OFFICIAL TRANSLATION OF

Fachspezifische Bestimmungen für den Studiengang Physik (M.Sc.) (Amtliche Bekanntmachung Nr. 68 vom 11. September 2018)

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Subject-Specific Provisions for the Master of Science in Physics (MSc)

dated 4 April 2018

On 12 June 2018 in accordance with Section 108 subsection 1 of the Hamburg higher education act (Hamburgisches Hochschulgesetz, HmbHG) the Executive University Board of Universität Hamburg ratified the Subject-Specific Provisions for the Master of Science in Physics adopted on 4 April 2018 by the Faculty of Mathematics, Informatics and Natural Sciences in accordance with Section 91 subsection 2 no. 1 HmbHG dated 18 July 2001 (HmbGVBl. p. 171) and amended 28 November 2017 (HmbGVBl. p. 336).

Preamble

These subject-specific provisions supplement the Examination Regulations of the Faculty of Mathematics, Informatics and Natural Sciences dated 11 April 2012 and 4 July 2012, as amended, which govern the master of science (MSc) degree programs and provide a description of the modules for physics as a subject.

I. Supplemental provisions

Section 1
Program and examination objectives, academic degree
Implementation of the degree program

Section 1 subsection 1:

(1) The Master of Science in Physics (MSc) has a research-oriented profile.

(2) The master constitutes a further professional qualification enabling in-depth, research-related training in the physics degree program.

(3) Students are able to contemplate complex issues and address them using scientific methods, even beyond the current state of knowledge.

(4) The program provides the subject-specific methods required for the challenges of a changing professional world and interdisciplinary applications, as well as expanding on skills and knowledge to enable students to work scientifically, apply and critically evaluate scientific knowledge, and act responsibly

(5) The Master of Science in Physics qualifies the student for a doctorate. The doctoral degree regulations provide further detailed information.

The degree program focuses predominantly on:

a) specialized knowledge oriented to current research issues on the basis of in-depth fundamental knowledge,
b) methodological and analytical skills that lead to independent expansion of scientific knowledge centered on research methods;
c) imparting in-depth expertise and scholarly knowledge that enables analysis and resolution of problems of basic research, applied research, and technology previously not addressed;
d) enabling students to work independently, with a problem-oriented, interdisciplinary, and responsible approach to solving problems from current research in physics and conclusively present the results;
e) key professional qualifications and skills.

Section 4
Program and examination structure, modules, and ECTS credits (ECTS)

Section 4 subsections 2 and 3:

(1) The master's degree program is divided into two segments, a one-year advanced specialist learning phase, and a one-year research phase.

The one-year specialist learning phase provides the advanced knowledge required for independent work in the field of physics. It consists of advanced modules (= required elective modules) made up of the following five advanced areas:

- accelerator and elementary particle physics
- solid state and nanostructure physics
- laser physics and photon science
- astronomy and astrophysics
- biomedical physics

A total of 48 ECTS credits must be successfully completed. The following requirements must be met:

At least 16 ECTS credits must be earned for advanced modules in at least one of the five advanced areas listed. A maximum of 32 ECTS credits may be gained for any individual advanced area.

A minimum of 8 ECTS credits must be successfully completed in advanced modules in experimental physics and theoretical physics.

For the elective area, a total of 12 ECTS credits may be selected, usually over two semesters, from the courses offered at Universität Hamburg. The individual modules should have a logical connection to each other.

The one-year research phase is made up of three modules, and should be seen as a single, indivisible unit.

The introductory and preparatory projects together make up 30 ECTS credits, and are part of the third subject semester. The final subject semester consists of a master's thesis worth 30 ECTS credits. The introductory and preparatory projects in the third semester precede the master's thesis; the preparatory project is completed with an ungraded presentation. These provide the student with knowledge of current research and special methods from the master's thesis subject area. Students complete the six-month master's thesis in the fourth semester. The thesis should demonstrate that the student is able to work under guidance on a physics problem taken from the forefront of research using scientific methods, to present and interpret the problem, the means of solving it, and the solution itself consistently and comprehensively.

Students who have successfully completed at least 44 ECTS credits during the first year of study are eligible to commence the research phase and the introductory project. On commencing the research phase, the following must be documented: The physic's academic office must be informed of the date, area of research, and supervising professor / assigning professor.

