The Department of Physics

at the Philipps-University

Marburg

Past and Present

By courtesy of Karl-Heinz Kretschmer

The past

Physics has a longstanding tradition at the Philipps-University going back into the 16th century. This scientific area, which at that time naturally differed greatly from contemporary physics, was covered by Antonius Niger (in Marburg from 1533-1536), the first professor of natural philosophy, Burkhard Mithoff (1531-1536), astronomer and professor of anatomy and mathematics and by Victorin Schönfeld (1557-1591), who also taught medicine. Around 1700 Johann Daniel Dorstenius, professor of medicine (1695-1706), started a collection of physical equipment.

From 1688 to about 1697 Denis Papin, a student of Christian Huygens, worked as a professor of mathematics in Marburg. He was called to the court of Landgrave Karl in Kassel in 1695. Denis Papin is regarded as one of the great physicists of the Philipps-University. He became famous by constructing the first steam-powered water pump. Papin's continual improvement of this device eventually led to his inventing the safety valve. This work was stimulated by his correspondence with Gottfried Wilhelm Leibniz, who reported similar developments from England (Savery, 1698). Papin invented the pressure cooker now named after him and which is still used while he was in London before he came to Marburg.

The Dörnberger Hof (Renthof 6, first home of physics) and the Renthof 5

Among the physics professors in Marburg, many of whom were actually physicians who also taught physics, was the internationally renowned philosopher, mathematician and physicist Christian Wolff (1724-1740). Michail W. Lomonossow, probably his most well-known student (1736-1739), translated Christian Wolff's book on experimental physics into Russian (Wolfianskaja experimentalnaja fisika, St. Petersburg, 1746). Many terms that Lomonossow borrowed from Wolff are still being used in the Russian scientific literature.

The availability of experimental equipment was rather limited in this era. Requests to the Landgrave in Kassel for funding were often without success and teaching conditions were far from ideal.

The Renthof 5, main building of the Physics Department

Teaching and research in physics in the contemporary sense started only in 1817 with the appointment of Christian Ludwig Gerling (1817-1864) as professor of mathematics, physics and astronomy in Marburg. Gerling was a close friend of Carl Friedrich Gauß who had a chair in Göttingen. His scientific interest focused on geodesy and the development of its methods. He is known for his application of the Gaussian method of least squares to the field of geodesy, on which he published a book in 1843. Apart from his activities in the field of geodesy, Gerling carried out meridian measurements. A measuring station was set up in Marburg in order to support the measurements of the earth's magnetic field initiated by Gauß and Weber and measurements were carried out regularly.

In the meantime, other chairs in physics had been established. Carl Herrmann Knoblauch (1849-1853) first taught as an extraordinary professor in Marburg and was later appointed full professor of experimental physics. The Irish physicist John Tyndall, known for his research on light scattering in colloids, thermoelectricity and magnetism, worked for Knoblauch for quite a long time. Knoblauch was a very active scientist who also got involved in academic politics. His work paved the way for new concepts in the field of energy conservation. His greatest success was an explanation of the nature of thermal radiation. He was one of the five founders of the Physical Society in Berlin and in 1878 he became chairman of the Akademie Leopoldina in Halle.

His successor Rudolf Arnd Kohlrausch (1853-1857) is more well-known. After the University of Rinteln had been dissolved, Kohlrausch was transferred first to Kassel and later as teacher to the grammar school Philippinum in Marburg for disciplinary reasons. He and his colleague Wilhelm Weber from Göttingen succeeded in demonstrating that the ratio of magnetic and electrostatic units contains the velocity of light. In the Kohlrausch-Weber experiment (1856), they were able to obtain a result which - apart from a misinterpreted factor 2 - corresponds to the presently known velocity of light with a precision of 3.65 %. This incredibly precise result for the time showed that electric and magnetic phenomena must be related to light and thus comprised part of the foundation on which Maxwell's theory of electrodynamics was built.

Gerling was succeeded by Franz Emil Melde (1864-1901). During his tenure Marburg was annexed by Prussia (1866). As a consequence, the University experienced an until then unprecedented upswing. Melde supported modern phycics instruction and developed laboratory instructions into an effective form of teaching. In addition to research in the fields of continuum mechanics, current dynamics, and meteorology, his major scientific contribution was in acoustics. During work with oscillating strings he discovered the principle of the parametric amplifier, a principle which is still relevant today. Melde received a number of awards for the scientific devices he developed. One of them was a certificate he received at the world exhibition in Chicago in 1893.

From 1877 to 1880 Ferdinand Karl Braun held a position as extraordinary professor of theoretical physics in Marburg. In 1909 he and Marconi received the Nobel Prize for their contributions to wireless telegraphy. The Braun tube, still an indispensable part of TV and computer screens, and the crystal detector, one of the first semiconductor devices, are still known today. The assistant lecturer Friedrich Wilhelm Feußner (1880-1918) is regarded as having initiated the subject of Theoretical Physics in Marburg (1910). Hence, it is justified to say that Theoretical Physics has been an independent area of research in Marburg since the end of the 19th century.

