mathemati						
	-	e (1 major) Computer S	-					
	-		Computer Science (20	23)				
	-	e (1 major) Quantum E						
	-	e (1 major) Physics Int	•					
	-		onal Mathematics (202	24)				
IMaste	a s aegre	e (1 major) Mathemati	cs (2024)					
Master's v	with 1 major F	Physics International (2024)	-	• generated 21-Jun-2024 • exa r (120 ECTS) Physics Internati	-	page 14 / 153		



Master's degree (1 major) Information Systems (2024)

Module title			Abbreviation					
Quanti	um Communications			10-l=QC-221-m01				
Modul	e coordinator		Module offered by					
	of the Chair of Computer Scien		Institute of Comput	er Science				
ECTS	Method of grading	Only after succ. compl. of module(s)						
5 numerical grade								
Duratio		Other prerequisites	;					
	1 semester graduate							
	Contents							
	 Introduction Hilbert Spaces and Operators Quantum Mechanics Quantum States Quantum Circuit Elements Entanglement and Its Applications Quantum Key Distribution Quantum Channel Quantum Error Correction Coding Continuous-Variable Quantum Communications Further Topics 							
Intend	ed learning outcomes							
• • g • c • c • c • c • c • c • c • c • c • c		ments, ions using quantum uch as quantum telep and decoherence in	mechanics, includin portation, superdens quantum communic	g protocols like Quantum Key se coding and error correction, ations and learn strategies to				
Modul	e taught in: English							
	d of assessment (type, scope, la formation on whether module of			tion offered — if not every seme-				
lf anno examir prox. 1 Langua	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: English creditable for bonus							
Allocat	tion of places							
Additio	onal information							
Focuse	es available for students of the I	Master's programme I	nformatik (Computer	r Science, 120 ECTS credits): LR				
Worklo		P 0.000		,				
150 h								
	ng cycle							
reacili								

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

Module appears in

Master's degree (1 major) Computer Science (2021) Master's degree (1 major) Computer Science (2023) Master's degree (1 major) Aerospace Computer Science (2023) Master's degree (1 major) Quantum Engineering (2024) Master's degree (1 major) Physics International (2024) Master's degree (1 major) Computational Mathematics (2024) Master's degree (1 major) Mathematics (2024)

Module title					Abbreviation	
Advand	ed Pro	gramming		-	10-I-APR-172-m01	
Module	e coord	inator		Module offered by		
				Institute of Computer Science		
		Chair of Computer Scier	Ĩ.		erScience	
ECTS						
5	<u> </u>					
Duratio	·	Module level	Other prerequisites			
1 seme		undergraduate				
Conten						
		ledge of basic program				
		complex problems are licates occur. In this lea				
		structure. Also, further				
cussed				Security and	paratter programmi	
Intend	ed learr	ning outcomes				
Studen	its learr	advanced programmi	ng paradigms especial	ly suited for space a	oplications. Differen	t patterns are
		nted in multiple langua				
allel pr	ocessir	ig concepts are introdu	ced culminating in the	use of GPU architect	tures for extremely q	uick proces-
sing.						
		number of weekly con	tact hours, language –	- if other than Germa	n)	
V (2) +	Ü (2)					
		essment (type, scope,			tion offered — if not	every seme-
		on on whether module		a bonus)		
		ation (approx. 60 to 12				
		by the lecturer at the be				
		f one candidate each (a es per candidate).	approx. 20 minutes) of		i ili gloups ol 2 callu	iuales (ap-
		ssessment: German an	d/or English			
	ble for		, 0			
Allocat	ion of p	olaces				
Additio	onal info	ormation				
Worklo	ad					
150 h						
-	ng cycl	a				
	is cycl	•				
Referre	ed to in	LPOI (examination reg		degree programmes)		
				<u> </u>		
Module	e appea	rs in				
		ree (1 major) Computer	Science (2017)			
	-	ree (1 major) Computer				
		s (Bachelor) Computer				
Master	's degre	ee (1 major) Nanostruct	ure Technology (2020)			
Master	's degre	ee (1 major) Physics (20	020)			
Master	's teacł	ning degree Gymnasiun	n MINT Teacher Educat	ion PLUS, Elite Netw	ork Bavaria (ENB) (2	020)
		y course MINT Teacher				
	-	ree (1 major) Business I	nformation Systems (2	2020)		
Master's w	ith 1 major	Physics International (2024)	-	9 generated 21-Jun-2024 • exa r (120 ECTS) Physics Internati	-	page 18 / 153

Master's degree (1 major) Physics International (2020) Master's degree (1 major) Quantum Engineering (2020) Bachelor' degree (1 major) Computer Science und Sustainability (2021) Master's degree (1 major) Quantum Technology (2021) Bachelor' degree (1 major) Business Information Systems (2021) Bachelor' degree (1 major) Artificial Intelligence and Data Science (2022) Bachelor' degree (1 major) Artificial Intelligence and Data Science (2023) Bachelor' degree (1 major) Business Information Systems (2023) Bachelor' degree (1 major) Business Information Systems (2023) Master's degree (1 major) Quantum Engineering (2024) Master's degree (1 major) Physics International (2024) Bachelor' degree (1 major) Business Information Systems (2024) Bachelor' degree (1 major) Artificial Intelligence and Data Science (2024) Bachelor' degree (1 major) Digital Business & Data Science (2024)

Module title					Abbreviation		
Operat	Operating Systems 10-I-BS-191-m01						
Modul	e coord	inator		Module offered by			
holder	of the (Chair of Computer Scier	nce II	Institute of Comput	er Science		
ECTS	1	od of grading	Only after succ. con	· · · · · · · · · · · · · · · · · · ·			
5		rical grade		• • • •			
Duratio	on	Module level	Other prerequisites				
1 seme	ester	undergraduate					
Conter	nts						
Introduction to computer systems, development of operating systems, architecture principles, interrupt proces-							
		ing systems, processes nt, device and file man			tion and communica	ation, memo-	
Intend	ed lear	ning outcomes					
The stu	udents (oossess knowledge an	d practical skills in bui	ding and using esse	ntial parts of operati	ing systems.	
		, number of weekly con	<u> </u>		· · ·		
V (2) +		, <u>.</u>					
		t in: English					
		sessment (type, scope, on on whether module			tion offered — if not	every seme-	
		nation (approx. 60 to 12					
		by the lecturer at the b		the written examina	tion may be replaced	d by an oral	
		of one candidate each (
		es per candidate).					
		ssessment: German an	id/or English				
	ble for						
Allocal	tion of p	Jaces					
Additio	onal inf	ormation					
Worklo							
	au						
150 h							
Teachi	ng cycl	e					
Referre	ed to in	LPOI (examination reg	gulations for teaching-	degree programmes)			
Modul	e appea	ars in					
	-	ree (1 major) Computer					
	-	ee (1 major) Nanostruct					
	-	ee (1 major) Physics (20					
	-	ree (1 major) Business	•	2020)			
	-	ee (1 major) Physics Int					
	-	ee (1 major) Quantum E ree (1 major) Aerospace		220)			
	-	ree (1 major) Aerospace ree (1 major) Computer	•				
	-	ee (1 major) Quantum T		5 mily (2021)			
	-	ree (1 major) Business		2021)			
	-	ree (1 major) Artificial I	•				
Master's	ith 1 maio	Physics International (2024)	IMI Mürzburg	• generated 21-Jun-2024 • exa	am reg da.	page 20 / 153	
muster 5 W	ini i maju	r nysics international (2024)	-	r (120 ECTS) Physics Internati	-	puge 20 / 153	

Julius-Maximilians-UNIVERSITÄT WÜRZBURG

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

Modul	e title				Abbreviation	
Compu	uter Arch	itecture			10-I-RAK-152-m01	
Modul	e coordi	nator		Module offered by		
Dean c	of Studie	s Informatik (Compute	er Science)	Institute of Comput	ter Science	
ECTS	Metho	d of grading	Only after succ. cor	npl. of module(s)		
5	numer	ical grade				
Durati	on	Module level	Other prerequisites	i		
1 seme	ester	undergraduate				
Conter	nts					
		architectures, comma ector processors, mult	nd processing through i-core processors.	pipelining, statical	and dynamic instruc	tion schedu-
Intend	ed learn	ing outcomes				
		naster the most impor operating systems.	tant techniques to desi	gn fast computers a	s well as their intera	ction with
			itact hours, language –	- if other than Germa	an)	
V (2) +		,			,	
			language — if other th can be chosen to earn		ition offered — if not	every seme-
lf anno examir prox. 1 Langua	ounced b nation of 5 minute	f one candidate each (es per candidate). ssessment: German ar	eginning of the course, approx. 20 minutes) or			
	tion of p					
Additi	onal info	ormation				
Worklo	oad					
150 h						
	ng cycle	1				
Referre	ed to in	LPOI (examination re	gulations for teaching-	degree programmes)		
	Nr. 3 b)		0			
-		Rechnerarchitektur				
Modul	e appea	rs in				
Bachel Bachel First st Master Master Bachel Bachel Bachel	lor' degr lor' degr lor' degr cate exar r's degre r's teach lor' degr lor' degr lor' degr	ee (1 major) Aerospac nination for the teach e (1 major) Physics (2 ing degree Gymnasiur	tics (2015) ional Mathematics (20 e Computer Science (20 ng degree Gymnasium 016) n MINT Teacher Educat e Computer Science (20 Science (2017) Science (2019)	o15) Computer Science (ion PLUS, Elite Netw	-	016)
Master's w	vith 1 major	Physics International (2024)		• generated 21-Jun-2024 • ex r (120 ECTS) Physics Internat	-	page 22 / 153

Julius-Maximilians-UNIVERSITÄT WÜRZBURG

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' degree (1 major) Aerospace Computer Science (2020) Bachelor' degree (1 major) Computer Science und Sustainability (2021) Bachelor' degree (1 major) Artificial Intelligence and Data Science (2022) Bachelor' degree (1 major) Artificial Intelligence and Data Science (2023) Bachelor' degree (1 major) Mathematics (2023) Master's degree (1 major) Physics International (2024) Bachelor' degree (1 major) Artificial Intelligence and Data Science (2024)

Modul					Abbreviation
	d Analy				10-M=AAANin-152-m01
Modul	e coord	inator		Module offered by	
		es Mathematik (Mathema		Institute of Mathem	atics
ECTS		od of grading	Only after succ. con	pl. of module(s)	
10		rical grade			
Duratio	-	Module level	Other prerequisites		
1 seme	_	graduate			
Conter					
theory particu theory	of Hilbe Ilar FEM of ellip	ert spaces and Fourier an methods), principles of	alysis, spectral theor functional analysis, f	y and quantum mecl unction spaces, emb	partial differential equations, nanics, numerical methods (in pedding theorems, compactness, othods from functional analysis.
		h the contents of the mod	dule "Functional Ana	lysis" is strongly reco	ommended.
Intend	ed learı	ning outcomes			
to esta	ablish a	•	her acquired skills a		f higher analysis. He/She is able f mathematics and questions in
Course	es (type	, number of weekly conta	ct hours, language —	- if other than Germa	n)
V (4) + Module		t in: English			
		essment (type, scope, la on on whether module ca			tion offered — if not every seme-
(appro Assess Langua	ox. 20 m sment o	inutes) or c) oral examina ffered: In the semester in ssessment: English	ation in groups (grou	ps of 2, 15 minutes p	
Allocat	tion of p	olaces			
Additio	onal inf	ormation			
Worklo	oad				
300 h					
Teachi	ing cycl	e			
Referre	ed to in	LPOI (examination regu	lations for teaching-o	degree programmes)	
Modul	e appea	irs in			
Master	r's degr	ee (1 major) Mathematics	International (2015)		
	-	ee (1 major) Physics Inter			
	-	ee (1 major) Mathematics			
	-	ee (1 major) Mathematics			
master	i s uegr	ee (1 major) Physics Inter	national (2024)		

Modul	e title				Abbreviation
		eometry			10-M=ADGMin-152-m01
Modul	e coord	inator		Module offered by	
Dean c	of Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics
ECTS		od of grading	Only after succ. com	pl. of module(s)	
10	nume	rical grade			
Duratio	on	Module level	Other prerequisites		
1 seme	ester	graduate			
Conter	nts				
Centra folds.	l and a	dvanced results in differe	ntial geometry, in pa	rticular about differe	ntiable and Riemannian mani-
Basic k	knowled	d previous knowledge: dge from the modules "In is" is recommended.	troduction to Differen	itial Geometry", "Inti	roduction to Topology" and "Geo-
Intend	ed lear	ning outcomes			
		•			lds or Riemannian manifolds, is al methods in differential geome-
Course	es (type	, number of weekly conta	ct hours, language —	· if other than Germa	ın)
V (4) + Modul		t in: English			
		sessment (type, scope, la ion on whether module ca			tion offered — if not every seme-
(appro Assess Langua	x. 20 m sment o	inutes) or c) oral examina iffered: In the semester in issessment: English	ation in groups (group	os of 2, 15 minutes p	
Allocat	tion of	places			
Additio	onal inf	ormation			
Worklo	bad				
300 h	-				
-	ng cycl	e			
Referre	ed to in	LPOI (examination regu	lations for teaching-	legree programmes)	
Modul	e appea	ars in			
		ee (1 major) Mathematics	International (2015)		
	-	ee (1 major) Physics Inter			
	-	ee (1 major) Mathematics			
Master	r's degr	ee (1 major) Mathematics	International (2022)		
Master	r's degr	ee (1 major) Physics Inter	national (2024)		

Module	e title				Abbreviation
Comple					10-M=AFTHin-152-m01
Module	e coord	inator		Module offered by	
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics
ECTS	1	od of grading	Only after succ. com	pl. of module(s)	
10	nume	rical grade			
Duratio		Module level	Other prerequisites		
1 seme	ster	graduate			
Conten	its				
geome ons (e. Recom	tric me g. ellip mende		es of families of hold	omorphic and merom	ions with modern analytic and orphic functions. Special functi- is" is recommended.
		ning outcomes	-	, , ,	
The stu ticular	ident is the (ge	acquainted with the fund	ties of holomorphic f	unctions. He/She is	f higher complex analysis, in par- able to establish a connection ations in other subjects.
Course	s (type	, number of weekly conta	ct hours, language —	· if other than Germa	n)
V (4) + Module		t in: English			
		sessment (type, scope, la ion on whether module ca			tion offered — if not every seme-
(appro Assess	x. 20 m ment o age of a	inutes) or c) oral examina iffered: In the semester in issessment: English	ation in groups (group	os of 2, 15 minutes p	
Allocat	ion of	places			
Additio	onal inf	ormation			
Worklo	ad				
300 h					
Teachi	ng cycl	e			
Referre	ed to in	LPOI (examination regu	lations for teaching-o	legree programmes)	
		U		<u> </u>	
Module	e appea	ars in			
		ee (1 major) Mathematics	International (2015)		
	-	ee (1 major) Physics Inter			
	-	ee (1 major) Mathematics			
	-	ee (1 major) Mathematics			
Master	's degr	ee (1 major) Physics Inter	national (2024)		

Module	e title				Abbreviation
Lie The	eory				10-M=ALTHin-152-m01
Module	e coord	inator		Module offered by	
Dean o	f Studi	es Mathematik (Mathema	atics)	Institute of Mathem	natics
ECTS	1	od of grading	Only after succ. com	pl. of module(s)	
10	I	rical grade			
Duratio		Module level	Other prerequisites		
1 seme	ster	graduate			
Conten					
examp Recom Basic k	les, app mende nowleo d. Furth	olications, e.g. in physics d previous knowledge: lge of the contents of the	s and control theory. modules "Functiona	l Analysis" and "Intro	ssification of Lie algebras, classic oduction to Topology" is recom- tion to Differential Geometry" is
		ning outcomes			
The stu	ident is hese to	acquainted with the fun			in Lie theory. He/She is able to eory, analysis, topology and line-
Course	s (type	, number of weekly conta	ct hours, language —	if other than Germa	n)
V (4) + Module		t in: English			
		sessment (type, scope, la ion on whether module ca			tion offered — if not every seme-
(approz Assess Langua	x. 20 m ment o	inutes) or c) oral examina ffered: In the semester in ssessment: English	ation in groups (group	os of 2, 15 minutes p	
Allocat	ion of _l	olaces			
Additio	onal inf	ormation			
Worklo	ad				
300 h			,		
_	ng cycl	e			
	0 .)	-			
Referre	ed to in	LPOI (examination regu	lations for teaching-o	legree programmes)	
Module	e appea	ars in			
		ee (1 major) Mathematics	International (2015)		
	-	ee (1 major) Physics Inter			
Master	's degr	ee (1 major) Mathematics	International (2021)		
1	-	ee (1 major) Mathematics			
Master	's degr	ee (1 major) Physics Inter	national (2024)		

Module	e title				Abbreviation
Topolo	gy				10-M=ATOPin-152-m01
Module	e coord	inator		Module offered by	
Dean of	f Studie	es Mathematik (Mathema	atics)	Institute of Mathem	natics
ECTS		od of grading	Only after succ. com	pl. of module(s)	
10	nume	rical grade			
Duratio	n	Module level	Other prerequisites		
1 seme	ster	graduate			
Conten	ts				
		opology, topological inva ing spaces.	ariants (e. g. fundame	ental group, connect	ion), construction of topological
Intende	ed learı	ning outcomes			
		acquainted with the funnon problems.	damental results, the	orems and methods	in topology and is able to apply
Course	s (type	, number of weekly conta	ct hours, language —	if other than Germa	n)
V (4) + Module		t in: English			
		s essment (type, scope, la on on whether module ca			tion offered — if not every seme-
(approx Assess	k. 20 m ment o ge of a	inutes) or c) oral examina ffered: In the semester in ssessment: English	ation in groups (group	os of 2, 15 minutes p	
Allocat	ion of p	olaces			
Additio	nal inf	ormation			
Worklo	ad				
300 h					
Teachir	ng cycl	e			
Referre	d to in	LPOI (examination regu	lations for teaching-d	legree programmes)	
Module	e appea	irs in			
Master Master Master	's degro 's degro 's degro	ee (1 major) Mathematics ee (1 major) Physics Inter ee (1 major) Mathematics ee (1 major) Mathematics ee (1 major) Physics Inter	national (2020) 5 International (2021) 5 International (2022)		

Modul	e title				Abbreviation
Numbe	er Theo	ry			10-M=AZTHin-152-m01
Modul	e coord	inator		Module offered by	
Dean c	of Studi	es Mathematik (Mathema	atics)	Institute of Mathem	atics
ECTS		od of grading	Only after succ. com	npl. of module(s)	
10	nume	rical grade			
Duratio	on	Module level	Other prerequisites		
1 seme	ester	graduate			
Conter	nts				
applica overvie Recom	ations t ew of th mende	o prime number distribut e development of moder d previous knowledge:	ion and diophantine n number theory.	equations; discussion	ducts, their analytic theory with on of the Riemann hypothesis, uired in the modules "Introducti-
		', "Introduction to Numbe			
Intend	ed lear	ning outcomes			
structu	ires in r	•	methods for the sol		neory, can deal with algebraic equations. He/She has insight
Course	es (type	, number of weekly conta	ct hours, language —	- if other than Germa	n)
V (4) + Module		t in: English			
		sessment (type, scope, la ion on whether module ca			tion offered — if not every seme-
(appro Assess Langua	x. 20 m sment o	inutes) or c) oral examina ffered: In the semester in ssessment: English	ation in groups (group	ps of 2, 15 minutes p	
Allocat	tion of	places			
Additio	onal inf	ormation			
Worklo	bad				
300 h					
Teachi	ng cycl	e			
Referre	ed to in	LPO I (examination regu	lations for teaching-o	degree programmes)	
Modul	e appea	ars in			
Master	r's degr	ee (1 major) Mathematics	International (2015)		
	-	ee (1 major) Physics Inter			
	-	ee (1 major) Mathematics			
	-	ee (1 major) Mathematics			
master	s aegr	ee (1 major) Physics Inter	national (2024)		

Discret	e title				Abbreviation
Distret	te Math	ematics			10-M=VDIMin-152-m01
Module	e coord	inator		Module offered by	
		es Mathematik (Mathem	atics)	Institute of Mathem	natics
ECTS	1	od of grading	Only after succ. con		latics
5	1	rical grade			
Duratio		Module level	Other prerequisites		
1 seme		graduate			
Conten		3.44440	1		
graph t Recom	theory of mende	thods and results in a se or combinatorics) d previous knowledge: lge of the contents of the			coding theory, cryptography,
		ning outcomes			natics is required.
		acquainted with advand	ced results in a select	ed topic in discrete r	mathematics.
		, number of weekly conta		•	
		, number of weekly conta	act nours, language –		
V (3) + Module		t in: English			
Method	d of ass	_			tion offered — if not every seme-
					mination of one candidate each
(approx Assess Langua	x. 15 mi ment o age of a	ffered: In the semester in ssessment: English	ation in groups (group	os of 2, approx. 10 m	inutes per candidate)
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		bonus			
credital Allocat		bonus			
Allocat	ion of _l	bonus blaces			
Allocat	ion of _l	bonus			
Allocat	ion of j onal inf	bonus blaces			
Allocat Additio 	ion of j onal inf	bonus blaces			
Allocat Additio Worklo	ion of j onal inf oad	bonus blaces ormation			
Allocat Additio Worklo 150 h	ion of j onal inf oad	bonus blaces ormation			
Allocat Additio Worklo 150 h Teachir	ion of j onal inf oad ng cycl	bonus blaces ormation	ulations for teaching-o	legree programmes)	
Allocat Additio Worklo 150 h Teachir	ion of j onal inf oad ng cycl	bonus olaces ormation e	ulations for teaching-o	legree programmes)	
Allocat Additio Worklo 150 h Teachir	ion of p onal inf oad ng cycl ed to in	bonus blaces ormation e LPOI (examination regu	ulations for teaching-o	legree programmes)	
Allocat Additio 150 h Teachir Referre Module	ion of p onal inf oad ng cycl ed to in e appea	bonus blaces ormation e LPOI (examination regu		legree programmes)	
Allocat Additio Worklo 150 h Teachir Referre Module	ion of j onal inf oad ng cycl ed to in e appea	bonus places ormation e LPO I (examination regu	s International (2015)	legree programmes)	
Allocat Additio Worklo 150 h Teachin Referre Master Master Master	cion of j onal inf oad ng cycl ed to in e appea 's degr 's degr	bonus places ormation e LPO I (examination regu urs in ee (1 major) Mathematic	s International (2015) rnational (2020)	legree programmes)	
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Allocati Additio Worklo 150 h Teachin Referre Module Master' Master' Master'	ion of p onal inf oad ng cycl ed to in e appea 's degr 's degr 's degr	bonus places ormation e LPO I (examination regulation regulation ee (1 major) Mathematic ee (1 major) Physics Inte ee (1 major) Quantum En	s International (2015) rnational (2020) gineering (2020) s International (2021)		
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Module t	title				Abbreviation
Groups a	and th	eir Representations			10-M=VGDSin-152-m01
Module	coord	inator		Module offered by	
		es Mathematik (Mathema	atics)	Institute of Mathem	atics
		od of grading	Only after succ. com		-
		rical grade		• • • •	
Duration	1	Module level	Other prerequisites		
1 semest	er	graduate			
Contents	5				
the S-rin	gs of S		er theory of finite grou	ups, interrelations a	nd special techniques such as
	owled	lge of algebra is assume	d, such as can be acq	uired in the module	s "Introduction to Algebra" and
		ning outcomes			
					the ability to work on contempo- y his/her skills to complex pro-
Courses	(type,	number of weekly conta	ct hours, language —	if other than Germa	n)
V (4) + Ü Module t	• •	t in: English			
		essment (type, scope, la on on whether module c			tion offered — if not every seme-
(approx. Assessm	20 m ient o e of a	inutes) or c) oral examin ffered: In the semester ir ssessment: English	ation in groups (group	os of 2, 15 minutes p	
Allocatio					
Addition	al info	ormation	·		
Workloa	d				
300 h					
Teaching	g cycle	9			
Referred	to in	LPOI (examination regu	lations for teaching-c	legree programmes)	
Module a	appea	rs in			
		ee (1 major) Mathematics	International (2015)		
	-	ee (1 major) Physics Inter			
	-	ee (1 major) Mathematics			
	-	ee (1 major) Mathematics			
waster's	aegre	ee (1 major) Physics Inter	national (2024)		

