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

A guide and suggestions for students

Date: March 23, 2015
Authors: apl. Prof. Dr. Andreas Just (Studies advisor astronomy)
Dr. Guido Thimm (Scientific Manager, ZAH[1])
English translation by PD Dr. Coryn Bailer-Jones (MPIA[2])

Contents

[1] **Z**entrum für **A**stronomie der Universität **H**eidelberg (ZAH)
[2] **M**ax **P**lanck **I**nstitute for **A**stronomy

The Astronomy programme

You are interested in studying astronomy at Heidelberg University. This guide gives an overview of the B.Sc and M.Sc Physics degree programmes and how you can study astronomy within them. It is based on the official regulations of the Faculty for Physics and Astronomy ("Prüfungsordnungen") and the module handbooks.

Heidelberg – a centre of excellence in astronomy

Heidelberg offers an ideal environment for higher education in astronomy and physics. It is one of the largest centres for teaching and research in Germany, comprising several major institutes. The **Zentrum für Astronomie der Universität** (ZAH) is made up of the **Astronomische Rechen-Institut** (ARI), the **Institut für Theoretische Astrophysik** (ITA), and the **Landessternwarte Königstuhl** (LSW). The **Max-Planck-Institut für Astronomie** (MPIA) and **Max-Planck-Institut für Kernphysik** (MPIK) as well as the **Heidelberger Institut für Theoretische Studien** (HITS) are primarily research institutes, but staff there also contribute to teaching and student supervision at all levels. The mission of the **Haus der Astronomie** (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 **Institut für Theoretische Physik** (ITP) which looks at (among other things) dark energy, 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 degree programmes in Heidelberg generally start in the winter semester (October). Students are selected based on their application, which must be received by 15 July. 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 – hopefully soon – 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.

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. To achieve this you can attend the introductory astronomy courses in the third and fourth semesters and you can do the astrophysics lab course at the Landessternwarte on the Königstuhl. Following this - in the fifth and sixth semester - you can select to study more advanced astronomy courses on observational methods, stellar astronomy, extragalactic astronomy and cosmology, numerical simulation methods, and statistical methods. These are complemented by lectures on specific astronomical topics, seminars on current research, courses on programming, as well as the opportunity to do your Bachelor's project in astronomy.

- 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. For those with no astronomy background from their B.Sc., a special block course "Introduction to astronomy" (MVAstro0) is offered before the start of the winter semester, as described later.

- 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 Faculty for Physics and Astronomy of Heidelberg University, from which students receive their degrees.

Entrance requirements

A deep interest in physical phenomena and problem solving, as well as mathematical ability, form the backbone of a successful degree in physics. Also important is the ability to use and to write computer programs. Proficiency in English is valuable, and indeed essential for the Master's programme, because all Master's courses and most of the modern astronomical literature are in English. Improving all of these skills forms an important part of your education and the degree programme.

Applications to the B.Sc, M.Sc, and PhD programmes are assessed by the Faculty for Physics and Astronomy, not least to help you determine your suitability for studying physics. If you are unsure yourself whether you are suited, we recommend that you make use of the faculty's student advisory service ("Studienberatung"). The university's Physics and Mathematics student committee ("Fachschaft") is also a useful source of information and advice.

The Physics Bachelor's programme

The usual duration for the Bachelor programme, including the examinations, is six semesters. During this time you need to obtain a total of 180 credit points (CPs)[3]. The programme is organized into study blocks, each of which is subdivided into study modules. Modules are of various types, including lectures, seminars, lab courses, exercises, and a combination thereof. All modules are examined in some way. This organization permits you to include astronomical modules according to your interest and study requirements.

There are three distinct study blocks. You need to achieve a certain number of credit points in each:

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

Modules in the mandatory block "Physics and Mathematics"

The goal of this block is to learn the fundamentals of physics and mathematics via lectures, exercise sessions, and lab courses. Following each lecture course there is a written examination, and at the end of the first semester you will also take an orientation exam. **A total of 129 CPs must be obtained in the mandatory block**.

The physics part of this block comprises nine lecture courses in experimental and theoretical physics, a basic and an advanced lab course, a seminar, a course on presentation techniques, and, in the sixth semester, the Bachelor project ("Bachelorarbeit"). For this last component you need to identify a project and supervisor yourself (see later for details).

In the mathematics component, the basic mathematics lecture course *Linear Algebra I* (PMA1) is mandatory. You then have a choice. You could either take the lecture courses *Mathematics for Physicists II and III* (PMP2 and PMP3), or for those more interested in pure mathematics you can take the courses *Calculus II and III* (PMA2 and PMA3) together with the students in Mathematics. In the general skills block (see below), you have the choice of various other mathematics courses.

