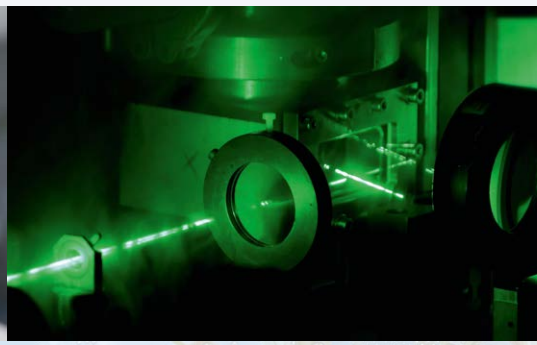
Philipps Universität Marburg



RESEARCH IN MARBURG 2010 – 2014

The Old University. Photo: Markus Farnung

RESEARCH IN MARBURG 2010 – 2014

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Photo: Reinhold Eckstein

PREFACE

Research in Marburg

Outstanding achievements in the individual sciences contribute to the advancement of knowledge, which forms the basis for interaction among academic disciplines and cultures and their thematic and methodical cross-pollination. Research is bundled into interdisciplinary joint ventures within Philipps-Universität, with regional partners, and worldwide. In this publication, we introduce some outstanding individuals from Marburg and their research topics, including a few of the 13 Leibniz Award winners, as well as the pooling of groups into research fields within Philipps-Universität – and we do so across the entire range of academic disciplines.

For the period from 2010 to 2014, we highlight academic fields from across the entire university in which innovative individual research has led to comprehensive cooperative efforts. Our affiliation with Justus Liebig University Giessen to form the Giessen-Marburg Research Alliance is especially important to Philipps-Universität. It enables us to continue developing our research in the medium and long term with an especially reliable partner. Several joint research projects were launched in 2014 alone. For the first time, academics in Marburg and Giessen are considering the topic of security – which plays an important role in current social discourse – from a historical perspective. Neuroscientists from both universities are combining their expertise to thoroughly analyze the mechanisms of perception, and they are arriving at insights that will also apply to medicine. Chemists and pharmaceutical chemists from Marburg and Giessen are joining scientists from Frankfurt to explore how the targeted action of drugs can be improved. Top-level research knows no national boundaries. Medicine, in particular, has built networks throughout the entire European Union and beyond in its principal areas of focus: tumor and inflammation research, as well as infection biology in close association with cellular biology. For example, physicists and mathematicians have been cooperating for decades with other scientists in both the United States and Russia. The members of the Center for Near and Middle Eastern Studies do not simply study their colleagues from the Islamic world; they also collaborate with them.

We are especially grateful to the scientists and academics for their participation in this publication, and we hope that reading it will bring you both enjoyment and new insights.

Prof. Dr. Katharina Krause

PRESIDENT OF PHILIPPS-UNIVERSITÄT MARBURG

PREFACE

A Supportive Environment for Talent

Today's young academics are tomorrow's top researchers. This is why it is the university's task to foster promising, talented individuals early on and to avoid losing sight of them during the important transitional phases leading to the next stage of their academic career, instead offering them support wherever possible.

Of course, every researcher has to find his or her own way. But advice, mentoring, funding and additional training that leads to interdisciplinary qualifications all play an important role in helping people to consistently pursue the paths they have chosen. In this brochure about research in Marburg, new talent is a recurring theme.

We present the work of an international postgraduate program in the neurosciences and sketch the unusual career of a chemist who, shaped by his experiences abroad, began to take his field of research in a new direction at an early age. We contemplate the research undertaken by a young cell biologist who was able to develop his skills while associating with highly experienced Marburg microbiologists; he is now a junior professor. We report on an outstanding semiconductor physicist who began her career as a Heisenberg professor and now plays a key role in shaping the materials science department in Marburg. You will also meet a Leibniz Prize winner who, as a young researcher at the Marburg Center for Near and Middle Eastern Studies, was instrumental in bringing about the interdisciplinary reorientation of Arab and Middle Eastern Studies throughout Germany.

These scientists and academics were all up-and-coming talents themselves until just a few years ago; today they can serve as role models. The point they have in common is that they all conducted independent research early in their careers. That is what we want to support in Marburg: early independent research undertaken at home and abroad, while at the same time the young researchers are integrated into existing structures and supported by programs for up-and-coming talent that take individual personalities into account.

Prof. Dr. Ulrich Koert

VICE PRESIDENT FOR RESEARCH, PROMOTION OF YOUNG TALENT, KNOWLEDGE TRANSFER AND INTERNATIONAL AFFAIRS

International law expert Professor Christoph Safferling and students conducting academic analysis of war crimes trials.

SECURITY, ORDER, CONFLICT

We use experiences from the past to learn for the future. Social and political developments do not just appear out of nowhere. They always have historical roots that must be studied in order to understand the present and shape the future. At Philipps-Universität, the subjects of security, order and conflict form an interdisciplinary focus in humanities and social science research. Marburg's academics study culture, politics and key players in the Near and Middle East from various perspectives, contributing to a comprehensive understanding of the region. Their approach can serve as a model for future area studies on other regions of the world. Scholars from Marburg and Giessen pool their expertise in order to take a new approach that considers security from a historical perspective, from the early modern period to the present. Their insights will enrich political discourse in the future. Researchers in Marburg also study how various societies cope with war crimes, and are in demand as political advisers. They play important roles in German government think tanks that examine the political situation in the Middle East, and ways to come to terms with Germany's Nazi past.

Photo: Florian Hansen

CONSTRUCTIONS OF (IN)SECURITY THROUGHOUT HISTORY

Thinking the future safe

Internet, financial markets, climate change and traffic - these days, security plays a crucial role in almost all areas of life. However, security has always been an important political core concept. Scholars from Marburg and Giessen are now addressing the question of how security has been constructed and established in different eras, to what extent different notions of security have influenced political processes, and how the understanding of security has changed throughout history.

»Let others wage war. You, lucky Austria, shall marry!« This was the Habsburg dynasty's motto as it expanded and secured its territory from the late Middle Ages forward. The importance of dynastic marriages in creating political security is only one of manifold subjects studied by historians, political scientists, social scientists, legal scholars, and art historians in the SFB/Transregio 138 Collaborative Research Center known as »Dynamics of Security. Forms of Securitization in a Historical Perspective«. The 60 participating researchers from Marburg and Giessen are interested in how security has gained in importance in particular areas and different social contexts and what kind of political processes resulted from those developments. Thereby, they also focus on the ambivalence the quest for security might provoke. Human beings spend a lot of thought, time and energy in order to establish political and social security and yet, paradoxically, increased insecurity is what they get quite often. »A current example of this ambiguity is the development in Iraq,« says Professor Dr. Christoph Kampmann, historian at Marburg University and spokesman of the SFB/TRR 138. »The alliance of Western nations has invested enormous military resources in the security of that region, yet the result is that parts of Iraq are now controlled by those very forces that we were supposed to be fighting.«

»This Collaborative Research Center provides us, for the first time, with a platform for pursuing interdisciplinary security research which spans several epochs. The cooperation between our three institutions, the Universities of Marburg and Giessen and Marburg's Herder Institute, gives us the opportunity to explore diverse aspects of securitization in history. Those three institutions also collaborate regarding the graduate school integrated into the SFB/TRR 138.«

PROF. DR. CHRISTOPH KAMPMANN

»Security has long been a central research topic in social sciences, but not in historical scholarship,« Kampmann explains. »We try to advance existing approaches and to reformulate central questions in order to develop a set of methods and ways to analyze dynamics of security interdisciplinary in different eras.« The so-called Copenhagen School, well known in political sciences, coined the term »securitization«. In accordance with this concept, scholars at the research center grasp security as a social construct that has changed dynamically throughout the course of history. Security is a variable concept with regard to space and time, since threats and dangers are constantly changing or can be understood in new or different ways. »The depiction of what security is and the political implementation of security are interdependent,« says Kampmann. The question which concepts of security will ultimately dominate a political process is negotiated by the individuals of a society as a kind of collective enterprise. Therefore, the analysis of certain constellations of power and diverse strategies to legitimate political decisions is also crucial for the researchers.

In 19 sub-projects, the scholars address how security is portrayed and constructed in different times and places and under different political circumstances. For example, one project deals with religious conflicts in the context of security in federal political systems of the Early Modern Age. Another examines, from various points of view, the issue of security in an urban environment. For instance, the distinction between the private sphere, which was considered safe, and the public sphere, which was considered unsafe, was an important socio-cultural issue in the Early Modern Age in terms of both the architectural drawing of boundaries and artistic portrayals. In the late 19th century, the public debate on urban security was always linked to social riots in cities like London and Hamburg and to the search for new systems of security measures.

Modern international law is essential to the understanding of collective security. Some researchers are studying the formation of international law institutions and their contribution to the security of nations. Others are analyzing how the condemnation of genocide gradually became established internationally starting in the 1920s, beginning with a network of East Central European players who fleshed out the legal elements of genocide as a criminal offense. The degree to which security can be exported is highly relevant in international relations. The researchers are studying the contested utility and the consequences of military interventions abroad. They examine the conditions under which security can be created from the outside and the extent to which such achievement of security has followed typical patterns throughout the course of history.

Ever since the 2008 financial crisis, political security has also been tied to the question of how global financial markets can be supervised and regulated more effectively. Participants in one sub-project are analyzing which players in the financial economy were important to the process, and how risks – a controversial term in the context of security and insecurity – have been dealt with since then.

»Our research program is highly relevant, not just because security is of immense political importance in our time,« says Christoph Kampmann, »but also because our historical perspective is the very thing that enables us to contribute to the current discourse and to bring out new aspects.«

For more information:

»Dynamics of Security« Collaborative Research Center on the web: *www.dynamiken-der-sicherheit.de*

Arrival of Maria Elisabeth of Austria in Brussels, Leonard Schenk, Pieter Schenk (II), Staten van Holland en West-Friesland, 1727.

Source: Rijksmuseum, Amsterdam

The German Research Foundation's SFB/Transregio 138 Collaborative Research Center

»Dynamics of Security. Forms of Securitization in a Historical Perspective.«

- **Start date:** April 1, 2014
- **Participants:** Philipps-Universität Marburg, Justus Liebig University Giessen, Herder Institute for Historical Research on East Central Europe – Institute of the Leibniz Association, Marburg
- **Spokesman:** Christoph Kampmann (Professor of Modern History and the Early Modern Age, Marburg)
- **Deputy spokespersons:** Eckart Conze (Professor of Recent History, Marburg), Horst Carl (Professor of History of the Early Modern Age, Giessen), Regina Kreide (Professor of Political Theory and the History of Ideas, Giessen).
- **Board member representing the Herder Institute:** Peter Haslinger (Director of the Herder Institute, Marburg, and Professor of the History of East Central Europe, Giessen)

CONDUCTING ACADEMIC RESEARCH ON DEALING WITH WAR CRIMES

A critical look at the past

Marburg legal scholars, historians and social scientists are studying war crimes trials and transitions to democratic and peaceful systems in post-conflict societies. They are also sought after as experts on commissions formed to examine the Nazi past of German government ministries and to analyze the history of international criminal law and its implementation.

The International Research and Documentation Centre for War Crimes Trials (ICWC) was founded in Marburg in 2003. It emerged as an offshoot of the Max Planck Institute for European Legal History in Frankfurt, to address the dearth of information about war crimes trials around the globe. The first project involved war crimes trials against Germans and Japanese after World War II, which remain milestones in the history of international criminal law to this day. The 400 rolls of film and nearly half a million pages of documents collected for the project formed the original ICWC documentary archive, which has grown many times larger since then.

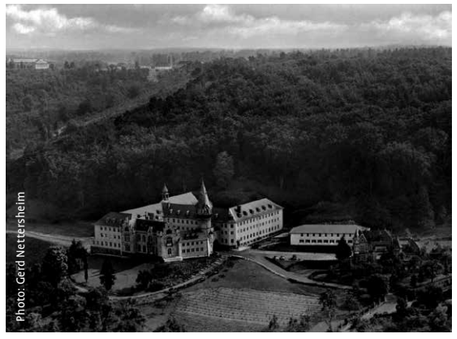


Photo: Gerd Nettersheim

Rosenburg Castle near Bonn, the seat of the Justice Ministry until 1973.

The ICWC gained a special profile with its observation of war crimes trials and with training students to become trial observers.« In our work, we take a critical look at the criminal procedure codes and offer recommendations,« explains Professor Dr. Christoph Safferling, a professor of criminal and international law. »We examine whether proceedings are conducted according to due-process criteria, how the court treats the parties involved, which legal problems are discussed in hearings and how proceedings are organized and conducted.«

In »Transitional Justice«, a research project underway since 2012, the ICWC cooperates closely with the Marburg Center for Conflict Studies. The two organizations analyze the difficult transitions from periods of massive human rights violations, genocide and war crimes to peaceful national and international regimes, as in Cambodia following the Khmer Rouge dictatorship. The results are meant to provide valuable recommendations for future situations in which societies are coming to terms with their experiences of injustice.

For years, politicians and lawmakers have sought the expertise of the ICWC's Marburg scholars to help them come to terms with Germany's Nazi past. In 2004, the German Foreign Minister appointed an independent commission of historians to examine the Foreign Ministry's role during the Nazi era and the continuity of its personnel after 1945. The international panel, headed by Marburg historian Professor Dr. Eckart Conze, currently Director of the ICWC, presented its report titled »The Foreign Ministry and the Past« in 2010. The document painted a nuanced picture of the extent to which the German Foreign Office and many of its diplomats were actively involved in the Nazi regime and how employees tainted by their Nazi past were able to continue their careers after the war.

In 2011, the German Federal Intelligence Service (BND) appointed a commission of historians that included Wolfgang Krieger, a professor of modern history in Marburg. With the support of an internal research group called »History of the BND«, the commission is devoting special attention to the tenure of the BND's first president, Reinhard Gehlen (1945-1968). One of its initial conclusions is that under Gehlen, entire networks of officials with Nazi pasts managed to become permanently ensconced in the BND. During the Cold War, the Americans used former Nazi officials with the expectation that they would provide information about the Soviet Union. According to the commission, there were also cases in which crimes committed by employees were overlooked. For the commission, this raises the basic question of what role intelligence services play in democratic societies and how closely they adhere to constitutional principles. Making certain that the past is not forgotten is not the scholars' only interest: remaining impartial is also important to them.


Source: Harvard Law School Library, Harvard University

Judges in the Nuremberg trials

In 2012, an independent academic commission for the critical study of its Nazi Past was created at the Federal Ministry of Justice. It examines the continuity of the ministry's staffing and areas of responsibility during the transition to postwar West German democracy. Two thirds of the lawyers who had been Nazi Party members were given positions in the West German judicial service. In some sensitive areas, staff continuity meant that Nazi ideology continued to influence policy after the war. For instance, the government denied compensation claims for the Sinti and Roma. The commission will present its report in 2016.

Other projects of the ICWC address the question of female war criminals and the trials against these perpetrators or the origins of international criminal law and its norms such as the 1948 UN Genocide Convention, the US Film campaign on the Nuremberg Military tribunal and The Allied War Crimes Trial Program as the First ›Global Justice Network‹. A new research effort, supported by the German Research Council (DFG), aims at analyzing the dynamics of victims' recognition in post-genocidal societies such as Germany, Cambodia, and Ruanda in a comparative perspective.

For more information:
International Research and Documentation Centre for War Crimes Trials
www.uni-marburg.de/icwc

»Arabellion«: Graffiti in Egypt. Photos: Dr. Ariel Bottros

Research on moderate Islamists

The political science department at the Center for Near and Middle Eastern Studies (CNMS) has created forums to promote dialogue between decision-makers in moderate Islamist parties and German partners in politics and business. These forums reflect the transformation and growing moderation of certain Islamist parties in the context of the Arab Spring. Their discussion topics include the development of a constitutional state and the roles of civil society, the economy, energy policy and social development. Prof. Dr. Ouaissa and his team have been conducting the research project on behalf of the German Foreign Ministry since 2013, in the context of the European Neighborhood Policy. In preparation for the dialogues, scholars analyze the participating Islamist parties from Egypt, Tunisia, Morocco, Algeria, Jordan and Libya, as well as German foreign policy on the relevant issues. The goals of the Euro-Mediterranean partnership are peace, stability and prosperity.« To achieve this, policymakers are also dealing with new players, like moderate Islamist parties,« says Ouaissa. »No matter how we feel about them, it is important to acknowledge and understand them. They are heterogeneous and, like all other players, are subject to constant change. Many of them are established parties today, not unlike Europe's sectarian parties.«

THE »ARAB SPRING« – A CHALLENGE FOR RESEARCH

Quo vadis, Arab world?

Marburg scholars are studying the background and consequences of the political upheavals that have shaped the region from Morocco to Yemen since 2011. They are focusing in 9particular on key players in civil society, who are reflecting – through art, for example – on deep-seated social developments that have received scant attention from scholars to date.

In Arab countries, more so than in Europe, art is a means to convey political messages. »It is often subversive and far more closely tied to political and social developments than in Germany or Europe at the moment,« says Marburg Arab Studies Professor Friederike Pannewick. This is especially true in the wake of the upheavals known collectively as the »Arab Spring«. Literature, theater, music, film and graffiti are all important forms of expression that people use to process their experiences of suffering and death under dictatorships, and to express their hopes and dreams. Through art, they can address sensitive issues that are otherwise taboo in public. This is why Prof. Dr. Pannewick, a 2012 Leibniz Prize winner, always considers Arab literature, art and culture within their context. »They are the seismograph of a society,« she notes.

»The processes of working through the ›Arab Spring‹ culturally and politically cannot be separated,« says Pannewick, whose work dovetails with other disciplines under the umbrella of the Marburg Center for Near and Middle Eastern Studies (CNMS). The CNMS, which opened in 2006, is a hub for oriental studies in the state of Hesse. With seven professorships, it is the largest university institution in Germany to address the Near and Middle East in research and teaching. Middle East Political scientists and economists, and scholars in Iranian, Arabic and Semitic as well as Ancient Near Eastern studies collaborate at the center, which also brings together liberal arts and social sciences methods. »The changes in the Arab world can be understood only by taking a broader approach,« says Prof. Dr. Rachid Ouaissa, a Professor of Politics of the Near and Middle East since 2009.

»The situation in the region is like a puzzle,« says Ouaissa. Long lasting narratives and ideologies such as pan-Arabism are now being supplanted by a struggle for new interpretations. »A reconfiguration of traditional views is underway. Research needs new concepts and methods to do justice to this development,« states Ouaissa, describing the starting point for a research project launched in 2013 under the title »Reconfigurations: History, Remembrance and Transformation Processes in the Middle East and North Africa.« Ouaissa is the spokesman of a research network supported by the Federal Ministry of Education and Research that bridges the gap between the broad regional expertise in Marburg and the disciplines of political science, peace and conflict studies, sociology, history, law, media studies, comparative cultural studies and religious studies.

