Note:
The following curriculum is a consolidated version. It is legally non-binding and for informational purposes only.
The legally binding versions are found in the University of Innsbruck Bulletins (in German).

Original version published in the University of Innsbruck Bulletin of 23 April 2007, Issue 34, No. 198
Amendment published in the University of Innsbruck Bulletin of 15 October 2008, Issue 2, No. 13
Amendment published in the University of Innsbruck Bulletin of 18 April 2012, Issue 21, No. 245
Modification published in the University of Innsbruck Bulletin of 24 May 2019, Issue 49, No. 475
Modification published in the University of Innsbruck Bulletin of 28 June 2019, Issue 67, No. 588

Complete version as of 1 October 2019

Curriculum for the
Master's Programme Physics
at the Faculty of Mathematics, Computer Science and Physics of
the University of Innsbruck

§ 1 Qualification Profile

The Master's degree follows the Bachelor's degree in physics and teaches the advanced knowledge and skills necessary for highly qualified, independent and innovative research plus development work in physics related technical professions. Furthermore, physics students in the course are taught strategies for solving problems that will make them attractive graduates for many other industrial and economic sectors. This is achieved by an in-depth study of selected frontline fields of physics together with integration into modern research.

Typical fields of activities for graduates, in addition to university-related research, include the implementation and support of research and development projects in physics and technology related industries and service sectors. Physicists find attractive employment opportunities in areas such as measurement and medical technology, information and telecommunications companies, as well as consulting firms and the financial sector.

Graduates should be able to use their knowledge to solve problems in science, technology, medicine and business. Therefore, the Masters study deepens the knowledge of both the foundations and methods of physics. Research based teaching in connection with the University's research strengths is included to promote creative thinking and also to prepare students for proceeding to the Doctoral program.

§ 2 Classification

The Master's Programme is part of the Physics Section of studies in Natural Sciences.

§ 3 Length and Scope

The Master's Programme Physics covers 120 ECTS credits (denoted below as ECTS-AP). Five compulsory modules covering altogether 25 ECTS-Credits and elective modules covering 72.5 ECTS-Credits must be passed. This corresponds to a duration of the study programme of four semesters.
The Master's Thesis corresponds to 22.5 ECTS-Credits.

§3a Language of Instruction:

The Master's Programme Physics is offered in English. In justified exceptional cases, examinations and the Master's Thesis may be passed and written in German respectively.

§ 4 Admission

(1) The prerequisite for admission to the Master's Programme Physics is the conclusion of a Bachelor's Programme Physics or other equivalent programme at a recognised Austrian or foreign post-secondary educational institution.

(2) Successful completion of the Bachelor's Programme or Teachers training course in physics at the University of Innsbruck counts as a prerequisite under paragraph (1).

§ 5 Types of courses and maximum number of participants

(1) **Lecture (VO)**

Lecture courses in didactic form covering the concepts, results and methods of the subject area. Aim: To stimulate interest and convey in a relatively short period of time well-structured knowledge and understanding of the subject area.

(2) **Proseminar (PS)**

These introductory seminars are usually in close connection with the content of a lecture course. Students are given exercises and their solutions are discussed in the Seminar. When the Seminar is connected with a lecture, the lecture contents are repeated with practical examples.

Aim: To practice solving problems, learn the methods of the field and practice presenting technical and scientific content of well learned content.

Continuous assessment. The number of students in each class: 25

(3) **Laboratory classes (PR)**

Promote the acquisition of skills through guided but independent work and the practical discussion of scientific content.

Continuous assessment. The number of students in each class is limited to 25.

(4) **Seminar (SE)**

Scientific examination of content and methods of a subject through presentations, written assignments and discussion sessions. The students learn to present scientific results through written reports and oral (seminar talk) presentations.

Continuous assessment. The number of students in each class: 15

§ 6 Name, type, extent and content of teaching modules and short description of the courses

(1) The Master´s Programme is divided into 4 areas of research focus

1. Quantum Physics (Q) with specialization in
   a. Experimental Physics (QEXP)
   b. Theoretical Physics (QTH)
2. Ion, Plasma- & Applied Physics (I) with specialization in
   a. Experimental Physics (IEXP)
   b. Theoretical Physics (ITH)
3. Astro- & Particle Physics (AT) with specialization in
   a. Astrophysics (ATA)
   b. Particle Physics (ATT)
4. Computational Physics (CP)