[3] Credit Points ("Leistungspunkte", LPs) are a measure of the amount of time required for a course module. This includes preparation, attendance, homework, and private study time. One CPs corresponds to 30 hours. In each semester you can expect a total time commitment of 900 hours (30 CPs). To achieve this you will also need to make considerable use of the lecture-free periods between the semesters.

General skills block

In this block you are able to learn skills which will be useful no matter what your future career may be. The opportunities across the whole university cover **soft skills**, **job-related skills**, and **subject-specific skills**. Success in learning and in work depend not only on excellence in your subject. **Soft skills** ("Persönlichkeitsbezogene Schlüsselkompetenzen") are important too. During your degree course you will have the opportunity to learn about project organization, group working, and making presentations, among other things. Under the category **job-related skills** ("Berufsbezogene Schlüsselkompetenzen") comes working with computers, data analysis, and English. These skills are generally taught as block course, i.e. intensive full time study. **Subject-specific skills** ("Fachspezifische Zusatzqualifikationen") can be obtained in the areas of electronics, computations physics, statistics, numerical methods, and hardware technology. In addition to the numerous courses offered by the Faculty for Physics and Astronomy, you can take courses at one of the other faculties, such as Mathematics and Computer Science, Biosciences, Chemistry and Earth Sciences, Medicine, or Economics and Social Sciences (although there may be relatively few suitable modules). More details can be found in the module handbook.
It is possible to take two key modules in this block already in the first semester. These are *Skills for effective studying* ("Basiskurs für ein nachhaltiges Studium", UKS1), and *Introductory mathematics* ("Mathematischer Vorkurs", UKV). Both courses are block courses starting at the end of September, about three weeks before the beginning of the lecture season in the winter semester. Attendance to these courses is not obligatory, but it is strongly recommended. Note that many of the courses in the General skills block have limited places, and you have no entitlement to attend a specific course. So sign up early for your course of interest!

You must obtain at least 20 CPs in the block "General skills" during your Bachelor studies.[4]

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 "Wahlpflichtbereich Physik" requirement. The astronomy modules are included in this and are listed under Physics in the module handbook. Beyond this requirement you are free to choose modules from other faculties[5], 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 second semester. This is fulfilled by (and equivalent to) successfully completing the PEP1 module.
- Register on time for the astronomy lab course.
- Register for your Bachelor's project.
- 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 faculty's examination secretary ("Prüfungssekretariat").

[4] One CP concerning Presentation Techniques is automatically part of the seminar PSEM in the mandatory block taken in the fifth semester.

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

Astronomy in the Physics Bachelor's programme

Astronomy course plans

You can study various areas of astronomy to different depths as part of the Physics Bachelor's programme. This is achieved primarily through your choices in the general skills and optional blocks. In the following we describe three different course plans ("Studienpläne") which include astronomy in to different depths and in different areas. Tables 1a-e give a tabular overview and lists the corresponding courses.

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

You would like to learn the basics of astronomy and want to keep open the opportunity to do a Master's in astronomy, but you also want to have time to explore other parts of physics. In that case you should take the module *Introduction to Astronomy* (WPAstro) in the optional block, for a total of 10 CPs. This comprises the courses *Introduction to Astronomy I and II* in the fifth and sixth semesters (respectively), plus the *Astrophysics lab I* at the end of the fifth semester (February/March). You could instead start with these in the third semester (see "Astro-VK" in Table 1b), thus giving you more flexibility in later semesters. Note that with this course plan, you need to obtain the 14 CPs to meet the "Wahlpflichtbereich Physik" requirement in a different area of physics.

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

If you would like to study astronomy to greater depth, and achieve the "Wahlpflichtbereich Physik" requirement in astronomy, then you should select astronomy courses to achieve at least 14CPs within the optional block. We recommend that you do the WPAstro module and then do at least one of the two modules *Astronomical techniques compact* (MVAstro1) or *Cosmology* (MVAstro4) from the Master's programme, each of which provides 6 CPs (see later in this document). 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. A workproject ("Projektpraktikum") is an ideal way to learn more about an area of research, perhaps even as a preparatory step for your Bachelor's project.

- **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) Theoretical astrophysics (Astro-Theo), (2) Observational astronomy (Astro-Obs) and (3) Computational astronomy (computer simulations) (Astro-Sim):

(1) **Theoretical astrophysics (Astro-Theo)** focus 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.

All astronomers - even theorists - need to have some idea of how the data are obtained. We therefore recommend you attend the lecture course *Astronomical Techniques Compact* (MVAstro1). This module includes one lab course in astronomy, *Astrophysics Lab II*. It is offered as a one-week block course between the lecture periods, in September/October and in February/March, following on immediately from *Astrophysics Lab I*. There is much demand for these courses, so do register early. As an alternative to MVAstro1 you may attend *Cosmology* (MVAstro4).

