Max Planck RESEARCH
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FOCUS
Migrants
Science Integrates the Topic of Immigrants

ASTRONOMY
Turbulent Star Births

MEDICINE
Genes That Come Close to the Bone

INFORMATICS
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ON LOCATION

Amid the Colony

The Dolphin Gull Larus scoresbii lives on the coasts of South America and on the Falkland Islands. The animals breed in colonies that nest near sea lions or other sea birds, such as penguins and cormorants. Dolphin Gulls build their nests in protected areas between boulders or tufts of grass. The clutch contains one to three eggs from which, after nearly four weeks, the chicks hatch. Dolphin Gulls do not feed from the sea, but from the coasts, on such delicacies as sea lion excrement, cormorant vomit, marine invertebrates, mussels and insects. In their search for food, they also regularly comb through washed-up algae. Scientists working with Petra Quillfeldt at the Max Planck Institute for Ornithology are studying the food strategies of these birds. They are investigating whether the individual animals specialize in certain food sources. To follow the birds over a longer time period, they are tagged with a small data logger that uses GPS to capture their position for the coming days, and that stores acceleration data for behavioral analyses. Stable isotopes are used to differentiate the food sources. To capture the birds, the researchers set a wire basket trap on the nest. The seagull watches and, as soon as the researcher leaves, will try to occupy its nest again. The reader for the data dangles from the researcher’s neck, and the data is read out via a radio link.
Migrants

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Residents with an immigrant background make up around a quarter of the population in Germany’s major cities. A team of scientists has been investigating whether these inhabitants are adequately represented in political bodies, what their motives are for getting involved, and what resentments they encounter.

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Time and again, young people take to the streets to battle with the police. Most of these riots have one trigger, but multiple causes. One of the factors can be the way in which the police treat young people – including foreign youth. A German-French comparison yields surprising results.

32 The Myth of the Healthy Migrant
The official statistics would have us believe that the “immigrant fate” guarantees a long life – and not only in Germany. According to official figures, the life expectancy of migrants far exceeds that of their fellow host-country citizens. Is this due to a healthier lifestyle, or to errors in the recorded statistics?

ON THE COVER: Today, one out of every five German citizens has a migration background – that’s more than 16 million people. Responding to this demographic development is not the responsibility solely of politicians and administrative authorities. Increasingly, science, too, is addressing the topic of immigration.

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The Guttenberg case and subsequent allegations of plagiarism against German politicians such as Silvia Koch-Mehrin and Jorgo Chatzimarkakis do little to enhance the value of science in our society. The doctoral degree, which should be a strong currency, has thus come under pressure. At least some sections of the public are left with the impression that copying the work of another is a mere peccadillo en route to a desirable title. Even though the true figure outshone by these prominent cases may be much higher, allegations like these are in no way applicable to the vast majority of scientists. I refer of course to those who hope, through their scientific work, to contribute to the advancement of knowledge, and who rightly object to the shadow of collective suspicion cast by individual cases.

At the Max Planck Society alone, some 5,000 junior scientists are currently working for their doctorates. These are young men and women from all parts of the world who devote years of effort to their studies at one of the 80 Max Planck Institutes or within the network of 63 International Max Planck Research Schools. They trace the origins of the universe, seek out hidden nanostructures in cells, analyze the anatomy depicted in the works of Leonardo da Vinci – wrestling with themselves in pursuit of knowledge. The goal of every dissertation is to put this effort down on paper. That is what makes the doctoral degree a reliable currency.

The route to a doctorate may vary – even conducting research when the working day is done is possible. It is hard work, and even one successful career in life is a great achievement in itself. Anyone who competes in the triathlon of family, science and a political or business career, coping through it all with fair play right down to the last footnote, deserves the greatest respect. But when the rules are flouted because a doctorate is intended solely as a shiny badge, the candidate deserves to be ejected from the playing field of science and from politics. It is, in the end, a matter of truth and honesty.

Nevertheless, we should regard the Guttenberg case and the other instances of plagiarism as an opportunity. They prove that a doctorate can have substance as the central currency of science only when it is based on serious research – and besides independence, that takes, above all, time. In a world that seems to be spinning faster and faster through the speed of the Internet and the smartphone, time, above all, is becoming a scarce commodity. Because more can be accomplished at an ever faster rate, expectations rise accordingly. Science must address these expectations – but attention to detail and a commitment to thoroughness are ill-equipped to keep pace when the Internet, in particular, accelerates the media.

Of course, digital communication and the ability to exchange ideas in seconds are also a blessing for research – particularly in an organization such as the Max Planck Society, which is represented and networked worldwide. With a few mouse clicks, the discoveries made by international research teams can be dispatched around the world. Cooperation that was once inconceivable is now a possibility. Databases offer access to ever more extensive funds of knowledge. The fact that “copy and paste” also invites plagiarism is a sad but simple truth. This
brings us to the heart of the debate about these affairs: the technical facilities available, whether to detect plagiarism or to commit it, and the trend toward speed renders it essential to embed agreed standards more firmly into day-to-day scientific life.

Even though we cannot exclude the possibility that researchers in our ranks may simply appropriate the findings of another, The call for tighter rules is natural

we do have a series of precautions anchored in our practices to counter this. First of all, there is the quality of training we offer: our graduate students have three years in which to complete their doctorates. They take part in the research conducted at a Max Planck Institute and, at the same time, are integrated into a university. This generally results in excellent supervision. Our International Max Planck Research Schools in particular offer structured programs for young scientists. They benefit from an extensive range of courses in which practice and recording of science – in writing – plays an ever greater role. We may say that, over ten years, the principle of the International Max Planck Research Schools has become a model for success. Surveys confirm this: almost three-quarters of the Max Planck Society's doctoral students describe themselves as very satisfied with the support and supervision they receive.

But these excellent conditions would be of no avail if the light of criticism didn't still burn at every institute. In accordance with the Rules of Good Scientific Practice laid down by the Senate of the Max Planck Society, we promote scientific integrity and encourage open dialog. Clearly, falsifying the results of research or plagiarizing the work of others is not something to be made light of. It strikes at the heart of scientific endeavor. To supervise doctoral candidates is to accept a very special duty to set an example. Furthermore, there is an ombudsperson at every scientific facility of the Max Planck Society. These persons occupy a position of trust that not only obliges them to investigate abuses, but also explicitly requires them to shield whistleblowers beneath the mantle of anonymity.

The value of the doctoral degree can be strengthened only if we can establish a stable exchange rate nationwide for this currency of science. There must be high standards of quality regulating the exchange of dissertation for doctorate. Given the recent instances of plagiarism, the call for tighter rules is natural, and indeed justified. The matter is now subject to a debate in which the universities and the Scientific Council have a voice. Welcome, too, is the intention of the Alliance of German Science Organizations to collate and discuss the arguments at a conference in Berlin in late November. However, it is of at least equal importance that the existing rules of good scientific practice not merely be written down on paper, but also be communicated and lived up to at every university – starting from the basic studies. From their first seminar on, students develop their own internal, individual standard that remains with them for the rest of their scientific career. Also among the central keys to quality is the relationship between doctoral student and supervisor. Where cooperation is sufficiently close for a genuine scientific relationship to develop, this not only increases the chances of a better result, it also becomes morally far harder to pass off plagiarized work or falsified test results. Closer cooperation leads to a fairer exchange – as at the International Max Planck Research Schools or the graduate schools born of the Excellence Initiative. This is the right path to follow – not least because it favors quality over quantity.

Further, one should be prepared to accept binding responsibility for the quality of one's work. That is something that should be enshrined in the regulations for doctoral students, at least some parts of which should adhere to uniform standards. In contrast to past practice, there should be a ubiquitous duty to make a statutory declaration that the dissertation is genuinely one's own work, composed in good faith. To give such a declaration the force of law – as opposed to an oath sworn on one's honor – is to add the sanction of potential criminal consequences. It is not a question of casting suspicion upon science – on the contrary, it is an expression of the importance of a dissertation for society.

One should accept responsibility for the quality of one's work only by taking steps like these can we strengthen the reputation of the doctorate as a trademark and ensure that it is recognized internationally as a guarantee of scientific standards. The bar must be set very high in order for the doctoral degree to be generally accepted as a certificate that attests to high-quality scientific work. Only in this way can it remain a source of trust and a means to what we seek: the advancement of knowledge.

Peter Gruss, President of the Max Planck Society
A Showcase for the Future

On September 7, the Federal Minister of Research, Annette Schavan, opened the new Max Planck Science Gallery at the Berlin Science Forum in front of 120 invited guests from the worlds of politics and science.

Large-format touch screens are replacing conventional displays; visitors can almost grasp knowledge with their hands, surfing the world of research of the 80 Max Planck Institutes just like on a computer, dipping into different research subjects. “Thank you to the Max Planck Society, which has made a major contribution over many years in bringing science into the heart of society and now underpins this with this wonderful idea of the Science Gallery,” remarked Minister Schavan. Max Planck President Peter Gruss emphasized that the new showroom should be the starting point for entering into a dialogue with the public. The Gallery will provide constantly changing insights into research and act as a “showcase for the future, inviting wonder and amazement.” In addition to Members of the Bundestag, guests at the event included ministers, representatives from the world of science, and publishers Friede Springer and Stefan von Holtzbrinck. In the ensuing panel discussion with Stefan von Holtzbrinck, Annette Schavan and Peter Gruss, science journalist Gert Scobel (3sat) asked how, aside from exhibitions, the most complex science subjects are brought to the public. Do internet channels such as Facebook and Twitter offer new options and do they even reduce the importance of conventional media such as newspapers and television? Peter Gruss confirmed that good science journalists are still in demand: “These people have to be able to translate the language of researchers so that the extract is understood.” The fact that science, which left its famous “ivory tower” long ago, must itself also get active in an exchange with the public is obvious. But scientists are primarily responsible for the acquisition of new knowledge. A paradox here is the fact that this role is not really appreciated in the media, as Ms. Schavan stressed: “Nothing changes society as much as the knowledge that science and research bring, but this rarely features in the main news.”

Future Dialogue in India

Siemens and the Max Planck Society organize an international discussion forum in New Delhi on “Sustainable Cities”

The focus was the question of how megacities can provide decent living conditions for their inhabitants. The aim of the conference was to bring together politicians, business leaders and scientists to find solutions to a pressing world problem. With its rapid population growth and its three megacities – Delhi, Calcutta and Mumbai – India was the perfect location, and Indian interest was correspondingly high. The speakers provided immediate insight into the main problems of sprawling cities with over a million inhabitants, ranging from lack of basic food and lack of water supply to inadequate medical aid and lack of electricity networks, transportation systems and housing. The one-day conference made it clear in particular that major world problems can be solved only if science, industry and politics work together and there is a global pool of accessible solution strategies.
“We need more basic research in Africa”

Stefan H. E. Kaufmann

For the first time, the Max Planck Society is setting up a Max Planck Research Group in Africa. The new research group of the Max Planck Institute for Infection Biology will start work in 2012 at the National Research Institute for Tuberculosis and HIV in Durban, South Africa. Stefan H. E. Kaufmann, Director at the Berlin Max Planck Institute, describes why it is important to conduct basic research on infectious diseases in Africa.

Why did you choose Durban?
An important criterion was the fact that a new research institute dedicated to investigating HIV and tuberculosis is being built there. The KwaZulu Natal Research Institute for Tuberculosis and HIV is a project run by the University of KwaZulu Natal and the Howard Hughes Medical Institute in the US. The Max Planck Research Group will be based at this institute and will find excellent working conditions there. Durban also has a number of well-equipped clinics where patients with a form of tuberculosis that is resistant to current drugs can be treated.

Why is the Max Planck Society setting up a research group in South Africa?
Stefan Kaufmann: In setting up a Max Planck Research Group, our aim is to promote basic research on HIV and tuberculosis in Africa. Scientists will benefit from the physical proximity to the centers of infection. Knowledge from laboratory and clinic can then have a mutually stimulating effect, because up to now, mainly clinical studies were conducted in Africa. They wanted to investigate the effectiveness of drugs against infectious diseases that are widespread there. In South Africa and other countries in Africa, there is a diabolical connection between two of the most dangerous infections; the high number of AIDS patients has also meant a resurgence of tuberculosis. As a result of their weakened immune systems, HIV patients are particularly vulnerable to tuberculosis pathogens.

What will the Research Group be looking at?
It will conduct basic research into HIV or tuberculosis at the highest scientific level.

When will the Research Group be starting its work?
The application and selection procedures are currently under way. We hope that the Group will be ready to start by the end of 2012, by which time the new institute should also be completed.

The only tuberculosis vaccine currently available is over 90 years old. What makes the development of vaccines against tuberculosis so difficult?
The problem lies in activating a different arm of the immune defense, namely the cellular immune response. Effective vaccines boost the production of proteins, so-called antibodies that bind to pathogens and then destroy them. The tuberculosis pathogen, however, is a bacterium that hides inside cells in the body and therefore can’t be reached by antibodies. Our aim is thus to stimulate the cellular immune response of the body because it can then also track down the pathogens in the cells and render them harmless. This, however, is regulated more strongly by the body. Matters are compounded by the fact that we must be better than nature in developing vaccines, because the body can keep the bacteria in check for a long time – but it can no longer get rid of them.

How could the development of new vaccines and drugs be accelerated?
A very important point is the improved combination of basic research and clinical studies. At present, there are few points of contact, so the previously rigid scheme of pre-clinical and clinical research must be deconstructed. If, for example, an active ingredient shows unexpected effects in a patient, this must be quickly reverted to basic research.

How long will it be before a new vaccine against tuberculosis reaches the market?
Our own vaccine candidate is in phase II of clinical development at Stellenbosch, South Africa. A total of twelve vaccine candidates are currently being clinically tested. If all tests run successfully, the first could be used in 2016.

Interview: Harald Rösch
World’s Largest Language Archive

The Berlin-Brandenburg Academy, the Royal Netherlands Academy of Sciences and the Max Planck Society finance the “Language Archive”

Languages evolve, change and die out; globalization, worldwide migration and technological innovations have sharply accelerated this change. There are currently around 6,500 languages in the world, most of which will, in all probability, no longer be spoken in a few generations. This change can’t be stopped, but attempts should be made to safeguard the linguistic and thus also the cultural wealth of mankind and make it accessible to systematic research. In recent years, as part of the “Documentation of endangered languages” funding initiative at the Volkswagen Foundation, comprehensive data on endangered languages has been recorded by numerous teams throughout the world, digitally archived at the Max Planck Institute for Psycholinguistics and made accessible by a series of tools. The results of this initiative, along with large language corpora from many other scientists, are part of the “Language Archive” that, with around 80 terabytes of data from 200 languages, is currently the world’s largest language corpus. The aim is to systematically expand it in the future, further decipher it with a variety of tools, and link it worldwide with other data repositories. It is freely accessible within the framework of legal possibilities and ethical obligations.

Dancing on the Volcano

The series of talks entitled “Responsibility of Science” by the Max Planck Society continues to attract considerable interest. Some 170 visitors came to Mainz for the fourth in the series at the end of September.

The subject “Geoengineering – Opportunity or Threat for the Earth” looked at how far scientists should intervene in the Earth’s system in order to cushion the consequences of climate change. Meinrat Andreae, Director at the Max Planck Institute for Chemistry, outlined prominent concepts of geoengineering, including re-enacting essentially violent volcanic eruptions in which aerosols are formed by the discharge of millions of tons of sulfur into the stratosphere, weakening the solar radiation and thus lowering the global temperature. Hauke Schmidt from the Max Planck Institute for Meteorology analyzes such concepts as part of an EU project using computer simulations and assumes that the global temperature could actually be lowered to a pre-industrial level. However, the studies also show that the global water regime would be significantly affected and the amount of precipitation would fall disproportionately. Both scientists thus also refer to the risks that particularly Carl Friedrich Gethmann had looked at. The philosopher and expert for technology consequences assessment of the University of Essen-Duisburg emphasized the many uncertainties with interference in complex systems. Nevertheless, German researchers should theoretically deal with geoengineering because expertise is needed if the call for practical application becomes louder in other industrialized countries. The forum in Mainz was facilitated by the science journalist Jan Lublinski.

The last event in the series for the moment took place on December 1 in Munich. The subject: “The Manipulated Mind – Methods in Neuroenhancement – What Does Science Say?” One of the people involved is Florian Holsboer, Director of the Max Planck Institute of Psychiatry.

“Yes, but …”: Those who took part in the discussion agreed that the pros and cons of what new findings offer from a scientific point of view must be carefully weighed up.

Photos: Berlin-Brandenburg Academy of Sciences – Angelika Fischer (top); MPI for Polymer Research – Stephan Imhof (bottom)
Molecular Light Switches Against Retinal Diseases

Sanofi will provide Frankfurt Max Planck researchers with funding worth 450,000 euros in the next three years to investigate retinal diseases.

Max Planck Innovation, the technology transfer subsidiary of the Max Planck Society, and Fovea Pharmaceuticals, a subsidiary of the pharmaceuticals company Sanofi, have signed a license agreement for the application of channel rhodopsins, which, if successful, should restore the sight of blind patients. The pigment proteins were discovered in 2002/2003 by Peter Hegemann of the Max Planck Institute of Biochemistry in Martinsried, together with Georg Nagel and Ernst Bamberg from the Max Planck Institute of Biophysics, and come from a small single-celled green alga. The unique nature of the channel rhodopsins lies in the fact that, on exposure, they become permeable to positively charged ions, as a result of which an electrical signal is triggered on the cell membrane. The corresponding gene sequences can also be expressed in other cells, such as nerve cells. Incorporated into the cell membrane, nerve cells can be switched on and off with these light-controlled ion channels. “We can now, for the first time, control the activity of nerve cells by light, without electrons or any chemical modification, without any problem and with as yet unparalleled spatial resolution,” explains Ernst Bamberg. Now the channels are to be further developed so that nerve cells of the retina in the human eye can be converted into light-sensitive cells with which patients whose sensory cells have been destroyed can again detect optical stimuli. A gene therapy such as this could be used in hereditary diseases such as retinitis pigmentosa, retinal dystrophies and glaucoma, age-related macular degeneration and diabetic retinopathy. Via its subsidiary Max Planck Innovation, which is responsible for the commercialization of Max Planck patents, the Max Planck Society receives initial and milestone payments of up to 26.4 million euros as part of the awarded license. Sanofi, in turn, receives the worldwide exclusive rights and secures for itself global rights to the results of the collaboration. “The history of the discovery of the light-activated ion channels is an example of how new techniques can be produced from knowledge-driven basic research, leading to new treatment methods for humans,” comments Egenhard Link from Max Planck Innovation.

Switches in the neuron: Channel rhodopsin-2, activated by blue light, switches the nerve cell “on”; halorhodopsin, activated by yellow light, switches it “off.”

On the Net

The mysterious hominids from the Denisova Cave
Bence Viola from the Max Planck Institute for Evolutionary Anthropology in Leipzig discovered the tooth fragments together with Russian colleagues in the Denisova Cave in the Altai Mountains. Initially, he thought the inconspicuous-looking object was the molar of a cave bear. But when the remaining fragments of the tooth turned up, it became obvious that it was the tooth of a hominin. DNA analyses revealed that it hailed from a previously unknown early human species living in Asia at least 30,000 years ago. http://www.mpg.de/4742597/Denisova-cave

Sharper than theory allows
Previously, the law formulated by Ernst Abbe in 1873 was regarded as the absolute lower limit. Objects lying closer to each other than 200 millionths of a millimeter, i.e. about one two hundredth of a hair’s breadth, could no longer be distinguished from one another. The STED (Stimulated Emission Depletion) microscopy, which the physicist Stefan Hell from the Max Planck Institute for Biophysical Chemistry in Göttingen invented, allows scientists to gain insights into the nano world far beyond this limit. http://www.youtube.com/maxplanck society

Research from the Living Room
Learning something new about oneself – and at the same time helping researchers. This is something anyone who is interested can now do, via a web panel for study participants. From their own home, they take part in online studies of the Max Planck Institute for Human Development, in which a team headed by Gerd Gigerenzer examines human rationality, risk and decision-making behavior. Registered participants can test their knowledge of human nature in the Opinion Club. abcwebpanel.mpib-berlin.mpg.de
Euro Sums Don’t Add Up

Will Europe fail if the euro collapses? Many believe it will, and are trying to save the euro. Our author holds a different view: If the euro is to be used as a tool to preserve European integration, the eurozone must be reduced to a core of countries that are equipped for long-term stability, allowing the remaining EU members to return to the more flexible European Monetary System.

TEXT FRITZ W. SCHARPF

The sinners must comply with draconian austerity dictates

The euro crisis is dividing Europe: In Greece, Ireland, Portugal and Spain (the GIPS countries), there are mass protests against the austerity programs dictated by Germany and the troika comprised of the European Central Bank, the EU Commission and the International Monetary Fund. In Berlin, Frankfurt and Brussels, the fault is seen to lie solely with the GIPS, who have lived beyond their means and breached all the rules of the Stability Pact. However, because of the belief that Europe will fail if the euro collapses, and that it will do so if even one of the GIPS declares bankruptcy, the sinners must be rescued at any price. But to receive the financial aid they need, they must comply with the troika’s draconian austerity dictates.

