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

**2022-2023**

## **Master's degree programme in Astronomy**

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- I. Learning outcomes
- II. Tracks/specializations
- III. Content of the degree programme
- IV. Electives
- V. Entry requirements and compulsory order
- VI. Admission to the degree programme
- VII. Transitional provisions
- VIII. Additional Requirements Open degree Programmes
- IX. Application deadlines



## 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 acquired specific knowledge and mathematical, experimental, and computer skills to solve astronomy problems in the relevant subject area, as well as 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. Assessment

- 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 assessing personal 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 the 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 the main subject area, therefore and thereby gaining new knowledge and skills.



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## **Appendix II Tracks of the degree programme (art. 3.6)**

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 specializations exist:
  - Theoretical and Observational Astronomy
  - Instrumentation and Informatics
  - Data Science



### Appendix III Content of the degree programme (art. 3.8)

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 (course code)	ECTS	Practical	Entry Requirements
Astronomy colloquium (WMAS001-00)	-		
Electrodynamics of Radiation Processes (WMAS008-05)	5		
General Relativity (WMPH009-05)	5		
Particle Physics Phenomenology (WMPH026-05)	5		
Student seminar Quantum Universe (WMPH039-05)	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 (WMAS901-60)	60	X	

#### Quantum Universe: Instrumentation and Informatics

Course unit (course code)	ECTS	Practical	Entry Requirements
Astronomy colloquium (WMAS001-00)	-		
Electrodynamics of Radiation Processes (WMAS008-05)	5		
General Relativity (WMPH009-05)	5		
Particle Physics Phenomenology (WMPH026-05)	5		
Student seminar Quantum Universe (WMPH039-05)	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 (WMPH004-20)	20	X	
Master Research Project Astronomy (WMAS902-40)	40	X	

#### Quantum Universe: Data Science

Course unit (course code)	ECTS	Practical	Entry Requirements
Astronomy colloquium (WMAS001-00)	-		
Electrodynamics of Radiation Processes (WMAS008-05)	5		
General Relativity (WMPH009-05)	5		
Introduction to Data Science (WMCS002-05)	5	X	
Particle Physics Phenomenology (WMPH026-05)	5		
Statistical Signal Processing (WMAS011-05)	5		
Student seminar Quantum Universe (WMPH039-05)	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 (WMAS901-60)	60	X	



**Science, Business and Policy**

Course unit (course code)	ECTS	Practical	Entry Requirements
Astronomy colloquium (WMAS001-00)	-		
Introduction Science and Business (WMSE001-10)	10		
Introduction Science and Policy (WMSE002-10)	10		
Master Research Project Astronomy (WMAS902-30)	30	X	
Work placement Business & Policy (WMSE902-40)	40	X	
Choice * - Astrophysics Core Courses - Quantum Universe Core Courses † - Optional Courses in Theoretical and Observational Astronomy	30	see app. IV see app. III see app. IV	see app. IV see app. III see app. IV

\* Courses with credits adding up to 30 ECTS must be selected.

† Quantum Universe Core Courses are: Electrodynamics of Radiation Processes, General Relativity, Particle Physics Phenomenology, Student seminar Quantum Universe.



## Appendix IV Electives (art. 3.9.1)

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 (course code)	ECTS	Practical	Entry Requirements
Formation and Evolution of Galaxies (WMAS005-05)	5	X	
<b>Biennial courses, offered in 2022-2023</b>			
Cosmic Structure Formation (WMAS004-05)	5		
Star and Planet Formation (WMAS017-05)	5		
High-Energy Astrophysics (WMAS006-05)	5	X	
<b>Biennial courses, offered in 2023-2024</b>			
Astrochemistry (WMAS018-05)	5		
Dynamics of Galaxies (WMAS014-05)	5		
Stars, Nucleosynthesis and Chemical Evolution (WMAS010-05)	5		

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

Course unit (course code)	ECTS	Practical	Entry Requirements
Applied Optics (WMME010-05)	5		
Basic Detection Techniques (WMAS002-05)	5	X	
Computational Physics (WMPH007-05)	5	X	
Elementary Particle Physics (WMPH034-05)	5		
Fundamental Constants (WMPH008-05)	5		
Introduction to Plasma Physics (WMPH035-05)	5		
La Palma Observation Trip (WMAS012-05)	5	X	
Lie Groups in Physics (WMPH011-05)	5		
Mathematical Methods of Physics (WMPH016-05)	5		
Nuclear Astrophysics (WMPH038-05)	5		
Quantum Experiments (WMPH017-05)	5		
Quantum Field Theory (WMPH018-05)	5		
Statistical Methods in Physics (WMPH030-05)	5		
Statistical Signal Processing (WMAS011-05)	5		
Basiscursus Master Lerarenopleiding (TEM0105)	5		
Masterstage 1 (TEM0205)	5	X	
Astronomical Data Science (WMAS007-05)	5	X	
<b>Biennial courses, offered in 2022-2023</b>			
Active Galaxies and AGN (WMAS022-05)	5		
Geometry & Differential Equations (WMMA017-05)	5		
Gravitational Waves (WMPH022-05)	5		
<b>Biennial courses, offered in 2023-2024</b>			
Geometry and Topology (WMMA018-05)	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 (course code)	ECTS	Practical	Entry Requirements
Advanced Detection Techniques (WMME005-05)	5		
Advanced Instrumentation and Extreme Environments (WMME006-05)	5		
Applied Optics (WMME010-05)	5		
Systems Engineering (WMIE021-05)	5		
Opto-mechatronics (WMME015-05)	5		
Basic Detection Techniques (WMAS002-05)	5	X	
Control Engineering (WBIE034-05)	5	X	
Device Physics (WBPH037-05)	5		
Imaging Techniques in Radiology 1 (WBBE012-05)	5		
La Palma Observation Trip (WMAS012-05)	5	X	
Mechatronics (WBIE011-05)	5		
Numerical Mathematics 2 (WBMA023-05)	5	X	
Robotics (WMIE005-05)	5	X	
Scientific Visualization (WMCS018-05)	5	X	
Statistical Signal Processing (WMAS011-05)	5		
Basiscursus Master Lerarenopleiding (TEM0105)	5		
Masterstage 1 (TEM0205)	5	X	
Astronomical Data Science (WMAS007-05)	5	X	
<b>Biennial courses, offered in 2022-2023</b>			
Active Galaxies and AGN (WMAS022-05)	5		
Gravitational Waves (WMPH022-05)	5		

