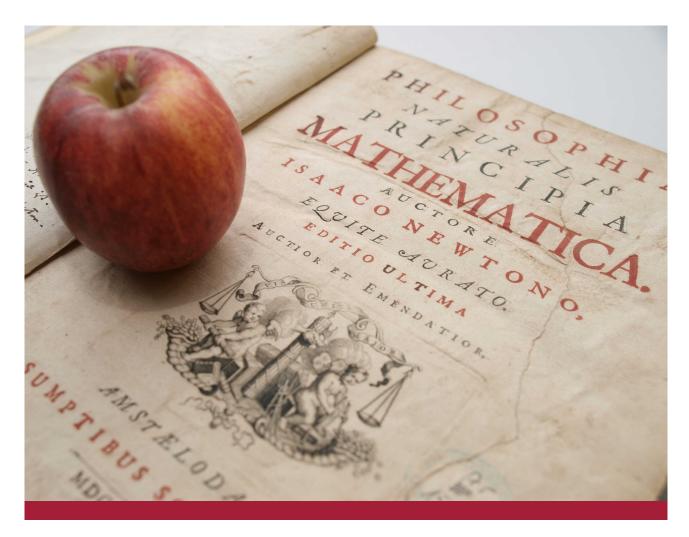




Mathematisch-Naturwissenschaftliche Fakultät



Department of Mathematics

Module Handbook Mathematical Physics Master of Science

Winter Semester 2018

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1 Program description

1.1 Study Concept

The Master of Science Mathematical Physics is an international research-oriented two year master's program offered jointly by the departments of Mathematics and Physics within the Faculty of Science of the University of Tübingen starting every year in the winter semester. It is geared towards students with a solid background in Mathematics as well as in Physics, and it requires a bachelor's degree in physics or mathematics or an equivalent degree. The scientific discipline "Mathematical Physics" is concerned with the mathematically rigorous formulation and analysis of physical theories and models. In this master's program students will thus deepen and broaden their knowledge of Mathematics and Physics in interdisciplinary courses in Mathematical Physics as well as in disciplinary courses in Mathematics and Theoretical Physics. At the end of the program they are particularly well prepared for jobs where the typical competences of mathematicians are needed in combination with applications of physics. The program is international and cannot be pursued without a solid knowledge of the English language. Language skill on the level of B2 according to the European Framework of Reference for Languages are therefore required. All mandatory modules and a large number of facultative modules are offered only in English. Some facultative modules may sometimes be offered only in German.

1.2 Program Structure and Qualification Goals

1.2.1 Program Structure

The Master's Program is a two year (four terms) consecutive study program with a modular structure. Based on the foundational modules "Geometry in Physics", "Mathematical Quantum Theory", "Mathematical Relativity", and "Mathematical Statistical Physics", to be attended during the first year, students can specialise rather freely according to their personal preferences in one or more areas of Mathematical Physics, Mathematics and/or Theoretical Physics. The few restrictions are that every student must take at least one module from the Mathematics master's program (module E1) and one module from the Theoretical Physics master's program (module E2), as well as a seminar (module E3). As a consequence, all graduates of the Master's Program have proven their ability to successfully conduct mathematical studies and theoretical physics studies at the master's level. A Scientific Project in the third term typically serves as a preparation for the Master Thesis (M.Sc. Thesis, 30 ECTS-points) written during the final term. During the second year students are also required to attend the Mathematical Physics Colloquium. This is a weekly colloquium where specialists lecture about recent developments in Mathematical Physics, and students have the opportunity to meet and discuss with international guest scientists and local researchers about current topics. The prescribed period of study is two years corresponding to a total of 120 ECTS points.

1.2.2 Qualification Goals

Students deepen and broaden their theoretical knowledge of different areas of mathematical physics, mathematics and theoretical physics. They become proficient in general and specific methods and principles in these areas. They can connect problems and questions from physics with their counterparts in mathematical models and are able to judge and critically question the relevance and adequacy of mathematical models and the derived consequences. They are able to report on and scrutinize the current state of research in the area of their specialisation. Graduates can apply their expanded knowledge in order to develop and successfully handle their own research projects. They are able to present, discuss, and defend the results of their research in writing and orally in front of a scientific audience. In the course of the Mathematical Physics Colloquium students practice scientific collaboration and discourse in interdisciplinary and internationally mixed groups.

Their education enables graduates in mathematical physics to successfully and professionally tackle complex mathematical modelling problems in physics and, after an appropriate familiarization with the subject, also in other areas of technology, finance or economics. They are moreover well prepared for interdisciplinary and international collaborations in mixed teams of different specialists from different cultural backgrounds, as are common nowadays in all areas of research and development.

1.3 Mentoring

At the start of the program every student will be assigned to a mentor from the group of professors involved in the master's program for the whole duration of his/her studies. Students meet their mentor at the beginning and later at least once per term in order to plan and discuss the progress of their studies. In particular, at these meetings the study and examination plan in compliance with the examination regulations is discussed. The module selection is documented and passed on to the head of the examinations board. During the first meeting possible gaps in the knowledge should be discussed in order to fill them by taking appropriate courses within the area of elective specialisation.

The mandatory mentoring program assures that students specialise in a purposeful way and select accordingly goal-oriented combinations of modules from mathematics and physics.

2 Study Plans

2.1 Overview by Modules

We provide here an overview of the study plan as a table showing the modules to be taken.

Suggested Term	Module Number	Module Title	Type of Course	Type of Module	Assign- ments	Type of Exam	ECTS- Points
Section 1: I	oundations						<u>'</u>
1	G1	Geometry in Physics	L+E	PM	НА	wr. o. or.	9
1	G2	Mathematical Quantum Theory	L+E	WPM	НА	wr. o. or.	9
2	G3	Mathematical Relativity	L+E	WPM	НА	wr. o. or.	9
2	G4	Mathematical Statistical Physics	L+E	WPM	НА	wr. o. or.	9
Section 2: I	Knowledge E	xpansion					
1–3	E1	Advanced Topics in Mathematics	L+E	PMW	НА	wr. o. or.	9
1–3	E2	Advanced Topics in Theoretical Physics	L+E	PMW	НА	wr. o. or.	9
2–3	ES	Seminar	S	PMW	s.M.	Р	3
Section 3: I	Elective Spec	cialisation		·			
2	FWP1	Advanced Topics in Mathematical Quantum Theory	L+E	WPM	НА	wr. o. or.	9
2	FWP1	Advanced Topics in Mathematical Quantum Theory (short version)	L+E	WPM	НА	wr. o. or.	6
3	FWP2	Advanced Topics in Mathematical Relativity	L+E	WPM	НА	wr. o. or.	9
3	FWP2	Advanced Topics in Mathematical Relativity (short version)	L+E	WPM	НА	wr. o. or.	6
3	FWP3	Advanced Topics in Mathematical Statistical Physics	L+E	WPM	НА	wr. o. or.	9
3	FWP3	Advanced Topics in Mathematical Statistical Physics (short version)	L+E	WPM	НА	wr. o. or.	6
Section 4: 9	Scientific Wo						
3	SP	Scientific Project	Р	PM	s.M.	-	9
3–4	MC	Mathematical Physics Colloquium	C+C	PM	-	-	3
4	MT	Master Thesis	MT	PM	s.M.	MT	30
		1	1	-1			

