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# **Appendices to the Teaching and Examination Regulations**

**2019-2020**

**Master's degree programme in Astronomy**



## Appendix I Teaching outcomes of the degree programme (art. 3.1)

The master graduate in Astronomy:

### 1. Knowledge and understanding

- 1.1. masters the fundamental astronomical and astrophysical concepts as well as the necessary tools from physics, mathematics and computer science, including modeling skills, at a level which permits admission to a PhD programme;
- 1.2. is familiar with the quantitative character of astronomy and astrophysics and with the relevant research methods;
- 1.3. who has completed
  - the Quantum Universe track has operational knowledge in i) an observational or theoretical astronomical or astrophysical subarea, ii) the area of instrumentation and information technology in astronomy, physics, and/or space research, or iii) the area of data science in astronomy, as well as knowledge of the state-of the art in at least one specific research area;
  - the Business, Science and Policy track has operational knowledge of and insight into the functioning of companies and administrations, as well as the relevant legislation and knowledge of the state-of the art in at least one specific research area;

### 2. Application of knowledge and understanding

- 2.1. is capable of carrying out research, aimed at understanding of astronomical phenomena, both observational and theoretical;
- 2.2. is capable of analyzing a (new) complex astrophysical problem, and to use modelling skills to develop a structured and well-planned research approach;
- 2.3. is capable of applying his/her specific knowledge and mathematical, experimental, and computer skills to solve astronomy problems in his/her own and related subject areas and fields;
- 2.4. is capable of collaborating in a (multi-disciplinary) team and has basic skills to manage a (collaborative) project;

### 3. Judgement

- 3.1. is capable of obtaining relevant information using modern information channels, and of interpreting this information critically in the context of an absolute standard;
- 3.2. is capable of managing and judging his/her and others' actions within a highly scientific and professional context, taking societal and ethical aspects into account;
- 3.3. is able of drawing conclusions on the basis of limited or incomplete information, and is able to realize and formulate the limitations of such conclusions;
- 3.4. is acting and conducting research according to the VSNU Code of Conduct for Academic Practice

### 4. Communication skills

- 4.1. is capable of communicating clearly in English, both verbally and in writing, on his/her subject and relevant applications, at a level which is understandable to experts and non-experts, and using modern communication tools;

### 5. Learning skills

- 5.1. is capable of addressing issues inside as well as outside his/her main subject area, therefore and thereby gaining new knowledge and skills.



## **Appendix II Tracks of the degree programme (art. 3.5)**

1. The Master's degree programme in Astronomy offers the following tracks:
  - Quantum Universe
  - Science, Business and Policy
  
2. In the Quantum Universe-track, the following specialisations exist:
  - Theoretical and Observational Astronomy
  - Instrumentation and Informatics
  - Data Science



### Appendix III Content of the degree programme (art. 3.6)

The assessment method(s) of the courses below can be found in the assessment plan of the degree programme and on Ocasys.

#### Quantum Universe: Theoretical and Observational Astronomy

Course unit	ECTS	Practical	Entry Requirements
Astronomy colloquium	-		
Electrodynamics of Radiation Processes	5		
General Relativity	5		
Particle Physics Phenomenology	5		
Student seminar Quantum Universe	5		
Astrophysics Core Courses	20	see app. IV	see app. IV
Optional Courses in Theoretical and Observational Astronomy	20	see app. IV	see app. IV
Master Research Project Astronomy	60	X	

#### Quantum Universe: Instrumentation and Informatics

Course unit	ECTS	Practical	Entry Requirements
Astronomy colloquium	-		
Electrodynamics of Radiation Processes	5		
General Relativity	5		
Particle Physics Phenomenology	5		
Project Information Technology	10	X	
Student seminar Quantum Universe	5		
Astrophysics Core Courses	20	see app. IV	see app. IV
Optional courses in Instrumentation and Informatics	20	see app. IV	see app. IV
Industrial Internship	20	X	
Master Research Project Astronomy	40	X	

#### Quantum Universe: Data Science

Course unit	ECTS	Practical	Entry Requirements
Astronomy colloquium	-		
Electrodynamics of Radiation Processes	5		
General Relativity	5		
Introduction to Data Science	5	X	
Particle Physics Phenomenology	5		
Statistical Signal Processing	5		
Student seminar Quantum Universe	5		
Astrophysics Core Courses	20	see app. IV	see app. IV
Optional Courses in Data Science	10	see app. IV	see app. IV
Master Research Project Astronomy	60	X	