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 (course code)	ECTS	Practical	Entry Requirements
Image Processing (WMCS008-05)	5	X	
Information Systems (WMCS009-05)	5	X	
La Palma Observation Trip (WMAS012-05)	5	X	
Machine learning (WMAI010-05)	5	X	
Modelling and Simulation (WMCS003-05)	5	X	
Neural Networks and Computational Intelligence (WMCS010-05)	5	X	
Pattern Recognition (WMCS011-05)	5	X	
Robotics for AI (WMAI011-05)	5	X	
Scalable Computing (WMCS017-05)	5	X	
Scientific Visualization (WMCS018-05)	5	X	
Software Maintenance & Evolution (WMCS013-05)	5	X	
Statistical Signal Processing (WMAS011-05)	5		
Systems Engineering (WMIE021-05)	5	X	
Web and Cloud Computing (WMCS005-05)	5	X	
Basic Detection Techniques (WMAS002-05)	5	X	
Basiscursus Master Lerarenopleiding (TEM0105)	5		
Masterstage 1 (TEM0205)	5	X	
Astronomical Data Science (WMAS007-05)	5	X	
<b>Biennial courses, offered in 2022-2023</b>			
Active Galaxies and AGN (WMAS022-05)	5		
Gravitational Waves (WMPHO22-05)	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 (course code)	ECTS	Practical	Entry Requirements
<b>offered in 2022-2023</b>			
Gas Flows in Galaxies (WMAS021-03)	3		
HI in Galaxies (WMAS009-03)	3		
Interferometry (WMAS015-03)	3		
Dwarf Galaxies (WMAS020-03)	3		

The capita selecta courses for 2023/2024 are not yet known. Courses are not decided on by the degree programme this far in advance.





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

For students admitted to the degree programme the conditional entry requirements for individual modules and order of examinations are listed in Ocasys.

## **Appendix VI Admission to the degree programme and different tracks (art. 2.1A.1 + 2.1B.1)**

Graduates with a degree from one of the following degree programmes and universities 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, University of Groningen
- BSc Astronomy, Leiden University
- BSc Physics & Astronomy, University of Amsterdam/Vrije Universiteit Amsterdam
- BSc Physics & Astronomy, Radboud University

Students with a background in a physics or related bachelor's degree programme and interested in pursuing a master's degree programme in Astronomy are encouraged to apply through the Admissions Office of the Faculty of Science and Engineering. The Board of Admissions of Astronomy will then assess the application and decides whether the applicant has sufficient background to register for the programme, possibly after following a bridging pre-master's programme.

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

There are no transitional provisions for Astronomy students.

## **Appendix VIII Additional Requirements Open degree Programmes (Art. 3.10)**

Students wishing to pursue an open degree programme may file a request with the Board of Examiners of Astronomy. The Board of Examiners will evaluate whether the proposed curriculum meets the learning outcomes of the degree programme.



## Appendix IX Admission

### Application and decision deadlines for admission (art. 2.7.1 and 2.7.3)

#### Programmes starting on 1 September 2022

Programme	Deadline of Application	Deadline of decision
Behavioural and Cognitive Neurosciences	1 May 2022	1 June 2022
Biology	1 May 2022	1 June 2022
Biomedical Engineering	1 May 2022	1 June 2022
Biomedical Sciences	1 May 2022	1 June 2022
Biomolecular Sciences	1 May 2022	1 June 2022
Ecology and Evolution	1 May 2022	1 June 2022
Energy and Environmental Sciences	1 May 2022	1 June 2022
Human-Machine Communication	1 May 2022	1 June 2022
Marine Biology	1 May 2022	1 June 2022
Mechanical Engineering	1 May 2022	1 June 2022
Medical Pharmaceutical Sciences	1 May 2022	1 June 2022
Nanoscience: for non-EU/EEA students	1 February 2022	1 June 2022
Nanoscience: for EU/EEA students	1 May 2022	1 June 2022
Science Education and Communication	1 May 2022	1 June 2022

#### Programmes starting on 1 September 2022 and 1 February 2023

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 2022	1 June 2022	15 October 2022	15 November 2022
Applied Physics	1 May 2022	1 June 2022	15 October 2022	15 November 2022
Artificial Intelligence	1 May 2022	1 June 2022	15 October 2022	15 November 2022
Astronomy	1 May 2022	1 June 2022	15 October 2022	15 November 2022
Chemical Engineering	1 May 2022	1 June 2022	15 October 2022	15 November 2022
Chemistry	1 May 2022	1 June 2022	15 October 2022	15 November 2022
Computing Science	1 May 2022	1 June 2022	15 October 2022	15 November 2022
Farmacie	1 May 2022	1 June 2022	15 October 2022	15 November 2022
Industrial Engineering and Management	1 May 2022	1 June 2022	15 October 2022	15 November 2022
Mathematics	1 May 2022	1 June 2022	15 October 2022	15 November 2022
Physics	1 May 2022	1 June 2022	15 October 2022	15 November 2022