Melde's successor Franz Joseph Matthias Richarz (1901-1920) was the director of the Physical Institute. He established the tradition of research in the physics of solids in Marburg which continues to this day. He also carried out investigations of the Heusler alloys which he had started while he was at the University of Greifswald. Heusler alloys, which were discoverd by Dr. Heusler, the director of the iron works in Dillenburg (Isabellenhütte), are magnetic metals which do not contain iron, cobalt or nickel. A small 'iron-free', neobaroque pavilion-like building was constructed specifically for the purpose of carrying out sensitive magnetic measurements. It now houses the telephone switchboard of the Department. While these investigations did not lead to any practical applications for several decades, the explanation of this phenomenon was a challenge for the newly developed quantum mechanics. Heusler alloys have recently become interesting in the context of spin electronics, which some scientists believe has the potential to become the basis for quantum computing. Other scientific work by Richarz dealt with the median density of the earth and gravitation. A shaft in the stairwell of the building Renthof 5 still testifies to that. His work on the molar heat capacity led to a scientific dispute with Einstein. Richarz was the first chairman and one of the founders of the Kurhessische Verein für Luftschiffahrt (an association for the advancement of airship travel in Hesse), which was established in 1909. Another member of this association was the meteorologist Alfred Lothar Wegener, who is also mentioned below.

Haus Richarz, now home of the library and the Theoretical Semiconductor Physics group

At that time theoretical physics was represented by Franz Arthur Schulze, who was first an extraordinary (1919) and later a full professor (1922-1937). His main area of expertise was the theory of relativity.

F.A. Schulze was succeeded by Erich Hückel, the 'father of theoretical chemistry'. Hückel became extraordinary professor of theoretical physics in 1938 and received the status of full professor only shortly before his retirement in 1962. Numerous modern methods in the fields of quantum chemistry and solid state physics are based on his work and he is known among all solid state physicists and chemists. In this context the Debye-Hückel- and the molecular orbital theory (HMO) should be mentioned. They are the basis of quantum chemistry and are known to all chemists.

The iron-free pavilion

Alfred Lothar Wegener, one of the greatest scientists of the Philipps-University, worked in Marburg during Richarz' term of office. After his habilitation in the fields of astronomy, meteorology and cosmic physics in Marburg, he became the director of the observatory in 1910. He subsequently became lecturer and was finally granted the title professor in 1916. Wegener became widely known for his pioneering theory on continental drift (1911). Although it was thought ludicrous at first, it has since been confirmed and is now quite acclaimed. More of local interest is his successful search for a meteorite which impacted in a forest near Treysa in 1916. This was the first meteorite whose orbit had been calculated (by Wegener). These calculations showed that meteorites can be part of our solar system and do not have to be of interstellar origin. Unfortunately, Richarz did not manage to obtain a permanent post for Wegener. He left Marburg in 1919 for Hamburg and later went to Graz. In 1930 he died during an expedition to Greenland.

The memorial plate for Alfred Wegener

Richarz' successor, Clemens Schäfer (1920-1926), is still well-known among physics students because of his textbooks. His extensive research included optics, thermodynamics, elasticity and even physico-physiological projects. He was committed to academic self-government and eventually served as rector of the Philipps-University.

Work in the already established field of solid state physics was continued by Eduard Grüneisen (1927-1947), who succeeded Schäfer. He worked mainly in this field and contributed important publications on elastic, thermal and electrical properties of solids which are still cited today. In this context, one should mention the Grüneisen parameter and the Grüneisen relation which established the relation between thermal extension, molar volume and compressibility on the one hand and specific heat capacity on the other hand. However, his lectures were not very popular and it is said that his students had a hard time with him. On the other hand, his behavior during the difficult times of the Nazi-dictatorship was exemplary and he thus was able to uphold the reputation of the Physics Faculty and of physicists in Marburg. Because he did not hide his disdain for the ruling power, he could not count on any financial support for his Faculty.

After the Second World War four chairs - two of them in physics - were established in the Department of Natural Sciences of the Philosophical Faculty on the initiative of the mathematician Kurt Reidemeister during his tenure as dean. In 1946 Siegfried Flügge (1946-1961) was appointed professor of structure of matter. This chair was established for him especially and he became director of the institute of the same name. Flügge further expanded the tradition of quantum mechanics in Marburg established by Hückel. He concentrated on theoretical nuclear physics and general aspects of quantum mechanics. Every German physics student knows his textbook "Rechenmethoden der Quantenmechanik" (published in cooperation with Hans Marschall). He was also editor of the renowned "Handbuch der Physik" for many years.

In 1947 Wilhelm Walcher (1947-1978), a full professor, became director of the Physical Institute succeeding Grüneisen. Walcher investigated the optics of electrons and ions. He played an important role in the development and construction of mass separators and accelerators. Atomic spectroscopy, Mößbauer effect, nuclear reaction and optical pumping were only some of the activities associated with the Physical Institute in Marburg. The so-called Beschleunigerturm (accelerator tower) which was built in 1955 still testifies to the important developments contributed to this field by Walcher at that time. The Department of Physics as well as innumerable students remember appreciatively his commitment to teaching. His lectures were well-known in Marburg, even outside the Department. They were influenced by the so-called Göttinger Schule (a particular teaching theory) which was established by Pohl. These lectures have served as a model of interesting and motivating teaching for his successors in experimental physics. Walcher's reputation in Marburg is still undiminished.

Apart from that Walcher was an important and influential member of numerous committees on a national and international level. His main interest was the establishment of several large-scale research institutions in the Federal Republic of Germany. He was a member of the board of directors of the Deutsche Elektronen-Synchroton (DESY, German Electron Synchroton) in Hamburg and he was one of the founding fathers of the Gesellschaft für Schwerionenforschung (GSI, Society for Heavy Ion Research) which was set up in Darmstadt. Walcher was rector of the University from 1952 to 1954. From 1959 to 1961 he was chairman of the Deutsche Physikalische Gesellschaft (German Physical Society), which he refounded by merging the existing physical societies in the individual states, and from 1961 to 1967 he was vice president of the Deutsche Forschungsgemeinschaft (German Research Council). His political commitment is also worth mentioning. He was part of a political group called the Göttinger Achtzehn which issued a manifesto against nuclear armament.