The scholars address developments beyond the scope of everyday political events. »The great social projects used by the postcolonial governing elites to justify their power have failed. They have lost their appeal as a utopia and as a cement holding together the various religious, linguistic and cultural groups. This is also true of Islamism,« says native Algerian Ouaissa. »But nothing new has taken their place yet.« There are no intellectuals setting the tone in the Middle East today; rather, the Arab Spring began in the form of a decentralized revolt among young people. The young generation has grown up in an environment characterized by individualization, urbanization and uncertain future prospects. The Marburg scholars are examining how various players have brought about change »from below,« and which of their own versions of reality they are offering in response to views of history initiated by governments. To gain a better understanding of the Arab Spring, they are also drawing comparisons to how political transformation processes are approached in other postcolonial countries and Eastern Europe. Finally, they study relationships spanning national boundaries, the role of the media and how global developments such as the world economic crisis affect the region.

Research in Marburg serves as a model of how regional studies will be structured in Germany in the future. The pronounced interdisciplinarity between the social sciences and the liberal arts is a unique feature of the Marburg

Poems as political slogans

A Syrian protestor is holding up a poem written by a Tunesian poet in the early 20th century.

»If one day the people will to live/ Then destiny must reply; /The night must disappear, /And bonds must break.«

»It is no coincidence that these verses invoking the irrevocable will of a people to live a self-determined life were quoted not only in the North African struggle for independence, but also on the signs held by demonstrators in Arab rebellions since 2011,« says Pannewick. »Poetry encapsulates the things that move people, and plays a central role in the politicized street of the Arab Spring.«

Photo: Friederike Pannewick

Foto: Georges Khalil

Graffiti in Cairo: Paint-brush against baton.

Martyrs and Cultural Memory

Marburg Arab Studies Professor Friederike Pannewick studies aesthetics and politics in Arab literature, theater and performance of the 20th and 21st centuries. The study of martyr figures in contemporary art (see graffiti art on p. 12/15) is one of her areas of interest:

»No one is born a hero or a martyr. It is only through stylized tributes to heroic self-sacrifice that someone becomes a martyr. Martyrdom requires a stage, an audience to witness the act and then celebrate and disseminate it in songs, poems and murals. Martyr figures have been omnipresent in Arab society for many centuries, especially since the beginning of the twentieth. They play an important role in how people cope with suffering and create meaning in difficult times, but they also express their hopes for a better future. Literature, art and music are important media with great political power to create these martyr images, but also to critically scrutinize them.«

model, as is its way of analyzing social, political and cultural processes from the protagonists' perspective, not primarily from that of the system. »It is important to us to engage in collaborative study with the region's actors, not take them as subjects of the research,« says Pannewick. »This is why active knowledge of Arabic and field research are part of our standard approach. We want to see more young scholars acquire these skills.«

For more information:
Center for Near and Middle Eastern Studies (CNMS)
www.uni-marburg.de/cnms

Foto: Georges Khalil

Professor Friederike Pannewick and Professor Rachid Ouaissa (left) discussing with a graffiti artist in Cairo, September 2012.

Linguists contemplate a map on which the dialects they are studying are highlighted

THE WORLD OF LANGUAGE

What constitutes language? It is the basis for human culture and social activity, and therefore enormously diverse and constantly changing. The scientific understanding of language, or linguistics, has long been a focus of research in Marburg. One of the oldest linguistic research centers is based at Philipps-Universität. Among its unique features are its linguistic maps and audio recordings of German dialects, which show how they have changed in the last 130 years. Language is never static, which is why Marburg linguists are also studying contemporary usage and analyzing regional trends as part of a long-term project. Marburg scholars working in linguistic disciplines – regional language research in linguistic dynamics, long-term diachrony from the Old High German period to the present, neurolinguistics, language theory and psycholinguistics – provide a fundamental contribution to the science of linguistics through their study of basic linguistic categories. The German Linguistic Atlas research building, slated for completion in 2015, will provide linguists with a central location for cooperative work in the future.

Photo: Rolf K. Wegst

MODERN STUDY OF LANGUAGE DYNAMICS

Tracking linguistic change

The research center »Deutscher Sprachatlas« in Marburg has one of the world's richest traditions of linguistic research. The discipline of language geography was established here in 1876. Today, the center is known for its innovative approach to the study of linguistic dynamics. From historical documents to professional language recordings and brain wave measurements, the research center in Marburg brings together a wide range of research data on linguistic change.

Marburg's scholars benefit from the unique position of research into German regional languages, having access to a comprehensive and unique collection of German dialect data beginning in the late 19th century. It all began with a questionnaire consisting of 40 short »popular« sentences that Georg Wenker sent to schools in the Rhineland region beginning in 1876. Teachers were asked to translate the sentences into their respective local dialects. In 1887, Wenker expanded his survey to include the entire German empire, later adding German-speaking areas outside of imperial Germany. Wenker and his successor, Ferdinand Wrede, collected data from 52,000 places, which they documented on 1,635 large-format linguistic maps. The maps were archived and digitized in the German Linguistic Atlas Research Center and are now available online in their entirety. These beginnings of language geography as an academic discipline represent an important reference point for the modern study of German linguistic dynamics.

The first sentence to be translated in Wenker's questionnaire read: »In the winter, the dry leaves fly about in the air (Im Winter fliegen die trockenen Blätter durch die Luft herum).« This is how Swabians in the town of Echterdingen translated the sentence in the late 19th century: »En Wenter fliat dia druckana Bledder en dr Luft rom.« In Esslingen, less than 12 miles away, the same sentence read: »Im Winter flüged di trockne Blätter i dr Luft ume.« Dialect sentences like this are rarely heard today. Although German regional languages still exist, they are changing – especially due to the influence of standard German, so that regional accent, known as »regiolects«, is replacing the old dialects. With the introduction of compulsory education around 1800, the form of German that would later become known as High German entered the German classroom, where it initially received a distinct regional tint as »regional High German.« In 1898, German pronunciation was initially standardized for the theater (Th. Siebs: »German Theater Pronunciation«).

Today's standard language became a common point of reference for all German speakers as it spread through radio and television in the 20th century.

»Language is the basis for social activity and an extremely exciting research topic,« says Prof. Dr. Jürgen Erich Schmidt, the director of the Deutscher Sprachatlas. »It is constantly changing. We want to understand why this is so, and under what conditions and at what speed it is occurring. Thanks to the Wenker maps, scholars in Marburg are able to study linguistic change in German over the course of more than a century. Because linguists never quite trusted Wenker's methodology, more surveys were conducted throughout the 20th century. This has proven to be a stroke of good luck,« says Schmidt. »Although today we know that their misgivings were unfounded, the result was that we now have a large number of documents from various time periods that help us to understand linguistic change. We also have sound recordings of language that were made from about 1920 on.«

Georg Wenker's maps were scientifically analyzed in a project at the German Linguistic Atlas Research Center funded by the German Research Foundation. The »Digital Wenker Atlas« is available to the public online and is now part of a comprehensive language geography information system. It provides a fascinating source for studying the many different forms of German dialects, both for linguists as well as interested non-academics. The system includes digitized scans of the original questionnaires, interactive linguistic maps from various periods, audio documentation of old local dialects and newer materials on current usage.

The interactive information system is being created as a part of the project Regionalsprache.de (REDE), a research project that began in 2008. The Academy of Sciences and Literature in Mainz has provided a grant of approximately 15 million Euro to fund the long-term project until 2027. In the context of REDE, a team of linguists working with the project directors, Prof. Schmidt, Prof. Herrgen, and Prof. Kehrein, collects and analyzes data on current linguistic usage and regional variation in Germany at 150 selected locations. In the process, linguists can also observe changes that are occurring today. In the state of Hesse, for instance, there is a trend away from dialects and toward more widespread use of High German. »This project gives us the unique opportunity to comprehensively describe variation and change in German regional languages,« says Schmidt. »And through the use of new methods, such as brain wave measurements in neurolinguistics, we can better understand how language is perceived and cognitively organized. This enables us to develop prognoses for future changes in language.« In addition to basic research in linguistics, REDE offers a wide range of possible applications, such as the development of voice-activated computer software or tools for criminologists who rely on forensic language recognition in their investigations.

In the fall of 2015, the German Linguistic Atlas Research Center will move into a new building in downtown Marburg, funded by the state and federal governments. »The building will bring the broad range of disciplines in Marburg linguistics together under one roof, offering groundbreaking opportunities for collaboration among the individual sub-disciplines,« explains Schmidt. »The research building will strengthen linguistics in Marburg, which is distinguished not only by its wide variety of methods, but also by a shared perspective on the basic foundation of human culture – language.«

Photo: Rolf K. Wegst

Linguist Rico Stiel of the REDE research project, with a linguistic map documenting dialect boundaries.

For more information:

The interactive, publicly accessible REDE research platform on the Internet: *www.regionalsprache.de*

German Linguistic Atlas Research Center: *www.deutscher-sprachatlas.de*

ESTABLISHING BASIC LINGUISTIC CATEGORIES

One brain, thousands of languages – how does it work?

Although all human beings have similar brain structures, there are 6,000 different languages, all constantly changing. What are the commonalities in all this diversity? Can we show that there are basic categories that exist in all languages? Marburg linguists study the fundamental building blocks of language, and one application for their insights is improving the diagnosis and treatment of language disorders.

Language is constantly changing. Why, and under what conditions? »This is largely a mystery,« says Marburg linguist Prof. Dr. Richard Wiese. »To find universally valid answers, we need empirically-established basic categories that enable us to develop precise linguistic concepts and theories. We can achieve this only through interdisciplinary research.«

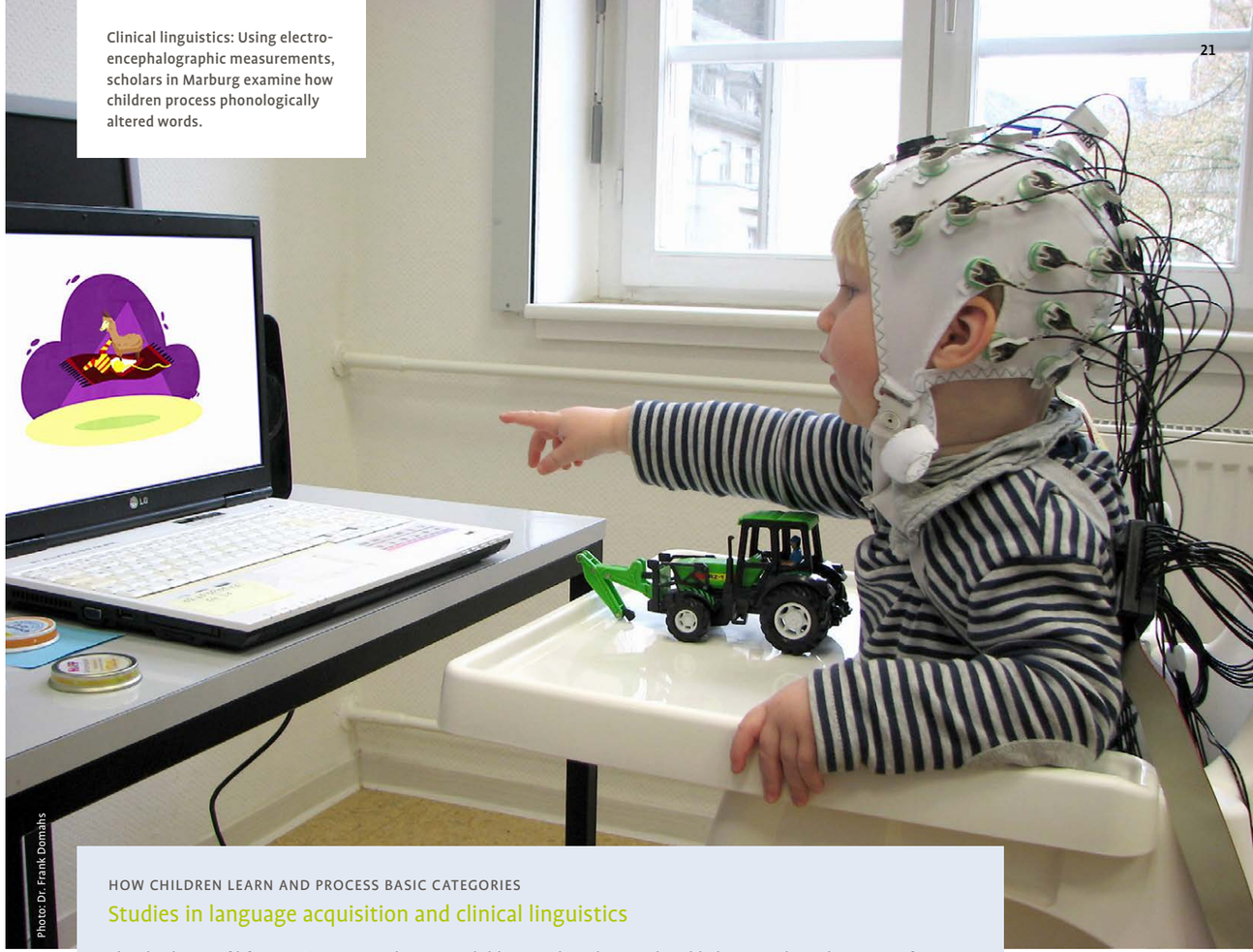
Theoretical linguistics and other linguistic disciplines have been working closely together at Philipps-Universität since 2000. »This brings empirical research to a new level,« says Professor Wiese. Some disciplines permit direct observation of language acquisition and language processing (neurolinguistics and clinical linguistics). They provide insights into how the human brain operates and is organized during language acquisition and during language perception and processing. Viewing the field through a different lens, regional language research has created an instrument, the linguistic dynamics test laboratory (regionalsprachen.de), that precisely tracks linguistic change over a period of 130 years.

The current research program serves as both the foundation and framework for the »Exploring Fundamental Linguistic Categories,« a LOEWE group of research projects that is fundamental to all linguistic disciplines. Marburg scholars are in the process of establishing basic categories in two areas. The »phonological word« field of research examines the production and understanding of units of sound in spoken language. The second field of research, known as the »syntax-semantics interface,« analyzes how symbols are combined to form meaning.

The phonological word is a central unit in grammar and language processing, which makes it a candidate for a basic linguistic category. The researchers are trying to define its key characteristics in a number of sub-projects. For instance, they examine how children learn sounds and words and then develop the intuitive ability to form correct grammatical structures (see box at right). Other projects address phonetic landmarks such as lexical stress, intonation and rhythm, along with graphemic border markers such as separation or compounding of words, as in the initial scripting of Old High German and Old Irish.

One of the biggest challenges in language theory is to determine the relationship between formal sentence structure and content. »The mechanisms in play here are most certainly basic categories,« says Wiese. In several projects, Marburg scholars studying the history of language examine how the use of cases has developed in various languages and throughout longer periods of time. They analyze how the number of cases has come to be reduced in many languages. For instance, Old High German had five cases, while today's German dialects often have only three. They also study alternative forms that arose to allow, for example, the subject and object to be accurately distinguished.

»In the LOEWE group of projects, we examine the strategy involved in identifying basic categories by applying several independent methodological tools to the same phenomena,« Wiese explains. »In Marburg, we have created a broad range of conditions favoring this approach through the research projects conducted to date.«



Clinical linguistics: Using electroencephalographic measurements, scholars in Marburg examine how children process phonologically altered words.

Photo: Dr. Frank Domahs

HOW CHILDREN LEARN AND PROCESS BASIC CATEGORIES

Studies in language acquisition and clinical linguistics

The third year of life is an important phase in a child's language development. Children usually learn a language easily by listening to their parents. They intuitively acquire the rules of grammar, although this is difficult for children with delayed or impaired language development. Prof. Dr. Christina Kauschke, a Marburg expert in clinical linguistics, is addressing this issue with her team in a number of studies. They use electrophysiological brain responses to examine how children process words with phonological or prosodic violations. For example, how do children at different stages of language development react when they hear the pseudoword Pohnig instead of the expected word Honig (»honey«)? »We want to find out whether children with delayed language development process such linguistic stimuli differently from typically developing children,« says Professor Kauschke. »We hope to use the neurophysiological data to develop intervention approaches.«

The results of studies in which five- to seven-year-old children form plural and participial forms have already proven useful in the development of targeted treatment approaches. When compared with younger children or those of the same age with typical language development, children with developmental language disorders are less likely to produce the correct forms with both real and pseudo -words. For example, the correct plural form Pakete (»packages«) becomes Pakets, and some children turn the verb trompeten (»to trumpet«) into the faulty participle getrompetet. »These kinds of symptoms can be effectively corrected,« reports Professor Kauschke. »We have developed treatment and training materials in which we incorporate correct word forms into stories. This specially designed input helps to gradually develop a sensitivity for forms that sound harmonious.«

In a study using electroencephalography, Marburg linguist Dr. Frank Domahs found evidence of delayed reactions in the brains of adults who had language disorders in childhood. It took adults who had experienced childhood language disorders 400 milliseconds to register incorrect participle formations such as gemarschiert (from marschieren, »to march«), compared with only 150 milliseconds among participants without a language disorder in childhood. These long-term effects on the brain's reaction were unknown until now.

The LOEWE group »Exploring of Basic Linguistic Categories« and the long-term »Theory and Empiricism of Linguistic Dynamics and Language Cognition« research program can be found on the Internet at *www.uni-marburg.de/fb09/lingbas*

CREATING THE FRAMEWORK FOR INTERNATIONAL THOUGHT AND ACTION

Science knows no borders

Marburg has been an international center of research and teaching for almost five centuries. Today the International Office and the Welcome Centre support foreign scholars and students during their stay at Philipps-Universität.

Philipps-Universität is a cosmopolitan university with a strong international presence. It intends to further strengthen its competitive position both at home and abroad. An international atmosphere enhances the quality of research and teaching. The university's goal is to help its graduates acquire the linguistic skills and intercultural competency that are important not only in terms of each individual's personal development, but also for enhancing professional opportunities in Germany and abroad.

»An institution's international character cannot be limited to mobility and inter-university exchanges,« says Prof. Dr. Katharina Krause, President of Philipps-Universität. »We believe that it is important for us as a university to address academic and social challenges and to take appropriate steps to encourage international thinking and action in academia. We want to contribute to the development and expansion of an international and intercultural academic environment.«

The aim of the Department of International Affairs and Family Service is to create conditions that favor an international atmosphere, and adapt them to academic, research, teaching, and study needs. The presidium established the department in 2011 with the goal of combining cross-departmental responsibilities under one roof.