L=lecture, S=seminar, SL=seminar or lecture, E=exercise class, Pr=project work, C=colloquium, T=tutorial PM=compulsory module, PMW=compulsory module with choice, WPM=elective module HA=homework assignment, MT=master thesis, or.=oral exam, wr.=written exam, o.=or, P=presentation s.M. = see module description

Two out of the three basic modules Mathematical Quantum Theory, Mathematical Relativity, and Mathematical Statistical Physics are mandatory. The third one is optional. Within the area "Elective Specialization", the three listed modules from the Mathematical Physics program can be chosen as well as a large number of advanced modules from the master's degree programs Mathematics, Physics, or Astro and Particle Physics, cf. Section 3.

2.2 Overview by the Course of Studies

We first provide a general study plan showing the distribution of credit points over the different areas and the general time line. On the following pages example study plans for different types of specialisation are provided, where possible courses are assigned to the modules E1 and E2 as well as the modules from the area of Elective Specialisation.

Term	СР	Foundations of Mathematical Physics	Knowledge Expansion	Elective Specialisation	Scientific Work
1.	27	07.00			
2.	30	27 CP	21 CP	00.00	
3.	31			30 CP	40.00
4.	32				42 CP

Figure 2.1: General Study Plan

2.3 Example Study Plans

The example study plans shown below shall give an idea how the individual study in the different specialisations could look like. They are not meant as a recommendation, and it is neither guaranteed that the courses listed will be offered each year, nor that they all will be given in English.

Example Study Plan without Specialisation

Term	СР	Foundations of Mathematical Physics	Knowledge Expansion	Elective Specialisation	Scientif	ic Work	
		Geometry in Physics (9 CP)	Linear Partial				
1.	27	Mathematical Quantum Theory (9 CP)	Differential Equations (9 CP)				
				Mathematical Statistical Physics (9 CP)			
2.	30	Mathematical Relativity (9 CP)	Seminar(3 CP)	Advanced Topics in Mathematical Quantum Theory (9 CP)			
			Quantum Field	Advanced Topics in Mathematical Relativity (6 CP)			
3.	31		Theory and Particle Physics (9CP)	Advanced Topics in Mathematical Statistical Physics (6 CP)	Mathe- matical Physics	Scientific Project (9 CP)	
4.	32				Colloquium (3 CP)	Master Thesis (30 CP)	

Figure 2.2: The program Mathematical Physics can be completed to a large extent also without choosing a particular specialisation. In this case we recommend taking all four foundational modules G1 to G4 and also all three advanced courses FWP1, FWP2, and FWP3. The modules from the area Knowledge Expansion should then be chosen in accordance with the planned specialisation in the Scientific Project and the Master Thesis, cf. e.g. the following study plans.

Example Study Plan Quantum Theory

Term	СР	Foundations of Mathematical Physics	Knowledge Expansion	Elective Specialisation	Scientif	ic Work
1.	27	Geometry in Physics (9 CP) Mathematical Quantum Theory (9 CP)	Operator Theory (9 CP)			
2.	30	Mathematical Statistical Physics (9 CP)	Quantum Field Theory and Particle Physics (9 CP) Seminar(3 CP)	Advanced Topics in Mathematical Quantum Theory (9 CP)		
3.	31			Calculus of Variations (9 CP) Computational Methods in Physics / Astrophysics (6 CP) Theoretical Condensed Matter	Mathe- matical Physics Colloquium	Scientific Project (9 CP)
4.	32			Physics (6 CP)	(3 CP)	Master Thesis (30 CP)

Figure 2.3: The mathematical foundations of quantum theory are predominantly allocated to areas of analysis. Thus we recommend that those specialising in one of the areas Mathematical Quantum Theory, Quantum Field Theory, Condensed Matter, Many-Body Quantum Systems, or Quantum Information attend mathematical courses from analysis, e.g. Operator Theory, Partial Differential Equations, Calculus of Variations, and Numerical Analysis.

Example Study Plan Relativity

Term	СР	Foundations of Mathematical Physics	Knowledge Expansion	Elective Specialisation	Scientif	ic Work
		Geometry in Physics (9 CP)	Astronomy and			
1.	27	Mathematical Quantum Theory (9 CP)	Astrophysics (9 CP)			
2.	30	Mathematical Relativity (9 CP)	Nonlinear Partial Differential Equations (9 CP)	Riemannian Geometry (9 CP)		
۷.	30		Seminar(3 CP)			
				Advanced Topics in Mathematical Relativity (9 CP)		
3.	31			Theoretical Astrophysics (6 CP)	Mathe-	Scientific Project
				Computational methods in Physics / Astrophysics (6 CP)	matical Physics Colloquium (3 CP)	(9 CP)
4.	32					Master Thesis (30 CP)

Figure 2.4: The mathematical foundations of relativity are predominantly allocated to areas of geometry and analysis. Thus we recommend that those specialising in one of the areas Mathematical Relativity, Astronomy, Cosmology, or Astro Physics attend mathematical courses from geometry, e.g. Riemannian Geometry and Lorentz Geometry, and from analysis, e.g. Partial Differential Equations, Calculus of Variations, and Numerical Analysis.

Example Study Plan Statistical Physics

Term	СР	Foundations of Mathematical Physics	Knowledge Expansion	Elective Specialisation	Scientific Work		
		Geometry in Physics (9 CP)					
1.	27	Mathematical Quantum Theory (9 CP)	Stochastic Processes (9 CP)				
_		Mathematical	Advanced Statistical	Mathematical Statistical Physics (9 CP)			
2.	30	Relativity (9 CP)	Physics (9 CP)	Density Functional Theory (6 CP)			
				Advanced Topics in Mathematical Statistical Physics (6 CP)		Scientific	
3.	31		Seminar (3CP)	Mathematical Statistics (9 CP)	Mathe- matical Physics	Project (9 CP)	
4.	32				Colloquium (3 CP)	Master Thesis (30 CP)	

Figure 2.5: The mathematical foundations of statistical physics are predominantly allocated to areas of probability. Thus we recommend that those specialising in one of the areas Mathematical Statistical Physics, Soft Matter, or Density Functional Theory attend mathematical courses from probability, e.g. Stochastic Processes and Mathematical Statistics.