(2) **Compulsory modules**

1.	Compulsory Module: Basic Concepts in Research: Quantum Physics	h	ECTS-Credits
	VO Basic Concepts of Quantum Physics Introductory understanding of research related topics in atomic physics, molecular physics, quantum optics, and quantum information: light-matter interactions, coherent effects, interferometry, entanglement, matter waves, quantum gases, precision measurements, macroscopic quantum phenomena.	3	5
	Total	**3**	**5**
	Learning Outcomes: Graduates of this module are expected to understand and explain the content of the course, and to be able to apply the methods of the course. They should acquire the ability to further develop the basic concepts of quantum physics by themselves. Furthermore, they should acquire a basic understanding of research oriented approaches to quantum physics.		
	Prerequisites: none		

2.	Compulsory Module: Basic Concepts in Research: Ion, Plasma and Applied Physics	h	ECTS-Credits
	VO Basic Concepts of Ion, Plasma and Applied Physics Introductory understanding of research related topics in Ion, Plasma and Applied Physics: Electron-Matter and Ion-Matter Interactions, Plasmas in nature and technological applications, behavior of Plasmas, concepts of Nuclear Fusion and Energy Physics, Molecular Physics, Mass Spectrometry and Analysis, Cluster Physics and Nanotechnology, Nonlinear Dynamics, fundamentals of Electrical Engineering.	3	5
	Total	**3**	**5**
	Learning Outcomes: Graduates of this module are expected to understand and explain the content of the course, and to be able to apply the methods of the course. They should acquire the ability to further develop the basic concepts of Ion, Plasma and Applied Physics by themselves. Furthermore, they should acquire a basic understanding of research oriented approaches to Ion, Plasma and Applied Physics.		
	Prerequisites: none		

3.	Compulsory Module: Basic Concepts in Research: Astrophysics and Particle Physics	h	ECTS-Credits
	VO Basic Concepts of Astrophysics and Particle Physics Galaxies, Cosmology, Structure Formation and Structural Evolution, Dark Matter and Dark Energy, Gamma and X-ray Astrophysics. Relativistic Kinematics, Electromagnetic, Strong and Weak Elementary Processes, Feynman Diagrams, Hadron Systematics, Quarks and Quantum Chromodynamics, Electroweak Unification.	3	5
	Total	**3**	**5**
	Learning Outcomes: Graduates of this module are expected to understand and explain the content of the course, and to be able to apply the methods of the course. They should acquire the ability to further develop the basic concepts of Astrophysics and Particle Physics by themselves. Furthermore, they should acquire a basic understanding of research oriented approaches to Astrophysics and Particle Physics.		

	Prerequisites: none

4.	**Compulsory Module: Preparation of the Master's Thesis**	**h**	**ECTS-Credits**
	Agreement on the topic, the scope and the form of the Master's Thesis on the basis of a brief summary of the contents (abstract) as well as agreement on the work processes and the study progress. Planning of an appropriate time frame for the completion of the Master's Thesis.	-	7.5
	Total	**-**	**7.5**
	Learning Outcomes: After successful completion of this module, the students will be able to write a brief summary of the content of the planned Master's Thesis (exposé), to outline an anticipated schedule and to conclude a written Master's Thesis agreement.		
	Prerequisites: none		

5.	**Compulsory Module: Defence of the Master's Thesis**	**h**	**ECTS-Credits**
	Concluding Defence of the Master's Thesis		2.5
	Total		**2.5**
	Prerequisites: the successful completion of all other compulsory and elective modules as well as the positive assessment of the thesis.		

(3) **Elective modules**

1.	**Elective Module: Quantum Physics II**	**h**	**ECTS-Credits**
a.	**VO Quantum Physics II** Scattering Theory, Relativistic Quantum Mechanics, Quantization of Linear Field Equations, Locality, Spin-Statistics-Theorem, Elements of Quantum Electrodynamics.	4	6
b.	**PS Quantum Physics II** Discussion, getting a deeper knowledge and practice with the contents of the lecture course; getting exercise in scientific argumentation and in the presentation of Mathematical and Physical Contents.	2	4
	Total	**6**	**10**
	Learning Outcomes: Graduates of this module are expected to understand and explain the content of the course, and to be able to apply the methods of the course. They should acquire the ability to work on further concepts and methods of Quantum Physics by themselves. Furthermore, they should acquire a deeper understanding of Quantum Physics.		
	Prerequisites: none		

2.	Elective Module: Laser Physics, Laser Spektroscopy and Photonics	h	ECTS-Credits
	VO Laser Physics, Laser Spectroscopy & Photonics Optical Amplification, Gauß's Beam Optic and Optical Resonators, types of Lasers, Continous and Pulsed Lasers, Ultrashort Pulses, Coherence and Statistical Properties of Light, Doppler Confined and Unconfined Methods of Spectroscopy, Spectroscopy with Short Pulses, Coherent Spectroscopy, Atomic Clocks, Acusto- and Electrooptics, Linear and Nonlinear Optics, Conversion of Frequencies, Light Guides, Optical Communication Technology.	4	7.5
	Total	**4**	**7.5**
	Learning Outcomes: Graduates of this module are expected to understand and explain the content of the course, and to be able to apply the methods of the course. They should acquire the ability to further develop the concepts and methods of Laser Physics, Laser Spectroscopy and Photonics by themselves. Furthermore, they should acquire a basic understanding of Laser Physics, Laser Spectroscopy and Photonics.		
	Prerequisites: none		