The master's thesis must be supervised by a professor from the Department of Physics. This professor must consent to the supervision before the research phase begins. The research phase may be completed in a working group of the Department of Physics, or, depending on the area of specialization, within the University, in the Faculty of Mathematics, Informatics and Natural Sciences or the Faculty of Medicine, or in nonuniversity research institutions, provided the predominant methodology is that of physics. In this case, the research phase may begin only when the examinations board approves the application and a member of the professorial staff declares their consent to providing a second assessment of the mater's thesis pursuant to Section 14 subsection 9.

(2) Modules chosen as part of the physics advanced phase may not simultaneously be counted towards the elective area.

(3) Module descriptions are provided in Annex A to the Subject-Specific Provisions for the Master of Science in Physics—Table of Modules, and the module handbook for the Master of Science in Physics which expands upon these subject-specific provisions.

Section 5
Course types

Section 5 sentence 2:
All course types pursuant to Section 5 of the Examination Regulations for Master of Science degree programs may be implemented. Typically, the advanced phase is made up of a combination of lectures and group work, such as exercises and practical courses and internships, and the research phase is made up of projects and seminars.

Section 13
Completed coursework and module examinations

Section 13 subsection 5:
Examinations are held in German or English. As a rule, the examination is held in the language in which the course was conducted. If the examiner and the student agree, the examination may also be taken in a language other than the language of the module.

Section 14
Master's thesis

Section 14 subsection 1:
A colloquium consisting of a presentation and an academic discussion of the subject matter of the thesis as part of an academic seminar is a mandatory component of the final module. The presentation comprises one-sixth of the grade for the final module. The presentation should be given no later than six weeks after submission of the thesis. The presentation and discussion are assessed by both assessors, or by one of

the two thesis assessors in the presence of an invigilator. The invigilator must be a doctoral graduate or have an equivalent qualification or higher. The assessment of the thesis should occur promptly, no later than six weeks after submission.

Section 14 subsection 2 sentence 1:
Students who have earned at least 75 ECTS credits in total may be allowed to commence work on the final module, the master's thesis.

Section 14 subsection 4:
The master's thesis may be written in either German or English. The decision must be mutually agreed between the student and the supervisor.

Section 14 subsection 5 sentence 1:
The workload for the master's thesis equates to 30 ECTS credits. The master's thesis must be completed within 6 months.

Section 15
Evaluation of examinations

Section 15 subsection 3 sentence 5:
If a module is comprised of multiple course examinations, the grade for the module is calculated on the basis of the average grades for each component weighted according to the assigned ECTS credits.

Section 15 subsection 3 sentence 9:
The overall final grade for the master's degree program is comprised of the grade for the advanced phase (50 percent), the grade for the thesis (45 percent), and the grade for the elective (5 percent).
The grade for the advanced phase is calculated as a weighted average of the highest grades amounting to 48 ECTS credits.
The average of the two assessor's grades for the written thesis constitute five-sixths of the grade for the final module (master's thesis) with the grade awarded for the colloquium constituting the remaining one-sixth.
The grade for the elective area is calculated as a weighted average of the highest grades amounting to 12 ECTS credits.
The examinations from the introductory project and the preparatory project are ungraded and are not used to calculate the overall final grade.

Section 15 subsection 4:
The overall final grade "pass with distinction" is awarded if a grade of 1.0 is earned for the master's thesis, and all relevant module examinations with the exception of at most one is graded 1.0. Given the lack of comparability, ungraded modules such as

those graded as “passed” will not be counted towards the calculation of the overall final grade.

Information about the Module						Courses				Examinations			
Duration in Semesters	**Frequency**	**Recommended Semester**	**Module Prerequisites**	**Module Type: Required (Req.), Required Elective (RE), or Elective (E)**	**Module Number/Code**	**Module**	**Course Title**	**Course Type**	**Cr. Hrs. per Week**	**Examination Prerequisites**	**Type of Examination**	**Graded**	**ECTS Credits**
Required module (60 ECTS credits)													
1	every semester	third	see Specific Provisions, Section 4	Req.	PHY-MF-EP	**Introductory project**			15	PCom		no	15
Intended learning results: Students are familiar with current academic literature and possess greater depth of knowledge in an area of current research, from which the subject of the master's thesis should arise. Students are able to independently gather material information, establish background information, and grasp a specific topic.													
1	every semester	third	PHY-MF-EP	Req.	PHY-MF-VP	**Preparatory project**			15	PCom	lecture/colloquium	no	15
Intended learning results: By completing the preparatory assignments, students have sufficient knowledge of the subject area, and the specific experimental and/or theoretical methods involved to enable successful application to issues from which the topic of the master's thesis should arise. Planning and structuring of the intended research project.													
1	every semester	fourth	see Specific Provisions, Section 14 subsection 2	Req.	PHY-MF-MA	**Final module—master's thesis**			15		master's thesis (five-sixths) colloquium (one-sixth)	yes	30
Intended learning results:													