Philipps-Universität maintains university-level cooperative agreements with 68 universities in non-European countries and 600 ERASMUS agreements with more than 300 European universities. It is also a party to many cooperative agreements at the departmental and institutional levels. Our international cooperation is focused on cross-border research projects and international programs to promote up-and-coming academic talent. Examples include the German-Canadian international research training group called The Brain in Action, funded by the German Research Foundation (DFG); the German-Russian Enzymes and Multienzyme Complexes research training group, a joint project with the University of Giessen, Lomonossov University in Moscow and the Russian Academy of Sciences; and the International Max Planck Research School for Environmental, Cellular and Molecular Microbiology, a cooperative venture between Philipps-Universität and the Max Planck Institute for Terrestrial Microbiology.

Philipps-Universität is affiliated with two Chinese universities, Zhejiang University in Hangzhou and Tongji University in Shanghai, as well as the University of Kent in England, through special strategic relationships. These partnerships involve close cooperation in research, teaching and administration, including joint research projects and alliances, support for new talent in the form of binational promotions and summer schools, double and joint degree programs, structured mobility models and joint programs to provide advanced qualifications in university administration. Over the long term, strategic partnerships also help to increase Philipps-Universität's visibility and Marburg's appeal as an academic center.

Philipps-Universität is a preferred destination for foreign scholars and students alike from around the world. More than 20 prize winners and fellowship holders with grants from the Alexander von Humboldt Foundation conduct research at Philipps-Universität each year, and about a quarter of all doctoral students in Marburg come from abroad. Over 3,000 students from 130 countries are enrolled in bachelor's and master's degree programs at Philipps-Universität. Cooperative agreement and exchange programs with universities in more than two dozen countries, together with special international programs such as the International Undergraduate Study Program and the International Summer University, give students from Germany and abroad the opportunity to gain academic experience in other countries, and acquire skills that are indispensible for working and interacting in international and intercultural environments. The university guest house and the Max Kade Center, which opened in 2014, offer foreign scholars and students comfortable and welcoming accommodations.

In 2007, Philipps-Universität established the »Welcome Centre,« one of the first of its kind in Germany. The center offers a broad range of services to enable scholars from abroad to concentrate on research and teaching in Germany during their stay in Marburg.

Philipps-Universität's international orientation by the numbers:

- 68 cooperative agreements with universities outside Europe
- 600 ERASMUS agreements with 300 European universities
- 3,000 foreign students from 130 countries
- One of the 20 most popular universities in Germany for students from China and the U.S. (Source: »Wissenschaft weltoffen« 2012 and 2014)
- 400 foreign students are enrolled in exchange programs every year
- 500 students spend one or two semesters abroad
- 20 percent of doctoral students come from abroad

For more information:
www.uni-marburg.de/international

Pakistani biophysicist Dr. Sumaira Ashraf is a guest of the Marburg Department of Physics until 2016. Ashraf, who holds the Alexander von Humboldt Foundation's Georg Foster research grant, is involved in nanoparticle research within the biophotonics research group headed by Prof. Dr. Wolfgang Parak. Ashraf is delighted with Marburg and the pleasant working environment in the biophotonics lab. She has been involved with the biophotonics research group for some time, having written a portion of her doctoral thesis in Marburg in 2010.

Photo: Reinhold Eckstein, Philipps-Universität Marburg

THE BRAIN IN ACTION

Eye tracker. Photo: Anna Schroll/Hessen schafft Wissen (Hesse Creates Knowledge)

Our brain is highly efficient when it comes to understanding the environment. It can perceive, recognize, and act. Experiences do not simply pass us by, but are literally imprinted on our brains. Neuroscience research focuses on the fascinating process of how an image of the world develops in our heads. In Marburg, a systematic approach plays an important role in this context as scholars here and in Giessen study everyday perception. For example, the interplay between the eyes and hands is a complex interaction that involves many regions of the brain, but this often becomes noticeable only when the process is not working properly, as in neurological disorders such as Parkinson's disease, or after a stroke. Mental disorders are also reflected in the brain. This is genetically determined to some extent, but environmental conditions and experiences also change how genes are expressed in the brain. Clinical neuroscientists, psychiatrists and psychologists collaborate in investigating these relationships. Marburg's Department of Psychology and the Neurosciences is known for its experimental and neurobiological focus.

3 | THE BRAIN IN ACTION | NEUROPHYSICS

UNDERSTANDING THE NEURAL PROCESSES UNDERLYING PERCEPTION AND ACTION

The senses – windows to the world

Humans perceive their environment using all their senses, then interpret it by means of action. In joint research projects, scientists in Marburg, Giessen and at partner universities in Canada study how the brain processes an endless number of sensory impressions and controls everyday actions. These researchers are breaking new ground as they study perception and action in more natural settings.

When you go for a walk outside, you perceive your own motion via what is known as an »optical flow.« The senses are like a window that the world seems to flow past. »We move our eyes more frequently than our hearts beat,« says Prof. Dr. Frank Bremmer. Tests with a camera that moves the way our eyes do show that the input signal our brain has to process is very blurry. But we do not notice that at all. To process the visual input signals, various structures and cells in the brain are activated. Bremmer explains what the brain does during the visual process: »A single neuron perceives only a small segment of the world. What we see consists of the combined images of many neurons.«

The processing of sensory signals has been studied a great deal in recent years, but usually in limited laboratory settings. For instance, visual experiments were performed in darkened rooms and auditory experiments in test chambers with reduced sound. »We are now going a step further and studying perception in more natural settings, in which several senses are often addressed simultaneously,« says neurophysicist Bremmer. In the international research training group (IRTG) called »The Brain in Action – BrainAct,« headed by Bremmer and his colleague Prof. Dr. Katja Fiehler from Giessen, neurophysicists join psychologists, physicians and sports scientists from Marburg, Giessen and three Canadian universities to study the neuronal processes on which everyday perceptions and actions are based.

In a natural environment we are usually exposed to multiple stimuli, as the simple example of turning a page demonstrates. You see the page and hear the sound of the paper moving. In contrast, optical and acoustic signals can be temporally decoupled when we turn the page on a computer. The scientists are studying the degree to which signals can be separated in time and still be associated with each other. »Colleagues in the IRTG are examining how liberal the sensory system is. In doing so, they also consider the extent to which the integration window differs in healthy and sick people, e.g. psychiatric patients, during the perception of associated signals,« says Bremmer, explaining how the research is relevant to medicine.

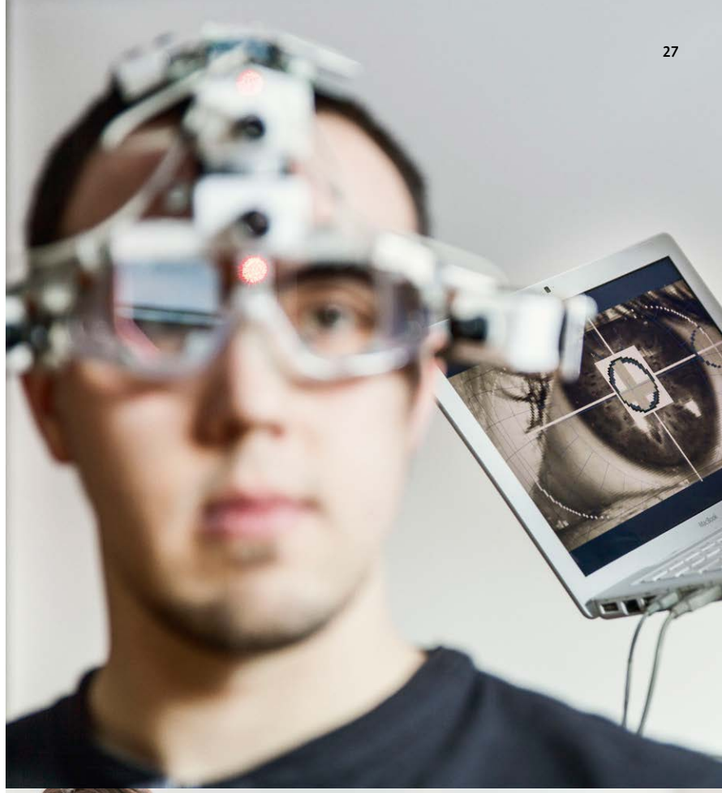
How do sensory stimuli determine our actions? The scientists are analyzing how vision is used when grasping an object. For instance, we hold a raw egg differently than a stone. The process involves several steps that take place in the brain. »From the sensory system to the nerve fibers to the motor system, there are only a few processing steps in the brain,« Bremmer explains. »This basic research on how the sensory system and motor functions are related in the context of acting in the environment could be relevant to robot development, for example.«

The brain is constantly processing spatial information. How does this work? »The retina acquires visual signals, which are combined with information on the viewing direction of the eye. In this way, the brain codes the position of objects in space,« Bremmer elucidates. This enables us, for example, to pick up a cup when we are looking in a different direction. Insights into brain processes, from perception to spatial coding in the brain to hand or full body movements, should be applicable to medicine in the future. »Together with neurologists at the university hospital and our Canadian colleagues, we are searching for ways to diagnose neurodegenerative and psychiatric disorders more reliably,« says Bremmer.

»The capabilities of the universities involved in the IRTG complement one another in ideal ways,« states Bremmer. »During their six- to twelve-month stay at one of the partner universities, the doctoral candidates become familiar with a wide range of topics and methods in the neurosciences.« The Marburg and Giessen scientists work with neurological and psychiatric patients, investigate attentiveness and eye movements in a natural environment, examine child development from a psychological standpoint and conduct studies in sports science. One of the Canadian partners is researching Parkinson's in an animal model, while other groups have been able to directly influence populations of neurons for brief periods of time using transcranial magnetic stimulation. »At one of the three Canadian partner universities we can also measure brain activity during full arm and hand movements in a magnetic resonance imaging system,« notes Bremmer while describing the collaboration.

Bremmer and many of the scientists from the IRTG are plumbing related research topics also in the »Cardinal Mechanisms of Perception: Prediction, Evaluation, Categorization« Collaborative Research Center (SFB) headed by Prof. Dr. Karl Gegenfurtner, a psychologist from Giessen. These »mechanisms« generate complex internal models of the environment, which the brain is constantly developing and modifying, allowing us to predict our environment and the consequences of our actions, evaluate potential risks or benefits of stimuli and responses and sort the endless number of environmental signals into categories. The Center, started in 2014, has taken on the task of defining these mechanisms at the behavioral level, identifying neuronal functional cycles and describing how they work using mathematical models. The SFB also studies how perceptual mechanisms develop throughout life and how they affect psychiatric illnesses.

»The IRTG and the SFB are perfect examples of the active research alliance created by Marburg and Giessen in 2012,« says Bremmer. »We have been working closely together for many years. Such extensive research programs can be undertaken only if we combine our expertise.«



Eye tracker. Photo: Anna Schroll/Hessen schafft Wissen (Hesse Creates Knowledge)

For more information:

International Research Training Group (IRTG 1901) »The Brain in Action«: *www.forschungsallianz-gi-mr.de/projekte/gradkolleg/brain*

»Cardinal Mechanisms of Perception: Prediction, Evaluation, Categorization« Collaborative Research Center *www.forschungsallianz-gi-mr.de/projekte/sfb/wahrnehmung*

NEUROBIOLOGY OF MENTAL ILLNESS

The complex interplay of environment and genes

Many people with mental illnesses have only a limited ability to experience joy, interact with others or adequately experience the environment. But how does this happen in the first place? Are mental disorders more the product of genetics, or the social environment? Marburg psychologists and physicians study their relationships and risk factors.

Everyone is familiar with mild mood swings. They usually pass after a short time, and as we live life we develop strategies for recovering from temporary, minor lows. But people with mental disorders are unable to do so. During the acute phase of their illness, they can no longer regulate their moods, their perceptions of their surroundings and other people are distorted, and they may withdraw and react differently than usual. Why is this the case? What happens in the brain during certain emotions, and what determines social behavior and communication? »We know that illnesses such as depression and schizophrenia are attributable to both genetic and environmental factors. But determining which particular factors have to interact to trigger an illness is still a wide-open field of research,« says Prof. Dr. Rainer Schwarting, a Marburg psychologist.

To answer these questions and continue to develop treatments, it is important to begin by understanding the underlying neuronal, genetic and environmental foundations of emotions and behavior. To this end, Schwarting works with mice and rats, because genetic and environmental influence can be strictly controlled with these animals. The biopsychologist and his team study neurobiological processes on the basis of communication among the rodents. »Mice and rats communicate through calls in the ultrasound range,« explains Schwarting. »Depending on age, emotional state and social context, we can distinguish various classes of ultrasound vocalization.«

When newborn rats are separated from their mother and removed from the nest in the first few days of life, they produce isolation-induced calls in the 40 kilohertz (kHz) range. These vocalizations presumably express negative emotions of abandonment and fear. They prompt the mother to pay more attention to her young. Isolated young animals also remain anxious as adults and even pass this trait on to their offspring, as experiences can lead to changes in the expression of certain genes in the brain. These relationships among socioenvironmental factors and genes are used to study fear and depression. In contrast, the animals express positive emotions during play with other members of their species. Rats emit interaction-induced calls at a frequency of 50 kHz, causing other rats to approach. This effect is presumably mediated in the brain by the dopamine system, also known as the reward system. When animals emit few of these social calls, it can be a sign of disease-related changes in social behavior and communication.

The Marburg psychologist works closely with Prof. Dr. Tilo Kircher, a physician. The results from the animal models are funneled into his clinical research, and conversely the team working with Kircher relays hypotheses from their work with patients to the psychologists, so that the latter can conduct basic research in the animal model. Kircher and his team use functional magnetic resonance imaging (fMRI) to study ill and healthy subjects. The scientists have used the imaging procedure for several purposes, such as to demonstrate the interaction between the oxytocin receptor gene and an environmental factor defined as attachment to parents in childhood.

The relationship between genetic and environmental causes of mental illnesses also plays an important role in the DFG research unit 2107, in which Kircher and Schwarting study risk factors for mental illnesses. One of their shared interests is the effect of the »age of father« one of the environmental factors related to the development of schizophrenia and autism. Since the number of fathers who are over 50 when their children are born is increasing, this is a very topical research subject internationally. Population studies in Scandinavia demonstrated the link years ago. »The reasons lie in the complex interaction of genes and environmental factors, but we don't know yet how exactly this works,« reports Kircher. Throughout human life, about two gene mutations occur each year in the gonads. These changes are passed on to the next generation. The older a father is, the more mutations have likely occurred, and the greater the risk of illness. »But by no means does a high paternal age inevitably lead to a mental disorder. On average, the risk is greater by a factor of 1.3, and it increases in linear fashion with age,« explains Kircher. In order to thoroughly understand how the paternal age risk factor leads to illness, the Schwarting team is studying rats with older fathers. From an early age, these rats are carefully observed to detect behavioral abnormalities, such as social withdrawal and the absence of social calls. »The causal chain as to why and when illness begins, and due to which factors, can be effectively tracked in experiments using the animal model,« says Schwarting. The results are expected to improve our understanding of certain human illnesses. »Because people often become ill between the ages of 20 and 30, we want to know what exactly changes in the brain at this age,« says Kircher, alluding to one of the fundamental questions in the joint research project done by the Marburg psychologists and physicians.

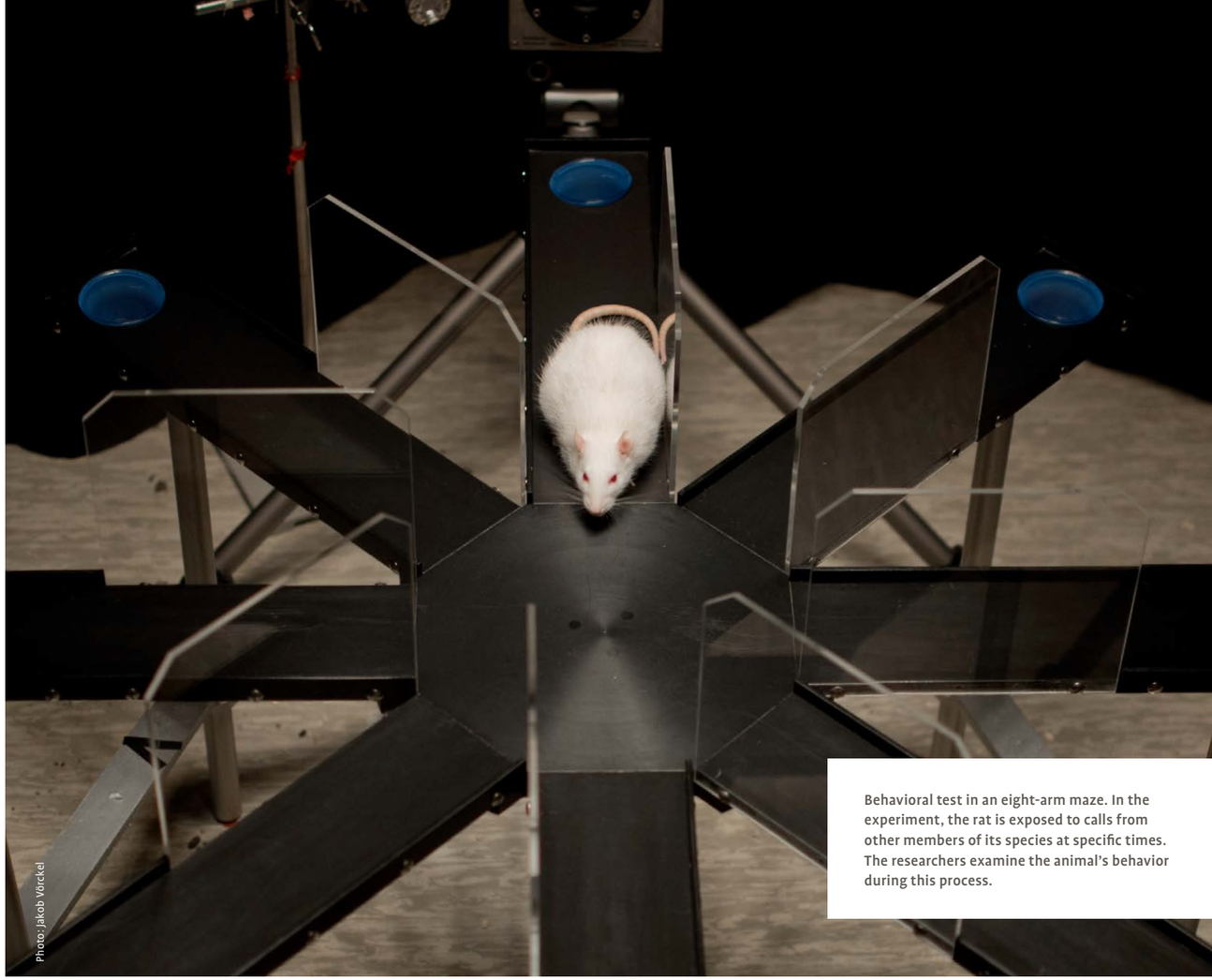


Photo: Jakob Vörckel

Behavioral test in an eight-arm maze. In the experiment, the rat is exposed to calls from other members of its species at specific times. The researchers examine the animal's behavior during this process.