Geometrical Mechanics 10-M=VGEMin-152-m01 Module coordinator Module offered by Institute of Mathematik (Mathematics) Institute of Mathematics ECTS Method of grading Only after succ. compl. of module(s) 10 numerical grade Duration Module level Other prerequisites 1 semester graduate Contents The module builds on the topics covered in module no-M=ADGM and discusses these in more detail: symplec: tite geometry, cotangent bundles and other examples of symplectic manifolds, symmetries and Noether theore phase space reduction, nomal forms, introduction to Poolson 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. Knowlege of theoretical mechanics can also be useful. Intended learning utcomes	Modul	e title				Abbreviation
Dean of Studies Mathematik (Mathematics) Institute of Mathematics ECTS Method of grading Only after succ. compl. of module(s) 10 numerical grade Duration Module level Other prerequisites 1 semester graduate Contents The module builds on the topics covered in module to-M=ADGM and discusses these in more detail: symplectic geometry, cotangent bundles and other examples of symplectic manifolds, symmetries and Noether theore phase space reduction, normal forms, introduction to Poisson geometry. Recommended previous knowledge: Advanced knowledge of the contents of the module "Introduction to Topology" is also recommended. Knowle ge of theoretical mechanics can also be useful. Intended learning outcomes The student is acquainted with selected advanced applications of differential geometry to geometric mechanic mad questions in physics. Courses (type, number of weekly contact hours, language — if other than German, examination offered — if not every sem ster, information on whether module can be chosen to earn a bonus) a) written examination (approx. 90 to 120 minutes, usually chosen) or b) oral examination of one candidate ac (approx. 20 in tage shows on the subsequent semester Language of assessment : English Method of assessment : English Altoration of places <td< th=""><th>Geome</th><th>etrical N</th><th>Aechanics</th><th></th><th></th><th>10-M=VGEMin-152-mo1</th></td<>	Geome	etrical N	Aechanics			10-M=VGEMin-152-mo1
Dean of Studies Mathematik (Mathematics) Institute of Mathematics ECTS Method of grading Only after succ. compl. of module(s) 10 Inumerical grade Duration Module level Other prerequisites 1 semester graduate Contents The module builds on the topics covered in module 10-M=ADGM and discusses these in more detail: symplectic geometry, cotangent bundles and other examples of symplectic manifolds, symmetries and Noether theore phase space reduction, normal forms, introduction to Poisson geometry. Recommended previous knowledge: Advanced knowledge of the contents of the module "Introduction to Topology" is also recommended. Knowlege of the contents of the module "Introduction to Topology" is also recommended. Knowlege of theoretical mechanics can also be useful. Intended learning outcomes The student is acquainted with selected advanced applications of differential geometry to geometric mechanic mad questions in physics. Courses (type, number of weekly contact hours, language — if other than German, examination offered — if not every sem ster, information on whether module can be chosen to earn a bonus) a) written examination (approx. 90 to 20 minutes, usually chosen) or b) oral examination of one candidate ea (approx. 20 minutes) or c) oral examination in groups (groups of 2, 15 minutes per candidate) Assessment Offered: In the semester in which the course is offered and in the s	Modul	e coord	inator		Module offered by	<u> </u>
ECTS Method of grading Only after succ. compl. of module(s) 10 numerical grade - Duration Module level Other prerequisites 1 semester graduate - Contents - - Contents - - The module builds on the topics covered in module 10-M=ADGM and discusses these in more detail: symplec: - ic geometry, cotangent bundles and other examples of symplectic manifolds, symmetries and Noether theore - 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. Knowlege of the contents of a sus full. Intended learning outcomes - The student is acquainted with selected advanced applications of differential geometry to geometric mechanic Hey/She is able to establish a connection between his/her acquired skills and other branches of mathematics and questions in physics. Courses (type, number of weekly contact hours, language – if other than German, examination offered – if not every sem ster, information on whether module can be chosen to earn a bonus) a) written examination (approx. 90 to 120 minutes, usually chosen) or b)				ematics)	· · ·	natics
10 numerical grade - Duration Module level Other prerequisites 1 semester graduate Contents The module builds on the topics covered in module 10-M=ADGM and discusses these in more detail: symplectic geometry, cotangent bundles and other examples of symplectic manifolds, symmetries and Noether theore 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. Knowle ge of the ortical mechanics can also be useful. Intended learning outcomes The student is acquainted with selected advanced applications of differential geometry to geometric mechanic He/She is able to estabilish a connection between his/her acquired skills and other branches of mathematics and questions in physics. Courses (type, number of weekly contact hours, language — if other than German, examination offered — if not every sem ster, information on whether module can be chosen to earm a bonus! Adduct aught in: English Method of assessment (type, scope, language — if other than German, examination of one candidate ea (approx. 20 to 120 cm inutes, usually chosen) or b) oral examination of one candidate ea (approx. 20 to 120 cm inutes, ousually chosen) or b) oral examination for proxes to the course is offered and in the subse		1		<u></u>		
Duration Module level Other prerequisites 1 semester graduate	_					
1 semester graduate	Durati			Other prerequisites		
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The student is acquainted with selected advanced applications of differential geometry to geometric mechanic He/She is able to establish a connection between his/her acquired skills and other branches of mathematics and questions in physics. Courses (type, number of weekly contact hours, language — if other than German) V (4) + Û (2) Module taught in: English Method of assessment (type, scope, language — if other than German, examination offered — if not every sem ster, information on whether module can be chosen to earn a bonus) a) written examination (approx. 90 to 120 minutes, usually chosen) or b) oral examination of one candidate ea (approx. 20 minutes) or c) oral examination in groups (groups of 2, 15 minutes per candidate) Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: English creditable for bonus Allocation of places Additional information Workload 300 h Teaching cycle Referred to in LPO 1 (examination regulations for teaching-degree programmes) Module appears in Master's degree (1 major) Mathematics International (202) Master's degree (1 major) Mathematics International (2020) Master's degree (1 major) Mathematics International (2021)	-					
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Module	e title				Abbreviation
Selecte	ed Topi	cs in Mathematical Phys	ics		10-M=VMPHin-152-m01
Module	e coord	inator		Module offered by	
		es Mathematik (Mathema	atics)	Institute of Mathem	atics
ECTS		od of grading	Only after succ. com		
10		rical grade			
Duratio	on	Module level	Other prerequisites		
1 seme		graduate			
Conten	ts				
terial s Recom Depend	ciences mende ding on	, geometric field theory, d previous knowledge: the content, basic and a	advanced topics in q dvanced knowledge	uantum theory.	iid dynamics, mathematical ma- of analysis is required. In case of
		commended to consult th	e lecturer.		
		ning outcomes			
					She is able to establish a and questions in physics.
		, number of weekly conta			
V(4) +		, number of weekly collid	ici nours, ianguage —		ui <i>)</i>
		t in: English			
		-	nguage — if other the	an German, examina	tion offered — if not every seme-
		on on whether module ca			and shored in hor every sellie
(approx Assess Langua	x. 20 m ment o	inutes) or c) oral examina ffered: In the semester in ssessment: English	ation in groups (group	os of 2, 15 minutes p	
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	d to in	LPOI (examination regu	lations for toaching a	lagraa programmac)	
Neiene			tations for teaching-t		
 Moduli	e appea	rc in			
		ee (1 major) Mathematics	International (2015)		
	-	ee (1 major) Physics Inter			
	-	ee (1 major) Mathematics			
	-	ee (1 major) Mathematics			
	-	ee (1 major) Physics Inter			
master	Jucgh				

	e title				Abbreviation
Numer	ic of Pa	rtial Differential Equatio	ns		10-M=VNPEin-152-m01
Modul	e coord	inator		Module offered by	
Dean o	of Studi	es Mathematik (Mathema	atics)	Institute of Mathen	natics
ECTS		od of grading	Only after succ. con		
10		rical grade			
Duratio	on	Module level	Other prerequisites		
1 seme		graduate			
Conten	nts	<u> </u>	,		
(numer discon Recom	rical me tinuous mende	ethods for elliptic, parabo 5 Gelerkin finite elements d previous knowledge:	olic and hyperbolic pa s method, finite differ	artial differential equ ences and finite vol	finite elements, error estimates uations; finite elements method ume methods). equations, such as can be acqui
		dules "Introduction to Fu			
		ning outcomes			
The stu	udent is	acquainted with advance	ed methods for discr	etising partial differ	ential equations.
Course	es (type	, number of weekly conta	act hours, language –	- if other than Germa	an)
V (4) + Module	• •	t in: English			
mouule					
Motho	d of acc	coccmont (tuno scono la	if other the	an Corman oxamina	ation offered if not even com
		sessment (type, scope, la ion on whether module c			ation offered — if not every seme
ster, in a) writt (approz Assess Langua	iformati ten exa x. 20 m sment o	ion on whether module c mination (approx. 90 to 1 inutes) or c) oral examin ffered: In the semester ir ssessment: English	an be chosen to earn 20 minutes, usually ation in groups (grou	a bonus) chosen) or b) oral ex ps of 2, 15 minutes p	camination of one candidate eac oer candidate)
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ster, in a) writt (appro: Assess Langua credita Allocat	iformati ten exa x. 20 m sment o age of a ible for tion of j	ion on whether module c mination (approx. 90 to 1 inutes) or c) oral examin ffered: In the semester in ssessment: English bonus blaces	an be chosen to earn 20 minutes, usually ation in groups (grou	a bonus) chosen) or b) oral ex ps of 2, 15 minutes p	camination of one candidate eac oer candidate)
ster, in a) writt (appro: Assess Langua credita Allocat Additic Worklo 300 h	iformati ten exa x. 20 m sment o age of a ible for tion of j	ion on whether module c mination (approx. 90 to 1 inutes) or c) oral examin ffered: In the semester in ssessment: English bonus blaces	an be chosen to earn 20 minutes, usually ation in groups (grou	a bonus) chosen) or b) oral ex ps of 2, 15 minutes p	camination of one candidate eac oer candidate)
ster, in a) writt (appro: Assess Langua credita Allocat Additic Worklo 300 h	iformati ten exa x. 20 m sment o age of a ible for tion of p onal inf	ion on whether module c mination (approx. 90 to 1 inutes) or c) oral examin ffered: In the semester in ssessment: English bonus blaces	an be chosen to earn 20 minutes, usually ation in groups (grou	a bonus) chosen) or b) oral ex ps of 2, 15 minutes p	camination of one candidate eac oer candidate)
ster, in a) writt (appro: Assess Langua credita Allocat Additic Worklo 300 h Teachin 	iformati ten exa x. 20 m sment o age of a ible for tion of p onal inf	ion on whether module c mination (approx. 90 to 1 inutes) or c) oral examin ffered: In the semester ir ssessment: English bonus places ormation	an be chosen to earn	a bonus) chosen) or b) oral ex ps of 2, 15 minutes p offered and in the s	camination of one candidate eac oer candidate) ubsequent semester
ster, in a) writt (appro: Assess Langua credita Allocat Additic Worklo 300 h Teachin 	iformati ten exa x. 20 m sment o age of a ible for tion of p onal inf	ion on whether module c mination (approx. 90 to 1 inutes) or c) oral examin ffered: In the semester in ssessment: English bonus blaces	an be chosen to earn	a bonus) chosen) or b) oral ex ps of 2, 15 minutes p offered and in the s	camination of one candidate eac oer candidate) ubsequent semester
ster, in a) writt (appro: Assess Langua credita Allocat Additic 300 h Teachi Referre	iformation ten exa x. 20 m sment o age of a able for tion of p tion of p onal inf oad ng cycl ed to in	ion on whether module c mination (approx. 90 to 1 inutes) or c) oral examin ffered: In the semester ir ssessment: English bonus blaces ormation e LPO I (examination regu	an be chosen to earn	a bonus) chosen) or b) oral ex ps of 2, 15 minutes p offered and in the s	amination of one candidate eac per candidate) ubsequent semester
ster, in a) writt (appro: Assess Langua credita Allocat Modulo Referre Modulo	iformati ten exa x. 20 m sment o age of a ible for tion of p onal inf onal inf oad ng cycl ed to in e appea	ion on whether module c mination (approx. 90 to 1 inutes) or c) oral examin ffered: In the semester in ssessment: English bonus places ormation e LPO I (examination regu	an be chosen to earn	a bonus) chosen) or b) oral ex ps of 2, 15 minutes p offered and in the s	amination of one candidate eac per candidate) ubsequent semester
ster, in a) writt (appro: Assess Langua credita Allocat Additic Worklo 300 h Teachin Referre Module	iformati ten exa x. 20 m sment o age of a ible for tion of p onal inf onal inf onal inf oad ed to in e appea	ion on whether module c mination (approx. 90 to 1 inutes) or c) oral examin ffered: In the semester in ssessment: English bonus blaces ormation e (e LPO I (examination regu ars in ee (1 major) Mathematics	an be chosen to earn 20 minutes, usually ation in groups (group which the course is allations for teaching-out s International (2015)	a bonus) chosen) or b) oral ex ps of 2, 15 minutes p offered and in the s	amination of one candidate ea per candidate) ubsequent semester
ster, in a) writt (appro: Assess Langua credita Allocat Additic Worklo 300 h Teachin Referre Master Master	iformati ten exa x. 20 m sment o age of a ible for tion of p onal inf onal inf onal inf oad ed to in e appea r's degr	ion on whether module c mination (approx. 90 to 1 inutes) or c) oral examin ffered: In the semester in ssessment: English bonus blaces ormation e LPO I (examination regu ars in ee (1 major) Mathematics ee (1 major) Physics Inter	an be chosen to earn 20 minutes, usually ation in groups (group 1 which the course is 1 ulations for teaching-on 1 s International (2015) rnational (2020)	a bonus) chosen) or b) oral ex ps of 2, 15 minutes p offered and in the s degree programmes	amination of one candidate ear per candidate) ubsequent semester
ster, in a) writt (appro: Assess Langua credita Allocat Additic Worklo 300 h Teachin Referre Master Master Master Master	iformati ten exa x. 20 m sment o age of a uble for tion of p onal inf onal inf oad ng cycl ed to in e appea d's degr d's degr	ion on whether module c mination (approx. 90 to 1 inutes) or c) oral examin ffered: In the semester in ssessment: English bonus blaces ormation e (e LPO I (examination regu ars in ee (1 major) Mathematics	an be chosen to earn 120 minutes, usually ation in groups (group n which the course is ulations for teaching-out s International (2015) rnational (2020) s International (2021)	a bonus) chosen) or b) oral ex ps of 2, 15 minutes p offered and in the s degree programmes	amination of one candidate ear per candidate) ubsequent semester

Modul					Abbreviation	
Partial	Differe	ential Equations of N	Nathematical Physics		10-M=VPDPin-152-m01	
Modul	e coord	linator		Module offered by		
Dean of Studies Mathematik (Mathem			hematics)	Institute of Mathematics		
ECTS Method of grading				. compl. of module(s)		
10		rical grade				
Duratio		Module level	Other prorequisitor			
1 seme						
Conten		graduate				
examp ons an Recom Basic k	les; ini d gene mende mowlee	tial and boundary va ralisations; Hilbert s d previous knowled dge from the module	alue problems; well-posed pace methods; Sobolev s ge: es "Ordinary Differential E	d and ill-posed probl spaces and Fourier tr quations" and "Intro	duction to Partial Differential	
			vell as basic knowledge o	f functional analysis	•	
	-	ning outcomes				
equation	ons, as	well as standard ex		al physics. He/She is	the theory of partial differential s able to establish a connection ions in physics.	
Course	s (type	, number of weekly	contact hours, language -	– if other than Germa	an)	
V (4) + Module		t in: English				
			pe, language — if other th ule can be chosen to earr		ation offered — if not every seme	
(approz Assess	x. 20 m ment o age of a	inutes) or c) oral exa offered: In the semes assessment: English	o to 120 minutes, usually amination in groups (grou ster in which the course is	ps of 2, 15 minutes		
Allocat	ion of	places				
Additio	onal inf	ormation				
Worklo	ad					
300 h						
Teachi	ng cvcl	e				
	3	-				
Referre	ed to in	LPOI (examination	regulations for teaching-	degree programmes)	
					/	
Module	anne	ars in				
			natics International (2015))		
	-		International (2015))		
	-		natics International (2020))		
	-	-	natics International (2022			
	-			.,		
	-		International (2024))		

Module title Abbreviation										
Pseudo Riema	annian and Riemannian	10-M=VPRGin-152-1	n01							
Module coord	linator		Module offered by	fered by						
	es Mathematik (Mather	natics)	Institute of Mathematics							
l l	od of grading	Only after succ. compl. of module(s)								
10 numerical grade										
Duration Module level Other prerequisites										
1 semester	graduate									
Contents										
The module builds on the topics covered in module 10-M=ADGM and discusses these in more detail: Rieman- nian and pseudo-Riemannian manifolds, Levi-Civita connection and curvature, geodesics and the exponential map, Jacobi fields, comparison theorems in Riemannian geometry, submanifolds, integration, d'Alembert and Laplace operators, causal structure of Lorenz manifolds, Einstein equations and applications in general relativity theory.										
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 modules "Introduction to Topology", "Geometric Mechanics" and "Lie Theory" is also recommended.										
Intended learning outcomes										
The student is acquainted with advanced topics in differential geometry on Riemannian and pseudo-Riemannian manifolds. He/She is able to establish a connection between his/her acquired skills and other branches of mathematics and questions in physics.										
Courses (type, number of weekly contact hours, language — if other than German)										
V (4) + Ü (2) Module taught in: English										
Method of assessment (type, scope, language — if other than German, examination offered — if not every seme- ster, information on whether module can be chosen to earn a bonus)										
a) written examination (approx. 90 to 120 minutes, usually chosen) or b) oral examination of one candidate each (approx. 20 minutes) or c) oral examination in groups (groups of 2, 15 minutes per candidate) Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: English creditable for bonus										
Allocation of places										
Additional inf	ormation									
		_								
Workload										
300 h										
Teaching cycl	e									
Referred to in LPO I (examination regulations for teaching-degree programmes)										
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 (2021) Master's degree (1 major) Mathematics International (2022)										
-	r Physics International (2024)		• generated 21-Jun-2024 • exa	am. reg. da-	page 36 / 153					
			r (120 ECTS) Physics Internati							



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

Modul	e title	Abbreviation					
Optimi	Optimization for Machine Learning 10-M-OML-222-mo1						
Modul	e coordinator		Module offered by	<u> </u>			
Dean c	of Studies Mathematik (Mather	matics)	Institute of Mathem	natics			
ECTS	Method of grading		Only after succ. compl. of module(s)				
10 numerical grade							
Durati		Other prerequisites					
1 seme	· · · · · · · · · · · · · · · · · · ·						
Conter	Contents						
	programming, quadratic progr ng problems such as support v		ization, first order m	ethods, application	to machine		
Intend	ed learning outcomes						
	udent is acquainted with the re achine learning problems, bot			e to apply these metl	nods to prac-		
	es (type, number of weekly con	·		an)			
V (4) +							
Metho	d of assessment (type, scope,	language — if other th		ition offered — if not	every seme-		
	formation on whether module						
	ten examination (approx. 90 to examination of one candidate						
	examination in groups (groups		-				
	age of assessment: German an		per culturate)				
	ment offered: Only when anno	ounced in the semester	r in which the course	s are offered and in	the subse-		
	semester						
	ble for bonus						
Alloca	tion of places						
Additio	onal information						
Worklo	bad						
300 h							
Teachi	ng cycle						
Referre	ed to in LPO I (examination reg	gulations for teaching-	degree programmes)				
	· · · · · · · · · · · · · · · · · · ·	<u> </u>					
Modul	e appears in						
Bache	lor' degree (1 major) Economat	hematics (2022)					
Bache	lor' degree (1 major) Mathemat	tical Data Science (202	2)				
Bache	lor' degree (1 major) Artificial II	ntelligence and Data S	cience (2022)				
	nge program Mathematics (202	-					
	lor' degree (1 major) Artificial II	-	cience (2023)				
	lor' degree (1 major) Economat						
	lor' degree (1 major) Mathemat						
	r's degree (1 major) Physics Int						
	lor' degree (1 major) Economat		• ()				
Bache	lor' degree (1 major) Artificial li	ntelligence and Data S	cience (2024)				
Master's w	vith 1 major Physics International (2024)	-	• generated 21-Jun-2024 • exa r (120 ECTS) Physics Internati	-	page 38 / 153		

Module title					Abbreviation		
Advanc	ed Ana	lysis			10-M-VAN-222-m01		
Module	coord	inator		Module offered by			
Dean of	fStudie	es Mathematik (Mathema	atics)	Institute of Mathem	atics		
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)			
10	nume	rical grade					
Duratio	n	Module level	Other prerequisites				
1 seme	ster	undergraduate					
Conten	ts						
Continu rems.	uation o	of analysis in several vari	ables; Lebesgue mea	sure and Lebesgue	integral in R^n, integral theo-		
Intende	ed learr	ning outcomes					
		acquainted with advanc understand the construct			of the Lesbegue integral, he or		
Course	s (type,	, number of weekly conta	ct hours, language —	if other than Germa	n)		
V (4) +	Ü (2)						
		e ssment (type, scope, la on on whether module ca			tion offered — if not every seme-		
b) oral (c) oral (examin examin ge of a	nination (approx. 90 to 1 ation of one candidate e ation in groups (groups c ssessment: German and, bonus	ach (15 to 30 minutes of 2, 10 to 15 minutes	s) or			
Allocat	ion of p	olaces					
Additio	nal inf	ormation					
Worklo	ad						
300 h							
Teachir	ng cycl	9					
Referre	d to in	LPOI (examination regu	lations for teaching-o	legree programmes)			
Module	appea	rs in					
		ree (1 major) Mathematic	al Data Science (202	2)			
	-	gram Mathematics (2023)					
		ee (1 major) Quantum Eng					
Master'	Master's degree (1 major) Physics International (2024)						

Advanced Astro Imaging 11-AAI-Int-201-m01 Module coordinator Module offered by Managing Director of the Institute of Theoretical Physics and Astronomy and Astrophysics Faculty of Physics and Astronomy ECTS Method of grading Only after succ. compl. of module(s) 6 numerical grade
Managing Director of the Institute of Theoretical Physics Faculty of Physics and Astronomy and Astrophysics Faculty of Physics and Astronomy ECTS Method of grading Only after succ. compl. of module(s) 6 numerical grade
and Astrophysics ECTS Method of grading Only after succ. compl. of module(s) 6 numerical grade
6 numerical grade
Duration Module level Other prerequisites
1 semester graduate
Contents
 Image Acquisition: a) Motivation: History of Astronomical Imaging - From the Eye to the Detector; b) Atmospiric Transmission: Ground Based vs. Space Based Imaging; c) Observing Techniques and Instruments; d) Optic 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 Process
Algorithms
3) Advanced Processing: a) FITS File Format; b) Image Reconstruction; c) Fourier Analysis; d) Speckle Interferor try; e) Maximum Entropy Methods; f) Interferometry; g) Image Classification, Machine Learning Methods
4) Outlook: a) Future Challenges: Scientific Questions / Instruments / Data Processing; b) Future Facilities Rad to Gamma-rays; c) Imaging in Other Scientific Fields
Intended learning outcomes
The aim of the module is to convey a fundamental understanding of imaging methods using examples from modern astronomy, incorporating measurements from ground- and space-based instruments. The students acquire the following qualifications: ability to process and interpret raw-image data, to perform data reduction, image and interpret raw-image data, to perform data reduction, image data, to perform the students acquired to the students acquir
analysis, application and improvement of processing algorithms. The concepts and methods are not limited to the field of astronomy but applicable to many other areas.
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 sem ster, information on whether module can be chosen to earn a bonus)
a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 n nutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (ap prox. 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 meth
of assessment is changed, the lecturer must inform students about this by four weeks prior to the original exa 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)

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Module appears in

Module title			Abbreviation					
Cosmology 11-AKM-Int-201-m01								
Module coordinator		Module offered by						
Managing Director of the Institute of Tl and Astrophysics	neoretical Physics	Faculty of Physics a	ind 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								
Expanding Space-Time, Friedmannian Matter, Primordial Nucleosynthesis, Co Clusters, Intergalactic Medium, Cosmo	osmic Microwave Bac							
Intended learning outcomes								
Basic knowledge of cosmology. Knowl se to observations. Insight into curren								
Courses (type, number of weekly conta	act hours, language –	- if other than Germa	in)					
V (3) + R (1) Module taught in: English								
Method of assessment (type, scope, la ster, information on whether module c			tion offered — if not every seme-					
a) written examination (approx. 90 to 2 nutes) or c) oral examination in groups prox. 8 to 10 pages) or e) presentation If a written examination was chosen as stead take the form of an oral examinat of assessment is changed, the lecture nation date at the latest. Language of assessment: English Assessment offered: In the semester in	20 minutes) or b) ora (groups of 2, approx /talk (approx. 30 min method of assessmution of one candidate r must inform student	al examination of one . 30 minutes per can utes). ent, this may be chan e each or an oral exa s about this by four	ndidate) or d) project report (ap- 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 regu	lations for teaching-	degree programmes)						
	3							
Module appears in								
Master's degree (1 major) Physics Inte	rnational (2020)							
exchange program Physics (2023)								
Master's degree (1 major) Physics International (2024)								

Module	e title				Abbreviation
Selecte	ed Topi	cs of Theoretical Solid St	ate Physics		11-AKTF-Int-201-m01
Module coordinator				Module offered by	<u> </u>
	ing Dire	ector of the Institute of Th	eoretical Physics	Faculty of Physics a	and Astronomy
ECTS	<u> </u>	od of grading	Only after succ. con	npl. of module(s)	
6	1	rical grade		-	
Duratio	n	Module level	Other prerequisites		
1 seme	ster	graduate			
Conten	ts				
ments	to bring				ntend to present new develop- ects are many-body localization
Intende	ed lear	ning outcomes			
theoret	ical po		on the basis of anal	ytical and numerical	isorder and interactions from a methods. Therefore, we envisage
Course	s (type	, number of weekly conta	ct hours, language –	- if other than Germa	an)
V (3) + Module		t in: English			
		essment (type, scope, la on on whether module ca			tion offered — if not every seme-
prox. 8 If a writ stead t of asse nation Assess	to 10 p ten exa ake the ssmen date at ment o	bages) or e) presentation, amination was chosen as e form of an oral examina	talk (approx. 30 min method of assessm tion of one candidate must inform student	utes). ent, this may be cha e each or an oral exa is about this by four	ndidate) or d) project report (ap- nged and assessment may in- mination in groups. If the methoo weeks prior to the original exami- ubsequent semester
Allocat					
Additio	nal inf	ormation			
Worklo	ad				
180 h					
Teachi	ng cycl	e			
Referre	d to in	LPOI (examination regu	lations for teaching-	degree programmes)	
Module	e appea	ars in			
	-	ee (1 major) Physics Inter			
	-	ee (1 major) Quantum Eng			
	-	ee (1 major) Quantum Eng ee (1 major) Physics Inter	·		
musiel	Jucgi		114101141 (2024)		

High-E	e title		Abbreviation		
	nergy A	Astrophysics			11-APL-Int-201-m01
Module	e coord	inator		Module offered by	
Managi	ing Dire	ector of the Institute of T	heoretical Physics	Faculty of Physics a	and Astronomy
and Ast					
ECTS	Methe	od of grading	Only after succ. cor	npl. of module(s)	
6	nume	rical grade			
Duratio	n	Module level	Other prerequisites	5	
1 seme	ster	graduate			
Conten	ts				
	ion pro				of light with matter, particle-ac- nysical shock waves, kinetic
Intende	ed lear	ning outcomes			
	-	ains knowledge in funda adiative processes in ast	•	gy astrophysics, suc	h as particle acceleration and
		, number of weekly conta		- if other than Gorma	un)
V (3) +		, number of weekly conta	act nours, language -		ui <i>)</i>
		t in: English			
			anguage — if other th	an German, examina	tion offered — if not every seme-
		ion on whether module o			,
nutes) prox. 8 If a writ stead ta	or c) or to 10 p ten exa ake the ssmen	al examination in groups bages) or e) presentation amination was chosen as e form of an oral examina	s (groups of 2, approx /talk (approx. 30 min s method of assessm	k. 30 minutes per car nutes). ent, this may be cha	e candidate each (approx. 30 mi- ndidate) or d) project report (ap- nged and assessment may in-
Langua	ge of a	t is changed, the lecture the latest. ssessment: English ffered: In the semester in	r must inform studen	ts about this by four	weeks prior to the original exami
Langua	ge of a ment o	the latest. ssessment: English ffered: In the semester i	r must inform studen	ts about this by four	weeks prior to the original exami
Langua Assess	ge of a ment o	the latest. ssessment: English ffered: In the semester i	r must inform studen	ts about this by four	weeks prior to the original exami
Langua Assess Allocat	ge of a ment o ion of 	the latest. ssessment: English ffered: In the semester i	r must inform studen	ts about this by four	mination in groups. If the method weeks prior to the original exami ubsequent semester
Langua Assess Allocat	ge of a ment o ion of 	the latest. ssessment: English ffered: In the semester in places	r must inform studen	ts about this by four	weeks prior to the original exami
Langua Assess Allocat	ge of a ment o ion of p	the latest. ssessment: English ffered: In the semester in places	r must inform studen	ts about this by four	weeks prior to the original exami
Langua Assess Allocat Additio 	ge of a ment o ion of p	the latest. ssessment: English ffered: In the semester in places	r must inform studen	ts about this by four	weeks prior to the original exami
Langua Assess Allocat Additio Worklo	ge of a ment o ion of j nal inf ad	the latest. ssessment: English ffered: In the semester in places ormation	r must inform studen	ts about this by four	weeks prior to the original exami
Langua Assess Allocat Additio Worklo 180 h	ge of a ment o ion of j nal inf ad	the latest. ssessment: English ffered: In the semester in places ormation	r must inform studen	ts about this by four	weeks prior to the original exami
Langua Assess Allocat Additio Worklo 180 h Teachin 	ge of a ment o ion of p nal inf ad	the latest. ssessment: English ffered: In the semester in places ormation	r must inform studen	ts about this by four offered and in the su	weeks prior to the original exami
Langua Assess Allocat Additio Worklo 180 h Teachin 	ge of a ment o ion of p nal inf ad	the latest. ssessment: English ffered: In the semester in olaces ormation	r must inform studen	ts about this by four offered and in the su	weeks prior to the original exami
Langua Assess Allocat Additio 180 h Teachin Referre 	ge of a ment o ion of j nal inf ad ng cycl	the latest. ssessment: English ffered: In the semester in olaces ormation e LPO I (examination regu	r must inform studen	ts about this by four offered and in the su	weeks prior to the original exami
Langua Assess Allocat Worklo 180 h Teachin Referre Module	ge of a ment o ion of p nal inf ad ng cycl	the latest. ssessment: English ffered: In the semester in places ormation e LPO I (examination regu	r must inform studen	ts about this by four offered and in the su	weeks prior to the original exami
Langua Assess Allocat Morklo 180 h Teachin Referre Module	ge of a ment o ion of j mal inf ad ad ad ad ad ad ad ad ad ad ad ad ad	the latest. ssessment: English ffered: In the semester in olaces ormation e LPO I (examination regu	r must inform studen	ts about this by four offered and in the su	weeks prior to the original exami