2.4 Overview by Study Progress and Credit Requirements

			Exam			Te	eachi	ng			Te	rm	
		Type of Exam	Duration (min)		Weight in the final grade	Type of Course			ECTS Points (CP)	is a red Composite ma are ma allocate to countion on	points to commen ulsory al arked as ion of Eo rses is fo ily. Cred ed upon	of examination of examination of semestions of the contractions of the contraction of the complet of the comple	ters nly. S he nts a- nly
		oe of	ratior	Grading	ight	oe of	Status	S/	TS F	1.	2.	3.	4.
		Τχ	na	ğ	×	Τ̈́	Ste	SWS		СР	СР	СР	СР
Fou	ndations of Mathematical Pl	hysics:							27				
G1 (Geometry in Physics							6	9				
1.	Lecture	Wr.	90–120	g	9	L	0	4		6			
2.	Exercises	or Or.	or 20–30	9		Е	0	2		3			
G2 I	Mathematical Quantum Theor	у						6	9				
1.	Lecture	Wr.	90–120	g	9	L	f	4		6			
2.	Exercises	or Or.	or 20–30	9		Е	f	2		3			
G3 I	Mathematical Relativity							6	9				
1.	Lecture	Wr.	90–120 or	g	9	L	f	4			6		
2.	Exercises	or Or.	20–30	9		Е	f	2			3		
G4 I	Mathematical Statistical Physic	cs						6	9				
1.	Lecture	Wr. or	90–120 or	g	9	L	f	4			6		
2.	Exercises	Or.	20–30	9		E	f	2			3		
Kno	wledge Expansion:								21				
E1 /	Advanced Topics in Mathemati	ics						6	9				
1.	Lecture	Wr. or	90–120 or	g	9	L	0	4		6			
2.	Exercises	Or.	20–30	9		E	0	2		3			
E2 /	Advanced Topics in Physics							6	9				
1.	Lecture	Wr. or	90–120 or	g	9	L	0	4			6		
2.	Exercises	Or.	20–30	9		Е	0	2			3		
E3 5	Seminar							2	3				
1.	Seminar	Pres.	45–90	g	3	S	0	2				3	
Flec	tive Specialisation:								30				

Here the modules FWP1, FWP2 and/or FWP3, as well as further suitable advanced modules from the Master's Programs in Mathematics, Physics, and Astro and Particle Physics, can be chosen. The choices need to be discussed and agreed upon with the Mentor. Modules from other areas need to be approved by the examinations board.

			Exam			Te	eachii	ng			Те	rm	
		Exam	Duration (min)		Weight in the final grade	Type of Course			ECTS Points (CP)	is a recomposite are material allocate to countries on the countries of th	points to commen ulsory al arked as ion of E0 rses is fo lly. Cred ed upon	of exams semest dation o locations such. TI CTS poir or informatis are of complet	ers nly. s ne nts a- nly
		Type of Exam	Duratic	Grading	Weight	Type o	Status	SWS	ECTS	1. CP	2. CP	3. CP	4. CP
FW/I	P1 Advanced Mathematical Q		Theory			·		4/6	6/9	CP	CP	CP	Oi
1.	Lecture	Wr.	90–120			L	f	2/4	0/9		3/6		
		or Or.	or 20–30	g	9	E	f	2			3		
	Exercises FWP2 Advanced Mathematical F						l	4/6	6/9		3		
1.	Lecture	Wr.	90–120			L	f	2/4	0/9			3/6	
		or	or	g	9	E	f						
2.	Exercises	Or.	20–30			E	I	2				3	
	P3 Advanced Mathematical St	Wr.	90–120			l .		4/6	6/9			0.40	
1.	Lecture	or	or	g	9	L	f	2/4				3/6	
2.	Exercises	Or.	20–30			E	f	2				3	
	entific Work								42				
SP :	Scientific Project	I		I		I	I		9				
1.	Project	Proj.		ng	9		0					9	
MC Mathematical Physics Colloquium								3					
1.	Colloquium			ng			o					1	2
MT	Master Thesis								30				
1.	Thesis	Thes.		g	30		О						30
	•				•	•	•						

Marking system : g=graded, ng=non graded

Form of examination: MA=Master Thesis, Or.=oral exam, Wr.=written exam, Pres.=presentation Form of teaching: L=lecture, E=exercise class, S=seminar, Proj.=project work, Coll.=colloquium

Status : o=obligatory, f=fakultative

Other : o.=or, SWS=hours in class per week, CP=credit points=ECTS points

3 Module Descriptions

Section 1: Foundations

Module Number: G1	Module Title: Geometry in Physics							of Module: ulsory Modu	le		
ECTS-Points	9						·				
Workload - Time in Class - Self-Study	Workload: 270 h	Time 90 h	_	lass	:		Self-St 180 h	tudy:			
Duration	1 Semester										
Frequency	Winter Semester	Winter Semester									
Term	1										
Language of Instruction	English										
Forms of Teaching and Learning	Lectures 4 SWS + Exercise	Lectures 4 SWS + Exercise Classes 2 SWS, Homework Assignements									
Content	relevance for physics. Partic and associated notions of cu	The module provides an introduction to fundamental methods of differential geometry and their relevance for physics. Particular topics are manifolds, differential forms, Riemannian metrics and associated notions of curvature, Riemannian geometry of submanifolds, real and complex vector bundles, and connections. Applications of these concepts in Physics are discussed.									
Objectives	Students obtain knowledge notions of differential geom differential and integral calc notions are naturally applied explain proofs given in the leteral Through homework assignment and independent acquaintar	etry. ulus a I withi cture. ents a	The and e n ph	y de expe ysica xerci	velor rienc al the	o, in pee throuseories.	articular, a ugh exampl Students a students de	deeper undees how the are able to expense.	derstar mathe reprodu	nding of ematical uce and precise,	
	lectures. They learn how to develop solution strategies o	ransfe	er the	ese n	netho	ods to r	new problen				
Requirements for Obtaining Credit, Grading, Weight if applicable	Title	Type of Course	Status	SWS	ECTS	Assignments	Type of Exam	Dur. of Exam (min)	Grading	Weight for Grade	
	Geometry in Physics	L E	0	2	6	yes	wr. o. or.	90-180 o. 20-30	g	100	
	In this module students need to successfully complete assignments in order to be admitted to the exam. The type of examination is set by the instructor.										
Transfer	Module G1 corresponds to the ule G1 is a prerequisite for presenting and in module SP S	articip	atior	ı in r	nodu						

Prerequisites	_
Responsible Persons	Christoph Bohle, Carla Cederbaum, Stefan Teufel