Candidates are able to familiarize themselves with an issue taken from current research, apply appropriate scientific methods with increasing independence, and present the results in an academically appropriate form.												
Astronomy and astrophysics												
1	every semester	first or second	none	RE	PHY-MV-A-E02	**Laboratory astrophysics**				none	colloquium	yes	5
							Laboratory astrophysics Exercises in laboratory astrophysics	L L	2 2				
Intended learning results: Students understand laboratory astrophysics as a foundation of observational astrophysics. Students are able to: - define necessary lab experiments by implementing observational astronomy requirements; - plan and implement measurements relevant to astrophysics in the university laboratory; - obtain and evaluate measurement data relevant to astrophysics in realistic conditions.												
1	every semester	first or second	none	RE	PHY-MV-A-E12	**Astronomical observation methods and instruments**				none	oral examination	yes	5
							Astronomical observation methods and instruments Practical course on astronomical observation methods and instruments	L PC	2 2				
Intended learning results: Students are familiar with the most important astronomical observation methods and instruments; are familiar with current infrared/optical technologies; understand the interactions between astronomical research and technical/experimental foundations.												

1	every semester	first or second	none	RE	PHY-MV-A-E14	**Cosmology**				none	written examination or oral examination	yes	7
							Cosmology Exercises in cosmology	L PC	3 2				
Intended learning results: Students are able to utilize problem solving strategies; analytical thinking; theory development in physics; apply mathematical and information technology strategies.													
1	annually, winter semester	first or second	none	RE	PHY-MV-A-E17	**Extragalactic astrophysics**				none	written examination or oral examination	yes	7
							Extragalactic astrophysics Exercises in extragalactic astrophysics	L PC	3 2				
Intended learning results: Students are able to use problem solving strategies and analytical thinking and evaluate astronomical data; are familiar with theory development in physics; apply mathematical and information technology strategies.													
	every semester	first or second	none	RE	PHY-MV-A-E19	**Seminar on extragalactic astronomy**				none	presentation, written paper	yes	3
							Seminar on extragalactic astronomy	S	2				
Intended learning results: Student have an overview and understanding of selected extragalactic astronomy subject matter.													
1	annually, summer semester	first or second	none	RE	PHY-MV-A-E23	**Galaxy evolution**				none	written examination or oral examination	yes	7

							Galaxy evolution Exercises in galaxy evolution	L PC	3 2				
Intended learning results: Students have insights into the development of the universe, linear and non-linear growth of cosmic structures, the creation of elliptical and spiral galaxies, and observational techniques for observing galaxies.													
1	every semester	first or second	none	RE	PHY-MV-A-E24	**Seminar on galaxy evolution**				none	presentation, written paper	yes	3
							Seminar on galaxy evolution	S	2				
Intended learning results: Students are able to discuss selected classical scientific publications on the subject of galaxy creation and development, using material chosen from both theoretical and data-driven papers.													
1	annually, winter semester	first or second	none	RE	PHY-MV-A-T10	**Interstellar medium, star- and planet formation**				none	written examination or oral examination	yes	7
							Interstellar medium, star- and planet formation Exercises in interstellar medium, star- and planet formation	L PC	3 2				
Intended learning results: - Students possess fundamental knowledge of the interstellar medium (including the make-up, physical properties, dynamics) and creation of stars (including requirements, time scales, thermodynamics, development of protostars, gas jets). - Students also know and can apply hydrodynamic and magneto-hydrodynamic equations.													
1	annually, summer semester	first or second	none	RE	PHY-MV-A-T16	**Introduction to the general theory of relativity (GRT) and astrophysical applications**				none	written examination	yes	8

