Students can participate in European or worldwide research activities in which for example actual measurements of astronomical and cosmic activity
are made to developing the theoretical insights for explaining observations – such as the phenomenon of dark energy. In Heidelberg, students have direct access to modern equipment.

4.2 Theoretical skills

Graduate students doing research purely in theoretical physics – in any of the three branches – are required to have extremely strong mathematical and analytical skills, which are further developed in the course of their research. Developing models that highlight the fundamental features of the systems studied, their (often extremely difficult) analytical and computational solution makes the theorist an ideal problem solver for many different types of complex problems. The knowledge required of the fundamental theories as well as the experimental environments underlying the validation of the physical hypotheses once again necessitate a strongly analytical mind that is able to synthesise and create new ideas. From a physical point of view, knowledge of the influence of strong electromagnetic fields, equilibration processes, particle interactions as well as the effects of high/low temperature and densities are usually part of the knowledge profile of the student. Computing is a basic central competence of the student who chooses research in a theoretical field.

4.3 International exchange programme

Students of the HGSFP will be able to participate in the extensive international exchange programme of the School. Within this programme it is forseen that student exchanges with leading physics institutions around the world occur within the three branches of the School. Here already well-established institutions such as the physics departments at Stanford, Harvard and JILA in the USA, SISSA in Italy, ITEP in Russia, the ENS in France have expressed their interest. Furthermore a guest programme with these institutions will be established.

4.4 Other skills

Within the HGSFP, other skills that may be helpful to further the careers of students are on offer. These include key competencies such as writing scientific texts and time and project management.

4.5 Scholarships

A limited number of PhD scholarships for study at the HGSFP are available.

5 Organisation

The School is governed by a directorate consisting of three faculty members (one per physics branch), the administrative director of the school as well as a graduate student representative. The Central Office of the HGSFP handles all organisational issues with respect to the School and is the seat of the administrative director.

6 Contact

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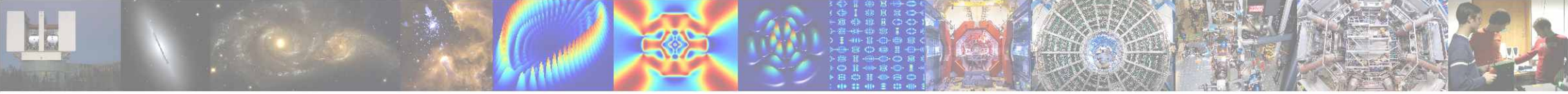
Heidelberg Graduate School of Fundamental Physics

General Information

http://www.fundamental-physics.uni-hd.de



1 General Information

The Heidelberg Graduate School of Fundamental Physics (HGSFP) has been established in Heidelberg in recognition of the scientific excellence of the fundamental physics done at Heidelberg University by the Excellence Initiative of the German Federal and State Governments.

The School will regularly invite applications from students local and abroad to the doctoral programme.

2 Background information and goals

A substantial grant awarded by the Excellence Initiative allows the Department of Physics and Astronomy to introduce and develop modern concepts of doctoral training in physics to increase its status of excellence both within Germany and abroad.

In our time of exciting developments all across fundamental physics, it must be a goal of the most interested PhD students to extend their knowledge beyond their immediate area of research to neighbouring branches of physics to see where seemingly disparate fields of physics grow together and depend on each other. Active learning, cross-disciplinary discussions involving students and staff alike, international exchange and mentoring are the key concepts of modern graduate training. A modular training programme and flexible entrance requirements serve to allow easier acceptance of foreign students from different countries, who come to Germany with varying degrees according to their countries of origin. The doctoral programme will be integrated with the Bachelor-Master system.

The new concept for the doctoral programme at the Heidelberg Graduate School of Fundamental Physics addresses these points. It has specifically been approved of and funded by the Excellence Initiative of the central government through the Deutsche Foschungsgemeinschaft (DFG - German Research Foundation).

3 Branches of Physics of the Graduate School

Three of the most exciting and rapidly developing branches of physics are well represented at the University of Heidelberg and the local research institutions. They form the core of research around the Graduate School.

These branches are

- The physics of elementary particles and their fundamental interactions, which will experience dramatic evolution as the Large Hadron Collider at CERN goes into operation this year
- The physics of complex quantum systems, for which Bose-Einstein condensates, the physics of disordered systems or atomic and molecular quantum dynamics are prominent examples
- Astronomy and Astrophysics, which is faced with the mysterious discoveries of dark matter and dark energy and which depends on links to all areas of physics, from quantum dynamics to relativity

The branch of the Graduate School dealing with Astronomy and Astrophysics is identical with the International Max Planck Research School of Astronomy and Cosmic Physics at the University of Heidelberg.

4 Benefits to industry through the high skill profile of Heidelberg graduate students

Students graduating from the Heidelberg Graduate School of Fundamental Physics benefit industry through the wide range of skills that they acquire.

First, it is assumed that students entering the Graduate School have an excellent knowledge of basic physics, including mechanics, electromagnetism, quantum mechanics, statistical mechanics and thermodynamics. Both theoretical as well as experimental knowledge is assumed, with slight specialisations through a master's thesis. This basic knowledge is deepened throughout the period of the doctoral study.

During the course of the doctoral study, additional skills are obtained which may differ according to the profile chosen by the student. The largest differing criterion in skill profile is the education as an experimentalist or theorist.

4.1 Experimental skills

Students pursuing doctoral study in an experimental field in physics develop a wide range of skills that can be both hands-on but also analytic. The possibilities are delineated below:
Students researching in experimental particle physics have a chance of being at the cutting edge of research in the world, as Heidelberg Institutes play a leading role in the CERN collaborations in Geneva. In Heidelberg, detectors and electronics are designed and built. As such, students obtain competencies in fields ranging from embedded to large computational systems for detectors. They may also play a pivotal role in such new endeavours as Grid Computing. Analysis and interpretation of results play a further central role. Knowledge of particle properties and their interactions with materials is an essential part of their knowledge and rounds this profile.
Students who decide to do research in complex quantum systems also have many opportunities for hands-on experimentation. Here a focus may lie on low temperature systems. Laser optical systems for trace element detection, laser cooling and magnetic traps, as well as ultracold atomic systems offer a rich environment for fundamental research for the experimentalist.
Here again, students obtain competencies in designing, building and operating the requisite systems, data taking, computation and analysis. In addition to this, students learn the complex theories underlying the experiments and devise methods of verifying these.
For students who are trained in the fields of astronomy and cosmology, no distinction is made between theory and experiment, as these are extremely closely linked.