Astronomy within the Physics Bachelor's and Master's programmes at Heidelberg University

A guide and suggestions for students

(Last update: June 7, 2022)

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The Astronomy programme at Heidelberg University

We are pleased that you are interested in astronomy as part of your studies in physics at Heidelberg University. This study plan is designed to help you find the path that works best for you. The guidelines were prepared on the basis of the examination regulations and module manuals of the Faculty of Physics and Astronomy, which contain all legally binding regulations.

Heidelberg – a centre of excellence in astronomy

Heidelberg offers you ideal conditions for an excellent physics and astronomy education. The city is home to one of the few major centers of astronomical research and teaching in Germany, the **Center for Astronomy of Heidelberg University (ZAH)**. The ZAH is made up of **the Astronomische Rechen-Institut (ARI)**, the **Institut für Theoretische Astrophysik (ITA)**, and the **Landessternwarte Königstuhl (LSW)**. Also the **Max Planck Institute for Astronomy (MPIA)** and **Max Planck Institute für Nuclear Physics (MPIK)** as well as the **Heidelberg Institute for Theoretical Studies (HITS)** are primarily research institutes. The mission of the **Haus of Astronomy (HdA)** is public outreach, teacher training, and promoting exchange between scientists. Other institutes within the university are also involved - directly or indirectly - in fundamental astronomical research. These include the **Institute for Theoretical Physics (ITP)**, which among other things studies dark energy or gravity theories, the **Physikalisches Institut (PI)**, and the **Kirchhoff Institut für Physik (KIP)**, where the fundamental building blocks of the universe are studied. Together, these institutes make Heidelberg a lively, diverse, and dynamic place to learn astronomy, and for prospective astronomers to start their career.

Astronomy within the physics curriculum

Astronomers need a thorough grounding in astronomy, so the road to a successful education in astronomy takes you through physics. The physics BA-degree programme in Heidelberg generally start in the winter term, the MA-degree programme in the winter and summer term. Students are selected based on their application, which must be received around **15 July for the winter term** and around **January 15 for the summer term**. A full list of dates and complete information about the application procedure can be found on the website of the Faculty for Physics and Astronomy (see below).

Astronomy is the science of the physical principles and the origin of the universe as a whole. To achieve this, we observe the universe using not only the entire electromagnetic spectrum but also cosmic rays, neutrinos, and gravitational waves. To interpret these data scientifically, astronomy makes use of practically all areas of physics, including classical mechanics, nuclear physics, quantum mechanics, electromagnetism, thermodynamics, hydrodynamics, and relativity. Astronomy can only be practiced, therefore, with a thorough knowledge of physics. For this reason, astronomy is part of the physics curriculum, rather than a separate discipline. The modular Bachelor's and Master's programmes at Heidelberg University allow students to include astronomy to varying degrees of depth, and already in the early stages of their studies.

Prerequisites for a successful physics degree

As an essential prerequisite, you should have a deep interest in physical phenomena and problems as well as good mathematical skills. Knowledge of the computer and the English language is also useful. This knowledge is developed during the course of study and helps

you to understand the predominantly English-language specialist literature, which you must study at the latest in your research phase. In addition, all courses in the Master's programme are offered in English. The Department of Physics and Astronomy carries out an aptitude assessment procedure. This should enable you to assess whether this course of study is suitable for you. In case of doubt, we recommend that you consult the student advisory service of **the Department of Physics and Astronomy** (see below). Valuable information and assistance is also offered by the Student Council for Mathematics, Physics and Computer Science at Heidelberg University.

Main phases of studying physics/astronomy

- The main goal of the **six-semester Physics Bachelor's programme (B.Sc.)** is to learn the fundamental concepts of all areas of physics. Breadth rather than depth is the goal, although one can already **choose astronomy as a core subject**. In the 3rd and 4th semesters, you will attend the astronomical introductory lectures and the astrophysical laboratory courses. Following this basic training, you can choose advanced modules that expand your competencies in astronomy observational methods, stellar astronomy and astrophysics, extragalactic astrophysics and cosmology, numerical methods and statistical procedures, and astronomical research using computer simulations. In addition, practical training components, special lectures, seminars on topics from current research and, if necessary, an astronomical or astrophysical bachelor thesis round off your training.

- In the **four-semester Physics Master's programme (M.Sc.)** you specialize in particular areas of astronomy or physics, which also form the basis for the required Master's thesis. The Master's programme gives students the opportunity to study astronomy in depth before going on to do other things professionally, but it is also an essential step towards a research career.

- Those who achieve a good grade in their M.Sc. may apply to do a **PhD in astronomy**. The main component of any PhD programme is original and independent research. This can be done at one of the astronomical institutes within the university, or at one of the non-university research institutes already mentioned. In all cases, students are enrolled into the **PhD programme of the Department of Physics and Astronomy** of Heidelberg University, from which students receive their degrees.

The Physics Bachelor's programme

The Bachelor's degree program "Physics" can be carried out with a **subject share of 100% or 50%**. In the latter case, this proportion corresponds to the study opportunity within the framework of the **teacher training** option. Details on this form of Heidelberg physics studies can be found on the homepage of the Department of Physics and Astronomy in the so-called module plan of the Bachelor's degree program (see also web links at the end of this document).

The following explanations refer only to the 100 percent degree program.

The standard period of study for the Bachelor's degree programme is six semesters, including the examination times. During this period, you must complete a total of **180 credit points[1] (CPs)** for a successful completion of your studies.

The Bachelor's programme is divided into three **study blocks**, each study block in turn into **study modules**. Study modules can be different types of courses, e.g. lectures, seminars, internships, exercises or combinations of such courses. Each study module has an abbreviation, e.g. PEP1 for "Experimental Physics I", and is completed by an examination. The division of your study into study blocks makes it possible to take astronomical modules exactly when they fit into the course of study and your personal planning.

The study modules to be completed as part of the Bachelor's programme cover three different **study blocks A, B and C**, in which a different number of credit points have to be achieved:

A: Modules in the **mandatory block ("Pflichtbereich")** "physics and mathematics" with 129 CPs **B:** Modules in the **general skills block "(Wahlpflichtbereich")** "Übergreifende Kompetenzen" with 20 CPs **C:** Modules in the **optional block ("Wahlbereich")** with 31 CPs, which includes the so-called "Pflichtbereich Physik", in which you need to obtain at least 14 CPs[2]
Requirement: A total of 180 CPs in six semesters across blocks A, B and C

You should consult the Bachelor's module handbook and the examination regulations for details of which modules are available in which block. These documents are regularly updated and are available in the internet (see the links at the end of this document). The lectures in the mandatory block are mostly held in German, although tutorial classes are sometimes offered in English too. Some of the courses in the general skills and optional blocks are offered in English. This is the case for all the courses taken from the Master's programme (which can be identified as those with module labels starting with "M...").

[1] Credit Points (CP) measure the working time required for a training module. This includes attendance, preparation and follow-up times as well as times for any homework. One credit point corresponds to a working time of 30 hours. A total working time of about 30 CP (+/- 10%) or 900 hours (+/- 10%) is expected per semester. For this purpose, the lecture-free period between semesters must also be used to a considerable extent.

[2] In the extreme case even all 31 CPs can be obtained in the general skills block.

Modules in the mandatory block "Physics and Mathematics"

In this part, you will be taught the essential basic knowledge of physics and mathematics in the context of course lectures, exercises and internships. The events mentioned in this area must be completed in any case. After the first semester, an orientation examination in the form of an exam in experimental physics will be taken (course-ID is PEP1). **In total, you must complete 129 CP in the compulsory area.** More detailed information can be found in the module handbook already mentioned, which you can view on the website of the Faculty of Physics and Astronomy.