Module	title				Abbreviation
Method	ls of O	oservational Astronomy			11-ASM-Int-201-m01
Module coordinator				Module offered by	<u> </u>
Managi	ng Dire	ector of the Institute of Th	eoretical Physics	Faculty of Physics a	nd Astronomy
and Ast	-				·····,
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				
		oservational Astronomy a m radio, optical, X-ray ar			action and reduction of observa-
Intende	ed learı	ning outcomes			
(radio,	optical		nergies). Knowledge o		the electromagnetic spectrum plications of these methods and
Course	s (type	, number of weekly conta	ct hours, language —	if other than Germa	in)
V (3) + I Module		t in: English			
		e ssment (type, scope, la on on whether module ca			tion offered — if not every seme-
stead ta of asse nation of Assess	ake the ssmen date at ment o	form of an oral examina	tion of one candidate must inform student	e each or an oral exa s about this by four	nged and assessment may in- mination in groups. If the method weeks prior to the original exami- ubsequent semester
Allocati	-				
Additio	nal inf	ormation			
Worklo	ad				
180 h					
Teachir	ng cycl	e			
Referre	d to in	LPOI (examination regu	lations for teaching-o	legree programmes)	
Module	appea	in and the second se			
Master'	s degr	ee (1 major) Physics Inter	national (2020)		
	-	ee (1 major) Quantum Eng	gineering (2020)		
		gram Physics (2023)			
	-	ee (1 major) Quantum Eng			
Master	s degr	ee (1 major) Physics Inter	national (2024)		

Module title					Abbreviation		
Introduction to Space Physics							
Module	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	npl. of module(s)			
6	6 numerical grade						
Duratio	n	Module level	Other prerequisites				
1 semes	ster	graduate					
Content	ts						
3. Elemo 4. The s 5. Accel	mics of ents of sun and leration	f charged particles in n space physics heliosphere and transport of ener to measure energetic	getic particles in the he	eliosphere			
Intende	d lear	ning outcomes					
	ind the	lge in space physics, ir heliosphere. Knowled ments.					
Courses	s (type	, number of weekly con	tact hours, language –	- if other than Germa	n)		
V (3) + F Module		t in: English					
		s essment (type, scope, on on whether module			tion offered — if not	every seme-	
nutes) of prox. 8 If a writh stead ta of asses nation of Assessr	or c) or to 10 p ten exa ake the ssmen date at ment o	mination (approx. 90 to al examination in group ages) or e) presentatio amination was chosen form of an oral examin t is changed, the lectur the latest. ffered: In the semester ssessment: English	os (groups of 2, approx n/talk (approx. 30 min as method of assessm nation of one candidate er must inform student	. 30 minutes per can utes). ent, this may be chan e each or an oral exa ts about this by four	didate) or d) project nged and assessmen mination in groups. weeks prior to the or	t report (ap- nt may in- If the method riginal exami-	
Allocati	ion of p	olaces					
Additio	nal inf	ormation					
Workloa							
180 h	uu						
	a aval	•					
Teachin	ig cyci	e					
Referre	d to in	LPOI (examination reg	gulations for teaching-	degree programmes)			
Module	appea	urs in					
Master'	s degr	ee (1 major) Physics Int	ernational (2020)				
	-	ee (1 major) Quantum E gram Physics (2023)	ngineering (2020)				
		Physics International (2024)	JMU Würzburg	• generated 21-Jun-2024 • exa	m. reg. da-	page 46 / 153	
			-	r (120 ECTS) Physics Internati	-		



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

Module title					Abbreviation			
Theoret	tical As	trophysics		11-AST-Int-201-m01				
Module	coord	inator		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. con	pl. of module(s)				
6		rical grade						
Duratio	n	Module level	Other prerequisites					
1 seme	ster	graduate						
Conten	ts							
		retical astrophysics such jets, shock waves, radiat	-		lack holes, supernovae, pulsars,			
Intende	ed leari	ning outcomes						
			hods of theoretical a	strophysics. Ability t	o formulate theoretical models.			
		, number of weekly conta		, , , ,				
V (2) +	R (2)	t in: English	, , , ,					
ster, inf	formati	on on whether module ca	an be chosen to earn	a bonus)	tion offered — if not every seme-			
nutes) of prox. 8 If a writ stead ta of asse nation of Langua Assess	or c) or to 10 p ten exa ake the ssmen date at ge of a ment o	al examination in groups ages) or e) presentation/ amination was chosen as form of an oral examina- t is changed, the lecturer the latest. ssessment: English ffered: In the semester in	(groups of 2, approx talk (approx. 30 min method of assessme tion of one candidate must inform student	. 30 minutes per can utes). ent, this may be char e each or an oral exar s about this by four v	didate) or d) project report (ap- 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	d to in	LPOI (examination regu	lations for teaching-o	degree programmes)				
Module	appea	irs in						
	-	ee (1 major) Physics Inter	national (2020)					
		gram Physics (2023)						
Master'	Master's degree (1 major) Physics International (2024)							

Module	e title				Abbreviation
Selecte	ed Topi	cs of Theoretical Elemen	tary Particle Physics		11-ATTP-Int-201-m01
Modul	e coord	instar		Madula offered by	<u> </u>
				Module offered by	
and As	trophys			Faculty of Physics a	and Astronomy
ECTS					
6		rical grade			
Duratio		Module level	Other prerequisites		
1 seme		graduate			
Conten					
1. Adva 2. Pher 3. Higg	nced T nomenc s Physi	topics from the following echniques for Precision (ology of Collider Experime cs Physics	Calculations of Scatte		
		ning outcomes	-		
Ability	to appl	5		•	of particle physics phenomenolo-
Course	s (type	, number of weekly conta	act hours, language –	- if other than Germa	an)
V (3) +	R (1)	· · · · ·			
Module	e taugh	t in: English			
		s essment (type, scope, la on on whether module c			ation offered — if not every seme-
nutes) prox. 8 If a writ stead t of asse nation Langua	or c) or to 10 p tten exa ake the essmen date at age of a	al examination in groups ages) or e) presentation amination was chosen as form of an oral examina	(groups of 2, approx /talk (approx. 30 min method of assessm tion of one candidate must inform student	. 30 minutes per car utes). ent, this may be cha e each or an oral exa is about this by four	e candidate each (approx. 30 mi- ndidate) or d) project report (ap- nged and assessment may in- mination in groups. If the method weeks prior to the original exami- ubsequent semester
Allocat	ion of p	olaces			
Additio	onal inf	ormation			
Worklo	ad				
180 h					
Teachi	ng cycl	e			
Referre	ed to in	LPOI (examination regu	lations for teaching-	degree programmes)	
			0		
Module	e appea	irs in			
		ee (1 major) Physics Inter	rnational (2020)		
	•	ee (1 major) Physics Inter			

Module title					Abbreviation		
	Basic Imaging Concepts 11-BIC-Int-201-m01						
Module	e coord	inator		Module offered by			
Manag	ing Dire	ector of the Institute of Ap	plied Physics	Faculty of Physics a	nd Astronomy		
ECTS		od of grading	Only after succ. com	pl. of module(s)			
6	L	rical grade					
Duratio		Module level	Other prerequisites				
1 seme		graduate					
Conten	ts						
across tion, ce spread vanced	all ima entral-s functic I metho	ging modalities, including lice- theorem), 3) the syst on, modulation transfer fu	g 1) the concept of Fo tem theory of imaging unction, spatial resolution will be covered and a	ourier imaging, 2) ton g systems, and 4) iss ution, contrast, noise a comprehensive over	ng the most central aspects nography (Radon-Transforma- sues of image quality (point- e). During the course different ad- erview of modern imaging modali-		
Intende	ed learı	ning outcomes					
					ications. They understand the to interpret simple images.		
Course	s (type	, number of weekly conta	ct hours, language —	if other than Germa	n)		
V (3) + Module	• •	t in: English					
		essment (type, scope, la on on whether module ca			tion offered — if not every seme-		
nutes) prox. 8 If a writ stead t of asse nation	or c) or to 10 p tten exa ake the ssmen date at	al examination in groups ages) or e) presentation/ amination was chosen as e form of an oral examinat	(groups of 2, approx 'talk (approx. 30 min method of assessme tion of one candidate	. 30 minutes per can utes). ent, this may be char e each or an oral exar	e candidate each (approx. 30 mi- didate) or d) project report (ap- nged and assessment may in- mination in groups. If the method weeks prior to the original exami-		
Allocat	ion of p	olaces					
Additio	onal info	ormation					
Worklo	ad						
180 h							
Teachi	ng cycl	e					
Teachi	ng cycle	e: every year, after annou	ncement				
		LPOI (examination regu		legree programmes)			
		<u> </u>	0				
Module	e appea	urs in					
Master	's degr	ee (1 major) Physics Inter	national (2020)				
		gram Physics (2023)	national (2021)				
master	Master's degree (1 major) Physics International (2024)						

Module title					Abbreviation		
Models Beyond the Standard Model of Elementary Particle Physics					11-BSM-Int-201-m01		
Module	e coord	inator		Module offered by	Module offered by		
Managi and Ast		ector of the Institute of sics	Theoretical Physics	Faculty of Physics a	and Astronomy		
ECTS	Metho	od of grading	Only after succ. cor	mpl. of module(s)			
6	nume	rical grade					
Duratio	n	Module level	Other prerequisites	5			
1 seme	1 semester graduate						
Conten	ts						
	s of the rino Ph	-	-	and at High Energy Co	olliders		
• P • P • E • N • S	 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 						
Intende	ed leari	ning outcomes					
particle	e pheno and un	h tests of the standard menology, in particula derstand how to test th	r Higgs and neutrino p	hysics. Ability to con	struct extensions of	the standard	
Course	s (type	, number of weekly con	tact hours, language -	– if other than Germa	an)		
V (3) + Module		t in: English					
		essment (type, scope, on on whether module			ition offered — if not	every seme-	
ster, information on whether module can be chosen to earn a 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							
Teachi	ן זפ גערו	2					
reacini	is cycl	•					
Master's wi	th 1 majoi	Physics International (2024)	-	• generated 21-Jun-2024 • exa er (120 ECTS) Physics Internati	-	page 51 / 153	

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

Module appears in

Image a	title				Abbreviation	
Image and Signal Processing in Physics					11-BSV-Int-201-m01	
Module coordinator				Module offered by		
		ctor of the Institute of	of Applied Physics	Faculty of Physics a	and Astronomy	
		d of grading	Only after succ. co			
		ical grade				
Duratio	n	Module level	Other prerequisite	ç		
1 semes		graduate		5		
Content	I	Sidduite				
		naviadia sismala har		water and support Fauncia		
					r transformation; basic principles ampling theorem; Parsival theo-	
					nents, stationary signals; tomo-	
		l and Radon transfor				
		ing outcomes				
			image and signal proce	ssing Familiarity wit	h the physical principles of image	
					he various methods and in parti-	
		ng them to tomograp				
		°	ontact hours, language -	— if other than Germa	an)	
V (2) + Ü						
• •		in: English				
			e language — if other th	an German, examina	ition offered — if not every seme-	
			le can be chosen to ear		alon oncica in not every senie	
					e candidate each (approx. 30 mi-	
					ndidate) or d) project report (ap-	
			ion/talk (approx. 30 mi			
					nged and assessment may in-	
					mination in groups. If the method	
		the latest.	urer must inform studen	its about this by four	weeks prior to the original exami-	
			er in which the course is	s offered and in the s	ibsequent semester	
		ssessment: English	er m when the course is		absequent semester	
Allocati						
Additio	nal info	ormation				
Workloa	ad					
180 h						
Teachin	ig cycle	9				
	Referred to in LPO I (examination regulations for teaching-degree programmes)					
Referre						
Referre			regulations for teaching	-degree programmes)		
Referred	appea		regulations for teaching	-degree programmes)		
 Module		rs in		-degree programmes)		
 Module Master'	s degre	rs in ee (1 major) Physics I		-degree programmes)		
 Module Master' Master'	s degre s degre	rs in ee (1 major) Physics I	nternational (2020)	-degree programmes))	
 Module Master' Master' exchang	s degre s degre ge prog	rs in ee (1 major) Physics I ee (1 major) Quantum gram Physics (2023)	nternational (2020)	-degree programmes)		

Module title					Abbreviation	
Bosoni	sation	and Interactions in One	e Dimension		11-BWW-Int-201-m01	
Module coordinator				Module offered by	<u> </u>	
Manag and As	-	ector of the Institute of sics	Theoretical Physics	Faculty of Physics a	and Astronomy	
ECTS		od of grading	Only after succ. cor	npl. of module(s)		
6		rical grade				
Duratio	on	Module level	Other prerequisites	5		
1 seme	ster	graduate				
	bility c	f Fermi systems in one sonisation and Luttinge		nions, correlation fu	nctions, models with spin, renor-	
malizat The bel 3. Inter 4. Beth 5. Spin 6. Diso 7. Non-	tion gro low me acting e ansa -1/2 ch rdered abelia	oup, and the sine-Gordo ntioned topics will be p fermions on a lattice (H tz ains systems n bosonisation and the	on model). presented in different y ubbard model, t/J mod WZW model (Kac-Moo	rears: del, transport proper		
		ation, applications of t	he WZW model)			
		ning outcomes			atotation of all on the states	
		th the peculiarities of or experimentally relevant f			uisition of the theoretical tools to sport in 1D.	
		, number of weekly con			•	
V (3) +	R (1)	t in: English				
					ation offered — if not every seme-	
nutes) prox. 8 If a writ stead t of asse nation Langua	ster, information on whether module can be chosen to earn a 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	places				
Additio	onal inf	ormation				
Worklo	ad					
180 h						
Teachi	ng cycl	e	_			
Referre	ed to in	LPOI (examination reg	gulations for teaching-	degree programmes		
				<u> </u>		

Module appears in

Module title					Abbreviation	
Conten	nporar	y Astrophysics			11-CAP-Int-201-m01	
Module coordinator				Module offered by	<u> </u>	
Manag and As	-		of Theoretical Physics	Faculty of Physics a	and Astronomy	
ECTS	1	od of grading	Only after succ. co	mpl. of module(s)		
6	nume	rical grade				
Duratio	on	Module level	Other prerequisite	5		
1 seme	ster	graduate				
Conten	ts					
Telesco Mediur	opes an n, Mol	nd Detectors, Stellar ecular Clouds, Struct	Structure and Atmosphe	res, Stellar Evolution	xoplanets, Astronomical Scales, and their End Stages, Interstella Expanding Universe, Galaxies, Ac	
Intend	ed lear	ning outcomes				
of astro	ophysio	cal research. He/She		pret his/her own obs	rs the methods and instruments ervations. He/She is familiar with rs and galaxies.	
Course	s (type	, number of weekly c	ontact hours, language -	– if other than Germa	an)	
V (3) +						
		it in: English				
			e, language — if other th lle can be chosen to earr		ation offered — if not every seme	
nutes) prox. 8 If a writ stead t of asse nation	or c) or to 10 p tten ex ake the ssmen date a	ral examination in gro bages) or e) presenta amination was chose e form of an oral exar	oups (groups of 2, appro tion/talk (approx. 30 min en as method of assessm nination of one candidat	x. 30 minutes per can nutes). nent, this may be cha ne each or an oral exa	e candidate each (approx. 30 mi- ndidate) or d) project report (ap- anged and assessment may in- amination in groups. If the metho weeks prior to the original exami	
Allocat	ion of	places				
Additio	onal inf	ormation				
Worklo	ad					
180 h						
Teachi	ng cycl	e				
	Teaching cycle: every year, after announcement					
			regulations for teaching-	degree programmes)	
Module	e appe	ars in				
master	Master's degree (1 major) Physics International (2020) exchange program Physics (2023)					
	ige pro		International (2020)			

8 numerical grade	Module title					Abbreviation	
Managing Director of the Institute of Theoretical Physics Faculty of Physics and Astronomy ECTS Method of grading Only after succe. compl. of module(s) 8 numerical grade Duration Module level Other prerequisites 1 semester graduate 2. Warnier functions and localized basis functions 3. 3. Numerical evaluation of topological invariants 4. Hartree-Fock and static mean-field theory 5. 5. Many-body methods for solid state physics 6. 6. Anderson impurity model (AIM) and Kondo physics 7. Dynamical mean-field theory (DFT) 8. DFT + DMET methods for realistic modeling of solids 9. Strongly correlated electrons Intended learning outcomes Theoretical Treatment of the above topics complemented by hands-on tutorials to be held in the CIP-Pool. Familiarity with DFT software packages such as VASP or Wienzk and construction of maximally localized Wannier functions by projecting DFT results onto atomic orbitals using wanniergo. Knowledge how to obtain many-body solutions of the AIM and explore some of its limiting cases such as the Kondo regime. Ability to use impurity solvers based on exact diagonalization or continuous-time quantum Monte Carlo for the solution of the DMFT self-consistency equations. Coursese	Computational Materials Science (DFT)					11-CMS-Int-201-m01	
and Astrophysics Only after succ. compl. of module(s) ECTS Method of grading Only after succ. compl. of module(s) 8 numerical grade Duration Module level Other prerequisites 1 semester graduate Contents 1. Density functional theory (DFT) 2. Wannier functions and localized basis functions 3. Numerical evaluation of topological invariants 4. Hartree-Fock and static mean-field theory 5. Andreson impurity model (AIM) and Kondo physics 7. Dynamical mean-field theory (DFT) 8. Or prevalented electrons 8. Or prevalented electrons	Module	coord	inator		Module offered by		
8 numerical grade Duration Module level Other prerequisites 1 semester graduate 2. Contents 3. Numerical evaluation of topological invariants 4. Hattree-Fock and static mean-field theory 5. Many-body methods for solid state physics 6. Anderson inpurity model (AIM) and Kondo physics 7. Dynamical mean-field theory (DMFT) 8. DFT + DMFT methods for roalistic modeling of solids 9. Strongly correlated electrons Intended learning outcomes Theoretical treatment of the above topics complemented by hands-on tutorials to be held in the CIP-Pool. Familiarity with DFT software packages such as VASP or Wienzk and construction of maximally localized Wannier functions of the AIM and explore some of its limiting cases such as the Kondo regime. Ability to use impurity solvers based on exact diagonalization or continuous-time quantum Monte Carlo for the solution of the DMFT self-consistency equations. Courses (type, number of weekly contact hours, language — if other than German, examination offered — if not every semester, inform	-	-		eoretical Physics	Faculty of Physics a	nd Astronomy	
8 numerical grade - Duration Module level Other prerequisites 1 semester graduate 1 semester graduate 1 bensity functional theory (DFT) 2. Wannier functions and localized basis functions 3. Numerical evaluation of topological invariants 4. Hartree-Fock and static mean-field theory 5. Anderson impurity model (AIM) and Kondo physics 7. Dynamical mean-field theory (DMFT) 8. DFT + DMFT methods for realistic modeling of solids 9. Strongly correlated electrons Interdet lear-Ting outcomes Courses (type, number of weekly contact hours, language – if other than German) V (a) + R (a) Modulu taught in: English Mathed of assessment (type, scope, language – if other than German, examination offered – if not every seme-ster, information on whether module canb echosen to earn a bonus) <td>ECTS</td> <td>Metho</td> <td>od of grading</td> <td>Only after succ. con</td> <td>npl. of module(s)</td> <td></td>	ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)		
1 semester graduate - Contents - 2. Wannier functions and localized basis functions - 3. Numerical evaluation of topological invariants - 4. Hartree-Fock and static mean-field theory - 5. Many-body methods for solid state physics - 6. Anderson impurity model (AIM) and Kondo physics - 7. Dynamical mean-field theory (OMFT) - 8. DFT + DMFT methods for realistic modeling of solids - 9. Strongly correlated electrons - Intended learning outcomes - Theoretical treatment of the above topics complemented by hands-on tutorials to be held in the CIP-Pool. Familiarity with DFT software packages such as VASP or Wienzk and construction of maximally localized Wannier functions of the AIM and explore some of its limiting cases such as the Kondo regime. Ability to use impurity solvers based on exact diagonalization or continuous-time quantum Monte Carlo for the solution of the DMFT self-consistency equations. 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 can be chosen to earn a bonus) a) written examination was chosen as method of assessment, this may be changed and assessment may instead take the form of an ora	8	nume	rical grade				
Contents 1. Density functional theory (DFT) 2. Wannier functions and localized basis functions 3. Numerical evaluation of topological invariants 4. Hartree-Fock and static mean-field theory 5. Mamy-body methods for solid state physics 6. Anderson impurity model (AIM) and Kondo physics 7. Dynamical mean-field theory (DMFT) 8. DFT + DMFT methods for realistic modeling of solids 9. Strongly correlated electrons Intended learning outcomes Theoretical treatment of the above topics complemented by hands-on tutorials to be held in the CIP-Pool. Familiarity with DFT software packages such as VASP or Wienzk and construction of maximally localized Wannier functions by projecting DFT results onto atomic orbitals using wanniergo. Knowledge how to obtain many-body solutions of the AIM and explore some of its limiting cases such as the Kondo regime. Ability to use impurity solvers based on exact diagonalization or continuous-time quantum Monte Carlo for the solution of the DMFT self-consistency equations. Courses (type, number of weekly contact hours, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus) Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information week for on an cal examination of a no cal examination of one candidate each (approx. 30 minutes) or o) are assessment and in groups. Groups 62, approx. 30 minutes per candidate) of a project report (approx. 30 re) presentation/talk (approx. 30 minutes).<	Duratio	n	Module level	Other prerequisites	;		
 Density functional theory (DFT) Wannier functions and localized basis functions Numerical evaluation of topological invariants Hartree-Fock and static mean-field theory Anany-body methods for solid state physics Anderson impurity model (AIM) and Kondo physics Dynamical mean-field theory (DMFT) B. DFT + DMFT methods for realistic modeling of solids Strongly correlated electrons Intended learning outcomes Theoretical treatment of the above topics complemented by hands-on tutorials to be held in the CIP-Pool. Familiarity with DFT software packages such as VASP or Wienzk and construction of maximally localized Wannier functions of the AIM and explore some of its limiting cases such as the Kondo regime. Ability to use impurity solvers based on exact diagonalization or continuous-time quantum Monte Carlo for the solution of the DMFT self-consistency equations. Courses (type, number of weekly contact hours, language — if other than German, examination offered — if not every semester, information on whether module can be chosen to earn a bonus) a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 minutes) or c) are axmination in groups (groups of 2, approx. 30 minutes) project report (approx. 30 to 120 minutes) or b) oral examination in groups. If the method of assessment (s changed, the lecturer must inform students about this by four weeks prior to the original examination of places Ta 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 dates. Language of assessment : English Atten examination false Language of assesssment is the semester in which the course is offered and in	1 seme	ster	graduate				
 2. Wannier functions and localized basis functions 3. Numerical evaluation of topological invariants 4. Hartree-fock and static mean-field theory 5. Many-body methods for solid state physics 6. Anderson impurity model (AIM) and Kondo physics 7. Dynamical mean-field theory (DMFI) 8. DFT + DMFT methods for realistic modeling of solids 9. Strongly correlated electrons Intended learning outcomes Theoretical treatment of the above topics complemented by hands-on tutorials to be held in the CIP-Pool. Familiarity with DFT software packages such as VASP or Wienzk and construction of maximally localized Wannier functions by projecting DFT results onto atomic orbitals using wanniergo. Knowledge how to obtain many-body solutions of the AIM and explore some of its limiting cases such as the Kondo regime. Ability to use impurity solvers based on exact diagonalization or continuous-time quantum Monte Carlo for the solution of the DMFT self-consistency equations. Courses (type, number of weekly contact hours, language — if other than German) V (a) + 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 can be chosen to earn a bonus) a) written examination ingroups (groups of 2, approx. 30 minutes) or () oral examination in groups (groups of 2, approx. 30 minutes) or d) project report (approx. 30 to 120 minutes) or c) 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 of places Language of assessment: English Assessment offered: In the semester in which the course is offered and in the subsequent se	Conten	ts					
stency equations. 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 seme- ster, information on whether module can be chosen to earn a bonus) a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 mi- nutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (ap- prox. 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	2. Wani 3. Num 4. Hartr 5. Many 6. Ande 7. Dyna 8. DFT + 9. Stror Intende Theoret liarity w ctions b	 Density functional theory (DFT) Wannier functions and localized basis functions Numerical evaluation of topological invariants Hartree-Fock and static mean-field theory Many-body methods for solid state physics Anderson impurity model (AIM) and Kondo physics Dynamical mean-field theory (DMFT) DFT + DMFT methods for realistic modeling of solids Strongly correlated electrons Intended learning outcomes Theoretical treatment of the above topics complemented by hands-on tutorials to be held in the CIP-Pool. Familiarity with DFT software packages such as VASP or Wien2k and construction of maximally localized Wannier functions by projecting DFT results onto atomic orbitals using wannier90. Knowledge how to obtain many-body solu-					
V (4) + R (2) Module taught in: English Method of assessment (type, scope, language — if other than German, examination offered — if not every seme- ster, information on whether module can be chosen to earn a bonus) a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 mi- nutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (ap- prox. 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 	stency	equatio	ons.				
Module taught in: English Method of assessment (type, scope, language — if other than German, examination offered — if not every seme- ster, information on whether module can be chosen to earn a 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 Workload 240 h			, number of weekly collid	et nours, language –	n other than defilld		
ster, information on whether module can be chosen to earn a 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 Moditional information Workload 240 h			t in: English				
nutes) 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 Mdditional information Workload 240 h						tion offered — if not every seme-	
Assessment offered: In the semester in which the course is offered and in the subsequent semester Allocation of places Additional information Workload 240 h	nutes) of prox. 8 If a writ stead ta of asse nation of	nutes) 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.					
Additional information Workload 240 h	·			which the course is	offered and in the su	ıbsequent semester	
 Workload 240 h	Allocat	ion of p	olaces				
 Workload 240 h							
240 h	Additio	Additional information					
240 h							
	Worklo	ad					
Teaching cycle	240 h						
	Teachir	ng cycl	e				

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

Module appears in

Module title					Abbreviation		
Renorn	Renormalization Group and Critical Phenomena 11-CRP-Int-201-m01						
Module	e coord	inator		Module offered by	lodule offered by		
Manag and As		ector of the Institute of sics	Theoretical Physics	Faculty of Physics a	ind Astronomy		
ECTS		od of grading	Only after succ. cor	npl. of module(s)			
6	nume	rical grade					
Duratio		Module level	Other prerequisites	i			
1 seme	ster	graduate					
Conten	ts						
4. Phas 5. Pertu 6. Low-	n field concep se diag urbation dimens						
Intende	ed lear	ning outcomes					
sics. U	ndersta	wledge of the principle anding of the concept o theory.					
Course	s (type	, number of weekly cor	itact hours, language –	- if other than Germa	ın)		
V (3) + Module		t in: English					
Metho	d of ass	sessment (type, scope,	language — if other th	an German, examina	tion offered — if not	every seme-	
ster, in	formati	on on whether module	can be chosen to earn	a bonus)			
nutes) prox. 8 If a writ stead t of asse nation Langua	or c) or to 10 p tten exa ake the essmen date at age of a	mination (approx. 90 to al examination in grou bages) or e) presentatio amination was chosen e form of an oral examin t is changed, the lectur the latest. ssessment: English ffered: In the semester	ps (groups of 2, approx on/talk (approx. 30 min as method of assessm nation of one candidate er must inform studen	x. 30 minutes per car lutes). ent, this may be cha e each or an oral exa ts about this by four	ndidate) or d) project nged and assessmen mination in groups. weeks prior to the or	t report (ap- nt may in- If the method riginal exami-	
Allocat	ion of p	olaces					
Additio	onal inf	ormation					
Worklo	ad						
180 h							
Teachi	Teaching cycle						
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module	Module appears in						
Master	's degr	ee (1 major) Physics Int gram Physics (2023)	ernational (2020)				
	-	r Physics International (2024)	-	• generated 21-Jun-2024 • exa r (120 ECTS) Physics Internati	-	page 59 / 153	