This interpretation of the situation, which prevails particularly in Berlin, is less than accurate. Frivolous fiscal policies in Greece have certainly contributed to the present crisis. In Ireland and Spain, however, following the introduction of the euro, the governments reduced their sovereign debt far below the Maastricht limit – and far below the German level. Also, in contrast to Germany, until the onset of the international financial crisis in 2008, they balanced their budgets and even achieved surpluses.

In Ireland and Spain, sovereign debt was not the cause but an effect of the financial crisis, as the state sought to rescue banks (just as in Germany) and safeguard jobs. The fact that debt levels escalated far faster in those countries than in Germany and that the financial markets responded with prohibitive risk premiums is attributable to imbalances prior to the
crisis, the responsibility for which lay not with the fiscal policies of the GIPS but primarily with the European Monetary Union itself and the monetary policy of the European Central Bank.

The monetary union may have come about in response to French pressure, but Germany ensured that the European Central Bank (ECB) and its monetary policy were based on the model deployed by the Bundesbank in the 1970s. The independent Central Bank was tasked not just with safeguarding monetary value, but with facilitating economic growth without inflation, provided only that the fiscal policies and wage policies of the social partners remained within the framework specified by monetary policy.

This, in principle monetarist, model had generally worked very well in Germany because the Bundesbank oriented its monetary and interest rate policy toward the inflation risks and toward the growth potential of the German economy; because there was close communication between bank and government; and because Germany’s economically savvy trade unions were able to integrate the annually announced monetary policy targets into their assessment of the scope for wage bargaining.

Naturally enough, these prerequisites could not be reproduced when the model was transferred to the European level. The monetary union began on January 1, 1999 with eleven members – including Ireland, Portugal and Spain, with Greece not being granted membership until 2001. Even though all of the member states had made heroic efforts in the 1990s to meet the Maastricht criteria for entry, the economic, political and institutional differences within the euro group were so great that, in the judgment of American economists in particular, the eurozone did not qualify as an optimal currency area in which macroeconomic development could be successfully controlled by centralized and uniform monetary policy.

The advocates of monetary union had expected that the Union itself, coupled with easier trading conditions and the free movement of capital in a single currency area, would encourage convergence and rapidly smooth out the remaining differences. And at first it seemed they were right: inflation rates dropped, state deficits were reduced and interest on sovereign debt fell everywhere to the German level once the financial markets no longer had to worry about the risk of devaluation.

Unlike Germany in this case, countries that had previously been forced to pay high risk premiums now profited from the growth stimulus of a steep reduction in the cost of borrowing, which also made it easier to comply with the deficit rules contained in the Stability Pact. In contrast to previous concerns, the initial risks did not lie in the fiscal policies of the member states. They lay, instead, in monetary policy that had been left solely to the independent European Central Bank.

To reduce inflation rates to meet the Maastricht criterion, the states joining the eurozone had been able to rely on the restrictive monetary policies of their national central banks. In the end, they came close to (but did not quite match) the low German level. Upon joining the monetary union, however, they lost all influence over monetary instruments. And the ECB, which was now responsible, aimed its money supply and interest rate policies at the eurozone as a whole rather than at the problems of individual states.

In doing so, it was indeed able to successfully limit the average euro inflation rate. For countries whose inflation or growth rates were above or below the eurozone average, however, the ECB was not and is not in a position to assume the function that the Bundesbank fulfilled for the German econ-
omy. Its uniform monetary policy oriented toward the euro average is too restrictive for some countries and too lax for others. For both groups, the effects of its monetary policy are thus misdirected, as one sees its economy overheat, while the other is driven into recession.

The first victim of misdirected monetary policy was Germany, which entered the monetary union with the lowest rate of inflation and its economy in a downswing. The nominal ECB interest rate was too high for this situation, whereas for the GIPS, with their significantly higher inflation rates, it was too low. For this reason, the real interest rates (after adjusting for inflation) that determined business decisions in Germany were particularly high, whereas in the GIPS, they fell below zero from time to time.

The already weak consumer and investment demand in Germany was further depressed by excessive borrowing costs, while the extremely low real interest rates in the GIPS stoked domestic demand. Germany, as a result, slipped into a recession between 2001 and 2005, with steeply rising unemployment, while strong economic growth financed by borrowing in Ireland, Spain and Greece caused unemployment to fall.

In the first half of the decade, Germany was the “sick man of Europe.” Without the monetary union, monetary policy would have countered this situation, and an expansive fiscal policy might have stabilized employment. Given that these options aimed at domestic demand were precluded (Germany was already in breach of the Stability Pact as a result of its recession-induced reduction in revenue and increase in expenditure), all that remained was the supply-side Hartz IV policy and a flight into exports. The latter was made possible by the extremely restrained wage policy of the trade unions, under which wages in Germany fell in real terms.

In the GIPS, on the other hand, credit-fueled domestic demand not only stimulated demand for imports, but drove up wages and unit labor costs*. The ensuing loss of international competitiveness caused increasingly negative current account balances. Without the monetary union, these deficits would soon have been corrected, whether by a balance of payments crisis or by falling exchange rates and higher risk premiums. In the euro zone, however, there was no exchange rate risk for investors, and current-account deficits were readily financed through capital inflows from surplus countries like Germany. This resulted in increasing macroeconomic imbalances in the eurozone.

It took the international financial crisis to put an end to this vicious circle. While banks in the creditor countries were forced to write down or

Fresh borrowings were available only at exorbitant risk premiums

write off US securities, banks in the debtor countries were unable to refinance themselves. In both cases, governments had to take on debt to save their banks and safeguard jobs. The global credit crunch – and the bursting of the real estate bubbles in Ireland and Spain – thrust the credit-dependent economies of the GIPS into a particularly deep crisis, causing sovereign debt levels to escalate even in countries that had previously been rock solid. Now, at last, the rating agencies and financial markets began to doubt the solvency of the GIPS. Consequently, fresh borrowing was available only at exorbitant risk premiums.

It is this problem that the rescue programs for Greece, Ireland and Portugal have so far addressed. But providing access to affordable credit merely buys time. And the necessary reduction of extreme levels of sovereign debt will not be enough. The true magnitude of the challenges becomes clear only when one considers the development in real effective exchange rates. This shows how dramatically the inter-

* In economics, unit labor costs are the quotient of employee compensation and gross domestic product.
national competitiveness of the GIPS has decayed since the start of the monetary union. If this deficit is not corrected, no rescue program can alter these countries’ dependence on loans or transfers from abroad. There are only two ways in which it can be corrected: either by nominal devaluation or real devaluation.

Nominal devaluation, which also presupposes a drastic “haircut” for these heavily indebted states, has been categorically ruled out in the political discussion thus far because it would require the country concerned to at least temporarily leave the monetary union, and because such an event would rhetorically be equated with the failure of European integration. If such a decision were nevertheless to be made, the country’s exports would immediately become cheaper, its current account would return to balance and its dependence on inflows of capital would cease.

Admittedly, the rising cost of imports would push up prices and real incomes would fall. However, the gain in international competitiveness would be lost if trade unions in the export industries would try to compensate real-income losses through higher nominal wage increases. That would certainly be difficult, but there are examples – not just in Germany – that illustrate that wage restraint can be achieved in consensus with the trade unions. If this were to succeed, GIPS countries could escape their dependence on capital inflows and European rescue programs, and achieve economic recovery through their own efforts.

If, on the other hand, Greece and other deficit countries continue to defend their membership in the monetary union, the reduction in export prices necessary to restore international competitiveness would be achievable only by a real-terms devaluation that would necessitate a rapid reduction in unit labor costs – and therefore a drastic cut in nominal wages. This could not be achieved anywhere – not even in Germany – in consensus with the trade unions. Instead, government-enforced wage cuts would be required, which could perhaps be implemented in the public sector. In the private sector, on the other hand – which would be crucial for competitiveness – the state would not have (in Germany at least) the constitutional powers or (anywhere) the practical ability to effectively dictate wages. Even a European “economic government” could not alter these conditions.

In the long term, of course, and under the pressure of high rates of unemployment, market forces could bring about a reduction in unit labor costs. Until then, however, current accounts would remain in deficit. GIPS countries thus will continue to depend on capital inflows and, given the distrust of capital markets, they will continue to depend on rescue credits or eurobonds in order to at least reduce the interest cost of rising debt burdens.

Meanwhile, the uniform monetary policy pursued by the ECB will still be part of the problem. Even the present low ECB interest rates are too high for the crisis in GIPS economies, and real interest rates in those countries have reached extreme levels. As its chief economist, Jürgen Stark explained in a lecture on June 20th of this year, the ECB perceives its task to lie solely in “guaranteeing price stability in the eurozone. The ECB may not and will not deviate from this task because, for example, real growth or inflation rates in some eurozone member states are substantially lower than in other member states.” Having triggered an increase in macroeconomic imbalances, uniform monetary policy in a non-uniform eurozone now also stands in the way of resolving the crisis within the monetary union.

In conclusion, the attempt to save the euro in its present form, whether through loans, eurobonds or direct financial transfers to the deficit countries, will do nothing to change the fundamental structural

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**A nominal devaluation is categorically ruled out in the political discussion**

Photo: ddp images

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problems of the monetary union. This assistance will make it easier for GIPS governments to finance their deficits, but the rigorous austerity conditions will deepen and prolong the economic crisis and force governments into measures that lack democratic legitimacy. Should they be implemented, they will be perceived as the impositions of European bodies and donor countries. There, however, political frustration is rising as financial commitments seem to grow inexorably without achieving their promised effect.

The attempt to rescue the euro is therefore more likely to undermine the democratic legitimacy of politics and politicians in the member states and drive the European nations apart than to hasten progress toward a democratically legitimate political union. If the euro is to be used as a tool to preserve European integration, the eurozone should be reduced to a closely integrated core of countries committed to long-term stability, allowing the remaining EU members to return to the more flexible European Monetary System. Otherwise, the euro crisis could actually blow the European Union apart.

Uniform monetary policy stands in the way of resolving the crisis

The AUTHOR

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NOTE

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Diversity in the City Council

Residents with an immigrant background make up around a quarter of the population in Germany’s major cities. A team of scientists headed by Karen Schönwälder at the Max Planck Institute for the Study of Religious and Ethnic Diversity in Göttingen has been investigating whether these inhabitants are adequately represented at City Hall. They have also been looking at the motives and conditions under which councilors with foreign roots involve themselves in politics, and the resentments they encounter.

TEXT BIRGIT FENZEL

At the national and state government level in Germany, politicians with an immigrant background are no longer a rarity. Popular examples include Philipp Rösler, who came to Germany as a child from Vietnam and whose heady career has seen him become Federal Minister of Economics and chairman of the FDP; and the Ministers of Lower Saxony and Baden-Württemberg, Aygün Özkan and Bilkay Öney, and Green Party chairman Cem Özdemir, all of whom are of Turkish origin. The latter was first elected to the Bundestag in 1994, along with SPD member Leyla Onur, the first two Germans of Turkish descent to enter parliament.

But what about political involvement among people with an immigrant background at the grassroots level? This was one of the central questions addressed in a field study by political scientist Karen Schönwälder and her research group at the Max Planck Institute for the Study of Religious and Ethnic Diversity. The project received financial support from the Heinrich Böll Foundation and the Mercator Foundation.

In order to, first of all, arrive at some reliable figures on how many people with an immigrant background hold political office in Germany’s city halls, the researchers in Göttingen began with an inventory of 77 cities with more than 100,000 inhabitants. They searched every list of candidates and elected councilors for the period from 2001 to March 2011 in search of individuals who either themselves arrived in Germany as first-generation immigrants or who were born of at least one immigrant parent. In the process, they analyzed the results of two local authority elections in every city.

“AN UPWARD TREND, BUT AT A LOW LEVEL”

The results of this general inventory of city councils aroused interest above and beyond the scientific community – and not just because such a study had never been undertaken before. Its purpose was also to reveal the extent to which the institutions of democracy reflect the increasing diversity of our society.

In this respect, there have evidently been some changes in the past ten years. The study showed that, during the period under investigation, the number of councilors with a migration background rose from 116 to 198. Similarly, the number of candidates for election rose by around 40 percent during this period. The researchers’ findings also showed an increase in the number of cities in which immigrants were elected to the council, with several such representatives frequently joining the council at the same time. “In only 15 of the 77 cities were the councils uniformly composed of ‘old-established’ Germans, compared with 24 prior to 2001,” says Karen Schönwälder. “That is a significant change, but not yet cause for euphoria.” Given that over a quarter of big-city populations have an immigrant background, the fact that these segments account for a mere 4 percent of a total of 4,670 council members is far from sufficient.

“We’re seeing an upward trend here, but still at a low level,” confirms social scientist Daniel Volkert, who, as a member of the Frankfurt city council members with an immigration background: Eugenio Munoz del Rio, Imren Ergindemir, Mike Josef (SPD), Nimatoulaye Diallo, Onur Azcan, Ilham Arslaner (Greens), Ilias Galanos, Albina Nazarenus-Vetter (CDU), Merve Ayyildiz (Linke) 

Photos: SPD party, Frankfurt (top row, 3), Green party, Frankfurt (middle row, 3), CDU party, Frankfurt (bottom left, 2), DIE LINKE (bottom, right image)
visory committees and networks also play a positive role as a meeting ground for different political elites.”

But at the end of the day, Karen Schönwälder and her colleagues established that none of the 77 cities have a proportion of immigrant councilors that matches the immigrant proportion of their populations. From the scientist’s perspective, this is an untenable situation in a democracy. “In cities where, in some cases, over a third of the population are first-generation immigrants or descendants of immigrant families, the imbalance between social diversity and largely homogeneous parliaments must be overcome as a matter of urgency,” she emphasizes. One of the yardsticks of achievement in terms of equal opportunities and integration is the extent to which these segments of the population participate in political decisions. If large parts of the population are excluded from such participation, the principle of political equality that lies at the heart of democracy is at risk.

In addition to the number of local politicians with a migration background, the scientists also analyzed their biographical backgrounds. They found that the vast majority were first-generation immigrants or descendants of immigrant families, the imbalance between social diversity and largely homogeneous parliaments must be overcome as a matter of urgency,“ she emphasizes. One of the yardsticks of achievement in terms of equal opportunities and integration is the extent to which these segments of the population participate in political decisions. If large parts of the population are excluded from such participation, the principle of political equality that lies at the heart of democracy is at risk.

In addition to the number of local politicians with a migration background, the scientists also analyzed their biographical backgrounds. They found that the vast majority were first-generation immigrants, some of them arriving as children. Many came as dependants, or to study in Germany. “The high proportion of women struck us as particularly notable,” says Karen Schönwälder. While women still account for less than half of all councilors with an immigrant background, at 40 percent, their proportion exceeds the overall ratio of female city councilors, which stands at 33 percent.

The study revealed large differences in the national origins of council members. “The large number of male and female councilors of Turkish origin stands out,” says socio-economics graduate Cihan Sinanoglu, who, like Daniel Volkert, is working on a doctorate centering on this research project. In the eyes of the researchers, this refutes the prejudiced view that citizens of Turkish origin are especially unwilling to integrate. Alongside Turkish immigrants, Europeans from elsewhere in the EU constitute the numerically dominant groups. There are also a series of council members originating from Africa and the Arab states. “But there is hardly anyone from, for instance, Southeast Asia,” Karen Schönwälder has found.

As diverse as the individuals, their origins and careers may be, the motives for their political activities and their self-image appear to be, in many cases, strikingly similar. “Most entered politics because they wanted to do something for their city,” says Karen Schönwälder. This much emerged from an analysis of the questionnaires sent, as part of the study, to all council members concerned. Together with around 30 personal interviews conducted by the team, the questionnaires provided information on the type of people who have made their way into local politics,

None of the 77 cities have a proportion of immigrant councilors that matches the immigrant proportion of their populations.
how the political representatives of the immigrant population perceive their own career and conditions, and not least, also the obstacles they have to contend with.

The researchers were surprised by the strength of the response to their inquiries. “Over 60 percent completed and returned their questionnaires – normally the response rate is well below 50 percent.” As to why participation in the study should have been so enthusiastic, Karen Schönwälder can only speculate. “Maybe it was because we were the first to ask these things, or perhaps they were pleased that someone was finally taking an interest,” she suspects.

POLITICALLY ACTIVE IMMIGRANTS ARE OFTEN HIGHLY EDUCATED

It also emerged that migrant workers and refugees are less prominently represented among politically active immigrants. By far the majority of those who make a career for themselves in local politics in their new homeland are highly educated. For example, 66 percent of councilors in the sample have a university degree. Frequently, they are “educational climbers”: over half of their parents had little or no school education.

Before their election, many immigrant councilors were involved in trade unions, school and university student representative bodies, community activist groups or other political groups. >
As the study showed, the route to the council chamber often lies through involvement in an immigrant advisory or integration committee. Only 36 percent were elected to the council without previously having held party office.

In the interviews, many reported a feeling of exclusion coupled with these first party experiences. “You feel lost, as though you are out of place. You know no one and you feel terribly inhibited in joining. And it takes a while before you warm up, so to speak,” reported one interviewee. In principle, however, the participants in the study described the way they were accepted as positive. “Those who we surveyed largely see themselves as respected by other councilors. They regard their nomination as recognition of their competence and popularity,” notes Cihan Sinanoglu.

RIGID ALLOCATION OF ROLES ALLOWS LITTLE LATITUDE

“Nevertheless, they see it as a problem when they are put under external pressure to concentrate exclusively on the political issues of immigration and integration,” he continues. Although immigrant councilors, through their experience and education, have a wide range of knowledge and skills, they have limited opportunity to use them in the political arena. Around 35 percent reported problems in being recognized as experts in matters outside of immigration and integration. This allocation of roles conflicts with the way many of those surveyed see themselves. Summarizing the councilors’ feelings, the Göttingen-based research group leader explains: “They don’t want to be restricted to an immigration role.”

On the other hand, quite a few of the interviewees were somewhat ambivalent on this issue. One commented: “Fifteen years ago, I was angry at being pushed into something. But in the end, it was an opportunity to qualify myself for other things.” Almost two-thirds of council members with an immigrant background described themselves as satisfied at having achieved something for the immigrant population. Even councilors whose foreign origin is not central to their own self-awareness – something that applies to around two-thirds of the entire group – specifically target parts of their electoral campaigns at immigrant voters.

At election time, but not only then, local politicians with a migration background may encounter open resentment against their origin. When one participant in the study was handing out leaflets in the street, someone snapped at him: “Beat it. Haven’t you people got more important things to do, like feeding your own people, instead of running in a election here?”

MORE DIFFICULT TO TAKE PART

In interviews with the researchers, 26 percent reported receiving negative or discriminatory comments in connection with their political activities—some even voiced by traditional party members. One interviewee recalled comments in the early days such as: “What’s a black head doing here? Isn’t he in the wrong place?” or “Well, who’s this, then?” Ultimately he was nevertheless accepted: “In the end, some remarked, ‘Well, you speak good German.’” Another participant in the study related how, while no one was directly hostile to him, he frequently overheard seemingly harmless banter. As he put it, “Things that are said in jest can often be meant in earnest.” To his ears, being called “you Austrian” was degrading.

According to Karen Schönwälder, such experiences were common to male and female members of all parties and differing national origins. However, those concerned described these negative experiences as never overwhelming in and of themselves. After all, no one likes to present themselves as a victim. “It was much more the case in our observations that the experiences highlighted were positive ones,” says the scientist.

Nevertheless, the authors of the study believe that negative attitudes toward certain immigrant groups are
among the factors that make it more difficult for citizens with an immigrant background to take part in politics. The fact that people with an immigrant background, who collectively make up over a quarter of big-city populations, constitute just 4 percent of those sitting in the council chamber – in the opinion of Karen Schönwälder and her colleagues – is an indicator of deeper underlying structural causes.

“The process of immigration itself means that immigrants must first become acquainted with a new political system and its institutions.” Another barrier exists in the fact that some initially – or even over an extended period – possess only limited political rights. Many also suffer the disadvantage of belonging to economically weaker segments of the population. “Time and money make it easier to assume a political mandate.” Here, too, the political scientist sees a need for action, insofar as a democracy can’t allow itself to offer opportunities solely to those who are well off. Her recommendation to German society: “If the level of representation of the immigrant population is to be significantly increased, such structural contexts must not be overlooked.”

**IMMIGRANT QUOTA OF 15 PERCENT PLANNED**

Above all, the mainstream political parties have some ground to make up – an opinion shared by many participants in the study. “Most thought that their party should do more to enable people with a migration background to play an equal role in party affairs,” says Daniel Volkert. The SPD was quick to recruit people of non-German origin, but they occupy hardly any leadership positions. Social Democrat party chief Sigmar Gabriel and Secretary General Andrea Nahles announced after a meeting of the party’s steering committee, they are planning to introduce an immigrant quota. A voluntary commitment to a minimum 15 percent target on federal party committees was adopted at the party conference in early December.

What effects this resolution will have at the local level remains to be seen. On the other hand, broadening the participation and co-determination practiced by all segments of a city’s population in the interests of democratic equality is not, in Karen Schönwälder’s opinion, a task for the political parties alone: “Diversity within political institutions is a project that concerns the whole of society.”