The **compulsory area of physics** includes nine course lectures in experimental and theoretical physics, the beginner and advanced internships, a seminar, a course on presentation techniques and the bachelor's thesis in the 6th semester. In order to find a supervisor for the Bachelor's thesis, please contact one of the numerous scientific working groups, depending on your personal interest. How this works in detail is described below.

In the **compulsory area of mathematics**, the basic lecture *"Linear Algebra I"* is mandatory for all students in the Bachelor's degree program in Physics. Apart from that, you have the choice as far as the other compulsory elective modules in the field of mathematics are concerned. You can take the two courses *Higher Mathematics for Physicists II and III*, optimized for the needs of physics, which summarize the material of the lectures *"Analysis I and II"* and *"Higher Analysis"*. On the other hand, you can also complete the basic mathematics modules *"Analysis II"* and *"Higher Analysis"* together with the students of mathematics.

Compulsory elective block "Interdisciplinary Competences"

In the compulsory elective area "Interdisciplinary Competences", you are to be taught skills that are also essential in today's professional life. Heidelberg University's corresponding services cover the areas of **personal key competences, job-related key competences** and **subject-specific additional qualifications**.

In addition to the purely professional qualification, success in studies and later careers also depends on **personality-related key competences** ("Persönlichkeitsbezogene Schlüsselkompetenzen"). These include, for example, organizational skills, teamwork or presentation techniques. In the Bachelor's programme, you have the opportunity to acquire such skills.

Job-related key competences ("Berufsbezogene Schlüsselkompetenzen") include, e.g., the use of computers, the analysis of data or a good knowledge of the English language. The offers in this area are usually held within the framework of block courses, i.e. the course does not extend over a whole semester, but the content is conveyed in a concentrated manner within one or two weeks.

Subject-specific additional qualifications ("Fachspezifische Zusatzqualifikationen") can be acquired in the fields of electronics, computational physics, statistical and numerical methods or hardware informatics. The Department of Physics and Astronomy offers corresponding modules itself. In addition, offers from other faculties can also be selected here, e.g. mathematics and computer science, engineering, biology, chemistry, medicine or economics and business administration. In most cases, only a few modules or module blocks

from the basic studies of the respective subject are offered for selection. Further details are listed in the module handbook.

Already in the first semester, two central modules are offered: the basic course "Key Competences for Sustainable Studies" (*„Schlüsselkompetenzen für ein nachhaltiges Studium")* and the "Mathematical Preliminary Course" ("*Mathematischer Vorkurs")*. Both courses start at the end of September about three weeks before the start of the lecture period. Participation in the mathematical preliminary course is not mandatory, but is strongly recommended. Please note that for many elective (compulsory) courses offered within the framework of the three areas of competence, the number of participants is usually limited and there is no entitlement to participation. In addition, you must prove a total of at least 20 CPs from the range of compulsory elective modules "Interdisciplinary Competences"[3].

Optional block

This block gives you the opportunity to deepen your knowledge in specific areas or to learn new subjects. You need to obtain **at least 31 CPs** in this block. Of these, **at least 14 CPs** must be obtained within a single area of physics of your choice, such as astronomy, theoretical physics, environmental physics, etc., which is the so-called **general skills block "Wahlpflichtbereich Physik"** requirement.

Beyond this requirement you are free to choose modules from other faculties[4], such as Mathematics and Computer Science, Biosciences, Chemistry and Earth Sciences, Medicine, or Economics and Social Sciences. Those modules which are recommended for the Physics Bachelor's programme and which are regularly on offer are listed in the **module handbook**.

Important deadlines

Be aware in particular of the following deadlines during your Bachelor's studies:

- Complete your **preliminary exam** ("Orientierungsprüfung") by the end of the third semester. This is fulfilled by (and equivalent to) successfully completing the PEP1 module.
- Register on time for the **astronomy lab course (module WPAstro)**.
- **Register for your Bachelor's project**. You have to prove 142 CPs to do so.
- If you intend to continue on to do the **Master's, apply for it** during your final semester.

More details can be found in the official regulations ("Prüfungsordnung") for the Bachelor's programme, and further information and the necessary forms can be obtained from the Departments examination secretary ("Prüfungssekretariat").

[3] You will receive a credit point on presentation techniques as part of the seminar in the compulsory area of physics (PSEM) in the fifth semester.

[4] See Appendix 5 of the official university regulations ("Prüfungsordnung") for the Bachelor's programme.

Astronomy in the Physics Bachelor's programme

Astronomy course plans

During your Bachelor's degree programme "Physics" you can study astronomy in different intensity and thematic orientation. In principle, you take advantage of the flexibility offered by the compulsory elective and optional blocks (31 CP in total, of which at least 14 CP must be completed in the compulsory elective block) of the Bachelor's programme. This results in various ways in which you can design your studies. Tables 1a-e give a tabular overview and lists the corresponding courses.

- **Introductory astronomy (Astro-GK) - Table 1a**

You decide to get to know the **basics of astronomy**, but are also interested in other areas of physics and would like to keep yourself open to continue your master's degree with a **focus on astronomy**. In this case, you will listen to **astronomy as an elective topic** and only take the basic course *"Introduction to Astronomy"* (module abbreviation WPAstro) in the optional block of your Physics studies. This course offer corresponds to a total of 10 CP. You take the basic course in the fifth and sixth semesters (see Table 1a). The *"Astrophysical Lab part I"*, which is part of the WPAstro module, should be taken in the winter semester in February/March. You can also start the basic course WPAstro in the third semester (see "Astro-VK" in the elective block in Table 1b), thus giving you more flexibility in your design of the compulsory elective block in the 5th and 6th semesters.

- **Advanced astronomy (Astro-VK) – Table 1b**

If you would like to **study astronomy to greater depth** you can do this as part of the **compulsory elective block**. You should select astronomy courses to achieve at least 14 CPs within the optional block C. We recommend that you do the WPAstro module and then do at least one of the two modules *"Astronomical techniques compact"* (MVAstro1) and *„Galactic and Extragalactic Astronomy"* (MVAstro3) or *„Stellar Astronomy & Astrophysics"* (MVAstro2) from the Master's programme of physics (see Table 1b). You could also choose an astronomically-themed seminar in your fifth semester as your mandatory seminar (PSEM) and/or you could do your Bachelor project on an astronomical topic.

- **Career astronomy (Astro-Theo/-Obs/-Sim) - Tables 1c,d,e**

The following course plans are intended for those who really want to focus on astronomy, perhaps because they want to pursue a career in astronomy. They are also ideal if you know you want to do a Master's focusing on astronomy, because they allow you to already select courses with the Master's programme in mind. We have put together three different course plans, each focusing on a different aspect of astronomy, i.e. (1) Cosmology, (2) Observational astronomy and (3) Computational astronomy, i.e. research based on computer simulations:

> **(1) Cosmology** (Astro-Cos) focusses on how we address astronomical problems by a direct application of the known laws of physics. The lecture course *"Theoretical Astrophysics"* (MKTP2) is therefore an indispensable part of this course plan. It builds on the core theoretical physics lectures (PTP1-4), and looks in particular at those concepts and methods widely used in astrophysics, including radiation transfer, hydrodynamics, plasma physics, and stellar dynamics.