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

Module title Abbreviation					Abbreviation	
Advan	ced Top	ics in Astrophysics	11-CSAM-Int-201-m01			
Module coordinator Module offered by				Module offered by		
		ector of the Institute of Th	eoretical Physics	Faculty of Physics a	ind Astronomy	
	strophys	sics	,	, ,	,	
ECTS		od of grading	Only after succ. con	npl. of module(s)		
6		rical grade				
Duration 1 seme		Module level graduate	Other prerequisites	ination committee r	aquirad	
Conter		graduate	Approvatition exam		equileu.	
are rel dynam format	evant to nics, hea tion, as	the following topics: Steating and cooling process well as related topics.	ellar structure, star fo	rmation and develop	physics will be conveyed which oment, radiation transport, gas istry, accretion and jets, galaxy	
		ning outcomes				
		advanced skills in curren ndependently get acquai			physics.	
Course	es (type	, number of weekly conta	ct hours, language –	- if other than Germa	n)	
V (3) + Modul		t in: English				
ster, ir	nformati	on on whether module ca	an be chosen to earn	a bonus)	tion offered — if not every seme-	
nutes) prox. 8 If a wri stead t of asse nation	or c) or 3 to 10 p itten exa take the essmen date at	al examination in groups ages) or e) presentation, amination was chosen as form of an oral examina	(groups of 2, approx /talk (approx. 30 min method of assessme tion of one candidate	. 30 minutes per can utes). ent, this may be chan e each or an oral exa	nged and assessment may in- mination in groups. If the method weeks prior to the original exami-	
Alloca	tion of p	olaces				
Additi	onal inf	ormation				
Workle	oad					
180 h	180 h					
Teaching cycle						
Referr	ed to in	LPOI (examination regu	lations for teaching-o	degree programmes)		
	Module appears in					
	Master's degree (1 major) Physics International (2020)					
maste	Master's degree (1 major) Physics International (2024)					

Module tit	e	Abbreviation				
Advanced Topics in Solid State Physics				11-CSFM-Int-201-m01		
Module co	ordinator		Module offered by			
Managing and Astrop	Director of the Institute of Th hysics	neoretical Physics	Faculty of Physics a	nd Astronomy		
	thod of grading	Only after succ. con	npl. of module(s)			
6 nu	nerical grade					
Duration	Module level	Other prerequisites				
1 semester	graduate	Approval from exam	ination committee re	equired.		
vered in an				anced courses on topics not co- arch developments or to subjects		
	arning outcomes					
In-depth kr face betwe	owledge and understandin en teaching and research.	- ·		ter physics. Insight into the inter-		
V (3) + R (1)	pe, number of weekly conta ght in: English	ict hours, language –	- if other than Germa	n)		
	assessment (type, scope, la ation on whether module c			tion offered — if not every seme-		
prox. 8 to 1 If a written stead take of assessm nation date	o pages) or e) presentation examination was chosen as the form of an oral examina	/talk (approx. 30 min method of assessme tion of one candidate	utes). ent, this may be chai e each or an oral exa	ididate) or d) project report (ap- nged and assessment may in- mination in groups. If the method weeks prior to the original exami-		
Allocation	· · · · ·	-				
	-					
Additional	information					
Workload						
180 h						
Teaching c	ycle					
Referred to	Referred to in LPO I (examination regulations for teaching-degree programmes)					
Module ap	pears in					
Master's degree (1 major) Physics International (2020) Master's degree (1 major) Quantum Engineering (2020) Master's degree (1 major) Quantum Engineering (2024) Master's degree (1 major) Physics International (2024)						

Module title					Abbreviation	
Advan	Advanced Computer Tomography 11-CTA-Int-201-m01					
Modul	e coord	inator		Module offered by		
Manag	ing Dire	ector of the Institute of Ap	plied Physics	Faculty of Physics a	and Astronomy	
ECTS	·	od of grading	Only after succ. con	npl. of module(s)		
6	·	rical grade				
Durati		Module level	Other prerequisites	i		
1 seme		graduate				
This ac medica on to v ting th ty of st gebrain ny thes ror sou images waters Intend The stu basic i solution firm im any we Course	Contents 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 applicatio on to various tasks in engineering and medical science, this lecture emphasizes on the mathematics of "inver- ting the Radon transform". Starting with the simple Filtered Back Projection method which is applied to a varie- ty of standard recording geometries (parallel, fan, cone, helix) the advanced course lays out the strategies for al- gebraic reconstruction techniques (ART) along with many types of regularization schemes which may accompa- ny these methods. Students will have the opportunity to see how Radon data is recorded and how different er- ror 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 firm impression (first-hand experience) of the various sources of measurement errors in CT which can impede any well-prepared reconstruction.					
	e taugh	t in: English				
ster, in	formati	on on whether module ca	an be chosen to earn	a bonus)	tion offered — if not every seme-	
nutes) prox. 8 If a wri stead 1 of asse nation Langua	a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 mi- nutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (ap- prox. 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					
Alloca	tion of p	olaces				
Additio	onal info	ormation				
Worklo	Workload					
180 h	180 h					
Teachi	ng cycl	9				
Teachi	ng cycle	e: every year, after annou	ncement			
Referre	ed to in	LPOI (examination regu	lations for teaching-	degree programmes)		

Module appears in

Module title					Abbreviation	
	Electron and Ion Microscopy 11-EIM-Int-201-m01					
Modul	e coord	inator		Module offered by		
Manag	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	on	Module level	Other prerequisites			
1 seme	ster	graduate				
Conter	ts					
trons a	nd cha		measurement princi	ples: SEM, STEM, TE	nteraction of matter with elec- M, sample preparation, advan-	
Intend	ed lear	ning outcomes				
and ins	strumer		of detectors and cor	ntrast mechanisms. I	py. He/she knows the theoretical He/she knows different modi of Its in this field.	
Course	s (type	, number of weekly conta	ct hours, language —	- if other than Germa	n)	
V (3) + Module		t in: English				
		s essment (type, scope, la ion on whether module ca			tion offered — if not every seme-	
				-	e candidate each (approx. 30 mi-	
nutes) prox. 8 If a wri stead t of asse nation	or c) or to 10 p tten exa take the essmen date at	al examination in groups bages) or e) presentation/ amination was chosen as e form of an oral examination	(groups of 2, approx 'talk (approx. 30 min method of assessme tion of one candidate	. 30 minutes per can utes). ent, this may be char e each or an oral exar	didate) or d) project report (ap- nged and assessment may in- mination in groups. If the method weeks prior to the original exami-	
Allocat	ion of _l	olaces				
Additio	onal inf	ormation				
Worklo	ad					
180 h						
	Teaching cycle					
Teaching cycle: annually, after announcement						
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Modul	e appea	ars in				
Master	's degr	ee (1 major) Physics Inter	national (2020)			
		gram Physics (2023)				
	-	ee (1 major) Quantum Eng				
Master	Master's degree (1 major) Physics International (2024)					

Module title					Abbreviation	
Introduction to Plasma Physics					11-EPP-Int-201-m01	
Module	e coord	linator		Module offered by	<u>I</u>	
Managi and As		ector of the Institute of Th sics	eoretical Physics	Faculty of Physics a	and Astronomy	
ECTS	1	od of grading	Only after succ. con	npl. of module(s)		
6		rical grade		• • • •		
Duratio	on	Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	ts					
Transpo thin the celerat	ort equ e solar ion and	ations for energetic parti wind, Particle acceleration d transport in galaxies an	cles, Properties of ma on via shock waves a	agnetic turbulence, F nd via interaction wit	elds, Magnetohydrodynamics, Propagation of solar particles wi- th plasma turbulence, Particle ac- liation.	
Intende	ed lear	ning outcomes				
Knowle	dge of	fundamental processes i	n plasma astrophysi	cs.		
Course	s (type	, number of weekly conta	ct hours, language –	- if other than Germa	an)	
V (2) + Module	• • •	ıt in: English				
		sessment (type, scope, la ion on whether module c			tion offered — if not every seme-	
prox. 8 If a writ stead t of asse nation Langua	to 10 p tten exa ake the ssmen date at age of a	bages) or e) presentation, amination was chosen as e form of an oral examina	/talk (approx. 30 min method of assessm tion of one candidate must inform student	utes). ent, this may be cha e each or an oral exa is about this by four	ndidate) or d) project report (ap- 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						
Teachi	ng cycl	e				
Referre	ed to in	LPOI (examination regu	lations for teaching-	degree programmes)		
Module	e appea	ars in				
	-	ee (1 major) Physics Inter	national (2020)			
	exchange program Physics (2023)					
Master	Master's degree (1 major) Physics International (2024)					

Module title					Abbreviation	
Current Topics in Experimental Physics					11-EXE5-Int-201-m01	
Module	coord	inator		Module offered by		
chairpe	erson of	examination committee		Faculty of Physics a	ind Astronomy	
ECTS	Metho	od of grading	Only after succ. com	npl. of module(s)		
5	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				
suring a link the	and eva learnt	aluation methods which a . He/She knows about fie	are necessary to acqued by a cqued by a cque	ire this knowledge.	physics and insight into the mea- He/She is able to classify and to	
		number of weekly conta	ct hours, language —	· if other than Germa	n)	
V(2) +		t in: English				
			nguaga if other the	an Corman, ovamina	tion offered — if not every seme-	
		on on whether module ca			liton onered — If not every seme-	
nutes) of prox. 8 If a writ stead ta of asse nation of	or c) ora to 10 p ten exa ake the ssment date at	al examination in groups ages) or e) presentation, mination was chosen as form of an oral examina	(groups of 2, approx /talk (approx. 30 min method of assessme tion of one candidate	. 30 minutes per can utes). ent, this may be chan e each or an oral exa	e candidate each (approx. 30 mi- ndidate) or d) project report (ap- 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				
Worklo	ad					
150 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)						
Master's degree (1 major) Physics International (2024)						

Module	e title				Abbreviation	
Current Topics in Experimental Physics					11-EXE6A-Int-201-m01	
Module	e coord	inator		Module offered by		
chairpe	erson of	f examination committee		Faculty of Physics a	ind Astronomy	
ECTS		od of grading	Only after succ. com	pl. of module(s)		
6	L	rical grade				
Duratio		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	
Intend	ed learı	ning outcomes				
suring link the	and eva e learnt		are necessary to acquelds of application.	ire this knowledge.	physics and insight into the mea- He/She is able to classify and to	
V (3) +		, number of weekty conta				
		t in: English				
ster, in a) writt nutes) prox. 8 If a writ	formati en exar or c) or to 10 p tten exa	on on whether module can nination (approx. 90 to 1 al examination in groups ages) or e) presentation amination was chosen as	an be chosen to earn 20 minutes) or b) ora (groups of 2, approx 'talk (approx. 30 min method of assessme	a bonus) I examination of one . 30 minutes per can utes). ent, this may be chan	ition offered — if not every seme- e candidate each (approx. 30 mi- ididate) or d) project report (ap- nged and assessment may in- mination in groups. If the method	
of asse nation	essmen date at				weeks prior to the original exami-	
Allocat	ion of p	olaces				
Additio	onal info	ormation				
Worklo	ad					
180 h						
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's degree (1 major) Physics International (2024)						

Module	e title			Abbreviation		
Current Topics in Experimental Physics					11-EXE6-Int-201-m01	
Module coordinator				Module offered by		
chairperson of examination committee				Faculty of Physics and Astronomy		
ECTS Method of grading		Only after succ. com	v after succ. compl. of module(s)			
6	numerical grade					
i i i			Other prerequisites			
1 semester graduate Approval from examination committee required.					equired.	
Conten	ts					
Current study a	•	in experimental physics.	Credited academic a	achievements, e.g. ir	n case of change of university or	
Intend	ed learı	ning outcomes				
Master suring link the	's level and eva e learnt	. He/She commands kno aluation methods which a . He/She knows about fie	wledge in a current fi are necessary to acqu elds of application.	eld in experimental ire this knowledge.	ule in experimental physics on physics and insight into the mea- He/She is able to classify and to	
		, number of weekly conta	ct hours, language —	if other than Germa	n)	
V (3) +						
		t in: English				
		essment (type, scope, la on on whether module ca			tion offered — if not every seme-	
nutes) prox. 8 If a writ stead t of asse nation	or c) or to 10 p tten exa take the essmen date at	al examination in groups ages) or e) presentation, amination was chosen as form of an oral examina	(groups of 2, approx. 'talk (approx. 30 mine method of assessme tion of one candidate	. 30 minutes per can utes). ent, this may be chan e each or an oral exa	e candidate each (approx. 30 mi- ididate) or d) project report (ap- nged and assessment may in- mination in groups. If the method weeks prior to the original exami-	
Allocat	ion of p	olaces				
Additio	onal inf	ormation				
Worklo	ad					
180 h						
Teachi	ng cycl	9				
Referre	ed to in	LPOI (examination regu	lations for teaching-c	legree programmes)		
		5				
Module	e appea	irs in				
		ee (1 major) Physics Inter	national (2020)			
	-	ee (1 major) Physics Inter				
	- 0.					

Module	e title				Abbreviation
Current Topics in Experimental Physics					11-EXE7-Int-201-m01
Module coordinator				Module offered by	
chairperson of examination committee				Faculty of Physics and Astronomy	
ECTS Method of grading		Only after succ. com	succ. compl. of module(s)		
7	numerical grade				
Duration Module level		Other prerequisites			
1 semester graduate Approval from examination committee required.					equired.
Conten					
Current study a	•	in experimental physics.	Credited academic a	achievements, e.g. ir	n case of change of university or
Intende	ed learı	ning outcomes			
suring link the	and eva e learnt	-	are necessary to acquelds of application.	ire this knowledge.	physics and insight into the mea- He/She is able to classify and to
V (3) +		, number of weekly collid	ci nouis, ialiguage —		ui <i>)</i>
		t in: English			
ster, in a) writt nutes)	formati en exar or c) or	on on whether module ca mination (approx. 90 to 1	an be chosen to earn 20 minutes) or b) ora (groups of 2, approx	a bonus) Il examination of one . 30 minutes per can	tion offered — if not every seme- e candidate each (approx. 30 mi- ndidate) or d) project report (ap-
If a writ stead t of asse nation	tten exa ake the ssmen date at	amination was chosen as form of an oral examina	method of assessme tion of one candidate	ent, this may be cha e each or an oral exa	nged and assessment may in- mination in groups. If the method weeks prior to the original exami-
Allocat	ion of p	olaces			
Additio	onal info	ormation			
Worklo	ad				
210 h					
Teachi	ng cycl	e			
	_ •		-		
Referre	ed to in	LPOI (examination regu	lations for teaching-c	legree programmes)	
		5			
Module	e appea	irs in			
		ee (1 major) Physics Inter	national (2020)		
	-	ee (1 major) Physics Inter			

Module t	itle			Abbreviation	
Current T	opics in Experimental Physics	5		11-EXE8-Int-201-m01	
Module coordinator			Module offered by		
chairperson of examination committee			Faculty of Physics and Astronomy		
ECTS Method of grading		Only after succ. com	y after succ. compl. of module(s)		
8 n	numerical grade				
Duration		Other prerequisites			
1 semester graduate Approval from examination committee required.					
Contents					
Current to study abr		Credited academic a	ichievements, e.g. ir	n case of change of university or	
Intended	learning outcomes				
Master's suring an link the le	level. He/She commands kno nd evaluation methods which a earnt. He/She knows about fie	wledge in a current fi are necessary to acqu elds of application.	eld in experimental ire this knowledge.	ule in experimental physics on physics and insight into the mea- He/She is able to classify and to	
	(type, number of weekly conta	ct hours, language —	If other than Germa	in)	
V(4) + R	(2) aught in: English				
		naugaa if ather the	n Cormon overing	tion offered if not even come	
	rmation on whether module ca			tion offered — if not every seme-	
nutes) or prox. 8 to If a writte stead tak of assess nation da	c) oral examination in groups o 10 pages) or e) presentation/ en examination was chosen as se the form of an oral examination	(groups of 2, approx. 'talk (approx. 30 mine method of assessme tion of one candidate	. 30 minutes per can utes). ent, this may be chan each or an oral exa	e candidate each (approx. 30 mi- ididate) or d) project report (ap- nged and assessment may in- mination in groups. If the method weeks prior to the original exami-	
Allocatio	n of places				
Additiona	al information				
Workload	d				
240 h					
Teaching	cvcle				
	, -,				
Referred	to in LPO I (examination regu	lations for teaching-c	legree programmes)		
	<u> </u>				
Module a	appears in				
	degree (1 major) Physics Inter	national (2020)			
	degree (1 major) Physics Inter				
	· ·	P*			

	<u>e title</u>				Abbreviation	
Nonphy	ysical I	Minor Subject			11-EXNP6-Int-201-m01	
Module coordinator				Module offered by		
chairperson of examination committee			!	Faculty of Physics and Astronomy		
ECTS Method of grading		Only after succ. compl. of module(s)				
6	nume	rical grade				
Duration Module level		Other prerequisites				
1 semester graduate			Approval from examination committee required.			
Conten	ts					
Non-te	chnica	l minor. Crediting for acad	demic achievements,	e.g. from university	change or study abroad	
Intend	ed lear	ning outcomes				
		osseses advanced know ical minor subject (mathe			irements of a module in the field).	
Course	s (type	, number of weekly conta	act hours, language –	- if other than Germa	an)	
V (3) + Module		t in: English				
a) writt nutes) prox. 8	en exa or c) oi to 10 p		20 minutes) or b) ora (groups of 2, approx	al examination of on	e candidate each (approx. 30 mi- ndidate) or d) project report (ap-	
of assention Langua Allocat	ake the essmen date at age of a tion of	amination was chosen as e form of an oral examina t is changed, the lecture t the latest. assessment: English	method of assessme tion of one candidate	ent, this may be cha e each or an oral exa	nged and assessment may in- mination in groups. If the method	
of assention Langua Allocat	ake the essmen date at age of a tion of pnal inf	amination was chosen as e form of an oral examina t is changed, the lecturer t the latest. assessment: English places	method of assessme tion of one candidate	ent, this may be cha e each or an oral exa	nged and assessment may in- mination in groups. If the method	
of assention Langua Allocat Additio	ake the essmen date at age of a tion of pnal inf	amination was chosen as e form of an oral examina t is changed, the lecturer t the latest. assessment: English places	method of assessme tion of one candidate	ent, this may be cha e each or an oral exa	nged and assessment may in- mination in groups. If the method	
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of asse nation Langua Allocat Additio Worklo 180 h	ake the essmen date a age of a ion of onal inf	amination was chosen as e form of an oral examina t is changed, the lecture t the latest. assessment: English places	method of assessme tion of one candidate	ent, this may be cha e each or an oral exa		
of asse nation Langua Allocat Additio Worklo 180 h Teachin	ake the essmen date a age of a ion of onal inf oad	amination was chosen as e form of an oral examina t is changed, the lecture t the latest. assessment: English places	s method of assessme tion of one candidate must inform student	ent, this may be cha e each or an oral exa ts about this by four	nged and assessment may in- imination in groups. If the method weeks prior to the original exami	
of asse nation Langua Allocat Additio Worklo 180 h Teachin	ake the essmen date a age of a ion of onal inf oad	amination was chosen as e form of an oral examina t is changed, the lecture t the latest. assessment: English places	s method of assessme tion of one candidate must inform student	ent, this may be cha e each or an oral exa ts about this by four	nged and assessment may in- imination in groups. If the method weeks prior to the original exami	
of asse nation Langua Allocat Additio Worklo 180 h Teachin	ake the essmen date at age of a ion of onal inf onal inf oad	amination was chosen as e form of an oral examina t is changed, the lecturent t the latest. assessment: English places formation e LPO I (examination regu	s method of assessme tion of one candidate must inform student	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 method weeks prior to the original exami	
of asse nation Langua Allocat Worklo 180 h Teachin Referre Module	ake the essmen date at age of a ion of onal inf onal inf oad ed to in	amination was chosen as e form of an oral examina t is changed, the lecturent t the latest. assessment: English places formation e LPO I (examination regu	s method of assessme tion of one candidate must inform student lations for teaching-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 method weeks prior to the original exami	

Module title Abbreviation					Abbreviation		
Curren	t Topic	s in Physics			11-EXP6A-Int-201-m01		
Module coordinator				Module offered by			
chairp	erson o	f examination committee		Faculty of Physics a	nd Astronomy		
ECTS	Metho	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	Approval from exam	ination committee re	equired.		
Conter	nts						
		in experimental or theor tudy abroad.	etical physics. Credit	ed academic achiev	ements, e.g. in case of change of		
Intend	ed lear	ning outcomes					
physic a curre this kn	s on Ma ent field lowledg	aster's level in the study p in physics and insight in re. He/She is able to class	programme Nanostru to the measuring and sify and to link the le	cture Technology. He d calculating method arnt. He/She knows	ule in theoretical or experimental e/She commands knowledge in Is which are necessary to acquire about fields of application.		
Course	es (type	, number of weekly conta	ct hours, language –	- if other than Germa	n)		
V (3) + Modul		t in: English					
		sessment (type, scope, la on on whether module ca			tion offered — if not every seme-		
nutes) prox. 8 If a wri stead 1 of asse nation	or c) or 3 to 10 p tten exa take the essmen date at	al examination in groups bages) or e) presentation/ amination was chosen as e form of an oral examination	(groups of 2, approx 'talk (approx. 30 min method of assessme tion of one candidate	. 30 minutes per can utes). ent, this may be chan e each or an oral exa	e candidate each (approx. 30 mi- didate) or d) project report (ap- nged and assessment may in- mination in groups. If the method weeks prior to the original exami-		
	tion of p	¥					
Additio	onal inf	ormation					
Worklo	bad						
180 h							
Teachi	Teaching cycle						
Referred to in LPO I (examination regulations for teaching-degree programmes)							
Modul	e appea	ars in					
Master	r's degr	ee (1 major) Physics Inter	national (2020)				
1	-	ee (1 major) Quantum Eng					
1	-	ee (1 major) Quantum Eng					
Master	Master's degree (1 major) Physics International (2024)						