(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. Many issues in astronomy are related to the evolution of the

universe as a whole, so we recommend that you attend, in the fifth semester, the two lecture courses *Cosmology* (MVAstro4) and *Observing the Big Bang* (MVSpec), which will introduce you to the observational and theoretical aspects of cosmology. You can get direct hands on experience of working with data in a workproject, in which you can obtain between 4 and 12 CPs. The main course on observational methods is then done in sixth semester by attending the lecture course *Astronomical Techniques* (MKEP5). This is a broader and deeper course than the otherwise similar course *Astronomical Techniques Compact* (MVAstro1), and is therefore credited with 8 rather than 6 CPs.

(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 is **Computational astronomy (Astro-Sim)**. The two primary modules here are *Fundamentals of computer simulation methods* (MVComp1) [6] 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.

In all three cases you should first do the WPAstro module as part of the optional block, as described for Astro-VK. You should do these early enough during your studies so that you have sufficient time during your fifth and sixth semesters to focus on the more advanced astronomy courses.

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 semester and *Introduction to computational physics* (UKWR2) in the 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.

[6] 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.

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

The course plans in Tables 1a-e summarize the different ways in which you can study astronomy within the Physics programme. These show in which semester you should take the various modules, how many CPs you can obtain for each, and to which study block – A,B or C – the modules belong. There is a separate table for each of the five study plans described above. The total number of CPs you obtained in each semester is shown in the bottom row of each table. Remember that you need to obtain a total of 180 CPs for the successful completion of the Bachelor's programme.

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	**Mandatory 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		Bachelor Project (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)	6					Physics Practical II (PAP2)	7		Mandatory Seminar (PSEM)	2				
	Mandatory courses in Mathematics	**24**	Linear Algebra I (PMA1)	8		Mathematics for Physicists II (PMP2) *or* Calculus II (PMA2)	8		Mathematics for Physicists III (PMP3) *or* Calculus III (PMA3)	8										
B	**Job-related skills**	**20**	Skills for effective studying (UKS1)	4											Presentation Techniques (UKS2, only with PSEM)	1				
	Subject-specific skills		Introductory mathematics (UKV)	3		C++ Basics	1		Numerical Methods (UKNum)	3								Statistical Methods (UKSta)	3	
C	**Options (Astro-GK)**	**10**													Introduction to Astronomy I (WPAstro)	4		Introduction to Astronomy II (WPAstro)	4	
															Astrophysics Lab I (WPAstro)	2				
Σ CP		**154**	**30**			**30**			**26**			**22**			**20**			**26**		
CPs still to be collected		**26**	**0**			**0**			**4**			**8**			**10**			**4**		

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	**Mandatory 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	Bachelor Project (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)	6			Physics Practical II (PAP2)	7	Mandatory Seminar (PSEM)	2		
	Mandatory courses in Mathematics	**24**	Linear Algebra I (PMA1)	8	Mathematics for Physicists II (PMP2) *or* Calculus II (PMA2)	8	Mathematics for Physicists III (PMP3) *or* Calculus III (PMA3)	8						
B	**Job-related skills**	**20**	Skills for effective studying (UKS1)	4							Presentation Techniques (UKS2, only with PSEM)	1		
	Subject-specific skills		Introductory mathematics (UKV)	3	C++ Basics	1	Numerical Methods (UKNum)	3	Python: Programming for scientists	2			Introduction to Com-puter-Physics (UKWR2)	6
C	**Options (Astro-VK)**	**21**					Introduction to Astronomy I (WPAstro)	4	Introduction to Astronomy II (WPAstro)	4	Astronomical Techniques Compact (MVAstro1) *with* Astrophysics Lab II *or* Cosmology (MVAstro4)	6	Workproject (WPProj)	5
									Astrophysics Lab I (WPAstro)	2				
Σ CPs		**170**	**30**		**30**		**30**		**30**		**20**		**30**	
CPs still to be collected		**10**	**0**		**0**		**0**		**0**		**10**		**0**	