							Introduction to the general theory of relativity (GRT) and astrophysical applications Exercises in introduction to the general theory of relativity (GRT) and astrophysical applications	L L	4 2				
Intended learning results: - Students have a fundamental understanding of the general theory of relativity. - Students understand and are able to describe curved space in multiple dimensions. - Students understand astrophysical phenomena based on the general theory of relativity.													
Accelerator and elementary particle physics													
1	annually, winter semester	first or second	none	RE	PHY-MV-BE-E09	**Accelerator physics I**				none	written examination or oral examination	yes	5
							Accelerator physics I Exercises in accelerator physics I	L PC	2 2				
Intended learning results: Students possess an understanding of the basics of accelerator physics. Students are able to design the basic elements of a simple accelerator and calculate its key parameters.													
1	annually, summer semester	first or second	none	RE	PHY-MV-BE-E02	**Accelerator physics II**				none	written examination or oral examination	yes	5
							Accelerator physics II Exercises in accelerator physics II	L PC	2 2				

Intended learning results: Students understand important aspects in the planning and development of accelerator facilities: influencing the quality of the beam, ability to improve beam properties, limitation of attainable energy, luminosity, and beam currents, creation of high-intensity and coherent x-rays.													
1	annually, winter semester	first or second	none	RE	PHY-MV-BE-E05	**Experimental astroparticle physics**				none	presentation and oral examination	yes	8
							Experimental astroparticle physics Exercises in experimental astroparticle physics	L PC	4 2				
Intended learning results: Students are able to contextualize specific experiments and their results. Students are also able to critically examine how to best interpret measurement results. Students are able to understand how a measurement or observation for a physics question in the field of astroparticle physics is derived.													
1	annually, summer semester	first or second	none	RE	PHY-MV-BE-E15	**Physics and the application of laser-plasma-accelerators: from medical imaging to high-energy physics**				none	written examination or oral examination	yes	8
							Physics and application of laser-plasma-accelerators Exercises in physics and application of laser-plasma-accelerators	L PC	4 2				
Intended learning results: Students have in-depth insights into the following areas of physics: - Fundamentals of plasma wakefield acceleration: Where do the ultrahigh field gradients come from? Why are the electron bunches so short? - Applications: synchrotron and undulator radiation, free-electron lasers (FELs), table-top FELs driven by laser plasma accelerators, medical imaging with laser-driven undulator sources, open questions in laser-based high-energy colliders.													

1	annually, summer semester	first or second	none	RE	PHY-MV-BE-E18	**Particle physics and the Large Hadron Collider (LHC): accelerator, detector and physics**				none	written examination or oral examination	yes	8
							Particle physics and the Large Hadron Collider (LHC) Exercises in particle physics and the Large Hadron Collider (LHC)	L PC	4 2				
Intended learning results: Students have in-depth understanding of current particle physics issues, particularly research topics investigated at the LHC. Students are prepared for potential bachelor’s, master’s, or doctoral thesis in the field.													
1	annually, winter semester	first or second	none	RE	PHY-MV-BE-T01	**Quantum mechanics II**				none	written examination or oral examination	yes	8
							Quantum mechanics II Exercises in quantum mechanics II	L PC	4 2				
Intended learning results: Students are able to summarize the main recent scientific developments in the fields of second quantization, correlation functions, time-dependent perturbation theory, and relativistic quantum mechanics.													
1	annually, summer semester	first or second	none	RE	PHY-MV-BE-T02	**Physics of the standard model**				none	written examination or oral examination	yes	6
							Physics of the standard model Exercises in physics of the standard model	L PC	3 1				
Intended learning results:													

Students are prepared for research projects (e.g., master's thesis) in theoretical particle physics.													
1	annually, winter semester	first or second	none	RE	PHY-MV-BE-T04	**Quantum field theory I**				none	written examination or oral examination	yes	8
							Quantum field theory I Exercises in quantum field theory I	L PC	4 2				
Intended learning results: Students have been given a theoretical and technical introduction to quantum field theory. Students know canonical and path-integral quantization methods for bosonic and fermionic fields with a focus on symmetries, and functional techniques using the functionals generated for correlation functions and perturbation theories in the form of Feynman diagrams.													
1	annually, summer semester	first or second	none	RE	PHY-MV-BE-T06	**Quantum field theory II**				none	written examination or oral examination	yes	8
							Quantum field theory II Exercises in quantum field theory II	L PC	4 2				
Intended learning results: Students have in-depth and expanded quantum field theory knowledge and are familiar with renormalisation theories, non-abelian gauge theories, and their covariant quantization methods. They are able to discuss spontaneous symmetry breaking and topological solutions in quantum field theory.													
1	annually, winter semester	first or second	none	RE	PHY-MV-BE-T07	**Theory of general relativity**				none	written examination or oral examination	yes	8
							Theory of general relativity Exercises in theory of general relativity	L PC	4 2				
Intended learning results:													