					Abbreviation		
Current Topics in Physics 11-EXP6-Int-201-m01					11-EXP6-Int-201-m01		
Module	coord	inator		Module offered by			
chairpe	rson o	f examination committee		Faculty of Physics a	nd Astronomy		
		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	Approval from exam	ination committee re	equired.		
Content	s						
	•	in experimental or theor tudy abroad.	etical physics. Credit	ed academic achieve	ements, e.g. in case of change of		
Intende	d learı	ning outcomes					
physics a curren	on Ma nt field	aster's level in the study p in physics and insight in	programme Nanostru to the measuring and	cture Technology. He l calculating method	ule in theoretical or experimental e/She commands knowledge in s which are necessary to acquire about fields of application.		
Courses	s (type	, number of weekly conta	ct hours, language —	if other than Germa	n)		
V (3) + R	R (1)						
ster, infi a) written nutes) of prox. 8 f If a writt stead ta of asses nation of Languag Allocati Addition	Courses (type, number of weekly contact hours, language — if other than German) V (3) + R (1) Method of assessment (type, scope, language — if other than German, examination offered — if not every seme- ster, information on whether module can be chosen to earn a 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 Workload						
		_					
Teachin	Teaching cycle						
Referred	Referred to in LPO I (examination regulations for teaching-degree programmes)						
	-						
	Module appears in						
Master's Master's	s degro s degro	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
Current Topics of Theoretical Physics					11-EXT5-Int-201-m01
Module coordinator				Module offered by	<u> </u>
chairpe	erson o	f examination committee	2	Faculty of Physics a	ind Astronomy
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)	
5	nume	rical grade			
Duratio	on	Module level	Other prerequisites		
1 seme	ster	graduate	Approval from exam	ination committee r	equired.
Conten	ts				
Current study a	•		redited academic ach	nievements, e.g. in c	ase of change of university or
Intende	ed lear	ning outcomes			
sters th Course V (2) +	ne resp s (type R (2)	ective methods. He/She , number of weekly conta	is able to apply these	e methods to current	in theoretical physics and ma- problems in theoretical physics. n)
		t in: English			
ster, in a) writt	formati en exa	on on whether module c mination (approx. 90 to 1	an be chosen to earn 20 minutes) or b) ora	a bonus) Il examination of one	tion offered — if not every seme-
ster, int a) writte nutes) of prox. 8 If a writt stead ta of asse nation	formati en exai or c) or to 10 p tten exa ake the ssmen date at	on on whether module comination (approx. 90 to 1 al examination in groups bages) or e) presentation, amination was chosen as a form of an oral examina t is changed, the lecturer the latest.	an be chosen to earn 20 minutes) or b) ora 5 (groups of 2, approx /talk (approx. 30 min 5 method of assessme tion of one candidate	a bonus) Il examination of one . 30 minutes per car utes). ent, this may be cha e each or an oral exa	
ster, int a) writte nutes) of prox. 8 If a writt stead ta of asse nation	formati en exal or c) or to 10 p tten exa ake the ssmen date at ge of a	on on whether module comination (approx. 90 to 1 al examination in groups bages) or e) presentation, amination was chosen as form of an oral examina t is changed, the lecturer the latest. ssessment: English	an be chosen to earn 20 minutes) or b) ora 5 (groups of 2, approx /talk (approx. 30 min 5 method of assessme tion of one candidate	a bonus) Il examination of one . 30 minutes per car utes). ent, this may be cha e each or an oral exa	e candidate each (approx. 30 mi- ididate) or d) project report (ap- nged and assessment may in- mination in groups. If the method
ster, in a) written nutes) of prox. 8 If a writen stead to of assen nation Langua	formati en exal or c) or to 10 p tten exa ake the ssmen date at ge of a	on on whether module comination (approx. 90 to 1 al examination in groups bages) or e) presentation, amination was chosen as form of an oral examina t is changed, the lecturer the latest. ssessment: English	an be chosen to earn 20 minutes) or b) ora 5 (groups of 2, approx /talk (approx. 30 min 5 method of assessme tion of one candidate	a bonus) Il examination of one . 30 minutes per car utes). ent, this may be cha e each or an oral exa	e candidate each (approx. 30 mi- ididate) or d) project report (ap- nged and assessment may in- mination in groups. If the method
ster, int a) writt nutes) prox. 8 If a writ stead ta of asse nation Langua Allocat	formati en exat or c) or to 10 p tten exa ake the ssmen date at ge of a ion of p	on on whether module comination (approx. 90 to 1 al examination in groups bages) or e) presentation, amination was chosen as form of an oral examina t is changed, the lecturer the latest. ssessment: English	an be chosen to earn 20 minutes) or b) ora 5 (groups of 2, approx /talk (approx. 30 min 5 method of assessme tion of one candidate	a bonus) Il examination of one . 30 minutes per car utes). ent, this may be cha e each or an oral exa	e candidate each (approx. 30 mi- ididate) or d) project report (ap- nged and assessment may in- mination in groups. If the method
ster, int a) writt nutes) prox. 8 If a writ stead ta of asse nation Langua Allocat	formati en exat or c) or to 10 p tten exa ake the ssmen date at ge of a ion of p	on on whether module comination (approx. 90 to 1 al examination in groups bages) or e) presentation, amination was chosen as the form of an oral examina t is changed, the lecturer the latest. ssessment: English	an be chosen to earn 20 minutes) or b) ora 5 (groups of 2, approx /talk (approx. 30 min 5 method of assessme tion of one candidate	a bonus) Il examination of one . 30 minutes per car utes). ent, this may be cha e each or an oral exa	e candidate each (approx. 30 mi- ididate) or d) project report (ap- nged and assessment may in- mination in groups. If the method
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ster, int a) writt nutes) of prox. 8 If a writ stead ta of asse nation of Langua Allocat Additio 150 h	formati en exan or c) or to 10 p tten exa ake the ssmen date at ge of a ion of p mal info	on on whether module comination (approx. 90 to 1 al examination in groups bages) or e) presentation, amination was chosen as e form of an oral examina t is changed, the lecturer the latest. ssessment: English blaces	an be chosen to earn 20 minutes) or b) ora 5 (groups of 2, approx /talk (approx. 30 min 5 method of assessme tion of one candidate	a bonus) Il examination of one . 30 minutes per car utes). ent, this may be cha e each or an oral exa	e candidate each (approx. 30 mi- ididate) or d) project report (ap- nged and assessment may in- mination in groups. If the method
ster, ini a) writt nutes) of prox. 8 If a writ stead ta of asse nation Langua Allocat Additio Worklo	formati en exan or c) or to 10 p tten exa ake the ssmen date at ge of a ion of p mal info	on on whether module comination (approx. 90 to 1 al examination in groups bages) or e) presentation, amination was chosen as e form of an oral examina t is changed, the lecturer the latest. ssessment: English blaces	an be chosen to earn 20 minutes) or b) ora 5 (groups of 2, approx /talk (approx. 30 min 5 method of assessme tion of one candidate	a bonus) Il examination of one . 30 minutes per car utes). ent, this may be cha e each or an oral exa	e candidate each (approx. 30 mi- ididate) or d) project report (ap- nged and assessment may in- mination in groups. If the method
ster, int a) writt nutes) of prox. 8 If a writ stead ta of asse nation Langua Allocat Additio 150 h Teachin 	formati en exan or c) or to 10 p tten exa ake the ssmen date at ge of a ion of p mal inf ad	on on whether module comination (approx. 90 to 1 al examination in groups bages) or e) presentation, amination was chosen as e form of an oral examina t is changed, the lecturer the latest. ssessment: English blaces	an be chosen to earn 20 minutes) or b) ora 3 (groups of 2, approx /talk (approx. 30 min 5 method of assessme tion of one candidate r must inform student	a bonus) al examination of one . 30 minutes per can utes). ent, this may be chan e each or an oral exa is about this by four	e candidate each (approx. 30 mi- ididate) or d) project report (ap- nged and assessment may in- mination in groups. If the method weeks prior to the original exami-
ster, int a) writt nutes) of prox. 8 If a writ stead ta of asse nation Langua Allocat Additio 150 h Teachin 	formati en exan or c) or to 10 p tten exa ake the ssmen date at ge of a ion of p mal inf ad	on on whether module comination (approx. 90 to 1 al examination in groups bages) or e) presentation, amination was chosen as a form of an oral examina t is changed, the lecturer the latest. ssessment: English blaces	an be chosen to earn 20 minutes) or b) ora 3 (groups of 2, approx /talk (approx. 30 min 5 method of assessme tion of one candidate r must inform student	a bonus) al examination of one . 30 minutes per can utes). ent, this may be chan e each or an oral exa is about this by four	e candidate each (approx. 30 mi- ididate) or d) project report (ap- nged and assessment may in- mination in groups. If the method weeks prior to the original exami-
ster, ini a) writt nutes) of prox. 8 If a writ stead ta of asse nation of Langua Allocat Additio 150 h Teachin Referre 	formati en exan or c) or to 10 p tten exa ake the ssmen date at ge of a ion of p nal inf ad	on on whether module comination (approx. 90 to 1 al examination in groups bages) or e) presentation, amination was chosen as a form of an oral examina t is changed, the lecturer the latest. ssessment: English blaces ormation e LPO I (examination regu	an be chosen to earn 20 minutes) or b) ora 3 (groups of 2, approx /talk (approx. 30 min 5 method of assessme tion of one candidate r must inform student	a bonus) al examination of one . 30 minutes per can utes). ent, this may be chan e each or an oral exa is about this by four	e candidate each (approx. 30 mi- ididate) or d) project report (ap- nged and assessment may in- mination in groups. If the method weeks prior to the original exami-
ster, ini a) writt nutes) of prox. 8 If a writ stead ta of asse nation of Langua Allocat Additio 150 h Teachin Referre Module	formati en exat or c) or to 10 p tten exat ake the ssmen date at ge of a ion of p onal info ad	on on whether module comination (approx. 90 to 1 al examination in groups bages) or e) presentation, amination was chosen as a form of an oral examina t is changed, the lecturer the latest. ssessment: English blaces ormation e LPO I (examination regu	an be chosen to earn 220 minutes) or b) ora 5 (groups of 2, approx /talk (approx. 30 min 5 method of assessme tion of one candidate r must inform student allations for teaching-o	a bonus) al examination of one . 30 minutes per can utes). ent, this may be chan e each or an oral exa is about this by four	e candidate each (approx. 30 mi- ididate) or d) project report (ap- nged and assessment may in- mination in groups. If the method weeks prior to the original exami-

Current Topics of Theoretical Physics 11-EXT6A-Int-201-m01 Module coordinator Module offered by 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 in theoretical physics. Credited academic achievements, e.g. in case of change of university or study abroad. Intended learning outcomes Intended tearning outcomes The student posseses deepened knowledge meeting the requirements of a module in theoretical physics on <i>I</i> ster's level. He/S he commands advanced technical knowledge in a current field in theoretical physics on <i>I</i> ster's level. He/S he commands advanced technical knowledge in a current problems in theoretical physics or <i>I</i> of ster's knowledge in a current field in theoretical physics and mesters the respective methods. He/S he is able to apply these methods to current problems in theoretical physics or <i>I</i> of ster's knowledge in a current field in theoretical physics and mesters it respective methods. He/S he commands advanced technical knowledge in a current field in theoretical physics on <i>I</i> ster's knowledge of assessment (hype, scope, language – if other than German, examination offered – if not every sen ster, information on whether module can be chosen to earn a bonus) 0 yorition examination in groups (groups of 2,	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 Contents	Current Topics of Theoretical Physics					11-EXT6A-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 and masters the respective methods. He/She is able to apply these methods to current problems in theoretical physics and masters the respective methods. He/She commands advanced technical knowledge in a current field in theoretical physics and masters (type, number of weekly contact hours, language – if other than German, examination offered – if not every sensers (type, number of weekly contact hours, language – if other than German, examination offered – if not every sensers, information on whether module can be chosen to earn a bonus) 0 (3) + R (1) Module taught in: English Method of assessment (type, scope, language – if other than German, examination offered – if not every senser, information on whether module can be chosen to earn a bonus) a) written examination (approx. 30 to 120 minutes) or b) oral examination of one candidate each (approx. 30 to 100 pages) or e) presentation/talk (approx. 30 minutes). If a written examination was chosen as met	Module coordinator				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 possees deepened knowledge meeting the requirements of a module in theoretical physics on M ster's level. He/She commands advanced technical knowledge in a current field in theoretical physics and msters the respective methods. He/She is able to apply these methods to current problems in theoretical physics and msters the respective methods. He/She is able to apply these methods to current problems in theoretical physics on M odule targht in: English Method of assessment (type, scope, language — if other than German) V (3) + R (1) Module car be chosen to earn a bonus) a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 nutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (approx. 30 to 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 eatemination of one candidate each or an oral examination in groups. (Fither was the shanged, the lecturer must inform students about this by four weeks prior to the original each attor and take at the latest. Language of assessment: English	chairpe	erson o	f examination committee		Faculty of Physics a	ind Astronomy	
Duration Module level Other prerequisites 1 semester graduate Approval from examination committee required. Contents Content 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 and mster's level. He/She commands advanced technical knowledge in a current field in theoretical physics and mster's level. He/She commands advanced technical knowledge in a current problems in theoretical physics and mster's level. He/She commands advanced technical knowledge in a current problems in theoretical physics and mster's level. He/She commands advanced technical knowledge in a current problems in theoretical physics and mster's level. He/She commands advanced technical knowledge in a current problems in theoretical physics and mster's level. He/She commands advanced technical knowledge in a current problems in theoretical physics and mster's level. He/She motion 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 sen ster, information on whether module can be chosen to eam a bonus) a) written examination in groups (groups of 2, approx. 30 minutes). If a written examination in groups (groups of 2, approx. 30 minutes). If a written examination of an cale examination of one candidate each or an oral examination in groups. If the	ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)		
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Module appears in							
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	Module	appea	urs in				
				national (2020)			
Master's degree (1 major) Physics International (2024)							

Module title			Abbreviation		
Current Topic	s of Theoretical Physics			11-EXT6-Int-201-m01	
Module coor	linator		Module offered by		
chairperson o	of examination committee		Faculty of Physics a	and Astronomy	
	od of grading	Only after succ. com	pl. of module(s)		
6 nume	erical grade				
Duration	Module level	Other prerequisites			
1 semester	graduate	Approval from exam	ination committee re	equired.	
Contents					
Current topic study abroad		redited academic ach	ievements, e.g. in c	ase of change of university or	
Intended lea	rning outcomes				
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Additional in	formation				
Workload					
180 h					
Teaching cycle					
Referred to in	LPOI (examination regu	lations for teaching.	legree programmes)		
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 Module appe	ars in				
		national (2020)			
Master's degree (1 major) Physics International (2020) Master's degree (1 major) Physics International (2024)					

Module title					Abbreviation					
Current Topics of Theoretical Physics					11-EXT7-Int-201-m01					
Module	e coord	inator		Module offered by	<u> </u>					
chairpe	erson o	f examination committee		Faculty of Physics a	and Astronomy					
ECTS	Metho	od of grading	Only after succ. com	pl. of module(s)						
7	nume	rical grade								
Duratio	on	Module level	Other prerequisites							
1 seme	ster	graduate	Approval from exam	ination committee r	equired.					
Conten	ts									
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Intende	ed lear	ning outcomes								
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		, number of weekly conta	ct hours, language —	if other than Germa	ın)					
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		essment (type, scope, la on on whether module ca			tion offered — if not every seme-					
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Module appears in										
Master's degree (1 major) Physics International (2020)										
Master	's degr	ee (1 major) Physics Inter	national (2020)							

Module title					Abbreviation
Current Topics of Theoretical Physics					11-EXT8-Int-201-m01
Module coordinator				Module offered by	<u> </u>
chairpe	erson o	f examination committee	!	Faculty of Physics a	ind Astronomy
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)	
8	nume	rical grade			
Duratio	on	Module level	Other prerequisites		
1 seme	ster	graduate	Approval from exam	ination committee r	equired.
Conten	ts				
Current study a	•		redited academic ach	nievements, e.g. in c	ase of change of university or
Intend	ed lear	ning outcomes			
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Module title			Abbreviation			
Field Theory in Solid State Physics			11-FFK-Int-201-m01			
Module coordinator		Module offered by				
Managing Director of the Institute of T and Astrophysics	neoretical Physics	Faculty of Physics a	nd Astronomy			
ECTS Method of grading	Only after succ. con	npl. of module(s)				
8 numerical grade						
Duration Module level	Other prerequisites					
1 semester graduate						
Contents						
Green's functions An outline could be: 1. Single-particle Green's function 2. Review of second quantization 3. Diagrammatic method using many p 4. Diagrammatic method for finite T 5. Landau theory of Fermi liquids 6. Superconductivity 7. One-dimensional systems and boso Intended learning outcomes Working knowledge of the methods of	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					
Courses (type, number of weekly conta	act hours, language –	- if other than Germa	n)			
V (4) + R (2) Module taught in: English						
Method of assessment (type, scope, la ster, information on whether module of			tion offered — if not every seme-			
 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. Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: English 						
Allocation of places						
Additional information						
240 h						
Teaching cycle						
Referred to in LPO I (examination regulation)	llations for teaching-o	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	
Solid State Physics 2 11-FK2-Int-201-m01					11-FK2-Int-201-m01	
Module coordinator Module offe				Module offered by		
Manag	Managing Director of the Institute of Applied Physics			Faculty of Physics a	nd Astronomy	
ECTS	<u> </u>	· · · · · ·	Only after succ. com	· · · · · · · · · · · · · · · · · · ·	Ind Astronomy	
	·	od of grading	Only aller Succ. con			
8	·	rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	graduate	Approval from exam	ination committee re	equired.	
Conten	Its					
a. Elect b. Bloc c. Elect 2. Sem a. Elect b. Ferm c. Elect d. Boltz 3. The c a. Mact b. Pola plasmo c. Ferro 4. Sem a. Char b. Intrin c. Dope d. Phys e. Hete 5. Mag a. Atom b. Dia- c. Ferro 6. Supe a. Pher b. Mod	trical ar h theor trons i-classi trical tra- ni surfac- trical tra- zmann- dielectr roscopi rizabili- ons, inte- omagne icondu- racteris- nsic ser ed semi sics and erostruc netism nic dia- and pa omagne ercondu- nomena- lels of s	cal models of dynamic pr ansport in partially and co ces; measurement technic ansport in external magne equations of transport ic function and ferroelect c electrodynamics and m ty of solids, of lattices, of er-band transitions, Want tism ctors tics niconductors conductors l applications of p-n junc tures and paramagnetism ramagnetism in metals tism uctivity	rocesses ompletely filled band ques etic fields trics icroscopic theory valence electrons ar nier-Mott excitons		ns; optical phonons, polaritons,	
Intende	ed leari	ning outcomes				
	-	effects, concepts and mo h applications of experim		lid state physics. Far	niliarity with the theoretical prin-	
Course	s (type	, number of weekly conta	ct hours, language —	- if other than Germa	n)	
V (4) + Module		t in: English				
	Method of assessment (type, scope, language — if other than German, examination offered — if not every seme- ster, information on whether module can be chosen to earn a bonus)					
nutes) prox. 8	or c) or to 10 p	al examination in groups ages) or e) presentation	(groups of 2, approx talk (approx. 30 min	. 30 minutes per can utes).	e candidate each (approx. 30 mi- didate) or d) project report (ap-	
stead t of asse	ake the	form of an oral examination	tion of one candidate	e each or an oral exa	nged and assessment may in- mination in groups. If the method weeks prior to the original exami-	

Master's with 1 major Physics International (2024)

Julius-Maximilians-UNIVERSITÄT WÜRZBURG

Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: English

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)

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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)

					Abbreviation	
Solid State Spectrocopy 11-FKS-Int-201-m01					11-FKS-Int-201-m01	
Module coordinator				Module offered by		
Manag	Managing Director of the Institute of Applied Physics			Faculty of Physics a	nd Astronomy	
ECTS		od of grading	Only after succ. com	pl. of module(s)		
6	nume	rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	ts					
-		ny particle picture of elec X-ray spectroscopies.	ctrons in solids, Light	-matter interaction,	Optical spectroscopy, Electron	
Intende	ed lear	ning outcomes				
	their a				rent methods of spectrosco- rn developments in the related	
Course	s (type	, number of weekly conta	ct hours, language —	if other than Germa	n)	
V (3) + Module		t in: English				
		sessment (type, scope, la on on whether module ca			tion offered — if not every seme-	
prox. 8 If a writ stead t of asse nation Assess	to 10 p tten exa ake the ssmen date at ment o	bages) or e) presentation/ amination was chosen as e form of an oral examinat	talk (approx. 30 min method of assessme tion of one candidate must inform student	utes). ent, this may be char e each or an oral exa s about this by four	ndidate) or d) project report (ap- nged and assessment may in- mination in groups. If the method weeks prior to the original exami- ubsequent semester	
Allocat	ion of p	olaces				
Additio	nal inf	ormation				
Worklo	ad					
180 h						
Teachi	ng cycl	e				
Referre	Referred to in LPO I (examination regulations for teaching-degree programmes)					
			-			
Module	Module appears in					
		ee (1 major) Physics Inter	national (2020)			
Master	's degr	ee (1 major) Quantum Eng				
		gram Physics (2023)				
	-	ee (1 major) Quantum Eng				
Master	Master's degree (1 major) Physics International (2024)					

Module title					Abbreviation
Visiting Research 11-FPA-Int-201-m01					11-FPA-Int-201-m01
Module coordinator Module offered by					
		f examination committee		Faculty of Physics a	
ECTS	1	od of grading	Only after succ. con	· · · · ·	
10		rical grade			
Duratio		Module level	Other prerequisites		
2 01 0 01		graduate	Approval from exam		required.
Conter	าts		<u> </u>		
analys		locumentation of the res			sics. Experimental work including visits to other universities or re-
Intend	ed learı	ning outcomes			
		h current research topics yze and document scient		neoretical physics. V	Vithin experimental physics, the
Course	es (type	, number of weekly conta	ct hours, language –	- if other than Germa	an)
R (o) Module	e taugh	t in: English			
		essment (type, scope, la on on whether module ca			ation offered — if not every seme-
		(10 to 20 pages) ssessment: English			
Allocat	tion of p	olaces			
Additio	onal inf	ormation			
Worklo	oad				
300 h					
-	ng cycl	e			
		-			
Referred to in LPO I (examination regulations for teaching-degree programmes)					
					,
	e appea	urs in			
			national (2020)		
	Master's degree (1 major) Physics International (2020) Master's degree (1 major) Quantum Engineering (2020)				
	Master's degree (1 major) Quantum Engineering (2020) Master's degree (1 major) Quantum Engineering (2024)				
Master	Master's degree (1 major) Physics International (2024)				

Module title	e			Abbreviation		
Professional Specialization Physics International 11-FS-P-Int-201-m01						
Module coo	ordinator		Module offered by			
	n of examination committee		Faculty of Physics a	and Astronomy		
	thod of grading	Only after succ. con				
	t) successfully completed					
Duration	Module level	Other prerequisites				
1 semester	graduate					
Contents						
for the envi pics.	saged topic of the master th			s that are of particular relevance quired underlying fundamental to-		
	arning outcomes					
for the mas				of relevance to the topic chosen bility to present and convey this		
Courses (ty	pe, number of weekly conta	ct hours, language —	- if other than Germa	in)		
S (4) Module tau	ght in: English					
	assessment (type, scope, la ation on whether module ca			tion offered — if not every seme-		
	scussion (30 to 45 minutes) If assessment: English					
Allocation of	of places					
Additional	information					
Workload						
450 h						
	Teaching cycle					
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module app	pears in					
Master's de	egree (1 major) Physics Inter	national (2020)				
Master's de	egree (1 major) Physics Inter	national (2024)				

Module title				Abbreviation
Introduction	to Gauge/Gravity Dua	lity		11-GGD-Int-201-m01
Madula	dinatar		Modulo offered by	
Module coor			Module offered by	
Managing Di and Astroph	rector of the Institute o ysics	of Theoretical Physics	Faculty of Physics a	and Astronomy
ECTS Met	nod of grading	Only after succ. co	mpl. of module(s)	
8 num	erical grade			
Duration	Module level	Other prerequisite	S	
1 semester	graduate			
Contents				
 Quanti Interaci Renorri Gauge Confori Large I Supersi Supersi Elements of Annife Riema Maximi Black I Elements of Open a Strings Type II D-Brari Ale AdS/C Statem Near-hi Field-co Tests of Hologri Hologri Hologri Finite of Quanti Black I Hologri Transpi Application Finite of Quanti Hologri Finite of Quanti Black I Hologri Transpi Application Finite of Quanti Hologri Finite of Quanti Black I Hologri Finite of Quanti Hologri <l< th=""><th>nalisation Group Fields mal Symmetry N expansion symmetry of gravity olds, coordinate covariant on curvature ally symmetric spaceting tooles of string theory and closed strings in background fields B String Theory res FT correspondence to the correspondence orizon limit of D3-Bran perator correspondence of the correspondence of the correspondence of the correspondence of the correspondence of the correspondence of the correspondence aphic principle s to non-conformal the aphic renormalisation aphic C-Theorem ns I: Thermo- and hydr um field theory at finite tooles aphic linear response ort coefficients: Shear ns II: Condensed matte</th><th>ance and metric mes ence es ce Correlation functions Conformal anomaly ories group odynamics e temperature formalism viscosity and conductiver physics ssner-Nordström black</th><th></th><th></th></l<>	nalisation Group Fields mal Symmetry N expansion symmetry of gravity olds, coordinate covariant on curvature ally symmetric spaceting tooles of string theory and closed strings in background fields B String Theory res FT correspondence to the correspondence orizon limit of D3-Bran perator correspondence of the correspondence of the correspondence of the correspondence of the correspondence of the correspondence of the correspondence aphic principle s to non-conformal the aphic renormalisation aphic C-Theorem ns I: Thermo- and hydr um field theory at finite tooles aphic linear response ort coefficients: Shear ns II: Condensed matte	ance and metric mes ence es ce Correlation functions Conformal anomaly ories group odynamics e temperature formalism viscosity and conductiver physics ssner-Nordström black		

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 can be chosen to earn a 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

reach

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)

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

Module title				Abbreviation
Group Theory	,			11-GRTM-Int-201-m01
Module coord	linator		Module offered by	^
Managing Dir and Astrophy	ector of the Institute of Th sics	neoretical Physics	Faculty of Physics a	and Astronomy
	od of grading	Only after succ. con	npl. of module(s)	
6 nume	rical grade			
Duration	Module level	Other prerequisites		
1 semester	graduate	Approval from exam	ination committee r	equired.
Contents				
			ren. Darstellungen. T	ensoren. Klassifikationstheorem.
Intended lear	ning outcomes			
	ded learning outcomes a	vailable but not trans	lated vet.	
der Lage, Prol		pentheorie zu erkenn	en und mit Hilfe der	ere der Lie-Gruppen. Sie sind in erlernten Methoden zu lösen. Sie robleme anwenden.
Courses (type	e, number of weekly conta	ict hours, language –	- if other than Germa	in)
V (3) + R (1) Module taugh	at in Fnalich			
		nguaga if ather th	an Corman avamina	tion offered if not even come
	ion on whether module c			ition offered — if not every seme-
nutes) or c) or prox. 8 to 10 p	ral examination in groups bages) or e) presentation,	(groups of 2, approx /talk (approx. 30 min	. 30 minutes per car utes).	e candidate each (approx. 30 mi- ndidate) or d) project report (ap-
stead take the	e form of an oral examina It is changed, the lecturer	tion of one candidate	e each or an oral exa	nged and assessment may in- mination in groups. If the method weeks prior to the original exami-
	ssessment: English			
	offered: In the semester in	which the course is	offered and in the si	ubsequent semester
Allocation of	places	-		
Additional inf	ormation			
Workload				
180 h				
Teaching cycl	e			
Referred to in	LPOI (examination regu	lations for teaching-	degree programmes)	
Module appea	ars in			
	ree (1 major) Physics Inter	national (2020)		
-	gram Physics (2023)			
	ree (1 major) Physics Inter	mational (2024)		

Module	Module title Abbreviation					
Optical	Proper	ties of Semiconductor N	anostructures		11-HNS-Int-201-m01	
Module	0.001	nator		Module offered by		
		ctor of the Institute of A	anlied Physics			
ECTS		d of grading	Only after succ. con	· · · · · ·	inu Astronomy	
6		ical grade				
Duratio	- r	Module level	Other prerequisites			
1 semes	ster	graduate				
Conten	ts					
or macr ging the tures of with a f of nove for quar	Semiconductor Nanostructures are frequently referred to as 'artificial materials'. In contrast to atoms, molecules or macroscopic crystals, their electronic, optical and magnetic properties can be systematically tailored via chan ging their size. The lecture addresses technological challenges in the preparation of semiconductor nanostructures of varying dimensions (2D, 1D, oD). It provides the basic theoretical concepts to describe their properties, with a focus on optical properties and light-matter coupling. Moreover, it discusses the challenges and concepts of novel optoelectronic and quantum photonic devices based on such nanostructures, including building blocks for quantum communication and quantum computing architectures					
		ing outcomes				
foundat novel p	tions. K hotonio	n the fundamental prope fnowledge of the technol c devices.	logical methods to fa	bricate such structu	res, and of their appl	
Courses	s (type,	number of weekly conta	ect hours, language —	if other than Germa	ın)	
V (3) + F Module		in: English				
		essment (type, scope, la			tion offered — if not	every seme-
		on on whether module c nination (approx. 90 to 1				
prox. 8 If a writ stead ta of asses nation of Assessi	to 10 p ten exa ake the ssment date at ment of	al examination in groups ages) or e) presentation, mination was chosen as form of an oral examina is changed, the lecturer the latest. fered: In the semester ir ssessment: English	/talk (approx. 30 min 5 method of assessme tion of one candidate r must inform student	utes). ent, this may be cha e each or an oral exa s about this by four	nged and assessmer mination in groups. I weeks prior to the or	nt may in- If the method
Allocati	ion of p	laces				
Additio	nal info	ormation				
Workloa	ad					
180 h						
Teachin	ng cycle)				
Referre	d to in	LPOI (examination regu	lations for teaching-o	legree programmes)		
Module	e appea	rs in				
Master' Master'	's degre	ee (1 major) Physics Inter ee (1 major) Quantum En ram Physics (2023)				
Master's wi	th 1 major	Physics International (2024)	-	generated 21-Jun-2024 • exa r (120 ECTS) Physics Internati	-	page 90 / 153



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

Module title Abbreviation						
		or Physics			11-HPH-Int-201-m01	
Module	e coord	inator		Module offered by		
		ector of the Institute of A	1	Faculty of Physics a	nd Astronomy	
ECTS		od of grading	Only after succ. con	npl. of module(s)		
6	nume	rical grade				
Duratio		Module level	Other prerequisites			
1 seme	ster	graduate				
Conten	ts					
		als with the fundament				
		ling to methods for des				
		es of monolithic semiconese can be used to mo				
		nsionality systems. Exar				
		ning outcomes				
	To provide the student with a working knowledge semiconductors pertaining to crystal structure, symmetries,					
	and band structures, as well as electrical and optical properties. This establishes a solid basis preparing him for					
the mo	the more targeted specially lectures in the program.					
Course	s (type	, number of weekly cont	act hours, language –	- if other than Germa	n)	
V (3) +						
		t in: English	_			
		essment (type, scope, l on on whether module			tion offered — if not	every seme-
		nination (approx. 90 to				
		al examination in group			didate) or d) project	report (ap-
		ages) or e) presentation amination was chosen a			and accessmer	nt may in-
		form of an oral examin				
		t is changed, the lecture				
		the latest.		66 1 1 1 1		
		ffered: In the semester i ssessment: English	n which the course is	offered and in the su	ibsequent semester	
Allocat	-					
Allocal		Jaces				
••••••						
Additio	nat inf	ormation				
	<u> </u>					
Worklo	ad					
180 h			_			
Teachi	ng cycl	9				
			_			
Referre	d to in	LPO I (examination reg	ulations for teaching-	degree programmes)		
Module	e appea	irs in				
	-	ee (1 major) Physics Inte				
	-	ee (1 major) Quantum Ei	ngineering (2020)			
		gram Physics (2023)				
	-	ee (1 major) Quantum Ei ee (1 major) Physics Inte	,			
	-	Physics International (2024)	· · · ·	generated 21-Jun-2024 • exa	m reg da	nage 02 / 452
master S W	an i majul	i nysics international (2024)	-	r (120 ECTS) Physics Internation	-	page 92 / 153