From 1927 to 1963 solid-state physics was also represented by Eckhardt Vogt. He started as an assistant of Grüneisen, who held him in high esteem, and habilitated in 1932 in Marburg. In 1938 he was appointed extraordinary professor. Vogt continued the research on Heusler alloys and other magnetic metals and was highly respected in industry.

In 1955 Hans Wolter was appointed to the newly established chair in applied physics (1955-1976). He dealt with numerous application-related problems on a theoretical as well as on an experimental level, among them optics, schlieren and contrast methods, theory of color (color television), physics of antennas and microwaves, cybernetics, and medical applications. During his time in Marburg the surgeon Zenker, who was the first to carry out an operation using a heart-lung machine, developed a blood pump in cooperation with the Physical Institute and the Institute of Applied Physics. This blood pump may be regarded as the precursor of the heart-lung machine and its prototype still exists. Wolter's X-ray telescope is regarded as one of the most important instruments in modern extraterrestrial physics.

The Castle and the Renthof 7, now housing the Neurophysics Group

The Faculty of Physics had a very clear structure at that time. In the mid-fifties there were three institutes: the Physical Institute (director: Walcher), with a department of theoretical physics (Hückel), the Institute for Structure of Matter (director: Flügge) and the Institute for Applied Physics (director: Wolter). The lecture schedule of the summer semester of 1957 only mentions eight *lecturers. Apart from the above mentioned there were Vogt, Huster, Becker and Madelung. A comparison to the present lecture schedule will demonstrate how much has changed since then.*

Günther Ludwig (1963-1983) was the head of the department of theoretical physics and was also Flügge's successor after Flügge went to Freiburg in 1961. Ludwig's name is strongly connected with research on the foundations of physics, in particular of quantum mechanics. His textbooks are among the most demanding for students. He also gained a high reputation worldwide for his work on scientific theory which dealt with the topic "What is a physical theory?". It is due to his commitment that Marburg was known to be especially dedicated to theoretical physics for a long time.

Tremendous progress in physics resulting in the development of many new areas of research led to an expansion of the teaching staff at German universities. This trend could also be observed in Marburg where increasing numbers of students also contributed to the expansion of physics. First of all, new chairs were established in the area of theoretical physics. Joachim Petzold (1962-1996) succeeded Hückel as full professor of theoretical physics. His areas of expertise were quantum mechanical scattering theory, physics of fields and later primarily EEG-analysis. Three more chairs for theoretical physics were established in addition to the two already mentioned. Their names demonstrate the shift of focus in physics at the University of Marburg:

Otfried Madelung (1962-1987) was appointed to the chair of theoretical solid-state physics. Siegfried Großmann (extraordinary professor in 1963, full professor from 1966 to 1998) was appointed to the chair of mathematical physics and Gerald Grawert (1965 - 1995) to the chair of theoretical nuclear physics. These chairs were then grouped together as the Institutes of Theoretical Physics I - V.

Two new chairs were established in experimental physics, reflecting and complementing the developments in theoretical physics.

Josef Stuke (1967-1983) was appointed to the chair of experimental solid-state physics and Rudolf Bock (1967-1995) to the chair of experimental nuclear physics. In 1970 Bock was granted a leave of absence to work at the Gesellschaft für Schwerionenforschung (GSI, Society for Heavy Ion Research) in Darmstadt until his retirement and became one of the directors of this scientific research center.

The five chairs for theoretical physics and the four chairs for experimental and applied physics covered a broad spectrum of research and teaching. In addition to Walcher's experimental research areas, Stuke's chair covered research on experimental semiconductor physics while Bock treated *experimental nuclear physics. Madelung's group investigated theoretical problems in semiconductor physics focusing on bandstructure calculations. His textbooks on semiconductor physics and solid-state theory are well-known. Madelung was also the editor of a data collection on semiconductor materials (the Landolt-Börnstein) for many years. Grawert dedicated himself to nuclear physics problems, in particular to scattering theory, and Großmann, who concentrated on mathematical and statistical physics, was especially successful in the field of chaos theory and nonlinear dynamics. His works on turbulence are regarded as classics. In 1977 here in Marburg, Großmann and Thomae first determined one of the most important constants in nonlinear dynamics, the bifurcation scaling exponent. While this picture suggests extensive cooperation between theorists and experimentalists at an early time, particularly successful, lasting, and extensive cooperation existed, at the beginning, only in the area of semiconductor physics. In other fields the degree of such cooperation varied strongly from time to time and from problem to problem.*

During the turbulent times of "68" Madelung was rector of the University. The politically motivated students' movement of 1968 was only one of the things that had a significant impact on his year in office; he was also responsible for the difficult task of writing a new charter for the University and of adapting it to the new Hessian university law, an undertaking that threatened to destroy the inner peace of the University. Demonstrations, violent disruptions of lectures and other actions were the background for his rather difficult political activities as rector. Nevertheless he managed to avert harm to the University in these turbulent times of radical change. Fortunately, the Department of Physics, like most other departments of natural sciences and medicine, was hardly affected by these events.

In the seventies, after it had temporarily been called Sektion Physik (Section of Physics), the new Hessian university law designated the Physics Faculty Fachbereich Physik (Department of Physics) one of the eight departments of natural sciences. This marked the official end of the organisational unit of the faculties of natural sciences. Deans, who were elected for one year now became the executive force in the Department of Physics rather than institute directors. Decisions were made by the Fachbereichsrat (committee for the academic self-government on a departmental level) which consisted of professors, scientific and non-scientific employees and students. Research groups were created and replaced the institutes as subdivisions. Several professors with related scientific interests and their co-workers and students work together in these groups. The lecture schedule of 1991, for example, mentions 15 of these research groups. Depending on their interests professors and their co-workers can be members of several research groups.