3.	Elective Module: Seminar (Q)	h	ECTS-Credits
	SE Seminar Quantum Physics Discussion of actual topics in Atomic Physics, Molecular Physics, Quantum Optics and Quantum Information.	2	5
	Total	**2**	**5**
	Learning Outcomes: Graduates of this module are expected to reflect the problems of quantum physics in a creative and methodical manner and to present the results clearly through written reports and/or oral presentation.		
	Prerequisites: none		

4.	Elective Module: Advanced Laboratory Class 2	h	ECTS-Credits
	PR Advanced Laboratory Class 2 The practical accomplishment of the following experiments should make clear the experimental working in Physics; Examples: Counter Experiments, Semiconductor Spectroscopy, Nonlinear Optics, Diode Lasers, Amplitude and Phase Modulation, Laser Spectroscopy, Electron Absorption and Creation of Negative Ions, Ion-Molecule-Reactions.	4	10
	Total	**4**	**10**
	Learning Outcomes: Graduates of this module are expected to understand the problems of the technical details of Experimental Physics by performing advanced experiments. They should have acquired the ability to conduct the experiments by themselves. Furthermore, they should have acquired a deeper understanding of experimental techniques in Physics.		
	Prerequisites: none		

5.	Elective Module: Advanced Laboratory Class 3	h	ECTS-Credits
	PR Advanced Laboratory Class 3 The practical accomplishment of experiments is a preparation for the master thesis. In general the experiments are conducted with state-of-the-art research technology. Examples: Electronic Stabilizer, Stabilization by Lasers, Interaction of Electrons with Free Biomolecules, Analytic Mass Spectroscopy, Scanning Tunneling Microscope/Nanolitography.	3	7.5
	Total	**3**	**7.5**
	Learning Outcomes: Graduates of this module are prepared by the practical accomplishment to the experimentally oriented master thesis. They should have acquired the ability to conduct the experiments by themselves. Furthermore, they should have acquired a deeper understanding of experimental techniques in Physics.		
	Prerequisites: none		

6.	Elective Module: Research Class in Experimental Quantum Physics	h	ECTS-Credits
	PR Research Class in Experimental Quantum Physics Introduction to experimental scientific research in the field of Atomic Physics, Molecular Physics, Quantum Optics and Quantum Information; guided work in current research.	8	12.5
	Total	**8**	**12.5**
	Learning Outcomes: Graduates of this module are expected to conduct actual research by guided accomplishment of projects in Quantum Physics. They should have acquired the ability to conduct innovative experiments by themselves (attended by tutors). Furthermore, they should have acquired a deeper understanding of experimental techniques in Quantum Physics.		
	Prerequisites: none		

7.	Elective Module: Particle Traps and Laser Cooling	h	ECTS-Credits
	VO Particle Traps & Laser Cooling Magnetic Traps, Dipol Traps, Ion Traps, Doppler and Sub-Doppler Cooling, selected applications for Quantum Gases, Interferometry and Quantum Information.	3	5
	Total	**3**	**5**
	Learning Outcomes: Graduates of this module are expected to understand and explain the content of the course, and to be able to apply the methods of the course. They should acquire the ability to further develop the contents and methods of Particle Traps and Laser Cooling by themselves. Furthermore, they should acquire a basic understanding of Particle Traps and Laser Cooling.		
	Prerequisites: none		

8.	Elective Module: Mathematical Methods 3	h	ECTS-Credits
	VO Mathematical Methods of Physics 3 Group Theory, Stochastic Processes or Mathematical Software Packages used in Physics.	2	5
	Total	**2**	**5**
	Learning Outcomes: Graduates of this module are expected to understand and explain the content of the course, and to be able to apply the methods of the course. They should acquire the ability to further develop the basic concepts in Mathematical Methods by themselves. Furthermore, they should acquire a deeper understanding of Mathematical Methods in Physics.		
	Prerequisites: none		

9.	Elective Module: Relativity	h	ECTS-Credits
	VO Relativity Minkowski Geometry, Pseudo-Riemannian Geometrie, Einstein Equations, Solution by Schwarzschild – Kruskal, Cosmology (Solution by Robertson- Walker)	3	5
	Total	**3**	**5**
	Learning Outcomes: Graduates of this module are expected to understand and explain the content of the course, and to be able to apply the methods of the course. They should acquire the ability to further develop topics in Relativity by themselves. Furthermore, they should acquire a basic understanding of Relativity.		
	Prerequisites: none		