Conformal Field Theory 2 11-KFT2-Int-201-m01 Module coordinator Module offered by Managing Director of the Institute of Theoretical Physics Faculty of Physics and Astrophysics ECTS Method of grading Only after succ. compl. of module(s) 6 numerical grade Duration Module level Other prerequisites 1 semester graduate 5 Minimal models (critical statistical mechanics models (lsing, 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 of pactors (logerator 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, lagangian formulation of the partition function, fermionization, orbifolds in general, Si/2z orbifold, Gaussian and Askhin T-eller models, duality between original and orbifold theory. Basic un- derstanding or 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- plications in contemporary condensed matter physics. Co		Module title Abbreviation				
Managing Director of the Institute of Theoretical Physics Faculty of Physics and Astronomy CTS Method of grading Only after succ. compl. of module(s) 6 numerical grade Duration Module level Other prerequisites 1 semester graduate Contents 5 Minimal models (critical statistical mechanics models (lsing, tricritical lsing, 3 state Potts model, restricted so- lid-on-solid models), correlation functions of the critical lsing model, fusion rules and the Verlinde algebra, Land 	Conform	nal Fie	ld Theory 2			11-KFT2-Int-201-m01
and Astrophysics Only after succ. compl. of module(s) ECTS Method of grading Only after succ. compl. of module(s) Duration Module level Other prerequisites 1 semester graduate - Contents S S S Minimal models (critical statistical mechanics models (lsing, 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 (lagrangian formulation of the partition function, representati- sons 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, S/Zz orbifold, Gaussian and Askhin-Teller models, duality between original and orbifold theories, marginal ope- rators, the space of c=1 theories) Intended learning outcomes Intended learning outcomes Acquisition 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 fors students of theoretical physics by exposure to an	Module	coord	inator		Module offered by	
6 numerical grade Duration Module level Other prerequisites 1 semester graduate 6 finimal 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, lacobi theta function indentities) 8 Free bosons on the torus (Lagrangian formulation of the partition function, remionization, orbifolds in general, S1/22 orbifold, Gaussian and Askhin-Teller models, duality between original and orbifold theores, marginal ope- rators, the space of c=+ thories) Intended learning outcomes Acquisition 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- plications in contemporary condensed matter physics. Courses (type, number of weekly contact hours, language — if other than German) V (3) + R (1)				eoretical Physics	Faculty of Physics a	nd Astronomy
Duration Module level Other prerequisites 1 semester graduate Contents 5 Minimal models (critical statistical mechanics models (lsing, tricritical Ising, 3 state Potts model, restricted so- icid-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, S/122 orbifold, Gaussian and Askhin-Teller models, duality between original and orbifold theories, marginal ope- rators, the space of c= theories) Intended learning outcomes Acquisition of both practical and conceptional familiarity with the methods of conformal field theory. Basic un- derstanding of critical phenomena, quartum 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- plications in contemporary condensed matter physics. Courses (type, number of weekly contact hours, language — if other than German) V (3)	ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)	
1 semester graduate Contents 5 Minimal models (critical statistical mechanics models (lsing, 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, Srl/2a orbifold, Gaussian and Askhin-Teller models, duality between original and orbifold theories, marginal ope- rators, the space of c=1 theories) Intended learning outcomes Courses (type, number of students of theoretical physics by exposure to an ambitious method with significant ap- plications in contemporary condensed matter 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 seme- ster, information on whether module can be chosen to earn a bonus) a) written examination in grou	6	nume	-			
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Allocation of places Additional information Workload 180 h	nutes) of prox. 8 If a writ stead ta of asse nation	or c) or to 10 p ten exa ake the ssmen date at	al examination in groups bages) or e) presentation/ amination was chosen as e form of an oral examina- t is changed, the lecturer the latest.	(groups of 2, approx 'talk (approx. 30 min method of assessme tion of one candidate	. 30 minutes per can utes). ent, this may be chan e each or an oral exa	didate) or d) project report (ap- nged and assessment may in- mination in groups. If the method
Additional information Workload 180 h	Assess	ment o	ffered: In the semester in	which the course is	offered and in the su	ubsequent semester
 Workload 180 h	Allocat	ion of p	olaces			
 Workload 180 h						
180 h	Additio	nal inf	ormation			
180 h						
		ad				
Teaching cycle						
	Teachir	ng cycl	e			

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	Module title Abbreviation					
Confor	mal Fie	ld Theory		_	11-KFT-Int-201-m01	
Module	e coord	inator		Module offered by		
		ector of the Institute of	Theoretical Physics	Faculty of Physics a	and Actronomy	
and As			Ineoretical Physics	Faculty of Physics a	and Astronomy	
ECTS	Meth	od of grading	Only after succ. cor	npl. of module(s)		
6	nume	rical grade				
Duratio	on	Module level	Other prerequisites	6		
1 seme	ster	graduate				
Conten	Its					
dimensi tricritic riance der cor sional terestin states mensio topolog their na course o Introp point) 1 Confo tions) 2 Confo tion an on, the 3 The c lian) bo and ou duality 4 Kac o	1 Conformal theories in D dimensions (conformal group, conformal algebra in 2D, constraints on correlation func					
		ds, minimal models in ន្ ning outcomes				
Acquis derstar standir plicatio	ition of nding o ng in pa ons in o	both practical and con f critical phenomena, q articular for students of contemporary condense	uantum field theory, a theoretical physics by ed matter physics.	nd functional integra exposure to an amb	ation. Enhanced leve itious method with s	l of under-
		, number of weekly con	tact nours, language –	- If other than Germa	in)	
V (3) + Module		t in: English				
Metho	d of as	sessment (type, scope, ion on whether module			ition offered — if not	every seme-
nutes) prox. 8 If a wri stead t of asse nation	or c) or to 10 p tten ex ake the essmen date at	mination (approx. 90 to ral examination in group pages) or e) presentatio amination was chosen e form of an oral examin t is changed, the lectur t the latest.	ps (groups of 2, approx n/talk (approx. 30 min as method of assessm nation of one candidate er must inform studen	and a minutes per car utes). ent, this may be char e each or an oral exa	ndidate) or d) project nged and assessme mination in groups. weeks prior to the o	report (ap- nt may in- If the method
	.,-		-	r (120 ECTS) Physics Internati	-	

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

Additional information

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	Module title Abbreviation					
Magne					11-MAG-Int-201-m01	
Module	e coord	inator		Module offered by		
Manag	ing Dire	ector of the Institute of Ap	oplied Physics	Faculty of Physics a	nd Astronomy	
ECTS	<u> </u>	od of grading	Only after succ. con	npl. of module(s)		
6	L	rical grade				
Duratio		Module level	Other prerequisites			
1 seme		graduate				
Conten	ts					
					etism, Anisotropy, Domain struc- e magnetic properties. Kondo ef-	
Intende	ed learr	ning outcomes				
measu to appl se field	re them y these ls. Capa	. Skills in constructing si skills to the mentioned f ability of assessing the p	mple models and de fields of magnetism. recision of observatio	scribing the mathem Competence to inde ons and of their anal	•	
		, number of weekly conta	ict nours, tanguage –	- II OLIIEI LIIAII GEIIIIA	11)	
V (3) + Module		t in: English				
		e ssment (type, scope, la on on whether module ca			tion offered — if not every seme-	
nutes) prox. 8 If a writ stead t of asse nation Assess	or c) or to 10 p tten exa ake the essment date at ment o	al examination in groups ages) or e) presentation/ amination was chosen as form of an oral examina	(groups of 2, approx /talk (approx. 30 min method of assessme tion of one candidate must inform student	. 30 minutes per can utes). ent, this may be chan e each or an oral exa s about this by four	e candidate each (approx. 30 mi- didate) or d) project report (ap- nged and assessment may in- mination in groups. If the method weeks prior to the original exami- ubsequent semester	
Allocat	ion of p	olaces				
Additio	onal info	ormation				
Worklo	ad					
180 h						
Teachi	ng cycl	9				
Referre	ed to in	LPOI (examination regu	lations for teaching-o	degree programmes)		
Module	e appea	rs in				
Master	's degre	ee (1 major) Physics Inter	national (2020)			
	-	ee (1 major) Quantum Eng	gineering (2020)			
		gram Physics (2023)				
	-	ee (1 major) Quantum Eng				
master	s uegre	ee (1 major) Physics Inter	national (2024)			

Modul	e title				Abbreviation
Maste	r Thesis	Physics International			11-MA-P-Int-201-m01
Modul	e coord	inator		Module offered by	
chairp	erson o	f examination committee		Faculty of Physics a	and Astronomy
ECTS	Metho	od of grading	Only after succ. con	npl. of module(s)	
30	nume	rical grade			
Durati	on	Module level	Other prerequisites		
1 semester graduate					
Contents					
		work on an experimental nd according to scientific			s, in particular using state-of-the-
Intend	ed lear	ning outcomes			
		pendently work on an exp hods and scientific aspec			in particular according to state- tten final thesis.
Course	es (type	, number of weekly conta	ct hours, language –	- if other than Germa	an)
					-
		essment (type, scope, la on on whether module ca			ition offered — if not every seme-
		s (750 to 900 hours total ssessment: English)		
Alloca	tion of _l	olaces			
Additi	onal inf	ormation			
Time to	o compl	ete: 6 months			
Workle					
900 h					
Teachi	ing cycl	e			
Referr	ed to in	LPOI (examination regu	lations for teaching-o	legree programmes)	
			U		
Modul	e appea	urs in			
Maste	r's degr	ee (1 major) Physics Inter ee (1 major) Physics Inter			

Module title Abbreviation					Abbreviation	
Multi-w	vaveler	igth Astronomy			11-MAS-Int-201-m01	
Module	Coord	inator		Module offered by		
			poorotical Physics		Faculty of Physics and Astronomy	
and Ast		ector of the Institute of Th sics			ind Astronomy	
ECTS		od of grading	Only after succ. con	npl. of module(s)		
6		rical grade				
Duratio		Module level	Other prerequisites	;		
1 seme		graduate				
Contents						
 Phenomenology of active galactic nuclei and extragalactic jets Jet-emission processes VLBI observations of jets High-energy observations of jets Multimessenger signatures of jets 						
Intende	ed lear	ning outcomes				
					e galactic nuclei and their extra- n writing an observing proposal.	
Course	s (type	, number of weekly conta	ict hours, language –	- if other than Germa	ın)	
V (3) + I						
		t in: English				
		sessment (type, scope, la on on whether module c			tion offered — if not every seme-	
nutes) of prox. 8 If a writ stead ta of asse nation of	or c) or to 10 p ten exa ake the ssmen date at	al examination in groups bages) or e) presentation amination was chosen as e form of an oral examina	(groups of 2, approx /talk (approx. 30 min method of assessm tion of one candidate	x. 30 minutes per car iutes). ent, this may be cha e each or an oral exa	e candidate each (approx. 30 mi- ndidate) or d) project report (ap- nged and assessment may in- mination in groups. If the method weeks prior to the original exami-	
Allocati	ion of _l	olaces				
Additio	nal inf	ormation				
Worklo	ad		-			
180 h						
Teachir	ıg cycl	e				
Referre	d to in	LPOI (examination regu	lations for teaching-	degree programmes)		
Module	appea	urs in				
		ee (1 major) Physics Inter	national (2020)			
	-	gram Physics (2023)				
Master'	s degr	ee (1 major) Physics Inter	mational (2024)			

Scientific Methods and Project Management Physics International 11-MP-P-Int-201-m01 Module correlation committee Faculty of Physics and Astronomy Conternation committee Faculty of Physics and Astronomy ECTS Module for any of module(s) Introduction for the organing Only after succ. compl. of module(s) Introduction to the scientific approach and practice, including project planning within a current experimental or theoretical research topic in physics. Establishment of a scientific project planning within a current experimental or theoretical research topic of relevance to the topic chosen for the master thesis, Ability to establish a research plan for the master thesis, and to plan the required experimental or theoretical research topic of relevance to the topic chosen for the master thesis. Ability to present the project in seminar talk. Converse (type, number of weekly contact hours, language — if other than German) R (a) Method of assessment (type, scope, language — if other than German, examination offered — if not every seme ster, information on whether module can be chosen to earn a bonus) Language Language Language — if other than German, examination offered — if not every seme ster, information Language Langua	Modul	e title				Abbreviation
chairperson of examination committee Faculty of Physics and Astronomy ECTS Method of grading Only after succ. compl. of module(s) 15 (not) successfully completed Duration Module level Other prerequisites 1 semester graduate Contents Introduction to the scientific approach and practice, including project planning within a current experimental or theoretical research topic in physics. Establishment of a scientific project plan for the planned master thesis. Intendel learning outcomes Knowledge of the scientific approach and practice, including project planning in a current experimental or theoretical research topic of relevance to the topic chosen for the master thesis. Ability to establish a research plan for the master thesis, and to plan the required experimental or theoretical work. Ability to present the project in seminar talk. Courses (type, number of weekly contact hours, language — if other than German) R (4) Module taught in: English Method of sacessment (type, scope, language — if other than German, examination offered — if not every seme ster, information Language of assessment: English Allocation of places <	Scienti	ific Met	thods and Project Manag	ement Physics Interr	national	11-MP-P-Int-201-m01
ECTS Method of grading Only after succ. compl. of module(s) 15 (not) successfully completed Duration Module level Other prerequisites 1 semester graduate Contents Introduction to the scientific approach and practice, including project planning within a current experimental or theoretical research topic in physics. Establishment of a scientific project plan for the planned master thesis. Intended learning outcomes Knowledge of the scientific approach and practice, including project planning in a current experimental or theoretical research topic of relevance to the topic chosen for the master thesis. Ability to present the project in seminar talk. Courses (type, number of weekly contact hours, language — if other than German) R (4) Module taught in: English Method of assessment: (type, scope, language — if other than German, examination offered — if not every seme ster, information on whether module can be chosen to earn a bonus) Language of assessment: English Allocation of places	Modul	e coord	linator		Module offered by	
15 (not) successfully completed	chairpe	erson o	f examination committee		Faculty of Physics a	and Astronomy
Duration Module level Other prerequisites 1 semester graduate Contents Introduction to the scientific approach and practice, including project planning within a current experimental or theoretical research topic in physics. Establishment of a scientific project plan for the planned master thesis. Intendel learning outcomes Knowledge of the scientific approach and practice, including project planning in a current experimental or theoretical research topic of relevance to the topic chosen for the master thesis. Ability to present the project in seminar talk. Courses (type, number of weekly contact hours, language — if other than German) R (a) Module taught in: English Method of assessment (type, scope, language — if other than German, examination offered — if not every seme ster, information on whether module can be chosen to earn a bonus) talk with discussion (30 to 45 minutes) Language of assessment: English Allocation of places Workload 450 h Teaching cycle Module appears in Module appears in Module for playsics International (2020)	ECTS			Only after succ. con	npl. of module(s)	
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Knowledge of the scientific approach and practice, including project planning in a current experimental or theo- retical research topic of relevance to the topic chosen for the master thesis. Ability to establish a research plan for the master thesis, and to plan the required experimental or theoretical work. Ability to present the project in seminar talk. Courses (type, number of weekly contact hours, language — if other than German) R (4) Module taught in: English Method of assessment (type, scope, language — if other than German, examination offered — if not every seme ster, information on whether module can be chosen to earn a bonus) talk with discussion (30 to 45 minutes) Language of assessment: English Allocation of places Additional information Workload 450 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)						
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R (4) Module taught in: English Method of assessment (type, scope, language — if other than German, examination offered — if not every seme ster, information on whether module can be chosen to earn a bonus) talk with discussion (30 to 45 minutes) Language of assessment: English Allocation of places Additional information Workload 450 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)	retical for the	researc master	ch topic of relevance to th	e topic chosen for th	e master thesis. Abi	ility to establish a research plan
Module taught in: English Method of assessment (type, scope, language — if other than German, examination offered — if not every seme ster, information on whether module can be chosen to earn a bonus) talk with discussion (30 to 45 minutes) Language of assessment: English Allocation of places Additional information Workload 450 h Teaching cycle Referred to in LPO I (examination regulations for teaching-degree programmes) Module appears in Mostler's degree (1 major) Physics International (2020)	Course	es (type	, number of weekly conta	ct hours, language –	- if other than Germa	an)
ster, information on whether module can be chosen to earn a bonus) talk with discussion (30 to 45 minutes) Language of assessment: English Allocation of places Additional information Workload 450 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)		e taugh	it in: English			
Language of assessment: English Allocation of places Additional information Workload 450 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)						ation offered — if not every seme-
 Additional information Workload 450 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 450 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)	Allocat	tion of	places			
 Workload 450 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)						
450 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	onal inf	ormation			
450 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	bad				
Teaching cycle Referred to in LPO I (examination regulations for teaching-degree programmes) Module appears in Master's degree (1 major) Physics International (2020)	450 h					
Referred to in LPO I (examination regulations for teaching-degree programmes) Module appears in Master's degree (1 major) Physics International (2020)		ng cvcl	e			
Module appears in Master's degree (1 major) Physics International (2020)						
Module appears in Master's degree (1 major) Physics International (2020)	Referre	ed to in	LPO I (examination regu	lations for teaching-	degree programmes)
Module appears in Master's degree (1 major) Physics International (2020)						
Master's degree (1 major) Physics International (2020)		e appez	ars in			
				national (2020)		
masier s uegree (1 major) r mysics miemanonal (2024)		•				

Advand	e title				Abbreviation	
	ced Ma	gnetic Resonance Imag	ing		11-MRI-Int-201-m01	1
Modul	e coord	inator		Module offered by	<u> </u>	
		ector of the Institute of A	Applied Physics	Faculty of Physics and Astronomy		
ECTS	1	od of grading	Only after succ. co	· · · · · ·	, , , , , , , , , , , , , , , , , , ,	
6	nume	rical grade		£		
Duratio	on	Module level	Other prerequisite	S		
1 seme	ester	graduate				
Conten	nts					
the fun course 1) the N 2) the p and me 3) the c 4) the p	ndamen covers NMR sig princip easurer concep physica	, has played a major rol tals of nuclear magnetic gnal theory and signal ev- es of spatial encoding, nent parameters, t of k-space and Fourier I, methodological and t n biomedical research,	c resonance (resonan volution (Bloch equat magnetic resonance i imaging, echnical possibilities	ce principle, relaxations) maging (MRI) and co and limitations of M	on times, chemical s rresponding imaging RI. Finally, typical ap	shift) this g sequences
		ning outcomes			ig will be covered.	
tical-th on/ima	ieoretic age-pro	are familiar with the bas al description and the p cessing principles. The ns and applications.	hysical basics of mod	dern MRI, MRI-instrur	nentation and image	e-formati-
Course	es (type	, number of weekly cont	tact hours, language -	– if other than Germa	an)	
V (3) +	R (1)					
		t in: English				
Module Metho	e taugh d of as :	t in: English sessment (type, scope, l ion on whether module			ntion offered — if not	t every seme
Module Method ster, in a) writt nutes) prox. 8 If a writ stead t of asse nation Assess	e taugh d of ass format ten exa or c) or to 10 p tten exa take the essmen date al sment o	sessment (type, scope,	can be chosen to earn 120 minutes) or b) or os (groups of 2, appro- n/talk (approx. 30 min as method of assessm ation of one candidat er must inform studen	n a bonus) al examination of on x. 30 minutes per car nutes). nent, this may be cha re each or an oral exa its about this by four	e candidate each (ap ndidate) or d) project nged and assessme mination in groups. weeks prior to the o	pprox. 30 mi t report (ap- nt may in- If the metho riginal exam
Module ster, in a) writt nutes) prox. 8 If a writ stead t of asse nation Assess Langua	e taugh d of ass format ten exa or c) or t to 10 p tten ex cake the essmen date at sment o age of a	Sessment (type, scope, ion on whether module mination (approx. 90 to al examination in group bages) or e) presentation amination was chosen a e form of an oral examin t is changed, the lecture the latest. ffered: In the semester ssessment: English	can be chosen to earn 120 minutes) or b) or os (groups of 2, appro- n/talk (approx. 30 min as method of assessm ation of one candidat er must inform studen	n a bonus) al examination of on x. 30 minutes per car nutes). nent, this may be cha re each or an oral exa its about this by four	e candidate each (ap ndidate) or d) project nged and assessme mination in groups. weeks prior to the o	pprox. 30 mi t report (ap- nt may in- If the metho riginal exam
Module ster, in a) writt nutes) prox. 8 If a writ stead t of asse nation Assess Langua	e taugh d of ass format ten exa or c) or t to 10 p tten ex cake the essmen date at sment o age of a	Sessment (type, scope, ion on whether module mination (approx. 90 to al examination in group bages) or e) presentation amination was chosen a e form of an oral examin t is changed, the lecture the latest. ffered: In the semester ssessment: English	can be chosen to earn 120 minutes) or b) or os (groups of 2, appro- n/talk (approx. 30 min as method of assessm ation of one candidat er must inform studen	n a bonus) al examination of on x. 30 minutes per car nutes). nent, this may be cha re each or an oral exa its about this by four	e candidate each (ap ndidate) or d) project nged and assessme mination in groups. weeks prior to the o	pprox. 30 mi t report (ap- nt may in- If the metho riginal exam
Module ster, in a) writt nutes) prox. 8 If a writ stead t of asse nation Assess Langua Allocat	e taugh d of ass format ten exa or c) or t to 10 p tten ex cake the essmen date at sment o age of a tion of	Sessment (type, scope, ion on whether module mination (approx. 90 to al examination in group bages) or e) presentation amination was chosen a e form of an oral examin t is changed, the lecture the latest. ffered: In the semester ssessment: English	can be chosen to earn 120 minutes) or b) or os (groups of 2, appro- n/talk (approx. 30 min as method of assessm ation of one candidat er must inform studen	n a bonus) al examination of on x. 30 minutes per car nutes). nent, this may be cha re each or an oral exa its about this by four	e candidate each (ap ndidate) or d) project nged and assessme mination in groups. weeks prior to the o	pprox. 30 mi t report (ap- nt may in- If the metho riginal exam
Module ster, in a) writt nutes) prox. 8 If a writ stead t of asse nation Assess Langua Allocat	e taugh d of ass format ten exa or c) or t to 10 p tten ex cake the essmen date at sment o age of a tion of	Sessment (type, scope, ion on whether module mination (approx. 90 to al examination in group bages) or e) presentation amination was chosen a e form of an oral examin t is changed, the lecture t the latest. ffered: In the semester ssessment: English blaces	can be chosen to earn 120 minutes) or b) or os (groups of 2, appro- n/talk (approx. 30 min as method of assessm ation of one candidat er must inform studen	n a bonus) al examination of on x. 30 minutes per car nutes). nent, this may be cha re each or an oral exa its about this by four	e candidate each (ap ndidate) or d) project nged and assessme mination in groups. weeks prior to the o	pprox. 30 mi t report (ap- nt may in- If the metho riginal exam
Module Method ster, in a) writt nutes) prox. 8 If a writ stead t of asse nation Assess Langua Allocat	e taugh d of ass format ten exa or c) or to 10 p tten exa take the essmen date at sment c age of a tion of p	Sessment (type, scope, ion on whether module mination (approx. 90 to al examination in group bages) or e) presentation amination was chosen a e form of an oral examin t is changed, the lecture t the latest. ffered: In the semester ssessment: English blaces	can be chosen to earn 120 minutes) or b) or os (groups of 2, appro- n/talk (approx. 30 min as method of assessm ation of one candidat er must inform studen	n a bonus) al examination of on x. 30 minutes per car nutes). nent, this may be cha re each or an oral exa its about this by four	e candidate each (ap ndidate) or d) project nged and assessme mination in groups. weeks prior to the o	pprox. 30 mi t report (ap- nt may in- If the metho riginal exam
Module Method ster, in a) writt nutes) prox. 8 If a writ stead t of asse nation Assess Langua Allocat Additic	e taugh d of ass format ten exa or c) or to 10 p tten exa take the essmen date at sment c age of a tion of p	Sessment (type, scope, ion on whether module mination (approx. 90 to al examination in group bages) or e) presentation amination was chosen a e form of an oral examin t is changed, the lecture t the latest. ffered: In the semester ssessment: English blaces	can be chosen to earn 120 minutes) or b) or os (groups of 2, appro- n/talk (approx. 30 min as method of assessm ation of one candidat er must inform studen	n a bonus) al examination of on x. 30 minutes per car nutes). nent, this may be cha re each or an oral exa its about this by four	e candidate each (ap ndidate) or d) project nged and assessme mination in groups. weeks prior to the o	pprox. 30 mi t report (ap- nt may in- If the metho riginal exam
Module Method ster, in a) writt nutes) prox. 8 If a writ stead t of asse nation Assess Langua Allocat Morklo 180 h	e taugh d of ass format ten exa or c) or to 10 p tten exa take the essmen date at sment o age of a tion of ponal inf	sessment (type, scope, ion on whether module mination (approx. 90 to al examination in group bages) or e) presentation amination was chosen a e form of an oral examin t is changed, the lecture t the latest. ffered: In the semester ssessment: English blaces ormation	can be chosen to earn 120 minutes) or b) or os (groups of 2, appro- n/talk (approx. 30 min as method of assessm ation of one candidat er must inform studen	n a bonus) al examination of on x. 30 minutes per car nutes). nent, this may be cha re each or an oral exa its about this by four	e candidate each (ap ndidate) or d) project nged and assessme mination in groups. weeks prior to the o	pprox. 30 m t report (ap- nt may in- If the metho riginal exam
Module Method ster, in a) writt nutes) prox. 8 If a writ stead t of asse nation Assess Langua Allocat Additic 180 h Teachi	e taugh d of ass format ten exa or c) or 8 to 10 p tten exa take the essmen date at sment o age of a tion of ponal inf	sessment (type, scope, ion on whether module mination (approx. 90 to al examination in group bages) or e) presentation amination was chosen a e form of an oral examin t is changed, the lecture t the latest. ffered: In the semester ssessment: English blaces ormation	can be chosen to earn 120 minutes) or b) or os (groups of 2, appro- n/talk (approx. 30 min as method of assessm ation of one candidat er must inform studen in which the course is	n a bonus) al examination of on x. 30 minutes per car nutes). nent, this may be cha re each or an oral exa its about this by four s offered and in the su	e candidate each (ap ndidate) or d) project nged and assessme mination in groups. weeks prior to the o ubsequent semester	pprox. 30 m t report (ap- nt may in- If the metho riginal exam
Module Method ster, in a) writt nutes) prox. 8 If a writ stead t of asses nation Assess Langua Allocat Morklo 180 h Teachin Teachin	e taugh d of ass format ten exa or c) or to 10 p tten exa take the essmen date at sment o age of a tion of onal inf onal inf	sessment (type, scope, ion on whether module mination (approx. 90 to al examination in group bages) or e) presentation amination was chosen a e form of an oral examin t is changed, the lecture t the latest. ffered: In the semester ssessment: English blaces ormation	can be chosen to earr 120 minutes) or b) or os (groups of 2, appro- n/talk (approx. 30 min as method of assessm ation of one candidat er must inform studen in which the course is in which the course is	n a bonus) al examination of on x. 30 minutes per car nutes). hent, this may be cha te each or an oral exa ts about this by four s offered and in the sub red and in the subsec	e candidate each (ap ndidate) or d) project nged and assessme mination in groups. weeks prior to the o ubsequent semester	pprox. 30 mi t report (ap- nt may in- If the metho riginal exam
Module Method ster, in a) writt nutes) prox. 8 If a writ stead t of asses nation Assess Langua Allocat Morklo 180 h Teachin Teachin	e taugh d of ass format ten exa or c) or to 10 p tten exa take the essmen date at sment o age of a tion of onal inf onal inf	sessment (type, scope, ion on whether module mination (approx. 90 to al examination in group bages) or e) presentation amination was chosen a e form of an oral examin t is changed, the lecture t the latest. ffered: In the semester ssessment: English blaces ormation	can be chosen to earr 120 minutes) or b) or os (groups of 2, appro- n/talk (approx. 30 min as method of assessm ation of one candidat er must inform studen in which the course is in which the course is	n a bonus) al examination of on x. 30 minutes per car nutes). hent, this may be cha te each or an oral exa ts about this by four s offered and in the sub red and in the subsec	e candidate each (ap ndidate) or d) project nged and assessme mination in groups. weeks prior to the o ubsequent semester	pprox. 30 mi t report (ap- nt may in- If the metho riginal exam
Module Method ster, in a) writt nutes) prox. 8 If a writ stead t of asses nation Assess Langua Allocat Additic UWorklo 180 h Teachin	e taugh d of ass format ten exa or c) or to 10 p tten exa take the essmen date at sment o age of a tion of onal inf onal inf	sessment (type, scope, ion on whether module mination (approx. 90 to al examination in group bages) or e) presentation amination was chosen a e form of an oral examin t is changed, the lecture t the latest. ffered: In the semester ssessment: English blaces ormation	can be chosen to earr 120 minutes) or b) or os (groups of 2, appro- n/talk (approx. 30 min as method of assessm ation of one candidat er must inform studen in which the course is in which the course is	n a bonus) al examination of on x. 30 minutes per car nutes). hent, this may be cha te each or an oral exa ts about this by four s offered and in the sub red and in the subsec	e candidate each (ap ndidate) or d) project nged and assessme mination in groups. weeks prior to the o ubsequent semester	pprox. 30 mi t report (ap- nt may in- If the metho riginal exam