In line with this, we recommend the course *"Cosmology"* (MKTP5), which teaches the theoretical and observational basics of cosmology. The corresponding course schedule can be found in Table 1c.

(2) Observational astronomy (Astro-Obs) is concerned with exploiting the various forms of information received from the astronomical sources – electromagnetic waves, cosmic rays, neutrinos, gravitational waves – to understand the universe. This includes using instruments as well as reducing, analysing, and interpreting data. A first reference to practice is obtained during a "*Workproject"* (WPProj). Depending on the effort, up to 12 CP can be awarded here, but at least 4 CP are required. The observation methods required for an observing astronomer are then taught in the sixth semester in the lecture *"Astronomical Techniques"* (MKEP5), which is rated 8 CP and in which most relevant topics are addressed in depth. In addition, the in-depth lecture *"Galactic and Extragalactic Astronomy (Block*)" (MVAstro3) introduces the observation and physics of distant cosmic objects. The corresponding course schedule for this form of your Bachelor's degree can be found in Table 1d.

(3) The rapid development and wide availability of high performance computers has opened up new opportunities to perform detailed simulations of astrophysical processes. It is now possible, for example, to simulate the formation of planets, stars, and galaxies on useful lengthscales and timescales. The third course plan in astronomy therefore is **Computational astronomy (Astro-Sim)**. The two primary modules here are *"Fundamentals of computer simulation methods"* (MVComp1) [5] and *"Computational statistics and data analysis"* (MVComp2) in the fifth and sixth semesters. This can be supplemented with a "*Workproject"* (WPProj) in the fifth semester in which you can gain direct experience with using such simulations. During your Master's studies you can then dedicate more time to taking other advanced astronomical courses, as described below. The corresponding course schedule for this form of your Bachelor's degree can be found in Table 1e[6].

In all three variants described above, you should attend the WPAstro module in the 3rd and 4th semesters. This module consists of the two *lectures "Introduction to Astronomy I & II"* (WPAstro.1 and WPAstro.2) and the *"Astrophysical Labcourse part I"* (WPAstro.3). A supplementary project internship in the future area of the bachelor's thesis can also be an ideal first step to gain an insight into the research work and to establish contact with a research group in which you may want to complete your master's thesis in a subsequent master's program.

[5] There is currently a scheduling conflict between MVComp1 and the mandatory physics module PEP5 (in the winter semester). It is therefore difficult in practice to do Astro-Sim during the B.Sc. at the moment. If you are interested in this area, you can do it during your M.Sc. (see below). We are working to resolve this conflict.

[6] Please note that compulsory electives/elective blocks (Part C) must still attend a course with 2 CP in the sixth semester in order to meet the required 30 CPs.

General skills: subject-specific skills and soft skills

The Bachelor's programme includes various courses designed to help you improve your general skills. They are designed to help and complement your learning.

As already mentioned, we strongly recommend that you attend the two courses Skills for effective studying *("Basiskurs für ein nachhaltiges Studium")* (UKS1), and Introductory mathematics *("Mathematisches Vorkurs")* (UKV) before the start of your first semester. We also recommend you to learn a computer programming language, for example by attending C++ Basics or Python: Programming for scientists in your second or fourth semester.

The modules *"Numerical methods"* (UKNum) in the third or fifth semester and *"Introduction to computational physics"* (UKWR2) in the fourth or sixth semester provide a general background in the use of computers for solving physical problems. These are important methods for any area of physics or astronomy.

The module *"Statistical methods"* (UKSta) in the sixth semester is important for any scientist: many careers involving physics involve some kind of statistical analysis and interpretation of data. This is particularly true in astronomy, which is often referred to as a "data-driven" science on account of the large amounts of data which are obtained with ground-based telescopes, satellites, and computer simulations.

Tabular summary of astronomy in the Physics Bachelor's programme (Tables 1a-e)

The course plans in Tables 1a-e provide you with a compact overview of your Bachelor's degree in Physics if you would like to deal with astronomy within the framework of it.

The study plans show you in which of the four study blocks A (compulsory modules physics and compulsory elective mathematics), B (interdisciplinary competences) or C (elective) the respective course is to be classified and how many credit points you collect in the respective block over six semesters upon successful attendance. For each possible variant of your studies, we have created a separate study plan, e.g. Table 1d for a course of study with a focus on observational astronomy. The total sum of the total credit points or the credit points collected per semester can be found in the bottom row of the tables. Events that you have to attend in any case are printed in red font.

Please note that a total of 180 CPs are required for a successful Bachelor's degree program. However, credit points earned in addition to Master's modules can be transferred to the Master's programme as a study achievement and credited there. In case of doubt, we ask you to have this checked in the Examination Office (Prüfungssekretariat).

Table 1a: Course plan for „Introductory astronomy" (Astro-GK)

Study block		CP	1st Semester		2nd Semester		3rd Semester		4th Semester		5th Semester		6th Semester	
A	Mandantory courses in Physics	105	Experimental Physics I (PEP1)	7	Experimental Physics II (PEP2)	7	Experimental Physics III (PEP3)	7	Experimental Physics IV (PEP4)	7	Experimental Physics V (PEP5)	7	Bachelorarbeit (BPA)	12
			Theoretical Physics I (PTP1)	8	Theoretical Physics II (PTP2)	8	Theoretical Physics III (PTP3)	8	Theoretical Physics IV (PTP4)	8	Advanced Physics Practical I (PFP1)	4	Advanced Physics Practical II (PFP2)	7
					Physics Practical I (PAP1)	7			Physics Practical II (PAP2)	6	Mandatory Seminar (PSEM)	2		
	Mandatory courses in Mathematics	24	Linear Algebra I (PMA1)	8	Higher Mathematics for PhysicistsII (PMP2) ***or*** Calculus II (PMA2)	8	Higher Mathematics for PhysicistsIII (PMP3) ***or*** Calculus III (PMA3)	8						
B	Interdisciplinary Competences	20	Skills for effective studying (UKS1)	4			C++ Basics	1	Statistical Methods (UKSta)	3	Presentation Techniques (UKS2, only with PSEM)	1		
			Introductory Mathematics (UKV)	3			Python: Programming for scientists	2			Numerical Methods (UKNum)	3	Another course from the field „UK"	3
C	Optional block	10									Introduction to Astronomy I (WPAstro.1)	4	Introduction to Astronomy II (WPAstro.2)	4
											Astrophysics Lab I (WPAstro.3)	2		
	CPs still available in this block	21	0		0		4		6		7		4	
	Σ CP	180	30		30		30		30		30		30	

Tabelle 1b: Course plan for „Advanced astronomy“ (Astro-VK)