10.	Elective Module: Theoretical Quantum Optics	h	ECTS-Credits
a.	**VO Theoretical Quantum Optics** Production and Detection of Photons, Jaynes-Cummings Modell, Cavity Quantum Electrodynamics, Laser Cooling, Theory of Ultracold Atomic Gases, implementation of Quantum Computers and Quantum Communication by Quantum Optical Methods.	3	4.5
b.	**PS Theoretical Quantum Optics and Information** Discussion, getting a deeper knowledge and practice with the contents of the lecture course; getting acquainted with scientific argumentation and presentation of theoretical contents in Physics.	1	3
	Total	**4**	**7.5**
	Learning Outcomes: Graduates of this module are expected to understand and explain the content of the course, and to be able to apply the methods of the course. They should acquire the ability to further develop topics in Theoretical Quantum Optics and Quantum Information by themselves. Furthermore, they should acquire a basic understanding of Theoretical Quantum Optics and Quantum Information.		
	Prerequisites: none		

11.	Elective Module: Research Class in Theoretical Quantum Physics	h	ECTS-Credits
	PR Research Class in Theoretical Quantum Physics Introduction to scientific research in Theoretical Physics in the fields of Atomic Physics, Molecular Physics, Quantum Optics and Quantum Information; guided work on scientific projects.	6	7.5
	Total	**6**	**7.5**
	Learning Outcomes: Graduates of this module are expected to understand the problems of the technical details of Quantum Physics by conducting practical work in research projects in Quantum Physics. They should have acquired the ability to conduct simple innovative projects by themselves. Furthermore, they should have acquired a deeper understanding of projects in Theoretical Physics by studying the scientific literature.		
	Prerequisites: none		

12.	Elective Module: Theoretical Quantum Information	h	ECTS-Credits
	VO Theoretical Quantum Information (Q) Fundamentals of Classical Information Theory, protocols of Quantum Cryptography and Quantum Communication, theory of Entangled States, Quantum error correction, Quantum Computers and Quantum Simulators, Algorithms in Quantum Information.	2	5
	Total	**2**	**5**
	Learning Outcomes: Graduates of this module are expected to understand and explain the content of the course, and to be able to apply the methods of the course. They should acquire the ability to further develop topics in Theoretical Quantum Information by themselves. Furthermore, they should acquire a deeper understanding of Theoretical Quantum Information.		
	Prerequisites: none		

13.	Elective Module: Theory of Condensed Matter	h	ECTS-Credits
	VO Theory of Condensed Matter Quantum theory of Condensed Matter, BCS model of Superconductivity, Superfluidity, Bose-Einstein Condensation, modern topics in the theory of Solid State Physics, Nanostructures.	3	5
	Total	**3**	**5**
	Learning Outcomes: Graduates of this module are expected to understand and explain the content of the course, and to be able to apply the methods of the course. They should acquire the ability to further develop topics in Condensed Matter Physics by themselves. Furthermore, they should acquire a basic understanding of the theory of Condensed Matter.		
	Prerequisites: none		

14.	Elective Module: Ion and Plasma Physics (Introduction)	h	ECTS-Credits
	VO Ion and Plasma Physics (Introduction) Production of charge carriers, production and properties of Plasma, gas discharge, interactions of Ions with neutral and other charged particles, surfaces and light, analysis of Ions and Plasma, magnetic confinement of Plasma, dynamics of Plasma and instabilities, layers of space charge, modelling of Individual Molecules, Clusters, Nanoparticles and Plasma.	4	7.5
	Total	**4**	**7.5**
	Learning Outcomes: Graduates of this module are expected to understand and explain the content of the course, and to be able to apply the methods of the course. They should acquire the ability to further develop topics in Ion and Plasma Physics. Furthermore, they should acquire a basic understanding of Ion and Plasma Physics.		
	Prerequisites: none		

15.	Elective Module: Data Acquisition and Analysis	h	ECTS-Credits
	VO Data Acquisition and Analysis Basics of processing of discrete signal, discrete Fourier transform (DFT), LTI-systems, convolution theorem, scanning theorem, digital filters (IIR, FIR), computer assisted acquisition of data with LABVIEW, analog-to-digital conversion (ADC), digital-to-analog conversion (DAC).	2	2.5
	Total	**2**	**2.5**
	Learning Outcomes: Graduates of this module are expected to understand and explain the content of the course, and to be able to apply the methods of the course. They should acquire the ability to further develop topics in Data Acquisition and Data Analysis by themselves. Furthermore, they should acquire a basic understanding of Data Acquisition and Data Analysis.		
	Prerequisites: none		