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					
Compu	tationa	ll Astrophysics			11-NMA-Int-201-m01
Module	e coord	inator		Module offered by	
Manag	ing Dire	ector of the Institute of 1	Theoretical Physics	Faculty of Physics a	and Astronomy
and As	<u> </u>		Only offer avec as		
ECTS 6		od of grading rical grade	Only after succ. cor	npl. of module(s)	
0 Duratio		Module level	Other prerequisites	<u> </u>	
1 seme		graduate		•	
Conten		Sidduite			
rithms Lattice ENO). <i>I</i> CL).	(tree- a -Boltzm Aethod	nd polynomial codes). I nann). Hyperbolic conse s of high-performance c	Particle-mesh method rvation laws (fluid dyr	s (particle-in-cell me namics, finite differen	neir applications. N-body algo- thods). Vlasow methods (e.g., nce method, Riemann solver, Pl). GPGPU programming (OPEN-
Intend	ed lear	ning outcomes			
					of physics with the aid of numer blems and to validate the result
Course	s (type	, number of weekly cont	tact hours, language –	– if other than Germa	in)
V (3) + Module		t in: English			
					ition offered — if not every seme-
ster, in	format	on on whether module	can be chosen to earn	n a bonus)	
nutes) prox. 8 If a writ stead t of asse nation Langua	or c) or to 10 p tten exa ake the ssmen date at age of a	al examination in group bages) or e) presentation amination was chosen a e form of an oral examin	es (groups of 2, approx n/talk (approx. 30 mir as method of assessm ation of one candidat er must inform studen	k. 30 minutes per car nutes). ent, this may be cha e each or an oral exa ts about this by four	e candidate each (approx. 30 mi ndidate) or d) project report (ap- nged and assessment may in- mination in groups. If the metho weeks prior to the original exam ubsequent semester
Allocat					
Additio	nal inf	ormation			
Worklo	ad				
180 h					
	ng cvcl	e			
	ng cycl	e			
Teachi			ulations for teaching-	degree programmes)	1
Teachi		e LPOI (examination reg	ulations for teaching-	degree programmes)	
Teachi Referre 	ed to in	LPOI (examination reg	ulations for teaching-	degree programmes)	
 Module	ed to in e appea	LPOI (examination reg		degree programmes)	
Teachin Referre Module Master	ed to in e appea 's degr	LPOI (examination reg		degree programmes)	

Module title					Abbreviation		
Nano-Optics 11-NOP-Int-201-m01						L	
Module coordinator				Module offered by			
Manag	Managing Director of the Institute of Applied Physics			Faculty of Physics a	nd Astronomy		
ECTS	Metho	od of grading	Only after succ. compl. of module(s)				
6	numei	rical grade					
Duratio	on	Module level	Other prerequisites				
1 seme	ster	graduate					
Conten	ts						
from th copy ar basis, c	The lecture conveys theoretical fundamentals, experimental techniques, and applications of nano-optics starting from the discussion of the focusing of light. Based on this, the fundamentals of modern far-field optical micros-copy are discussed. In the following, the near-field optical microscopy is introduced and discussed. As a further basis, quantum emitters are introduced and their light emission in nano-environments is derived. Plasmons in 2D, 1D and o dimensions are introduced and discussed in detail. This finally leads to the concept of optical an-						
Intende	ed learr	ing outcomes					
		n-depth knowledge of t ns of nano-optics as w				escription	
Course	s (type,	number of weekly con	tact hours, language –	- if other than Germa	n)		
V (3) + Module	• •	t in: English					
		essment (type, scope, on on whether module			tion offered — if not	every seme-	
a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 mi- nutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (ap- prox. 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. Assessment offered: In the semester in which the course is offered and in the subsequent semester							
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)							
	Master's degree (1 major) Quantum Engineering (2020) exchange program Physics (2023)						
		ee (1 major) Quantum E	ngineering (2024)				
	-	ee (1 major) Physics Inte					
	-	Physics International (2024)	· · · · · ·	generated 21-Jun-2024 • exa	ım. reg. da-	page 104 / 153	
			ta record Maste	r (120 ECTS) Physics Internati	onal - 2024		

Module title					Abbreviation	
Organic Semiconductors 11-OHL-Int-201-m01						
Module coordinator				Module offered by		
Managing Director of the Institute of Ap		plied Physics	Faculty of Physics a	nd Astronomy		
			Only after succ. compl. of module(s)			
6	nume	rical grade				
Duratio	on	Module level	Other prerequisites			
1 seme	ester	graduate				
Conter	nts					
Fundar ons.	nentals	s of organic semiconducto	ors, molecular and po	olymer electronics ar	nd sensor technology, applicati-	
Intend	ed lear	ning outcomes				
In-dep	th knov	vledge of the properties o	f organic semicondu	ctor materials and th	eir applications.	
		, number of weekly conta	-			
V (3) +		,			,	
-		t in: English				
		s essment (type, scope, la ion on whether module ca			tion offered — if not every seme-	
 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. Assessment offered: In the semester in which the course is offered and in the subsequent semester 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)						
Modul	Module appears in					
Master's degree (1 major) Physics International (2020)						
	Master's degree (1 major) Quantum Engineering (2020)					
	-	gram Physics (2023)				
	Master's degree (1 major) Quantum Engineering (2024)					
Master	Master's degree (1 major) Physics International (2024)					

Module title Abbreviation					Abbreviation	
Advanced Seminar Physics A					11-OSP-A-Int-201-m01	
Module coordinator				Module offered by		
Managing Director of the Institute of Applied Physics			plied Physics	Faculty of Physics a	and Astronomy	
ECTS				pl. of module(s)		
5	nume	rical grade				
Duration Module level Other prerequisit		Other prerequisites	IS			
1 semester graduate						
Conter	nts					
Semin	ar on cu	irrent topics in theoretica	l and experimental p	hysics		
Intend	ed lear	ning outcomes				
		vledge about a current to rizing them and presentir			. Ability to read scientific publica-	
		, number of weekly conta			ın)	
S (2) Module taught in: English Method of assessment (type, scope, language — if other than German, examination offered — if not every seme-						
talk wi	th discu	on on whether module ca Ission (30 to 45 minutes)		a Dollus)		
-		ssessment: English				
Allocat	tion of p	olaces				
Additio	onal inf	ormation				
	_					
Workload						
150 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) Master's degree (1 major) Physics International (2024)					

Module title Abbreviation					Abbreviation	
Advanc	ed Sen	ninar Physics B			11-OSP-B-Int-201-m01	
Module coordinator				Module offered by		
Managi	Managing Director of the Institute of Applied Physics			Faculty of Physics a	and Astronomy	
ī				npl. of module(s)	,	
5	numerical grade					
Duratio	Duration Module level Other prerequisites					
1 semes	1 semester graduate					
Conten	ts					
Semina	r on cu	irrent topics in theoretica	l and experimental p	hysics.		
Intende	d lear	ning outcomes				
					. Ability to read scientific publica-	
tions, s	umma	rizing them and presentir	ng them to a peer auc	lience.		
Courses	s (type	, number of weekly conta	ct hours, language –	- if other than Germa	an)	
S (2)						
Module	taugh	t in: English				
		sessment (type, scope, la ion on whether module ca			ation offered — if not every seme-	
talk wit	h discı	ussion (30 to 45 minutes)				
Langua	ge of a	ssessment: English				
Allocati	ion of _l	olaces				
Additio	Additional information					
Workload						
150 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)					
Master'	Master's degree (1 major) Physics International (2024)					

Module title					Abbreviation	
Advanced Laboratory Course Master Part 1					11-P-FM1-Int-201-m01	
Module coordinator				Module offered by		
Managing Director of the Institute of Ap		oplied Physics	Faculty of Physics a	ind Astronomy		
			Only after succ. cor	Dnly after succ. compl. of module(s)		
3	(not)	successfully completed				
Duratio	on	Module level	Other prerequisites			
1 semester graduate Preparation and safety briefing.						
Conten	Its					
solid st tic resc	tate pro onance	operties, surfaces and int	erfaces. Experiments	s covering the topics	nents and correlated systems, x-ray radiation, nuclear magne- ith visible light, Hall effect, super-	
Intend	ed lear	ning outcomes				
ledge o ge of ez presen	of how t xperim ting an	to prepare a scientific pu ental methods, of using s d discussing the results i	blication and use sta cientific publication n the form of a scien	te-of-the-art analysis s, of performing and tific publication.	perimental outcome. Basic know- s systems and software. Knowled- evaluating an experiment, and	
	e s (type	, number of weekly conta	ct hours, language -	- if other than Germa	in)	
P (3) Module	e taugh	t in: English				
	_		if other th	an Corman, ovamina	tion offered if not even come	
		ion on whether module c			tion offered — if not every seme-	
Studen fic pub succes regulat	nts mus licatior sfully c ions ar	n) an experiment to be co	nsidered to have suc s 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	places				
Additio	onal inf	ormation				
Worklo	ad					
90 h	90 h					
Teaching cycle						
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Module	e appea	ars in				
		ee (1 major) Physics Inter	national (2020)			
Master's degree (1 major) Quantum Engineering (2020)						
	exchange program Physics (2023)					
	-	ee (1 major) Quantum En				
Master	Master's degree (1 major) Physics International (2024)					

Module title				Abbreviation	
Advanced Lab	ooratory Course Master P	art 2		11-P-FM2-Int-201-m01	
Module coord	linator		Module offered by		
Managing Dir	ector of the Institute of A	oplied Physics	Faculty of Physics a	and Astronomy	
	od of grading	Only after succ. con	npl. of module(s)		
3 (not)	successfully completed				
Duration Module level Other prerequisites					
1 semester graduate Preparation and safety briefing.					
Contents					
solid state pro tic resonance	operties, surfaces and int	erfaces. Experiments	covering the topics	nents and correlated systems, x-ray radiation, nuclear magne- ith visible light, Hall effect, super-	
Intended lear	ning outcomes				
ledge of how ge of experim	to prepare a scientific pu	blication and use sta	te-of-the-art analysis s, of performing and	perimental outcome. Basic know- s systems and software. Knowled- evaluating an experiment, and	
Courses (type	, number of weekly conta	ect hours, language –	- if other than Germa	an)	
P (3)					
Module taugh					
	sessment (type, scope, la ion on whether module c			ation offered — if not every seme-	
fic publication successfully or regulations an	st successfully prepare, p n) an experiment to be co	nsidered to have suc s to be considered to	cessfully completed have successfully c	aluate (in the form of a scienti- this experiment. Students must ompleted this module. Detailed	
Allocation of	places				
Additional inf	formation				
Workload					
90 h					
Teaching cycl	le				
Referred to in	LPOI (examination regu	lations for teaching-	degree programmes)		
	U. C.				
Module appea	ars in				
	ree (1 major) Physics Inter	mational (2020)			
-	ree (1 major) Quantum En				
- ,	gram Physics (2023)				
-	ree (1 major) Quantum En				
master's degr	ree (1 major) Physics Inter	national (2024)			

Module titl	e			Abbreviation
Advanced I	aboratory Course Master P	art 3		11-P-FM3-Int-201-m01
Module co	ordinator		Module offered by	
Managing I	Director of the Institute of A	pplied Physics	Faculty of Physics a	and Astronomy
	thod of grading	Only after succ. cor		
3 (no	t) successfully completed			
Duration	Module level	Other prerequisites	5	
1 semester graduate Preparation and safety briefing.				
Contents				
solid state tic resonan	properties, surfaces and in	terfaces. Experiments	s covering the topics	nents and correlated systems, x-ray radiation, nuclear magne- ith visible light, Hall effect, super-
Intended le	arning outcomes			
ledge of ho ge of exper presenting	w to prepare a scientific pu imental methods, of using and discussing the results	blication and use sta scientific publication in the form of a scien	te-of-the-art analysis s, of performing and tific publication.	perimental outcome. Basic know- s systems and software. Knowled- evaluating an experiment, and
	pe, number of weekly conta	act hours, language -	– if other than Germa	an)
P (3) Module tau	ght in: English			
	assessment (type, scope, la ation on whether module c			ation offered — if not every seme-
fic publicat successfull regulations	ust successfully prepare, p ion) an experiment to be co	onsidered to have suc s to be considered to	ccessfully completed have successfully c	aluate (in the form of a scienti- this experiment. Students must ompleted this module. Detailed
Allocation	of places			
Additional	information			
		-		
Workload				
90 h				
Teaching c	/cle			
Referred to	in LPO I (examination regu	lations for teaching-	degree programmes))
Module ap	pears in			
Master's de	egree (1 major) Physics Inte	rnational (2020)		
	egree (1 major) Quantum En	gineering (2020)		
- ,	rogram Physics (2023)	/ 、		
	egree (1 major) Quantum En			
master s de	egree (1 major) Physics Inte	mational (2024)		

Module	e title				Abbreviation
Advanc	ed Lab	ooratory Course Master P	art 4		11-P-FM4-Int-201-m01
Module	e coord	inator		Module offered by	
Manag	Managing Director of the Institute of Applied Physics			Faculty of Physics a	ind Astronomy
ECTS	Meth	od of grading	Only after succ. cor	npl. of module(s)	
3	(not)	successfully completed			
Duratio	on	Module level	Other prerequisites		
1 seme	ster	graduate	Preparation and saf	ety briefing.	
Conten	ts				
solid st tic reso	tate pro onance	operties, 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 lear	ning outcomes			
ledge o ge of ex presen	of how t xperim ting an	to prepare a scientific pu ental methods, of using s d discussing the results i	blication and use sta cientific publication n the form of a scien	te-of-the-art analysis s, of performing and tific publication.	perimental outcome. Basic know- s systems and software. Knowled- evaluating an experiment, and
	s (type	, number of weekly conta	ict hours, language –	- if other than Germa	in)
P (3) Module	e taugh	t in: English			
		sessment (type, scope, la ion on whether module c			tion offered — if not every seme-
Studen fic pub succes regulat	its mus licatior sfully c ions ar	n) an experiment to be co	nsidered to have suc s 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	places			
Additio	onal inf	ormation			
Worklo	ad				
90 h					
Teachi	ng cycl	e			
	- /				
Referre	ed to in	LPOI (examination regu	lations for teaching-	degree programmes)	
Module	e anne:	ars in			
		ee (1 major) Physics Inter	national (2020)		
	-	ee (1 major) Quantum En			
	-	gram Physics (2023)	- · ·		
	-	ee (1 major) Quantum En			
Master	's degr	ee (1 major) Physics Inter	national (2024)		

Module title					Abbreviation			
Physics	s of Cor	nplex Systems			11-PKS-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. con	npl. of module(s)				
6	nume	rical grade						
Duratio	n	Module level	Other prerequisites					
1 semes	ster	graduate						
Conten	ts							
 2. Intro 3. Entro 4. Phas 5. Unive 6. Spin 	 Theory of critical phenomena in thermal equilibriumt Introduction into the physics out of equilibriumt Entropy production and fluctuationst Phase transitions away from equilibriumt Universalityt Spin glasses 							
		eural networks ning outcomes						
In-dept na in co univers	h know omplex ality. A	/ledge of concepts and m many-body systems. The	orough understandin	g of the concepts of	nding of collective phenome- entropy, entropy production and o perform research tasks in the			
Course	s (type	, number of weekly conta	ct hours, language –	- if other than Germa	n)			
V (2) + I Module		t in: English						
		s essment (type, scope, la on on whether module ca			tion offered — if not every seme-			
nutes) of prox. 8 If a writ stead ta of asses nation of Langua	or c) or to 10 p ten exa ake the ssment date at ge of a	al examination in groups ages) or e) presentation/ amination was chosen as form of an oral examina	(groups of 2, approx 'talk (approx. 30 min method of assessme tion of one candidate must inform student	. 30 minutes per can utes). ent, this may be char e each or an oral exa is about this by four y	e candidate each (approx. 30 mi- didate) or d) project report (ap- nged and assessment may in- mination in groups. If the method weeks prior to the original exami- ubsequent semester			
Allocati	ion of p	olaces						
 Additio	nal info	ormation						
Worklo	ad							
180 h								
Teachir	ig cvcl	6						
	5 ., 5							
Referre	d to in	LPOI (examination regu	lations for teaching.	legree programmes)				
Module	20000	urc in						
		ee (1 major) Physics Inter	national (2020)					
mastel	JUCSI	ce (I major) i mysics miler	national (2020)					



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

Module	title				Abbreviation	
Physics	of Ad	vanced Materials			11-PMM-Int-201-m01	
Module coordinator Module offe				Module offered by		
Managing Director of the Institute of Applied Physics				Faculty of Physics a	nd Astronomy	
	-	od of grading	Only after succ. com			
		rical grade				
Duratio	Duration Module level Other prerequisites					
1 semes	1 semester graduate					
Content	ts					
als and groups.	super Two-d		eterostructures and su		d polymers; magnetic materi- ds to characterize these material	
			rastarization mathed	of vorious groups	f madarn matarials	
		h the properties and cha				
		, number of weekly conta	ct hours, language —	If other than Germa	in)	
V (3) + F Module		t in: English				
		s essment (type, scope, la on on whether module ca			tion offered — if not every seme-	
stead ta of asses nation of Assession	ake the ssmen date at ment o	form of an oral examina	tion of one candidate must inform student	each or an oral exa s about this by four	nged and assessment may in- mination in groups. If the method weeks prior to the original exami- ubsequent semester	
Allocati	-	-				
Additio	nal inf	ormation				
Additio	inat init					
Worklo	ad					
180 h	uu					
		•				
Teachin	ig tytt	e				
Referre	d to in	LPOI (examination regu	lations for teaching-d	legree programmes)		
Module	appea	irs in				
		ee (1 major) Physics Inter	national (2020)			
	-	ee (1 major) Quantum Eng				
		gram Physics (2023)				
	-	ee (1 major) Quantum Eng				
Master	s degr	ee (1 major) Physics Inter	national (2024)			

Dhana	e title				Abbreviation			
Filelio	menolo	gy and Theory of Super	conductivity		11-PTS-Int-201-m01			
Modul	e coord	inator		Module offered by	<u> </u>			
	ing Dire	ector of the Institute of A ector of the Institute of T sics		Faculty of Physics a	and Astronomy			
ECTS	<u> </u>	od of grading	Only after succ. con	npl. of module(s)				
6	nume	rical grade						
Duratio	on	Module level	Other prerequisites					
1 seme		graduate						
materia ventior superc grams des, ph of the H	al scien nal and onduct and fur nase flu Higgs m	ce for calculating tempe unconventional superc ors. Extension of Ginzbu actional integrals. Theor actuations, and coupling acchanism. Interplay of	erature profiles in sup onductivity. Review of urg-Landau theory to a etical formalism of Wa g to the electromagnet magnetism and conve	erconductors. Overv BCS theory and its a quantum field theo ard identities and res ic field. Interpretatio ntional/unconventio	chnological platforms, Methods of iew of the phenomenology of com applicability for different types of ry formalism using Feynman dia- sponse functions. Goldstone mo- on of the Meissner effect in terms onal superconductivity. Discussi-			
		research topics and pers ning outcomes	spective on room-temp	perature supercondu	ictivity.			
arch. K as well tors an	nowled as the d their s (type	lge of BCS mean-field th	eory, the quantum-fie Higgs mechanism. Ba with competing magn	ld theory methods n asic understanding c etic phases.	sm in the context of current rese ecessary to extend BCS theory, of unconventional superconduc- an)			
Module	e taugh	t in: English						
		sessment (type, scope, l ion on whether module	0 0		ition offered — if not every seme-			
nutes) prox. 8 If a writ stead t of asse nation Assess	or c) or to 10 p tten exa ake the essmen date at sment o	al examination in group bages) or e) presentation amination was chosen a e form of an oral examin	s (groups of 2, approx n/talk (approx. 30 min is method of assessm ation of one candidate er must inform student	a. 30 minutes per car utes). ent, this may be cha e each or an oral exa ts about this by four	e candidate each (approx. 30 mi- ndidate) or d) project report (ap- nged and assessment may in- mination in groups. If the metho weeks prior to the original exami ubsequent semester			
Langua	ion of .							
Allocat		Jiaces						
-		Jiaces						
Allocat		ormation						
Allocat			-					
Allocat Additic	onal inf							
Allocat Additic Worklo	onal inf							
Allocat	onal inf oad	ormation						
Allocat Additic Worklo 180 h	onal inf oad	ormation						
Allocat Additio Worklo 180 h Teachin	onal inf oad ng cycl	ormation	ulations for teaching-	degree programmes)				
Allocat Additio Worklo 180 h Teachin	onal inf oad ng cycl	ormation e	ulations for teaching-	degree programmes)				

	Module title Abbreviation						
Quantu	m Field	d Theory I			11-QFT1-Int-201-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)			
8	nume	rical grade					
Duratio	n	Module level	Other prerequisites				
1 seme	ster	graduate	Approval from exam	ination committee re	equired.		
Conten	ts						
 Lagra Field Asym Gaug Pertu Feyni Quar Radia 	 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) Renormalisation (optional). 						
		ning outcomes					
They kr process standin	now hor ses in t ng of ra	w to use perturbation the he framework of quantur diative corrections and re	ory and how to apply n electrodynamics in enormalisation.	/ Feynman rules. The leading order. More	ivistic quantum field theories. y are able to calculate basics over, they have a basic under-		
Course	s (type	, number of weekly conta	ct hours, language –	- if other than Germa	n)		
V (4) + Module		t in: English					
		essment (type, scope, la on on whether module ca	0 0		tion offered — if not every seme-		
nutes) of prox. 8 If a writ stead ta of asse nation Langua Assess	or c) or to 10 p ten exa ake the ssmen date at ge of a ment o	al examination in groups ages) or e) presentation, amination was chosen as form of an oral examina- t is changed, the lecturer the latest. ssessment: English ffered: In the semester in	(groups of 2, approx 'talk (approx. 30 min method of assessm tion of one candidate must inform student	. 30 minutes per can utes). ent, this may be chan e each or an oral exa ts about this by four	e candidate each (approx. 30 mi- ididate) or d) project report (ap- nged and assessment may in- mination in groups. If the method weeks prior to the original exami- ubsequent semester		
Allocat	ion of p	olaces					
Additio	nal inf	ormation					
Worklo	ad						
240 h							
Teachir	ng cycl	e					
Referre	d to in	LPO I (examination regu	lations for teaching-	degree programmes)			

Modul	e title			Abbreviation					
Quantu	um Fiel	d Theory II			11-QFT2-Int-201-mo	1			
Modul	e coord	inator		Module offered by	offered by				
-	ing Dire	ector of the Institute of Sics	Theoretical Physics	Faculty of Physics a	aculty of Physics and Astronomy				
ECTS	Meth	od of grading	Only after succ. cor	npl. of module(s)					
8	nume	rical grade							
Duratio		Module level	Other prerequisites	i					
1 seme	ester	graduate							
Conter	nts								
2. Path 3. Rend 4. Rend 5. Gaug 6. Spor	 Generating Functionals Path Integrals Renormalization Renormalization group Gauge theories Spontaneous Symmetry Breaking Effective Field Theory (optional) 								
-		ning outcomes							
In-dept zation	th knov and of	vledge of the concepts gauge theories. Ability ulational methods.							
Course	es (type	, number of weekly con	tact hours, language –	- if other than Germa	in)				
V (4) + Module		t in: English							
Metho	d of ass	sessment (type, scope,	language — if other th	an German, examina	ition offered — if not	every seme-			
		on on whether module		-					
nutes) prox. 8 If a wri stead t of asse nation Langua	or c) or to 10 p tten exa take the essmen date at age of a	mination (approx. 90 to al examination in group bages) or e) presentatio amination was chosen e form of an oral examin t is changed, the lectur the latest. ssessment: English ffered: In the semester	os (groups of 2, approx n/talk (approx. 30 min as method of assessm nation of one candidate er must inform studen	x. 30 minutes per car lutes). ent, this may be char e each or an oral exa ts about this by four	ndidate) or d) project nged and assessme mination in groups. weeks prior to the o	t report (ap- nt may in- If the method riginal exami-			
Allocat	tion of _l	olaces							
Additio	onal inf	ormation							
Worklo	bad								
240 h									
	ng cycl	e							
Referre	ed to in	LPOI (examination reg	gulations for teaching-	degree programmes)					
			<u></u>						
Modul	e appea	ars in							
Master	r's degr	ee (1 major) Physics Int gram Physics (2023)	ernational (2020)						
		r Physics International (2024)	-	• generated 21-Jun-2024 • exa r (120 ECTS) Physics Internati	-	page 119 / 153			



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

Module					Abbreviation	
Advanc	ed The	ory of Quantum Comput	ing and Quantum Inf	ormation	11-QIC-Int-201	-mo1
Module	coord	inator		Module offere	d by	
Managi	ng Dire	ector of the Institute of Tl	neoretical Physics		sics and Astronomy	
and Ast	-				, , , , , , , , , , , , , , , , , , , ,	
ECTS	Metho	od of grading	Only after succ. cor	npl. of module(s	5)	
6	nume	rical grade				
Duratio	n	Module level	Other prerequisites	5		
1 seme	ster	graduate				
Conten	ts					
2. Quar 3. Com 4. Enta 5. Quar	ntum th posite ngleme ntum oj	ary of classical informati leory seen from the pers systems and the Schmid ent measures perations, POVMs, and the ates and quantum comp	pective of information t decomposition he theorems of Kraus	·	g	
		the theory of decoherer				
Intende	ed lear	ning outcomes				
Knowle depth ι	dge of Inderst f quan	ve understanding of quar handling tensor product anding of the phenomer tum information theory.	s and dealing with qu non of entanglement.	uantum effects i Knowledge of t	n multipartite quant he fundamental mat	um systems. In- hematical con-
Course	s (type	, number of weekly conta	act hours, language –	– if other than G	erman)	
V (3) + I	R (1)					
Module	e taugh	t in: English				
		essment (type, scope, la on on whether module c			mination offered —	if not every seme-
nutes) prox. 8 If a writ stead ta of asse nation Assess Langua	or c) or to 10 p ten exa ake the ssmen date at ment o ge of a	mination (approx. 90 to a al examination in groups bages) or e) presentation amination was chosen as form of an oral examina- t is changed, the lecture the latest. ffered: In the semester in ssessment: English	s (groups of 2, approx /talk (approx. 30 min s method of assessm ation of one candidate r must inform studen	k. 30 minutes pe nutes). ent, this may be e each or an ora ts about this by	er candidate) or d) pr e changed and asses l examination in gro four weeks prior to t	oject report (ap- sment may in- ups. If the methoo he original exami
Allocat	ion of p	olaces				
Additio	nal inf	ormation				
			-			
Worklo	ad					
180 h						
Teachir	ıg cycl	e				
 Referre Module		LPOI (examination regu	llations for teaching-	degree program	mes)	
						1 .
		Physics International (2024)	IMII Würzburg	 generated 21-Jun-202 	A e exam reg da.	page 121 / 153