Study block		CP	1st Semester		2nd Semester		3rd Semester		4th Semester		5th Semester		6th Semester	
A	**Mandantory courses in Physics**	**105**	Experimental Physics I (PEP1)	7	Experimental Physics II (PEP2)	7	Experimental Physics III (PEP3)	7	Experimental Physics IV (PEP4)	7	Experimental Physics V (PEP5)	7	Bachelorarbeit (BPA)	12
			Theoretical Physics I (PTP1)	8	Theoretical Physics II (PTP2)	8	Theoretical Physics III (PTP3)	8	Theoretical Physics IV (PTP4)	8	Advanced Physics Practical I (PFP1)	4	Advanced Physics Practical II (PFP2)	7
					Physics Practical I (PAP1)	7			Physics Practical II (PAP2)	6	Mandatory Seminar (PSEM)	2		
	Mandatory courses in Mathematics	**24**	Linear Algebra I (PMA1)	8	Higher Mathematics for Physicists II (PMP2) ***or*** Calculus II (PMA2)	8	Higher Mathematics for Physicists III (PMP3) ***or*** Calculus III (PMA3)	8						
B	**Interdisciplinary Competences**	**20**	Skills for effective studying (UKS1)	4			Numerical Methods (UKNum)	3	C++ Basics	1	Presentation Techniques ((UKS2, only with PSEM)	1	Einführung in die Com-puter-Physik (UKWR2)	6
			Introductory Mathematics (UKV)	3					Python: Programming for scientists	2				
C	**Optional block**	**22**					Introduction to Astronomy I (WPAstro.1)	4	Introduction to Astronomy II (WPAstro.2)	4	Astronomical Techniques Compact (MVAstro1.1) ***with*** Astron. Prakt. II (MVAstro1.2)	6	Galactic and Extragalactic Astronomy (MVAstro3) ***or*** Stellar Astronomy & Astrophysics (MVAstro2)	6
									Astrophysics Lab I (WPAstro.3)	2				
	CPs still available in this block	**9**	**0**		**0**		**0**		**0**		**9**		**0**	
	Σ CP Astro-VK	**180**	**30**		**30**		**30**		**30**		**29**		**31**	

Tabelle 1c: Course plan for career astronomy with emphasis on theoretical astrophysics (Astro-Cos)													
Study block		**CP**	**1st Semester**		**2nd Semester**		**3rd Semester**		**4th Semester**		**5th Semester**		**6th Semester**	
A	**Mandantory courses in Physics**	**105**	Experimental Physics I (PEP1)	7	Experimental Physics II (PEP2)	7	Experimental Physics III (PEP3)	7	Experimental Physics IV (PEP4)	7	Experimental Physics V (PEP5)	7	Bachelorarbeit (BPA)	12
			Theoretical Physics I (PTP1)	8	Theoretical Physics II (PTP2)	8	Theoretical Physics III (PTP3)	8	Theoretical Physics IV (PTP4)	8	Advanced Physics Practical I (PFP1)	4	Advanced Physics Practical II (PFP2)	7
					Physics Practical I (PAP1)	7			Physics Practical II (PAP2)	6	Mandatory Seminar (PSEM)	2		
	Mandatory courses in Mathematics	**24**	Linear Algebra I (PMA1)	8	Higher Mathematics for Physicists II (PMP2) ***or*** Calculus II (PMA2)	8	Higher Mathematics for Physicists III (PMP3) ***or*** Calculus III (PMA3)	8						
B	**Interdisciplinary Competences**	**20**	Basiskurs für ein nachhaltiges Studium (UKS1)	4			Numerical Methods (UKNum)	3	C++ Basics	1	Presentation Techniques (UKS2, only with PSEM)	1	Introduction into Computer-Physics (UKWR2)	6
			Introductory Mathematics (UKV)	3					Python: Programming for scientists	2				
C	**Optional block**	**31**					Introduction to Astronomy I (WPAstro.1)	4	Introduction to Astronomy II (WPAstro.2)	4	Theoretical Astrophysics (MKTP2)	8	Workproject (WPProj)	5
									Astrophysics Lab I (WPAstro.3)	2	Cosmology (MKTP5)	8		
	CPs still available in this block	**0**	**0**		**0**		**0**		**0**		**0**		**0**	
	Σ CP Astro-Theo:	**180**	**30**		**30**		**30**		**30**		**30**		**30**	

Tabelle 1d: Course plan for career astronomy with emphasis on observational astronomy (Astro-Obs)													
Study block		**CP**	**1st Semester**		**2nd Semester**		**3rd Semester**		**4th Semester**		**5th Semester**		**6th Semester**	
A	**Mandantory courses in Physics**	**105**	Experimental Physics I (PEP1)	7	Experimental Physics II (PEP2)	7	Experimental Physics III (PEP3)	7	Experimental Physics IV (PEP4)	7	Experimental Physics V (PEP5)	7	Bachelorarbeit (BPA)	12
			Theoretical Physics I (PTP1)	8	Theoretical Physics II (PTP2)	8	Theoretical Physics III (PTP3)	8	Theoretical Physics IV (PTP4)	8	Advanced Physics Practical I (PFP1)	4	Advanced Physics Practical II (PFP2)	7
					Physics Practical I (PAP1)	7			Physics Practical II (PAP2)	6	Mandatory Seminar (PSEM)	2		
	Mandatory courses in Mathematics	**24**	Linear Algebra I (PMA1)	8	Higher Mathematics for Physicists II (PMP2) ***or*** Calculus II (PMA2)	8	Higher Mathematics for Physicists III (PMP3) ***or*** Calculus III (PMA3)	8						
B	**Interdisciplinary Competences**	**20**	Skills for effective studying (UKS1)	4			C++ Basics	1	Statistical Methods (UKSta)	3	Presentation Techniques (UKS2, only with PSEM)	1	Datenanalyse (UKBI2)	1
			Introductory Mathematics (UKV)	3			Python: Programming for scientists	2			Numerical Methods (UKNum)	3	Another course from the field „UK“	2
C	**Optional block**	**31**					Introduction to Astronomy I (WPAstro.1)	4	Introduction to Astronomy II WPAstro.2)	4	Galactic and Extragalactic Astronomy (Block) (MVAstro3)	6	Astronomical Techniques (MKEP5)	8
									Astrophysics Lab I (WPAstro.3)	2	Workproject (WPProj)	7		
	Mandantory courses in Physics	**0**	**0**		**0**		**0**		**0**		**0**		**0**	
Σ CP Astro-Obs:		**180**	**30**		**30**		**30**		**30**		**30**		**30**	

Tabelle 1e Course plan for career astronomy with emphasis on computational astronomy (Astro-Sim)													
Study block		**CP**	**1st Semester**		**2nd Semester**		**3rd Semester**		**4th Semester**		**5th Semester**		**6th Semester**	
A	**Mandantory courses in Physics**	**105**	Experimental Physics I (PEP1)	7	Experimental Physics II (PEP2)	7	Experimental Physics III (PEP3)	7	Experimental Physics IV (PEP4)	7	Experimental Physics V (PEP5)	7	Bachelorarbeit (BPA)	12
			Theoretical Physics I (PTP1)	8	Theoretical Physics II (PTP2)	8	Theoretical Physics III (PTP3)	8	Theoretical Physics IV (PTP4)	8	Advanced Physics Practical I (PFP1)	4	Advanced Physics Practical II (PFP2)	7
					Physics Practical I (PAP1)	7			Physics Practical II (PAP2)	6	Mandatory Seminar (PSEM)	2		
	Mandatory courses in Mathematics	**24**	Linear Algebra I (PMA1)	8	Higher Mathematics for Physicists II (PMP2) ***or*** Calculus II (PMA2)	8	Higher Mathematics for Physicists III (PMP3) ***or*** Calculus III (PMA3)	8						
B	**Interdisciplinary Competences**	**20**	Skills for effective studying (UKS1)	4			Numerical Methods (UKNum)	3	C++ Basics	1	Presentation Techniques (UKS2, only with PSEM)	1	Statistical Methods (UKSta)	3
			Introductory Mathematics (UKV)	3					Python: Programming for scientists	2	Another course from the field „UK"	3		
C	**Optional block**	**31**					Introduction to Astronomy I (WPAstro.1)	4	Introduction to Astronomy II (WPAstro.2)	4	Fundamentals of Simulation Methods (MVComp1)	8	Computational Statistics and Data Calculus (MVComp2)	6
									Astrophysics Lab I (WPAstro.3)	2	Workproject (WPProj)	5		
	CPs still available in this block	**2**	**0**		**0**		**0**		**0**		**0**		**2**	
	Σ CP Astro-Sim:	**180**	**30**		**30**		**30**		**30**		**30**		**30**	

The Physics Master's programme

The goal of the Master's programme is for you to learn about fundamental scientific methods, and to apply these in an extended research project. You can also use the courses to gain deeper, subject-specific knowledge, according to the courses you choose. The Master's programme is also intended as preparation for entering a PhD programme in physics or astronomy.