Tabelle 1c: Course plan for career astronomy with emphasis on theoretical astrophysics (Astro-Theo)													
Study block		**CP**	**1st Semester**		**2nd Semester**		**3rd Semester**		**4th Semester**		**5th Semester**		**6th Semester**	
A	**Mandatory 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	Bachelor Project (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)	6			Physics Practical II (PAP2)	7	Mandatory Seminar (PSEM)	2		
	Mandatory courses in Mathematics	**24**	Linear Algebra I (PMA1)	8	Mathematics for Physicists II (PMP2) *or* Calculus II (PMA2)	8	Mathematics for Physicists III (PMP3) *or* Calculus III (PMA3)	8						
B	**Job-related skills**	**20**	Skills for effective studying (UKS1)	4							Presentation Techniques (UKS2, only with PSEM)	1		
	Subject-specific skills		Introductory mathematics (UKV)	3	C++ Basics	1	Numerical Methods (UKNum)	3	Python: Programming for scientists	2			Introduction to Com-puter-Physics (UKWR2)	6
C	**Options (Astro-Theo)**	**31**					Introduction to Astronomy I (WPAstro)	4	Introduction to Astronomy II (WPAstro)	4	Theoretical Astrophysics (MKTP2)	8	Workproject (WPProj)	5
									Astrophysics Lab I (WPAstro)	2	Astronomical Techniques Compact (MVAstro1) *with* Astrophysics Lab II *or* Cosmology (MVAstro4)	6		
											MVSpec, e.g. "Star clusters"	2		
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	**Mandatory 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	Bachelor Project (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)	6			Physics Practical II (PAP2)	7	Mandatory Seminar (PSEM)	2		
	Mandatory courses in Mathematics	**24**	Linear Algebra I (PMA1)	8	Mathematics for Physicists II (PMP2) *or* Calculus II (PMA2)	8	Mathematics for Physicists III (PMP3) *or* Calculus III (PMA3)	8						
B	**Job-related skills**	**20**	Skills for effective studying (UKS1)	4					UK	1	Presentation Techniques (UKS2, only with PSEM)	1		
											UK	1		
	Subject-specific skills		Introductory mathematics (UKV)	3	C++ Basics	1	Numerical Methods (UKNum)	3	Data Analysis (UKBI2)	1	Python: Programming for scientists	2	Statistical Methods (UKSta)	3
C	**Options (Astro-Obs)**	**31**					Introduction to Astronomy I (WPAstro)	4	Introduction to Astronomy II (WPAstro)	4	Cosmology (MVAstro4)	6	Astronomical Techniques (MKEP5)	8
											MVSpec (Obs. the Big Bang)	3		
									Astrophysics Lab I (WPAstro)	2	Workproject (WPProj)	4		
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	**Mandatory 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	Bachelor Project (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)	6			Physics Practical II (PAP2)	7	Mandatory Seminar (PSEM)	2		
	Mandatory courses in Mathematics	**24**	Linear Algebra I (PMA1)	8	Mathematics for Physicists II (PMP2) *or* Calculus II (PMA2)	8	Mathematics for Physicists III (PMP3) *or* Calculus III (PMA3)	8						
B	**Job-related skills**	**20**	Skills for effective studying (UKS1)	4							Presentation Techniques (UKS2, only with PSEM)	1		
	Subject-specific skills		Introductory mathematics (UKV)	3	C++ Basics	1	Numerical Mathods (UKNum)	3	Python: Programming for scientists	2	UK	3	Statistical Methods (UKSta)	3
C	**Options (Astro-Sim)**	**31**					Introduction to Astronomy I (WPAstro)	4	Introduction to Astronomy II (WPAstro)	4	Fundamentals of Simulation Methods (MVComp1)	8	Computational Statistics and Data Analysis (MVComp2)	8
									Astrophysics Lab I (WPAstro)	2	Workproject (WPProj)	5		
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 divided into two phases, each lasting one year:

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

- **Phase 2 (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 the 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 **elective block** ("Wahlpflichtbereich") (76 CPs) **B:** Modules in the **specialization 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,C

Modules of the Study phase

Some modules are graded, some are not. Those which are will make up your final Master's grade, weighted by the number CPs in that module.

In the **elective block** you need to obtain a total of 16 CPs over the two semesters of the study phase (phase 1). The courses on offer are listed in the Master's module handbook with the code "MK…", which stands for "Master Kernmodul" (Kernmodul = core module). These courses are graded. The remaining 60 CPs are obtained in the research phase (phase 2).

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 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 (phase 2) you will focus on research. You first take the mandatory modules *Scientific Specialization* (MFS*)*, which is not graded, and the *Methods and Project Planning* (MFP), which is graded. Each is credited with 15 CPs towards what you need to obtain in the elective block. The remaining 30 CPs in this block come from the Master's thesis itself.

The goal of the *Scientific Specialization* (MFS) module is to learn about the subject area of your intended Master's project. This will be achieved through studying the relevant literature, perhaps attending specific courses, and by taking an active role in the research group in which you want to do your Master's thesis. For this reason, you should identify the subject area of your Master's thesis, and identify an appropriate research group, by the beginning of your third semester. Although it is possible to still change the topic for your Master's project at the end of the third semester, this should be avoided, because the MFS module may not be repeated. A late change would leave you with very little time to learn about your new subject, so we advise against this.

Following the subject specialization, the next step is to learn about the methods and tools you will need for carrying out your chosen research project. This is obtained in the *Methods and Project Planning* (MFP) module. This could include things such as how to analyse astronomical data, or how to use and modify a simulation programme. The topic of your Master's project must be fixed by the end of this module.

Note that in order to do MFS and MFP you must have a supervisor, generally the person who will also supervise your Master's project. You should therefore contact research groups and potential supervisors of interest before the start of the third semester. We describe below how to do this.