A special feature of the University of Marburg is the emergence of the physics education group, which supports physics student teachers as well as physics teachers. Shortly after the Second World War, the Physics Faculty had already started to take a special interest in teacher training. Specific, needs-oriented seminars and lectures were offered to secondary school student teachers. They also participated in setting up experimental demonstrations for the lectures. Theses for the State Teaching Examination were allowed to be tailored to future teaching responsibilities. Special theoretical lectures for student teachers were first offered at this time. Due to these measures, it was unnecessary to establish special chairs for teacher training as was then propagated. The group was set up by a senior teacher of a local secondary school, who was employed by the University especially for this purpose.

In an effort to better the prospects of the members of the non-professorial teaching staff as well as to provide better guidance for students, many assistant lecturers, lecturers and senior assistant lecturers were granted the status of professors. These measures were not restricted to Marburg or Hesse but they were implemented particularly thoroughly in the Department of Physics of the Philipps-University. As a consequence this Department had about 20 H2 and H3 (later C2 and C3) professors in addition to the nine H4 (later C4) professors.

Backgroud left: the lab building of the Experimental Semiconductor and the Surface Physics Groups

The present

The establishment of the Department of Physics and its research groups marks the start of a new era which continues through the present day. The large number of professors makes it impossible to mention every one of them here. Therefore, only those who made influential contributions which *paved the way for future developments and who are currently no longer active members of the Department will be mentioned. We leave the acknowledgement of the presently (summer 2002) active members of the Department for future generations.*

As a result of the quick increase in the number of lecturers the Department was able to break new ground in teaching. Tutorials were introduced to complement the introductory experimental physics lecture. These tutorials not only reviewed and deepened the subject matter of the lectures through exercises but also could be used to present new and, in particular, theoretical material. Students could now be allowed to start either in the winter or in the summer semester. The courses for student teachers could be separated from those for students who wanted to achieve a diploma. In addition, it was possible to offer complementary and more specialized courses, the practical training for advanced students could be updated and could become more research-oriented, and the courses for students minoring in physics could be better adapted to their needs.

Unfortunately, the expansion of other sectors of the University soon restricted those new opportunities. Positions that became vacant were often transferred to other departments. In order to counteract this uncoordinated transfer of vacant positions a structural scheme was set up in cooperation with the government of Hesse at the beginning of the eighties, while Prof. Madelung was dean of the Physics Department. Surprisingly, this scheme is, in general, still valid today. On paper, the Department is granted about 19 professors, and about 50 positions for scientists in total which are paid by the state of Hesse. Later, at the end of the eighties, this plan was updated and has recently been adapted to the present circumstances. At the beginning of the 21st century the Department of Physics has seven C4 and twelve C3/C2 professors, 52 scientific employees (including the professors) and 54 additional employees on positions financed by the state of Hesse. In addition, the Department, fortunately, also has been able to obtain external funds and therefore also has externally funded positions which ensure successful research. In the summer semester 2001, there were 54 such positions.

In the following presentation of the present research groups and their achievements in the areas of research and teaching a chronological ordering will be abandoned.

The present structure of the Physics Department includes numerous research groups, which focus on four research areas and can accordingly be grouped together as follows:

- *Neurophysics: neurophysics group*
- *Atomic and nuclear physics: atomic physics group, heavy ion physics group*

- Solid state physics and material sciences: experimental semiconductor physics group, theoretical semiconductor physics group, nuclear solid states physics group, surface physics group
- Theoretical physics: foundation of physics group, statistical physics group, complex systems group, many body theory group

This structure reflects the organization of the physical institutes that existed in the sixties and was described above. The following observations will show that while a subdivision into several research areas within these four categories exists, various forms of cooperation increasingly dominate the work of the Department of Physics in Marburg including joint projects within the Department and the University as well as with research groups at other universities in Germany and abroad.

Neurophysics

This group can be regarded as the successor of the Institute for Applied Physics. In 1978 Wolter was succeeded by Heribert Reitböck, who had been working for Westinghouse, USA. Reitböck established a biophysical research group, the neurophysics group in Marburg, which dealt with such fascinating topics as brain function, and natural and artificial intelligence. In the meantime, the focus of this group has shifted to problems connected with vision and automatic pattern recognition. Promising projects, like for example retina implantation, attract many students to this group. Multi-electrode contacts are a pioneering development. They are used worldwide for in vivo nerve leads. This research has led to the foundation of a start-up company.

Atomic and nuclear physics

When the research groups were founded in the early seventies, Walcher's Institute for Experimental Physics was divided into numerous smaller units. This was not at all surprising considering the wide range of Walcher's interests, which included atomic physics, surface physics, and nuclear and high energy physics. These groups later maintained a formal cooperation based on the well functioning infrastructure of the former institute.

Scientist in the atomic physics group working on atomic spectroscropy profited from the mass separator on the one hand, and on the other hand they were able to quickly make use of laser technology, and thus were able to provide amazingly precise information on the electron shell and its interaction with atomic nuclei. The Van-de-Graaff-generator, which was set up to replace the original accelerator, was used for highly sensitive nuclear physics analyses which were applied to physical, medical and environmental problems.