The Master's programme offers a broad range of courses covering a broad range of topics, and in particular those which are the focus of research at the university and associated research institutes. It is characterized in particular by a very wide range of courses that give students the opportunity to tailor their studies to their own preferences. It is divided into two phases, each lasting one year:

- **Section I (1st and 2nd semesters): Study phase**
  The first year comprises lectures, seminars, and other courses.

- **Section II (3rd and 4th semesters): Research phase**
  In the second year you carry out an extended research project under supervision. This includes both a preparation phase as well as the actual project work and writing of your Master's thesis.

To obtain the Master's degree you need to **obtain at least 120 CPs over the four semesters**, normally **with 30 CPs in each semester**. As with the Bachelor's programme, a certain number of credit points (CPs) must be obtained within modules in each of three study blocks. These are:

A: Modules in the **compulsory elective block ("Wahlpflichtbereich")** (76 CPs) **B:** Modules in the **specialisation block ("Vertiefungsbereich")** (24 - 28 CPs) **C:** Modules in the **optional block ("Wahlbereich")** (16 - 20 CPs)
Requirement: A total of 120 CPs in four semesters across A, B, and C

Modules of the Study phase

In the **compulsory elective block** of the Master's programme, a total of 16 CP must be completed in the first two semesters (Section I). The courses in question are indicated in the course catalogue or in the module handbook for the Master's programme with the abbreviation "MK..." for "Master Core Module". Furthermore, 60 CPs from the research phase (Section II) have to be added.

The **specialization block** comprises the mandatory seminar (MVSem*, "Pflichtseminar"*) for 6 CPs and the specialization module (MVMod, *"Vertiefungsmodul"*) for 18-22 CPs. Both MVSem and MVMod are graded. MVMod consists of courses which you can choose freely, but with interrelated topics, to make a total of 12 to 16 CPs, as well as an oral exam (for 6 CPs) on the content of these courses. The grade you obtain in this oral exam applies to the full set of CPs which you obtain in the MVMod, i.e. this grade is weighted by the number of CPs (18 - 22 CPs) you obtain in MVMod. (Note that some courses you take in MVMod may be directly graded, but these grades will not form part of your final Master's grade.)

In the **optional block** you can freely choose modules from physics, from neighbouring subject areas, or from the general skills area (*"Übergreifende Kompetenzen"*, denoted with the abbreviation "UK..."). These are intended to complement your core education, and do not form part of your final Master's grade.

Modules of the research phase

In the third and fourth semesters (Section II), intensive contact with research is established. In order to be able to enter this phase of your Master's programme, you must provide proof of certain academic achievements, which are regulated in detail in the admission requirements for the Master's examination. These can be found in the **examination regulations for the Master's programme in Physics**.

In the compulsory elective area of the research phase, the ungraded compulsory module *"Scientific Specialization"* (MFS) and the graded compulsory module *"Methods and Project Planning"* (MFP) must first be completed with 15 CP each. Subsequently, the also graded *"Master Thesis"* (MFA) must be prepared, which completes the physics training with 30 CP. In order to find a supervisor for your Master's thesis, please contact one of our numerous scientific working groups, depending on your personal interest. How this works is described below.

As part of the ungraded module *"Scientific Specialization"* (MFS), you familiarize with the topic of your upcoming master's thesis, e.g. through literature studies, and be actively involved in the work of your research group in which you want to write your master's thesis. The topic should already be roughly outlined at this time. Afterwards, it is still possible to change the topic of the master's thesis, but then there is no time left for reading into the new topic. The scientific specialization is therefore not repeatable.

After your scientific specialization, the training in *"Methods and Project Planning"* (MFP) takes place, during which tools for the upcoming master's thesis are taught, e.g. the evaluation of astronomical observation data or the use of a simulation code. This module is graded. At its end, the topic of the master's thesis must also be determined.

Before completing the MFS module, the modules MFP and MFA must be registered at the Examination Secretariat of the Department of Physics and Astronomy. The time of working on your Master's thesis is limited to six months. It is the crowning glory of your physics studies ;-).

When planning your studies, please keep in mind that for the overall grade of the Master's examination, the grades of the two core modules (MK...) in the compulsory elective area, the specialisation module (MVMod), the compulsory seminar (MVSem), the module *"Methodological Knowledge and Project Planning"* (MFP) and the Master's thesis (MFA) are weighted according to your credit points. Further information can be found in the examination regulations (see the section Information on the Internet at the end of this document). The **Module Handbook for the Master's Programme** provides a description of the various sub-areas of the programme and a detailed compilation of the course modules assigned to the various areas, including the corresponding module descriptions. The current module handbook is available on the homepage of the Department of Physics and Astronomy (see again the section **Information on the Internet**).

Important deadlines

Be aware in particular of the following deadlines during your Master's studies:

- Register for your oral examination as part of the module MVMod,
- obtain admission to the second phase of the programme (research phase)[7]
- register for the modules in the research phase: MFP and MFA, and
- apply ahead of time for a PhD position, preferentially when you start your research phase.

Extensive information on all detailed questions of the studies, forms and much more can be found on the FAQ website of the Examination Secretariat at https://www.physik.uni-heidelberg.de/studium/bsc/faqs-pav.

Astronomy in the Physics Master's programme

Structure and variations in the astronomy course plans

If you focus your Master's programme in Physics on astronomy, you can take advantage of the flexibility offered by the elective, specialisation and option area of the Master's programme. When planning, however, you should consider how you can best expand and supplement your professional requirements in the course of your Master's degree.

Those who have not yet received an astronomy education at the beginning of their Master's degree at Heidelberg University can acquire the appropriate basics by participating in a three-week block course *"Introduction to Astronomy" (Block)* (MVAstro0) at the beginning of the respective winter and summer semesters.

The following study plans take into account typical previous knowledge from the Bachelor's programme and the objectives of your studies. They give you the security of not forgetting anything in your plans or doing anything wrong. However, there is still enough room for manoeuvre within the framework of our recommendations to incorporate your personal interests and inclinations into your studies. Please note that you sometimes have to supplement our compilation of courses and lectures with further courses in study block C (options) in order to achieve the minimum necessary credit points (60 CP in the two semesters of the continuing education phase). Often, however, no exactly suitable courses can be found, so that in individual cases you will exceed the number of 30 CP per semester by a few credit points. This is a valid option.

Our recommendations for your Master's degree can be divided into the following four variants, which are presented in Tables 2a-d. The four variants refer to in which of the three study areas "Elective", "Specialisation" or "Option" astronomy should play a role for you:

[7] Admission is obtained by a successful oral examination at the end of the Master-Module MVMod.