For more information:

Behavioral neurosciences:
www.uni-marburg.de/fb04/team-schwarting

Department of Psychiatry
www.psychiatrie-marburg.de

DFG research unit 2107 »Neurobiology of affective disorders: A Translational Perspective on Brain Structure and Function«
www.for2107.de

WHERE SCIENCE AND BUSINESS MEET

Innovations »Made in Marburg«

Science provides the basis for innovation. But how do research results lead to products? Supporting researchers and companies along this path has been the core business of TransMIT Gesellschaft für Technologietransfer mbH (TransMIT Society for Technology Transfer) for the last 18 years. The company manages more than 500 patent applications for Philipps-Universität.

»Technology transfer is connected with the intention to innovate, courage, and a sense of the right investment at the right time«, says Dr. Michaela Kirndörfer, the director of the TransMIT GmbH patent department. The company was founded in 1996 as a joint project of universities, cooperative banks and savings banks in central Hesse, together with the Giessen-Friedberg Chamber of Commerce and Industry. The enterprise has become a mainstay for Philipps-Universität, one of its three university partners. The other two are Justus Liebig University Giessen and the Technische Hochschule Mittelhessen University of Applied Sciences.

With about 167 employees and offices in Marburg, Giessen, Friedberg, Frankfurt am Main, and Nuremberg, TransMIT professionally develops and markets the potential of about 7.000 scholars. »In practical terms, this means that we develop and maintain many contacts to individual departments and scholars at universities, connect them with contacts in the business world, and coordinate projects«, explains Michaela Kirndörfer the core business of the technology transfer company. »In addition to transfers from the university to the economy, the company now also offers transfers to the university.« When companies ask us for help with specific technical problems, we search for specialists at the universities. We also make it possible for scholars to try out their first commercial activities within the protected framework of the GmbH, if they have an interesting business idea but aren't ready to start their own company yet.«

More than 150 TransMIT centers and project areas have emerged from the three TransMIT GmbH partner universities. They offer a wide range of innovative technologies and services in areas such as materials science, biotechnology, chemistry, pharmaceuticals, medicine, medical technology, communication and media, corporate ethics and management, and information technology.

TransMIT manages more than 500 patent applications for Philipps-Universität, including more than 100 granted patents. The company also markets about 20 inventions annually. One successful example is an improved medical drape for operating rooms developed by a Marburg university hospital employee. TransMIT provided support in drawing up the patent application, handled the market analysis and patent research, filed the patent application and, finally, found businesses to act as production and distribution partners. Today, the invention is used routinely in hospitals.

A promising invention for the Department of Medical Microbiology in Marburg makes it possible to detect leishmaniasis, an infectious disease, in human beings and dogs. With the support of a company based in central Hesse, the scientists were able to develop a routine test in order to diagnose the disease using a drop of blood.

Another »Made in Marburg« invention is an electrochemical micro-measuring cell that employs safe electrolytes, derived from organic solvents, which could replace the conventional flammable battery electrolytes. Possible applications for the new battery concept are electromobility and renewable energy storage.

Marburg cardiac surgeons were granted a European patent for inventing a process to reliably secure and manipulate tissue, especially during minimally invasive heart surgery, where direct visual monitoring is not possible. In the past, adhesions could not be reliably recognized. The new instrument minimizes the risk of inadvertent injury to the heart muscle and also facilitates risk-free access to deeper tissues such as the pericardium.

»TransMIT's commercial activities as a professional mediator in industry are attracting global attention to Marburg as an academic center, and to research results obtained there. In this way, the university and the technology service provider have successfully complemented each other for the last 18 years«, mentions patent engineer Michaela Kirndörfer.

TransMIT GmbH – the Society for Technology Transfer of the universities in central Hesse

Founded: 1996

Employees: 167 (2013)

Locations: Frankfurt, Friedberg, Giessen, Marburg

Scientists served: about 7.000

Business areas:

- TransMIT Centers
- Patents, Innovation and Start-Up Consulting
- TransMIT Academy
- IT Solutions

For more information:
www.transmit.de

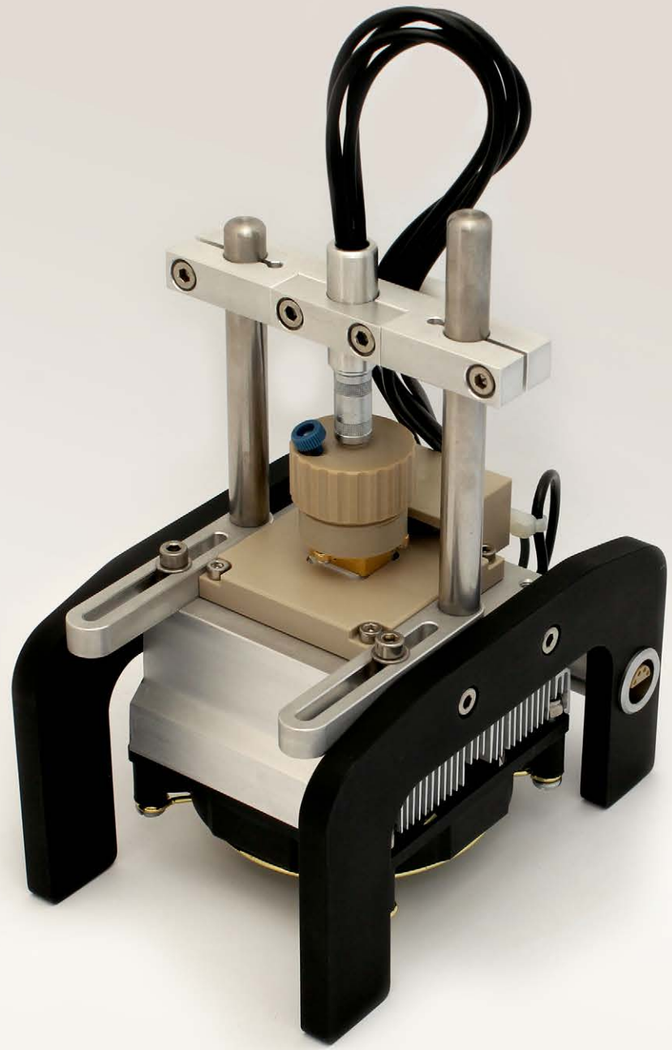


Photo: Philipps-Universität Marburg/AG Roling

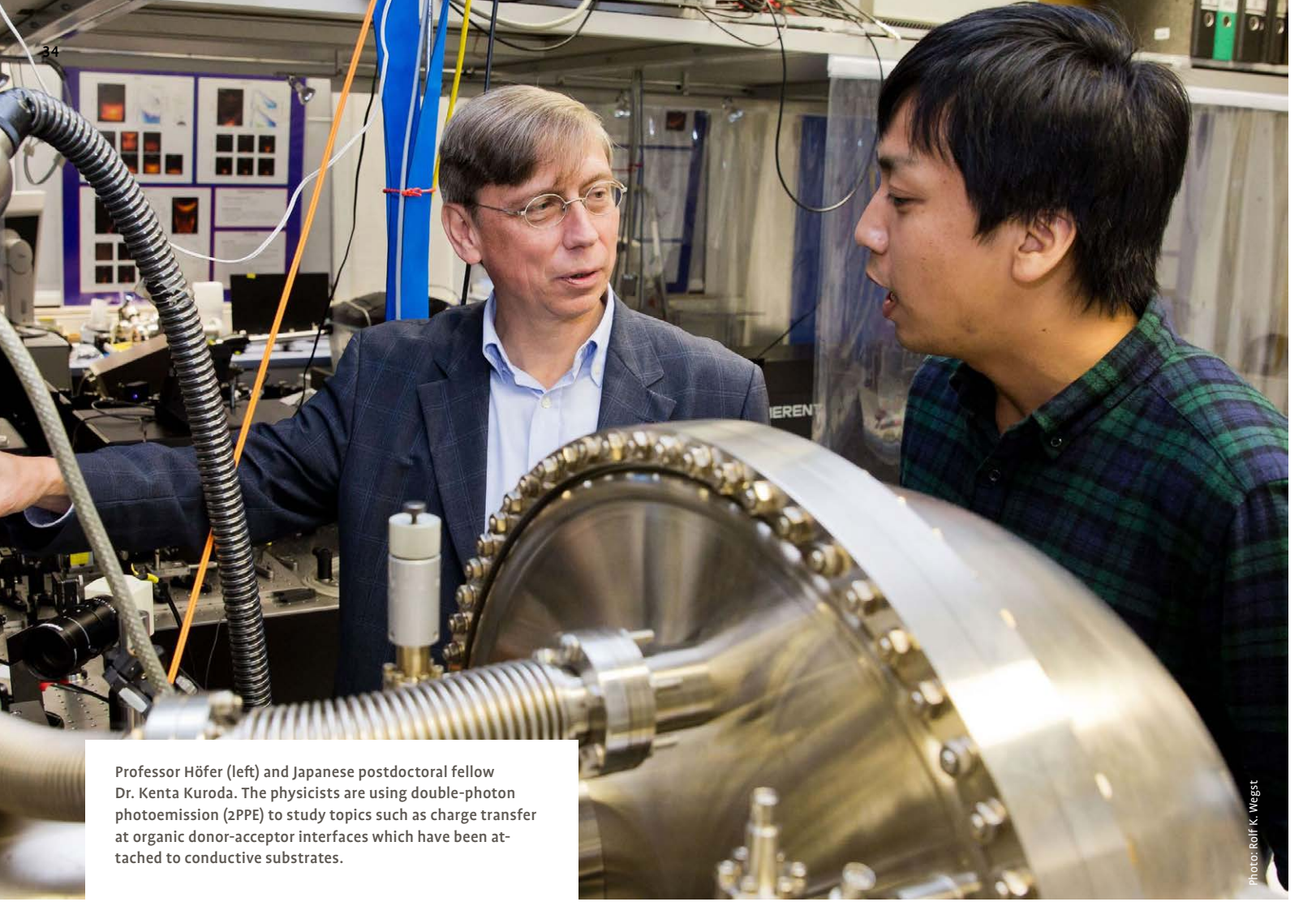
An invention »Made in Marburg«: An electrochemical micro-measuring cell can replace the flammable battery electrolytes used nowadays, and thus contribute to an energy supply that consumes fewer resources. The battery concept is suitable for the use in the fields of electromobility and renewable energy storage.

FROM ATOMS TO FUNCTIONAL MATERIALS

Photo: Anna Schroll/Hessen schafft Wissen (Hesse Creates Knowledge)

As complementary sciences, physics and chemistry create the foundations for future communication and energy technologies. Marburg chemists synthesize molecules and materials with certain properties, while physicists study their functional characteristics. Semiconductor research and optoelectronics are fields in which Marburg scientists have internationally recognized expertise. At Philipps-Universität, functional materials based on semiconductors, surfaces and interfaces are studied in a special research area and a research training group.

Chemistry is an interdisciplinary science that also drives the life sciences in important ways. In a LOEWE priority program, chemists, pharmaceutical chemists and bio-scientists collaborate to seek new chemical strategies for modulating and controlling biological processes. Scientists from Marburg, Giessen and Frankfurt are bringing together their expertise within this Hessian research alliance.



Professor Höfer (left) and Japanese postdoctoral fellow Dr. Kenta Kuroda. The physicists are using double-photon photoemission (2PPE) to study topics such as charge transfer at organic donor-acceptor interfaces which have been attached to conductive substrates.

Photo: Rolf K. Wegst

CONTROLLING STRUCTURES AND DYNAMICS BETWEEN MATERIALS

Interface control

Today, many electronic devices rely on the transport of charges across the interface between different materials. But how exactly does this work and how can it be controlled? Marburg physicists and chemists are addressing this issue within the framework of a collaborative research center. In the long term, their insights may translate into the fabrication of new materials with novel functions.

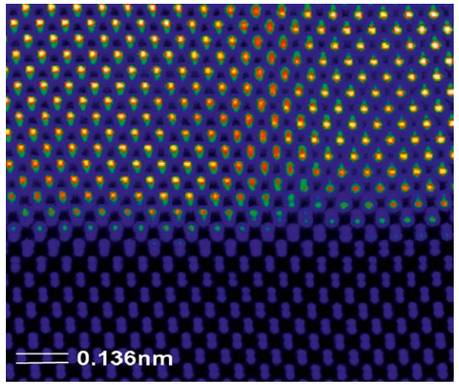
Evermore functions on increasingly smaller surfaces: Today's semiconductor devices, as those integrated in computer chips, are miniaturized to an extent that their optical and electronic properties are determined largely by their internal interfaces or, as physics Nobel laureate Herbert Kroemer puts it, »the interface is the device.«

Basic research, which initiated this development to miniaturization decades ago, has been unable to keep up with the rapid technological progress. This in turn limits new advances, such as hybrid materials that combine the properties of metals or other inorganic materials with those of organic or biomaterials. Biosensors and new types of solar cells are examples of their potential application.

»It is extremely difficult to track down the faint traces of interfaces experimentally, as they are often hidden under several layers of other materials,« says Prof. Dr. Ulrich Höfer, professor of surface physics at Philipps-Universität. He is the spokesman for the Collaborative Research Center on the »Structure and Dynamics of Internal Interfaces« (SFB 1083), which was established by the German Research Foundation (DFG) in 2013 to close this knowledge gap. The study of internal interfaces is considered one of the most pressing research issues in solid-state physics. »Such a complex issue necessitates a long-term commitment in order to achieve lasting results,« says Höfer. More than 60 scientists in the fields of semiconductor physics, surface physics and surface chemistry, chemical synthesis, structural analysis and laser spectroscopy are involved in the center, which is set up to operate over a 12-year period. Altogether, members of 15 research groups in the Marburg chemistry and physics departments are joined by a guest project based at the renowned Donostia International Physics Center in San Sebastián, Spain.

Höfer believes that the Center for the study of internal interfaces comes at just the right time. »Considerable progress has been made in recent years in electron microscopy and laser spectroscopy. Presently, it is for the first time that we can characterize certain structures on the atomic scale, as we now finally have the necessary microscopy at our disposal. Additionally, optical methods allow us to monitor electronic processes at interfaces deep within solid objects.« Initially, the research is not focusing on operational functional materials, as these usually contain many poorly defined interfaces. »Instead, the focus is on gaining a fundamental understanding of physical processes at the interface,« says Höfer, explaining the Center's current emphasis. To that end, the scientists are developing model systems with individual, specially prepared internal interfaces. These are then structurally characterized at the atomic level so that their optical and electronic properties can be studied systematically. Knowing how chemical bonding, electronic coupling and energy transfer between materials function it will one day become possible to customize interfaces and manufacture materials or components with novel properties and functions.

Interfaces between two inorganic semiconductors can be highly controlled and described very effectively, and form the basis of the worldwide semiconductor industry. However, model development for interfaces between different organic materials and between organic and inorganic semiconductors is still in its infancy. This notwithstanding, the team headed by Marburg professor of molecular solid-state physics Prof. Dr. Gregor Witte has reached a first milestone towards a deeper understanding of organic-to-organic interfaces. In an experiment, small amounts of fullerene C60, a spherical molecule made up entirely of carbon atoms, was layered on top of an organic semiconductor made of pentacene, an elongated molecule. As the structures of these two materials are as different as a regular orange pile and a brick wall, it was necessary to match them up at their interface. This was achieved by fine tuning the pentacene's temperature during the growth of the C60overlayer. Depending on the temperature, the researchers were able to create two-dimensional surfaces, one-dimensional chain compounds or even zero-dimensional assemblages of molecules (clusters).



The interface between gallium phosphide and silicon as seen in a transmission electron microscope. Source: Prof. Dr. Kerstin Volz

Pentacene is an electron donor while C60 acts as an electron acceptor. Such interfaces between donor and acceptor materials are critical to the functioning of organic solar cells. It is at the interface, where the bonded electron-hole pairs generated by sunlight, also known as excitons, are separated and converted into electric current. This allows the study of the fundamental physical process in an organic solar cell at the pentacene/C60 interface. »Pentacene/C60 is a promising model system for using spectroscopic methods to systematically study and theoretically describe the influence of the interface's atomic structure on the dynamics of charge transfer,« explains Höfer. »This is a central topic at our collaborative research center and a great challenge.«

For more information:

»Structure and Dynamics of Internal Interfaces« Collaborative Research Center: *www.uni-marburg.de/sfb1083*

FROM BASIC RESEARCH TO THE INDUSTRIAL MANUFACTURING PROCESS

Computing with light

Marburg physicists combine optics and electronics to develop semiconductors for even faster data processing. They are world leaders in research in this field. Their recipe for success is the dovetailing of theory and experiment, of laboratory synthesis and analysis under the microscope, and of academic research and industrial application.

The number of Internet applications is growing every day, as is the demand for transmitting ever-larger volumes of data at ever-higher speeds. Hardware has to keep up. The technical possibilities of silicon, the standard material used to transmit signals electronically in microchips, have been exhausted. »Faster computing speed can be achieved if signal transmission is done optically, because nothing is faster than light,« says Marburg physicist Prof. Dr. Wolfgang Stolz. However, silicon's structure makes it unsuitable for optical signal processing. This has led Marburg physicists to search for a new compound material that generates laser light and also has crystal lattices suitable for use with silicon. Their quest is part of a project funded by the German Research Foundation.

Scientists in various disciplines have worked closely together to address this problem. The team led by Prof. Dr. Stephan Koch, professor of theoretical semiconductor physics, was able to head the search in the right direction by predictive theoretical modeling of the optical properties of semiconductor structures. This eliminated the need for experimental testing of every conceivable material combination. The scientists working with Wolfgang Stolz utilized the modeling results to produce large-surface, layered structures in the laboratory. They applied a complex mixture consisting primarily of gallium, nitrogen, arsenic and phosphorus to silicon disks. Because these are all elements from groups III and V of the periodic table, the resulting products are referred to as III/V semiconductors. The scientists found that the crystal lattices were well adapted for use with silicon, and that the optically active layers had few defects. Analyses by a research team headed by Prof. Dr. Kerstin Volz confirmed their results. Volz specializes in characterizing the atomic structure of materials. Her results are helping the theoreticians to constantly correct the models, and providing the experimental physicists with insights on how to improve crystal growth in the laboratory.