Students are familiar with the basics of general relativity and able to undertake research projects on topics in field theory, theoretical cosmology, and mathematical physics, for example in the context of a master's thesis.													
Biomedical physics													
1	annually, winter semester	first or second	none	RE	PHY-MV-BP-E01	**Biomedical physics I**				none	oral examination	yes	5
							Biomedical physics I Exercises in biomedical physics I	L PC	2 2				
Intended learning results: Students are familiar with current medical imaging methods (PET, SPECT, MRI, CT, multi-modal) and fundamental radiation therapy.													
1	annually, winter semester	first or second	none	RE	PHY-MV-BP-E05	**Seminar on biomedical physics**				none	presentation, written paper	yes	3
							Seminar on biomedical physics	S	2				
Intended learning results: Students are familiar with current medical imaging (PET, SPECT, MRI, CT, multimodal) and the fundamental techniques of radiotherapy.													
1	annually, summer semester	first or second	none	RE	PHY-MV-BP-E02	**Biomedical physics II**				none	oral examination	yes	5
							Biomedical physics II Exercises in biomedical physics II	L PC	2 2				
Intended learning results: Students are familiar with structures of macromolecules, cells, and tissues, as well as with key factors of cellular and extra-cellular biochemistry as they relate to disease, including cancer.													
1	annually, winter semester	first or second	none	RE	PHY-MV-BP-E03	**Biomedical physics III**				none	oral examination	yes	3

							Biomedical physics III	L, PC	2				
Intended learning results: Students are familiar with the fundamentals of radiative transfer and its application in radiation therapy and radiation safety. Additionally, students have insight into the role of medical imaging in radiation therapy.													
1	annually, summer semester	first or second	none	RE	PHY-MV-BP-E04	**Biomedical physics IV**				none	oral examination	yes	3
							Biomedical physics IV	L, PC	2				
Intended learning results: Students are familiar with the fundamentals of the physics of radiation therapy. Students also have an overview of the physical and biological optimization of a radiation plan in the application of a range of radiation techniques and treatment plans for some types of tumors.													
Solid state and nanostructure physics													
1	annually, summer semester	first or second	none	RE	PHY-MV-FN-E01	**Advanced solid state physics**				none	written examination or oral examination	yes	8
							Advanced solid state physics Exercises in advanced solid state physics	L, PC L, PC	4 2				
Intended learning results: Students have in-depth knowledge of the latest scientific research in solid state and nanostructure physics. They also possess sufficient in-depth expertise to conduct an experimental master's thesis in the field of solid state and nanostructure physics.													
1	annually, winter semester	first or second	none	RE	PHY-MV-FN-E02	**Nanostructure physics I: Physics and technology of semiconductors and nanostructures**				none	written examination or oral examination	yes	8
							Nanostructure physics I	L PC	4 2				

							Exercises in nanostructure physics I						
Intended learning results: Students are able to summarize the main findings into the synthesis of and research into semiconductor nanostructures and devices.													
1	annually, summer semester	first or second	none	RE	PHY-MV-FN-E04	**Nanostructure physics II: Magnetism and surface**				none	written examination or oral examination	yes	8
							Nanostructure physics II: Magnetism and surface Exercises in nanostructure physics II Magnetism and surface	L PC	4 2				
Intended learning results: Students are able to summarize the main current scientific developments in the fields of magnetism and nanomagnetism. Students can summarize and provide detailed descriptions of the main experimental techniques in the magnetic surface imaging. They can select and use specialized techniques in the theoretical description of magnetic phenomena.													
1	annually, summer semester	first or second	none	RE	PHY-MV-FN-E11	**Nanostructure physics IV—nanobiotechnology**				none	written examination or oral examination	yes	4
							Nanobiotechnology Exercises in nanobiotechnology	L PC	2 1				
Intended learning results: Students are able to summarize the main research results on the application of nanostructures and nanomaterials in the field of medicine and biotechnology.													
1	annually, summer semester	first or second	none	RE	PHY-MV-FN-E12	**Modern methods in characterizing surfaces and nanostructures**				none	written examination or oral examination	yes	5