- **Astronomy as a minor option – Table 2a**
  This variant is aimed at students who only want to listen to astronomy in the "optional area" during their physics studies and would like to focus on another branch of physics. In this case, we recommend attending an in-depth astronomy lecture in the 1st and 2nd semesters. An example of the selection can be found in Table 2a, for the start of studies in the winter or summer semester. The missing credit points must be achieved in other areas of physics.

- **General astronomy– Table 2b**
  The selection of lectures and courses is intended to cover astronomy with the widest possible range and is aimed at students who have heard an introduction to astronomy during their bachelor's degree or have not yet had contact with astronomy. We then recommend attending the block course *"Introduction to Astronomy" (Block)* (MVAstro0). In the study plan, the courses and lectures are adapted accordingly depending on the start of studies in the winter or summer semester. The corresponding curricula can be found in Table 2b.

- **Advanced astronomy– Table 2c**
  The set of courses in this plan are aimed at students who followed the introductory astronomy (Astro-GK) or advanced astronomy (Astro-VK) course plans during their Bachelor's studies (see above). There are three different subplans shown in Table 2c, one for each of theoretical astronomy (Astro-Cos), observational astronomy (Astro-Obs), and computational astronomy (Astro-Sim). The broad distinction between them is summarized in the description of the Bachelor's programme above.

- **Career astronomy– Table 2d**
  This course plan is intended for students who followed the "career astronomy" course plan during their Bachelor's studies, either cosmology (Astro-Cos), observational astronomy (Astro-Obs), or computational astronomy (Astro-Sim). The idea is that you continue to focus on your chosen area - theoretical or observational - during your Master's studies. The course plans are summarized in Table 2d. Please note when planning that you can only have one of the modules MVAstro1 and MKEP5 credited as a study achievement. If, for example MVAstro1 in the B.Sc. have been evaluated as a course of study in the elective area (see Table 1b), then you can no longer have the module MKEP5 in the Master's degree evaluated as a study achievement.

All but the first of the above course plans will lead to a Master's degree which covers a broad scope of physics yet also has a strong astronomical component.

Tabular summary of astronomy in the Physics Master's programme (Tables 2a-d)

The curriculum presented in Table 2a is relevant to you if, in addition to your specialisation in another area of physics, you want to pursue astronomy as an option, in each case for the start of studies in the winter or summer semester.

The study plans compiled in Tables 2b-d give you a compact overview of the general (Table 2b), in-depth (Table 2c) or focus (Table 2d) study of astronomy, also for the beginning of studies in the winter or summer semester.

The tables show you colour coded in which of the three areas compulsory elective, specialisation or option the respective course is to be classified. In addition, the credit points that you collect in the respective area over four semesters upon successful attendance are indicated. In all three areas, the total performance points specified at the beginning of each table can be provided. Please note that a graded oral examination takes place for the courses selected as part of the specialisation area.

Tabelle 2a: Course plan for your Physics Masters studies with Astronomy as a minor option

Start in winter semester

	1st Semester		2nd Semester		3rd Semester		4th Semester	
					Elective block ("Wahlpflicht") (76 CPs			
					Specialisation block ("Vertiefung") (24-28 CPs)			
					Optional block ("Option") (16-20 CPs)			
Astro as minor option ∑LP=120	One course ("MK") taken from the range of core courses offered	8	One course ("MK") taken from the range of core courses offered	8	Scientific Specialisation (MFS)	15	Master Thesis (MFA)	30
					Methods and Project Planning (MFP)	15		
	Advanced Seminar (MVSem) in the 1st or 2nd semester (6LP)							
	MVMod = 18LP							
	...		...					
			Oral Examination	6				
	Theoretical Astrophysics (MKTP2) *or* Introduction to Astronomy (Block) (MVAstro0)	8 8	Stellar Astronomy and Astrophysics (MVAstro2) *or* Galactic and Extragalactic Astronomy (MVAstro3)	6 6				
	Astronomical Techniques (compact) (MVAstro1)	6						

Tabelle 2a: Course plan for your Physics Masters studies with Astronomy as a minor option

Start in summer semester

	1st Semester		2nd Semester		3rd Semester		4th Semester	
Astro as minor option ∑LP=114[8]-120	One course ("MK") taken from the range of core courses offered	8	One course ("MK") taken from the range of core courses offered	8	Scientific Specialisation (MFS)	15	Master Thesis (MFA)	30
					Methods and Project Planning (MFP)	15		
	Advanced Seminar (MVSem) in the 1st or 2nd semester (6 LP)							
	MVMod = 18-22LP							
	...		...					
			Mündliche Prüfung	6				
	Stellar Astronomy and Astrophysics (MVAstro2) *or* Galactic and Extragalactic Astronomy (MVAstro3) *or* Introduction to Astronomy (Block) (MVAstro0)	6 6 8	Cosmology (MKTP5) *or* Theoretical Astrophysics (MKTP2)	8 8				

[8] Additional courses in the specialisation or optional block required!

Tabelle 2b: Course plan for your Physics Master studies with Astronomy on a general level for BAs from other Universities

Start in winter semester

	1st Semester		2nd Semester		3rd Semester		4th Semester	
General Astronomy ∑LP=108[9]	**Elective block ("Wahlpflicht") (76 Leistungspunkte)**							
	Specialisation block ("Vertiefung") (24-28 Leistungspunkte)							
	Optional block ("Option") (16-20 Leistungspunkte)							
	Theoretische Astrophysics (MKTP2)	8	Astronomical Techniques (MKEP5)	8	Scientific Specialisation (MFS)	15	Master Thesis (MFA)	30
					Methods and Project Planning (MFP)	15		
	Advanced Seminar (MVSem)	6						
	MVMod = 20 LP							
	Cosmology (MKTP5) *or* Introduction to Astronomy (Block) (MVAstro0)	8 8	Stellar Astronomy and Astrophysics (MVAstro2)	6				
			Oral Examination	6				
			Galactic and Extragalactic Astronomy (MVAstro3)	6				

Tabelle 2b: Course plan for your Physics Master studies with Astronomy on a general level for BAs from other Universities

Start in summer semester

	1st Semester		2nd Semester		3rd Semester		4th Semester	
General Astronomy ∑LP=108-110[10]	Astronomical Techniques (MKEP5)	8	Theoretical Astrophysics (MKTP2)	8	Scientific Specialization (MFS)	15	Master Thesis (MFA)	30
					Methods and Project Planning (MFP)	15		
	Advanced Seminar (MVSem)	6						
	MVMod = 20-22 LP							
	Stellar Astronomy and Astrophysics (MVAstro2) *or* Introduction to Astronomy (Block) (MVAstro0)	6 8	Cosmology (MKTP5)	8				
			Mündliche Prüfung	6				
	Galactic and Extragalactic Astronomy (MVAstro3)	6						

[9] Additional courses in the specialisation or optional block required!

[10] Additional courses in the specialisation or optional block required!