Once the right combination of materials had been found, the researchers worked in collaboration with industry to launch a project funded by the Federal Ministry of Education and Research with the goal of readying their results for use in practical applications. Coordinated by Professor Stolz, the consortium covered the entire production process, from the delivery of high-purity chemicals to the construction of a facility to produce a laser prototype. In late 2010, the small computer chip factory's two facilities were officially opened at the university's Lahnberge campus. »Because III/V semiconductors alter silicon's conductivity, the materials are carefully kept separate in one facility before production, then combined at the second facility during production,« Stolz explains.

Meanwhile, the research continues. »We are in the process of optimizing crystal growth to the point of perfection,« explains Kerstin Volz. An important piece of equipment in this process is the custom-made transmission electron microscope (TEM) acquired for research in Marburg in 2012. Using the TEM, Volz can observe crystal structures at the atomic level and determine whether the material has the desired characteristics. »Thanks to the TEM, we know how the materials grow on top of one another,« the professor reports. »They form pyramid-shaped structures at their interface.« Volz has started developing a sample holder for the TEM so that the results of structural analysis can be applied in the laboratory more quickly than in the past. The holder lets scientists observe crystal growth under the microscope as it occurs. »You can see the atoms moving, and you can intervene directly, such as by modifying the temperature or the mixing ratio of the materials,« the physicist explains. This would represent an enormous advance for Professor Stolz's research team. »It saves us a lot of effort if we can examine the individual atomic steps in a single experiment, instead of having to perform a separate experiment externally for each of them.«

Optimizing the crystal growth of III/V semiconductor materials on a silicon substrate and modeling the desired optical properties will also be key research objectives in the coming years, as will incorporating the new material into electronic circuits. To address these issues, a new project is in the works, in which the Marburg scientists will cooperate with two other universities in Hesse, along with industrial partners. Young scientists in a research training group coordinated by Professor Volz are also involved in the research. »The development of functional materials is an important topic for the future, and it has great potential for industrial applications,« says Volz. With this in mind, the Marburg research groups are not limiting their studies solely to innovative components for faster computers. Stolz names other examples of applications in which the combination of optics and silicon-based electronics promises more efficient signal transmission. »Among other things, it makes improvements to decentralized power production and distribution possible. Using this technology, cameras can also become much more powerful.«

For more information:

Material Sciences Center (WZMW) at Philipps-Universität:
www.uni-marburg.de/wzmw

Photo: Thorsten Richter

Physicist Stefan Ziegler operates the production system for a silicon-based laser.

MODULATING BIOLOGICAL PROCESSES WITH NEW CHEMICAL STRATEGIES

Making new keys

Why do drugs have side effects? Because they often affect parts of the body for which they are not intended. An agent typically has to fit into a specific pocket of an enzyme within the body, like a key into a lock. Because enzymes are complex and flexible, it is difficult to make the right keys. A Hessian research alliance under Marburg leadership is dedicated to this task.

Drugs should act as precisely as possible on their targets in the body. Like a key in a lock, they must exactly fit to the enzymes in the body that cause disease when they malfunction. »However, because of the biological system's tremendous complexity, achieving the desired specificity in a drug's action remains a largely unsolved problem,« says Prof. Dr. Eric Meggers, a professor of chemical biology in Marburg. This is why side effects are so common. New chemical strategies are needed to develop agents that bond to only one of the many thousands of enzymes in the body. Meggers heads up a research alliance of Philipps-Universität, Justus Liebig University Giessen, and Goethe University Frankfurt that is dedicated to this task.

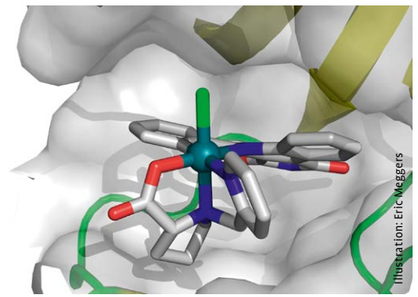


Illustration: Eric Meggers

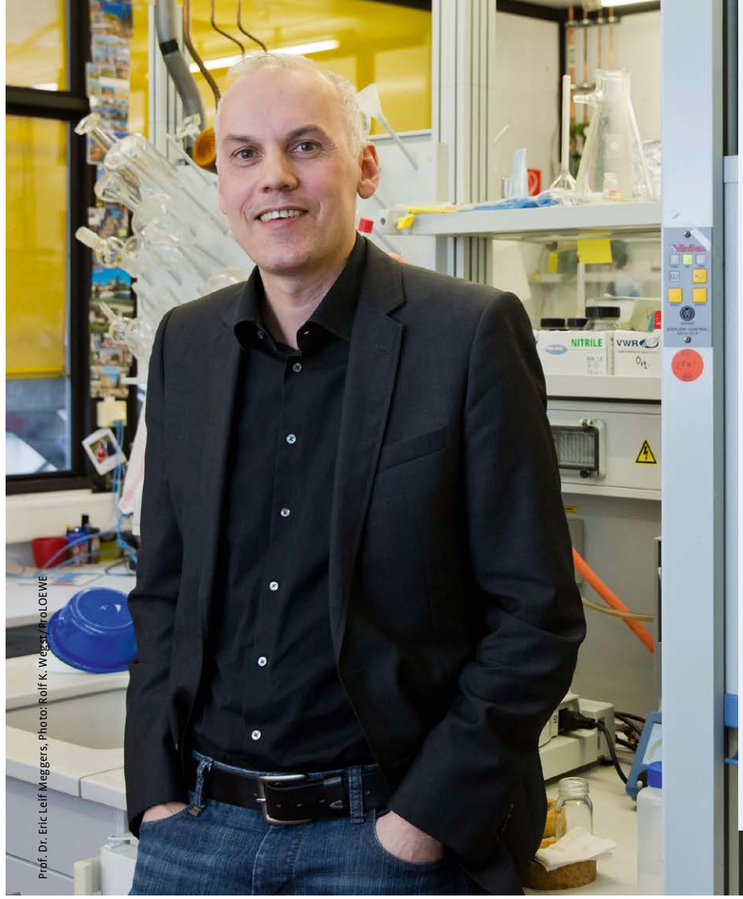
A metal complex bonded to an enzyme

Twenty research groups from the three universities are involved in the LOEWE research initiative called »Innovative Synthetic Chemistry for the Selective Modulation of Biological Processes,« which began in 2014. Scientists in synthetic, pharmaceutical and theoretical chemistry, as well as structural analytics, are working closely together to find new keys. The development process for a new drug, for example, begins with the chemical synthesis of molecules. To this end, the LOEWE project's scientists use all possible compound classes and methods from organic, inorganic and nano-based chemistry. »We experiment with everything the periodic table has to offer,« says Meggers. The researchers are going beyond the current approach of developing active pharmaceutical ingredients exclusively from organic molecules. Meggers has demonstrated that organometallic compounds can bond highly selective to enzymes. »Many drug side effects arise because the agent's molecules are usually very flexible. With metals, we can restrict flexibility and thus control enzyme activity more precisely,« Meggers explains. »The advantage is that a central metal, like an adhesive, creates structures without affecting other properties of the compounds.«

Meggers estimates that it will take a few more decades for this basic research to yield new pharmaceutical agents. The only successful example to date of an anti-cancer drug containing metal is cisplatin and its analogs. The transition metal bonds to nucleic acids and restricts cell division in cancer cells. »The metal is highly effective against tumors, but also toxic. This is why in the past there have been so many reservations about using metals in medications,« says Meggers, who works primarily with materials like iridium, rhodium and ruthenium. To produce molecules with specific properties, the research alliance chemists use rational design to combine and vary atoms in an organometallic compound that serves as a framework. Until today, neither for organic nor organometallic compounds the requirements for precisely targeting enzymes are well established. This is why one of the key objectives of the LOEWE initiative is to examine how and how quickly selectivity works, and study the interactions between synthesized molecules and enzymes. A research team headed by Marburg's pharmaceutical chemist Prof. Dr. Gerhard Klebe is examining these interactions using X-ray structure analysis. In addition to X-ray, nuclear magnetic resonance spectroscopy is another important method for determining the structure of possible agents. This skill is brought to the research alliance by Frankfurt chemists working under Prof. Dr. Harald Schwalbe.

The recognition that organometallic compounds bind selectively to enzymes is highly relevant to drug development in the pharmaceutical industry. Novartis, in Cambridge, Massachusetts, supports the research in Hesse in terms of its potential industrial applications. Scientists at the company have carefully examined the properties of the compounds in question and have found them completely suitable for developing new pharmaceutical agents. In mouse experiments, they explored the compounds' efficacy, tolerability, and breakdown in the body. The next step is to investigate whether the compounds can be used to shrink tumors. Scientists at the Wistar Institute in Philadelphia are studying how the compounds work in the treatment of melanoma.

Two of the organometallic compounds produced by the Marburg researchers during the preliminary stages of the LOEWE project are now sold commercially in the United States. Biologists use one of the products, a ruthenium compound, as a selective kinase inhibitor, or a precise »tool« to block certain enzymes. Marburg researchers have also applied the principle of lock and key recognition to the production of catalysts. These are initial applications, and the potential is far from exhausted. On the contrary, »because new structures can be created with metals, scientists will be able to invent many new functions in the future,« says Meggers to illustrate this research field's critical importance.



Prof. Dr. Eric Leif Meggers, Photo: Rolf K. Wegst/pLOEWE

At home in several different research cultures

As a scientist Eric Meggers, born in 1968, has become acquainted with various research cultures. After earning a chemistry degree in Bonn, he completed a doctorate in Basel in 1999. He went to California for postdoctoral research, and in 2002 accepted an assistant professorship at the University of Pennsylvania in Philadelphia. He accepted a position in Marburg in 2006. What did he learn during his time in the United States? »Most of all, the spirit of approaching a goal pragmatically and directly, and of wanting to achieve something as a team,« says Meggers. »However, there is considerable competitive pressure to quickly build your own reputation as a researcher.« He succeeded, and in the United States he developed the concept of molecular selectivity through the use of organometallic compounds. The Hesse Excellence Initiative is funding the further development of Meggers' concept. In Germany, he values the outstanding support he receives from the university and the German Research Foundation. Meggers is also in demand in China as an international expert. He has held a professorship at the College of Chemistry and Chemical Engineering at Xiamen University since 2011. He is impressed by the drive and motivation of Chinese scientists. »They are very ambitious, and their entire lives are subordinate to the project. This results in successful research.«

Facts on the LOEWE »Innovative Synthetic Chemistry for the Selective Modulation of Biological Processes« research initiative

Underway since the beginning of 2014

Goal: Basic research on the interaction and precise matching of agent molecules and enzymes as the basis for innovations in drug development.

Partners: Philipps-Universität Marburg, Justus Liebig Universität Giessen, Goethe-Universität Frankfurt

Departments: Chemistry, Biochemistry, Pharmaceutics, Physics

Spokesmen: Prof. Dr. Eric Meggers, Philipps-Universität Marburg; Prof. Dr. Harald Schwalbe (deputy), Goethe University Frankfurt am Main, Prof. Dr. Peter R. Schreiner (deputy), Justus Liebig University Giessen

JOURNEY INTO ACADEMIC INDEPENDENCE

Intergenerational contract

In addition to research and teaching, one of a university's core objectives is to promote young academic talent. There is a generational agreement of sorts between experienced scholars and young talent. Philipps-Universität supports every phase of an academic career and also participates in programs to promote young talent throughout Hesse.

When they complete their studies, emerging young scholars have acquired the basic professional qualifications for an academic career. A doctorate represents the journey into academic independence. Philipps-Universität offers a wide range of doctoral options. Choices include individual doctoral study or participation in a structured graduate school in or outside of research programs; and writing monographs or authoring a cumulative dissertation.

The supervisory agreement helps to make the doctoral phase more transparent and productive. Doctoral candidates and their faculty advisors use it to document their respective rights and obligations. It contains a work plan and schedule, and both parties agree to regular discussions on the progress of the work. Constructive cooperation with the faculty advisor is critical to the success of doctoral studies, but involvement in academic projects and networks is also important. Hence Philipps-Universität's support for »structured doctoral programs.« The advantages for young scholars include a transparent process, subject-specific postgraduate training, development of key skills, and intensive communication with other scholars, both at home and abroad. Professors also benefit from this support. It improves the quality of doctoral theses, and the programs are integrated into existing research alliances and supported by the Marburg University Research Academy (MARA), Philipps-Universität's umbrella organization for promoting young talent. Twelve of these programs (Graduiertenkollegs) have been implemented since 2009. Ideally, they provide a financial boost and serve as a space for proving out research training groups or graduate schools. One of the success stories to emerge from this form of support is the »Functionalization of Semiconductors« research training group approved by the German Research Foundation, which is funding 12 doctoral student positions until 2016. The young scientists in the program are studying a central, future-oriented subject in the field of materials science, which qualifies them for both a continued academic path and a career in industry.

MARA coordinates all programs to promote young talent and organizes networking platforms for doctoral students in the humanities and the social, natural, and life sciences. Advanced training programs in interdisciplinary skills are a key feature. They include project management, writing workshops, presentation techniques, career planning strategies, support in obtaining third-party funding for a research project, conference organization, staff selection, ethical issues in research and pedagogical skills. MARA also provides advice on issues of funding a doctoral program and supports applications to grant providers, research funding organizations and the European Union.

A unique feature in Marburg is advanced training for communication of science to the public. The purpose of this program is to help young scholars present their topics to a broad public and the media in a way that is both accessible and interesting. This enables them to promote the public discussion of research and help shape its content. An understandable presentation and a convincing communication concept can also be the decisive factor in the acceptance of a grant application. In workshops, some of which are part of a cooperative effort with the »Science in Dialogue« initiative, scholars learn what makes the media tick, which topics even stand a chance of publication, how to edit information to make it understandable, how to conduct an interview and how to use social media to describe one's research to an outside audience. MARA offers a one-year mentoring program called »Communication of Science to the Public« so students can practice what they have learned. It includes individual mentoring by journalists specializing in academia and joint events, including a visit to an editorial office that focuses on academic issues.

Young scholars also need support in the postdoctoral period. There is some discussion about the path to a professorship, but it is clear that there is not one single recipe for success. Depending on the scientific culture in a particular field, the mentoring environment and available resources, a postdoctoral qualification or junior professorship – with or without tenure track – can lead to success. All approaches are possible and are centrally supported at Philipps-Universität. Experience has shown that a period of study abroad in a well-known research environment during the postdoctoral qualification phase expands the horizon and is a must in some fields. MARA's Academic Career and Development Center offers interdisciplinary support for postdoctoral fellows, postdoctoral thesis candidates, and junior professors, such as advanced training on developing and managing research projects, third-party applications, mentoring and coaching. All young scholars with doctoral degrees who are interested in an academic career can apply for financial support from the central research grant fund at Philipps-Universität. The research department also provides support for applications to the German Research Foundation's Heisenberg Program and for the European Union's ERC Starting Grants.

Philipps-Universität helps women, in particular, to pursue an academic career. This begins with a one-year mentoring program, in which women students on the verge of graduation and new graduates are assisted with their decision-making process. The university is also involved in incentive programs throughout the state of Hesse, one of which is the ProProfessur project for highly qualified women scholars on the path to a professorship. They are supported in an individually customized, 18-month career-planning program, and benefit from the latest methods as they prepare to assume research, leadership and management responsibilities in academia.

These many tools that support young scholars in Marburg enable them to find their individual paths and prepare them for the challenges along the way. As Albert Einstein said: »Personalities are not shaped by pretty speeches, but by their own work and achievement.«

For more information:

Marburg University Research Academy (MARA):
www.uni-marburg.de/mara

Photo: Christian Stein

Young academic talent in a MARA workshop

Marburg microbiologists working with a super-resolution fluorescence microscope

Photo: Thomas Ernsting/Hessen schafft Wissen (Hesse Creates Knowledge)

THE BUILDING BLOCKS OF LIFE

There is a long tradition in the life sciences at Philipps-Universität, where a focus on the specialized fields of cell biology, microbiology and virology has emerged. The university continues to build on successful vaccine research since Emil von Behring and on its expertise in highly pathogenic viruses. The LOEWE Center for Synthetic Microbiology, with its planned research building, symbolizes the pioneering orientation of the Marburg Department of Microbiology, which brings together the university and the Max Planck Institute for Terrestrial Microbiology. This association, with its extensive expertise and interfaces to medical, chemical and pharmaceutical research fields such as biochemistry and biological pharmaceutics, offers scientists an outstanding research environment. Marburg scientists study various fields of cell biology. Basic research, which is intended to decipher the principles governing the building blocks of life and how these building blocks interact with the environment, plays an important role in this context. In addition, an understanding of processes in microorganisms should help to comprehend how diseases develop and to create new tools for biotechnology.

MICROORGANISMS ARE CONSTANTLY ADAPTING TO THEIR ENVIRONMENT

The real rulers of the planet

Microorganisms are omnipresent in the environment and make up a large part of the biomass on earth. Every human body contains ten times as many microbial cells as human cells. In their seemingly endless diversity, microorganisms have entered every conceivable habitat and can exist even under extremely arid or hot conditions. Marburg scientists are studying the secret to their success: adaptability.

Microorganisms are constantly monitoring their environment. They are always on guard, for example, while they hunt for available food sources. They also have to adapt to changing climatic conditions. »They react to these changing conditions with stress responses in order to improve their chance of survival,« explains Prof. Dr. Erhard Bremer, a microbiologist. For microorganisms there is only one constant: change. Understanding their enormous biochemical and physiological potential for adaptation to environmental conditions is the goal of the Collaborative Research Center known as »Microbial Diversity in Environmental Signal Response« (SFB 987), which is funded by the German Research Foundation. The Center was created in 2012 under the direction of Prof. Dr. Mohamed Marahiel, a biochemist, and Prof. Dr. Erhard Bremer. It fosters very close collaboration among research groups at Philipps-Universität and the Max Planck Institute for Terrestrial Microbiology (MPI). »Microorganisms have become so biologically diverse because the demands of evolution forced them to do so,« Bremer explains. »We study the mechanisms by which they interpret and respond to signals from the environment. This provides us with insights into the functioning of individual cells, cell assemblies and microbial ecosystems.«

Among other things, the Center focuses on the question of how nutrients are recognized. Where food is concerned, microorganisms are both friends and foes. They can be food competitors and engage in biological warfare with each other by means of toxins or antibiotics, for example. In principle, however, they are not individual fighters. They communicate intensively based on the motto »strength in numbers,« and they join forces to build their »homes,« i.e. surface-associated polymer matrices known as biofilms.