Karen Schönwälder believes that the FDP and CDU also need to catch up. “The FDP could be an attractive prospect for highly qualified EU migrants, and the CDU has large numbers of supporters among ethnic German immigrants. But what elected or party offices do they hold?” Still, there seems to be some movement. As SPD party chief Sigmar Gabriel and Secretary General Andrea Nahles announced after a meeting of the party’s steering committee, they are planning to introduce an immigrant quota. A voluntary commitment to a minimum 15 percent target on federal party committees was adopted at the party conference in early December.

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**GLOSSARY**

Voting rights in local authority elections
In Germany, apart from German nationals, only citizens of other EU states have the right to vote in local authority elections, provided they were registered in the corresponding local authority area at least three months prior to the poll. They are entitled to hold council office even without German citizenship.

Migration background
A concept that overcomes the restriction of previous terms to non-German nationals only and includes all immigrants and their children. This group is variously defined. The Federal Statistical Office categorizes “all persons who migrated to the present territory of the Federal Republic of Germany after 1949 and all non-German citizens born in Germany, and all those born in Germany as German citizens with at least one parent who migrated to Germany after 1949 or was born in Germany as a non-German citizen” as a single group.

Primary immigrants
Those who leave their country of origin in order to live in another country are described as first-generation immigrants. The children of such immigrants are described as second-generation immigrants.
Time and again, young people in Europe’s cities are taking to the streets to battle with the police, as happened this summer in Great Britain. Most of these riots have one trigger, but multiple causes. One of the factors can be the way in which the police treat young people. To delve a little deeper, Dietrich Oberwittler and Daniela Hunold at the Max Planck Institute for Foreign and International Criminal Law in Freiburg are comparing circumstances in Germany and France. Their results are surprising.
It was as if the aggression needed a valve. The release came with the death of Mark Duggan, who was killed by a police bullet. Although the course of events remained unclear, violence swept the London suburb of Tottenham, spreading quickly to other British cities.

The fighting between mainly young people and the police acquired a momentum of its own in Great Britain, just as the riots did in suburban France in fall 2005. In France, too, the trigger was a police operation with a fatal outcome: In the Parisian suburb of Clichy-sous-Bois, two young men were electrocuted in an electricity substation as they fled from the police. Rumors soon began to circulate that the police had caused their deaths. The resulting unrest among the youth of Paris spread to the whole of France.

**FRENCH GOVERNMENT DECLARES AN EMERGENCY**

After four weeks of street fighting, the Paris banlieues and 200 other French suburbs resembled battlefields. Over 9,000 cars were burned out and 3,000 arrests were made. The government was forced to declare a state of emergency, as the country seemed to be coming apart at the seams.

Many feared that the fire might spread to other countries, but that didn’t happen. In Germany, too, things remained quiet despite widespread television and newspaper reporting of events. So why is it that riots of this kind haven’t happened elsewhere, before or since?
For all the interest it has attracted, the question has yet to be answered conclusively. Street violence is, after all, an issue that surfaces almost on a daily basis, and surveys consistently show that, for a majority in society, it is a cause for concern. What makes the systematic study of violence among young people, primarily from immigrant families, so relevant is the fact that it is an issue about which public opinion and scientific findings contrast starkly. “Criminality among immigrants – it is, of course, a hot social topic that we are researching,” says Dietrich Oberwittler, research group leader at the Max Planck Institute for Foreign and International Criminal Law in Freiburg.

Dietrich Oberwittler has been studying the causes of youth violence for years. Simple, monocausal explanations are inadequate. In seeking to explain human actions and motives, it is virtually impossible to point to any single cause. What does consistently emerge, however, is that there is often a yawning gap between subjective explanations and empirical results.

Drawing a comparison between Germany and France promises to shed new light on this issue: Both countries are destinations of choice for immigrants, but they differ sharply in the intensity with which conflicts are staged. The streets are a battleground in one country, but not in the other. Yet both have a substantial immigrant population. According to the OECD, 8 percent of those living in France were born abroad, while in Germany the figure is 13 percent.

But here is where the similarities end. Above all, living conditions in the two countries’ suburbs differ widely. Whereas the French banlieues are a focus of poverty and structural problems, such segregation is not found to the same extreme in German cities. There has long been a scientific consensus that this concentration exacerbates the tendency toward violence and criminality.

However, there is another, thus far much less well known key factor that some suspect may also play an important role: the personal contact between adolescents and the police. It is precisely this contact that forms the subject of a research project entitled “Police and young people in multiethnic societies” (POLIS) being conducted by the Max Planck Institute for Foreign and International Criminal Law. Dietrich Oberwittler’s hypothesis is that this contact in France follows a different pattern than that in Germany.

THE POLICE ARE NOT THE ONLY CAUSE OF TENSION

It was, after all, the encounter between the police and youths that ended with the death of two young men that triggered the street fighting in France in 2005. In London, too, this August, a police operation sparked off riots and looting. “The police are not the sole cause of tensions, but they are an important contributing factor,” says Daniela Hunold, who works as a scientist at the Max Planck Institute in Freiburg. Much would be gained if it were to emerge that the intensity of conflict were attributable to the conduct of the police. But how does one set about proving such a thing?

Together with French colleagues at the University of Grenoble, the researchers in Freiburg embarked on a large-scale bi-national research project. The issues they are studying include how conflicts arise and how prejudices are formed and consolidated in personal encounters between young people and the police.

The project follows the same pattern in France and in Germany: The qualitative element entails systematic observations of and interviews with young peo-
Escalating conflict: French police are seen here fighting street battles with students protesting against the abolition of employment protection for young workers in 2006 (top). With tensions rising as a result of the increase in the retirement age, there were violent clashes during a student demonstration in Lyon in 2010 (bottom).
people and police officers of all ranks. Meanwhile, the quantitative element that began in summer 2011 supplements these findings with an extensive and representative questionnaire-based survey of over 5,000 school students. The investigations are spread across three suburbs of differing social composition in each of two German locations: one a major city and the other a mid-sized town. Colleagues in France are carrying out a parallel study on the same basis. This will provide researchers in both countries with representative insight into – and a national comparison between – contacts between police and young people.

For several months in 2009 and 2010, Daniela Hunold accompanied police officers in two German cities as they carried out routine patrols by car and on foot. The researchers would prefer not to disclose the names of the cities, at least until the study is complete, in order to protect the police officers who took part in the study against undue prejudice. It is possible that those with connections to the police in the cities in the study might be able to identify the departments concerned and jump to the wrong conclusions based on provisional results.

FAIRNESS MEANS WITHOUT DISCRIMINATION

Daniela Hunold has a degree in geography and is a criminologist by trade. These experiences, however, were new to her. “The high degree of professionalism among the police is worth noting,” she says. “As a rule, contacts with young people are very neutral and objective. It is my impression that the police in Germany are at pains to be as transparent as possible and avoid arbitrary decisions. And they generally succeed.” Police rules define how they should approach people and, as Daniela Hunold has observed, such contacts are rarely colored by the officers’ own emotions or character traits.

It may be that the police officers were particularly correct in the presence of an observer, but the researchers have no concerns that their findings may suffer in this respect: it is unlikely that anyone would be able to play-act for the entire duration of the study. What’s more, the researchers compared their observations of the police at work with the experiences of the young people they interviewed.

It is indispensable that a modern, professional police exercise fairness in its approach to citizens – fair in this context meaning without discrimination. But is that really possible? It is, after all, the job of the police to treat criminals somewhat differently than the respectable public. But how does a police officer distinguish between them – often at a distance?

Certain forms of discrimination are scarcely avoidable. “Sometimes there really is no discrimination-free way of doing things,” says Daniela Hunold. “Even police officers need to reduce the complexity of the situation in order to act. That’s quite natural.” As she has observed, this leads to a general
tendency for the police to be more strongly guided by prejudice than the average citizen. However, this is a product, not of the character or personality of the police officer, but of the tasks that being a police officer entails: namely the need to distinguish the “good guys” from the “bad guys”, sometimes in a matter of seconds.

Nevertheless, in the German cities studied, the police were, on the whole, professional and fair in their dealings with young people. But do young people see it that way? This is the crucial point. It can happen that a young man perceives a police check to be unfair – because he believes he is being picked on for his foreign appearance. That may be true, but there may also be other reasons.

Comparing subjective and objective perceptions is one of the most important tasks of empirical sociological research. “The quality of contact between young people and the police is very much subjective by nature, and the two sides may be left with quite contrasting impressions of the same encounter,” says Dietrich Oberwittler. It is thus all the more important to approach the issue with scientific distance and empirical methods.

**ETHNIC ORIGINS PLAY VERY MINOR ROLE**

Studying the day-to-day contacts between the police and citizens is worthwhile, given that the feeling of being unfairly treated can lead young people to develop destructive attitudes. The criteria under which, for example, police checks take place “on suspicion” are therefore important. “It can’t be done entirely without cause,” says Daniela Hunold. Otherwise checks would have to be made entirely at random, which would be neither practicable nor efficient. “Generally, it is the clothes or the location that are the trigger.”

But it is not always just those concerned whose perception is incorrect. Third parties, members of the public, can be mistaken too. “Immigration on its own is often taken to be the cause of criminal behavior – which is an illusion,” Dietrich Oberwittler adds. Empirical studies prove that young people are more likely to display an above-average tendency toward criminality if they, as individuals, experience social deprivation in problem residential areas. Their ethnic origins play little if any role. Studies in the US and other countries have yielded similar results, indicating that this theory has broad validity.

But it is also already evident that the way in which police officers behave differs depending on the district in which they are working. That could have to do with the varying workload or work organization, but it could also reflect prejudice against the district and its residents. “The influence of the socio-spatial context is one of the deciding issues in understanding police work, conflict and the development of prejudices,” says Dietrich Oberwittler.

It is still too soon to draw any final conclusions from the POLIS project. Nevertheless, Dietrich Oberwittler and...
Daniela Hunold have some initial suspicions that are the subject of discussion with their French colleagues. Whereas conflicts between young people from difficult neighborhoods and the police are rare in Germany and can be categorized, at best, as the result of some “perceived injustice,” violent clashes are a regular occurrence in France.

The interaction between police and young people in France can be more emotional and more aggressive. Even if it is primarily the significantly more difficult living conditions and poorer prospects for immigrants in France that are responsible, the behavior of the French police is markedly different from that of their German counterparts.

The French researchers report that their police officers are more arbitrary and more confrontational in their dealings with young people. On the one hand, this can be explained by the higher risk to which the police are exposed. French police officers thus feel under greater pressure to exercise authority and power in order to assert themselves.

GUARDIANS – AND TROUBLESHOOTERS

It is not part of Dietrich Oberwittler’s approach to speculate about the causes of these differences. However, the fact that the French police are organized along significantly more centralized and to some extent more military lines than in Germany offers some explanation. The shorter training afforded to French police officers must also play a role. “Whereas officers in Germany will have several years of theoretical training behind them at the police college, junior officers in France often learn their duties in practice by training on the job.” This does not encourage objective, by-the-book working methods.

“In discussions with our French colleagues, it has become apparent that this strong desire, as the old German police motto goes, to be citizens’ “friend and helper” does not exist as such in France,” adds Daniela Hunold. This may be connected with the shock to society prompted by the Nazi experience. But even before 1933, there were efforts made in Germany to reform the police. Even then, there was an understanding that the police should not only react to conflict: they could and should prevent it. As long ago as the 1920s, Prussian politicians and senior police officers, such as Carl Severing and Bill Drews, began to demilitarize the police, advocating instead a modern, republican police ethos that set the tone for the whole of Germany. In 1931, a modern Police Act took effect in the Free State of Prussia that required police officers to play a preventative role and to act in the interests of citizens. After 1945, the police in the Federal Republic of Germany carried on these traditions.

More recent reforms have followed a similar path, with a higher proportion of women involved in front-line policing, an increasing emphasis on recruiting from the immigrant communities, and most recently in Berlin, for example, a duty to wear name or number badges.

A form of division of labor has developed to fulfill the dual strategy of the police to act as both guardians and troubleshooters. The police are now increasingly specialized – from SWAT teams to patrol officers to community support officers. The latter enjoy relative independence in deciding their duties and their beats, and actively seek contact with citizens, especially the young. “They often develop a very friendly attitude,” Daniela Hunold has observed. The trust thus engendered has distinct advantages. Yet there is also the risk of a loss of authority, something that can cause critical situations to escalate more quickly.

At the end of the day, conflicts between police and young people do occur in Germany, albeit far less often than in France. And when it comes to confrontation, both sides can be at fault, because there can be provoca-
tion and a lack of respect on both sides. Mistakes and cases of excessively harsh treatment do happen in Germany on a regular basis and attract close media attention. The huge police presence at the annual May Day demonstrations in Berlin and the protests against the planned new railway station in Stuttgart in fall 2010 are typical scenarios.

GREATER INTERCULTURAL SKILLS WOULD BE WELCOME

Nevertheless, Daniela Hunold has also seen how patrol officers and community officers attempt to avoid escalation on a daily basis. Taking a young person into custody is a demanding task that requires energy, time and strong nerves. “If it isn’t really necessary, officers avoid doing so.” Beyond this, however, Daniela Hunold has noted a general humanitarian interest in fair treatment.

Still, there is room for improvement. For example, it would help if the police were to develop even greater intercultural skills, to give them a better understanding of youth culture or characteristics specific to individual migrant groups. This, too, is all part of the pattern: a better understanding helps avoid conflict.

How the work of the police should change in order to avoid future confrontations is likely to be a topical question in Great Britain, too. However, in order to answer the question, it is first necessary to identify the causes of this summer’s riotous behavior. The conflicts were all the more surprising insofar as the British police do not have a reputation for being excessively harsh. “As for the background to the riots, at present, one can only speculate, and a systematic study will likely take years,” says Dietrich Oberwittler. Marked social inequality and the lack of prospects for the socially deprived probably played a role. But the behavior of the police also may have contributed: “It is known from previous studies that the police stop and search immigrants with far greater frequency.” This could partially explain ethnically tinged conflicts.

What differences research into police actions in Great Britain, Germany and France may make in practice remains to be seen. “There’s a deep gap between knowledge and reality,” Dietrich Oberwittler believes. In Germany there is some – albeit limited – interest on the part of the police. Research in the US is much further developed. Work began there as a result of the violent conflicts and systematic failures on the part of sheriffs in the 1960s; it was obvious that something had to be done. In Germany, the pressure to act was never so great – due, no doubt, to the ongoing internal attempts by the police to reform themselves, accompanied by internal police research. “On the other hand, it is an unfortunate fact that police organizational systems tend to be more sluggish when it comes to change than other administrative systems,” says Daniela Hunold.

The problem in France is far greater. There’s a lot of pressure to act, but minimal willingness to apply the results of research. In fact, the French public tends to support politicians who see a heavy-handed approach as an expression of political strength and capability. The recent rearmament of the police force and the abolition of the local neighborhood police under the then Minister of the Interior Nicolas Sarkozy are a good example of this. Why this should be the case is another question altogether.

GLOSSARY

POLIS
Abbreviation for “Police and young people in multiethnic societies.” This Franco-German research project is studying the interaction between police and young people (with an immigrant background) and their mutual perception of one another in France and Germany.

Empirical social research
A discipline distinct from theoretical social research that describes social structures and developments on the basis of qualitative and quantitative data surveys.

Socio-spatial context
A term that describes the structure of the environment in which people live, relating, for example, to individual city districts.
Statistical aging: It is not because of their healthy diets that immigrants in Germany live to be almost 15 years older than Germans, but rather because of erroneous numbers.
Suddenly Rembrandt Scholz’s gestures come alive. He leans back, rocks on his chair and plants his glasses in his curly gray hair. Laughter lines play around his eyes as he leafs through pages filled with masses of numbers in black and white. “I find looking at charts rather fun,” he says, unable to refrain from grinning slightly at himself. Especially when they have a lot to say.

And the charts lying before the researcher from the Max Planck Institute for Demographic Research in Rostock have a fair amount to say. About Berlin. About life. Which, in Zehlendorf – so say the numbers – happens to last considerably longer than in Kreuzberg. To be more precise, it lasts more than eight years longer. While a newborn in Kreuzberg could, in 1994, expect to live just 65.5 years on average, a boy born just a few kilometers further southwest had an average of almost 74 years ahead of it.

Rembrandt Scholz saw these columns of numbers for the first time in the 1990s, when he was still working at university hospital Berlin Charité. He had obtained them through the state health administration authorities – the first researcher ever to do so. The demographer actually hoped these numbers would tell him how life expectancy was influenced by socio-economic conditions: unemployment, average income, healthcare.

**CONTRADICTORY NUMBERS RAISE DOUBTS**

But quite incidentally, the numbers also told him something else. “Something had to be wrong,” says Scholz, and points to the chart that boils down the life of Kreuzberg residents to the surprisingly small figure of 65.5 years. At the same time, Scholz could see from the data that the share of foreigners living in Kreuzberg in 1994 was over 30 percent.

But the life expectancy ought to be quite high in areas where many foreigners reside. After all, according to the official data of the statistical offices of the 16 German states, migrants in Germany have a much higher life expectancy than the indigenous population. This observation is often summed up as the “healthy migrant effect.” But if that’s true, how can a neighborhood with such a high percentage of foreigners have such a low life expectancy? “It’s a contradiction.” Rembrandt Scholz’s eyes light up. He likes these moments, “when you find something that didn’t exist before.” A trail, a lead, a contradiction. “Of course it’s exciting to catch such a break,” he says. Since this discovery, the researcher has diligently chipped away at the crack. He has managed to at least partially uncover the secret of the long-lived migrants.

Today, a migrant in Germany who is 65 years old has, on average, a good two-thirds of his life behind him. After all, he can expect to live another 30 years, reaching an age that exceeds even the current record held by Japanese women. A German of the same age, in contrast, has, on average, just half that long left to live, namely exactly 15.6 years. At least that is what the calculations yield when the numbers of the regional statistical offices...
The traditional way of life and the supporting role of the family are considered to be key factors for a longer life.

In conflict with this, however, is the fact that migrants have many disadvantages, such as, frequently, lower income and poorer education opportunities. For these reasons, also a very different explanation for the high life expectancy of migrants is offered: the salmon error. Actually, to be scientifically accurate, it is called the “salmon bias,” and refers to a known, generally human phenomenon: “In older persons, there is apparently a deep-seated desire to see one’s homeland again,” explains Rembrandt Scholz. Like salmon that repeatedly swim upstream to lay their eggs in the place where they were born, migrants, too, are drawn back to their birthplace – often when they are old and sick.

Such a connection has already been proven for Mexican and Latin American migrants in the US. There, studies are used. Neatly and scientifically determined from the number of living and dead. Readily reviewable and verifiable by all.

Science has four different explanations for this great difference between native and immigrant populations, which can also be observed in many other migration countries. The first cites the healthy migrant effect. According to this theory, it is primarily healthy, fit, resilient people who immigrate, since those who are ill wouldn’t be able to overcome the hurdles of an unfamiliar environment and language.

Immigration laws amplify this effect. A German-Italian agreement from 1956, for example, stipulated that labor migrants (Gastarbeiter) from Italy had to pass a health test before they could immigrate. Those who didn’t pass it weren’t allowed to come to Germany. Since this resulted in only healthy people immigrating, also the life expectancy of the immigrants was higher than that of the native population, went the explanation.

OLDER PEOPLE OFTEN RETURN TO THEIR BIRTHPLACE

The second theory is also based on the health of the migrants. It assumes that, thanks to their culture, many migrants have a healthier lifestyle than the citizens of western industrialized nations and immigration countries. Studies in the US show, for instance, that Latin Americans there drink less alcohol than Americans. And for migrants in Germany, the traditional way of life and the supporting role of the family were identified as key factors for a longer life.

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showed that immigrants who returned to their homeland were in poorer health than migrants who stayed in the US. Since the ill or very old immigrants emigrate back, the average life expectancy of those who stay in their new country increases.

**STATISTICS IS THE IDEAL PLACE FOR ETERNAL LIFE**

It could also be a similar situation in Germany, says Scholz. He suspects there is even more behind the salmon error: “It often happens that older people who want to visit their native country for just a short time actually also die there.” This fact doesn’t always make it into the German registration statistics. Instead, the migrant lives there for quite a while longer and possibly reaches extreme old age before any administrative institution notices that a person included in the statistics is no longer there.

This brings Rembrandt Scholz to the fourth and final explanation, and the one that he finds most plausible: that migrants in Germany don’t, in fact, live to an older age than the indigenous population. The incredibly high life expectancy calculated for migrants is due, very simply, to data errors. Not a mystery, but a myth.

The data from Berlin would then simply be less error-ridden, more up to date and more precise than the data for Germany as a whole. But how did the myth of the long-lived migrant – the errors in the nationwide data – come about? Demographers can and must live and deal with the fact that official statistics always entail a certain error rate. But errors that add up to a life expectancy at least 15 years higher than it actually is?

Rembrandt Scholz believes this is certainly possible, as the reported figures can be correct only if citizens report them truthfully. For many migrants, however, there are good reasons to keep quiet about certain things. “Immigrants who are not from the EU lose 30 percent of their pension entitlements if they return to their native country,” says Scholz, naming one example. Many immigrants thus don’t report their departure when they leave Germany, and in this way they can, theoretically, live for eternity – at least according to German statistics. The situation is similar for migrants who do actually go back to their native country for a specific period, but who don’t report their departure for fear of losing their right to naturalization.