Once you have completed and passed MFS and MFP, you need to register your intended Master's project in the examination office of the Faculty of Physics and Astronomy. The *Master Thesis* (MFA) must be completed within sixth months. It is the final step of the physics programme.

Note that your final grade for the Master's is a weighted average of the grades you obtain in the core modules (MK…) in the elective block, the modules in the specialization block (MVMod and MVSem), the MFP module, and the Master's thesis (MFA). The weighting factor is the number of CPs for each module. You can find further information on this in the examination regulations (see links below).

The module handbook describes the different components of the Master's programme and gives a comprehensive list and description of the modules on offer. The current version can be found on the homepage of the Faculty of Physics and Astronomy.

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: MFS, MFP, MFA and
- apply ahead of time for a PhD position, preferentially when you start your reseach phase.

More details can be found in the official regulations ("Prüfungsordnung") for the Bachelor's programme or from the faculty's examination secretary ("Prüfungssekretariat").

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

Astronomy in the Physics Master's programme

Structure and variations in the astronomy course plans

You can use the flexibility inherent in the elective, specialization, and optional blocks to focus your Master's studies on astronomy. When doing this, you need to be aware of the requirements which some courses have on having completed other modules.

To help you navigate through the set of available courses, we have put together a few different course plans which take these dependencies into account, thereby ensuring that you fulfil all the requirements. There is nonetheless some freedom with these plans for you to pursue specific interests.

Please take care that you complete our recommended course plans (see below) by further modules in study block C to achieve the minimum number of CPs, i.e. 60 CPs in the first two semester of your study phase. However, according to your interests it may not be possible to choose a combination of courses which gives you exactly 60 CPs. You may end up exceeding this by a point or two.

We recommend four different course plans, which are summarized in tables 2a-d:

- **Astronomy as a minor option – Table 2a**
  This is intended for students who wish to focus on a different area of physics than astronomy, but who nonetheless would like to attend some astronomy courses. These are done entirely within the optional block. The recommended plans are in Table 2a, one for starting in the winter semester, the other for the summer semester. Note that additional CPs must be obtained in other areas of physics.

- **General astronomy– Table 2b**
  This plan is designed to give you a broad overview of astronomy. It is aimed at students who either only attended the *Introduction to Astronomy* (WPAstro) course during their Bachelor's, or who have not yet attended any astronomy courses. In the latter case it would not be appropriate to start your Master's in the summer semester, however, because the Master's introductory module (MVAstro0) is currently offered only as a block course at the beginning of the winter semester in September/October. The choice of courses suitable for this plan are shown in Table 2b, according to whether you start in the winter or summer semesters.

- **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-Theo), 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 theoretical astrophysics (Astro-Theo), 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. Note that the courses *Astronomical Techniques compact* (MVAstro1) and *Astronomical Techniques* (MKEP5) have significant overlap, so you are not permitted to take both (even if you took MVAstro1 during your B.Sc.).

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)

Tables 2a-d summarize the four course plans described above. In each case there is a table for starting in the winter and summer semesters. Nonetheless, the Master's programme has been optimized for starting in the winter semester (October). Due to the dependencies of later courses on earlier courses, starting in the summer semester (April) can limit your choice of courses.

Tables 2c,d are additionally split into three or two parts, respectively, depending on whether you pursue the theoretical, observational, or computational courses. The three colours in each table correspond to the three blocks - A,B,C - described above, to which the modules are assigned. Also shown in the tables is how many CPs you will achieve for each module upon its successful completion. Recall that the oral exam in the specialization block is on the subject of the courses done in MVMod in that block, and its grade applies to all the CPs you choose to take in that block (not just the six specifically assigned to the oral exam).

Table 2a: Course plan for your Physics Master studies with Astronomy as a minor option								
Start in winter semester								
	1st Semester		**2nd Semester**		**3rd Semester**		**4th Semester**	
	Elective block („Wahlpflichtbereich“) (76 CPs)							
	Specialization block („Vertiefungsbereich“) (24-28 CPs)							
	Optional block („Optionen“) (16-20 CPs)							
Astro as minor option	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 Specialization (MFS)	15	Master Thesis (MFA)	30
					Methods and Project Planning (MFP)	15		
	Advanced Seminar (MVSem) in the 1st or 2nd semester (6 CPs)							
	MVMod: 12-16CPs + 6CPs = 18-22CPs							
	...		...					
			Oral Examination	6				
	Astronomical Techniques Compact (MVAstro1) with Astrophysics Lab II *or* Cosmology (MVAstro4)	6 6	Stellar Astronomy and Astrophysics (MVAstro2) *or* Galactic and Extragalactic Astronomy (MVAstro3)	6 6				