							Modern methods in characterizing surfaces and nanostructures Exercises in modern methods in characterizing surfaces and nanostructures	L PC	2 2				
Intended learning results: - Students understand a range of methods for the structural and chemical characterization of nanostructures and surfaces. - Students are able to make sound decisions when selecting methods for the chemical and structural characterization of nanostructures and surfaces.													
1	every semester	first or second	none	RE	PHY-MV-FN-E16	**Seminar on close-range interfacial physics and nanotechnology**				none	presentation	yes	3
							seminar	S	2				
Intended learning results: Students have in-depth knowledge of and insights into current developments in research into solid-state and nanostructure physics.													
1	annually, winter semester	first or second	none	RE	PHY-MV-FN-E18	**Biointerfaces and nanointerfaces**				none	written examination or oral examination	yes	6
							Biointerfaces and nanointerfaces	L	4				
Intended learning results: - Students have an overview of the main biophysical interface processes. - Students have a fundamental and interdisciplinary understanding for further lectures and final theses in this interdisciplinary field.													
1	annually, summer semester	first or second	none	RE	PHY-MV-FN-E23	**X-ray analytics and microscopy in the nanosciences**				none	term papers	yes	4
							X-ray analytics and microscopy in the nanosciences	L PC	2 1				

							Exercises in x-ray analytics and microscopy in the nanosciences						
Intended learning results: Students are able to summarize the main current x-ray analysis and x-ray microscopic methods for the examination of functional nanomaterials.													
1	annually, winter semester	first or second	none	RE	PHY-MV-FN-E31	**The art of computer-based modeling and simulation: experimental data**				none	final project report	yes	9
							The art of computer-based modeling and simulation: experimental data practical course and project	L PC, PR	2 5				
Intended learning results: Students understand the mathematical description of experimental data in explicit consideration of numerical and experimental errors.													
1	annually, winter semester	first or second	none	RE	PHY-MV-FN-E32	**Quantum transport and experimental quantum physics**				none	presentation and oral examination	yes	4
							Quantum transport and experimental quantum physics Seminar on quantum transport and experimental quantum physics	L S	2 1				
Intended learning results: - Students have expanded knowledge of important principles of semiconductor and solid-state physics and introduction of new, exotic states of matter. - Students understand important quantum effects in solids-state matter and how to investigate them using experiments.													

1	annually, winter semester	first or second	none	RE	PHY-MV-FN-E34	**Methods in nanobiotechnology**				none	presentation with written examination or oral examination	yes	7
							Methods in nanobiotechnology Exercises in methods in nanobiotechnology Practical: Methods in nanobiotechnology	L PC Req.	2 2 2				
Intended learning results: Students have an advanced introduction to current methods and aspects of nanobiotechnology and are prepared to conduct scientific work in the subject.													
1	every semester	first or second	none	RE	PHY-MV-FN-E37	**Required elective internship physics**				none	completion of internship (presentation and/or written paper)	yes	6–15
							internship, seminar	P, S	6–15				
Intended learning results: Students know and can apply current and sophisticated methods and knowledge of current techniques and processes. The module combines the teaching of key skills (particularly methodological competence, planning work, social skills / team work, documentation, delivering an academic presentation, literature research) and physics content.													
1	annually, winter semester	first or second	none	RE	PHY-MV-FN-T14	**Theory of condensed matter I**				none	written examination or oral examination	yes	8
							Theory of condensed matter I Exercises in theory of condensed matter I	L PC	4 2				

Intended learning results: Students have insight into the fundamental issues of, and experience in dealing with the typical methods of the theory of condensed matter.													
1	annually, summer semester	first or second	none	RE	PHY-MV-FN-T28	**Theory of condensed matter II**				none	written examination or oral examination	yes	8
							Theory of condensed matter II Exercises in theory of condensed matter II	L PC	4 2				
Intended learning results: Students have insight into recent issues and experience in dealing with specialized methods for the theory of condensed matter in the context of current research.													
Laser physics and photon science													
1	annually, winter semester	first or second	none	RE	PHY-MV-LP-E05	**Methods in modern x-ray physics I—spectroscopy**				none	written examination or oral examination	yes	8
							Methods in modern x-ray physics I—spectroscopy Exercises in methods in modern x-ray physics I—spectroscopy	L PC	4 2				
Intended learning results: Students have dealt with the fundamentals of modern x-ray physics. They possess introductory and applied knowledge of the use of x-rays to investigate a range of systems. Students possess sufficient well-founded technical knowledge to successfully complete an experimental master's thesis in the field of interactions of x-rays with material.													
1	annually, summer semester	first or second	none	RE	PHY-MV-LP-E06	**Modern molecular physics—cluster physics**				none	written examination or oral examination	yes	8