Last but not least, there is also the simple issue of names. German often has widely varying spellings for foreign names. It can thus easily happen that a person ends up with two or three names, and therefore also identities, in the civil register. Then, when this person dies, his further identities live on in the registers indefinitely. These are the so-called dead files – a nuisance, as persistent as it is unpleasant, that accompanies demographers everywhere and at all times. These dead files are particularly numerous in the data on older people because, here, more and more errors accumulate over time. “Such dead files,” says Rembrandt Scholz, “can also live on indefinitely.”

**LAW HINDERS DETECTION OF ERRORS**

But it isn’t the fault of the official statisticians that it is so difficult to remove them from the statistics, says the demographer. They can’t and, in fact, aren’t allowed to correct individual cases – this is stipulated by law in Germany. Specifically, the official statistics fundamentally cover only anonymized data; only case numbers are known, no names.

Only the civil register and registrar’s offices handle personal details – that is, municipal administration in townships and city districts that are not yet covered by official statistics. The latter start only with the statistics offices at the regional or city level, which are separate from the administrative process and to which the registers and registrar’s offices submit their data only in anonymized and cumulative form. There is no chance of it being traced back to an individual case. Changes to the register are forbidden.
by law even when errors and inconsistencies in the totals of the official statistics can be proven through mathematical methods.

**REVISION REVEALS MORE THAN 500,000 DEAD FILES**

This system is intended to protect data and make the official statistics independent. The other side of the coin is that errors in the official statistics data are compounded: once when regional statistical offices total the anonymous data from their cities and regions, and once again when the Federal Statistical Office adds up the columns of all the states. The figures for each classification level are kept up to date only by what is known as continuation: the cumulative changes in the figures – positive or negative, depending on the development – are simply added to the last count. In this way, once errors enter into the system, they stay in the system forever.

It was thus a great stroke of luck that Rembrandt Scholz was allowed to revise the Central Register of Foreigners (Ausländerzentralregister, abbreviated AZR). From 2000 to 2003, proprietary data was compared with that of the regional registrar’s offices, the welfare offices and other authorities. This is possible in the AZR because it doesn’t fall under the strict data protection of the same laws as the official statistics. Merely identifying duplicate persons uncovered more than half a million dead files, relates Scholz.

He was given access to all AZR details on gender, age, nationality, and entry and departure dates of those registered. This data was, of course, completely anonymized, as is always the case when science conducts research on official numbers. However, Scholz received not one, but two sets of data: one from the status before the revision and one from the status afterwards – a unique insight into the sources of errors in these statistics. “And I thought to myself: Now I have something, so I have to put it to use,” he says. And put it to use he did.

Whereas the life expectancy for foreigners that Scholz had calculated based on the official statistics was 96.5 years for men, the data from the Central Register of Foreigners (AZR) yielded a very different number: 80.8 years. This is still more than German men at the same point in time (2004) could expect from life. But a difference of 4.6 years is considerably smaller.

**CALCULATED MORTALITY DATA PROBABLY TOO HIGH**

Because such errors were never cleansed from the official statistics, the AZR data is much more accurate. It shows, according to Scholz, how much the official statistics data differs from reality. But the calculated life expectancy for the migrants is probably still too high in the Central Register of Foreigners data, thinks the demographer. After all, not all of the authorities participated equally in the data revision.

Another study indicates, in contrast, that the life expectancy of migrants could even be lower than that of the native population. Together with his colleague Eva Kibele from the Max Planck Institute for Demographic Research, Scholz also analyzed data from the Federal German Statutory Pension Scheme (Deutsche Rentenversicherung Bund, DRV). Although this data doesn’t include all foreigners, as not all of them are eligible to receive a pension, the
Statistics. However, this does not apply to the approximately 130,000 migrants without German citizenship who were included in the pension data. Not only are there 33 percent fewer foreigners included in this data, but there are also 33 percent more deaths than in the official statistics. Using this data as the basis, the life expectancy of 65-year-old foreigners is no longer an additional 30 years, but just half that, or exactly 15 years. This would mean that foreigners have even a somewhat shorter remaining lifetime than German 65-year-olds (15.6 years).

“We always act as if we know everything, but the statistics could be so much better,” says Scholz, glancing at the very different results. Other countries also have the same difficulties that Germany has collecting data on migrants. In fact, the Germans are very thorough in comparison, as Rembrandt Scholz knows. But the demographer feels that the many different civil registers in Germany are problematic – there are nearly 13,000. Many municipal units have their own civil register, and often also their own software. “I don’t even want to know how many errors happen there,” says Scholz, who advocates a central register.

Moreover, particularly the townships often have no great interest in the data that is recorded is very precise. This is because not only statistics are concerned, but also money. Those who die stop receiving a pension, so this is closely monitored – for instance with the aid of so-called life certificates. Those who live outside of Germany and collect a pension must submit this officially certified document to the DRV once a year. Only when this document confirms that the “pension recipient is alive” do the pension payments continue to that account.

MANY CIVIL REGISTERS FALSIFY COLLECTED DATA

For the German population, the DRV’s mortality and population figures are very similar to those in the official statistics. However, this does not apply to the approximately 130,000 migrants without German citizenship who were included in the pension data. Not only are there 33 percent fewer foreigners included in this data, but there are also 33 percent more deaths than in the official statistics. Using this data as the basis, the life expectancy of 65-year-old foreigners is no longer an additional 30 years, but just half that, or exactly 15 years. This would mean that foreigners have even a somewhat shorter remaining lifetime than German 65-year-olds (15.6 years).

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keeping their civil registers up to date, at least when it comes to departure notices, as dead files mean money for the municipalities. Often even for the mayor, whose pay grade, says Scholz, just as financial transfers to the municipality, increases in step with the population.

“There are mayors who have issued instructions that no departure notices are to be effected by their offices.” But that is precisely what is supposed to happen when a registration office determines that someone who is included in the statistics is no longer present.

“WE ARE RESPONSIBLE FOR THOSE WHO COME TO US”

There could be a bit of a drop in the number of dead files after the current census is completed. And, as a result, a correction in the population figures for one mayor or another. “I’m already looking forward to doing the recalculations,” says Rembrandt Scholz. But it is questionable whether this year’s census will help to finally and conclusively resolve the mystery of the long-lived migrants. The last census, in 1987, did provide better data. In retrospect, however, and compared with the data from the Central Register of Foreigners and the German pension insurance, Scholz thinks the life expectancy ascertained back then, which was a good five years above that of the native population, is still too high. “Registers always tend to accumulate too many registrations, and thus to keep alive and present in the official books people who have died or moved away,” he explains.

Numbers tell many stories, but they can also deceive. “We always have only the final result,” says Scholz. “And we think back from the result.” Stumbling upon dead files and having to track down data errors and statistical artifacts that are beyond realistic spurs the demographer on. “You have to really be passionate about this work,” he says. Or to put it somewhat differently: “You have to concentrate and fight your way through the data jungle until it clears.”

In the case of the high life expectancy of migrants, much is still in the dark, believes Scholz. He suspects that something like the effect of the healthy migrant does, in fact, exist, but that it is offset by other aspects, such as the poorer social and economic standing. “Foreigners are probably rather disadvantaged in terms of life expectancy,” concludes the demographer, “because their socio-economic disadvantage impacts them for a longer period than the rather short-term effect of having been healthy at the time of immigration.” He hopes that, in the coming years, it will become possible to determine the life expectancy of migrants more accurately, and also to break it down by nationality. “After all,” says Scholz, “we are responsible for those who come to us.”

GLOSSARY

Federal Statistical Office
Provides the realms of politics and business, but also the general public, with statistics on such diverse topics as population development, imports and exports, and energy supply.

Healthy migrant effect
One possible explanation for why the life expectancy of immigrants is higher, according to official statistics, than that of the native population. According to this theory, this is due to the fact that only healthy people emigrate, because only they are capable of building a new life in a foreign country.

Central Register of Foreigners
Administered by the Federal Office for Migration and Refugees and comprises more than 23 million records of all foreigners who hold a residence permit, that gives them the right to reside in Germany for a limited or unlimited time, and of all people who have applied for or been granted asylum.
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Songbirds with a Casanova Gene

Females inherit an “infidelity gene” from their fathers

Many birds are considered to be monogamous. In actual fact, however, in numerous pairs, one of the partners is unfaithful. This behavior has obvious benefits for the male, as it allows him to increase the number of offspring he produces, but it is somewhat less advantageous for females. Scientists at the Max Planck Institute for Ornithology in Seewiesen have now found a surprising explanation for why female zebra finches nevertheless actively seek other males: it appears that they inherit their willingness to play away from home from their fathers; there is no reason why infidelity should pay dividends for them. It is sufficient for the male parent to benefit from their promiscuity. This “Casanova gene” thus spreads among a population as long as the benefit to the male gene carriers is greater than the cost to the females. (PNAS, June 13, 2011)

Gently Restarting the Heart

Atrial fibrillation is better treated with several weak shocks than with one strong one

It may soon be possible to treat cardiac arrhythmias gently and painlessly. A team of researchers working with scientists from the Max Planck Institute for Dynamics and Self-Organization in Göttingen and from Cornell University in Ithaca in the US has used several weak shocks rather than one very strong one to halt atrial fibrillation in an animal model. Cardiac fibrillation results when electrical signals from the body propagate in chaotic waves and disrupt the regular heartbeat. The strong pulse of a defibrillator interrupts the chaotic waves with one shock and restarts the heartbeat – much like briefly switching a computer off and then on again. The weak shocks stop the chaotic waves in several steps and use 84 percent less energy. This method is therefore not as painful as the one that is currently in regular use, which is usually applied under general anesthesia. (NATURE, July 14, 2011)
Expensive, difficult to control and, until now, little understood: turbulence impedes the transport of oil and gas through pipelines. Researchers working with Björn Hof at the Max Planck Institute for Dynamics and Self-Organization in Göttingen determined the flow speed at which turbulence develops in liquids and gases as they surge through a pipe. They examined small eddies that either died away or split or acted as starting points for greater turbulence. The researchers determined, for liquids, the speed at which more eddies were created than disappear, thus finding the critical point for turbulence. A better understanding of turbulence could help in developing techniques with which it can be eliminated without a great deal of energy. (Nature Physics, June 5, 2011)
Sharing Is Child’s Play

Even three-years-olds give toys to another child if they were jointly earned.

Children sometimes seem to be very selfish at first glance: if they are given a reward without having earned it for any obvious reason, they rarely share it with others. According to scientists at the Max Planck Institute, this behavior changes if children have earned the reward jointly. In the study, children of ages two to three years were asked to pull together on a rope to bring a board with marbles closer to them. In this situation, they shared the property they acquired. However, when a child obtained the marbles on its own, it didn’t hand over any of them. This would seem to indicate that it is typical human behavior to share the proceeds of joint efforts. After all, our closest relatives, chimpanzees, are rarely generous – even if they worked together to acquire something. (Nature, July 20, 2011)

Even small children know who has earned a reward.

Cosmic Collisions Forge Gold

Researchers identify neutron stars as factories for heavy elements.

It seems that the location at which the heaviest chemical elements, such as lead and gold, are formed has been found: the violent collisions of merging neutron stars make ideal production sites. Using detailed numerical simulations, scientists at the Max Planck Institute for Astrophysics, working with Thomas Janka from the Excellence Cluster Universe and the Free University of Brussels have confirmed that this is where the relevant nuclear reactions take place. Elements heavier than iron are formed when uncharged neutrons are captured on moderately heavy seed nuclei in the r-process (r for rapid). The calculations show how tidal and pressure forces eject several Jupiter-masses of extremely hot material within a few thousandths of a second of the neutron stars’ merging. As this plasma cools to temperatures below 10 billion degrees, various nuclear reactions are set off, including the r-process. (The Astrophysical Journal, September 10, 2011)
Volcanoes as Rapid Recycling Plants

Oceanic crust reappears on the surface just 500 million years after sinking away

Geo-recycling in volcanoes is a much faster process than scientists previously assumed. Rock from the Earth's mantle that falls into the interior of the Earth from the ocean floor as a result of tectonic movement is returned to the surface via volcanoes after around just 500 million years – not, as previously assumed, after 2 billion years. Researchers from the Max Planck Institute for Chemistry in Mainz determined this using volcanic rock samples from Hawaii, analyzing the strontium isotope ratio in the remains of seawater inclusions in basalt. As the isotope ratio depends on when the water entered the rock, it is also possible to determine the age of the basalt. (Nature, August 10, 2011)

Origami on a Seed Capsule

Ice plants have a clever opening mechanism to ensure that their seeds germinate

Some plants have an almost artistic method of seed dispersal: The seed capsules of the ice plant Delosperma nakurensese, for example, unfold the lids of their seed capsules like a moveable piece of origami as soon as they are moistened by rain. Matt Harrington and his colleagues at the Max Planck Institute of Colloids and Interfaces in Potsdam discovered this in a detailed examination of the opening mechanism. The lids open because honeycomb-shaped cells on their interior absorb water and change their structure. When they dry, the lids close again and curve inward so that the seed chambers are tightly covered and can't open accidentally. In this way, the plant improves the chances that its seed will germinate in very dry areas. Taking this as their model, the researchers now want to develop materials that move when they become wet or when their temperature changes. (Nature Communications, June 7, 2011)

The seed capsules of the ice plant, D. nakurensese, open at the right time. During dry periods, five lids close the capsule (left). As soon as it rains, the five lids on the capsule open (center). They are pushed open by tissue that swells as it becomes saturated with water (right).
Nitrogen from the Soil Mixes with the Air

The impact of soil nitrogen on the atmosphere can vary widely, as two current studies show. It is suspected that nitrogen fertilizers are increasing the greenhouse effect in this way. Although fertilized soil speeds up the growth of plants, allowing terrestrial ecosystems to absorb more carbon dioxide from the atmosphere, it simultaneously releases more nitrous oxide—a much more significant greenhouse gas than carbon dioxide. Calculations done by a team of researchers working with Sönke Zehle at the Max Planck Institute for Biogeochemistry reveal that the damage caused by the addition of nitrogen slightly exceeds the benefits. Nitrogen fertilizers do, however, also have a positive effect on the atmosphere. Ulrich Pöschl and his colleagues at the Max Planck Institute for Chemistry have found that it strengthens the atmosphere’s ability to purify itself. Their study has shown that nitrous oxide is released from fertilized arable land and enters the atmosphere—the more acid the soil, the more nitrous oxide is released. In the air, it causes hydroxyl radicals to form, which oxidize pollutants, allowing them to be washed out. (Nature Geoscience, July 31, 2011)

Voice Cells Know Who’s Talking

A human’s voice is as characteristic as his or her face. There are probably even nerve cells in our brains that specialize in recognizing voices. In the brains of rhesus monkeys, researchers at the Max Planck Institute for Biological Cybernetics in Tübingen found neurons that are activated only by calls and sounds made by members of their species. These “voice” cells are in the temporal lobes of the cerebral cortex and respond twice as strongly to voices of members of the same species as they do to voices of other animals or other sounds. Like humans, rhesus monkeys have cells for recognizing faces in addition to voice cells. However, voice cells can distinguish more accurately between individual voices than face cells can between individual faces—possibly because there is more similarity between faces than voices. The researchers suspect that humans also have specialized nerve cells for recognizing voices. This is also indicated by the phenomenon of phonagnosia, an impairment suffered by humans who cannot identify familiar voices. (Current Biology, August 23, 2011)
Vesta Has Two Faces

The first high-resolution images of the asteroid hint at an exciting past

Vesta is a piece of cosmic luck: A small planet with a diameter of approximately 530 kilometers, it moves round the Sun in the asteroid belt on the far side of Mars’ orbit, and is believed to be one of the few elements remaining from the birth of the planetary system, which took place around 4.5 billion years ago. Scientists from the Max Planck Institute for Solar System Research had thus been waiting impatiently for results from their camera on the Dawn space probe. They saw the first images at the end of July – and were immediately surprised: Vesta seems to be divided in two. The northern hemisphere exhibits many craters; the southern hemisphere, in contrast, shows far fewer. The number of craters on the surface of a planet is used to gauge its age. The older a surface is, the longer it has been exposed to the bombardment of cosmic fragments. The images show that many processes have shaped the surface of Vesta over time.

The Diamond Planet

A star that changes into a planet made of diamonds? Although this sounds like science fiction, it appears to be reality. The discovery was made by an international team that included Michael Kramer from the Max Planck Institute for Radio Astronomy in Bonn. The diamond planet orbits an unusual star of extremely high density, a pulsar. This is a rapidly rotating neutron star, approximately the size of a city such as Cologne, that transmits a densely bundled beam of radio waves. Astronomers noticed regular modulation in the times the signals arrived from this recently discovered pulsar, PSR J1719-1438. This “interference” appears to be caused by the gravity exerted by a companion with low mass. The type of modulation revealed some information to the researchers about the small heavenly body: it is approximately half as big as Jupiter, with a diameter of just 60,000 kilometers. It orbits the pulsar in 2 hours and 10 minutes at a distance of 60,000 kilometers. And it should have been torn apart by gravity a long time ago – unless it is as dense as diamond. (Science, August 26, 2011)

Live Fast, Die Young

Young men are becoming sexually mature at an increasingly earlier age

For young men, the risk of dying soars during puberty, when they are producing the most testosterone. This is because they take particularly big risks at this stage of their lives and often die in accidents. Scientists at the Max Planck Institute for Demographic Research in Rostock used this phenomenon to help them determine the age at which young men have become sexually mature over the last 150 years. Their research showed that, since the mid-18th century, sexual maturity in boys has occurred around two and a half months earlier per decade. This means that an 18-year-old today is as physically developed as a 22-year-old in 1800. The reason appears to be improvements in health. This may also show that the same applies to boys as was already known for girls: the period in which young people are sexually mature, but are not considered adults in social terms, is becoming longer. (PLOS, August 16, 2011)
The Turbulent Birth of Stars and Planets

Exoplanets – planets that orbit stars other than the Sun – used to be a matter of science fiction. Some 15 years ago, with the first detection of an exoplanet, they became a matter of observational astronomy. Since then, exoplanet observations have provided astronomers with intriguing clues as to the formation of stars and planets. This is invaluable information for researchers interested in planetary and star formation, such as the team led by Thomas Henning, Director at the Max Planck Institute for Astronomy in Heidelberg.
The birth of planets and stars begins with clouds of gas and dust measuring many light-years in size. Such clouds can be found throughout our galactic home, the Milky Way, and for billions of years, they have acted as cosmic nurseries. In broad terms, what happens next has been known for decades: when a suitably large part of such a cloud exceeds a certain density, it begins to contract under its own gravity. Typically, such a region will not be perfectly motionless; instead, it is likely to rotate, if only ever so slightly. That is why, once contraction starts, there are two significant physical effects: contraction will reduce the cloud’s overall size. But at the same time, the rotation becomes faster and faster, due to what physicists call the conservation of angular momentum – think of a figure skater who pulls her arms close to her body in order to execute a pirouette. As the speed of rotation increases, the interplay between gravity and the centrifugal force pulls the collapsing cloud into the shape of a disk.

THE BIRTH FOLLOWS A PREDEFINED CHOREOGRAPHY

In the center of this protoplanetary disk, the gas reaches sufficient density and temperature for nuclear fusion to commence: a star is born. In the outer regions, gas and dust continues to swirl, with dust particles repeatedly colliding and sticking together, forming objects of rock-like consistency that grow continually in size. When these objects have reached a few kilometers in size, gravity takes over and ensures ever further growth as objects attract each other and coalesce. This is how planets, such as our own Earth, come into being.

This general picture of planet formation has been around for a number of years. But the devil is in the details, and there is as yet no physical model that can explain planet formation from beginning to end. In their search for
The Spitzer Space Telescope, one of NASA’s Great Observatories, was launched in 2003 and has been trailing the Earth in its orbit around the Sun ever since. Spitzer is an infrared telescope, sensitive for radiation that is typically associated with warm objects. Just as Spitzer ran out of the coolant it needs for proper operation, in May 2009, its European successor Herschel was launched. With a mirror measuring 3.5 meters in diameter, Herschel is the largest space telescope yet, and just like Spitzer, it specializes in collecting and analyzing the infrared radiation emitted by objects such as planets and nebulae.

The Max Planck Institute for Astronomy played a significant role in the construction of one of the three Herschel instruments, the far-infrared camera PACS – building on a long history of expertise in infrared astronomy, which also features key contributions to Herschel’s predecessor, the ISO satellite. Incidentally, this expertise also gained the Heidelberg group generous access to Spitzer observational data, which is quite unusual for a European research group and a strictly American project. “We were involved in a key program for the observation of protoplanetary disks, for which we carried out practically the entire analysis of the spectroscopic data,” says Henning.

WITH INFRARED RADIATION INTO THE HEART OF DARKNESS

When Herschel began its operations, Henning and his colleagues found an ideal opportunity to build on their earlier Spitzer observations in the framework of the Herschel program “Early phases of star formation.” The astronomers set their sights on a cloud of gas and dust with the name G011.11-0.12, an unusual phenomenon that has been difficult to observe due to its deep darkness. By using the Herschel Space Telescope, they were able to observe the infrared radiation emitted by the cloud, which helped them to understand the early stages of star formation.