Module title Abbreviation								
Quantum Me	chanics II			11-QM2-Int-201-mo	1			
Module coor	dinator		Module offered by					
Managing Dir and Astrophy	rector of the Institute of Tl vsics	neoretical Physics	Faculty of Physics and Astronomy					
ECTS Meth	od of grading	Only after succ. con	npl. of module(s)					
8 num	erical grade							
Duration								
1 semester	undergraduate							
Contents								
 "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 physically. The course is pivotal to subsequent theory courses in astrophysics, high energy physics and condensed 								
	state physics. The course e, number of weekly conta	· · · · · · · · · · · · · · · · · · ·		n				
V(4) + R(2)	e, number of weekly conta	act nours, language –	- II OLIIEI LIIAII GEIIIIA	iii <i>)</i>				
Module taug	ht in: English	_						
	sessment (type, scope, la tion on whether module c			tion offered — if not	every seme-			
nutes) or c) o prox. 8 to 10 If a written ex stead take th of assessmen nation date a	ster, information on whether module can be chosen to earn a 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. Assessment offered: In the semester in which the course is offered and in the subsequent semester							
Allocation of	places							
Additional in	formation							
Workload								
240 h								
Teaching cyc	le							
Master's with 1 maj	or Physics International (2024)		• generated 21-Jun-2024 • exa r (120 ECTS) Physics Internati		page 123 / 153			

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

Module appears in

Module	Module title Abbreviation							
Quantu		-			11-QTR-Int-201-m01			
Module	e coord	inator		Module offered by				
	r	ctor of the Institute of A						
ECTS	î	d of grading	Only after succ. con	pl. of module(s)				
6	<u> </u>	rical grade						
Duratio		Module level	Other prerequisites					
1 seme		graduate						
The lec action a as well the qua of supe Low dir vant ma tals, an	Contents 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							
		ledge of basic transport	experiments, its anal	ysis and its interpret	ation which enables	the student		
to disc	uss res	ults critical.		· · ·				
		number of weekly cont	act hours, language –	- if other than Germa	n)			
V (3) + Module		t in: English						
		essment (type, scope, l on on whether module o			tion offered — if not	every seme-		
nutes) prox. 8 If a writ stead t of asse nation Assess	or c) or to 10 p tten exa ake the ssment date at ment o	nination (approx. 90 to al examination in group ages) or e) presentation mination was chosen a form of an oral examina is changed, the lecture the latest. ffered: In the semester i ssessment: English	s (groups of 2, approx /talk (approx. 30 min s method of assessme ation of one candidate r must inform student	. 30 minutes per can utes). ent, this may be chan e each or an oral exa s about this by four	didate) or d) project nged and assessmer mination in groups. I weeks prior to the or	report (ap- nt may in- If the method		
Allocat	ion of p	laces						
Additio	onal info	ormation						
Worklo	ad							
180 h								
Teachi	ng cycl	5	_					
Referre	d to in	LPOI (examination reg	ulations for teaching-o	legree programmes)				
Module	e 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	ith 1 major	Physics International (2024)	-	generated 21-Jun-2024 • exa r (120 ECTS) Physics Internati	-	page 125 / 153		



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

Module					Abbreviation		
Radio A	stron	mical Interferometry			11-RAI-Int-211-m01		
Module	coord	inator		Module offered by			
		ector of the Institute of T	hooratical Physics	· · ·	and Astronomy		
and As	-		neoretical Physics	Faculty of Physics a	ind Astronomy		
ECTS	<u> </u>	od of grading	Only after succ. compl. of module(s)				
6		rical grade					
Duratio	I	Module level	Other prerequisites				
1 seme		graduate					
		gladdate					
Conten							
		and Background					
		adio astronomy					
		d development of radio		of chocial interact			
		s of radio interferometry f important concepts in		or special interest			
		al Concepts	auto astronolly				
1. Fouri		•					
		t of telescope aperture					
		n and Fourier Theorems					
c) (Rad	io) tele	scopes as spatial filters					
2. Inter							
		son interferometer					
		ment interferometer					
		y function					
		ce of limited bandwidth	e) Spatial frequencie	s in interferometry			
		systems	omotrio Arrous				
		nthesis by Radio Interfer t of (u ,v) coverage	ometric Arrays				
		figurations and transit a	rravs				
		ays and Earth-rotation s					
d) VLBI	-		,				
		parations and geometry					
4.Recei	ver Res	sponse					
a) Hete	rodyne	frequency conversion					
		eter sensitivity					
		veighting, gridding					
		smearing					
c) Calib		struction					
		struction alternative imaging algo	rithme				
b) Imag							
c) Seif							
,		nforming					
-		plications and Challeng	es				
•		d Wide-Field Imaging					
		Baseline Interferometry					
		py in Radio Interferomet	•				
		n in Radio Interferometry					
		in Science in Radio Inter	-				
		ncy Challenges Interferor	netry				
		Radio Interferometry					
		etry and Geodesy realization: Current and	Incoming Padia Into	ferometors			
		ncy arrays: LOFAR, GMRT	-				
		r Physics International (2024)		• generated 21-Jun-2024 • exa	am reg da-	page 127 / 153	
nuster S W	in i maju	r nysics memational (2024)	-	er (120 ECTS) Physics Internati	-	puse 12/ / 153	



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 can be chosen to earn a 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

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)

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

8 numerical grade Duration Module level Other prerequis 1 semester graduate Contents This course is complementary to the discussion of Wilscrease graduation Group and Critical Phenomena" (11)	. compl. of module(s) sites on's renormalizationg group (RG) as covered in the cour- 1-CRP). This course focuses on the diagrammatic formu-				
Managing Director of the Institute of Theoretical PhysicsAnd AstrophysicsECTSMethod of gradingOnly after succ.8numerical gradeDurationModule levelOther prerequis1 semestergraduateContentsThis course is complementary to the discussion of Wilscse "Renormalization Group and Critical Phenomena" (11)	s Faculty of Physics and Astronomy . compl. of module(s) sites on's renormalizationg group (RG) as covered in the cour- 1-CRP). This course focuses on the diagrammatic formu-				
Managing Director of the Institute of Theoretical PhysicsAnd AstrophysicsECTSMethod of gradingOnly after succ.8numerical gradeDurationModule levelOther prerequis1 semestergraduateContentsThis course is complementary to the discussion of Wilscse "Renormalization Group and Critical Phenomena" (11)	s Faculty of Physics and Astronomy . compl. of module(s) sites on's renormalizationg group (RG) as covered in the cour- 1-CRP). This course focuses on the diagrammatic formu-				
ECTS Method of grading Only after succ. 8 numerical grade Duration Module level Other prerequis 1 semester graduate Contents This course is complementary to the discussion of Wilson Se "Renormalization Group and Critical Phenomena" (11)	sites on's renormalizationg group (RG) as covered in the cour- 1-CRP). This course focuses on the diagrammatic formu-				
8 numerical grade Duration Module level Other prerequis 1 semester graduate Contents This course is complementary to the discussion of Wilscose "Renormalization Group and Critical Phenomena" (11)	sites on's renormalizationg group (RG) as covered in the cour- 1-CRP). This course focuses on the diagrammatic formu-				
DurationModule levelOther prerequis1 semestergraduateContentsThis course is complementary to the discussion of Wilsc se "Renormalization Group and Critical Phenomena" (11)	on's renormalizationg group (RG) as covered in the cour- 1-CRP). This course focuses on the diagrammatic formu-				
1 semester graduate Contents This course is complementary to the discussion of Wilsc se "Renormalization Group and Critical Phenomena" (11	on's renormalizationg group (RG) as covered in the cour- 1-CRP). This course focuses on the diagrammatic formu-				
This course is complementary to the discussion of Wilsc se "Renormalization Group and Critical Phenomena" (11	1-CRP). This course focuses on the diagrammatic formu-				
se "Renormalization Group and Critical Phenomena" (11	1-CRP). This course focuses on the diagrammatic formu-				
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					
conductivity, charge and spin density waves, and nema Courses (type, number of weekly contact hours, languag					
V (4) + R (2) Module taught in: English					
Method of assessment (type, scope, language — if othe ster, information on whether module can be chosen to e	er than German, examination offered — if not every seme- earn a 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: Once a year as announced					
Allocation of places					
Additional information					
Workload					
240 h					
Teaching cycle					

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

Module appears in

Module title			Abbreviation	
Theory of Relativity 11-RTT-Int-201-m01				
Module coord	inator		Module offered by	
Managing Dire and Astrophys	ector of the Institute of Th sics	eoretical Physics	Faculty of Physics a	nd Astronomy
ECTS Metho	od of grading	Only after succ. con	pl. of module(s)	
6 nume	rical grade			
Duration	Module level	Other prerequisites		
1 semester	graduate			
Contents				
 Mathematical Foundations Differential forms Brief Summary of the special relativity Elements of differential geometry Electrodynamics as an example of a relativistic gauge theory Field equations of the fundamental structure of general relativity Stellar equilibrium and other astrophysical applications Introduction to cosmology 				
	ning outcomes			
Familiarity with the basic physical and mathematical concepts of general relativity. Mathematical understanding of the formulation in terms of differential forms. Understanding of the formal similarity between electrodynamics and the theory of general relativity, viewing both of them as gauge theories. Application of the theory to simple models of stellar equilibrium. First contact with elements of cosmology.				
Courses (type	, number of weekly conta	ct hours, language –	- if other than Germa	n)
V (3) + R (1) Module taugh	t in: English			
	essment (type, scope, la on on whether module ca			tion offered — if not every seme-
 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	olaces			
Additional information				
Workload				
180 h				
Teaching cycle				
Referred to in	LPO I (examination regu	lations for teaching-	legree programmes)	
Module appea	irs in			

Module title			Abbreviation		
Black Holes 11-SLQ-Int-241-mo1				11-SLQ-Int-241-m01	
Module coordinator Module offe			Module offered by		
Managi and Ast		ector of the Institute of Th sics	eoretical 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	i	
1 seme	ster	graduate			
Contents					
 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 5. Firewall, fuzzball, complementarity - possible resolutions of information paradox 6. Wormholes and the factorization puzzle 					
Intende	ed lear	ning outcomes			
This course plays a bridging role joining the basics on GR learnt in the GR I course and the active research directions 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. Courses (type, number of weekly contact hours, language — if other than German)					
V (3) +		, and the of the entry contra			,
		t in: English			
Method of assessment (type, scope, language — if other than German, examination offered — if not every seme-					
ster, information on whether module can be chosen to earn a 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 following semester

Allocation of places

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)

Modul					Abbreviation
	Spintronics 11-SPI-Int-201-m01				
Modul	e coord	inator		Module offered by	
Manag	ing Dire	ector of the Institute of Ap	oplied Physics	Faculty of Physics a	nd Astronomy
ECTS		od of grading	Only after succ. com	npl. of module(s)	
6	nume	rical grade			
Duratio		Module level	Other prerequisites		
1 seme		graduate			
Conter					
giant n	nagneto		agnetoresistance. Ne		r emphasis on the phenomena of the fields of spin dynamics and
Intend	ed lear	ning outcomes			
	. Overv				oin transport in information tech- sistance, tunnel magnetoresi-
Course	es (type	, number of weekly conta	ct hours, language —	- if other than Germa	n)
V (3) + Modul		t in: English			
		s essment (type, scope, la on on whether module ca			tion offered — if not every seme-
a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 mi- nutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (ap- prox. 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. Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: English					
Allocat	tion of p	olaces			
Additio	onal inf	ormation			
	_				
Worklo	bad				
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)					
Master's degree (1 major) Quantum Engineering (2020)					
1		gram Physics (2023)	ringering (ass ()		
1	-	ee (1 major) Quantum Eng ee (1 major) Physics Inter			
Master's degree (1 major) Physics International (2024)					

Module	title				Abbreviation	
Scanning Probe Technologies				11-SPT-Int-201-m01		
Module coordinator				Module offered by	<u> </u>	
Managing Director of the Institute of Applied Physics			pplied Physics	Faculty of Physics a	and Astronomy	
ECTS	-	od of grading	Only after succ. con	, ,	•	
6	nume	rical grade				
Duratio	n	Module level	Other prerequisites			
1 semes	1 semester graduate					
Conten	ts					
surface enginee basic p	scienc ering; r rinciple	e; tip-sample interaction neasurement modes, e.g	ns; design principles a g., contact and non-co	and material conside intact, Kelvin probe,	microscopy; basic principles of erations; fundamentals of control friction force microscopy, etc; chniques and their application:	
Intende	ed lear	ning outcomes				
les, is a	ware c	of basic design principles	s, knows pros and cor	ns of various materia	ows the basic theoretical princip- lls, and is familiar of measure- ecent development in the field.	
Course	s (type	, number of weekly conta	act hours, language –	- if other than Germa	in)	
V (3) + I						
		t in: English				
		sessment (type, scope, la ion on whether module c			tion offered — if not every seme-	
a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 mi- nutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (ap- prox. 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						
Allocati	ion of _l	olaces				
Additio	nal inf	ormation				
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)						
		ee (1 major) Physics Inte	rnational (2024)			

Module title			Abbreviation			
Surface Science 11-SSC-Int-201-m01						
Module coordinator			Module offered by			
Managing Director of the Institute of Applied Physics Faculty of Physics and Astronomy						
ECTS Method of grad		Only after succ. com	pl. of module(s)			
6 numerical grade	j					
Duration Module l		Other prerequisites				
1 semester graduate						
Contents						
Relevance of surfaces and interfaces, distinction from bulk phases, classical description, continuum models, Atomic structure: reconstructions and adsorbates, surface orientation and symmetries, Microscopic processes at surface, thermodynamics, adsorption and desorption, Experimental characterization, Electronic structure of sur- faces, chemical bonding, surface states, spin-orbit coupling, Rashba effects, topological surface states, magne- tism						
Intended learning outco	mes					
The students have an ov characteristic of surface investigation of surface	s and interface	s. The students know	<i>i</i> the most important			
Courses (type, number of	of weekly conta	ct hours, language —	if other than Germa	n)		
V (3) + R (1) Module taught in: Englis	sh					
Method of assessment (type, scope, language — if other than German, examination offered — if not every seme- ster, information on whether module can be chosen to earn a bonus)						
a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 mi- nutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (ap- prox. 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. Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: English						
Allocation of places						
i						
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)						
Master's degree (1 major) Quantum Engineering (2020)						
exchange program Physics (2023) Master's degree (a major) Quantum Engineering (2024)						
Master's degree (1 major) Quantum Engineering (2024) Master's degree (1 major) Physics International (2024)						
Master's with 1 major Physics Inter		•	generated 21-Jun-2024 • exa	m reg da-	page 137 / 153	
		_	r (120 ECTS) Physics Internation	-	P~3~ 1/ (1)	

Module title			Abbreviation		
String 1	String Theory 1 11-STRG1-Int-201-m01				
Module coordinator Mo			Module offered by		
Managing Director of the Institute of Theoretical Physics and Astrophysics			eoretical Physics	Faculty of Physics a	nd Astronomy
ECTS		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				
action, dimens	Quanti ion, Qι	zation of the closed boso uantization of the open b	onic string and emerg osonic string, D-Bran	gent graviton, Quantu es, Gauge Fields and	Nambu-Goto action and Polyakov um Lorentz invariance and critical d Yang-Mills Theories, Relativistic ons, Effective Actions and Gravi-
Intende	ed learr	ning outcomes			
Familiarity with the classical and quantum theory of relativistic bosonic strings, in particular with the two classical actions for relativistic bosonic strings, the Nambu-Goto action and the Polyakov action. Ability to quantize the closed bosonic string and to understand the emergence of the massless graviton in the spectrum of the closed bosonic string. Knowledge of the the quantum Lorentz anomaly and the derivation of the critical dimension of the bosonic string. Understanding of the boundary conditions for the open string and its connection to D-branes. Knowledge of open string quantization and the spectrum of massless gauge fields, as well as of Yang-Mills fields for coincident branes. In-depth knowledge of relativistic conformal field theory, the string path integral and its BRST quantization and the calculation of string interactions. Thorough understanding of the low-energy effective actions in target space and the emergence of Einstein gravity.					
Courses	s (type,	, number of weekly conta	ct hours, language —	- if other than Germa	n)
V (4) + R (2) Module taught in: English					
		essment (type, scope, la on on whether module ca			tion offered — if not every seme-
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			
Additional information					
Workload					
240 h					
Teaching cycle					
	3 - 9 - 10	-			
Referred to in LPO I (examination regulations for teaching-degree programmes)					

Module title			Abbreviation		
	String Theory 2 11-STRG2-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		od of grading	Only after succ. con	npl. of module(s)	
6	nume	rical grade			
Duratio		Module level	Other prerequisites		
1 semes		graduate			
Conten	ts				
Superstring Theories and M Theory, in particular a short introduction to bosonic string theory, the theory of fer- mionic fields and representations of clifford algebra in diverse dimensions, a review of supersymmetry in two and higher dimensions, the classical and quantum version of the Ramond-Neveau-Schwarz Superstring, type 2 A/B Superstrings, the Gliozzi-Scherck-Olive Projection and Space-Time Supersymmetry in 10 dimensions, the ty- pe 1 Superstring, heterotic string theories, anomaly cancellation and restrictions on gauge groups, dualities bet- ween the five superstring theories as well as their relation to M Theory in 11D, D-Branes and supersymmetric gau-					
		upergravity and the AdS/ ning outcomes	CFT Correspondence.		
			atuina tha ania a and		
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 of the AdS/CFT Correspondence.					
Course	s (type	, number of weekly conta	ct hours, language –	- if other than Germa	n)
V (3) + I Module		t in: English			
					tion offered — if not every seme-
ster, information on whether module can be chosen to earn a 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					
Additio	nal inf	ormation			
Worklo	ad				
180 h					

Teaching cycle

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

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Module appears in

Module title	Abbreviation				
Topological Effects in Solid State Physics 11-TEFK-Int-201-m01					
Module coordinator Module offered I	by				
Managing Director of the Institute of Theoretical Physics Faculty of Physic and Astrophysics	s and Astronomy				
ECTS Method of grading Only after succ. compl. of module(s)					
8 numerical grade					
Duration Module level Other prerequisites					
1 semester graduate					
Contents					
 Geometric phase in quantum systems 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 					
9. Topological superconductors					
Intended learning outcomes In-depth theoretical understanding of the topological concepts in quantum physics related to solid state sy- stems. Ability to connect their knowledge with different research activities at the Department of Physics and Astronomy at Würzburg University. 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 seme- ster, information on whether module can be chosen to earn a 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) er candidate) or d) project report (ap- prox. 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. Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: English					
Allocation of places					
Additional information					
Workload					
240 h					
Teaching cycle					
Referred to in LPO I (examination regulations for teaching-degree programmes)					
	/				
Module appears in					

Module title			Abbreviation			
Theoretical Elementary Particle Physics 11-TEP-Int-201-m01						
Module coordinator Module offered by						
	ing Dire trophys	ector of the Institute of sics	Theoretical Physics	Faculty of Physics and Astronomy		
ECTS	Meth	od of grading	Only after succ. cor	npl. of module(s)		
8	nume	rical grade				
Duratio	on	Module level	Other prerequisites	;		
1 seme	ester	graduate				
Conter	nts					
 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 						
		s of the Standard Mode	2			
Intend	ed lear	ning outcomes				
standa calcula ons. Fa	ard mod ational amiliari	h the mathematical me el and its construction methods for scattering ty with the basics of ex , number of weekly cor	from symmetry princip and decay processes, tended theories.	les and experimenta tests of the standard	l observations. Knov models and there a	wledge of the
		, number of weekly cor	ilact nours, language -	- II other than Germa	(11)	
V (4) + R (2) Module taught in: English						
		sessment (type, scope, ion on whether module			tion offered — if not	every seme-
 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						
240 h						
Teaching cycle						
Referred to in LPO I (examination regulations for teaching-degree programmes)						
Master's w	ith 1 majo	r Physics International (2024)	-	• generated 21-Jun-2024 • exa er (120 ECTS) Physics Internati	-	page 144 / 153

Module title			Abbreviation			
Theoret	Theoretical Solid State Physics 2 11-TFK2-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	<u> </u>	od of grading	Only after succ. con	pl. of module(s)		
8		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) 						
Intende	ed learı	ning outcomes				
ty to ap	ply the	wledge of the topics liste methods listed. This pro d textbooks on theoretica	vides a thorough wo	rking knowledge of a		
Course	s (type	, number of weekly conta	ct hours, language –	- if other than Germa	n)	
V (4) + I Module		t in: English				
Method of assessment (type, scope, language — if other than German, examination offered — if not every seme- ster, information on whether module can be chosen to earn a bonus)						every seme-
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						
Allocat		ffered: In the semester in places				
Additio	nal inf	ormation				
Worklo	ad					
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)						
		ee (1 major) Physics Inter	national (2024)			
Master's wi	th 1 majoi	r Physics International (2024)	_	generated 21-Jun-2024 • exa r (120 ECTS) Physics Internati	-	page 146 / 153

Module title			Abbreviation		
				11-TFK-Int-201-m01	
Module coordinator Module offered by			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				
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					
· ·	,	of superconductivity			
		ning outcomes			
In-depth knowledge of the topics listed above. In-depth understanding of the concepts involved and ability to apply the methods listed. This provides a thorough working knowledge of a large number of topics treated in the standard textbooks on theoretical solid state physics.					
Courses	s (type	, number of weekly conta	ct hours, language –	- if other than Germa	n)
V (4) + I Module		t in: English			
		sessment (type, scope, la on on whether module ca			tion offered — if not every seme-
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. Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: English					
Allocati	ion of p	olaces			
Additional information					
Workload					
240 h					
Teaching cycle					
Referred to in LPO I (examination regulations for teaching-degree programmes)					
Kererre	u to in	LFUI (examination regu	tations for teaching-0	legree programmes)	
		•			
Module	appea	irs in			

Module title				Abbreviation		
Experimental Particle Physics 11-TPE-Int-201-m01						
Module coordinator				Module offered by		
Managing Director of the Institute of Ap		plied Physics	lied Physics Faculty of Physics and Astronomy			
ECTS			Only after succ. con	compl. of module(s)		
6			-			
Duration Module level		Other prerequisites				
1 seme	ester	graduate				
Conter	Contents					
Physics with modern particle physics detectors at the LHC and at the Tevatron. Discovery of the Higgs Boson. De- termination of the W boson and Top Quark mass. Measurement of standard model parameters. Search for phy- sics beyond the standard model.						
Intend	ed lear	ning outcomes				
Familiarity with the basic questions studied with a modern particle physics detector, and with modern data ana- lysis techniques in particle physics. Ability to put results into context and to assess their systematic uncertain- ties.						
Course	es (type	, number of weekly conta	ct hours, language –	- if other than Germa	n)	
V (3) + Modul	• •	t in: English				
Metho	d of ass	sessment (type, scope, la	nguage — if other tha	an German, examina	tion offered — if not every seme-	
ster, in	format	ion on whether module ca	an be chosen to earn	a bonus)		
a) written examination (approx. 90 to 120 minutes) or b) oral examination of one candidate each (approx. 30 mi- nutes) or c) oral examination in groups (groups of 2, approx. 30 minutes per candidate) or d) project report (ap- prox. 8 to 10 pages) or 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. Assessment offered: In the semester in which the course is offered and in the subsequent semester 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) exchange program Physics (2023)						
Master's degree (1 major) Physics International (2024)						

Module title Abbreviation					Abbreviation	
Particle Physics (Standard Model)					11-TPSM-Int-211-mo1	
Module coordinator				Module offered by		
Managi	ng Dire	ectors of the Institute of A	pplied Physics and	Faculty of Physics a	nd Astronomy	
		f Theoretical Physics and				
ECTS		od of grading	Only after succ. com	pl. of module(s)		
8	numerical grade					
Duratio		Module level	Other prerequisites			
	1 semester graduate Approval from examination committee required.					
Conten						
Electrov parity V Bhabha	weak sy 'iolatio a scatte		h the Higgs mechani	sm		
Higgs production and decay Experimental setup and results of key experiments to test the Standard Model and for determining its parame- ters Search for the Higgs boson						
Intende	ed learr	ning outcomes				
have es tal or th Course	stablish neoretio s (type,	ned and confirmed the st	andard model. They h ork of the standard m	nave basic knowledg odel can and knows	tle and the key experiments that ge in order to interpret experimen- its significance and limitations. n)	
	taugh	t in: English				
		essment (type, scope, la on on whether module ca			tion offered — if not every seme-	
 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					
240 h						
Teaching cycle						
Referred to in LPO I (examination regulations for teaching-degree programmes)						
		•				
Module	e appea	irs in				

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

Module title Abbreviation							
Theoretical Quantum Optics				11-TQO-Int-221-m01			
Module coordinator				Module offered by			
Managing Director of the Institute of Theoretical Physics and Astrophysics				Faculty of Physics and Astronomy			
			Only after succ. con	ompl. of module(s)			
8		rical grade					
Duratio	on	Module level	Other prerequisites	25			
1 seme	ster	graduate		-			
Conter	Contents						
 Semi-classical atom-field interactions Interaction of atoms with quantized light fields and dressed-atom model Master equation and open systems Coherence and interference effects Coherent light propagation in resonant media Photon statistics and correlations 							
		ptics of many-body syst					
Intended learning outcomes Comprehensive understanding of phenomena involving light and its interaction with atoms at the microscopi- cal level. Knowledge of density matrix formalism for quantum systems and the related mathematical concepts. In-depth understanding of quantum properties of light and their experimental signatures, including photon sta- tistics and correlations. Knowledge of the theory of open systems and master equation description involving Lindblad superoperators. Understanding and modeling the role of coherence and interference in light propagati- on effects in resonant atomic media. Knowledge of cooperative effects in many-body systems: super- and subra- diance, collective light shifts and their applications.							
Courses (type, number of weekly contact hours, language — if other than German)							
V (4) +	R (2)	· · · · · ·					
Modul	e taugh	t in: English					
Method of assessment (type, scope, language — if other than German, examination offered — if not every seme- ster, information on whether module can be chosen to earn a bonus)							
written examination (approx. 90 to 120 minutes) or oral examination of one candidate each (approx. 30 minutes) or oral examination in groups (groups of 2, approx. 30 minutes per candidate) or project report (approx. 8 to 10 pages) or 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. Assessment offered: In the semester in which the course is offered and in the subsequent semester Language of assessment: English							
Allocation of places							
Additional information							
Workload							
240 h							
Teaching cycle							
Referred to in LPO L (avamination regulations for teaching degree programmes)							
Referred to in LPO I (examination regulations for teaching-degree programmes)							
 Master's w	ith 1 majo	r Physics International (2024)		• generated 21-Jun-2024 • exa r (120 ECTS) Physics Internati		page 152 / 153	

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