

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

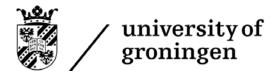
2. Application of knowledge and skills

- 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/modeling 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

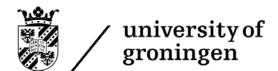


faculty of mathematics

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

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



faculty of mathematics

Appendix II Specializations 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 | 20 | see app. IV | see app. IV |
| Astronomy (Quantum Universe) | | | |
| 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 | 10 | see app. IV | see app. IV |
| Astronomy (Quantum Universe) | | | |
| 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 co | ourses, offered in 2 | 2016-2017 | |
| Stellar Structure and Evolution | 5 | | |
| Cosmic Structure Formation | 5 | | |
| Star and Planet Formation | 5 | | |
| | | | |
| Biennial co | ourses, offered in 2 | 2017-2018 | |
| High-Energy Astrophysics | 5 | X | |
| Dynamics of Galaxies | 5 | | |

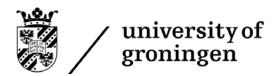
The assessment method of the courses can be found in the assessment plan of the degree programme and on Ocasys

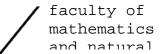
Optional Courses in Theoretical and Observational Astronomy

| Course unit | ECTS | Practical | Entry Requirements |
|-----------------------------------|-----------------------|-----------|---------------------------|
| | Yearly courses | | J 111 |
| Statistical Signal Processing | 5 | | |
| Inter Academy Course | 5 | | |
| Biennial | courses, offered in 2 | 2016-2017 | |
| Interferometry | 5 | | |
| Geometry & Differential Equations | 5 | | |
| Astronomical Data Science | 5 | X | |
| Biennial | courses, offered in 2 | 2017-2018 | |
| Basic Detection Techniques | 5 | X | |
| Space Mission Technology | 5 | | |
| Geometry and Topology | 5 | | |
| Qua | antum Universe Cou | rses | |
| 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

| rse unit | | Practical | Entry Requirements | | |
|---|-------------|--|---|--|--|
| Yearly courses | | | | | |
| Academy Course | 5 | | | | |
| ation and Evolution of Galaxies | 5 | | | | |
| rol Engineering | 5 | X | | | |
| tics | 5 | X | | | |
| ing Techniques in Radiology 1 | 5 | | | | |
| atronics | 5 | | | | |
| iples of Measurement Systems | 5 | | | | |
| tific visualization | 5 | Х | | | |
| tical Signal Processing | 5 | | | | |
| e Physics | 5 | | | | |
| erical Mathematics 2 | 5 | X | | | |
| amentation related physics courses on approval of the l of examiners | | See app. III or IV of the corresponding programme | See app. III or IV of the corresponding programme | | |
| Biennial courses, o | ffered in 2 | 2016-2017 | | | |
| ferometry | 5 | | | | |
| nomical Data Science | 5 | X | | | |
| r Structure and Evolution | 5 | | | | |
| ic Structure Formation | 5 | | | | |
| and Planet Formation | 5 | | | | |
| Biennial courses, o | ffered in 2 | 2017-2018 | | | |
| Detection Techniques | 5 | X | | | |
| e Mission Technology | 5 | | | | |
| Energy Astrophysics | 5 | X | | | |
| mics of Galaxies | 5 | | | | |
| Detection Techniques Mission Technology Energy Astrophysics | 5 5 5 | X | | | |

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 co | ourses, offered in 2 | 2016-2017 | | | |
| Stellar Structure and Evolution | 5 | | | | |
| Cosmic Structure Formation | 5 | | | | |
| Star and Planet Formation | 5 | | | | |
| | | | | | |
| Biennial co | ourses, offered in 2 | 2017-2018 | | | |
| High-Energy Astrophysics | 5 | X | | | |
| Dynamics of Galaxies | 5 | | | | |

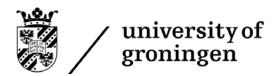
The assessment method of the courses can be found in the assessment plan of the degree programme and on Ocasys

Ontional Courses in Data Science

| Course unit | ECTS | Practical | Entry Requirements |
|--|------------------|-----------|---------------------------|
| Yea | rly courses | | <u> </u> |
| 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 course | es, offered in 2 | 2016-2017 | |
| Interferometry | 5 | | |
| Astronomical Data Science | 5 | X | |
| Biennial course | es, offered in 2 | 2017-2018 | |
| Basic Detection Techniques | 5 | Х | |
| 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.



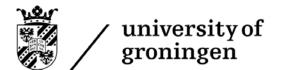
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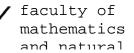
Capita Selecta Courses

| Course unit | ECTS | Practical | Entry Requirements |
|---------------------------------|--------------------------|------------|--------------------|
| | Yearly courses | | · · · · · · |
| La Palma Observation Trip | 3 | X | |
| Biennia | al courses, offered in 2 | 2016-2017 | |
| Gravitational Lensing | 3 | | |
| HI in the Universe | 3 | | |
| Project management | 3 | | |
| Stellar Populations in Galaxies | 3 | | |
| Exoplanets | 3 | | |
| Biennia | l courses, offered in 2 | 2017-2018* | |
| Cosmic Star Formation History | 3 | | |
| Cosmic Web | 3 | | |
| AGN | 3 | | |
| Milky Way | 3 | | |
| Astrochemistry | 3 | | |
| 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





Appendix V Entry requirements and compulsory order of examinations (art. 3.2)

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

Appendix VI Admission to the degree programme and different specializations (art. 4.1.1 + art. 4.2)

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

Appendix VII

Application deadlines for admission (art. 5.6.1)

| Deadline of Application | Non-EU | EU students |
|--|-------------------|---------------|
| | students | |
| Nanoscience | February 1st 2017 | May 1 st 2017 |
| Behavioural and Cognitive Neurosciences | May 1st 2017 | May 1st 2017 |
| Biomolecular Sciences (topprogramme) | May 1st 2017 | May 1st 2017 |
| Evolutionary Biology (topprogramme) | May 1st 2017 | May 1st 2017 |
| Remaining FMNS Masters | May 1st 2017 | May 1st 2017 |

Decision deadlines (art. 5.6.3)

| Deadline of Decision | Non-EU | EU students |
|---|-------------------|-------------------|
| | students | |
| Nanoscience | June 1st 2017 | June 1st 2017 |
| Behavioural and Cognitive Neurosciences | June 1st 2017 | June 1st 2017 |
| Biomolecular Sciences (topprogramme) | June 1st 2017 | June 1st 2017 |
| Evolutionary Biology (topprogramme) | June 1st 2017 | June 1st 2017 |
| Remaining FMNS Masters | November 1st 2017 | November 1st 2017 |