A portrait of two generations: Older stars in the central region of the object RCW 34, at a distance of 8,000 light-years from Earth, and younger stars (white-edged box near the top). False-color image based on infrared data taken with the Spitzer Space Telescope.

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or G011 for short. Previous observations had shown that G011 contains a number of newly born stars, making it an ideal target for studying the early phases of star formation.

An ideal target, that is, for observations in the infrared: In visible light, clouds like this are completely opaque, showing up as solid black against a starry background. Infrared radiation, on the other hand, can penetrate gas and dust. What you see of such a cloud depends heavily on the wavelength.

Following a fundamental law of physics, all bodies emit thermal radiation, and at temperatures between absolute zero (0 Kelvin, which corresponds to minus 273 degrees Celsius) and about room temperature, most of this radiation is emitted at infrared wavelengths. Henning and his colleagues made use of this principle when observing G011. *Spitzer* had already provided some images at relatively short wavelengths: at 8 micrometers, the cloud still appears dark, but in observing at successively longer wavelengths, the astronomers could peer ever more deeply into the cloud. The unique images obtained with *Herschel* at wavelengths between 70 and 350 micrometers revealed, hidden deep in the interior, 24 regions of increased density, so-called pre- or protostellar cores.

The temperatures of these cores, as derived from the infrared data, varied between 16 and 26 Kelvin, only slightly warmer than their environment, at 12 Kelvin. The masses of these cores ranged from 1 to 240 solar masses. Apparently, within the next million or so years, the cloud will transform into a star cluster, teeming with stars of various masses. “We can study in great detail the physical conditions at the very beginning of gravitational collapse,” says Thomas Henning.

20 YOUNG STARS IN A HOT GAS BUBBLE

Another interesting finding is that star formation proceeds in a very economical manner. Only around 10 percent of the available gas mass is turned into stars, leaving plenty of raw material for the formation of subsequent generations of stars.

While, in G011, a few regions have already taken the first steps toward collapsing under their own gravity, the question remains whether such a collapse will happen spontaneously or requires some external trigger.

As to the possible nature of such an external trigger, consider the star forma-
10,000 years
100,000 years
1 million years
10 million years
100 million years

Since interstellar gas clouds can span up to several light-years, different regions within those clouds will move at different speeds, leading to turbulent flows of gas and dust. Using spectroscopy, the astronomers were able to determine the age of the stars and stars-to-be in RCW 34. Surprisingly, there is a systematic trend, with objects inside the bubble being a few million years older than those at the edge. The researchers hypothesize that stars of the first generation in this nebula pushed matter outward, triggering the formation of a second generation of stars near the edge of the cloud.

**PROTOTESTELLAR DONUTS**

Are such external influences – candidates include not only young stars, but also expanding clouds of matter resulting from so-called supernova explosions, in which more massive stars end their lives – necessary in order for new stars to form? Thomas Henning is convinced that external triggers play a supporting role at best: “Turbulence in the clouds is perfectly sufficient to cause affected regions to contract and achieve critical density.” But how does this turbulence come about?

Stars and nebula in our cosmic neighborhood orbit the center of our home galaxy, the Milky Way, with objects closer to the center moving faster than their more distant cousins. Since interstellar gas clouds can span up to several light-years, different regions within those clouds will move at different speeds, leading to turbulent flows of gas and dust.

In fewer than one million years, the protostellar cores of G011 will have condensed sufficiently for protostellar disks to form around nascent stars. These disks are the birthplaces of planets. Many other young stars in the galaxy have already reached this stage, and have been rewarding targets for observation.

In many cases, the existence of these disks can be deduced only indirectly from characteristic infrared radiation emitted by their constituent dust particles. Since the disks are heated by the central object, the temperature of the disk’s inner regions is significantly higher than at the outer rim. By the fundamental laws of thermal radiation, this means that infrared radiation from the interior region will be emitted mostly at shorter wavelengths than is the case for the outer zones. In cases where emission at shorter infrared wavelengths was missing, astronomers concluded that the disks in question must feature a large central hole.

Direct evidence for this model was, however, lacking – at least until last year, when an international research group headed by Christian Thalmann and Johan Olofsson from the Max Planck Institute for Astronomy finally succeeded in producing a direct image of such a disk. Thalmann and his colleagues utilized a special camera on the Japanese *Subaru* telescope in Hawaii to observe the young star LkCa 15. The image showed a disk with a large central gap. In fact, the gap is so large that it could quite comfortably accommodate the orbits of all the planets in our own solar system.

A second set of observations with *Subaru*, again involving the Heidelberg astronomers, led to the discovery of a smaller type of disk. The disk around the star AB Aurigae, at a distance of 470 light-years from Earth, is about the size of our solar system. It consists of nested rings that are arranged somewhat asymmetrically around the star.

Another discovery, again by Max Planck researcher Olofsson and colleagues, involves the young star T Chamaeleontis (T Cha), at a distance of 330 light-years from Earth. Using the *Very Large Telescope* of the European Southern Observatory (ESO) in Chile, the astronomers found that a portion of the disk material has formed a thin dust ring at a distance of just 20 million kilometers from the star –
about one-third the orbital radius of Mercury, the planet closest to our Sun. Behind this ring extends a wide, dust-free region, up to about 1.1 billion kilometers from the star. That is where the outer part of the disk begins.

CLOSE TO THE LIMITS OF OBSERVATION

Even before these direct sightings of donut-shaped disks, astronomers had discussed the possible causes for the formation of such gaps. One possibility involves the central star’s radiation causing the dust particles to evaporate: Alternatively, a nearby (and as yet undiscovered) star could have swept up the dust. The most likely option, however, is that a planet has formed around the star, sweeping up gas and dust and, in the end, incorporating whatever material it has attracted.

“That, of course, is the most interesting possibility,” says Thomas Henning.

Early this year, an international team actually found evidence for this latter scenario. Near the outer edge of the large gap in the disk around T Chamaeleontis, they found what could be an orbiting body. It is located about a billion kilometers away from its central star, a distance comparable to that between Jupiter and the Sun. But these observations are at the limits of what is technically feasible for the astronomers. They were thus unable to determine beyond all doubt exactly what this object is. It may be a newly formed planet.

That planets grow in protoplanetary disks is, by now, an undisputed fact. In the case of some older stars, scientists have managed to observe a few exoplanets directly. In a few cases, it was even possible to detect substances such as water, sodium, methane and carbon dioxide in their atmospheres. But they have not yet succeeded in pinning down the evolutionary link – a young planet inside the disk that served as its birthplace.

Until recently, the astronomers had observed only the dust component of protoplanetary disks. But this accounts for only about a hundredth of the total mass. Most of the disk mass is in the form of gas, which is very difficult to observe, since the radiation emitted by the atoms and molecules is so extraordinarily weak.

Yet the gas plays a major role in the development of the overall disk and in the formation of planets. For instance, it exerts friction on the tiny dust particles, slowing them down at different rates depending on particle size. The resulting different speeds of the particles increase the likelihood of collisions, thus accelerating the growth of the particles.
At the Max Planck Institute in Heidelberg, astronomers and engineers are also involved in developing and constructing new instruments, including adaptive optics systems that can mitigate the effects of atmospheric turbulence, resulting in ground-based images of unparalleled sharpness. Adaptive optics plays a key role in the search for extrasolar planets.

Furthermore, gas is the key ingredient of giant planets, such as Jupiter and Saturn, which gather significant amounts of gas when forming their enormous atmospheres. For these reasons, astronomers are very interested in learning the typical lifetimes of such gaseous disks. The result would impose a strong constraint on the timescale of planet formation.

The astronomers in Heidelberg dug deep into their bag of observational tricks to address this question. In several star clusters with members aged between about 1 million and 20 million years, they determined the dust and gas quantities in the disks. What they found was surprising: the amounts of gas and dust decreased almost exactly in parallel, and rather quickly at that: disk matter largely disappeared with, at most, 10 million years. “That puts very strict limits on the timescale of planet formation,” explains Henning. And, as all these statements should apply equally to the formation of our own solar system, it imposes strict limits on the timescale of our own planetary origins, as well.

150 TYPES OF MOLECULES IN INTERSTELLAR CLOUDS

Last but not least, there is an aspect of the analysis of the gaseous components of disks that has a direct bearing on questions about the origins of life on Earth and elsewhere. In large interstellar clouds, astronomers have thus far found around 150 types of molecules, including complex organic substances. Not so in the protoplanetary disks, where, so far, no such chemical compounds have been observed. This leaves highly interesting questions unanswered: Can the complex precursor molecules of life survive the early phases of planet formation? Are they present in the circumstellar disks, and can they possibly make it to the surfaces of the young planets unharmed?

Detecting the more complex building blocks of life lies beyond the capabilities of today’s telescopes. However, using some sensitive radio telescopes, as well as Spitzer and Herschel, the researchers at the Max Planck Institute for Astronomy have at least been able to take some baby steps toward that goal: they managed to observe simple molecules such as carbon monoxide and water in protoplanetary disks. Now they are putting their hope in the next generation of telescopes, notably the Atacama Large Millimeter Array (ALMA). ALMA is a compound telescope consisting of nearly 70 separate radio telescopes that can be moved into different positions. ALMA is currently under construction in Chile and will gradually be put into operation in the coming years.

Hubble’s successor, the James Webb Space Telescope, promises another shift in cosmic perspective. The Heidelberg-based Max Planck researchers are involved in this project, too, developing key components of the MIRI instrument, which will work in the medium infrared range – and is expected to be good for more than one observational surprise.

GLOSSARY

Galaxy
The collection of billions and billions of stars to which our own planetary system belongs. The Milky Way Galaxy (from the Greek word galaxi for milk) consists of 150 to 200 billion suns, as well as interstellar gas and dust clouds. It features several spiral arms and, if viewed from the top, would look like a disk with a diameter of about 100,000 light-years. Viewed from the side, the disk is only about 1,000 light-years thick. At the heart of the Milky Way sits a gigantic black hole. The central bulge is surrounded by a spherical region (the so-called halo) that contains 150 globular clusters.

Very Large Telescope (VLT)
An array of four telescopes, each with a main mirror measuring 8 meters in diameter, complemented by several auxiliary telescopes. The VLT is designed for observations in visible light up to the mid-infrared. Light collected by these telescopes can be combined, in effect creating a single virtual telescope with ultra-high resolution – the Very Large Telescope Interferometer (VLTI). The observatory is situated atop the 2,635-meter-high Cerro Paranal in the Chilean Andes, and is operated by the European Southern Observatory (ESO).

Protostellar cores
Stars form inside interstellar clouds of gas and dust that collapse under their own gravity. Ultimately, a concentration of mass known as a protostellar core develops, which attracts additional matter and contracts ever further, transforming gravitational energy into heat. The result is a protostar that emits infrared radiation. Around such a protostar, matter will typically contract to form what is known as a protoplanetary disk: the birthplace of future planets.

James Webb Space Telescope
The James Webb Space Telescope (JWST) is the intended successor to the Hubble Space Telescope. With its 6.5-meter-mirror, it is set to peer much deeper into space than its predecessor, receiving infrared light from planetary systems-in-the-making, as well as the most distant galaxies. However, due to financial reasons, the project was recently put on hold by the American space agency, NASA. It is questionable whether the JWST can start as planned in 2018.
Congratulations to the Max Planck Foundation on five years of outstanding work!

5 years in which the Foundation
... has built up an endowment capital of more than 350 million euros
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Max Planck Society
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Prof. Peter Gruss, President
Nearly a quarter of all known illnesses are extremely rare and affect just a few thousand patients worldwide. Stefan Mundlos, a research group leader at the Max Planck Institute for Molecular Genetics, and his team specialize in the study of rare bone diseases. They are looking for the genes that trigger these disorders.
The much vaunted “decoding” of the human genome is something Stefan Mundlos dismisses as a rumor. “Sequenced – yes,” he says. “But decoded? We are nowhere near understanding the jumble of text.” The “jumble of text” he refers to is the sequence of three billion chemical building blocks in DNA, the hereditary molecule and human genetic substance. In it are hidden approximately 30,000 genes that contain the instruction manual for our body’s proteins and that control every second of its growth and metabolic processes, usually via biochemical signaling pathways.

The doctor from the Max Planck Institute for Molecular Genetics and Head of the Institute for Medical Genetics and Human Genetics at the Charité Universitätsmedizin hospital in Berlin goes on to speak about the “enormous opportunity” finally being used by genetic researchers to understand what actually goes on in our genome. This could enable us to detect the existence of diseases that, unlike cancer and diabetes, are actually determined by just a single genetic defect.

RARE INDIVIDUALLY BUT COMMON AS A GROUP

Stefan Mundlos and his colleagues from the “Development and Disease” research group focus their scientific ambition on diseases that are completely unknown to the majority of people. They are extremely rare and yet, together, they affect an estimated four to six million people in Germany alone, often from birth.

According to the European Union definition, a disease is rare if it affects fewer than one in 2,000 people. The World Health Organization (WHO) assumes that, of the 30,000 known diseases, between 6,000 and 8,000 fall into
this category. According to research carried out by the Network for Rare Diseases, five new ones are described every week in the specialist medical literature.

Rare diseases take very different forms, but are usually caused by mutations in certain genes and can thus be passed on from one generation to the next. They have names like brachydactyly type A, cutis laxa type II, and craniosynostosis, Philadelphia type. Many of these diseases are chronic and can involve severe impairments that patients survive for only a few years.

Other rare diseases have little impact on life expectancy, but cause obvious physical deformities. Persons affected by these conditions can expect little help from the pharmaceutical industry – the patient groups and corresponding market are simply too small. What is worse, however, is that the parents of affected children often consult numerous doctors in the hope of obtaining a diagnosis, and generally receive little more than a puzzled shrug of the shoulders in response.

HELP FOR DESPERATE PARENTS

“Knowing the cause provides a degree of relief for the parents,” says Stefan Mundlos. The doctor and his colleagues confirm this experience on an almost daily basis at the clinic of the Institute for Medical Genetics and Human Genetics in Berlin’s Charité hospital. They are also confronted with the gnawing question as to whether another child – or grandchildren – could also be affected and, if so, with what degree of likelihood.

“A correct diagnosis is crucial,” explains the pediatrician. “Without a diagnosis there can be no prognosis or therapy development.” The problem, however, is that, due to the recent nature of the research, diagnosis is not possible for many rare diseases because the corresponding genetic tests have not yet been developed.

DIAGNOSIS BY COMPUTER NETWORK

When children become ill due to a rare genetic defect – either shortly after birth or in the early years of life – it is difficult for their doctors to associate the often diffuse symptoms with a defined disease. No doctor can note the clinical symptoms of the thousands of diseases that affect ten or a hundred people throughout the world at a given time. Moreover, the symptoms associated with many rare diseases overlap and this also renders them difficult to diagnose.

Peter Robinson, a doctor and bioinformatician from Stefan Mundlos’s research group, aims to resolve this problem by adopting a systematic approach. He feeds the ever-expanding information about rare diseases into a computer program. The program links different symptoms and then assigns them to similar cases that have been encountered by other doctors in clinical practice. It can generate cross-references to all possible main and secondary symptoms. The program also stores the data about the underlying genetic mutations and molecular mechanisms.

“If such a system is available to researchers and doctors throughout the world and they can also enter data about their patients into it, a lot of time and effort can be saved in the diagnosis of rare diseases,” says Stefan Mundlos. The program’s “intelligence” increases with the volume of data and this, in turn, will enable doctors to make more precise diagnoses. This establishes a solid foundation for the diagnosis of rare diseases – one of the biggest problems facing doctors to date – that reflects the digital possibilities of the 21st century.

1 Shortness of fingers through duplication of a regulatory region in the DNA: the intermediate phalanges of the index and little finger are missing or too short.

2 Mouse embryo with the same duplicated regulatory region in its DNA. The region controls genes in the emerging legs and fingers (blue). The duplication alters the activity of the BMP2 gene and gives rise to brachydactyly as a result.
Ideally, Mundlos’s scientific projects feed directly into everyday clinical practice – when his team has managed to nail down the cause of a previously unexplained rare condition and it can then be demonstrated using a new genetic test. Every day, the doctors encounter rare diseases that share some features and symptoms but differ in others.

Blood samples and files from patients all over the world arrive at the institute every day. The scientists have now assembled a collection of diseases that they are systematically recording in a database. This enables them to identify certain “phenotypes,” as the geneticists call them, from all of the described disease patterns.

**DISEASES REVEAL THE FUNCTION OF GENES**

To what extent can specific defects, as arise for instance in diseases of the skeleton, be predicted on the basis of genetic information? And, above all, how is the information from a single mutated gene used to provide a specific clinical picture?

“These questions can be extremely well researched in the case of rare genetic diseases,” says Stefan Mundlos. “This means we can really understand how the text of a gene determines a function and how the function, in turn, determines a disease.” In other words: a gene can literally be decoded. “The task for the future is to seek answers for all possible rare diseases using functional genomics.”

This process is driven by the technical progress achieved in molecular medicine over the past two decades – particularly in the area of DNA sequencing and another method known as array CGH analysis. This “gene chip diagnosis” enables the discovery of very small chromosome mutations that cannot be detected using conventional chromosome analysis.

Defined DNA fragments (arrays), which cover the entire human genome as evenly as possible, are placed on a special device. The matching sections of the DNA to be tested bind to these fragments. The analysis requires both the patient DNA in which the genetic origin of the disease is being sought, and reference DNA. Both DNA samples bind to the array fragments, and are marked with different fluorescent dyes. The fluorescent signals are then identified with the aid of a scanner. Depending on how strong a given fluorescent signal is, it is possible to establish whether both DNA samples have bound equally or whether one has bound more and the other less. This enables the scientists to detect various minute DNA mutations. The individual signals are then assigned to certain gene regions using a computer program.

New technological developments also enable the fast and relatively cheap sequence analysis of complete genomes. The sequencing of an entire human genome used to take years; now a computer can, in just a few days, perform this task so accurately that
A mutation of the HOXD13 genes causes a complicated form of brachydactyly in which the fingers are fused together. The gene mutation causes a similar deformation in mice (right).

“high throughput sequencing” will soon become the standard method used in routine human genetic diagnostics. The quality, speed and now lower costs of these new technologies have long since revolutionized research into biological issues.

Equipped in this way, from the thousands of rare diseases, the Max Planck Researchers selected diseases of the skeleton as their research focus. There are 400 such diseases alone, along with a few hundred deformities of the extremities. Of these deformities of the hands and feet, at most a third have been characterized, ensuring that the researchers will have enough work to keep them busy for decades.

Stefan Mundlos’s team has been investigating the many forms of brachydactyly – literally “shortness of fingers and toes” – at the molecular level for more than ten years. This disease involves varying degrees of shortening of the fingers and, sometimes, metacarpals. Different forms of the disease with very similar effects arise in affected families. The average frequency of brachydactyly in the population is 1:200,000. The shortness in the digits is often symmetrical, and sometimes entire finger joints are missing. The likelihood of passing this disorder from parent to child is 50 percent.

In the embryo, the arms and hands arise from the extremity buds – a small mass consisting of two layers of tissue with stem cells that can develop into different types of cells. While these cells multiply and generate the form of the extremity, the individual elements of the skeleton also differentiate – into the upper arm, lower arm and hand, and, finally, the fingers.

The skeleton parts are initially established as a basic cartilaginous frame in which the joints gradually form. However, the segmentation of the cartilaginous mass into the individual finger bones doesn’t function correctly in children with brachydactyly. “Different signaling pathways join forces to regulate the normal process,” says Stefan Mundlos. And various genes with the corresponding proteins play a role in these signaling pathways.

**SIGNALING PATHWAYS FOR BONE FORMATION**

By carrying out tests on different forms of brachydactyly, the researchers discovered different mutations in these genes that give rise to malfunctioning proteins. The signaling pathway named after the bone morphogenetic proteins (BMPs) appears to play a particularly prominent role here. The signals from the BMPs cause the formation of cartilage structure. They also control segmentation with joint formation.

“This entire process requires extremely fine tuning,” says Max Planck scientist Mundlos. This involves various receptor molecules to which the BMPs bind and, in this way, transmit their effect, along with different inhibitors that block their activity. The mutations the researchers discovered in these molecules also cause the same clinical manifestations in mice that they observed in humans.

In addition, there are molecules, such as ROR2, that interact with the BMP signaling pathways. A mutation in the ROR2 gene generates an “impressive phenotype” as Mundlos says. It looks like a truncated hand, as the top bones in the fingers are missing. ROR2 and the growth factor Wnt regulate the activity of a small mass of cells right at the top of the fingers that produces the cells for the development of the fingers. In the absence of an intact ROR2 gene, this small cell mass is not formed.

One thing is certain from the scientists’ discoveries: the genetic root of brachydactyly is heterogeneous. This means that different mutations can cause the same physical changes. Up to now, it appeared that traditional mutations in the genes that code for proteins were solely responsible for the impaired pattern formations in the fingers. However, the mutation of a particular regulatory DNA sequence can also trigger brachydactyly.