Some members of the former Physical Institute founded further research groups dealing with high energy and nuclear physics in cooperation with theorists. The high energy group emerged from the collaboration with the large research centers DESY (Deutsches Elektronen-Synchrotron, German Electron Synchrotron) in Hamburg and GSI in Darmstadt. However, after the retirement of the faculty working in these groups, the Department of Physics decided to discontinue these projects in order to develop other focal points of research.

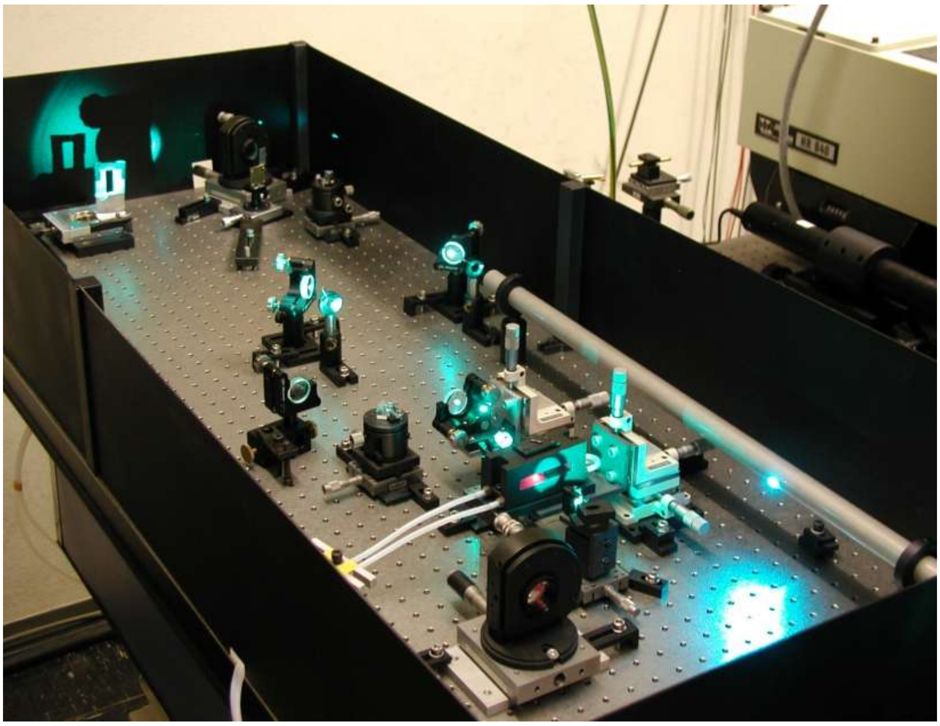
The heavy ion physics group, which emerged from the Institute of Nuclear Physics, continued to be closely associated with the large research centers. After Bock retired, the Department decided to continue this research direction rather than nuclear physics research in the classical sense. For this reason many Ph.D. and Master's students as well as their supervisors still often visit the GSI in Darmstadt in addition to the Max-Planck-Institute for Nuclear Physics in Heidelberg and CERN in Genf. At present, part of the research group is involved in a CERN project to investigate the quark-gluon plasma, a new form of hadronic matter.

Another research group which emerged from Walcher's institute concentrated on surface physics. Making this a central field of research in the following years was an obvious choice considering the other activities of the Department in the field of solid state physics. The expansion of the research areas of the heavy ion physics group, which resulted from merging with the surface physics group, will be discussed below.

Hans Ackermann (1978-2000) became Walcher's successor. He worked in the field of solid state physics using nuclear methods. These two research areas are now contained in solid state physics and material sciences groups and will therefore be discussed below.

Solid state physics and material sciences

The fragmentation caused by the establishment of research groups was soon found to be a problem. Madelung and Stuke decided to found a semiconductor physics group consisting of two professors of theoretical and three professors of experimental physics to counteract this development. This model proved to be very successful and was both highly regarded and imitated internationally. From the sixties to the eighties, this group investigated electronic properties of technologically relevant semiconductors focusing increasingly on amorphous semiconductors. Electrical transport *phenomena and optical characterization were dealt with experimentally. In addition, the application of these materials for devices such as solar cells from amorphous hydrogenated silicon was investigated. This experimental research was supported by theoretical work which focused on the influence of disorder on electronic properties of solids. In the course of time, Marburg became an internationally recognized center for research on disordered semiconductors.*



