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**Appendices for the Master's degree programme(s) in
 Astronomy**



Appendix I Teaching outcomes of the degree programme (art. 1.3)

The master graduate in Astronomy...

1. Knowledge, skills, and insight
 - 1.1 The MSc masters the fundamental astronomical and astrophysical concepts as well as the necessary tools from physics, mathematics and computer science including modeling skills. The level of these skills permits admission to PhD studies
 - 1.2 The MSc is familiar with the quantitative character of astronomy and astrophysics, and with the relevant research methods
 - 1.3
 - The MSc who has completed the Astronomy track has operational knowledge in an observational or theoretical astronomical or astrophysical subarea and knowledge of the state-of-the-art in at least one specific research area
 - The MSc who has completed the Instrumentation and Informatics track has operational knowledge in the area of instrumentation and information technology in astronomy, physics, and/or space research and knowledge of the state-of-the-art in at least one specific research area
 - The MSc who has completed the Business 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
 - The MSc who has completed the Data Science and Systems Complexity track has operational knowledge of and insight into Data Science and Systems Complexity in astronomy and knowledge of the state-of-the-art in at least one specific research area
2. Application of knowledge and skills
 - 2.1 The MSc is capable to carry out research, aimed at understanding of astronomical phenomena, both observational and theoretical
 - 2.2 The MSc is capable to analyse a (new) complex astrophysical problem, and data develop a structured and well-planned research/modelling approach
 - 2.3 The MSc is capable to apply his/her specific knowledge and skills in his/her own and related subject areas
 - 2.4 The MSc is capable to collaborate in a (multi-disciplinary) team and has basic skills to manage a (collaborative) project
3. Judgment
 - 3.1 The MSc is capable to obtain relevant information using modern information channels, and to interpret this information critically in the context of an absolute standard
 - 3.2 The MSc is capable to judge his/her and others' actions within a scientific context, taking societal and ethical aspects into account
 - 3.3 The MSc is able to draw conclusions on the basis of limited or incomplete information, and is able to realize and formulate the limitations of such conclusions
 - 3.4 The MSc is acting and conducting research according to the VSNU Code of Conduct for Academic Practice
4. Communication skills

The MSc is capable to communicate clearly, 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



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5. Learning skills
The MSc is capable to also address issues outside his/her main subject area, therefore and thereby gaining new knowledge and skills



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Appendix II Tracks of the degree programme (art. 2.2)

The degree programme has the following specializations:

- Theoretical and Observational Astronomy (Quantum Universe)
- Instrumentation and Informatics
- Data Science and Systems Complexity
- Science, Business and Policy



Appendix III Content of the degree programme (art. 2.3)

Specialization Theoretical and Observational Astronomy (Quantum Universe)

Course unit	ECTS	Practical	Entry Requirements
General Relativity	5		
Electrodynamics of Radiation Processes	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 (Quantum Universe)	20	see app. IV	see app. IV
Astronomy colloquium	-		
Master Research Project Astronomy	60	X	

The assessment method of the courses can be found in the assessment plan of the degree programme and on Ocasys

Specialization Instrumentation and Informatics

Course unit	ECTS	Practical	Entry Requirements
General Relativity	5		
Electrodynamics of Radiation Processes	5		
Particle Physics Phenomenology	5		
Student seminar Quantum Universe	5		
Project Information Technology	10	X	
Optional courses in Instrumentation and Informatics	30	see app. IV	see app. IV
Internship in Industry	20	X	
Astronomy colloquium	-		
Master Research Project Astronomy	40	X	

The assessment method of the courses can be found in the assessment plan of the degree programme and on Ocasys

Specialization Science, Business and Policy

Course unit	ECTS	Practical	Entry Requirements
Astrophysics Core Courses	20	see app. IV	see app. IV
Optional Courses in Theoretical and Observational Astronomy (Quantum Universe)	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	

The assessment method of the courses can be found in the assessment plan of the degree programme and on Ocasys



Specialization Data Science & Systems Complexity

Course unit	ECTS	Practical	Entry Requirements
General Relativity	5		
Electrodynamics of Radiation Processes	5		
Particle Physics Phenomenology	5		
Student seminar Quantum Universe	5		
Introduction to Data Science	5	X	
Optional Courses in Astronomy for DSSC	20	see app. IV	see app. IV
Optional Courses in Data Science	15	see app. IV	see app. IV
Astronomy colloquium	-		
Master Research Project Astronomy	60	X	

The assessment method of the courses can be found in the assessment plan of the degree programme and on Ocasys



Appendix IV Electives (art. 2.4)

Astrophysics Core Courses

Course unit	ECTS	Practical	Entry Requirements
Yearly courses			
Formation and Evolution of Galaxies	5		
Biennial courses, offered in 2017-2018			
High-Energy Astrophysics	5	X	
Dynamics of Galaxies	5		
Biennial courses, offered in 2018-2019			
Stellar Structure and Evolution	5		
Cosmic Structure Formation	5		
Star and Planet Formation	5		