This duplication is located in a sequence of the genome that is highly conserved from an evolutionary point of view and, moreover, is almost identical in different species – including chickens and mice. Further, it is located in a section of the DNA that doesn’t code the instruction manual for a protein. This area, which was largely unknown up to now, contains regulators that must switch genes and proteins on.
and off at exactly the right time during the development of the embryo for complex structures such as the hands or the skull to form. “This is a veritable treasure trove for future research,” predicts Stefan Mundlos.

**DIAGNOSIS: FAULTY GENE REGULATION**

Within the duplication, there is an enhancer element that regulates the activation of a BMP gene. “Consequently, we have proven for the very first time that changes in the non-coded DNA areas can also cause diseases,” says Mundlos. “The duplication of the regulatory element that influences the detailed control of genes during embryonic development disturbs the balance in the BMP signaling pathway considerably during the initial development of the fingers.”

Once discovered, the researchers are now also finding the new type of mutation in other rare diseases, such as craniostenosis, Philadelphia type, which also involves the duplication of this kind of enhancer element. With this disease, individual fingers and a child’s cranial sutures, in particular, fuse far too soon after birth and cause corresponding deformities. Mutations in the Hox genes, in contrast, cause phenotypes with, for example, more than five fingers. The Berlin-based researchers already discovered this many years ago.

Now they also understand, in molecular terms, how the genetic misinformation causes the additional fingers to grow. At the start of its development, the hand consists of a uniform plate. Out of this grow the individual elements – the fingers, which must be separated from each other. The cells in the spaces between the fingers receive a signal to not chondrify – that is, develop cartilage.

This “anti-cartilage signal,” as Stefan Mundlos calls it, is transmitted by one of the Hox genes. It, in turn, controls the activity of an enzyme that produces retinoic acid. Retinoic acid is a substance that is found at all possible stages of embryonic development. Mice with Hox mutations produce less

**PROTEINS FOR CARTILAGE**

In the course of their work on brachydactyly, the researchers from the Max Planck Institute for Genetics in Berlin produced proteins using methods from genetic engineering that trigger the production of cartilaginous mass. The artificial proteins for cartilage are modified by mutations as compared with the natural bone morphogenetic proteins (BMP). Cell culture tests showed that two of the modified proteins (light gray, dark gray, mutation: yellow) sometimes trigger the formation of cartilage far more intensively than the natural proteins. One of the two proteins binds more strongly to certain areas (orange, red, green) than other proteins and is not adequately blocked by the body’s own inhibitor (pink) to hinder the effect of the BMPs. In both cases, however, the BMP signaling pathway is excessively active. “This could also be used for treatment,” says Stefan Mundlos. For example, cartilage is needed for the production of bone tissue in patients with complicated bone fractures. The new BMPs are currently being tested in animal experiments.
If the mutated mice are given retinoic acid during embryonic development, the polydactyly disappears again. “However, retinoic acid is not a suitable drug for humans,” stresses Mundlos. It would cause serious problems for other aspects of embryonic development.

Moreover, in mice with certain Hox mutations, the long tubular bones are transformed into rounded ones. The Berlin team proved the existence of such homeotic transformations in the extremities of vertebrates for the first time. This shows that Hox genes influence the shape of bones.

The principle of chip-based chromosome analysis: Dye-stained genetic samples of patient and control DNA are mixed (A) and applied to a gene chip. Patient and control DNA bind differently to short DNA segments and stain them accordingly (B). The color of the individual dots on the chip indicates changes in the chromosomes. The color of a dot here has shifted in the direction of red (circle), which means that the green sample binds more weakly and does not have the corresponding chromosome section.

**ANTI-POWER-PLANT RADICALS**

Wrinkly skin and the loss of bone substance are typical features of aging. People with the rare genetic disease cutis laxa display such symptoms from childhood, however, and also suffer from intellectual disabilities. Five different forms of this disease are known. Together with an international research group, Stefan Mundlos’s team has now discovered the genetic defects at the root of cutis laxa. It appears that the gene PYCR1 is mutated. The protein product of this gene is involved in the metabolism of the amino acid prolin in the cell’s powerhouses, the mitochondria.

Due to the mutation, the patients’ cells are more sensitive to free radicals. These are harmful oxygen molecules that are produced by certain metabolic processes. Free radicals have long been suspected of triggering aging processes through programmed cell death (apoptosis). When the mitochondria are stimulated by the radicals, their membranes open and the fate of the entire cell is sealed. PYCR1 probably protects people against the consequences of stress from free radicals.

The mitochondria are the powerhouses of the cell. They have an elongated shape and invaginations of the inner membrane. The differences between healthy mitochondria (a,c) and those of cutis laxa patients (b) are visible under the electron microscope. The mitochondria of cutis laxa patients are sensitive to free radicals (d): treatment with the radical builder H$_2$O$_2$ destroys their network of thread-like proteins (red, nucleus blue).
Although it was already known that the Hox genes play a key role in the development of the extremity bud, the new tests have revealed that they also control delicate differentiation processes in subsequent phases of embryonic development – for example, the formation of connective tissue, cartilage and bones – around the eleventh or twelfth day of gestation in mice and the sixth to eighth week of pregnancy in humans.

**GENE ANALYSIS REVEALS NEW DISEASE**

The Berlin researchers seldom apply their expertise in functional genomics to diseases outside of the skeleton. Some time ago, however, a patient with Mabry syndrome – a disease characterized by delayed intellectual development and raised blood levels of the enzyme alkaline phosphatase (ALP) – came to them for a consultation. High ALP values are usually indicative of bone diseases, but the patient in question did not have any such disorders and nobody could understand the origin of his high ALP value.

“We discovered a new gene defect in him and consequently defined a new disease,” says Stefan Mundlos. From a molecular perspective, the enzyme hangs on the outside of liver and bone cells from a kind of anchor. According to the findings of the Berlin-based scientists, a mutation renders the anchor unusable. As a result, the enzyme can no longer adhere to the cells and large volumes of it swim around in the blood.

Exactly how the absence of the anchor ultimately causes the delay in brain development is still unknown. However, if a child with raised ALP levels and no indication of a bone disease presents somewhere in the world, now it will soon be able to undergo a genetic test for Mabry syndrome. This is how basic research is immediately incorporated into everyday clinical practice at the Charité’s Institute for Clinical Genetics.

At present, however, for most rare diseases, there is no treatment available that targets their molecular causes. “The research on these causes is a crucial prerequisite for the development of a treatment,” says Stefan Mundlos, and refers to Marfan syndrome – a disease from which the famous US President Abraham Lincoln suffered and that involves life-threatening complications of the aorta – as a positive example of such a disease.

Now, some 20 years after the discovery of the genetic defect that causes this disorder, a drug that is used in the treatment of high blood pressure and that addresses the cause of this condition is being tested. “It appears to work,” says the Max Planck researcher, and reports that one of his colleagues is now developing a specific therapeutic concept for the treatment of Marfan syndrome.

**MAX PLANCK FOUNDATION**

Through the Max Planck Foundation, a patron provided 250,000 euros in funding for a research project led by Stefan Mundlos on rare diseases in children. The non-profit Max Planck foundation was established in June 2006. It is funded by private patrons through a German national initiative. The Max Planck Foundation provides funding that enables the rapid and flexible support of cutting-edge research. The funding is used to provide support for special research projects, foster outstanding young scientists and recruit top scientists, thus guaranteeing the competitiveness of the Max Planck Society at the international level.

Further information: www.maxplanckfoerderstiftung.org

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**GLOSSARY**

**Enhancer element**

An enhancer is a base sequence in the DNA that plays an important role in transcription from DNA to RNA. It strengthens the transcription activity of a gene by influencing the accumulation of RNA polymerase (enzyme complex) at a particular start sequence, the promoter. The enhancer and promoter sequence may be located several bases apart. If the enhancer moves closer to the promoter through the removal of sections of the DNA, the gene transcription continues to increase. In the case of tumor cells, for example, an oncogene can reproduce very quickly in this way.

**Hox genes**

Hox genes are regulatory genes that control the processes involved in the early development of organisms. Their most important task consists in segmenting the embryo along the body’s longitudinal axis. In humans, for example, these genes control, among other things, the shape and formation of the vertebrae and ribs. They also regulate the generation and degeneration of blood vessels during embryonic development, and control the formation of vessels during pathological processes, for example during the emergence of tumors.

**Marfan syndrome**

Marfan syndrome (MFS) or the Marfan phenotype is a disease of the connective tissue caused by a genetic mutation. The mutation arises in the gene for fibrillin – one of the most important components of the microfibrils, which play a key role in the development of connective tissue. Marfan patients present with a wide variety of symptoms: often, their cardiac, vascular and skeletal systems, eyes and internal organs are affected. Marfan syndrome affects an average of one to two people in 10,000. This connective tissue disorder is still incurable.

**Duplication**

Duplication refers to the doubling of a certain section within a chromosome. This happens, for example, through the unequal exchange of gene sections between sister chromatids. The chromosome becomes longer as a result. This kind of gene mutation usually can’t be repaired by the body’s own repair mechanisms, and often causes congenital defects.
MATERIALS & TECHNOLOGY_3-D Scene Analysis
Humans need only a two-dimensional photo or film to be able to perceive a face or a body in 3-D. Researchers working with Thorsten Thormählen at the Max Planck Institute for Informatics in Saarbrücken are teaching this skill to computers, thus creating new ways of working with images and films. Applications already exist: a 3-D makeup guide and a program that can be used to manipulate human bodies in movies.

**TEXT TIM SCHÖDER**

The light stage (left) helps in the development of the face analysis program. The Saarbrücken researchers use it to create images in different lighting conditions in order to analyze the three-dimensional structure.
It was looking a lot like Christmas in Thorsten Thormählen’s lab in recent months. A huge light stage hung from the ceiling. Together with his colleagues, Thormählen had bolted metal strips from an Erector set to a round skeleton and then fitted it with several dozen LEDs. The light stage, used by the researcher to photograph faces, measures a good two meters in diameter.

Thorsten Thormählen and his colleagues at the Saarbrücken-based Max Planck Institute for Informatics are working at the boundary between reality and the computer world. They transplant images of real, three-dimensional objects into virtual scenes or manipulate the bodies of movie stars in video clips.

An activity that sounds almost like data falsification is actually genuine basic research – the Saarbrücken-based researchers want nothing less than to teach the computer to understand scenes. A human intuitively recognizes another human in a video. A computer, however, sees only a cloud of colorful pixels when a sequence of images is loaded into its system. “We want the computer to extract real, three-dimensional objects from a two-dimensional scene,” says Thormählen, summing up the mission of his “Image-based 3-D scene analysis” research group. For us humans, it’s child’s play. Even in a two-dimensional photo, we can see whether a house or a car is in the foreground. Teaching a computer to make intelligent observations is much more challenging.

**TWO-DIMENSIONAL IMAGES DELIVER 3-D INFORMATION**

A large light stage, for example. The researchers are extending an idea that Kristina Scherbaum and her mentor Volker Blanz implemented a number of years ago. They succeeded in reconstructing a three-dimensional image of a face from a conventional photo. Thormählen, Scherbaum and their colleagues are now beautifying the virtual, three-dimensional faces by creating the appropriate makeup for them.

“It works,” says Thormählen. “We photographed women at CeBIT and had our newly developed software determine the most suitable makeup for them. It is demonstrated in a three-dimensional visualization of the face.”

The ideal makeup guide in 3-D? It sounds almost trivial. In fact, Thormählen is working at the frontier of computer graphics with this software. This research is becoming the test case for determining whether a computer can extract correct 3-D information from a two-dimensional image. So what is the purpose of the light stage?

It is a vital tool for photographing faces in detail in a variety of lighting conditions. If a computer is to be
taught how to convert two-dimensional photos of faces into 3-D model heads, it must be trained in advance to do so using 3-D face data. To start the project, the researchers arranged for 56 women to sit, one after another, on the stage and took photos of them from different angles and in different lighting conditions. Stripe patterns were then projected onto the faces of the test subjects, showing the curvature of the nose, cheeks and chin.

**MATHEMATICAL FORMULAE FOR FACIAL DETAILS**

Scherbaum and Blanz’s proven software, which generates 3-D heads, was then deployed. This software collected information on all 56 faces, generating a standard head, a digital face template – a data record that the computer can use at a later stage to accurately recognize a face as a face.

If a two-dimensional photo of a new face is subsequently imported into the system, the portrait is measured using the existing template and is transformed – or morphed, to use the technical term – into a 3-D face model. The program thus describes the new face using the knowledge already stored in the system – a nose like face 25, cheekbones like face 34, a chin like face 56.

The software then performs an optimization process. It generates a 3-D image of the face, translates it back to 2-D, compares the data with the photo prototype and enhances the 3-D image again in the case of doubt. Until everything finally matches. One difficulty with this process is capturing, as mathematical descriptions, the countless details that humans comprehend at a glance. The computer is able to compare a new face with the stored patterns only if it has the necessary formulae to do so.

This work not only helps researchers discover the exact three-dimensional shape of a face, but it also helps them identify the properties of skin. The computer can calculate these details exactly for each pixel based on the surface reflectance, as the exact position of the LEDs on the light stage is known. The computer can even determine the position and depth of individual pores on the skin. The result is a very life-like “skin model” on the computer.

**THE OBJECTIVE: A LIFE-LIKE HUMAN IMAGE**

Of course, this is a considerable amount of work for a paltry makeup guide. For Thormählen, it is certainly more than that. He is attempting to come as close as possible to a life-like image of a human and is thus following a trend in computer graphics. The ultimate goal for the graphic designers is to develop
an artificial head that is indistinguishable from the real thing. It would be equally attractive for video games, theater movies and Internet applications.

It all depends on nuances, especially the interplay of light and the surface of the face. After all, humans are incredibly good at differentiating between genuine and fake faces. The wrong reflectance in the iris, and a digital android becomes repugnantly artificial. Illumination of the skin is also important. A face does not reflect light in the same way that a mirror does. Certain sections are scattered and reflected diffusely. Consideration must also be given to the light that penetrates into the skin and is reflected by the skin’s deeper layers. It gives the face its typical warm, “life-like” character. This is one reason why too much makeup can look unnatural.

Thormählen is trying to make the true-to-life artificial head as similar as possible to his makeup model. Of course, the computer must also be loaded with makeup information for the high-tech, 3-D makeup wizard. Thormählen and Scherbaum photographed the subjects with and without makeup. To do this, they hired a professional makeup artist from a Saarbrücken theater to apply makeup that best suited each individual woman.

THE COMPUTER AS MAKEUP ADVISOR

The makeup artist’s extensive knowledge about the makeup that best suited each face type, i.e. the eye and hair color that suits each complexion, now has to be converted into data by the Saarbrücken computer scientists. This will be added to the mountains of data available on morphable face models and the skin information derived from the light stage. The researchers must now consolidate this information, not intuitively in the way that humans can, but in the analytic formula language that computers understand.

Now, if a researcher scans a photo, the computer generates a 3-D face model, which it compares with the known faces in the database. A pale complexion? Then somewhat less rouge and a little more eye shadow would be suitable. At the end, the software suggests the makeup that best suits the new face. The artificial face can be turned and tilted and viewed in different lighting conditions – in sun-
shine or in a dimly lit disco. Thanks to the high-resolution photos taken on the light stage, the faces have a deceptively real look.

REAL SKIN MODELS FOR COMPUTER GAMES

Thormählen’s team originally wanted to develop a software program that offered women makeup suggestions that came close to the theoretical ideal of beauty. According to psychologists’ findings, such an ideal is characterized by sallow skin, fuller lips, thinner eyelids, long, dark eyelashes, higher cheekbones and a narrow nose. With good makeup, it could be possible to really sculpt the face to achieve such a look. The researchers ultimately felt it was more appropriate to aim for an individual optimum look and not the ideal standard.

The makeup system developed by the computer scientists represents the state of the art in computer graphics. The last five years have seen the emergence of sophisticated morphable models and real skin models. These could potentially have a wide range of applications, e.g. Internet services in which true-to-life, virtual employees speak, provide tips or help users operate equipment. The computer games industry is also a growing market. According to data provided by the German Trade Association of Interactive Entertainment Software (Bundesverband Interaktive Unterhaltungssoftware, BIU) and auditing firm PricewaterhouseCoopers, the industry is undergoing rapid expansion. In the games industry, global sales of computer games topped USD 50 billion in 2008. The games market has long since overtaken the DVD and Blu-ray movie business, which realized sales of just under USD 35 billion in the same year.

The more realistic the artificial figures and the virtual worlds are, the more attractive they are, and the more money customers are prepared to spend on them. Life-like faces play an important role in this area, as does the movement of figures. Thormählen scored a real coup in this regard last year. Using the new MovieReshape software, he succeeded in modifying the shape of the protagonists in a real video.

VIRTUAL POUNDS FOR HOLLYWOOD STARS

Up until then, talented computer graphics designers could perform such modifications only in photographs, by airbrushing out the beginnings of a politician’s paunch or a TV star’s wrinkles, for example. It was inconceivable that the same thing could be done in movies with 25 images per second. However, the new software can be used to easily make slight modifications to the people in the movie simply by moving small sliders back and forth on the screen to reduce or increase the size of the actor.

While no actual product exists yet, the prototype for the new image processing software has delivered very impressive results. The demo video has already attracted hundreds of thousands of clicks on the Internet: a Baywatch actor is shown jogging through the sand on the beach, in one shot with a flat chest, in another with more curved muscles. In another clip, an athlete shoots balls into a basketball hoop while his beer belly grows.

Critics complain that “not even videos are safe from forgery now.” Thorsten Thormählen acknowledges these concerns. For him, however, the new software is a tempting tool for jazzing up professional video recordings. “Previously, some Hollywood stars would put on a few pounds for a movie role,” says Thormählen. “This
can now be done on the computer using our software without any stress whatsoever.”

THE PROGRAM LEARNS TO DISTINGUISH BETWEEN BODIES

The ease with which the Baywatch Adonis runs along the beach hides the fact that developing MovieReshape also involved hard, mathematical work. As in the case of the artificial head, a digital model first had to be created. In this case, it was a morphable body model. Once again, the computer calculates a realistic, three-dimensional model from a two-dimensional scene. After all, the manipulation of a movie clip is convincing only if it is consistent with a realistic potential change in the three-dimensional movie object.

To produce the three-dimensional model, the researchers first scanned in the bodies of approximately 100 test subjects. The computer then learned to distinguish between fat and thin, long and short, or powerful and slim thighs. If the researchers then import a video clip into their computer, the program automatically adapts the digital body model to the figure in the image. It does this for each individual image in a movie clip. As already mentioned, a flicker-free video contains 25 images per second. It still takes hours to perform such an automatic image analysis. But then the process speeds up. Once the computer has analyzed all the images and the actor’s position, one movement of the slider is sufficient to increase or decrease the size of the body as desired – consistently in all images in the movie clip.

It sounds easy. The trick, however, is to morph the body in a way that is anatomically correct. It’s not enough to just lengthen the stomach and legs. The thickness of the limbs or the torso must also be changed. Otherwise the figure quickly becomes a caricature. The software extracts the mathematically formalized knowledge about the right proportions from the body scans saved in the system.

The computer also needs something else: correct knowledge of how a skeleton moves anatomically. For this, Thormählen was able to draw on an established procedure that has long been employed by computer scientists. This procedure uses a skeleton that defines the positions that bones can assume, or the angles that joints can make. Thormählen joined this artificial skeleton to his morphable body model. “This means that the software can position arms and legs in a way that is anatomically correct in an image sequence,” he says.

THE 3-D MODEL RESURRECTS CHARLIE CHAPLIN

The end result is that Thormählen and his colleagues have more or less automated the editing of moving images. This is exactly what the computer graphics industry needs. There is demand for programs that can load a computer with prior knowledge about the human figure. It is only with this prior knowledge and the appropriate software that the computer will eventually be able to modify the figure semi-automatically, or perhaps even completely automatically. “Currently, a lot of the work is still done manually, pixels are moved around on the screen using the mouse, areas are colored in or have their colors changed,” says Thormählen. Programs that automate these time-consuming tasks are therefore eagerly sought after.

Not only can the three-dimensional model be used to customize the actors’ bodies to the requirements of the script or even to suit popular taste, but it could also help animate actors. Ultimately, a certain amount of filming could one day be replaced by a photo shoot – filmmakers would then trans-
fer their actors’ movements to the computer. Even Charlie Chaplin could be resurrected in this way. All that would be necessary would be to load his head and body from old movie scenes into the computer. The computer could then make Chaplin walk and jump as desired. “We haven’t solved all the problems yet, but with a little work, we could teach our software to do this,” says Thormählen. Last December, he presented MovieReshape at SIGGRAPH Asia, one of the world’s most important conferences in the computer graphics industry.

The software would also be useful for sports analysis. It could, for example, demonstrate an ideal sequence of movements to an athlete, using his or her own image. It could be used to produce motivational videos in gyms: “This is how I would look if I worked out three times a week.”

The next objective for Thormählen’s team is to accelerate the morphing process and automate it even further, reducing the time needed for a computer to analyze the video data. In terms of faces, the computer scientist is hoping to make them even more life-like. The skin already looks authentic. Now, convincing movement and deceptively genuine facial expressions must be added. New and faster algorithms are needed to do this. “It would mean that a computer system could even identify moods,” says Thormählen. Controlling a computer using gestures or facial expressions would also not be beyond the realms of possibility. Computer game fans would not be the only ones who would benefit from such a development. Such a function could also make it easier for paraplegics to work on computers.