16.	Elective Module: Seminar (I)	h	ECTS-Credits
	SE Seminar (I) Independent work on a talk on a specific topic. The content of the talk should expand the acquired knowledge and address the current state of the research in the field.	2	5
	Total	**2**	**5**
	Learning Outcomes: Graduates of this module are expected to reflect the problems of Ion and Applied Physics in a creative and methodical manner and to present the results clearly in a written reports and/or oral presentation.		
	Prerequisites: none		

17.	Elective Module: Research Management	h	ECTS-Credits
	VO Research Management Project management, Quality Control (TÜV, approval of technical instruments), Patent Law.	2	5
	Total	**2**	**5**
	Learning Outcomes: Graduates of this module are expected to understand and explain the content of the course, and to be able to apply the methods of the course. They should acquire the ability to further develop topics in Research Management by themselves. Furthermore, they should acquire a basic understanding of Research Management.		
	Prerequisites: none		

18.	Elective Module: Measurement and Basic Experimental Techniques	h	ECTS-Credits
	VO Measurement and Basic Experimental Techniques Foundations of Electrical Engineering, Resonance, Oscillations, Phase and Group Velocity, Amplifier, Method of Coincidence, Lock-in Amplifier, General Measurement Techniques, Vacuum Technique, Leak Detection, Mass Spectroscopy and Methods of Analysis of Scientific and Ordinary Samples.	4	7.5
	Total	**4**	**7.5**
	Learning Outcomes: Graduates of this module are expected to understand and explain the content of the course, and to be able to apply the methods of the course. They should acquire the ability to further develop topics in Measurement Techniques and basic Experimental Techniques by themselves. Furthermore, they should acquire a basic understanding of the theory and practice of Measurement.		
	Prerequisites: none		

19.	Elective Module: Research Class in Experimental Ion and Plasma Physics	h	ECTS-Credits
	PR Research Class in Experimental Ion and Plasma Physics Introduction to scientific experimental research in the fields of Ion Physics, Plasma Physics and Applied Physics. Attended work on projects in the context of ongoing research projects.	8	12.5
	Total		
	Learning Outcomes: Graduates of this module are expected to conduct actual research by guided accomplishment of projects in Ion and Plasma Physics. They should have acquired the ability to conduct innovative experiments by themselves (attended by tutors). Furthermore, they should have acquired a deeper understanding of Experimental Techniques in Ion and Plasma Physics.		
	Prerequisites: none		

20.	Elective Module: Theory of Molecules	h	ECTS-Credits
	VO Theory of Molecules Theoretical Chemistry, Quantum Chemistry and Molecular Dynamics.	2	2.5
	Total	**2**	**2.5**
	Learning Outcomes: Graduates of this module are expected to understand and explain the content of the course, and to be able to apply the methods of the course. They should acquire the ability to further develop topics in the Theory of Molecules by themselves. Furthermore, they should acquire a basic understanding of the Theory of Molecules.		
	Prerequisites: none		

21.	Elective Module: Mechanics of Continua and Theoretical Plasma Physics	h	ECTS-Credits
a.	**VO Mechanics of Continua and Theoretical Plasma Physics** Kinetic Theory, Mechanics of Continua, Magneto-Hydrodynamics, Plasma Physics and Nuclear Fusion, Nonlinear Dynamics of Plasma and Fluids (turbulence and creation of structures)	3	4.5
b.	**PR Mechanics of Continua and Theoretical Plasma Physics** Discussion, getting a deeper knowledge and practice with the contents of the lecture course; getting acquainted with scientific argumentation and presentation of theoretical contents in Physics.	1	3
	Total	**4**	**7.5**
	Learning Outcomes: Graduates of this module are expected to understand and explain the content of the course, and to be able to apply the methods of the course. They should acquire the ability to further develop topics in Mechanics of Continua and Plasma Physics by themselves. Furthermore, they should acquire a basic understanding of the Mechanics of Continua and Theoretical Plasma Physics.		
	Prerequisites: none		

22.	Elective Module: Research Class in Theoretical Ion, Plasma and Energy Physics	h	ECTS-Credits
	PR Research Class in Theoretical Ion, Plasma and Energy Physics Introduction to scientific research in the field of Theoretical Ion, Plasma and Energy Physics. Guided participation in ongoing Research Projects.	6	7.5
	Total	**6**	**7.5**
	Learning Outcomes: Graduates of this module are integrated with the ongoing research projects in the field of Theoretical Ion, Plasma, and Energy Physics by contributing to the analytical and numerical solutions. In this process they will acquire a fundamental understanding of ongoing projects in Plasma and Energy and furthermore an ability to conduct new projects either in collaboration or by themselves.		
	Prerequisites: none		