The assessment method of the courses can be found in the assessment plan of the degree programme and on Ocasys

Optional Courses in Theoretical and Observational Astronomy (Quantum Universe)

Course unit	ECTS	Practical	Entry Requirements
Yearly courses			
Statistical Signal Processing	5		
Inter Academy Course	5		
Biennial courses, offered in 2017-2018			
Basic Detection Techniques	5	X	
Space Mission Technology	5		
Geometry and Topology	5		
Biennial courses, offered in 2016-2017			
Interferometry	5		
Geometry & Differential Equations	5		
Astronomical Data Science	5	X	
Quantum Universe Courses			
Computational Physics	5	X	
Fundamental Constants	5		
Lie Groups in Physics	5		
Quantum Field Theory	5		
Big Experiments	5		
Statistical Methods in Physics	5		
Elementary Particle Physics	5		
Introduction to Plasma Physics	5		
Mathematical Methods of Physics	5		

The assessment method of the courses can be found in the assessment plan of the degree programme and on Ocasys

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 Instrumentation and Informatics

Course unit	ECTS	Practical	Entry Requirements
Yearly courses			
Inter Academy Course	5		
Formation and Evolution of Galaxies	5		
Control Engineering	5	X	
Robotics	5	X	
Imaging Techniques in Radiology 1	5		
Mechatronics	5		
Principles of Measurement Systems	5		
Scientific visualization	5	X	
Statistical Signal Processing	5		
Device Physics	5		
Numerical Mathematics 2	5	X	
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
Biennial courses, offered in 2017-2018			
Basic Detection Techniques	5	X	
Space Mission Technology	5		
High-Energy Astrophysics	5	X	
Dynamics of Galaxies	5		
Biennial courses, offered in 2018-2019			
Interferometry	5		
Astronomical Data Science	5	X	
Stellar Structure and Evolution	5		
Cosmic Structure Formation	5		
Star and Planet Formation	5		

The assessment method of the courses can be found in the assessment plan of the degree programme and on Ocasys

For the specialization Instrumentation & Informatics a maximum of 30 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 Astronomy for DSSC

Course unit	ECTS	Practical	Entry Requirements
Yearly courses			
Formation and Evolution of Galaxies	5		
Inter Academy Course	5		
Biennial courses, offered in 2016-2017			
Stellar Structure and Evolution	5		
Cosmic Structure Formation	5		
Star and Planet Formation	5		
Biennial courses, offered in 2017-2018			
High-Energy Astrophysics	5	X	
Dynamics of Galaxies	5		

The assessment method of the courses can be found in the assessment plan of the degree programme and on Ocasys

Optional Courses in Data Science

Course unit	ECTS	Practical	Entry Requirements
Yearly courses			
Statistical Signal Processing	5		
Web and Cloud Computing	5	X	
Pattern Recognition	5	X	
Software Maintenance & Evolution	5	X	
Modelling and Simulation	5	X	
Image Processing	5	X	
Neural Networks and Computational Intelligence	5	X	
Contemporary Statistics with Applications	5	X	
Machine learning	5	X	
Robotics for AI	5	X	
Scalable Computing	5	X	
Information Systems	5	X	
Scientific Visualization	5	X	
Systems Engineering	5	X	
Biennial courses, offered in 2016-2017			
Interferometry	5		
Astronomical Data Science	5	X	
Biennial courses, offered in 2017-2018			
Basic Detection Techniques	5	X	
Space Mission Technology	5		

The assessment method of the courses can be found in the assessment plan of the degree programme and on Ocasys

For the specialization Data Science & Systems Complexity a maximum of 15 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
<i>Yearly courses</i>			
La Palma Observation Trip	5	X	
<i>Biennial courses, offered in 2016-2017</i>			
Gravitational Lensing	3		
HI in the Universe	3		
Project management	3		
Stellar Populations in Galaxies	3		
Exoplanets	3		
<i>Biennial courses, offered in 2017-2018*</i>			
Cosmic Star Formation History	3		
Cosmic Web	3		
AGN	3		
Milky Way	3		
Astrochemistry	5		
HI in the Galaxy	3		

The assessment method of the courses can be found in the assessment plan of the degree programme and on Ocasys

* The capita selecta courses for 2017/2018 are not guaranteed. The courses are decided on short notice by the teacher



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Appendix V Entry requirements and compulsory order of examinations (art. 3.4)

For students admitted to the programme there are no entry requirements for the individual Modules.



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Appendix VI Admission to the degree programme and different tracks/specializations (art. 5.1.1 + art. 5.2)

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 Physics students.



Appendix VIII

Application deadlines for admission (art. 5.6.1)

Deadline of Application	Non-EU students	EU students
Astronomy	May 1st 2018	May 1st 2018

Decision deadlines (art. 4.6.3)

Deadline of Decision	Non-EU students	EU students
Astronomy	November 1st 2018	November 1st 2018