From the labs

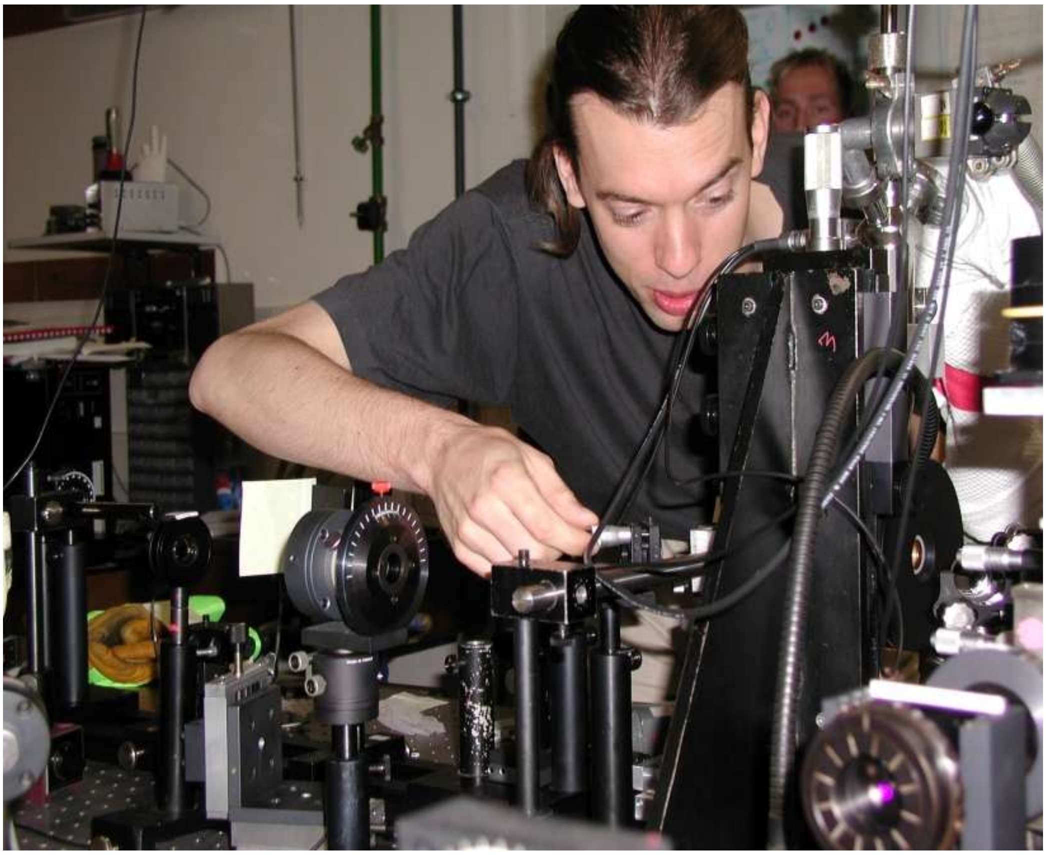
At that time molecular crystals and polymers had already been investigated for a long time in the Department of Physical Chemistry, which merged with the Department of Chemistry in 1997. The electronic properties of these organic materials and the theoretical concepts for their interpretation are in many respects similar to the inorganic disordered semiconductors investigated by the semiconductor physics group. Therefore, the physical chemistry groups and the semiconductor physics group developed a fruitful collaboration which even included the exchange of Ph.D. and Master's students. At that time, the government of the state of Hesse decided to support the emergence of research centers. In this context Madelung developed the concept for a Material Sciences Center (Wissenschaftliches Zentrum für Materialwissenschaften, WZMW). This initiative was supported by other members of the Department of Physics and of other departments and led to the foundation of this center in 1989. Physicists, physical chemists, chemists and geoscientists work together in this project. In the following years, the center was granted extensive financial support. The foundation of the Technology Laboratory turned out to be particularly successful. It fabricates and characterizes semiconductor structures, which are then investigated by the semiconductor physics group.

It should first be mentioned, however, that the successor to Stuke, Ernst Otto Göbel (1985-1995, since then honorary professor) changed the orientation of the semiconductor physics group. Göbel was an expert in the field of ultrashort time spectroscopy of semiconductors and semiconductor heterostructures. This research area was going through tremendous changes at that time, above all due to the availability of laser systems, which made it possible to generate extremely short light pulses. In addition, various epitaxial processes were available which facilitated the production of semiconductor structures with almost atomically smooth interfaces. One of these techniques (metal-organic chemical vapor deposition) could be set up in the Technology Laboratory of the Material Sciences Center. Due to the fruitful collaboration with chemists in Marburg sources were developed which, in contrast to the extremely poisonous, conventionally used materials, are much less harmful to the environment. These originally purely scientific activities led to the foundation of a company.

Although the research focus of the semiconductor physics groups shifted back to crystalline structures in Göbel's era, the expertise in the area of disordered systems that had been achieved by this group could still be used as the heterostructures which were investigated always have some disorder at their interfaces. Therefore, an understanding of the influence of disorder on optical and transport phenomena is necessary to interprete the experimental results. The Physics Department decided not to continue to make the research on amorphous semiconductors one of its research focuses after Walther Fuhs, who covered this area, left Marburg to take the position as one of the directors of the Hahn-Meitner-Institut in Berlin. Disorder in solids did, however, remain one of the main features of the semiconductor physics group and it is a research area that is also of interest to the research groups of the former Department of Physical Chemistry, where polymers and liquid crystals are investigated. These technologically important materials can only be understood and optimized if the structural disorder is considered on a molecular level.

In addition to the final establishment of the Material Sciences Center, Göbel's main and most significant merit was the active and inspiring role he played in establishing two research and teaching institutions.

Working in the lab



A number of scientists from the Material Sciences Center applied for the establishment of the Graduate College - Optoelectronics of Mesoscopic Semiconductors which came into being on April 1, 1993. The semiconductor physics group, the physical chemistry group, the Technology Laboratory of the Material Sciences Center, and later the many body theory group as well as the surface physics group were involved in the Graduate College. An average of 30 college members, some of whom received grants, could attend the lectures offered by the College and could present their research results worldwide through support from the Graduate College. The Graduate College ran for three years and after having been extended twice it ended naturally in 2002.

A short time later the Sonderforschungsbereich (Collaborative Research Center) SFB 383 - Disorder in Solids on Mesoscopic Scales was founded, encouraged by the success of the Graduate College. It started on October 1, 1994. The SFB 383 involved several research groups of the Department of Physics: semiconductor physics, surface physics, nuclear solid state physics, the Technology Laboratory of the Material Sciences Center, physical chemistry groups belonging to the Department of Chemistry, and the group working on electron microscopy of the Department of Geosciences. For reasons not inherent in the SFB this center did not receive funding for a third research period, although most of its projects applying for support were graded as excellent and will thus continue to receive funding from the Deutsche Forschungsgemeinschaft (German Research Council).