23.	Elective Module: Introduction to Scientific Research in Ion, Plasma and Energy Physics	h	ECTS-Credits
	VO Introduction to Scientific Research in Ion, Plasma, and Energy Physics Accompanying lecture to the research class in Theoretical Ion, Plasma and Energy Physics: special methods and procedures in the field of Ion, Plasma and Energy Physics.	2	5
	Total	**2**	**5**
	Learning Outcomes: Graduates of this module are expected to understand and explain the content of the course, and to be able to apply the methods of the course. They should acquire the ability to further develop topics in the field of Ion, Plasma and Energy Physics by themselves. Furthermore, they should acquire a basic understanding for scientific research in those fields.		
	Prerequisites: none		

24.	Elective Module: Numerical Mathematics	h	ECTS-Credits
	VO Numerical Mathematics Numerical solution of initial value problems of ordinary Differential Equations (one and many step Algorithms, variation of step size); boundary value problems in ordinary Differential Equations (theory, method of differences, variational methods). Partial Differential Equations of Hydrodynamics and Magneto-Hydrodynamics with and without external forces. Discontinuities in Numerical Calculations (Godunov Scheme).	2	5
	Total	**2**	**5**
	Learning Outcomes: Graduates of this module are expected to understand and explain the content of the course, and to be able to apply the methods of the course. They should acquire the ability to further develop topics in Numerical Mathematics by themselves. Furthermore, they should acquire a basic understanding of Numerical Mathematics.		
	Prerequisites: none		

25.	Elective Module: Astroparticle Physics	h	ECTS-Credits
	VO Astroparticle Physics Nucleosynthesis in Astrophysics, large structures in the Universe, interstellar matter; the standard model of Particle Physics formulated as a Gauge Theory, Radiative Corrections, Experimental Tests; Cosmic Rays, Neutrinos.	2	2.5
	Total	**2**	**2.5**
	Learning Outcomes: Graduates of this module are expected to understand and explain the content of the course, and to be able to apply the methods of the course. They should acquire the ability to work on further contents in Astroparticle Physics by themselves. Furthermore, they should acquire a basic understanding of Astroparticle Physics.		
	Prerequisites: none		

26.	Elective Module: Statistics and Data Analysis	h	ECTS-Credits
a.	**VO Statistics and Data Analysis** Fundamentals of Statistics in Data Acquisition, Test methods concerning small test samples, Statistics using Detectors, ideal and real Detectors in Astrophysics and Particle Physics (CCD, Multiplier, Counter…), defects and non linear properties of Detectors, Error Correction, Analysis of time ordered data.	2	2.5
b.	**PS Statistics and Data Analysis** Discussion, getting a deeper knowledge and practice with the contents of the lecture course; computer aided Analysis of Data.	1	2.5
	Total	**3**	**5**
	Learning Outcomes: Graduates of this module are expected to understand and explain the content of the course, and to be able to apply the methods of the course. They should acquire the ability to work on further topics in Statistics and Data Analysis by themselves. Furthermore, they should acquire a basic understanding of Statistics and Data Analysis.		
	Prerequisites: none		

27.	Elective Module: Seminar (AT)	h	ECTS-Credits
	SE Seminar (AT) Independent work on a talk on a specific topic. The content of the talk should expand the acquired knowledge and address the current state of the research in the field.	2	5
	Total	**2**	**5**
	Learning Outcomes: Graduates of this module are expected to reflect the problems of Astrophysics and Particle Physics in a creative and methodical correct manner and to present the results clearly in written reports and/or oral presentation.		
	Prerequisites: none		

28.	Elective Module: Special Course 1 (AT)	h	ECTS-Credits
	VO Special Course 1 (AT) Selected topics in Astroparticle Physics.	3	5
	Total	**3**	**5**
	Learning Outcomes: Graduates of this module are expected to understand and explain the content of the course, and to be able to apply the methods of the course. They should acquire the ability to further develop the basic concepts of Astroparticle Physics by themselves. Furthermore, they should acquire a deeper understanding of selected topics in Astroparticle Physics.		
	Prerequisites: none		

29.	Elective Module: Special Course 2 (AT)	h	ECTS-Credits
	VO Special Course 2 (AT) Selected topics in Astroparticle Physics.	2	5
	Total	**2**	**5**
	Learning Outcomes: Graduates of this module are expected to understand and explain the content of the course, and to be able to apply the methods of the course. They should acquire the ability to develop further concepts of Astroparticle Physics by themselves. Furthermore, they should acquire a deeper understanding of selected topics in Astroparticle Physics.		
	Prerequisites: none		