Table 2a: Course plan for your Physics Master studies with Astronomy as a minor option								
Start in summer semester								
	1st Semester		**2nd Semester**		**3rd Semester**		**4th Semester**	
Astro as minor option	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 Specialization (MFS)	15	Master Thesis (MFA)	30
					Methods and Project Planning (MFP)	15		
	Advanced Seminar (MVSem) in the 1st or 2nd semester (6CPs)							
	MVMod: 12-16CPs + 6CPs = 18-22CPs							
	...		...					
			Oral Examination	6				
	Stellar Astronomy and Astrophysics (MVAstro2) *or* Galactic and Extragalactic Astronomy (MVAstro3)	6 6	Astronomical Techniques Compact (MVAstro1) with Astrophysics Lab II *or* Cosmology (MVAstro4)	6 6				

Table 2b: Course plan for your Physics Master studies with Astronomy on a general level

Start in winter semester

	1st Semester		2nd Semester		3rd Semester		4th Semester	
General Astronomy	**Elective block („Wahlpflichtbereich“) (76 CPs)**							
	Specialization block („Vertiefungsbereich“) (24-28 CPs)							
	Optional block („Optionen“) (16-20 CPs)							
	Theoretical Astrophysics (MKTP2)	8	Astronomical Techniques (MKEP5)	8	Scientific Specialization (MFS)	15	Master Thesis (MFA)	30
					Methods and Project Planning (MFP)	15		
	Advanced Seminar (MVSem)	6						
	MVMod: 12/14CPs + 6CPs = 18/20CPs							
	Cosmology (MVAstro4) *or* Introduction to Astronomy (MVAstro0), if no Astronomy courses were attended during Bachelor studies.	6 8	Stellar Astronomy and Astrophysics (MVAstro2) *or* Galactic and Extragalactic Astronomy (MVAstro3)	6 6				
			Oral Examination	6				
	Basis course tutors (UKTutor) *or* Tools (MUK)	3 6	General Relativity (MKTP3)	8				

Table 2b: Course plan for your Physics Master studies with Astronomy on a general level

Start in summer semester

	1st Semester		2nd Semester		3rd Semester		4th Semester	
General Astronomy	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: 12CPs + 6CPs = 18CPs							
	Stellar Astronomy and Astrophysics (MVAstro2) *or* Galactic and Extragalactic Astronomy (MVAstro3)	6 6	Cosmology (MVAstro4)	6				
			Oral Examination	6				
	General Relativity (MKTP3)	8	Basis course tutors (UKTutor)	3				

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

Start in winter semester

	1st Semester		2nd Semester		3rd Semester		4th Semester	
	Elective block („Wahlpflichtbereich“) (76 CPs)							
	Specialization block („Vertiefungsbereich“) (24-28 CPs)							
	Optional block („Optionen“) (16-20 CPs)							
Advanced Astronomy “Astro-Theo”	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: 15CPs + 6CPs = 21CPs							
	Cosmology (MVAstro4) *or* Astronomical Techniques Compact (MVAstro1) with Astrophysics Lab II	6 6	Advanced Cosmology (MVSpec) Galactic and Extragalactic Astronomy (MVAstro3)	3 6				
			Oral Examination	6				
	Fundamentals of Simulation Methods (MVComp1)	8	Stellar Astronomy and Astrophysics (MVAstro2)	6				
Advanced Astronomy “Astro-Obs”	Advanced Atomic, Molecular and Optical Physics (MKEP3)	8	Astronomical Techniques (MKEP5)	8	Scientific Specialization (MFS)	15	Master Thesis (MFA)	30
					Methods and Project Planning (MFP)	15		
	Advanced Seminar (MVSem)	6						
	MVMod: 15CPs + 6CPs = 21CPs							
	MVSpec (e.g. Obs. the Big Bang)	3	Galactic and Extragalactic Astronomy (MVAstro3)	6				
			Stellar Astronomy and Astrophysics (MVAstro2)	6				
			Oral Examination	6				
	Environmental Physics (MKEP4)	8						
	Astrophysics Lab II	2						
Advanced Astronomy “Astro-Sim”	Theoretiscal 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: 16CPs + 6CPs = 22CPs							
	Fundamentals of Simulation Methods (MVComp1)	8	Computational Statistics and Data Analysis (MVComp2)	8				
			Oral Examination	6				
	Cosmology (MVAstro4) *or* Astronomical Techniques Compact (MVAstro1) *with* Astrophysics Lab II	6 6	Galactic and Extragalactic Astronomy (MVAstro3) *or* Stellar Astronomy and Astrophysics (MVAstro2)	6 6				