Module Number: G2	Module Title: Mathematical Quantum Theo	ry						of Module: re Module				
ECTS-Points	9 Solf Study											
Workload - Time in Class - Self-Study	Workload: 270 h											
Duration	I Semester											
Frequency	Winter Semester	Ninter Semester										
Term	1											
Language of Instruction	English											
Forms of Teaching and Learning	Lectures 4 SWS + Exercise (Classe	s 2 :	SWS	, Hor	meworl	k Assignem	ents				
Content	The module provides an intro- lation and analysis of quantu tions, Hilbert spaces, unitary ators, spectral theorem, tens In addition, basic notions fro analysis, or Hartree-Fock the methods and fields are motiv	m the group or pro m are ory ca	ories os an oduci as li n be	. Pard the ss, Poke sc discrete	rticul eir ge OVM catter usse	ar topion enerato ds, spec ring the d. In th	es are Four rs, spectral ctral measu eory, stabilit e lecture, th	ier transform theory of se tres, trace cl ty of matter, the mentioned	ation, lf-adjoi ass op semi-d l mathe	distribu- nt oper- perators. classical		
Objectives	Students obtain knowledge analyse known and new protexplain proofs given in the lemathematical models and to and of the results derived from through homework assignment independent acquaintant lectures. They learn how to the develop solution strategies of	olems ecture questi m it. ents a ce wi ransfe	from The on the one of	qua ey an ne rel xerci e not ese m	ntumre ablevar	n theory ole to in nce and asses , state ods to r	y. Students Interrelate p I adequacy I adequacy I adents dements, and I and probler	are able to hysical prob of the mathe evelop a con methods ex	reprod lems a ematica fident, cplaine	uce and and their al model precise, d in the		
Requirements for Obtaining Credit, Grading, Weight if applicable	Title	Type of Course	Status	SWS	ECTS	Assignments	Type of Exam	Dur. of Exam (min)	Grading	Weight for Grade		
	Mathematical Quantum Theory	L E	0	4 2	6	yes	wr. o. or.	90-180 o. 20-30	g	100		
	In this module students need to successfully complete assignments in order to be admitted to the exam. The type of examination is set by the instructor.											
Transfer	in the module FWP1 Advance	M.Sc. Mathematics. Successful completion of module G2 is a prerequisite for the participation in the module FWP1 Advanced Mathematical Quantum Theory. Successful completion of one of the modules G2, G3, or G4 is a prerequisite for the participation in the module SP Scientific Project.										
Prerequisites	-	-										
Responsible Persons	Christian Hainzl, Stefan Teuf	el										

Module Number: G3	Module Title: Mathematical Relativity							of Module: e Module		
ECTS-Points	9									
Workload - Time in Class - Self-Study	Workload: 270 h	Time 90 h	in C	lass			Self-St 180 h	udy:		
Duration	1 Semester									
Frequency	Summer Semester									
Term	2									
Language of Instruction	English									
Forms of Teaching and Learning	Lectures 4 SWS + Exercise (Classe	es 2 9	SWS	, Hor	mework	(Assigneme	ents		
Content	The module provides an intrics are Newton's theory of gequation, Schwarzschild moder models, black holes, Caugravitational waves can be di	ravity del. C ichy p	, spe Option Oroble	ecial nally,	theo othe	ry of rer topic	elativity, rel s such as c	ativistic effe	cts, Ei I mode	instein's Is, mat-
Objectives	Students obtain knowledge a them to analyse known and to reproduce and explain proposed and their mathema mathematical model and of the strong through homework assignment and independent acquaintan lectures. They learn how to the develop solution strategies of	new oofs g tical r ne res ents a ce wi ransfe	probgiven node ults of and e th the	lems in the ls and deriven the control of the contr	fron ne le d to ed fro se cl ions netho	n the the toute. question om it. asses: , states	neory of rel They are a on the relev students de ments, and new problen	ativity. Stud able to interi ance and ad velop a cont methods ex	dents a relate p dequac fident, splaine	are able physical by of the precise, d in the
Requirements for Obtaining Credit, Grading, Weight if applicable	Title	Type of Course	Status	SWS	ECTS	Assignments	Type of Exam	Dur. of Exam (min)	Grading	Weight for Grade
	Mathematical Polativity	L	0	4	6	VOC	wr. o.	90-180	_	100
	Mathematical Relativity	Е	0	2	3	yes	or.	o. 20-30	g	100
	In this module students need the exam. The type of examin							s in order to	be adn	nitted to
Transfer	M.Sc. Mathematics. Successful completion of module G3 is a prerequisite for the participation in the module FWP2 Advanced Topics in Mathematical Relativity. Successful completion of one of the modules G2, G3, or G4 is a prerequisite for the participation in the module SP Scientific Project.									
Prerequisites	Module G1 Geometry in Phys	odule G1 Geometry in Physics								
Responsible Persons	Carla Cederbaum, Gerhard H	luiske	ın, Fı	ank	Loos	e				

Module Number: G4	Module Title: Mathematical Statistical Phys	sics						of Module: e Module		
ECTS-Points	9									
Workload - Time in Class - Self-Study	Workload: 270 h	Time 90 h	in C	lass			Self-St 180 h	udy:		
Duration	1 Semester									
Frequency	Summer Semester									
Term	2									
Language of Instruction	English									
Forms of Teaching and Learning	Lectures 4 SWS + Exercise (Classe	s 2 S	SWS	, Hor	mework	(Assigneme	ents		
Content	concepts of probability theory bles, thermal equilibrium, B cesses, Wiener process), lat phase transitions), statistica tion to thermal equilibrium, B quantum systems, transport	e module provides an introduction to mathematical statistical physics. Particular topics are neepts of probability theory, classical statistical mechanics of gases (equivalence of ensems, thermal equilibrium, Boltzmann equation, entropy), Brownian motion (stochastic proses, Wiener process), lattice models (Ising model, Gibbs measure, thermodynamic limit, ase transitions), statistical quantum mechanics (quantum mechanical ensembles, transitot thermal equilibrium, Bose-Einstein condensate). Optionally, other topics such as open antum systems, transport phenomena, renormalization group theory and the fluctuation-sipation theorem can be discussed.								
Objectives	Students obtain knowledge use them to analyse known to reproduce and explain pr problems and their mathema mathematical model and of the state of th	and roofs gatical neres ents ance with	new given node ults o nd ea th the	probling the second of the sec	ems ne le id to ed fro se cl tions netho	from socture. question om it. asses soctors, states	statistical ph They are a on the relev students de ments, and new problem	nysics. Studible to inter- ance and adverse adverse and adverse adverse and adverse adverse adverse and adverse adverse adverse adverse and adverse ad	dents a relate dequad fident, oplaine	are able physical by of the precise, d in the
Requirements for Obtaining Credit, Grading, Weight if applicable	Title	Type of Course	Status	SWS	ECTS	Assignments	Type of Exam	Dur. of Exam (min)	Grading	Weight for Grade
	Mathematical Statistical Physics	L E	0	4	6	yes	wr. o. or.	90-180 o. 20-30	g	100
		In this module students need to successfully complete assignments in order to be admitted to the exam. The type of examination is set by the instructor.								
Transfer	Advanced Topics in Mathem	Successful completion of module G4 is a prerequisite for the participation in the module FWP3 Advanced Topics in Mathematical Statistical Physics. Successful completion of one of the modules G2, G3, or G4 is a prerequisite for the participation in the module SP Scientific Project.								
Prerequisites	-									
Responsible Persons	Marcello Porta, Roderich Tur	nulka								