These two institutions led to a close connection between the research areas of the departments involved and substantial support was received to set up new research groups. As a result, the Department of Physics is clearly dominated by research activities in the area of solid state physics at present.

Like many other physics professors before him who are nevertheless still in Marburg, Göbel received a number of offers for chairs at other institutions. When he finally decided to leave Marburg to become president of the Physikalische Technische Bundesanstalt (Federal Physical Technical Institute) in Braunschweig, the Physics Department decided to continue the internationally recognized research he had carried out. Ultrashort time spectroscopy of semiconductors and semiconductor heterostructures as well as the investigation of optical properties of organic and, more recently, also biological materials remain a research focus of the Department of Physics. The experimental branch of the semiconductor physics group has produced two start-up companies, which deal with semiconductor lasers and their development.

It has already been mentioned above that a surface physics group evolved from the Institute of Experimental Physics. At the beginning it was closely connected with the heavy ion physics group, but later it started to develop a second life. In the course of the development of sources for polarized heavy ions it turned out that nuclear spin-polarized atomic beams allow for nuclear magnetic resonance (NMR) experiments on surfaces. These experiments had previously been regarded as impossible due to the small amount of adsorption sites on a surface. Recently, scientists have succeeded in increasing the sensitivity to approximately 1,000 atoms per cm^2 *in a special experiment at the Max-Planck Institute for Nuclear Physics in Heidelberg. The surface physics group has recently been reinforced by the appointment of an additional chair. Modern short time experiments on atomic as well as electro-dynamical phenomena on metal and semiconductor surfaces are given priority in this research area. In this context, applications in the field of organic molecules are also being considered.*

The research group of Walcher's successor Hans Ackermann (1978-2000) also covers the area of solid state physics and material science. Ackermann originally specialized in nuclear solid state physics and matrix spectroscopy. The necessary experiments were mainly carried out with accelerators and research reactors in Berlin, Geneva, Grenoble, Heidelberg, Jülich and at the neighboring University of Gießen. Detailed information on local lattice structures and diffusive movements of isolated foreign atoms in a host lattice can be obtained using atomic probes, which can be observed using nuclear resonance and detection of radioactive radiation or using electron spin resonance. This is a problem which is also of great technological significance. Research *focused above all on metals, semiconductors and solid rare gases. In addition to this work, Ackermann's commitment to renewable energies and his opposition to the industrial use of nuclear energy was perhaps more significant. He founded a group consisting of active and enthusiastic students which researched the utilization of thermal solar energy. The Department has decided to continue the research on solar energy systems in the future.*

The fact that some members of this research group set out to make some experimental contributions to the question of whether there is chaos in quantum mechanical systems is an example of the flexibility of the research group system. Instead of investigating the wave nature of quantum particles directly, they decided to explore the analogous phenomenon of electromagnetic waves in resonating cavities. The ensuing experiments proved to be of great interest. These projects, which were carried out in cooperation with the statistical physics group of Prof. Großmann and the part of the semiconductor physics group which deals with chaos in lasers, were part of the Sonderforschungsbereich (Collaborative Research Center) 178 - Nonlinear Dynamics (Frankfurt, Darmstadt, Marburg). The close collaboration of experimental and theoretical groups in the investigation of complex nonlinear systems was a characteristical feature of the way this group operated. Their work was also highly interdisciplinary and they collaborated with research groups all over Hesse.

Theoretical physics

Two of the five professors of theoretical physics collaborate closely with corresponding experimental groups. The merger of theoretical semiconductor physics (Madelung) with the experimental institute (Stuke) has already been mentioned.

As already discussed, research on classical nuclear physics is no longer carried out in Marburg. And since Grawert, a member of the heavy ion physics group, retired there has been no research on theoretical nuclear physics in the Department either. Instead, the many body theory group, which deals with solid state phenomena dominated by the interaction of electrons with each other, was established. Such phenomena include magnetism and the optoelectronic properties of polymers. This research area ideally complements the activities of the semiconductor physics group both on a theoretical and on an experimental level. Promising developments, in which the many body physics group has had an important part, have recently taken place in this area. The many body theory group also founded a new European Graduate College - Electron-Electron Interactions in Solids which set up a collaboration between the University of Marburg and the Technical University of Budapest comprising research and teaching.

The statistical physics group has already been mentioned. Apart from Großmann Christian Wissel worked as professor in this group until 1992. He was interested in the application of physical statistical methods to biological ecological problems. He received his habilitation in biology. After having been on leave since 1992, he is now the head of the Department of Ecology of the Umweltforschungszentrum (Environment Research Center) in Leipzig with the status of a C4 professor. Großmann's research was continued after his retirement in 1998. The group, now called complex systems, has promising connections with other departments of the University of Marburg and within the Physics Department it is closely linked to the neurophysics group.

The foundation of physics group has a worldwide reputation. It emerged from Ludwig's group and continued to work on fundamental theoretical problems after his retirement. This rather small group played an important and essential role in the teaching of theoretical physics. It also helped broaden the range of research carried out in the Department. Unfortunately, it will not be possible to keep this line of research as a main focus, due to the fact that the Department is in the process of shrinking. Therefore one of Marburg's traditionally highly regarded fields of research will become extinct in a few years.