							Modern molecular physics—cluster physics Exercises in modern molecular physics—cluster physics	L PC	4 2				
Intended learning results: - Students are familiar with the fundamental knowledge, application of and latest scientific research on clusters. - Students are able to calculate the geometrical and electronic structures of small clusters. - Students have insight into the field sized between atoms and solid-state physics. - Students possess sufficient specialist knowledge to successfully complete an experimental master’s thesis in the field of very small nanostructures.													
1	annually, winter semester	first or second	none	RE	PHY-MV-LP-E09	**Introduction to the physics of quantum gases**				none	written examination or oral examination	yes	8
							Introduction to the physics of quantum gases Exercises in introduction to the physics of quantum gases	L PC	4 2				
Intended learning results: Students are familiar with the central area of modern atomic physics. Students possess knowledge of the latest research and are able to read original literature independently. The same applies for experimental observations and fundamental theoretical concepts. Students are prepared for an experimental or theoretical master’s thesis in the field of ultracold atoms.													
1	annually, summer semester	first or second	none	RE	PHY-MV-LP-E10	**Methods in modern x-ray physics II**				none	written examination or oral examination	yes	8
							Methods in modern x-ray physics II	L PC	4 2				

							Exercises in methods in modern x-ray physics II						
Intended learning results: - Students possess in-depth knowledge of the latest scientific experimental research into solid-state physics, using current x-ray physics methods. - Students possess in-depth expertise in experimentation sufficient to successfully complete an experimental master’s thesis in the field of solid-state and nanostructure physics.													
1	annually, winter semester	first or second	none	RE	PHY-MV-LP-E11	**Ultrafast optical physics I**				none	oral examination	yes	5
							Ultrafast optical physics I Exercises in ultrafast optical physics I	L PC	2 2				
Intended learning results: Students possess a fundamental knowledge of the description of ultrashort optical pulses, their generation, manipulation, diagnostics, and application in modern nonlinear optics and optical spectroscopy processes.													
1	annually, winter semester	first or second	none	RE	PHY-MV-LP-E26	**Ultracold quantum gases**				none	written examination or oral examination	yes	5
							Ultracold quantum gases Exercises in ultracold quantum gases	L PC	2 2				
Intended learning results: Students possess a comprehensive knowledge of current research topics in the field of ultracold quantum gases. They have also gained skills in experimental and theoretical methods required to understand the underlying fundamental concepts.													
1	annually, winter semester	first or second	none	RE	PHY-MV-LP-E28	**Nonclassical light and the central concepts of modern quantum physics**				none	written examination or oral examination	yes	8

							Nonclassical light and the central concepts of modern quantum physics Exercises in nonclassical light and the central concepts of modern quantum physics	L PC	4 2				
Intended learning results: Students can summarize the main scientific developments in the field of nonclassical light states, and possess a deeper understanding of quantum physics through the term “nonclassical”.													
1	annually, summer semester	first or second	none	RE	PHY-MV-LP-E29	**New experiments with XFEL sources**				none	written examination or oral examination	yes	4
							New experiments with XFEL sources Exercises in new experiments with XFEL sources	L PC	2 1				
Intended learning results: Students are able to better understand XFEL publications and develop their own ideas for conducting XFEL experiments.													
1	every semester	first or second		E		**Elective area**					Final module exam	yes	12
								L, PC, S, or Req.					
Intended learning results: There are no restrictions in the choice of the subject area, students should follow their inclinations and interests. This module aims to provide students with basic insights into a subject area of their choice.													

Student will also develop skills required for interdisciplinary collaboration.

[1]

PCE: practical examination

IR: internship report

SE: seminar examination

PCom: project completion

Section 24
Effective date

These subject-specific provisions (FSBs) become effective on the day following their official publication by Universität Hamburg. They apply for students commencing their studies in or after Winter Semester 2018/19.

Hamburg, 11 September 2018

Universität Hamburg