Surfaces are an important habitat for microorganisms. But how do they recognize the structure of surfaces and communicate about it? »This research topic is of interest to medicine, because the question of how we can interrupt cell-cell communication and prevent biofilm formation relates to drug resistance,« Bremer explains. »Our basic research is contributing to the long-term fight against pathogenic germs.«

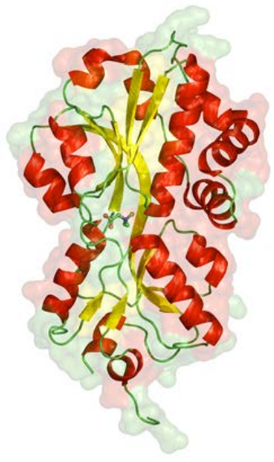
Microorganisms also affect global metabolic processes such as the production and absorption of methane, a natural greenhouse gas. In another area of focus of SFB 987, Marburg scientist try to understand the influence of microbes on the ecosystem by studying isolated species and whole communities in their natural environment. »Only about one percent of microorganisms can be cultured in the laboratory and analyzed using molecular techniques. But we cannot simulate all environmental conditions,« says Bremer, explaining one of the unique challenges in this field of research.

The scientists in Marburg study the whole spectrum of microbial life. They have a wide range of expertise in soil and aquatic bacteria, fungi and various extremophilic bacteria, which live in dry soil, the ocean or sulfuric acid near its boiling point. Moreover, they work closely with geneticists, cell biologists and structural biologists. »Thanks to this extensive expertise, it was possible to bring the MPI to Marburg in 1991, and to establish the LOEWE Center for Synthetic Microbiology here in 2010,« says Bremer, who began working at the MPI in 1992 and accepted a professorship at the university in 1995.

In Marburg, 40 research teams are studying microbiology-related topics. »This large number of scientists makes it possible to constantly integrate new issues into our research,« says Bremer, explaining the advantages in Marburg. »This also positively affects teaching and the promotion of new talent.« Among the young scientists who have benefited from the young investigator programs is Martin Thanbichler, whose career began in 2007 when he became a Max Planck research group leader at the MPI. He is now a professor in Philipps-Universität's biology department. »The mentoring is outstanding. At the same time, I was given the opportunity to conduct independent research early on,« he says, looking back at his career in Marburg. An expert in cell biology, Thanbichler uses fluorescent proteins as a tool to visualize the distribution of proteins and DNA within bacterial cells. »Cell biology is an increasingly important field of research, thanks in part to new microscopic methods. We want to understand how cellular components are arranged in three-dimensional space, and how they orchestrate essential processes such as cell growth and the transmission of hereditary information,« says Thanbichler, providing a glimpse of future research tasks.

Photo: Daniela Kiekebusch

Dr. Lin Lin, a postdoctoral fellow in the research group of Prof. Martin Thanbichler, analyzing fluorescently labeled bacterial cells



Crystal structure of a substrate receptor from the soil bacterium Bacillus subtilis in complex with its ligand ectoin, a small molecule conferring tolerance to salt stress (Tamara Hoffmann und Erhard Bremer).

For more information:

»Microbial Diversity in Environmental Signal Response« (SFB 987) Collaborative Research Center: *www.sfb987.de*

Professor Dr. Regine Kahmann

Born in 1948, Prof. Dr. Kahmann is one of the directors at the Max Planck Institute for Terrestrial Microbiology (Department of Organismic Interactions) and Professor of Genetics at Philipps-Universität. The award-winning scientist is a recipient of the German Research Foundation's Leibniz Prize and the Gregor Mendel Medal bestowed by Leopoldina (the German National Academy of Sciences) for outstanding pioneering achievements in general biology.

Photo: Reinhold Eckstein

What convinced you to move to Marburg in 2001?

The attractive combination of the university and the MPI was the deciding factor in my move from Munich to Marburg. The Max Planck Society is generously supporting basic research, and the cooperation with Philipps-Universität is marked by mutual trust. In addition, our colleagues at the university agreed to allow my department to assume one-third of the university's teaching load in genetics. That's another thing I like about Marburg. I enjoy getting to know every generation of students, together with their ideas and motivations, and advising and supporting young scientists along their path. Besides, Marburg is a pleasant city where I feel very much at home.

One of your areas of interest is corn smut, a pest that causes tumor-like structures on above-ground portions of maize plants. How much have you learned about how the fungus causes this disease?

We want to understand the mechanism by which the fungus infects a plant, and how we can manipulate these steps. We are interested in how our findings can be applied to related fungal pests of cultivated plants that are relevant to agriculture. It is fascinating that infection with the corn smut fungus is possible only when fungal cells that are genetically different can recognize each other through attractants, and then fuse. This normally happens on the leaf surface and leads to the development of filaments that form swellings at their tips and penetrate the plant with the help of these structures. As members of SFB 987, we are studying what happens when the fungus comes into contact with the plant surface. We already know that about 300 different molecules in the fungus are involved in controlling the interaction with the plant. They are formed either on contact with the surface or once the fungus has penetrated the plant tissue. These molecules are secreted by the fungus and quite amazingly, are largely completely novel. So far, we have determined only what five of these so-called effectors do. Determining the function of a novel protein is a long, arduous path that takes about three years per molecule, if all goes well. A few of these proteins suppress the plant's defenses, while others are able to cross into the plant cell and reprogram it. We aretrying to establish which of the 300 fungal proteins are taken up by the plant cell, how this occurs and what exactly happens inside the plant cell. But we do know that the fungus does not destroy the plant, because it needs living plant tissue in order to reproduce. On the other hand, it does have to reprogram the plant cells to generously provide it with nutrients, so that it can complete its life cycle and form spores.

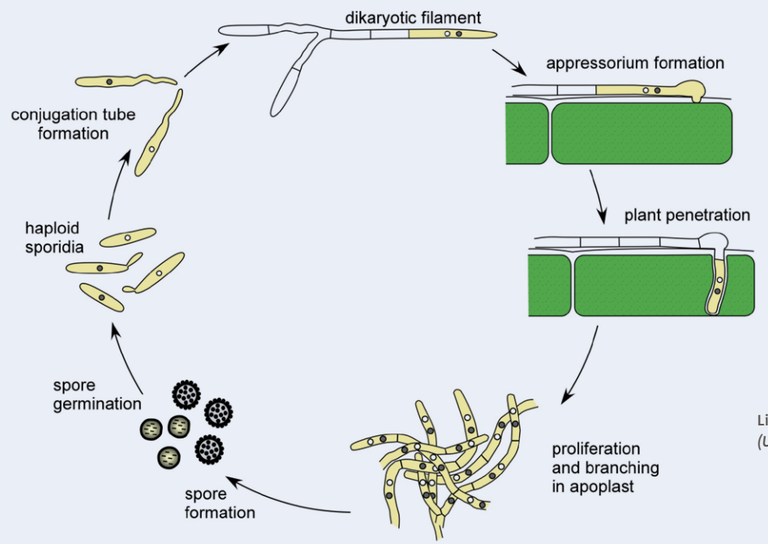


Illustration: Regine Kahmann

Life cycle of corn smut *(Ustilago maydis)*

APPLYING ENGINEERING CONCEPTS TO MICROBIOLOGY

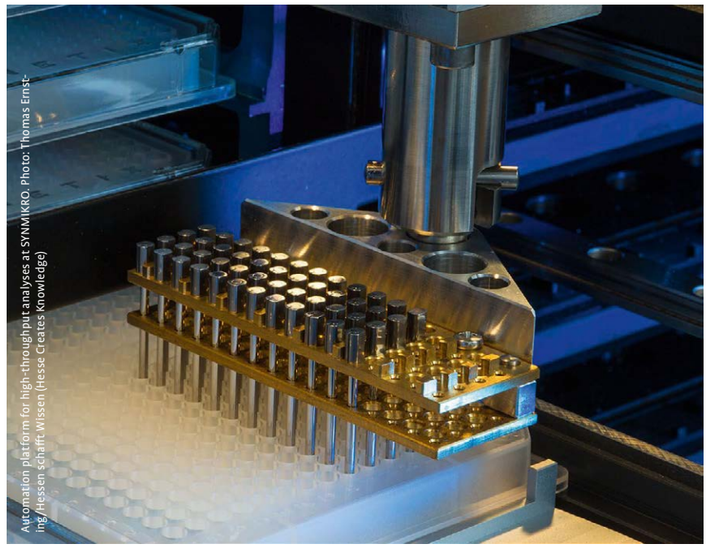
Building to understand and understanding to build

Even microscopic life forms are tremendously complex. That is why it is difficult for traditional approaches to achieve more than a descriptive and mechanistic understanding of them. At the LOEWE Center for Synthetic Microbiology, or SYNMIKRO, scientists use engineering concepts such as modularization and standardization to build simple versions of natural systems in order to understand their basic organizational principles.

Thanks to the tremendous methodological advances of the last few decades, biology has been able to zoom in on ever-tinier worlds. Nowadays, a regular approach is to image single molecules at the atomic level and study in detail their interactions with other molecules inside a cell. A large number of biological processes have already been described via this approach. At the LOEWE Center for Synthetic Microbiology (SYNMIKRO), scientists use engineering concepts such as modularization and standardization to identify basic principles that can be generally applied, such as feedback control systems, e.g., in regulatory circuits, and use them to examine what constitutes the »inmost« functions of a microbial cell or community. Based on analytical findings and the models derived from them, they attempt to build simple versions of complex natural systems, that is, to explore their essence.

The team headed by Prof. Dr. Torsten Waldminghaus, for example, is building a second, artificial chromosome

Alfalfa in a plant growth chamber at SYNMIKRO. Photo: Thomas Ernsting/Hessen schafft Wissen (Hesse Creates Knowledge)



Automation platform for high-throughput analyses at SYNMIKRO. Photo: Thomas Ernsting/Hessen schafft Wissen (Hesse Creates Knowledge)

in the model bacterium Escherichia coli, as an addition to the cell's own, in order to understand what actually makes up a chromosome. Chromosomes not only carry their cell's genetic information coding for cellular constituents like proteins, but also elements to ensure their own preservation. »Before a cell divides, chromosomes have to be copied, distributed among the daughter cells and folded, because they are many times longer than the cell itself,« Waldminghaus explains. The systems that perform this function generally consist of a DNA-binding protein and a corresponding binding site on the DNA. In a joint project with bioinformaticians, Waldminghaus has developed a new algorithm that can be used to identify these sites in the DNA sequences. Artificial chromosomes can now be built with both native and non-native distributions of these sites, in order to identify relationships between distribution and function.

Thus, this approach should yield findings of a new quality. Furthermore, the artificial chromosomes would also be valuable tools in both synthetic biology and biotechnology. They could be used to introduce significantly larger amounts of foreign DNA into cells than was previously possible – for example, entire metabolic pathways instead of just a few genes. Hence, as with most SYNMIKRO projects, Waldminghaus's work is described not only by the maxim »building to understand,« but also »understanding to build.« In fact, the latter is the main emphasis in some projects, such as that of Prof. Dr. Uwe Maier and Dr. Franziska Hempel. Using the diatom *Phaeodactylum tricornutum*, these two scientists have created a sort of solar-powered bioreactor that they can use to produce bio-plastics, spider silk and human antibodies against the hepatitis B virus, among other things. In comparison to classic production systems such as yeast and mammalian cells, these photosynthetic microalgae do not require costly sugar to grow, only water and light.

More than 30 teams from eight departments at the Philipps-Universität and the Max Planck Institute for Terrestrial Microbiology are involved in SYNMIKRO projects, thanks in part to the LOEWE program, the State of Hesse's excellence initiative, which has already contributed 43 million Euro to the center. LOEWE funding has made it possible to establish three professorships and five groups of young scientists at the university, and a fourth department at the Max Planck Institute. The German Council of Science and Humanities has also recognized the center's potential, and in the spring of 2014, it recommended funding for a new building that would accommodate roughly 270 SYNMIKRO employees. »Bringing everything together under one roof will enable us to cooperate even more closely than before,« says Prof. Dr. Bruno Eckhardt, the center's managing director. »And interdisciplinary work is the key to realizing our vision of a new quality of understanding.«

For more information:

LOEWE-Zentrum Synthetische Mikrobiologie (SYNMIKRO):
www.synmikro.com

Photo: Reinhold Eckstein

Professor Torsten Waldminghaus explains how a synthetic chromosome is designed. Among other things, the chromosomes will be used to study the functional relationship between the two DNA binding proteins SeqA and MutH, both of which recognize and bind to the »GATC« base sequence.

Social and ethical dimensions

In addition to biologists, chemists, physicists, computer scientists and mathematicians, SYNMIKRO members also include a theologian. Together with his colleagues in the natural sciences, Prof. Dr. Friedemann Voigt has developed a staged model for the ethical evaluation of synthetic biological research. The significance or purpose of a project, the extent to which it intervenes in a natural organism and the potential risk that it will alter the environment are all aspects that are fed into the model. For instance, as a newly created element, Torsten Waldminghaus's artificial chromosome is a relatively strong intervention at the molecular level. But because it is introduced into the cell alongside the natural chromosome, it has only a minor effect on the organism's behavior; furthermore, it has no effect on the environment, given that the purpose of the experiment is »merely« to enhance understanding, and the altered cells are not released. »If the cell's natural chromosome is eventually replaced by a synthetic one, which would mean stronger intervention in the organism as a whole, the project would have to be reevaluated,« Voigt points out. And that evaluation, he adds, would depend on the purpose of the research objectives. »Our model is intended to establish a relationship among research-specific aspects, social goals and concrete decision-makers, from individual researchers through the participating institutions on up to society in general. Through it, we hope to contribute to a nuanced view of this new branch of research,« the theologian explains. »Its importance lies not only in its potential applications, but also in the knowledge gained, which contributes to education and thus to humanity. With our work on the bioethics task force, we at SYNMIKRO aim to highlight this connection and make it a critical measure of evaluations.«

HOW CELLS GENERATE HIGHLY COMPLEX FUNCTIONAL COMPARTMENTS

Life through specialization and communication

Photo: Rolf K. Wegst

Prof. Roland Lill in the laboratory with junior scientist Dr. Nicole Rietzschel.

Human beings, animals and plants are made up of billions of cells. Any of these cells contain clearly delineated functional components that are surrounded by biological membranes. Marburg scientists have examined how the cell forms these specialized internal compartments, how communication between them takes place and what happens when their integrity is impaired in diseases or by pathogens.

Each component of a cell – such as the nucleus, mitochondria, chloroplasts or the endoplasmic reticulum – has its own space and shape, and thereby forms a specialized compartment. As in a large factory, different tasks are performed in different compartments. Although specific metabolic reactions are precisely localized within the cell, it still requires effective communication and close cooperation between the various compartments that make the cell viable. Defects or disruptions of cell compartmentation, e.g., by various genetic diseases or by bacterial intruders and viruses, impair cell viability. Prof. Dr. Roland Lill explains some examples of job-sharing between the different compartments of the cell: »Antibodies, insulin and other secretory proteins, among other things, are formed in the endoplasmic reticulum and Golgi apparatus; mitochondria function as the cell's power plants, and lysosomes act as a recycling center for used or damaged biomolecules.« Lill, a cell biologist, served as the coordinator of the Collaborative Research Center SFB 593 in Marburg, funded by the German Research Foundation (DFG). The Center has been studying the molecular mechanisms of compartmentalization in eukaryotic cells (cells that have a nucleus) since 2003. »This is a central research field in current cell biology, together with the question of how eukaryotes transport metals, metabolites, lipids, proteins and nucleic acids across membranes inside the cell,« says Lill.

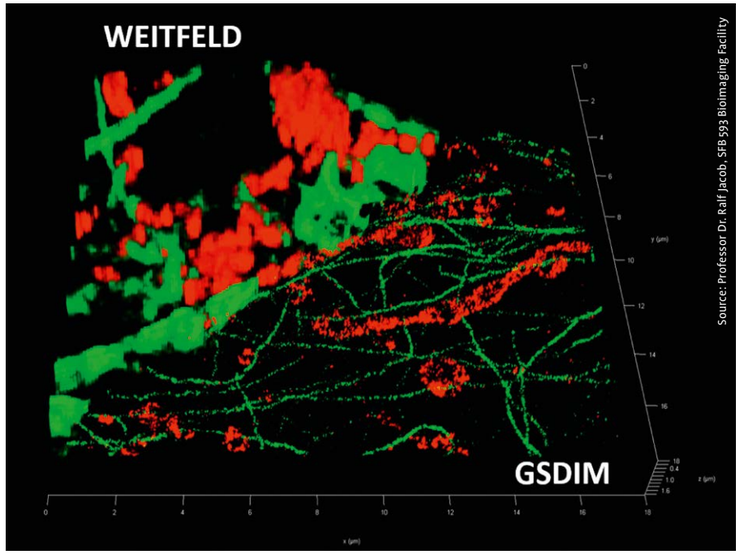
In recent years, Marburg's experts in biochemistry, molecular cell biology, microbiology, physiology, virology, pharmacology and molecular medicine have identified and described the structures and functions of a number of proteins and lipids important for the compartmentalization in eukaryotic cells. The Collaborative Research Center's 18 teams from the University and the local Max-Planck Institute for Terrestrial Microbiology (MPI) have chosen a broad experimental approach for their research. They are using a wide range of organisms, from yeast, pathogenic fungi and parasites to human cell culture systems and animal models. Methods that have only recently become available—such as those used to decode genomes and protein structures, and super-resolution light microscopy for the imaging of cell biological processes—have opened up new horizons in the study of the various processes. »These new techniques have helped us to realize that the mechanisms of intracellular transport and compartmentalization are far more complex than previously anticipated,« says Lill.

In addition to learning more about cellular processes, the scientists want to contribute to a better understanding of the molecular basis of disease. »We want to know how pathogens take advantage of the compartments to survive, and what happens to the compartmentalization of cells in genetic defects,« says Leibniz Prize winner Lill. »We draw important conclusions about the mechanisms of intracellular compartmentalization by comparing healthy and diseased cells.«

The team working with Lill is studying the formation of iron-sulfur proteins, which are involved in many cell processes that are essential for life, such as cellular respiration and energy production, DNA synthesis and repair, ribosome function, iron regulation and various metabolic activities. The Marburg scientists discovered that mitochondria produce a sulfur component needed for cytosolic iron-sulfur proteins and then transport it into the cell's cytosol. The researchers have decoded the 3D structure of the membrane transporter responsible for this process, and have identified many proteins involved in generating the iron-sulfur proteins. They also discovered that defects in this process are associated with various rare diseases, and create problems in DNA synthesis and repair, which can contribute to tumor formation.