Section 2: Knowledge Expansion

Module Number: E1	Module Title: Advanced Topics in Mathematic	atics						of Module: ulsory Modu	le with	Choice							
ECTS-Points	9																
Workload - Time in Class - Self-Study	Workload: 270 h	Time 90 h		Class	:		Self-Si 180 h	tudy:									
Duration	1 Semester																
Frequency	Every Semester																
Term	1–3																
Language of Instruction	English or German																
Forms of Teaching and Learning	Lectures 4 SWS + Exercise	Classe	es 2 (SWS	, Ho	meworl	k Assignem	ents									
Content	the correspondent SWS-cover mended subjects are for instations, Harmonic analysis, Lie tic processes, Calculus of v	required to attend one or more lectures as well as the respective exercise classes with correspondent SWS-coverage from the Master's degree program in Mathematics. Recomnded subjects are for instance Partial differential equations, Numerics of differential equasions, Harmonic analysis, Lie groups, Nonlinear functional analysis, Operator theory, Stochastorocesses, Calculus of variations, Symplectic geometry, Algebraic topology or Algebraic metry. Further details can be found in the module handbook of the degree program M.Sc. thematics.															
Objectives	The students aquire deepen of physical applications. The the methods at hand to tack ticular the concrete content of the chosen course in the r	y broa e mat related	den hema d qua	the batical	asis prol tion (of thei blems. goals, v	r mathemat The further vill follow fr	ical knowled qualification om the mod	ge and goals	d extend s, in par-							
Requirements for Obtaining Credit, Grading, Weight if applicable	Title	Type of Course	Status	SWS	ECTS	Assignments	Type of Exam	Dur. of Exam (min)	Grading	Weight for Grade							
	Advanced Topics in Mathematics	L E	0	2	6	yes	wr. o. or.	90-180 o. 20-30	g	100							
		In this module students need to successfully complete assignments in order to be admitted to the exam. The type of examination is set by the instructor.															
Transfer	The module may be a prerec	quisite	for t	ne m	aste	r thesis	i.										
Prerequisites	See prerequisites in the Moo	lule Ha	andb	ook l	M.Sc	. Math	ematics.										
Responsible Persons	Die Studiendekanin oder der	Die Studiendekanin oder der Studiendekan des Fachbereichs Mathematik															
Abbroviotiono																	

Abbreviations:

Module Number: E2	Module Title: Advanced Topics in Theoreti	cal Ph	ysics	3				of Module: ulsory Modul	le with	Choice	
ECTS-Points	9										
Workload - Time in Class - Self-Study	Workload: 270 h	Time 90 h		lass	:		Self-St 180 h	udy:			
Duration	1 Semester										
Frequency	Every Semester										
Term	1–3										
Language of Instruction	English or German										
Forms of Teaching and Learning	Lectures 4 SWS + Exercise	Classe	es 2 (SWS	, Ho	mework	(Assignem	ents			
Content	physics as well as the resp from the Master's degree pro- ticls Physics. Recommended physics, Theoretical astroph Advanced statistical physics, tum optics, Quantum information trophysics, Current topics in	s required to attend one or more advanced-level lectures from the field of theoretical ysics as well as the respective exercise classes with the correspondent SWS-coverage m the Master's degree program in Physics or the Master's degree program Astro and Parse Physics. Recommended subjects are for instance Quantum field theory and Particle ysics, Theoretical astrophysics, Relativistic astrophysics, Many-particle quantum systems, vanced statistical physics, Yang-Mills theory, Condensed matter physics, Theoretical quantum information theory, Cosmology, Numerical methods in physics and asphysics, Current topics in theoretical physics. Further details can be found in the module indbook of the corresponding degree programs.									
Objectives	The students aquire deeper pendently of rigorous mathe theoretical physics and exter qualification goals, in particu the module description of the the M.Sc. Astro and Particle	matica d the lar the chos	l form meth cond en c	malis lods crete	m. 7 at ha	They brand to ta tent rela	oaden the b ackle proble ated qualifa	pasis of their ems in physic ction goals,	r know cs. The will foll	ledge in e further low from	
Requirements for Obtaining Credit, Grading, Weight if applicable	Title	Type of Course	Status	SWS	ECTS	Assignments	Type of Exam	Dur. of Exam (min)	Grading	Weight for Grade	
	Advanced Topics in Theoretical Physics	L	0	4	6	yes	wr. o.	90-180 o. 20-30	g	100	
	Theoretical Physics	E	0	2	3		or.	0. 20-30			
	In this module students need the exam. The type of exami							s in order to	be adr	nitted to	
Transfer	The module may be a prerequisite for the master thesis.										
Prerequisites	See prerequisites in the Mod	See prerequisites in the Module Handbook M.Sc. Physics or M.Sc. Astro and Particle Physics.									
Responsible Persons	Die Studiendekanin oder der	Die Studiendekanin oder der Studiendekan des Fachbereichs Physik									

Module Number: ES	Module Title: Seminar							of Module: ulsory Modu	le with	Choice
ECTS-Points	3									
Workload - Time in Class - Self-Study	Workload: 90 h	Time 30 h	_	lass	•		Self-S 60 h	tudy:		
Duration	1 Semester						•			
Frequency	Every Semester									
Term	2–3									
Language of Instruction	English or German									
Forms of Teaching and Learning	Seminar: Presentation, Disc	ussion	, Tea	ımwc	ork, F	Handou	t			
Content	Various topics from various Physics.	us topics from various areas of Mathematical Physics, Mathematics or Theoretical ics.								
Objectives	The students have learnt to vanced topic in Mathematics form of an oral presentation. ical or physical results and a	or P They	hysic have	s by imp	app	olying s d their s	cientific moskills in the	ethods and presentation	to pres	ent it in
Requirements for Obtaining Credit, Grading, Weight if applicable	Title	Type of Course	Status	SWS	ECTS	Assignments	Type of Exam	Dur. of Exam (min)	Grading	Weight for Grade
	Seminar	S	0	2	3	yes	Р	45–90	g	100
Transfer	M.Sc. Mathematics, M.Sc.As	tro an	d Pa	rticle	Phy	sics or	M.Sc. Phy	sics.		
Prerequisites	Successful completion of on Physics".	Successful completion of one of the modules from the section "Foundations of Mathematical Physics".								
Responsible Persons	Christian Hainzl, Stefan Teuf	el								