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 („Wahlpflichtbereich“) (76 CPs)							
	Specialization block („Vertiefungsbereich“) (24-28 CPs)							
	Optional block („Optionen“) (16-20 CPs)							
Advanced Astronomy “Astro-Theo”	General Relativity (MKTP3)	8	Theoretical Astrophysics (MKTP2)	8	Scientific Specialization (MFS)	15	Master Thesis (MFA)	30
					Methods and Project Planning (MFP)	15		
	Advanced Seminar (MVSem)	6						
	MVMod: 16CPs + 6CPs = 22CPs							
	Galactic and Extragalactic Astronomy (MVAstro3)	6	Cosmology (MVAstro4) *or* Astronomical Techniques Compact (MVAstro1) *with* Astrophys. Lab II	6 6				
	MVSpec, e.g. Advanced Fluid Dynamics	4	Oral Examination	6				
	Stellar Astronomy and Astrophysics (MVAstro2)	6	Fundamentals of Simulation Methods (MVComp1)	8				
Advanced Astrnomy “Astro-Obs”	Astronomical Techniques (MKEP5)	8	Environmental Physics (MKEP4)	8	Scientific Specialization (MFS)	15	Master Thesis (MFA)	30
					Methods and Project Planning (MFP)	15		
			Advanced Seminar (MVSem)	6				
	MVMod: 14CPs + 6CPs = 20CPs							
	Galactic and Extragalactic Astronomy (MVAstro3)	6						
	Stellar Astronomy and Astrophysics (MVAstro2)	6	MVSpec (e.g. Star Clusters *or* Star Formation)	2				
			Oral Examination	6				
	Condensed Matter Physics (MKEP2)	8	Advanced Atomic, Molecular and Optical Physics (MKEP3)	8				
	Astrophysics Lab II	2						
Advanced Astronomy “Astro-Sim”	General Relativity (MKTP3)	8	Theoretical Astrophysics (MKTP2)	8	Scientific Specialization (MFS)	15	Master Thesis (MFA)	30
					Methods and Project Planning (MFP)	15		
	Advanced Seminar (MVSem)	6						
	MVMod: 12CPs + 6CPs = 18CPs							
	MVSpec, e.g. Advanced Fluid Dynamics	4	Fundamentals of Simulation Methods (MVComp1)	8				
			Oral Examination	6				
	Galactic and Extragalactic Astronomy (MVAstro3)	6	Cosmology (MVAstro4) *or* Astronomical Techniques Compact (MVAstro1) *with* Astrophysics Lab II	6				
	Stellar Astronomy and Astrophysics (MVAstro2)	6						

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 („Wahlpflichtbereich“) (76 CPs)							
	Specialization block („Vertiefungsbereich“) (24-28 CPs)							
	Optional block („Optionen“) (16-20 CPs)							
Career Astronomy “Astro-Theo”	Theoretical Statistical Physics (MKTP1)	8	General Relativity (MKTP3)	8	Scientific Specialization (MFS)	15	Master Thesis (MFA)	30
					Methods and Project Planning (MFP)	15		
	Advanced Seminar (MVSem)	6						
	MVMod: 15CPs + 6CPs = 21CPs							
	Cosmology (MVAstro4)	6	Advanced Cosmology (MVSpec)	3				
			Galactic and Extragalactic Astronomy (MVAstro3) *or* Stellar Astronomy and Astrophysics (MVAstro2)	6 6				
			Oral Examination	6				
	Fundamentals of Simulation Methods (MVComp1)	8	MVSpec, z.B. Advanced Fluid Dynamics	4				
			Statistical Methods (UKSta)	3				
Career Astronomy “Astro-Obs”	Theoretical Astrophysics (MKTP2) *or* Advanced Atomic, Molecular and Optical Physics (MKEP3)	8	Environmental Physics (MKEP4)	8	Scientific Specialization (MFS)	15	Master Thesis (MFA)	30
					Methods and Project Planning (MFP)	15		
	Advanced Seminar (MVSem)	6						
	MVMod: 14CPs + 6CPs = 20CPs							
	MVSpec, e.g. Small Stellar Systems *or* Extrasolar Planets	2	Galactic and Extragalactic Astronomy (MVAstro3)	6				
			Stellar Astronomy and Astrophysics (MVAstro2)	6				
			Oral Examination	6				
	MVSpec, e.g. Dark Matter-Theory & Experiments	4	UK	4				
	MVSpec, e.g. Statistical Methods in Particle Physics	4						
	Tools (MUK)	6						