GLOSSARY

Morphable body model
A body model that can be realistically morphed and made to move in three dimensions. It can be used as a template for manipulations in two-dimensional movie clips. Like the 3-D face model, it is generated by a software program that compares bodies from arbitrary two-dimensional movie clips with a catalog of scanned body shapes and gestures.

Morphable face model
A three-dimensional model of a face that can be manipulated. A software program creates it from an arbitrary person by comparing the face with a catalog of existing faces.

MovieReshape
A computer program that facilitates the fast and easy manipulation of body shapes and proportions of actors in movies. The software operates with a 3-D body model (see above).
Witness to past climate: Scientists such as those working at Grenoble’s CNRS analyze the gases contained in Arctic and Antarctic ice cores. In this way, they can reconstruct what temperatures once held sway in the polar regions, and how much carbon dioxide was in the air. Victor Brovkin’s team of researchers compare their simulations with this data.

When climatologists look into the past, they intend to learn for the future. Victor Brovkin and his team at Hamburg’s Max Planck Institute for Meteorology reconstruct historical climate changes and analyze what processes reinforce those changes. Their discoveries are helping to predict the future of the Blue Planet.
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ictor Brovkin comes across as a reserved and patient interviewee, but on one subject he expresses himself in blunt and adamant terms: “According to all we know, man is responsible for the fact that Earth’s climate has been changing faster than ever before in recent decades. Human activity has pumped greenhouse gases into the atmosphere.” The level of carbon dioxide alone has increased by 40 percent since the advent of industrialization, to 0.35 per mil. This gas is generated by the burning of fossil fuels, and its concentration in the atmosphere rose very markedly during the last century. This is reflected more and more clearly by a rise in average global temperatures.

It is important to re-emphasize the connection at this point, as climate history can also be abbreviated as follows: Global warming, including sudden changes, belongs to the planet’s history just like meteorite impacts, the shifting of the continental plates and volcanic eruptions. Atmospheric carbon dioxide levels, too, have fluctuated greatly over millions of years, as well as over millennia and even centuries. This has often occurred to the same extent that industry, traffic and agriculture have emitted greenhouse gases into the atmosphere over the last 200 years.

This style of rudimentary telling of climate history quickly leads into a corner, and it is one that Victor Brovkin and his colleagues at the Max Planck Institute for Meteorology in Hamburg want nothing to do with: the corner of those who still doubt or even deny man-made climate change. This group loves to argue that there have always been climate developments such as the changes we are now experiencing. What they don’t say, however, is that, based on all the data scientists now have at their disposal, the carbon dioxide concentration has never risen as quickly as it has during the last two hundred years. Or that, throughout the last two million years, there has always been less carbon dioxide in the atmosphere than there is today.

“The decisive difference between the interplay of global warming and the carbon cycle today and in pre-industrial times is that cause and effect have been reversed,” says Brovkin. “Carbon cycle” is the term scientists use to describe the perpetual cycle by which carbon-containing compounds such as carbon dioxide and methane come into the atmosphere, are absorbed by the oceans and plants, escape into the air, and so on.

FEEDBACK AMPLIFIES GLOBAL WARMING

Until some 200 years ago, whenever carbon dioxide was released into the air, it was invariably the result of global warming and, probably, changes in continental vegetation. The greenhouse effect of carbon dioxide then caused further heating of the planet. In the present case, however, it is different: Today’s climate change has been caused by the drastically increased emissions of greenhouse gases.

As a result of current global warming, the oceans absorb less carbon dioxide, meaning that they remove less
greenhouse gas from the atmosphere. This feedback effect amplifies global warming. According to calculations carried out by Brovkin and his team, the impact is considerable: If Earth’s temperature rises by 2 degrees, the warming releases so many additional greenhouse gases into the atmosphere that this alone heats the planet by about another 0.2 degrees.

For the sake of simplicity, the relationship between global warming and the carbon cycle may be represented as a play with a prologue and three acts that get progressively shorter in terms of world history as they come closer to the present day and become more relevant to today’s climate. The play is still being written, and could end badly for many of Earth’s creatures – including many humans. The truly tragic thing is that those who will suffer most from climate change are the ones who are least to blame for it.

**ICE AGE CYCLES: THE LONG-TERM DETERMINANTS OF CLIMATE**

For now, it is unclear what the full cast of the play looks like. We do not know what role individual actors play or whether other players are pulling strings backstage. Climatologists like Victor Brovkin and his colleagues want to bring order to this confusion. They approach the issues analytically, simulating the history of climate and comparing their results with real measurements in order to untangle the individual storylines and reveal the often obscure roles of the actors. Finally, they feed the information into their models to predict how the play will continue.

Their work could have an impact on the political stage, too, because Victor Brovkin is a co-author of the Assessment Reports of the International Panel on Climate Change (IPCC). He and his colleagues from around the world integrate their findings in relation to the physical principles of climate into the reports – for example, if they have identified new actors and are able to describe their roles.

The prologue of the play is relatively unimportant for these reports and for understanding current climate change, and scientists working with Victor Brovkin are not concerned with that period of history – although it repre-

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The global carbon cycle for the 1990s, showing the main annual fluxes in GtC yr⁻¹: pre-industrial ‘natural’ fluxes in black and ‘anthropogenic’ fluxes in red. Gross fluxes generally have uncertainties of more than ±20 percent, but fractional amounts have been retained to achieve overall balance when including estimates in fractions of GtC yr⁻¹ for riverine transport, weathering, deep ocean burial, etc. The net terrestrial loss of -39 GtC is inferred from cumulative fossil fuel emissions minus atmospheric increase minus ocean storage. The loss of -140 GtC from the ‘vegetation, soil and detritus’ compartment represents the cumulative emissions from land use change and requires a terrestrial biosphere sink of 101 GtC. ‘GPP’ is annual gross (terrestrial) primary production.
sents the longest period by far, at almost 4.6 billion years. It is necessary to give a brief overview of the period in order to demonstrate the complexity of climate history.

The main climate developments of the first billion years were shaped by the movements of the Earth’s tectonic plates. The breakup of the supercontinent Gondwana, which contained all of today’s continents, opened up pathways for new ocean currents – and the climate changed. Of course, this process is still ongoing today, but it takes much too long to play a role in today’s climate events. By way of summarizing the prologue, it must be stated that the Earth cooled down over the very long term, achieving a reduction of 5 to 10 degrees in the last 65 million years.

The first act comprises the last 800,000 years, and in it begins a phase that, in principle, still determines long-term climate trends today: the constant alternation of cold and warm periods. The causes of ice age cycles are cosmic in nature, because they are determined by Earth’s orbit around the Sun. “The tilt of Earth’s axis to the orbit is probably the most important factor,” explains Victor Brovkin. When the axis approaches perpendicular, the differences between the seasons become blurred. Particularly in the high northern latitudes, summers are no longer warm enough to melt the winter snow. Another factor that affects global climate is that the Earth teeters a little on its orbit, which is sometimes more like an ellipse and sometimes more like a circle.

These factors explain why ice spreads over the northern hemisphere at regular intervals. However, they do not explain why the ice then retreats, and climatologists have yet to fully understand the process. “It seems to be that the ice masses become so swollen at some point that the stronger solar radiation of summer renders them unstable,” says Victor Brovkin.

**IRON FERTILIZATION INCREASES ALGAL GROWTH**

Once it has started, the warming amplifies itself as greenhouse gases escape into the atmosphere. This feedback interests the Hamburg-based scientist: “The reasons behind it have not been fully explained,” he muses. Climatologists do, however, know a few mechanisms that come into play at the end of an ice age. The warming oceans store less carbon dioxide, because it is less soluble in warmer water; and the acidity of the oceans increases in warm periods, which again reduces their capacity to absorb greenhouse gases.

In order to determine the strength of these feedback mechanisms and identify further effects, climate historians use computer simulations to understand the relationship between global warming and the increase in greenhouse gases. Victor Brovkin and his colleagues have gained their insights with a model called Climber-2 (short for Climate-Biosphere Version 2) which they use as a kind of virtual time machine. They then compare the results of their calculations with carbon dioxide values obtained from ice cores by Jérôme Chappellaz’ team at the CNSR Laboratory for Glaciology and Environmental Geophysics in Grenoble.

Ice contains the air of the past in dissolved form or in tiny gas bubbles. Consequently, where ice has accumulated over thousands of years, climatologists can access an archive of historical greenhouse gas values. By analyzing the carbon dioxide content of Antarctic ice, scientists can see back up to one million years into the history of Earth’s climate.

With colleagues from the Potsdam Institute for Climate Impact Research, the University of Chicago and the University of Liège, Victor Brovkin has calculated how the volume of greenhouse gases in the atmosphere developed during the last ice age, which began some 120,000 years ago. In doing so, they gradually introduced more and more geophysical and biogeochemical processes into Climber-2, as the protagonists in the climate system.
Of particular interest to the scientists is the transition from a cold to a warm period some 12,000 years ago, because in just a few millennia, carbon dioxide levels increased by almost a third, climbing from 0.19 per mil to 0.27 per mil. Brovkin and his team managed to simulate this change fairly closely by integrating not only ocean circulation and carbonate chemistry, but also another two effects that they summarize using the keywords iron fertilization and land.

Iron fertilization means that, during the dry glacial periods, more iron-bearing dust gets blown from the land into the oceans, where it increases algal growth. Consequently, some researchers have constantly brought the iron fertilization of the oceans into play as a mechanism for removing carbon dioxide from the atmosphere. However, its effect is too limited to counteract the 0.1 per mil increase caused by humans to date.

Nevertheless, iron fertilization is important for understanding the relationship between global warming and atmospheric carbon dioxide, particularly when there is less iron fertilization of the oceans during a warm, moist period. This means that algae do not thrive and hence absorb less carbon dioxide. According to calculations by Brovkin’s team, this translates into an increase of 0.04 per mil in atmospheric carbon dioxide.

In the same way, land-based processes release carbon dioxide during warm periods, albeit in more limited quantities. However, many mechanisms are at work here, some of them mutually conflicting. One mechanism that contributes to increasing CO₂ levels is that microorganisms in the ground break down organic material such as leaves faster in warmer temperatures, allowing more greenhouse gases to escape. In addition, the north became wetter after the warm period, but the subtropics dried out, again releasing carbon dioxide. On the other hand, the higher the carbon dioxide concentration in the air, the more efficiently and productively plants build biomass, thus mitigating the strength of the greenhouse effect.

Compared with the oceans and their miniscule inhabitants, the land masses play only a secondary role in influencing climate. Still, it is important for climatologists to understand their reaction to global warming, not least in order to estimate how current climate change will impact agriculture and forestry.

In an attempt to identify other actors in the interplay between climate and carbon cycles, Victor Brovkin and his colleagues are applying themselves to the current warm period with particular intensity. This epoch, which began almost exactly 11,700 years ago and is known as the Holocene, merits the second act of the climate play all to itself for at least two reasons.

For one thing, world climate was unusually stable through the last 11,700 years. When the last remaining skeptics of man-made climate change point out that turbulent fluctuations have always formed part of climate history, they are right. However, it may well be that human civilization was able to develop only in the relatively more settled climate of the Holocene.

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Reconstructing the carbon balance: The Hamburg group simulated the development of greenhouse gas levels in the atmosphere during the last ice age (black line). Their calculations corresponded very closely to the results their research partners found in ice cores (red curve). (ppm - parts per million; 100 ppm = 0.1 per mil)
In addition, scientists have a particularly accurate and detailed picture of the Earth’s temperature for this epoch. Pollen has been obtained in practically all wetlands and in ocean sediments, and these can be reliably dated for at least the last 20,000 years using the radiocarbon method, based on the radioactive decay of a carbon isotope. By studying the pollen quantities and composition, scientists can reconstruct the vegetation of a given period, in turn enabling them to accurately deduce the temperatures to which the plants were exposed.

The precise data generated by mathematical and statistical analysis enables climatologists to better evaluate their simulations and to calibrate them more finely. The relatively short period that makes up the Holocene also requires less computing power than a full ice age cycle, so the Earth’s carbon dioxide cycle during this epoch can be reconstructed with higher spatial resolution and for smaller time intervals.

**CORAL REEFS AND PEAT BOGS COME INTO PLAY**

As shown in simulations, corals come into play as a factor during warm periods like the Holocene. Reefs practically spring out of the ocean floor in warmer shallow waters. In the process of coral formation, CO₂ is emitted into the atmosphere. Scientists have also integrated peat bogs into their model. Organic materials hardly decay at all in marshlands, so they store carbon. However, calculations show that, on balance, coral reefs have a greater impact.

The building activity of these sea creatures helps researchers absolve humankind of blame in the dispute over climate history, because in the 8,000 years before industrialization, the volume of carbon dioxide in the air increased slightly, by 0.02 per mil. Some scientists explain this increase by saying that the human population of the Earth was growing in this period, and that humans began to clear the forests. Some even go so far as to say that, by doing so, *Homo sapiens* delayed the next ice age. “However, our calculations show that the impact of coral reefs in this period was large enough to explain the increase,” says Thomas Kleinen, who simulated the scenario at the Max Planck Institute for Meteorology.

The third and, for now, final act of the climate play began with the advent of industrialization, some 200 years ago. In this act, humans took on a leading role, driving atmospheric carbon dioxide levels up to about 0.38 per mil to date. If coal, gas and oil were to...
continue to be burned unchecked, this concentration would rise to 1.9 per mil, heating the global greenhouse by more than 6 degrees.

If the warming effect is to be kept to 2 degrees as agreed in December 2009 by world heads of state at the climate conference in Copenhagen, greenhouse gas levels must not rise above 0.5 per mil. Even this level of warming is dangerous, because it occurs quickly and is amplified just as fast.

GREENHOUSE GASES PERSIST FOR THOUSANDS OF YEARS

Mechanisms that remove carbon dioxide from the atmosphere work much more slowly. Rocks weather faster on a warmer Earth, giving rise to silicon and calcium carbonates, which bind the gas. But it does not take mere centuries for the released carbon dioxide to be eliminated from the atmosphere, as some climatologists suppose. Victor Brovkin and David Archer of the University of Chicago have calculated that, although half of greenhouse gas emissions disappear within the first 1,000 years, some 10,000 years must pass before only a fifth remains. And it could take as long as several hundred thousand years for amounts to fall to pre-industrial levels.

The Hamburg group uses such calculations to try to predict the future development of the interplay between global warming and the carbon cycle. In doing so, they also foretell what would happen if methane were to bubble forth from the oceans, where it is currently bound as hydrate. This could happen if ocean temperatures were to rise by 3 degrees, and would lead to a further rise of up to 0.5 degrees in global temperatures.

“To enable us to predict such developments more accurately and reliably, we are now using the MPI Earth System Model, which was developed at our institute and integrates the JSBACH model for land surface,” explains Brovkin. The Earth System Model simulates events in the global greenhouse with a spatial resolution of some 100 kilometers and in intervals of 20 minutes. Climber-2 covers the Earth with a mesh size of thousands of kilometers and calculates climate processes in intervals of one day – too large to take differences between night and day into account.

“Bit by bit, we and other groups will integrate additional processes,” affirms Brovkin. One of the aspects scientists want to include in the future is the relationship between the carbon cycle on the one hand and the nitrogen and phosphate cycles on the other. Ultimately, plants do better if there are high levels of nitrogen and phosphorus in the ground, but nitrogen escapes from the ground into the atmosphere in the form of nitrous oxide – and then has a much stronger greenhouse effect than carbon dioxide.

The researchers also plan to include Arctic permafrost in their model. These soils store large volumes of organic materials, as long as they remain frozen. If the permafrost melts, microorganisms will break down the organic material, releasing carbon dioxide and methane. Like nitrous oxide, methane has a much stronger greenhouse effect than carbon dioxide.

Climatologists are also using the MPI Earth System Model to reconstruct the history of climate and carbon cycles more accurately. “We will come to fully understand the processes only when our models correctly reproduce even small variations in the carbon balance,” says Brovkin. Some details still need clearing up, because the curves that represent Earth’s temperature and the atmospheric carbon dioxide levels are like a mountain range: seen from afar, only the major peaks stand out against the horizon, but the closer one looks, the more secondary peaks and spikes appear. The curves associated with climate are similarly ragged.

Once more, the scientists are mainly concerned with gaining a basic understanding of the carbon cycle and its interplay with climate. “Our findings can’t be applied directly to industrial-
ization, because man-made emissions of greenhouse gases have switched cause and effect in climate development,” laments Brovkin. “But they do teach us many things about the relationship between climate and carbon cycles, enabling us to refine our models for prognostic purposes.”

In the medium term, the future course of the great climate play depends mainly on humankind. Then, in the long term, cosmic developments will again take over. And in the very long term, tectonic plates will come into the mix once more ... but that future is far beyond the timeframe relevant to us now, and the one that climatologists are contemplating through their models.

**GLOSSARY**

**Climber-2**
A model of intermediate complexity for simulating climate. It works with a spatial resolution of 5,000 kilometers longitude and 1,000 kilometers latitude and calculates climate in intervals of one day.

**JSBACH**
Land surface model in the MPI-ESM. JSBACH simulates processes on land and contemplates the exchange of heat, moisture and greenhouse gases between the continents and the atmosphere.

**Carbon cycle**
Describes the path of carbon-containing compounds such as carbon dioxide and methane through the atmosphere, bodies of water (especially oceans) and continents. Chemical transformations involving life forms such as microorganisms and plants play an important role in this cycle.

**MPI Earth System Model (MPI-ESM)**
Climate model of high complexity that works with a spatial resolution of about 100 kilometers and a temporal resolution of 20 minutes. It allows more detailed, reliable analysis and prognosis than Climber-2.

**Radiocarbon method**
Enables dating of organic material such as pollen and wood, exploiting the fact that carbon exists in different isotopes. These differ in terms of mass, and the isotope of mass 14 is subject to radioactive decay. The atmospheric isotope ratios remain constant because cosmic radiation produces carbon 14. In plant material, however, the ratio changes with time as a result of radioactive decay.

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The future of energy in her sights: Sibylle Günter, Scientific Director of the Max Planck Institute for Plasma Physics (IPP), puts her faith in fusion – but she also sees the importance of renewable energies.

To consolidate the scientific basis for a fusion reactor – this was Sibylle Günter’s objective when she took up her post as Scientific Director of the Max Planck Institute for Plasma Physics. But ever since the German government renounced nuclear fission, nuclear fusion has also had a difficult time politically. Sibylle Günter must therefore demonstrate, above all, political skill to gain acceptance for this way of generating energy.

Fukushima was not fair,” says Sibylle Günter and laughs. It is not cynical – not condescending laughter. It sounds more like thoughtful, like self-mocking laughter. After all, the sentence that was far and away the one heard most frequently after the reactor disaster in Japan has unintentionally become the main item on Sibylle Günter’s agenda: Fukushima has changed everything.

At the beginning of February, Günter had taken up her new post as Scientific Director of the Max Planck Institute for Plasma Physics in Garching. Six weeks later, a tsunami hit the nuclear power station on Japan’s east coast. Since then, nothing is as it was before: nuclear fusion, the scientific heart of the institute, has suddenly become a target. The technology is designed to generate energy in a power station by fusing deuterium and tritium nuclei, two heavy isotopes of hydrogen, to form helium. It has only the first word in common with nuclear fission, which drove Fukushima into chaos, but nobody is really interested in that.

Ever since, instead of providing scientific momentum as planned, instead of moving the institute forward, instead of conducting research herself, Sibylle Günter has been involved in damage limitation exercises. The important thing is to market her own research field – and to build bridges: between politics and science, between fusion and renewable energies. “I want to put the aspects they share at the focus of the discussion,” says Sibylle Günter.

This is the motto of her time in office, one could say, because it is not only in politics that gulfs must be overcome. The Rostock-born scientist also wants to build a bridge between theory and experimental physics, between children and career, east and west, man and woman.

At the moment, however, it is clear that top priority must be given to efforts to persuade key figures on the political level. Last week, she had a visit from the Federal Minister of Economics. He was followed by the leadership of the Green party in the European parliament. This week, the President of the Federation of German Industry (BDI) announced that he wanted to visit. And the energy experts of the CDU and CSU parliamentary coalition group would also like Günter to give them a tour of the institute. They all are motivated by the question of how safe nuclear fusion is, how reliably it will one day be able to generate energy, and primarily, why it is still needed at all – now, where the expansion of renewable energies is as good as decided and all problems appear to be solved.

The future of energy in her sights: Sibylle Günter, Scientific Director of the Max Planck Institute for Plasma Physics (IPP), puts her faith in fusion – but she also sees the importance of renewable energies.
“Unfortunately, the discussions in Germany are very emotional at present,” says Sibylle Günter. “Quite a few politicians would like to have a simple solution, but simple solutions are usually wrong.” For politicians, simple means: We put as much money as possible into regenerative energies. There is then nothing left for different solutions, not even for nuclear fusion.

**SOLAR THERMAL ENERGY CAN BE ONLY PART OF THE SOLUTION**

“There’s no question about it, renewable energies are important,” says Günter. “But we should not fight each other. Quite the opposite, we should be glad to have different options afterwards.”