Section 3: Elective Specialisation

Within the study area Elective Specialisation students can choose modules from the Master's Programs Mathematical Physics, Mathematics, Physics, and Astro and Particle Physics according to their individual interests. In particular, courses listed in the module descriptions E1 and E2 but not chosen there, the modules FWP1, FWP2 and/or FWP3, as well as other appropriate advanced modules from the programs Mathematical Physics, Mathematics, Physics, and Astro and Particle Physics are available. Note that not all modules can be offered every year, but there is always a broad choice. Also note that some modules from other programs might be offered only in German, but also here a choice of English courses is ensured. The selection of modules within the area Elective Specialisation must be discussed and decided together with the mentor. Each module can be selected only once. In agreement with the mentor and upon request at the examinations board, 9 ECTS points within the area of Elective Specialisation can be allocated for modules that serve to close knowledge gaps either in mathematics or physics.

Within the area of Elective Specialisation students obtain relevant skills. They learn to independently judge which additional qualifications and competences are relevant to their studies and to select courses accordingly. They are able to acquire specific knowledge also beyond the mandatory parts of the study program. Within the area of their specialisation they can report on and scrutinize the current state of research. In the exercise classes students learn to work confidently, precisely and independently with the notions, statements and methods presented during the lectures. They also learn how to apply methods to new problems and to analyse and solve them alone or in groups.

Module Number: FWP1	Module Title: Advanced Topics in Mathema	atical (Quan	ıtum	The	ory		of Module: e Module				
ECTS-Points	9											
Workload - Time in Class - Self-Study	Workload: 270 h	Time 90 h	in C	lass	:		Self-St 180 h	udy:				
Duration	1 Semester											
Frequency	not regularly, in Summer Sen	nester	,									
Term	2											
Language of Instruction	English											
Forms of Teaching and Learning	Lectures 4 SWS + Exercise (Classe	s 2 S	SWS	, Ho	mework	k Assignem	ents				
Content	like Hartree and Hartree-Formathematical models in qua tems. It will present both the	ne module provides an introduction to an advanced topic of mathematical quantum theory, le Hartree and Hartree-Fock theory, BCS theory, adiabate theory, renormalisation group, athematical models in quantum field theory and transport in interdependent ferminon sysms. It will present both the fundamental mathematical results and physical notions of the articular area, as well as provide an insight into the current state of research and the existing pen problems.										
Objectives	Students obtain knowledge a able to apply them in the ana ematical Quantum Theory. S concepts from the lecture as it into a larger framework. The of research in the specific are Through homework assignment independent acquaintant lectures. They learn how to to develop solution strategies solutions and to stand for the	lysis of tudent well a ney are a. ents a ce with transf	of knows are stored about the stored abo	own and a second a	and in the descriptions of the description of the descriptions of the description of the descriptions of the descriptions of the descriptions of t	new proname and content and co	oblems from nd prove the ext developed of critically of students de ments, and new proble group. The	the specific e essential sed in the lec- challenge the velop a conf methods exems, to ana	tatement tatement ture and e curre fident, cplaine lyse th	of Mathents and do to put ent state precise, do in the em and		
Requirements for Obtaining Credit, Grading, Weight if applicable	Title Advanced Topics in	Type of Course	Status	SWS	ECTS	Assignments	Type of Exam	Dur. of Exam (min)	Grading	Weight for Grade		
	Mathematical Quantum	L	0	4	6	yes	wr. o. or.	90-180 o. 20-30	g	100		
	Theory In this module students need the exam. The type of exami							in order to	be adr	nitted to		
Transfer	The module may be a prerequisite for the master thesis.											
Prerequisites	Module Mathematical Quanti	ım Th	eory.									
Responsible Persons	Christian Hainzl, Stefan Teuf	el										

Module Number: FWP1	Module Title: Advanced Topics in Mathema version)	atical C	Quan	tum ⁻	Theo	ry (sho		of Module: ve Module				
ECTS-Points	6											
Workload - Time in Class - Self-Study	Workload: 180 h	Time 60 h	in C	lass	:		Self-Si 120 h	tudy:				
Duration	1 Semester											
Frequency	not regularly, in Summer Ser	nester	•									
Term	2											
Language of Instruction	English											
Forms of Teaching and Learning	Lectures 2 SWS + Exercise	Classe	es 2 \$	SWS	, Hoi	meworl	Assignem	ents				
Content	theory, like Hartree and Har group, mathematical models systems. It will present both	The module provides a short introduction to an advanced topic of mathematical quantum neory, like Hartree and Hartree-Fock theory, BCS theory, adiabate theory, renormalisation troup, mathematical models in quantum field theory and transport in interdependent ferminon ystems. It will present both the fundamental mathematical results and physical notions of the articular area, as well as provide an insight into the current state of research and the existing pen problems.										
Objectives	Students obtain knowledge a able to apply them in the anal ematical Quantum Theory. S concepts from the lecture as it into a larger framework. The current state of research in the Through homework assignment and independent acquaintar lectures. They learn how to develop solution strategies solutions and to stand for the	Ilysis of tudent well an ney ar ne spe ents an ice wit transi s on th	of knoods are able cific and earth the fer the	own a able explained to a control of the control of the control of the control own a c	and retornation to the total the tot	new proname and control archeduced archeduce	bblems from nd prove the ext developed in parts a students de ments, and new problegroup. The	n the specific e essential s ed in the lec also critically evelop a cont methods ex ems, to ana	tarea of tatement are	of Mathents and ad to put enge the precise, d in the em and		
Requirements for Obtaining Credit, Grading, Weight if applicable	Title	Type of Course	Status	SWS	ECTS	Assignments	Type of Exam	Dur. of Exam (min)	Grading	Weight for Grade		
	Advanced Topics in Mathematical Quantum	L	0	2	3	yes	wr. o.	90-180	g	100		
	Theory E o 2 3 or. o. 20-30 g 100 In this module students need to successfully complete assignments in order to be admitted to the exam. The type of examination is set by the instructor.											
Transfer	The module may be a prerec	uisite	for th	ne m	aste	r thesis						
Prerequisites	Module Mathematical Quant	um Th	eory	•								
Responsible Persons	Christian Hainzl, Stefan Teuf	Christian Hainzl, Stefan Teufel										