**Science, Business and Policy**

<b>Course unit</b>	<b>ECTS</b>	<b>Practical</b>	<b>Entry Requirements</b>
Astrophysics Core Courses	20	see app. IV	see app. IV
Optional Courses in Theoretical and Observational Astronomy	10	see app. IV	see app. IV
Introduction Science, Business and Policy	20		
Internship Science, Business and Policy	40	X	
Astronomy colloquium	-		
Master Research / Thesis	30	X	



## Appendix IV Electives (art. 3.7)

The assessment method(s) of the courses below can be found in the assessment plan of the degree programme and on Ocasys.

### Astrophysics Core Courses

Course unit	ECTS	Practical	Entry Requirements
<b>Yearly courses</b>			
Formation and Evolution of Galaxies	5		
<b>Biennial courses, offered in 2019-2020</b>			
Astrochemistry	5		
Dynamics of Galaxies	5		
High-Energy Astrophysics	5	X	
<b>Biennial courses, offered in 2020-2021</b>			
Cosmic Structure Formation	5		
Star and Planet Formation	5		
Stars, Nucleosynthesis and Chemical Evolution	5		

### Optional Courses in Quantum Universe: Theoretical and Observational Astronomy

Course unit	ECTS	Practical	Entry Requirements
<b>Yearly courses</b>			
Collider Experiments	5		
Computational Physics	5	X	
Elementary Particle Physics	5		
Fundamental Constants	5		
Gravitational Waves	5		
Introduction to Plasma Physics	5		
La Palma Observation Trip	5	X	
Laser Cooling Trapping	5	X	
Lie Groups in Physics	5		
Mathematical Methods of Physics	5		
Nuclear Astrophysics	5		
Particle Cosmology	5		
Quantum Experiments	5		
Quantum Field Theory	5		
Statistical Methods in Physics	5		
Statistical Signal Processing	5		
<b>Biennial courses, offered in 2019-2020</b>			
Basic Detection Techniques	5	X	
Geometry and Topology	5		
<b>Biennial courses, offered in 2020-2021</b>			
Active Galaxies and AGN	5		
Astronomical Data Science	5	X	
Geometry & Differential Equations	5		
Interferometry	5		



For the specialization Theoretical and Observational Astronomy (Quantum Universe) a maximum of 20 ECTS may be chosen from the option groups in the table above or from the Capita Selecta Courses, listed below. For the specialization Science, Business and Policy a maximum of 10 ECTS may be chosen from the option groups in the table above or from the Capita Selecta Courses, listed below. For both specialisations, though, no more than three Capita Selecta Courses may be selected.

**Optional Courses in Quantum Universe: Instrumentation and Informatics**

Course unit	ECTS	Practical	Entry Requirements
<b>Yearly courses</b>			
Advanced Detection Techniques	5		
Advanced Instrumentation and Extreme Environments	5		
Applied Optics	5		
Systems Engineering	5		
Opto-mechatronics	5		
Basic Detection Techniques	5	X	
Control Engineering	5	X	
Device Physics	5		
Imaging Techniques in Radiology 1	5		
La Palma Observation Trip	5	X	
Mechatronics	5		
Numerical Mathematics 2	5	X	
Principles of Measurement Systems	5		
Robotics	5	X	
Statistical Signal Processing	5		
Instrumentation related physics courses on approval of the board of examiners		See app. III or IV of the corresponding programme	See app. III or IV of the corresponding programme

For the specialization Instrumentation & Informatics a maximum of 20 ECTS may be chosen from the option groups in the table above or from the Capita Selecta Courses, listed below. Though no more than three Capita Selecta Courses may be selected.