Prospects: Interdisciplinary and international cooperation

The most recent initiative of the Department of Physics is the foundation of a new interdisciplinary research center. The concept for this Research Center - Optodynamics, developed in cooperation with chemists and biologists, is to investigate dynamical processes occuring subsequent to optical excitation in inorganic, organic and biological systems on time scales which include up to 20 orders of magnitude. This initiative is based on research which has already been carried out on an interdisciplinary level within the Material Sciences Center in the area of inorganic and organic solids. Now biologists, who are principally interested in blue light receptors of plants and animals, will join this collaboration. The new research center aims to obtain a unified understanding of these phenomena based on the principles of quantum mechanics. A further objective is the utilization of these phenomena. Particularly exciting are prospects in the area of biological photoreceptors. The center has already been granted funding for the initial research period by the government of Hesse.

Until now, the numerous and usually very close international collaborations of all research groups of the Department have not been mentioned. These collaborations are extremely important for the teaching and training of students. Some of them even have been awarded respected prizes (Max Born Prize, Max-Planck Research Prize). However, such prestigious prizes have not only been awarded *for international contacts but also for outstanding success in research (see table below). The Department of Physics was able in turn to honor scientists of outstanding merit, such as Dr. Dieter Röß. As the chairman of the executive committee of the Wilhelm-Else-Heraeus-Foundation and a former industry manager he supported the Department in many ways. Master's students who were able to obtain a degree within 10 semesters with the final grade of "good" or better were awarded a nice little sum of money at a special ceremony. A considerable donation, which enabled the physics library to purchase a large number of monographs, was particularly helpful. Röß was appointed honorary professor in 1991 and has stayed in contact with the Department of Physics since then.*

Studying in Marburg (in front of Renthof 6)

Outlook for the future

What is the use of excellent scientific research if there are no longer scientists? The decline in numbers of students in the last few years clearly shows that we are facing a problem. Why is the number of people interested in studying physics decreasing so rapidly? Is this due to schools or teacher training? The Physics Department has been extremely active in the field of teacher training and has been committed to offering a high quality, needs-oriented training for secondary school teachers in the last few years. These efforts include special lectures in experimental and theoretical *physics and a special course of studies for secondary school student teachers. In addition, the Department organizes recurring teacher training seminars which offer local teachers the opportunity to keep in touch with new developments in physics. All of these activities are initiated and organized by the physics education group. This creative and active group deals not only with physics education but also establishes contacts with schools and offers diverse opportunities for secondary school students to get to know the Physics Department and its members and to find out about their research. Currently, the physics education group also takes an important and decisive part in developing the physics syllabus for secondary schools in the state of Hesse.*

In the past, schools used to "produce" sufficient numbers of motivated physics students. Nowadays, obviously, the University cannot rely on this kind of automatic recruitment any more but has to take an active part in kindling the interest of secondary school students in modern natural sciences by organizing specific events for them. Therefore, the Department of Physics has held regular workshops for 11th to 13th year students which have been very successful for the past three years.

The Department of Physics is now the smallest department of the Philipps-University with regard to the number of students but it is quite high-quality. Proof of this is not only the considerable amount of external funds that the Department receives and the international reputation of its research groups but also the careers of its graduate and Ph.D. students. Numerous scientists with a Ph.D. degree have been appointed to positions at prestigious universities at home and abroad and many of our former students have found excellent positions in commerce and industry in Germany and in other European countries.

The offers of positions at prestigious research centers within Germany to members of the Physics Department have already been mentioned. When the Department succeeded in keeping the respective scientist these offers were of immediate use. The offers that were taken on served to increase the prestige of the Department and also offered opportunities for new development.

Due to its longstanding tradition, the Department of Physics is dedicated to research in promising areas and to intensive tutoring of its students. Our slogan Zukunft mit Herkunft (Future with tradition) is still valid. Up to date information, in particular on the present research groups, can be found on the homepage of the Department of Physics at: http://www.physik.uni-marburg.de.

Scientific awards and prizes

Bruno Eckhardt:	*Leibniz Prize in 2001*
Stephan Koch:	*Leibniz Prize in 1997,* *Max Planck Research Prize in 1999*
Martin Holthaus:	*Gustav-Hertz Prize in 1998*
Detlev Lohse:	*Heinz-Meier-Leibniz Prize in 1997*
Wolfgang Stolz:	*Karl-Heinz-Beckurts Prize in 1995 (with Arndt Greiling)*
Siegfried Großmann:	*Karl Küpfmüller Ring in 1997,* *Grand Order of Merit of the Federal Republic of Germany in 1996,* *Max Planck Medal of the Deutsche Physikalische Gesellschaft (German Physical Association) in 1995,* *Full member of the:* *- Berlin-Brandenburgische Akademie der Wissenschaften (Academy of Sciences of Berlin-Brandenburg),* *- Deutsche Akademie der Naturforscher Leopoldina (German Academy of Naturalists Leopoldina),* *- Europäische Akademie der Wissenschaften und Künste (European Academy of Sciences and Arts)*
Ernst Göbel:	*Max Born Prize in 1990,* *Leibniz Prize in 1990*
Otfried Madelung:	*Order of Merit of the Federal Republic of Germany, 1st class in 1989*
Josef Stuke:	*Max Born Prize in 1986* *Wilhem Walcher: Grand Order of Merit of the Federal Republic of Germany in 1975,* *Honorary doctorate Dr. rer. nat. h.c. of the Ruhr University of Bochum,* *Honorary member of the Deutsche Physikalische Gesellschaft (German Physical Association)*
Günter Ludwig:	*Corresponding member of the Akademie der Wissenschaften und der Literatur (Academy of Sciences and Literature), Mainz,* *Member of the Academia di Science e Lettere Istituto Lombardo, Milano*

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Peter Thomas

(Translation: Renate Schmid, with help by Reinhard Noack)