Module Number: FWP2	Module Title: Advanced Topics in Mathema	atical F	Relat	ivity				of Module: e Module			
ECTS-Points	9										
Workload - Time in Class - Self-Study	Workload: 270 h	Time 90 h	in C	lass	:		Self-St 180 h	udy:			
Duration	1 Semester										
Frequency	not regularly, in Winter Seme	ster									
Term	3										
Language of Instruction	English										
Forms of Teaching and Learning	Lectures 4 SWS + Exercise (Classe	s 2 S	SWS	, Hor	mework	(Assigneme	ents			
Content	It will present both the fundar										
Objectives	Students obtain deepend kn learn analytic and geometric equations and to examine the mathematical solutions. Studencepts from the lecture as it into a larger framework. The of research in the specific are Through homework assignment independent acquaintant lectures. They learn how to to develop solution strategies solutions and to stand for the	techrese. Note that the control of t	nique Morec are a s to e e able nd ex th the er th	s in over, able expla e to kerci e not ese wn a	orde they to na in th desc se cl tions meth	er to produce do und ame and e conteribe and assess, statemods to within a	ove existend derstand the d prove the ext develope d critically of students dements, and new proble group. The	ce of solution of	ns of levanoratement and curre and curre ident, plained yse the	Einstein e of the ents and ad to put ent state precise, d in the em and	
Requirements for Obtaining Credit, Grading, Weight if applicable	Title	Type of Course	Status	SWS	ECTS	Assignments	Type of Exam	Dur. of Exam (min)	Grading	Weight for Grade	
	Advanced Topics in Mathematical Relativity	L E	0	2	6	yes	wr. o. or.	90-180 o. 20-30	g	100	
		In this module students need to successfully complete assignments in order to be admitted to the exam. The type of examination is set by the instructor.									
Transfer	The module may be a prerequisite for the master thesis.										
Prerequisites	Module Mathematical Relativ	Module Mathematical Relativity.									
Responsible Persons	Carla Cederbaum, Gerhard Huisken, Frank Loose										

Module Number: FWP2	Module Title: Advanced Topics in Mathemsion)	natical	Rel	ativit	y (sl	nort ve		of Module: e Module			
ECTS-Points	6										
Workload - Time in Class - Self-Study	Workload: 180 h	Time 60 h	in C	lass			Self-St 120 h	rudy:			
Duration	1 Semester										
Frequency	not regularly, in Winter Seme	ster									
Term	3										
Language of Instruction	English										
Forms of Teaching and Learning	Lectures 2 SWS + Exercise 0	Classe	s 2 S	SWS	, Hoi	mework	(Assignem	ents			
Content	The module provides a short relativity. It will present both to particular area, as well as proopen problems.	he fur	ıdam	enta	l ma	themat	ical results	and physical	l notion	s of the	
Objectives	Students obtain deepend knilearn analytic and geometric equations and to examine the mathematical solutions. Student concepts from the lecture as it into a larger framework. The current state of research in the Through homework assignment and independent acquaintan lectures. They learn how to to develop solution strategies solutions and to stand for the	techrese. Note that the second are special	nique Aorec are a s to c e able cific nd e th the er th	s in over, able sexplant area area ercipe see white white white see white area area area area area area area ar	orde they to na in th desc se cl tions meth	er to produce do und ame and e contestibe are assessingly states of the contestion o	ove existen derstand the derstand the derstand the ext developed in parts a students dements, and new proble group. The	ce of solution physical respective essential sed in the lecalso critically velop a continuation methods exems, to ana	ons of lelevand tateme ture and challe fident, kplaine lyse th	Einstein e of the nts and d to put nge the precise, d in the em and	
Requirements for Obtaining Credit, Grading, Weight if applicable	Title	Type of Course	Status	SWS	ECTS	Assignments	Type of Exam	Dur. of Exam (min)	Grading	Weight for Grade	
	Advanced Topics in Mathematical Relativity	L	0	2	3	yes	wr. o.	90-180 o. 20-30	g	100	
	In this module students need to successfully complete assignments in order to be admitted to the exam. The type of examination is set by the instructor.										
Transfer	The module may be a prereq	uisite	for th	ne m	aste	r thesis					
Prerequisites	Module Mathematical Relativ	ity.									
Responsible Persons	Carla Cederbaum, Gerhard Huisken, Frank Loose										

Module Number: FWP3	Module Title: Advanced Topics in Mathematic	atical S	Statis	stical	Phy	sics		of Module: e Module			
ECTS-Points	9										
Workload - Time in Class - Self-Study	Workload: 270 h	Time 90 h	in C	lass	:		Self-St 180 h	udy:			
Duration	1 Semester										
Frequency	not regularly, in Winter Seme	ster									
Term	3										
Language of Instruction	English										
Forms of Teaching and Learning	Lectures 4 SWS + Exercise	Classe	es 2 S	SWS	, Hoi	mework	Assigneme	ents			
Content	It will present both the funda										
Objectives	Students obtain knowledge a able to apply them in the an area of mathematical statistis statements and concepts fro lecture and to put it into a lar the current state of research Through homework assignmand independent acquaintar lectures. They learn how to to develop solution strategies solutions and to stand for the	alysis cal phomethe the the the the the the the the the	of krysics lectumew spec and eath the fer the	nowr s. St ure a vork. cific a xerci e no lese wn a	n and uden s we The area. se cl tions meth and v	I new parts are all as to y are all asses and to	problems from able to name of explain the object to descript students dements, and new problems froup. The	om the them the and prove context de tibe and critic velop a conf methods ex ems, to anal	atized the evelope cally chally chally chally chally challed the control of the c	specific ssential d in the nallenge precise, d in the em and	
Requirements for Obtaining Credit, Grading, Weight if applicable	Title Advanced Topics in	Type of Course	Status	SWS	ECTS	Assignments	Type of Exam	Dur. of Exam (min)	Grading	Weight for Grade	
	Mathematical Statistical Physics	L E	0	2	3	yes	wr. o. or.	90-180 o. 20-30	g	100	
		In this module students need to successfully complete assignments in order to be admitted to the exam. The type of examination is set by the instructor.									
Transfer	The module may be a prerec	uisite	for th	ne m	aste	r thesis	•				
Prerequisites	Module Mathematical Statist	ical Ph	nysic	s.							
Responsible Persons	Marcello Porta, Roderich Tur	Marcello Porta, Roderich Tumulka									