Other Marburg SFB 593 research teams have also studied the molecular causes of disease. For instance, the clinical group working under Prof. Dr. Joachim Hoyer found that a defect in a specific cell compartment of inner blood-vessel walls contributes to vascular disorders, possibly causing high blood pressure and kidney disease. The neurobiochemical group headed by Prof. Dr. Gerhard Schratt has shed light on how certain genetic snippets (microRNAs) are transported from the cell body to synapses in the brain's neurons. These results improve our understanding of the learning process and memory performance, and clarify the molecular basis of associated disorders.

The virology research group led by Prof. Dr. Hans-Dieter Klenk discovered that certain viral proteins play a pivotal role when an influenza virus jumps from animals to humans as a host. These proteins facilitate the penetration of viruses into the cell or the virus proliferation in the nucleus. A targeted mutation that would weaken the viral intruder could eventually become part of a strategy



A eukaryotic cell seen in the conventional (wide-field) and the super-resolution (GSDIM) microscope. This fluorescence image shows cytoskeletal microtubules in green and mitochondria in red.

to produce a vaccine. Enzymes in cells of the respiratory tract that activate the influenza virus also have been studied. In collaboration with pharmacologists, a team working with Prof. Dr. Wolfgang Garten has developed the first reagents that inhibit these enzymes and has tested them in cell cultures. Prof. Dr. Stephan Becker's research group has examined the mechanisms underlying the transport of Marburg and Ebola virus components to the cell surface and their assembly to functional viruses.

Researchers working with Prof. Dr. Regine Kahmann at the MPI addressed the question of how plants are infected by pathogenic fungi. They were able to demonstrate that infection is only successful if the fungus is able to introduce virulent proteins into the plant cells. One of these proteins alters the plant cell metabolism in such a way that tissue lignification is reduced and a red pigment is formed instead. This conversion allows the fungus to spread within the plant tissue, and facilitates better access to nutrients.

Cell biologists working with Prof. Dr. Maier are studying diatoms (algae), i.e. small, light-driven sea dwellers. Diatoms are cell biologically related to a few human parasites including the malaria parasite Plasmodium. Hence, basic research on intracellular protein transport in diatoms not only reveals the relevant processes in these algae, but also improves our molecular understanding of pathogenic organisms. Along these lines, Prof. Dr. Klaus Lingelbach's group has investigated how the malaria parasite alters its human host cell by introducing various proteins, thus allowing the host cell to be converted to the parasite's needs.

For more information:

»Mechanisms of cellular compartmentalization and the relevance for disease«, Collaborative Research Center SFB 593: *www.uni-marburg.de/sfb593*

Leibniz Prize Winners

at Philipps-Universität Marburg

2011 **Prof. Dr. Friederike Pannewick**
Arab Studies, Center for Near and Middle Eastern Studies

2006 **Prof. Dr. Gyburg Uhlmann, née Radke**
Classical Philology (at the Free University of Berlin since 2007)

2004 **Prof. Dr. Thomas Carell**
Organic Chemistry (at LMU Munich since 2004)

2003 **Prof. Dr. Roland Lill**
Cell Biology

2002 **Prof. Dr. Bruno Eckhardt**
Theoretical Physics

1997 **Prof. Dr. Paul Knochel**
Organometallic Chemistry (at LMU Munich since 1999)

1997 **Prof. Dr. Stephan W. Koch**
Theoretical Physics

1996 **Prof. Dr. Reinhard Lührmann**
Physiological Chemistry and Molecular Biology
(at the Max Planck Institute Göttingen since 1999)

1991 **Prof. Dr. Ernst Goebel**
Experimental Physics
(at the Braunschweig International Graduate School of Metrology since 1995)

1991 **Prof. Dr. Rolf Müller**
Molecular Biology

1989 **Prof. Dr. Manfred T. Reetz**
Organic Chemistry
(at Philipps-Universität until 1991, senior professor in Marburg since 2011)

1987 **Prof. Dr. Rudolf Thauer**
Biochemical Microbiology

Leibniz Prize Winner who is currently affiliated with Philipps-Universität:

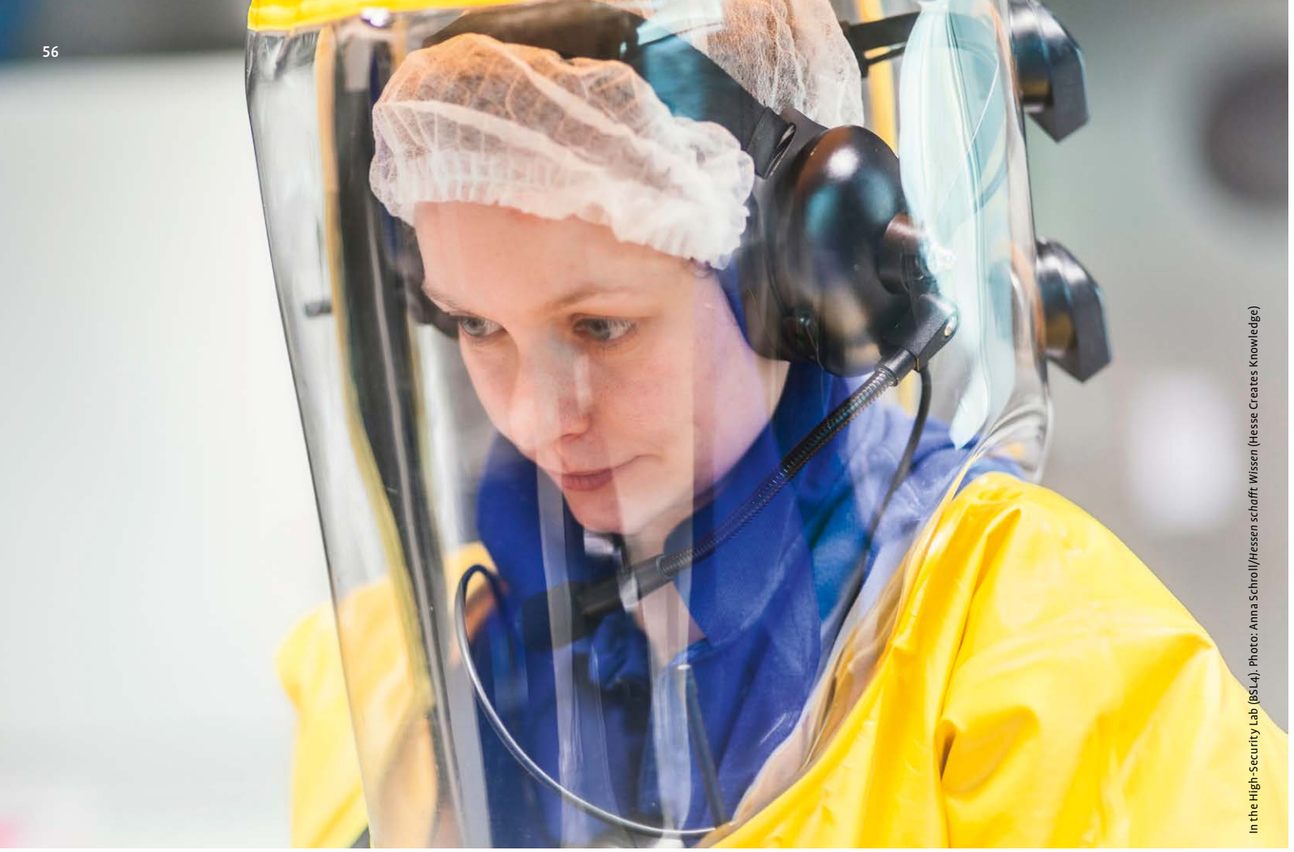
1993 **Prof. Dr. Regine Kahmann**
Molecular Genetics, LMU Munich, at Philipps-Universität since 2001

Old main auditorium at Philipps-Universität. Photo: Markus Farnung

The Gottfried Wilhelm Leibniz Prize is the most important research funding award in Germany. Since 1986, the German Research Foundation has awarded it annually to outstanding researchers working in Germany. The prize is endowed at up to 2.5 million Euro per recipient.

SERVING PATIENTS

Through its affiliation with the University Hospital of Giessen and Marburg, Germany's second-largest university hospital, Philipps-Universität is part of a strongly research-oriented medical community whose members work together to cure diseases. Research focuses especially on the fields of tumor biology, oncology, immunology, inflammation research, infection biology and the study of anti-infective agents. The research areas overlap and work closely with one another to examine causes and relationships in the development of tumor diseases. Basic research (Center for Tumor and Immune Biology, Biomedical Research Center) and point-of-care research (Carreras Leukemia Center, Anneliese Pohl Comprehensive Cancer Center Marburg) are located at Marburg. They share the common goal of improving therapeutic approaches. The new Particle Therapy Center, which offers treatment options for tumors that have traditionally been difficult or impossible to treat, will be a strong addition in the future. Research into anti-infective agents focuses on virology and vaccines, with the Marburg High-Security Virology Laboratory (BSL4) providing the necessary infrastructure. The university cooperates closely with Novartis Vaccines and Diagnostics GmbH, headquartered in Marburg, to develop flu vaccines.



In the High-Security Lab (BSL4). Photo: Anna Schroll/*Hessen schafft Wissen* (Hesse Creates Knowledge)

THE STUDY OF HIGHLY PATHOGENIC VIRUSES

In an emergency, speed is essential

From Ebola to Lassa fever to avian influenza virus, scientists at the Marburg High-Security Laboratory (BSL-4) study the most dangerous pathogens known to humankind. Why certain viruses are so threatening is still unknown. As part of the effort to prevent viral diseases, virologists collaborate with government agencies and drug manufacturers to reduce the amount of time needed to develop vaccines.

In the summer of 1967, a mysterious illness erupted in Marburg. Several employees at what was then the Behring plant initially complained of flu-like symptoms. They were soon suffering from internal bleeding, and within a few days five of the 24 patients had died of hemorrhagic fever. Within a few months, virologist Werner Slenczka and his colleagues had identified the previously unknown pathogen that had caused the outbreak, the Marburg virus. All of the afflicted individuals had worked in a laboratory with vervets, a species of African monkey that was being used at the time to produce a polio vaccine. About 40 years later, scientists discovered that the Egyptian fruit bat was the presumed animal host. When virus researcher Prof. Dr. Hans-Dieter Klenk came to Marburg in 1985, he continued to study the Marburg virus and established the first high-security laboratory at Philipps-Universität.

The Marburg virus and the closely-related Ebola virus are known as filoviruses, which are characterized by their filamentous structure. Prof. Dr. Stephan Becker, director of the Institute of Virology in the Department of Medicine, studies these highly pathogenic viruses today. As a young scientist, Becker worked with Slenczka and Klenk, and he is following in their footsteps. Becker played an important role in the planning process when the federal and state governments decided to invest in a new laboratory at the Lahnberge Science Campus. The level 4 high-security laboratory, dedicated in late 2007, is in the middle of a five-story building. The building's outer shell is made of stainless steel and sealed with Teflon. »We have sophisticated process-control technology and ventilation systems. Waste is rendered chemically and thermally inactive before it leaves the laboratory. Negative pressure prevents air from escaping the laboratory. All equipment and rooms are monitored around the clock,« says Becker, describing the security system. »Still, it's a manageable laboratory.« Before the 16 scientists who have access to the laboratory can begin their work, they are required to put on ventilated full-body protective suits and pass through three airlocks. The building, a red cube decorated with images of the Marburg virus, is next to the Institute of Virology and stands out even from a distance. »We don't isolate the lab. Transparency is critical to alleviating fear,« says Becker. »We conduct regular emergency drills with the fire department, emergency doctors and the police, and we notify the media.«

The Marburg virologists use the lab to identify pathogens and conduct diagnostic testing for viruses. The institute works closely with Frankfurt's treatment center for highly pathogenic viral diseases and is also the German government's consulting laboratory for filoviruses. Because many viruses, especially these, have no remedy as yet, basic research covers a broad range of possibilities. The eight research teams at the institute study why the viruses are so highly pathogenic, and how the pathogens incapacitate cellular defenses, replicate their own genomes, move about within the cell and use it for their own purposes. In 2013, Becker and his team discovered the Marburg virus's transport route. The virus uses the cytoskeleton, which is responsible for a cell's stability, movement and transport, to travel through the cell as if it were moving along a rail. Scientists working with Prof. Dr. Friedemann Weber have also discovered that cells recognize the virus as soon as it infects them and that specific enzymes (helicases) immediately take defensive action. The results of their research could yield methods for developing new vaccines.

During the 2009 swine flu pandemic, Marburg researchers used their expertise with influenza viruses to develop a new vaccine in collaboration with Marburg drug manufacturer Novartis. It took them six weeks to complete the vaccine – a very short time, especially given how long the drug approval process normally takes. Speed is essential during a pandemic, but a vaccine's safety also has to be guaranteed. To accelerate the processes employed by researchers, government agencies and industry during a pandemic, the Marburg virologists are affiliated with the German Center for Infection Research. There, they collaborate with their counterparts from other institutions, particularly the University of Giessen and the Paul Ehrlich Institute in Langen. Another component of this system is Marburg's cooperation with Novartis. The pharmaceutical company provides the scientists with cell cultures for their research and shares in the operating costs for the high-security lab. »We are available as partners and advisers, so that vaccines can be made available as quickly as possible,« says Becker. The scientists also cooperated closely with Novartis during the 2013 avian flu outbreak in China. Once the virus's gene sequence was known, Novartis had the pathogen synthesized and produced large amounts of it in cell cultures. »Today the virus no longer has to be physically shipped and cultured in chicken eggs. Working with Novartis and other scientists, we have developed a method in which we need only the virus's genetic data to produce seed influenza virus. This reduces the amount of time needed until the vaccine production stage,« says Becker.

Avian influenza and pathogens such as SARS create special challenges for virologists. They are RNA viruses, which constantly produce new variants and rapidly reproduce and adapt. Some of these pathogens cause bleeding, fever or severe pulmonary diseases. Scientists in Marburg and Giessen have been studying RNA viruses since 2013 in a collaborative research center funded by the German Research Foundation. »Our collaboration with Giessen has been a tradition ever since Prof. Klenk came to Marburg from there. We contribute expertise in highly pathogenic viruses to the project, while Giessen has extensive experience with influenza viruses and coronaviruses. One of our joint ventures is a clinical project in the field of lung research,« says Becker.

For more information:
Institute of Virology at Philipps-Universität Marburg:
www.uni-marburg.de/fb20/virologie

»RNA Viruses: Metabolism of Viral RNA, Immune Response of the Host Cells and Viral Pathogenesis« Collaborative Research Center: *www.uni-marburg.de/sfb1021*

TUMOR, IMMUNE AND INFECTION RESEARCH ARE NOW GROWING TOGETHER

When cells make mistakes

Cell mutations occur constantly in the human body. In the best-case scenario, if they cannot be repaired by a cell's internal repair mechanisms, the immune system eliminates the affected cells. But if this fails, tumors can develop. Chronic inflammation can also result in cancer. Physicians of Marburg are studying how tumor development, the immune system and inflammation are related with each other and how this yields in better treatment.

»A central objective of medical research is to modify therapies so that patients are treated better,« says oncologist Prof. Dr. Andreas Neubauer. This requires perseverance, tenacity and passion. »Many outstanding discoveries that result in improved therapies were made by accident, after countless experiments have already failed.« One of these chance discoveries, made in the 1960s, was cisplatin, an ingredient in many chemotherapy drugs today. Thanks to this agent, 95 percent of testicular cancers can now be completely cured.

Neubauer, who has been conducting research in Marburg for the last 15 years, is the director of the Department of Hematology, Oncology and Immunology at the University Hospital of Giessen and Marburg. He too has made such accidental discoveries. Working closely together with pathologists and gastroenterologists, he discovered that gastric lymphoma, a form of stomach cancer, could be treated with antibiotics. The results of a conclusive clinical trial were published in 2012. Today, 90 percent of patients respond to antibiotic therapy, which has thus become the standard treatment worldwide, and 80 percent become permanently cancer-free. Another chance discovery was made while treating a leukemia patient who had suffered a relapse after a bone marrow transplant. Neubauer discovered that sorafenib, a drug used to treat kidney and liver cancer, was effective with this patient, whose leukemia responded within a few days. The drug is now being administered as part of an international stem-cell transplant study managed by doctors in Marburg. It is also used to treat acute myeloid leukemia. »However, the body quickly develops resistance to the drug, which is why it works only for a short period of time. A transplant has to be performed soon after that,« says Neubauer.

Marburg researchers have also made advances in other areas of cancer research, such as in the treatment of chronic myeloid leukemia. For the last ten years, the disease has been controlled by administering a maintenance dose of imatinib, an enzyme-inhibiting agent in tablet form. This allows patients to survive for 30 years without requiring a bone marrow transplant. Prof. Dr. Andreas Burchert has improved the therapy by combining the drug with interferon, an endogenous molecule that activates immune defenses. »The tumor cells see themselves as intruders and essentially commit suicide,« says Neubauer, explaining the value of his colleague's discovery.

Neubauer's greatest wish is »that we can eventually treat cancer as a chronic disease, as we do with AIDS.« But that goal is still a long way off, he adds. One of the unsolved but central questions is how tumor cells manage to escape the immune system and modulate it to support them instead of fighting them. »We want to understand how this takes place and use the knowledge to continue developing immune therapies,« explains Prof. Dr. Rolf Müller. An expert in molecular tumor biology, Müller works closely with Neubauer. »We already have efficient immune therapies for melanoma, but unfortunately not all patients respond, and in some patients the tumor returns after a short time,« says Müller, highlighting the need for improved treatment methods. One of his interests is the search for agents that interfere with the interaction between tumor and immune cells. In this area, he collaborates with the Gynecology Clinic. »One of the deadliest forms of cancer in women is ovarian cancer. The fluid in the abdominal cavity contains large numbers of tumor and immune cells. We have developed technologies for analyzing these cells from a molecular biology standpoint,« says Müller, describing his research.