### Optional Courses in Quantum Universe: Data Science

Course unit	ECTS	Practical	Entry Requirements
<b>Yearly courses</b>			
Contemporary Statistics with Applications	5	X	
Gravitational Waves	5		
Image Processing	5	X	
Information Systems	5	X	
La Palma Observation Trip	5	X	
Machine learning	5	X	
Modelling and Simulation	5	X	
Neural Networks and Computational Intelligence	5	X	
Pattern Recognition	5	X	
Robotics for AI	5	X	
Scalable Computing	5	X	
Scientific Visualization	5	X	
Software Maintenance & Evolution	5	X	
Statistical Signal Processing	5		
Systems Engineering	5	X	
Web and Cloud Computing	5	X	
<b>Biennial courses, offered in 2019-2020</b>			
Basic Detection Techniques	5	X	
<b>Biennial courses, offered in 2020-2021</b>			
Active Galaxies and AGN	5		
Astronomical Data Science	5	X	
Interferometry	5		

For the specialization Data Science & Systems Complexity a maximum of 10 ECTS may be chosen from the option groups in the table above or from the Capita Selecta Courses, listed below. Though no more than three Capita Selecta Courses may be selected.

### Capita Selecta Courses

Course unit	ECTS	Practical	Entry Requirements
<b>Biennial courses, offered in 2019-2020</b>			
Cosmic Star Formation History	3		
Cosmic Web	3		
Stellar Populations in Galaxies	3		
Exoplanets	3		
<b>Biennial courses, offered in 2020-2021*</b>			
Dwarf Galaxies	3		
Gas Flows in Galaxies	3		
History of Modern Astronomy	3		
Project management	3		

\* The capita selecta courses for 2020/2021 are not guaranteed. Courses are decided on short notice by the degree programme.





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## **Appendix V Entry requirements and compulsory order of examinations (art. 4.4)**

For students admitted to the programme there is no compulsory order in modules. Entry requirements for the individual Modules are listed in App. III and App. IV.



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## **Appendix VI Admission to the degree programme and different tracks/specializations (art. 2.1.1 + art. 2.2)**

Holders of the following Bachelor's degrees from the University of Groningen are considered to have sufficient knowledge and skills and will be admitted to the Master's degree programme in Astronomy on that basis:

- BSc Astronomy



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## **Appendix VII Transitional provisions (art. 7.1)**

There are no transitional provisions for Astronomy students.



## Appendix VIII

### Application and decision deadlines for admission (art. 2.6.1 and 2.6.3)

#### Programmes starting on 1 September 2020

Programme	Deadline of Application	Deadline of decision
Behavioural and Cognitive Neurosciences	1 May 2020	1 June 2020
Biology	1 May 2020	1 June 2020
Biomedical Engineering	1 May 2020	1 June 2020
Biomedical Sciences	1 May 2020	1 June 2020
Biomolecular Sciences	1 May 2020	1 June 2020
Ecology and Evolution	1 May 2020	1 June 2020
Energy and Environmental Sciences	1 May 2020	1 June 2020
Human-Machine Communication	1 May 2020	1 June 2020
Marine Biology	1 May 2020	1 June 2020
Mechanical Engineering	1 May 2020	1 June 2020
Medical Pharmaceutical Sciences	1 May 2020	1 June 2020
Nanoscience: for non-EU/EEA students	1 February 2020	1 June 2020
Nanoscience: for EU/EEA students	1 May 2020	1 June 2020
Science Education and Communication	1 May 2020	1 June 2020

#### Programmes starting on 1 September 2020 and 1 February 2021

Programme	Deadline of Application for 1 September	Deadline of decision for 1 September	Deadline of Application for 1 February	Deadline of decision for 1 February
Applied Mathematics	1 May 2020	1 June 2020	15 October 2020	15 November 2020
Applied Physics	1 May 2020	1 June 2020	15 October 2020	15 November 2020
Artificial Intelligence	1 May 2020	1 June 2020	15 October 2020	15 November 2020
Astronomy	1 May 2020	1 June 2020	15 October 2020	15 November 2020
Chemical Engineering	1 May 2020	1 June 2020	15 October 2020	15 November 2020
Chemistry	1 May 2020	1 June 2020	15 October 2020	15 November 2020
Computing Science	1 May 2020	1 June 2020	15 October 2020	15 November 2020
Farmacie	1 May 2020	1 June 2020	15 October 2020	15 November 2020
Industrial Engineering and Management	1 May 2020	1 June 2020	15 October 2020	15 November 2020
Mathematics	1 May 2020	1 June 2020	15 October 2020	15 November 2020
Physics	1 May 2020	1 June 2020	15 October 2020	15 November 2020