Module Number: FWP3	Module Title: Advanced Topics in Mathe (short version)	ematic	al S	tatis	tical	Physic		of Module: e Module			
ECTS-Points	6										
Workload - Time in Class - Self-Study	Workload: 180 h	Time 60 h	in C	lass	:		Self-St 120 h	udy:			
Duration	1 Semester						·				
Frequency	not regularly, in Winter Seme	ster									
Term	3										
Language of Instruction	English										
Forms of Teaching and Learning	Lectures 2 SWS + Exercise (Classe	es 2 S	SWS	, Hoi	mework	(Assignem	ents			
Content	physics. It will present both t	e module provides a short introduction to an advanced topic of mathematical statistical ysics. It will present both the fundamental mathematical results and physical notions of the rticular area, as well as provide insight into the current state of research and the existing en problems.									
Objectives	Students obtain knowledge a able to apply them in the an area of mathematical statisti statements and concepts fro lecture and to put it into a I critically challenge the currer Through homework assignm and independent acquaintar lectures. They learn how to to develop solution strategies solutions and to stand for the	alysis cal ph m the arger at state ents a lec with transis on the contract of	of krysics lectured frame of rectand extended from the fer the	nowr i. Sti ure a ewon esea xerci e no ese wn a	n and uden is we rk. I irch i se cl tions meth and v	I new parts are lell as to They are in the salasses salasses to the today the today ithin a	problems from able to name of explain the explain the explain the expecific area extudents dements, and new problems. The	om the them ne and prove e context de describe and velop a conf methods ex ems, to ana	atized the evelope in pa	specific ssential d in the rts also precise, d in the em and	
Requirements for Obtaining Credit, Grading, Weight if applicable	Title Advanced Topics in	Type of Course	o Status	SWS 2	ω ECTS	Assignments	Type of Exam	Dur. of Exam (min)	Grading	Weight for Grade	
	Mathematical Statistical Physics	E	0	2	3	yes	or.	o. 20-30	g	100	
	In this module students need to successfully complete assignments in order to be admitted to the exam. The type of examination is set by the instructor.										
Transfer	The module may be a prerec	uisite	for th	ne m	aste	r thesis					
Prerequisites	Module Mathematical Statisti	cal Pr	nysic	 S.							
Responsible Persons	Marcello Porta, Roderich Tur	nulka									

Section 4: Scientific Work

Module Number: SP	Module Title: Scientific Project							of Module: oulsory Mod		
ECTS-Points	9						·			
Workload - Time in Class - Self-Study	Workload: 270 h	Time 15 h	in C	lass	:		Self-S 255 h	-		
Duration	1 Semester						·			
Frequency	Every Semester									
Term	3									
Language of Instruction	English									
Forms of Teaching and Learning	Individual supervision by a m	entor	stuc	ly of	sciei	ntific w	orks.			
Objectives	 Definition of an advantage of the proposal. Independent search at the proposal of th	nd stuce probef the py as a matical and in su	ndy o lems project prep	f the and aration aration are aration are	relevent met cone con for arrize sub	vant sc hodical xt of cu or the N thems stantia	approach arrent state Master The elves with ted, profes	to their solution of research sis a new subjectional and h, identifica	on 5-10 ct, interdisc	ciplinary
Requirements for Obtaining Credit, Grading, Weight if applicable	Title Scientific Project	т Туре of Course	o Status	SWS 1	© ECTS	Assignments	Type of Exam	Dur. of Exam (min)	g Grading	Weight for Grade
Transfer	Successful completion of this sis.	 s mod	le is	a pr	ereq	uisite f	or participa	ation in mod	ule Mas	ter The-
Prerequisites		Successful completion of module Geometry in Physics and of one of the modules Mathematical Quantum Theory or Mathematical Relativity.								
Responsible Persons	Stefan Teufel, Werner Vogels	ang.								

Module Number: MC	Module Title: Mathematical Physics Colloquium						Type of Module: Compulsory Module			
ECTS-Points	3									
Workload - Time in Class - Self-Study	Workload: Time in Class: 60 h				Self-St 30 h	Self-Study: 30 h				
Duration	2 Semester									
Frequency	Every Semester									
Term	3–4									
Language of Instruction	English									
Forms of Teaching and Learning	Presentations, discussions. Specific form of study: during the final semester students present their Master thesis.									
Content	During each semester on 15 appointed dates (2 h each) there will take place presentations and discussions on current topics in mathematical physics. Speakers are the researchers of the involved departments, guest scientists and master's students, who present the results of their Master Thesis.									
Objectives	Students gain an insight into the current development of mathematical physics beyond the area of their own specialization. They develop the ability to follow scientific presentations and to discuss and challenge them within a larger group of scholars. They therefore also obtain interdisciplinary and intercultural competencies through regular cooperation and discussion in mixed groups.									
Requirements for Obtaining Credit, Grading, Weight if	Title	Type of Course	Status	SWS	ECTS	Assignments	Type of Exam	Dur. of Exam (min)	Grading	Weight for Grade
applicable	Colloquium Winter Semester	С	0	2	1	no	-	-	ng	-
	Colloquium Summer Semester	С	0	2	2	no	-	-	ng	-
Transfer	-		1	1	1	-	ı	1	1	1
Prerequisites	-									
Responsible Persons	Carla Cederbaum, Stefan Te	ufel								

Module Number: MT	Module Title: Master Thesis							Type of Module: Compulsory Module			
ECTS-Points	30										
Workload - Time in Class - Self-Study	Workload: 900 h	Time 0 h	in C	lass	:		Self-S 900 h	tudy:			
Duration	1 Semester										
Frequency	Every Semester										
Term	4										
Language of Instruction	English or German										
Forms of Teaching and Learning	Master thesis										
Content	Students are assigned to workgroups and participate in seminars of the group. Under the supervision of the mentor students have to handle a concrete problem from mathematical physics by applying scientific methods and present it in written form in English or German. In particular this includes: • Definition of an advanced scientific task in coordination with the mentor; • Independent search and study of the relevant scientific literature; • Formulation of appropriate questions and methodical approach to their answers; • Independent execution and written presention of the project and the results in the context of the current state of research; • Presentation of the results in English in Mathematical Physics Colloquium.										
Objectives	 Students are able to develop acquaintance with a new problem within a given period of time and treat it with increasing independence by applying scientific methods; develop acquaintance with scientific literature on a new topic; critically interpret scientific results and integrate them into their state of knowledge; present their results in written form based on principles of Good Scientific Practice; present their work in an international scientific environment. 										
Requirements for Obtaining Credit, Grading, Weight if applicable	Title Master Thesis	Type of Course	o Status	SWS	30 ECTS	Assignments	Type of Exam	Dur. of Exam (min)	ص Grading	Weight for Grade	
Transfer	-										

Prerequisites	
	27 CP from the compulsory elective section Foundations of Mathematical Physics,
	a total of 18 CP from the sections Knowledge Expansion and Elective Specialisation,
	Successful completion of module SP Scientific Project.
Responsible Persons	Stefan Teufel, Werner Vogelsang.