Table 2c: Course plan for your Physics Master studies with Astronomy on an advanced level

Beginn im Wintersemester

	1st Semester		2nd Semester		3rd Semester		4th Semester	
					Elective block ("Wahlpflicht") (76 CPs)			
					Specialisation block ("Vertiefung") (24-28 CPs)			
					Optional block ("Option") (16-20 CPs)			
Advanced Astronomy Astro-Cos ∑LP=116[11]	Cosmology (MKTP5)	8	General Relativity (MKTP3)	8	Scientific Specialization (MFS)	15	Master Thesis (MFA)	30
					Methods and Project Planning (MFP)	15		
	Advanced Seminar (MVSem)	6						
	MVMod = 20 LP							
	Theoretical Astrophysics (MKTP2)	8	Galactic and Extragalactic Astronomy (MVAstro3)	6				
			Oral Examination	6				
	Quantum Field Theory (MKTP4)	8	Stellar Astronomy and Astrophysics (MVAstro2)	6				
Advanced Astronomy Astro-Obs ∑LP=114[12]	Advanced Atomic, Molecular and Optical Physics (MKEP3)	8	Astronomical Techniques (MKEP5)	8	Scientific Specialisation (MFS)	15	Master Thesis (MFA)	30
					Methods and Project Planning (MFP)	15		
	Advanced Seminar (MVSem)	6						
	MVMod = 18 LP							
			Galactic and Extragalactic Astronomy (MVAstro3)	6				
			Stellar Astronomy and Astrophysics (MVAstro2)	6				
			Oral Examination	6				
	Environmental Physics (MKEP4)	8	Cosmology compact (Block) (MVAstro4)	4				
	Laboratory Course Astrophysics II	2						
Advanced Astronomy Astro-Sim ∑LP=116[13]	Theoretical Astrophysics (MKTP2)	8	General Relativity (MKTP3)	8	Scientific Specialization (MFS)	15	Master Thesis (MFA)	30
					Methods and Project Planning (MFP)	15		
	Advanced Seminar (MVSem)	6						
	MVMod = 22 LP							
	Fundamentals of Simulation Methods (MVComp1)	8						
	Cosmology (MKTP5)	8	Oral Examination	6				
	Astronomical Techniques (compact) (MVAstro1)	6	Stellar Astronomy and Astrophysics (MVAstro2)	6				

[11] Additional courses in the specialisation or optional block required!
[12] Additional courses in the specialisation or optional block required!
[13] Additional courses in the specialisation or optional block required!

Table 2c: Course plan for your Physics Master studies with Astronomy on an advanced level

Start in summer semester

	1st Semester		2nd Semester		3rd Semester		4th Semester	
	Elective block ("Wahlpflicht") (76 CPs)							
	Specialisation block ("Vertiefung") (24-28 CPs)							
	Optional block ("Option") (16-20 CPs)							
Advanced Astronomy Astro-Cos ∑LP=116[14]	General Relativity (MKTP3)	8	Cosmology (MKTP5)	8	Scientific Specialisation (MFS)	15	Master Thesis (MFA)	30
					Methods and Project Planning (MFP)	15		
	Advanced Seminar (MVSem)	6						
	MVMod = 20 LP							
	Galactic and Extragalactic Astronomy (MVAstro3)	6	Theoretical Astrophysics (MKTP2)	8				
			Orla examination	6				
	Stellar Astronomy and Astrophysics (MVAstro2)	6	Quantum Field Theory (MKTP4)	8				
Advanced Astronomy Astro-Obs ∑LP=114[15]	Astronomical Techniques (MKEP5)	8	Advanced Atomic, Molecular and Optical Physics (MKEP3)	8	Scientific Specialisation (MFS)	15	Master Thesis (MFA)	30
					Methods and Project Planning (MFP)	15		
			Advanced Seminar (MVSem)	6				
	MVMod = 18 LP							
	Galactic and Extragalactic Astronomy (MVAstro3)	6						
	Stellar Astronomy and Astrophysics (MVAstro2)	6	Oral examination	6				
	Cosmology compact (MVAstro4)	4	Environmental Physics (MKEP4)	8				
	Laboratory Course Astrophysics II	2						
Advanced Astronomy Astro-Sim ∑LP=116[16]	General Relativity (MKTP3)	8	Theoretical Astrophysics (MKTP2)	8	Scientific Specialisation (MFS)	15	Master Thesis (MFA)	30
					Methods and Project Planning (MFP)	15		
	Advanced Seminar (MVSem)	6						
	MVMod = 22 LP							
			Cosmology (MKTP5)	8				
			Fundamentals of Simulation Methods (MVComp1)	8				
			Oral Examination	6				
	Stellar Astronomy and Astrophysics (MVAstro2)	6	Astronomical Techniques (compact) (MVAstro1)	6				

[14] Additional courses in the specialisation or optional block required!
[15] Additional courses in the specialisation or optional block required!
[16] Additional courses in the specialisation or optional block required!

Table 2d: Course plan for your Physics Master studies with Astronomy on a career level

Start in winter semester

	1st Semester		2nd Semester		3rd Semester		4th Semester	
	Elective block ("Wahlpflicht") (76 CPs)							
	Specialisation block ("Vertiefung") (24-28 CPs)							
	Optional block ("Option") (16-20 CPs)							
Career Astronomy Astro-Theo ∑LP =108[17]	Theoretical Statistical Physics (MKTP1)	8	General Relativity (MKTP3)	8	Scientific Specialisation (MFS)	15	Master Thesis (MFA)	30
					Methods and Project Planning (MFP)	15		
	Advanced Seminar (MVSem)	6						
	MVMod = 20 LP							
	Cosmology (MKTP5) ***or*** Fundamentals of Simulation Methods (MVComp1)	8 8	Stellar Astronomy and Astrophysics (MVAstro2)	6				
			Oral Examination	6				
			Galactic and Extragalactic Astronomy (MVAstro3)	6				
Career Astronomy Astro-Obs ∑LP=111[18]	Theoretical Astrophysics (MKTP2)	8	Environmental Physics (MKEP4)	8	Scientific Specialisation (MFS)	15	Master Thesis (MFA)	30
					Methods and Project Planning (MFP)	15		
	Advanced Seminar (MVSem)	6						
	MVMod = 19 LP							
	MVSpec, z.B. Asteroseismology	3	Cosmology compact (block) (MVAstro4)	4				
			Stellar Astronomy and Astrophysics (MVAstro2)	6				
			Oral Examination	6				
	Advanced Atomic, Molecular and Optical Physics (MKEP3)	8	Laboratory Course Astrophysics II	2				

[17] Additional courses in the specialisation or optional block required!

[18] Additional courses in the specialisation or optional block required!

Table 2d: Course plan for your Physics Master studies with Astronomy on a career level

Start in summer semester

	1st Semester		2nd Semester		3rd Semester		4th Semester	
						Elective block ("Wahlpflicht") (76 CPs)		
						Specialisation block ("Vertiefung") (24-28 CPs)		
						Optional block ("Option") (16-20 CPs)		
Career Astronomy Astro-Theo ∑LP=108[19]	General Relativity (MKTP3)	8	Theoretical Statistical Physics (MKTP1)	8	Scientific Specialization (MFS)	15	Master Thesis (MFA)	30
					Methods and Project Planning (MFP)	15		
	Advanced Seminar (MVSem)	6						
	MVMod = 20 LP							
	Stellar Astronomy and Astrophysics (MVAstro2)	6	Cosmology (MKTP5) *or* Fundamentals of Simulation Methods (MVComp1)	8 8				
			Oral Examination	6				
	Galactic and Extragalactic Astronomy (MVAstro3)	6						
Career Astronomy Astro-Obs ∑LP=111[20]	Environmental Physics (MKEP4)	8	Theoretical Astrophysics (MKTP2) *or* Advanced Atomic, Molecular and Optical Physics (MKEP3)	8 8	Scientific Specialisation (MFS)	15	Master Thesis (MFA)	30
					Methods and Project Planning (MFP)	15		
	Masterpflichtseminar (MVSem)	6						
	MVMod = 19 LP							
	Cosmology compact (Block) (MVAstro4)	4	MVSpec, z.B. Asteroseismology	3				
	Stellar Astronomy and Astrophysics (MVAstro2)	6						
			Oral Examination	6				
	Laboratory Course Astrophysics II	2	Advanced Atomic, Molecular and Optical Physics (MKEP3)	8				

[19] Additional courses in the specialisation or optional block required!