30.	Elective Module: Laboratory Class at the Telescope	h	ECTS-Credits
	PR Advanced Laboratory Class at the Telescope Management of Observations, CCD Direct Imaging, Stellar Spectroscopy, Data Analysis, writing a scientific report. The lecture course will be blocked (depending on the wheater) and takes place only during the winter term.	4	10
	Total	**4**	**10**
	Learning Outcomes: Graduates of this module are expected to understand the experimental methods and techniques in Astrophysics by attendance of this laboratory class. They should acquire the ability to accomplish observations on the telescope by themselves. Furthermore, they should acquire a basic understanding of the experimental research methods in Astrophysics.		
	Prerequisites: none		

31.	Elective Module: Astrophysics 2	h	ECTS-Credits
a.	**VO Astrophysics 2** The Planet System, Hydrodynamics of the Composition of a star, Evolution of stars and details of Nuclear Fusion, Formation and Dynamics of Galaxies, Galaxies in a global context, interstellar matter.	3	4
b.	**PS Astrophysics 2** Discussion, getting a deeper knowledge and practice with the contents of the lecture course; getting acquainted with scientific argumentation and presentation of Mathematical Contents.	2	3.5
	Total	**5**	**7.5**
	Learning Outcomes: Graduates of this module are expected to understand and explain the content of the course, and to be able to apply the methods of the course. They should acquire the ability to further develop topics in Astrophysics by themselves. Furthermore, they should acquire a deeper understanding in the field of Astrophysics.		
	Prerequisites: none		

32.	Elective Module: Research Class in Astrophysics	h	ECTS-Credits
	PR Research Class in Astrophysics Introduction to experimental scientific research in the field of Astrophysics. Attended work on projects in the context of ongoing Research Projects.	8	12.5
	Total	**8**	**12.5**
	Learning Outcomes: Graduates of this module are expected to conduct actual research by guided accomplishment of projects in Astrophysics. They should have acquired the ability to conduct innovative experiments by themselves (attended by tutors). Furthermore, they should have acquired a deeper understanding of experimental work on projects in Astrophysics.		
	Prerequisites: none		

33.	Elective Module: Laboratory Class in Particle Physics	h	ECTS-Credits
	PR Laboratory Class in Particle Physics Introduction to the methods in experimental Particle Physics by analysing six aspects of experiments performed at CERN: - Calculation of the decay of neutral Kaons (simulated data) - Simulation of the decay of a Kaon in a detector - Annihilation of Electrons and Positrons on the Z-peak - Analysis of Real Data - Determination of the branching ratio R (hadrons/leptons) Determination of the parameters of the Z-resonance	3	5
	Total	**3**	**5**
	Learning Outcomes: Graduates of this module are expected to conduct actual research by guided participation in projects in Particle Physics. They should have acquired the ability to conduct innovative experiments by themselves (attended by tutors). Furthermore, they should have acquired a deeper understanding of experimental techniques in Particle Physics.		
	Prerequisites: none		

34.	Elective Module: Research Class in Particle Physics	h	ECTS-Credits
	PR Research Class in Particle Physics Introduction to scientific research in Experimental Particle Physics. Guided work on projects in current Research.	8	12.5
	Total	**8**	**12.5**
	Learning Outcomes: Graduates of this module are expected to conduct actual research by participation in projects in Particle Physics. They should have acquired the ability to conduct innovative experiments by themselves (attended by tutors). Furthermore, they should have acquired a deeper understanding of experimental techniques in Particle Physics.		
	Prerequisites: none		

35.	Elective Module: Advanced Courses in Mathematics	h	ECTS-Credits
	Every student has to supply lecture courses with 15 ECTS-AP out of the Bachelor or Master Programme in Technical Mathematics; those courses must not be contained in the compulsory courses in the Bachelor or Master Programme in Physics.		15
	Total		**15**
	Learning Outcomes: In the major field of study „Computational Physics“ students have to acquire advanced knowlegde in Mathematics.		
	Prerequisites: The prerequisites specified in the respective curricula must be met.		