Marburg researchers hope to develop new therapy programs by bringing together tumor, immune and infection biology, along with basic and clinical research. There is widespread agreement that microorganisms such as viruses and bacteria are involved in the development of individual cancers, and that chronic infections also play an important role, as with tumors in the stomach, esophagus, pancreas and lungs. Inflammation is also a frequent cause of resistance to chemotherapy and radiation therapy. »These are old clinical observations, but we still don't know why they are true. That's why studying the relationship among cancer, inflammation and microorganisms has taken center stage in biomedical research worldwide,« says Müller. Doctors in Marburg have been examining these relationships since 2008, after receiving their initial impetus from the LOEWE »Tumor and Inflammation« Research Cluster. The next milestone was the new research building at the Center for Tumor and Immune Biology (ZTI), recommended by the German Council of Science and Humanities in 2010 and built with funds from the federal government and the State of Hesse. The structure, next to the Biomedical Center, was completed in 2014. »Eleven teams from various schools of thought in tumor biology, immune biology and molecular cell biology are given a shared infrastructure for their research here. Medical chemistry, genomics and specialized units for microscopy and imaging methods will also work in the ZTI building in the future,« says founding director Müller.

Neubauer and his team of researchers moved into the ZTI in 2014. Together with Müller and other teams, he is in the process of planning a research association to address the question of how to penetrate resistance in tumor therapy. Their approach considers the tumor cell itself in an attempt to understand which mechanisms and genetic changes contribute to resistance. In addition, they are studying the microenvironment. For example, leukemic stem cells are incorporated into connective tissue that also supports tumor cells. The researchers are searching for ways to interrupt this interaction so the tumor will again respond to treatment. They are still in the early stages of learning how to fight tumor cells by activating the immune system. »In this field, it is especially important to bring together tumor research and immune research at the ZTI,« say Neubauer and Müller.

For more information:
Center for Tumor and Immune Biology (ZTI):
www.uni-marburg.de/aktuelles/bau/campuslahnberge/zti/zti
Institute of Molecular Biology and Tumor Research:
www.imt.uni-marburg.de

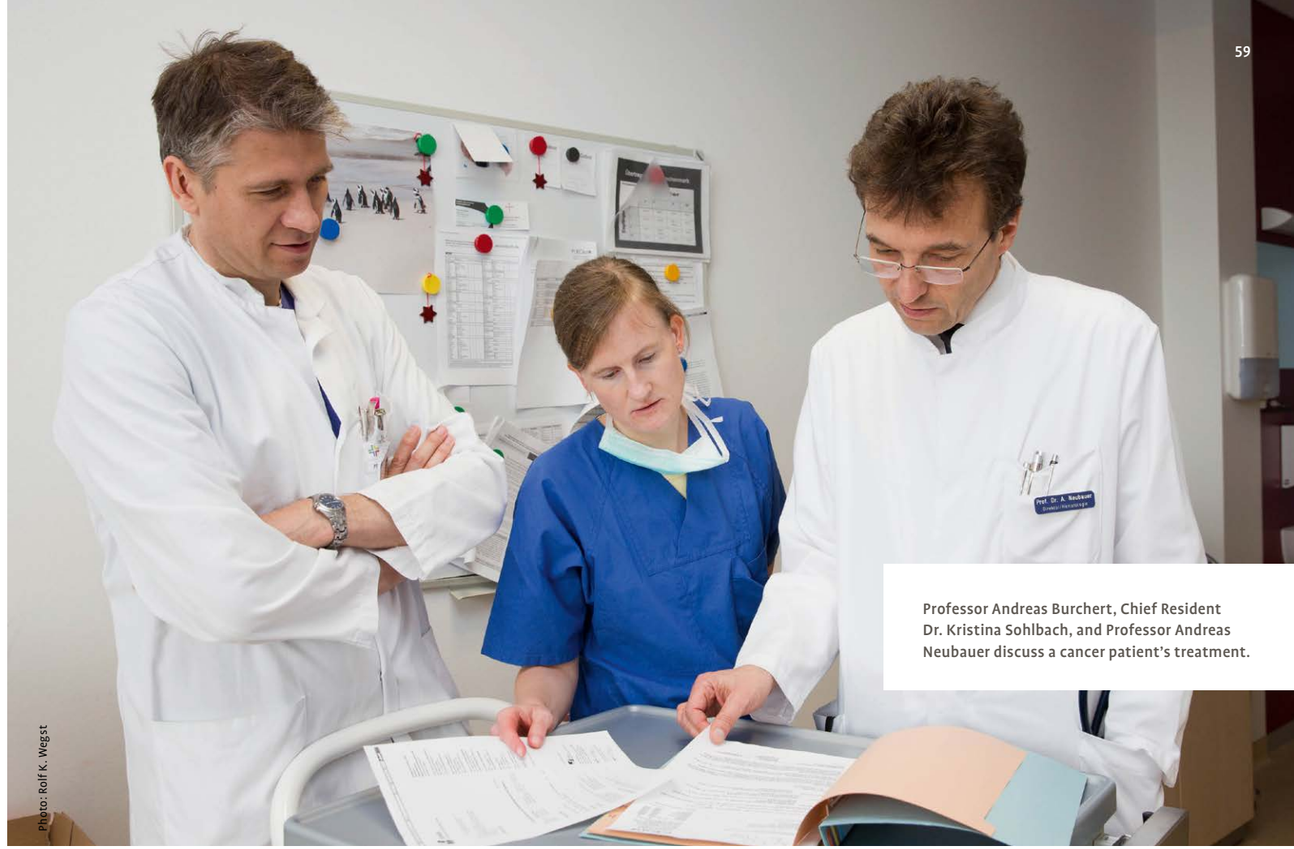


Photo: Rolf K. Wegst

Professor Andreas Burchert, Chief Resident Dr. Kristina Sohlbach, and Professor Andreas Neubauer discuss a cancer patient's treatment.

FACTS AND FIGURES

Lecture hall building. Photo: Markus Farnung

Staff

PROFESSORSHIPS
INDIVIDUALS, EFFECTIVE 10/1

DIVISION	2010	2011	2012	2013
Law, Economics and Social Sciences	56	55	52	52
Humanities	84	83	84	90
Sciences	108	109	110	112
Medicine	81	83	83	81
Total	**329**	**330**	**329**	**335**

NON-TEACHING STAFF (STATE FUNDS)
FULL-TIME EQUIVALENTS, EFFECTIVE 10/1

DIVISION	2010	2011	2012	2013
Law, Economics and Social Sciences	90	91	86	88
Humanities	158	166	173	150
Sciences	237	239	245	227
Medicine	270	279	278	264
Central Services and Administration	27	24	26	26
Central Hesse Study Center	10	10	10	10
Total	**791**	**809**	**818**	**765**

NON-TEACHING STAFF (THIRD-PARTY FUNDS AND LOEWE)
FULL-TIME EQUIVALENTS, EFFECTIVE 10/1

DIVISION	2010	2011	2012	2013
Law, Economics and Social Sciences	25	24	17	25
Humanities	40	51	65	94
Sciences	160	179	216	266
Medicine	133	144	156	159
Central Services and Administration	2	2	5	4
Central Hesse Study Center	1		1	2
Total	**360**	**400**	**460**	**549**

Joint projects (2010 – 2014)

HUMANITIES

TITLE	TERM	CONTACTS AT PHILIPPS-UNIVERSITÄT	DEPARTMENT
The Hellenistic Polis as a Way of Life. Urban Structures and Civil Identity Between Tradition and Change« (SPP 1209, participation)	since 2006	Prof. Dr. Winfried Held	06 History and Cultural Studies
Phonetic Competency: Between Grammar, Signal Processing and Neuronal Activity (SPP 1234, participation)	since 2006	Prof. Dr. Richard Wiese	09 German Language and Literature, Fine Arts
Reconfigurations. History, Memories and Transformation Processes in the Middle East and North Africa (Federal Ministry of Education and Research project)	since 2013	Prof. Dr. Rachid Ouaissa	Center for Near and Middle Eastern Studies (CNMS)
Foundation of Basic Linguistic Categories (LOEWE research cluster)	since 2012	Prof. Dr. Jürgen Schmidt, Prof. Dr. Richard Wiese	09 German Language and Literature, Fine Arts

Hannah Fischer, a non-teaching staff member at the German Language Atlas Research Center. Photo: Rolf K. Wegst

SCIENCES

TITLE	TERM	CONTACTS AT PHILIPPS-UNIVERSITÄT	DEPARTMENT
Electron-Electron Interaction in Solid Objects (IGRK 790)	2002 – 2011	Prof. Dr. Florian Gebhard	13 Physics
Group-specific Misanthropy: Causes, Phenomenology and Consequences (GRK 884)	2004 – 2012	Prof. Dr. Ulrich Wagner	04 Psychology
Nanowires and Nanotubes: From Controlled Synthesis to Function (SPP 1165, participation)	2004 – 2010	Prof. Dr. Andreas Greiner (now at the University of Bayreuth)	15 Chemistry
Intracellular and Intercellular Transport and Communication (GRK 1216)	since 2006	Prof. Dr. Uwe Maier	17 Biology
Biodiversity and Sustainable Management of a Megadiverse Mountain Ecosystem in Southern Ecuador (FOR 816)	since 2007	Prof. Dr. Jörg Bendix	19 Geography
Scattering Systems with Complex Dynamics (FOR 760, participation)	since 2007	Prof. Dr. Hans-Jürgen Stöckmann	13 Physics
Mathematical Methods for Extracting Quantifiable Information from Complex Systems (SPP 1324)	since 2008	Prof. Dr. Stephan Dahlke	12 Mathematics and Computer Science
Dynamics of Bacterial Membrane Proteins (FOR 929)	since 2008	Prof. Dr. Peter Graumann	15 Chemistry
Near-wall Transport and Structure Formation Processes in Turbulent Rayleigh-Bénard, Taylor, Couette and Tube Flows (FOR 1182)	since 2009	Prof. Dr. Bruno Eckhardt	13 Physics
Chromatin Changes in Differentiation and Malignancy (TRR 81, participation)	since 2010	Prof. Dr. Renate Renkawitz-Pohl u.a.	17 Biology
SYNMIKRO Synthetic Microbiology (LOEWE Center)	since 2010	Prof. Dr. Bruno Eckhardt	05 Protestant Theology 12 Mathematics and Computer Science 13 Physics 15 Chemistry 17 Biology 20 Medicine 16 Pharmacology 20 Medicine
Expectations and Conditioning as Basic Processes of the Placebo and Nocebo Reaction: From Neurobiology to Clinical Application (FOR 1328)	since 2010	Prof. Dr. Winfried Rief	04 Psychology
Functionalization of Semiconductors (GRK 1782)	since 2012	Prof. Dr. Kerstin Volz	13 Physics 15 Chemistry
Microbial Diversity in Environmentally Dependent Signal Response (SFB 987)	since 2012	Prof. Dr. Mohamed Marahiel	15 Chemistry 17 Biology
Structure and Dynamics of Inner Interfaces (SFB 1083)	since 2013	Prof. Dr. Ulrich Höfer	13 Physics 15 Chemistry
Gehirn und Handlung/The Brain in Action (IGRK 1901)	since 2013	Prof. Dr. Frank Bremmer	13 Physics
SynChemBio – Innovative Synthetic Chemistry (LOEWE research cluster)	since 2014	Prof. Dr. Eric Meggers	15 Chemistry
Dynamics of Security. Forms of Securitization in Historic Perspective (TRR 138)	since 2014	Prof. Dr. Christoph Kampmann	06 History and Cultural Studies
Cardinal Mechanisms of Perception: Prediction, Evaluation, Categorization (TRR 135, participation)	since 2014	Prof. Dr. Frank Bremmer	13 Physics

MEDICINE

TITLE	TERM	CONTACTS AT PHILIPPS-UNIVERSITÄT	DEPARTMENT
Allergic Immune Responses of the Lung (TRR 22)	2005 – 2014	Prof. Dr. Harald Renz	20 Medicine 15 Chemistry 17 Biology
Congenital Immunity of the Lung: Mechanisms of Pathogen Attack and Host Defense in Pneumonia (TRR 84, participation)	since 2010	Prof. Dr. Stefan Bauer, Prof. Dr. Bernd Schmeck	20 Medicine
Mechanisms of Cellular Compartmentalization and its Disease-related Changes (SFB 593)	2003 – 2014	Prof. Dr. Roland Lill	20 Medicine 15 Chemistry 17 Biology
Ras-dependent Pathways in Human Cancer (TRR 17, participation)	2004 – 2013	Prof. Dr. Rolf Müller, Prof. Dr. Andreas Neubauer, Prof. Dr. Andreas Burchert	20 Medicine
RNA Viruses: Metabolism of Viral RNA, Immune Response of the Host Cells and Viral Pathogenesis (SFB 1021)	since 2013	Prof. Dr. Stephan Becker	20 Medicine
Genetics of Drug Resistance in Cancer (KFO 210)	since 2008	Prof. Dr. Andreas Burchert, Prof. Dr. Andreas Neubauer	20 Medicine
K2P Channels – From the Molecule to Physiology and Pathophysiology (FOR 1086)	since 2008	Prof. Dr. Jürgen Daut	20 Medicine
Transcription Control in Developmental Processes (GRK 767)	2002 – 2010	Prof. Dr. Guntram Suske	20 Medicine
German Center for Infection Research (BMBF/Helmholtz Association, participation)	since 2011	Prof. Dr. Stephan Becker	20 Medicine
German Center for Lung Research (BMBF/Helmholtz Association, participation)	since 2011	Prof. Dr. Stefan Bauer, Prof. Dr. Uta-Maria Bauer, Prof. Dr. Andreas Neubauer, Prof. Dr. Harald Renz, Prof. Dr. Bernd Schmeck, Prof. Dr. Thorsten Stiewe, Prof. Dr. Eberhard Weihe	20 Medicine
EpimiRNA: MicroRNAs in the Pathogenesis, Treatment and Prevention of Epilepsy Under an Epileptogenic Insult (EU project, participation)	since 2013	Prof. Dr. Gerhard Schratt	20 Medicine
Pemphigus – from Autoimmunity to Disease (EU project, participation)	2008 – 2011	Prof. Dr. Michael Hertl	20 Medicine
Targeting the Tumor Microenvironment to Improve Pancreatic Cancer Prognosis (EU-Projekt)	2011 – 2014	Prof. Dr. Thomas Gress	20 Medicine
Tumor and Inflammation (LOEWE research cluster)	2008 – 2012	Prof. Dr. Rolf Müller, Prof. Dr. Harald Renz, Prof. Dr. Michael Lohoff	20 Medicine
Lung Diseases - New Approaches to Diagnosis and Treatment/Universities of Giessen and Marburg Lung Center (LOEWE Center, participation)	since 2010	Prof. Dr. Harald Renz	20 Medicine
Neurobiology of Affective Disorders: A Translational Perspective on Brain Structure and Function (FOR 2107)	since 2014	Prof. Dr. Tilo Kircher	20 Medicine 04 Psychology
Emerging Roles of Non-Coding RNAs in Nervous System Development, Plasticity and Disease (SPP 1738)	since 2014	Prof. Dr. Gerhard Schratt	20 Medicine

Abbreviations

SFB: Collaborative Research Center of the German Research Foundation (DFG), **TRR**: Transregio Collaborative Research Center of the DFG, **SPP**: Research Cluster Program of the DFG, **(I)GRK**: (International) Research Training Group of the DFG, **FOR**: DFG Research Group, **KFO**: Clinical Research Group of the DFG, **LOEWE**: State Offensive on the Development of Scientific and Economic Excellence, **BMBF**: Federal Ministry of Education and Research

Doctorates (per examination year)

DIVISION	2010	2011	2012	2013
Humanities	46	50	37	31
Law, Economics and Social Sciences	61	50	57	51
Sciences	139	151	139	149
Medicine	190	189	184	191
Total	**436**	**440**	**417**	**422**

Students (excluding those on leave, for the winter semester)

DIVISION	2010	2011	2012	2013
Law, Economics and Social Sciences	5,502	5,814	6,045	6,813
Humanities	6,628	6,753	6,985	7,741
Sciences	6,014	6,425	6,726	7,259
Medicine	3,001	3,012	3,093	3,178
Central Hesse Study Center	294	303	362	354
Total	**21,439**	**22,307**	**23,211**	**25,345**
Of these: Outgoing	479	453	400	478
Of these: Incoming	363	365	382	304

Graduates (excluding doctorates, per year of study)

DIVISION	2010	2011	2012	2013
Humanities	997	1,129	1,100	925
Medicine	435	376	387	420
Sciences	779	869	892	831
Law, Economics and Social Sciences	860	940	794	797
Total	**3,071**	**3,314**	**3,173**	**2,973**

DEGREE	2010	2011	2012	2013
Magister	228	147	81	37
Church examination	12	12	8	11
State examination	676	559	518	530
Diplom	806	727	527	238
Landesabitur high school diploma	384	417	435	330
Bachelor	810	1,107	1,072	1,081
Master	155	345	532	746
Total	**3,071**	**3,314**	**3,173**	**2,973**

»Medieval chemistry laboratory.« Dr. Michael Schween and Fritjof Schmock of the Department of Chemistry. Photo: Markus Farnung

Third-party expenditures

DIVISION	2010	2011	2012	2013
Law, Economics and Social Sciences	2,158,756	2,698,564	2,232,044	2,224,959
Humanities	3,801,873	4,358,150	5,571,390	7,630,202
Sciences	19,161,960	22,890,195	27,625,178	27,169,170
Medicine	24,059,791	27,885,088	30,482,159	26,996,469
Central Services and Administration	575,248	1,684,512	3,519,581	2,856,750
Total	**49,757,629**	**59,516,510**	**69,430,353**	**66,877,550**
LOEWE portion	5,467,505	9,889,858	14,744,601	10,410,427

Imprint

PUBLISHER
Philipps-Universität Marburg
The President
Biegenstraße 10
35032 Marburg
www.uni-marburg.de

TEXT AND EDITING
Andrea Ruppel, Corporate Publishing Executive Department

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TRANSLATION
Eriksen Translations Inc., New York

DESIGN
AS'C Arkadij Schewtschenko Communications, Frankfurt am Main
www.ascfrankfurt.de

PHOTOS
Cover page: Nuremberg trials, Photo: Harvard University; Prof. Dr. Roland Lill; Photo: Rolf K. Wegst; Laser, Photo: Markus Farnung (top, from left to right) SYNMIKRO: Plant growth chamber, Photo: Thomas Ernsting/*Hessen schafft Wissen* (Hesse Creates Knowledge) (bottom)

Back cover: Neurophysics, Working with the Eye Tracker, Photo: Anna Schroll/*Hessen schafft Wissen* (Hesse Creates Knowledge) (top); Linguist Victoria Schaub, Photo: Rolf K. Wegst (bottom)

Pages 4, 5: Rolf K. Wegst

PRINTING
LaserLine, Berlin

OCTOBER 2014

PRINTED IN GERMANY

Entrance to the Economics Department. Photo: Reinhold Eckstein

Philipps Universität Marburg