[20] Additional courses in the specialisation or optional block required!

Additional Informationen

How do I make contact to research groups?

Staff at the following institutes in Heidelberg offer and supervise Bachelor's, Master's, and PhD projects:

- Zentrum für Astronomie der Universität Heidelberg (ZAH)
- Institut für Theoretische Physik der Universität Heidelberg (ITP)
- Max-Planck-Institut für Astronomie (MPIA)
- Max-Planck-Institut für Kernphysik (MPIK)
- Heidelberger Institut für Theoretische Studien (HITS)

To make contact during your Bachelor's or Master's studies, talk directly to lecturers, with your tutors, or with the supervisors of lab projects. You should also look at the institute web sites to find out more about the research groups, and/or on individual researcher's websites, which sometimes list specific projects. The Department for Physics and Astronomy also maintains an online list of some of the projects on offer at the above institutes.

What is the difference between astronomy and astrophysics?

The distinction is largely historical and no longer relevant. Perhaps one could say that astronomy is broader because it does not just deal with physics, including aspects of geology, chemistry and biology. But the terms "astronomy" and "astrophysics" are generally used as synonyms today. Astrophysics is an important part of physics, as it deals with environments and states of matter which cannot be achieved in the laboratory, such as extreme vacuums, very high temperatures or densities, or strong magnetic fields.

What are the career opportunities with an education in astronomy?

Basically, you should choose the focus on astronomy and astrophysics if you are particularly interested in it. Especially in Heidelberg, you do not have to take into account the further career path, because a Heidelberg physics degree - despite all specialization - offers above all a broad education in physics. Thus, all labour market recommendations are unrestricted.

However, most students of astronomy choose this subject with a view to a later activity in science. In this case, universities with corresponding faculties and research institutions in Germany and abroad can be considered as employers. A certain flexibility - at least in the first years after the doctorate - is a basic prerequisite for a career in science.

Since a Heidelberg physics degree primarily offers a broad education in physics, there are also good career prospects outside of astronomy, for example, in high-tech sectors, such as the optical industry, mechanical engineering or microelectronics, and in particular in research and development both in the field of new products and in the field of new production processes. If you want to work more with mathematical models and computer applications after your studies, you will also find suitable jobs in research institutes, development departments, but also in banks, marketing, management consultancies, management and IT areas.

In addition, there are a variety of employment opportunities in meteorology, geophysics, oceanography, environmental physics, chemistry, biology, materials science, medical technology, but also in teaching-related fields of activity, such as in-house training and adult education, and also in science journalism.

If you want to work in astronomy after completing your doctorate, you will usually always find a so-called "postdoc position" on the worldwide job market. These are usually two- to three-year jobs. You should use this time to sharpen your own research profile and to publish scientifically interesting papers. This is a prerequisite for further postdoc positions and the prospect of permanent employment. The latter can be associated with a habilitation that lasts for at least five years. There are then vacancies as a private lecturer (Priv.-Doz.) or you can be appointed to a professorship by a university. However, pursuing a career in astronomy is a very competitive endeavor overall. And there are very few permanent positions in research and even fewer professorships.

Should you therefore decide to leave your academic career as an astronomer, you have very good career prospects. A study published in 2016 by the Cologne Institute for Economic Research, carried out on behalf of the German Physical Society (DPG)[21], attests to their high occupational and industry flexibility as all-rounders of the labour market. Unemployment was 2.5% in 2013. The number of people in employment increased by an average of 2.1% each year between 2005 and 2013. Students of physics are above average satisfied with their choice of study: 87 percent would study the subject again. It also showed that an average of 300 new jobs are created in Germany every year. In addition, because many will retire from the workforce in the coming years due to age, the demand for physical specialists is constantly increasing[22].

[21] https://www.dpg-physik.de/veroeffentlichungen/publikationen/studien-der-dpg/pix-studien/arbeitsmarktstudie_2016.pdf
[22] Aktuelle Arbeitsmarktanalysen finden sich unter https://www.dpg-physik.de/veroeffentlichungen/magazine-und-online-angebote/pj/arbeitsmarktartikel

Information in the Internet

- **The Faculty of Physics and Astronomy at Heidelberg University:**
  www.physik.uni-heidelberg.de

- **Information on applying for a place in physics (Bachelor/Master) in Heidelberg:**
  www.physik.uni-heidelberg.de/studium/bachelor/bewerbung
  www.physik.uni-heidelberg.de/studium/master/bewerber_europa

- **Advice on studying physics and astronomy:**
  www.physik.uni-heidelberg.de/studium/service/studienberater

- **Student committee for maths and physics:**
  https://mathphys.stura.uni-heidelberg.de/w/

- **Information on science as a career:**
  https://www.dfg.de/foerderung/wissenschaftliche_karriere/index.html

- **Astronomy at Heidelberg University:**
  https://www.zah.uni-hd.de

- **Links to the other astronomy institutes in Heidelberg:**
  www.zah.uni-heidelberg.de/astronomy-physics-in-heidelberg/

- **Physics B.Sc. module handbook:**
  https://www.physik.uni-heidelberg.de/c/image/f/studium/bachelor/pdf/BSc-Physik-Modulhandbuch.pdf

- **Examination regulations for the B.Sc.**
  https://backend-484.uni-heidelberg.de/sites/default/files/documents/2019-09/a14-01-1-12_po_ba_physik__homepage.pdf

- **Physics M.Sc. module handbook:**
  https://www.physik.uni-heidelberg.de/c/image/d/studium/master/pdf/MScModuleManual.pdf

- **Examination regulations for the M.Sc.**
  https://backend-484.uni-heidelberg.de/sites/default/files/documents/2020-10/Physik%20MSc%20PO%2C%2005.04.2019.pdf

- **Information on the astronomy lab course:**
  https://www.lsw.uni-heidelberg.de/users/jheidt/praktikum/index.html

- **Deutsche Physikalische Gesellschaft**
  https://www.dpg-physik.de

- **Deutsche Astronomische Gesellschaft:**
  https://www.astronomische-gesellschaft.org

- **General information on physics:**
  https://www.pro-physik.de

Dictionary of terms

German	English
Astrophysikalisches Praktikum	astrophysics lab course
Astronomie als Wahlfach	astronomy as elective topic
Bachelorstudium	Bachelor's programme
Bachelorarbeit	Bachelor's project (or thesis)
Fachschaft	student committee
Fachspezifische Zusatzqualifikationen	subject-specific skills
Forschungsphase	research phase
Masterstudium	Master's programme
Masterarbeit	Master's project (or thesis)
Module	module
Studienberatung	student advisory service
Studienplan	course plan
Pflichtbereich	mandatory block
Pflichtseminar	mandatory seminar
Praktikum	lab course
Projektpraktikum	workproject
Prüfungsordnungen	examination regulations
Prüfungssekretariat	examination office
Persönlichkeitsbezogene Schlüsselkompetenzen	soft skills
Studienblock (auch "Bereich")	study block
Übergreifende Kompetenzen	general skills
Vertiefungsbereich	specialization block
Vorlesung	single lecture, or lecture course
Wahlpflichtbereich	compulsory elective block
Wahlbereich	optional block
Weiterbildungsphase	study phase
Vertiefungsbereich	specialisation block