36.	Elective Module: Numerical Solution of Partial Differential Equations	h	ECTS-Credits
	VO Numerical Solution of Partial Differential Equations Numerical Algorithms for the solution of systems of Partial Differential Equations, especially the method of Finite Elements and Finite Differences; Analysis of stability of solutions; error estimates.	3	6
	PS Numerical Solution of Partial Differential Equations Discussion, getting a deeper knowledge and practice with the contents of the lecture course; acquiring exercise in scientific argumentation and in the presentation of Mathematical and Physical Contents.	2	4
	Total	**5**	**10**
	Learning Outcomes: Graduates of this module are expected to understand and explain the content of the course, and to be able to apply the methods of the course. They should acquire the ability to further develop topics in Numerical Solution of Partial Differential Equations by themselves. Furthermore, they should acquire a deeper understanding of this field.		
	Prerequisites: none		

37.	Elective Module: Particle Physics	h	ECTS-Credits
	VO Particle Physics Annihilation of Electrons and Positrons on the Z-peak, experiments at CERN, Hadrons and Leptons, Z-resonance, the standard model of Particle Physics, models beyond the standard model, results from the LHC.	2	2.5
	Total	**2**	**2.5**
	Learning Outcomes: Graduates of this module are expected to understand and explain the content of the course, and to be able to apply the methods of the course. They should acquire the ability to further develop topics in Particle Physics by themselves. Furthermore, they should acquire a deeper understanding of Particle Physics.		
	Prerequisites: none		

38.	Elective Module	h	ECTS-Credits
	Graduates should enroll in lecture courses of the Faculty of Mathematics, Computer Science and Physics marked by „WP“ (Wahlmodul Physik = elective module in Physics) corresponding to a workload of 15 ECTS-AP. Alternatively, they may enroll in modules of the Master Programmes in Mathematics or Computer Science, which are not part of the Master Programme in Physics.		15
	Total		**15**
	Learning Outcomes: Graduates should acquire further knowledge in addition to the contents of the compulsory modules (2) and the elective modules (3) out of the fields of Mathematics or Computer Science or further knowledge in one or more fields of Physics.		

(4) Combinations of optional modules to be completed are:

1. Major field of study: Quantum Physics
   a. Experimental Physics: 1, 2, 3, 4, 5, 6, 7, 38
   b. Theoretical Physics: 1, 2, 3, 8, 9, 10, 11, 12, 13, 38
2. Major field of study: Ion, Plasma and Applied Physics
   a. Experimental Physics: 4, 5, 14, 15, 16, 17, 18, 19, 38
   b. Theoretical Physics: 8, 9, 14, 15, 16, 17, 20, 21, 22, 23, 24, 38
3. Major field of study: Astrophysics and Particle Physics
   a. Astrophysics: 24, 25, 26, 27, 28, 29, 31, 32, 38 and either 8+9 or 30
   b. Particle physics: 4, 24, 25, 26, 27, 28, 29, 33, 34, 37, 38
4. Major field of study: Computational Physics: 8, 24, 26, 35, 36, 38, one of the modules 3, 16, 27
   plus one of the modules 6, 19, 32, 34
   or the modules 11 and 12
   or the modules 22 and 23

§ 7 Master´s Thesis

In the Master's Programme in Physics a Master's Thesis corresponding to 22.5 ECTS-Credits must be written. The Master's Thesis is a scientific paper on a topic from a subarea of physics.

§ 8 Admission procedures for the admission to courses with a limited number of participants

For courses with a limited number of participants, places in courses will be awarded as follows:

1. Students who have been granted an extension to complete their studies because of missing initial background are allowed to be preferred.
2. When places are not filled according to criterion 1, the remaining places are awarded first to students for whom the course is compulsory and then to students for whom the course is an optional module.
3. When places are not filled according to criteria 1 and 2, remaining places will be raffled by ballot.

§ 9 Examination Procedure

(1) There will be an examination for each compulsory and elective lecture module. The lecturer will announce at the beginning of the course whether the examination will be held orally or via a written paper.

(2) Successful participation in seminars will be assessed through a talk presentation plus seminar paper.

(3) Any additional assessment criteria of student performance will be announced by the lecturer at the start of the course.

(4) A module is completed by the positive assessment of its course components.

(5) The compulsory module "Preparation of the Master's Thesis" is evaluated by the supervisor of the Master's Thesis based on an abstract. Positive evaluation reads "successfully completed", negative evaluation "unsuccessfully completed".

(6) The Master´s Programme is completed by the final defence of the Master´s Thesis. This final exam will be assigned 2.5 ECTS-AP. The exam takes approx. 60 minutes and begins with a 20 minute public lecture presentation about the thesis followed by open discussion and questions about the talk. The exam is concluded with questions about the thesis from members of the examination board.

§ 10 Academic Degree

Graduates of the Master's Programme Physics are awarded the academic degree of "Master of Science" (abreviated as M.Sc.).

§12 Coming into force

(1) This curriculum comes into force on October 1 2007.

(2) The changes of the curriculum in the version of the University of Innsbruck Bulletin of 24 May 2019, Issue 49, No. 476 come into effect as of 1 October 2019 and are to be applied to all students.

(3) The changes of the curriculum acc. to the version of the University of Innsbruck Bulletin of 28 June 2019, Issue 66, No. 588 come into effect on 1 October 2019 and are to be applied to all students.