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 („Wahlpflichtbereich“) (76 CPs)							
	Specialization block („Vertiefungsbereich“) (24-28 CPs)							
	Optional block („Optionen“) (16-20 CPs)							
Career Astronomy “Astro-Theo”	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: 12LP + 6LP = 18LP							
	Galactic and Extragalactic Astronomy (MVAstro3)	6	Cosmology (MVAstro4)	6				
			Oral examination	6				
	Stellar Astronomy and Astrophysics (MVAstro2)	6	Fundamentals of Simulation Methods (MVComp1)	8				
	MVSpec, e.g. Advanced Fluid Dynamics	4	UK	2				
Career Astronomy “Astro-Obs”	Environmental Physics (MKEP4)	8	Theoretical Astrophysics (MKTP2) *or* Advanced Atomic, Molecular and Optical Physics (MKEP3)	8	Scientific Specialization (MFS)	15	Master Thesis (MFA)	30
					Methods and Project Planning (MFP)	15		
	Advanced Seminar (MVSem)	6						
	MVMod: 14LP + 6LP = 20LP							
	Galactic and Extragalactic Astronomy (MVAstro3)	6	MVSpec, e.g. Small Stellar Systems *or* Extrasolar Planets	2				
	Stellar Astronomy and Astrophysics (MVAstro2)	6						
			Oral Examination	6				
	Astrophysics Lab II	2	MVSpec, e.g. Dark Matter-Theory & Experiments	4				
			MVSpec, e.g. Statistical Methods in Particle Physics	4				
			Tools (MUK)	6				

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 Faculty for Physics and Astronomy also maintains an online list of some of the projects on offer at the above institutes.

How can I spend a semester abroad studying astronomy?

Details will be provided here in due course, on, for example
- an exchange programme with the Universidad Catolica in Santiago, Chile
- funding through the DAAD
- which semester is most appropriate
- the requirements you need to meet
- etc.

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?

An interest in astronomy is reason enough to go ahead and study it at the Bachelor's or Master's levels. These programmes in Heidelberg are designed to ensure that, whatever speciality you choose, you will acquire a broad education in physics, thereby keeping your career options open. All jobs which are open for physicists are equally open to physicists who specialise in astrophysics.

You will of course also study astronomy if you want to do it professionally. The main employers here are of course universities and publicly funded research institutes, both at home and abroad. Astronomy, like many fields of research, is highly internationalized, so you will need to be flexible about where you work. More on this below.

Heidelberg physics/astronomy graduates have very good job prospects outside of university-based research. Physicists often work in hightech industry, such as optics, engineering, and microelectronics, in research or in the development of new products or production methods. There are also opportunities in finance, marketing, and computing, working with mathematical and computational models. Physicists are also under demand as (management) consultants, on account of their training to approach and solve complex problems. Graduates with a physics background can be found employed wherever physical processes or measurement processes are involved, in fields as diverse as

meteorology, geophysics, oceanography, environmental physics, chemistry, biology, materials science and medicine. Physicists are also essential in all levels of education and in journalism.

Those who wish to continue in astronomical research after their PhD will generally need to apply for a "postdoc" position on the international market. These are usually three-year positions, during which you develop your own research profile and expertise and get known via conferences and publications. There may follow one or more further postdoc positions before you have a realistic chance of landing a permanent job in astronomy, such as a professorship or permanent teaching or research position. In Germany, the Habilitation was traditionally the route to getting a professorship, although this may no longer be a requirement, depending on the university. Be aware that far more PhDs are produced in astronomy each year than permanent positions are available. A good research profile, relevant skills, good contacts, flexibility, and a bit of luck are the ingredients for success.

If you decide to leave academic astronomy after your PhD or subsequent postdoc employment, your job chances as an educated physicist are very good. A study carried out by the "Institut der deutschen Wirtschaft Köln" for the Deutsche Physikalische Gesellschaft (DPG) in 2010 (see http://www.dpg-physik.de/veroeffentlichung/broschueren/studien/arbeitsmarkt_2010.pdf) showed that physicists have a range of talents and skills which make them attractive right across the employment market. The unemployment rate among physics graduates is only 2-3%, and an average of 300 new jobs are created for physicists in Germany every year. The study also showed that graduates who took physics have above-average satisfaction with their choice of subject: 87% would choose it again. The latest report about job prospects for physicists has been published in the “Physik Journal”, 12/2014, p41.

Informationen in the Internet

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

- **How to apply:**
  www.physik.uni-heidelberg.de/studium/bachelor/bewerbung

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

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

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

- **The astronomy institute at Heidelberg University:**
  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:**
  www.physik.uni-heidelberg.de/studium/bachelor/

- **Examination regulations for the B.Sc.**
  www.uni-heidelberg.de/md/studium/download/physik_po_bachelor.pdf

- **Physics M.Sc. module handbook:**
  www.physik.uni-heidelberg.de/studium/master/

- **Examination regulations for the M.Sc.**
  www.uni-heidelberg.de/md/studium/download/physik_po_master.pdf

- **Information on the astronomy lab course:**
  www.lsw.uni-heidelberg.de/seminars/

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

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

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

Dictionary of terms

German	English
Astrophysikalisches Praktikum	Astrophysics Lab course
Bachelorstudium	Bachelor's programme
Bachelorarbeit	Bachelor's project (or thesis)
Fachschaft	student committee
Fachspezifische Zusatzqualifikationen	subject-specific skills
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	elective block
Wahlbereich	optional block