Options, alternatives, possibilities: no matter what the topic is, Sibylle Günter always comes back to one of these terms. But the plasma physicist does not stop at slogans – she also has the relevant arguments up her sleeve: global energy demands will spiral to four times the current figure by 2100. The illustration on the left (source: Bundesverband Solarwirtschaft) shows the future trend. In about 40 years, the contribution from nuclear power will be missing, and oil and gas reserves will have been depleted. Sibylle Günter wants to compensate for the loss with fusion. In recent years, its technology has developed at a similar rate to that of microprocessors, whose power depends on the number of transistors that are integrated. The progress that fusion has made is measured by the so-called fusion product, from the values of the plasma density, temperature and energy confinement time that have been achieved.

Global energy demand is expected to increase to four times today’s figure by 2050. The illustration on the left (source: Bundesverband Solarwirtschaft) shows the future trend. In about 40 years, the contribution from nuclear power will be missing, and oil and gas reserves will have been depleted. Sibylle Günter wants to compensate for the loss with fusion. In recent years, its technology has developed at a similar rate to that of microprocessors, whose power depends on the number of transistors that are integrated. The progress that fusion has made is measured by the so-called fusion product, from the values of the plasma density, temperature and energy confinement time that have been achieved.

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Options, alternatives, possibilities: no matter what the topic is, Sibylle Günter always comes back to one of these terms. But the plasma physicist does not stop at slogans – she also has the relevant arguments up her sleeve: global energy demands will spiral to four times the current figure by 2100, and the demand for electricity could increase steeply. Directly next to it she sees the yellow area on her diagram, which stands for solar energy, becomes wider and wider. One click and a pink wedge moves into the dominant yellow. It represents fusion energy – at least from Günter’s point of view. From 2050 onwards, the wedge will compensate the deficit that will result from the renouncement of nuclear power and the slow depletion of oil and gas reserves.

“We need to campaign for politicians to put their faith not only in wind and sun,” says Günter. It sounds self-assured – and quite egoistic: “The nice thing about my job is that I am also fighting for my own specialist field all the time.”

There was not much time to prepare for everything, to understand the tricks and dodges of politics, or to learn how to lobby. Günter learned that she was to become the Scientific Director in October last year. She moved into her office in February. Fukushima was in March. She had been able to accompany her predecessor, Günther Hasinger, on political visits a few times, giving her a crash course in diplomacy. Then she was in at the deep end. “There are no seminars for this kind of thing. One simply has to look and see how things work,” says Günter tersely.

It certainly helped a little that fusion researchers have never had the easiest of positions. A scornful phrase that is often bandied about is that nuclear fusion is always 40 years away. Cynics call it a fusion constant, a time period decreed by nature. “I know all the jokes,” says Günter and calls up a second diagram – a kind of defense against all the malice. It shows how the mathematical product of density, temperature and energy confinement time has developed over the years. The value is considered to be the most important parameter for the success of fusion research. It shows how close the scientists are to igniting the solar fire on Earth.

The curve on Günter’s laptop increases steeply. Directly next to it she has drawn the same graph for Moore’s law – the empirical formula that states
that the number of transistors on a computer chip doubles every 18 months. The two lines hardly deviate from each other at all. “Nobody would argue that the computer industry has not made rapid progress,” says the plasma physicist. “Our success parameter has increased just as fast.”

**FUSION STILL HAS AN ENERGY PROBLEM**

This may all be reasonable and scientifically correct, but Günter is realistic enough to know that the only thing that counts in politics is the result, and fusion is still inputting significantly more energy into its experiments than is being output afterwards.

This is not going to change very quickly, either: ITER, the largest test reactor for nuclear fusion to date, is currently being built in Cadarache in the South of France. Its purpose is to show that the reaction will provide more energy than is needed to maintain the high ignition temperature. The reactor should be completed in 2020, and the crucial experiment is planned for 2027 – if the scientists can obtain the 15 billion euros that ITER is now expected to cost.

“The taxpayer has a right that we say: That’s enough, ITER must not cost any more,” says Sibylle Günter. “But it must not be the case that there is then no money left for research into other aspects of nuclear fusion.” The Institute Director again has the appropriate fig-
The solar fire on Earth: In the interior of the star, two protons (red) first convert into a deuterium nucleus (\(^2\text{H}\)), whereby one proton becomes a neutron (blue), and one positron (green) and one neutrino (black) are released. In a second step, the deuterium nucleus fuses with a further proton, emitting a quantum of gamma radiation and forming a helium-3 nucleus (\(^3\text{He}\)). This finally fuses with another helium-3 nucleus to form helium-4 (\(^4\text{He}\)), releasing two protons in the process. In the Earth’s fusion reactor (right), helium-4 is obtained by fusing one deuterium nucleus (\(^2\text{H}\)) with one tritium nucleus (\(^3\text{T}\)), and one neutron is released in this process.

The disciplines mathematics and physics had been particularly interesting at school; plasma physics, because it was one of the highlights at the University of Rostock; theoretical plasma physics, because it was no fun being an experimental physicist in East Germany, and there was hardly anything to do research on. “They had to collect parts for their instruments from scrap heaps, and this did not appeal to me,” says Günter. Pencil and paper became her tools.

**COURAGEOUS CHANGE OF DISCIPLINE AFTER TEN YEARS**

She wrote her doctoral thesis on dense plasmas – a topic that has nothing to do with magnetic nuclear fusion at all. She became pregnant. In December 1989, as East Germany was going through monumental changes, Sibylle Günter handed in her doctoral thesis. Six months later, now a young mother, she defended her thesis. The baby was ill and she was ill, but the defense was nevertheless successful. “It was not easy to obtain my doctorate with a small child, of course,” says Günter today. “But really, there is never a reasonable time to have children. If you want children, you simply have to go ahead and have them.”

After the fall of the Berlin Wall, science in Eastern Germany changed. Computers opened up new possibilities; the gulf between theory and experiment started to close. And Sibylle Günter was bang in the middle. The scientific child of reunification, with a new doctorate under her belt, was confronted with a problem: nearly all the interesting positions in Eastern Germany were already taken; there was no job in sight for the foreseeable future.

Sibylle Günter decided to take the plunge: In 1996, after ten years in the field of dense plasmas and directly after obtaining her post-doctoral lecturing qualification, she moved to Garching – into fusion research. “I felt like a student again,” she said. “I went to specialist conferences, where I didn’t know anybody and didn’t understand a word.” It was a challenge, but also a motivation. Günter, the theoretical physicist, linked up with the experimental physicists in Garching. She had them explain the discipline to her, and had to listen to stupid jokes, but she convinced her colleagues by predicting the result of the experiments.

Today, more than ten years later, theory and experiment are closely intertwined in plasma physics. There is hardly a talk that makes do without equations, without theoretical background knowledge. Mainframe computers have helped to successfully simulate experiments. The researchers have also been helped by a willingness to research the fundamental questions of the discipline, rather than just chasing after the ultimate goal of making fusion work. “We want to understand details, not just turn knobs,” says Günter. “The good interplay between theo-

ures to hand to support her arguments: Only two percent of the income from the Renewable Energy Act goes into research. The growth rates in energy research are still significantly below those of research into health issues. Not to mention the coal subsidies … Not to mention the coal subsidies … Not to mention the coal subsidies … Still, with the latter it is certain that energy will be generated afterwards. This is why every day is directed at this is science, and this is precisely why our work every day is directed at this is science, and this is precisely why our work every day is directed at this is science, and this is precisely why our work every day is directed at this is science, and this is precisely why our work every day is directed at this is science, and this is precisely why our work every day is directed at this is science, and this is precisely why our work every day is directed at this is science, and this is precisely why our work every day is directed at...
ry and experiment has become the hallmark of the Max Planck Institute for Plasma Physics.”

**THEORETICAL MODELS REVIVE THE STELLARATOR ANEW**

Wendelstein 7-X, an experiment the institute is setting up in Greifswald, is such a child of theory. Its concept, where the plasma is confined with the aid of three-dimensional solenoids, was already dead. Too complicated, not manageable enough. The theoretical models of the Max Plack researchers revived the stellarator, as this type of reactor is known. In the experiment, it now has to prove that it provides an alternative to tokamak reactors, to which ITER also belongs.

For Günter, this means that she has to build bridges between the old-established institute in Garching and the new part on the Baltic. The sub-institute in Greifswald was established in 1994, a classic child of German reunification: a project to improve the regional structure. Today, the Greifswald institute is one of the largest employers in the region. If something interesting happens there, it is in all the local newspapers. On the Garching campus, by contrast, the IPP is just one institute among many.

That is not the only difference: Garching does research, while Greifswald is building a huge machine. “If you are separated by 800 kilometers, and if one part of the institute has completely different problems, you grow apart,” says Sibylle Günter. “We need to actively do something to prevent this, so that it remains a joint institute.” She is in the process of intensifying the scientific contacts and initiating joint research projects. Günter was born in the state of Mecklenburg and travels back to her home state at least once a month. At the moment, it is more like once a week – to accommodate leading politicians such as Messrs. Rösler, Büttikofer & co. who want to have a tour through the Eastern German institute.

“When I talk to taxi drivers in Greifswald, they are extremely interested in our work. They have a positive at-
A FEMALE SCIENTIST SHOULD BE A ROLE MODEL FOR GIRLS

The Director prefers to talk with multipliers, with politicians, with journalists. In Greifswald, the Max Planck researchers recently started a project to train teachers. “Since fusion is still quite a way off, an advertising campaign is pointless. Education is the ideal solution,” says Sibylle Günter, who is now unstoppable: “The problem in Germany is simply that science education is in an extremely bad way. We need to change this in the long term. It cannot be done by the day after tomorrow.”

Female teachers, in particular, have a duty here, according to Günter’s point of view. They need to encourage girls, who are still greatly underrepresented in the natural sciences. They should be role models for them. Günter herself has done her part. When she was appointed to the management team of the IPP in 2000, she was the youngest female to ever become a Max Planck Director. “It is very important for girls – even for those from high schools who visit us – to see that women can do such things.”

She was only partly successful here with her own daughter, Stefanie, of all people. The baby whose illness once almost prevented her from defending her doctoral thesis is now 21 – and studying medicine. Really. For a long time, physics was also on her short list, but then she decided against science and for patients. But, in a way, the daughter is following in the footsteps of the mother. In the early 1980s, Sibylle Günter couldn’t make up her mind between medicine and physics, either. “But then I decided that I’m too lazy for medicine,” says Günter and laughs.

There is not a trace of laziness these days, though: her working day is well planned. Sibylle Günter starts it in the imposing Director’s office. There, on the top floor of the administration building, in front of the wall unit and beneath the colorful picture of a forest, she manages the issues of the institute with its 1,100 or so staff. After lunch she goes down to her old researcher’s office – it has no air conditioning, but it is filled with books and articles. Günt-
er supervises degree students, doctoral students and post-docs, discusses with colleagues, engrosses herself in science. “The people in the administration think this is somewhat strange,” says Günter. “But I want to be where my science is happening.”

In recent months, Günter has had hardly any time for this. Too often she was travelling, too often politics required her involvement. After all, Fukushima changed everything. There was no possibility of her taking a holiday. One sailing trip with colleagues in Greifswald is all she has been able to manage.

Sibylle Günter is convinced that these exceptional circumstances will last until the end of the year. Her hope is that, sometime next year, they, too, will be a thing of the past. “Greater rationality will return to the discussion when the switch to sustainable energy has to be put into practice, if not before,” says the Director. And then her work will calm down as well. Sibylle Günter, at least, is confident that she can convince the politicians of the purpose and success of nuclear fusion – so confident, in fact, that she has already booked her skiing holiday for next February.

GLOSSARY

Nuclear fusion
A fusion power station aims to produce energy by fusing deuterium and tritium nuclei, two heavy hydrogen isotopes, to form helium. The fusion reaction ignites in a hot plasma of more than 100 million degrees Celsius. Since the plasma will cool down immediately if it comes into contact with a material, it is confined in a magnetic field without coming into contact with the wall. The challenges of fusion research include confining a stable plasma, developing suitable materials for the high loads in the reactor, and proving that more energy is produced by the fusion reactions than is required to generate the plasma.

Stellarator
A type of reactor that generates the twisted magnetic field that is required to maintain a stable fusion plasma with the help of solenoids that are twisted like a Möbius strip. This type is more demanding than a tokamak in terms of construction, but theoretical investigations show its operation should be easier to manage.

Tokamak
This is the name of the fusion reactor on which most research has been done so far. Solenoids arranged in a circle generate a toroidal magnetic field. This must be twisted like a spiral so that the plasma inside remains stable. The twisting results when a current flows through the plasma. The generation of the plasma current causes operational problems that do not occur in the stellarator, the alternative type of reactor.

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The Short March to Capitalism

Old Buddhist temples, rural underdevelopment and extreme poverty on the one hand, skyscrapers, high-tech and world champion in exports on the other: during the past 40 years, China has surged forward to catch up with the industrialized nations. Tobias ten Brink at the Max Planck Institute for the Study of Societies in Cologne is researching the causes of this economic boom, as well as the factors that could lead to the destabilization of the Chinese success model.

When Chinese premier Wen Jiabao and 13 of his ministers visited Germany in mid-June this year, the press was hot on his heels. Newspapers reported almost daily on the status of Sino-German relations – albeit rarely without some mention of human rights abuses and crimes against the environment in China.

So far, so good, says researcher Tobias ten Brink, given that such circumstances do indeed exist in China’s one-party state. “But when the German media criticize employment conditions in China or present the country’s hunger for raw materials as a threat, while forgetting to mention that Western businesses in particular are largely responsible, that’s very one-sided,” the political scientist explains.

Without foreign direct investment, the about-face from Mao to market economy would scarcely have been so successful. In the course of globalization, many Western industries have recognized the opportunity and invested in China. Since then, huge numbers of mainland production plants have served as cheap workbenches at which workers are paid a pittance to assemble products on behalf of European, American and Far Eastern companies. “Many Chinese exports at present are “Chinese” only in the sense that they are assembled in China. This means that the bulk of the profits are pocketed by multinational groups rather than local producers or suppliers,” says Tobias ten Brink.

Nevertheless, the multinationals have not been the only ones to capitalize on this development. The investments and tax revenues have enabled
In just 40 years, China has become a driving force in the global economy.
Not only have the Chinese since become world-champion exporters, but they are continuing to extend their lead.

the People's Republic to catch up rapidly. In just 40 years, China has become a driving force in the global economy. Not only have the Chinese since become world-champion exporters, but they are continuing to extend their lead. The spectrum of goods from the Far East ranges from toys, bicycles, shoes and domestic appliances to digital cameras, computers, cell phones and automobiles.

SUCCESS THANKS TO FAVORABLE CONSTELLATIONS

Economic experts agree that low wage costs are not the sole reason for the substantial increase in foreign direct investment. “China’s success is largely contingent on factors that have not been influenced by the Chinese ruling elite, but that are based, instead, on favorable global economic and Far Eastern constellations,” says ten Brink.

The fuse was lit, for instance, as economic development stagnated in the traditional centers of capitalism. “The Chinese looked good because the rest were shabby in comparison,” explains the researcher, describing the situation in the 1990s when Western investors had pockets full of money and did not rightly know where to invest it. “In those days, there was a dearth of investment opportunities with too much available capital and too few worthwhile ways to invest it, which is why the investment rate in Europe, North America and Japan was so low.” Regardless of the risks that prevailed 20 years ago, investors were attracted by the promise of better profits in China’s fast developing economy.

CHINA’S ADVANTAGE OF UNDERDEVELOPMENT

From the very beginning, the main business took the form of exports to the traditional centers of capitalism. It is this that distinguishes China from, say, the US, where, since the 1990s, growth in gross domestic product has owed far more to credit-fueled consumption than to investment.

China’s ascent, on the other hand, according to Tobias ten Brink, has been driven by precisely the opposite forces: “The boom was based on unparalleled levels of investment and a comparatively low rate of consumption.” In addition, China discovered the advantage of underdevelopment and made the transition from the cheap workbench of the Western industrial countries to a serious competitor with products of its own.

The market-leading computer manufacturer Lenovo, which has lured customers away from the likes of Dell and Apple, is just one example of how China has succeeded in catching up by adapting existing technologies and processes. “Even though the Chinese may appear to be very good at it, that doesn’t mean they are the only ones to get ahead by copying,” says the Max Planck researcher. “We find the same thing in

Tobias ten Brink of the Max Planck Institute for the Study of Societies is investigating how, in just 40 years, China has risen from a developing country to become the world’s second-largest economy.
the history of virtually every developing and emerging country – German companies did the same at the end of the 19th century."

Another important factor cited by Tobias ten Brink in China’s unparalleled economic growth is the prominent interventionist role played by the state: “This, in particular, is what makes China so exciting for me, in that the typical distinction made in the social sciences between economics and politics is even less prevalent than in liberal market economies.” This particular feature also makes the country an interesting subject for comparative political economists.

**THE STATE CREATES THE BASES FOR CAPITAL FLOW**

In China, central government plays a decisive role in that, over and beyond its administrative and legislative functions, it creates the bases for the flow of capital – for example by providing a functioning transport, energy and communications infrastructure.

In addition, the state not only controls important industrial enterprises, but it also has a hand in the financial transactions and investments undertaken by major banks. Tobias ten Brink cites the huge economic stimulus programs that were set in motion during the global economic crisis as an exam-
ple of the “substantial economic policy freedom” that Beijing enjoys as a result of its control of the purse strings.

ANCHOR OF THE GLOBAL ECONOMY

When, during the global economic crisis of 2008/2009, the Chinese economy, too, began to falter, the government initiated the world’s largest economic stimulus package relative to GDP, worth the equivalent of around 460 billion euros. This not only saved the domestic economy from collapse, ten Brink believes. “At the time, China proved to be the sheet anchor of the global economy. Growth in the People’s Republic was probably the single most important factor in preventing the global economy from falling still further.” Because this state interventionism, coupled with a marked spirit of liberal market enterprise, was oriented more toward macroeconomic parameters than toward the needs of the population, in ten Brink’s view, the system is not what the Chinese Communist Party imagined when it decreed a socialist market economy to be the official line: “It’s rather the case that a new version of capitalism has emerged in China, a form of state capitalism driven by competition that combines some extremely heterogeneous production regimes, types of enterprise and government policies. The growth this model has achieved should cause every defender of the free market to fall silent.”

This does not, however, mean that there are no risks of destabilization. “The extremely high dependence on the world market entails some substantial risks,” says ten Brink, citing one of the greatest hazards that could bring the Chinese dragon crashing down to earth. The negative effects of this dependence made themselves felt in the years 2008 and 2009, when Chinese exports fell by a quarter as a result of the global crisis and the end of the consumer boom in the OECD member states.

MILLIONS OF PEOPLE LOST THEIR JOBS

“In the electronics and textile industries, which produce mainly for the world market, but also in other sectors, the number of layoffs ran into the millions. On top of that, the credit squeeze meant that there were fewer financial resources available for foreign investment in China,” explains Tobias ten Brink.

The obvious idea of ending the dependence of the Chinese economy on the global market by stimulating domestic demand presents the government with another problem. “To do so, wages would have to rise considerably, and the social security systems would have to be massively expanded. This, in turn – in the view of a large element of the ruling elite – would eliminate China’s principal competitive advantages in the shape of low labor costs and taxes.”

The scientist sees a further problem in the political system itself. Despite the stubbornly persistent impression of China as a unitary state under the total top-down control of the communist party, the image in reality is very different. Describing the reality in China, which resembles not so much a strict dictatorship as a fragmented party state, he explains: “The very fact that there are 22 provinces, five autono-
China may be a unitary state, but local authorities play a large role. What’s more, the government of this vast country is divided into five levels, rendering control down to the last detail practically impossible. The photo left shows a meeting of the “Chinese People’s Political Consultative Conference.”

mous regions and four cities with provincial status all coexisting side by side means that the picture on the ground is fairly disparate.”

Moreover, the division of government into five hierarchical levels makes it impossible to exercise control down to the last detail. Local government officials and representatives of the various authorities play a correspondingly large role. On the basis of ten Brink’s observations, they do not restrict themselves merely to administrative duties, but also participate in the economic life of their region. “In practice, they are not just supportive, but they also assume economic activities and develop competencies similar to those of an entrepreneur,” as the researcher discovered on his visits to the country.

“The relationship between party, state and entrepreneurs of all kinds is very close,” says ten Brink. “Around 90 percent of the 20,000 wealthiest Chinese have strong, frequently family-based relations with high-ranking government or party functionaries.” The varied alliances between parties are also supported by bribery and corruption, with regional economic subsidies in center field. One result has been, for example, the emergence of lively competition between city governments attempting to attract a maximum of subsidies and investors for their region. However, there is a downside to this internal Chinese competition between locations. “There’s evidence of overinvestment and duplication of investment resulting from this anarchic rivalry,” Tobias ten Brink reports. Speculative real estate market bubbles are threatening to burst, while an increasing number of loans are proving to be unrecoverable. “This could provoke a financial crisis, which the State Council, the Finance Ministry, the Central Bank and other political organs, such as the Huojin state fund, must try to overcome.”

ECONOMY AT RISK THROUGH SOCIAL INEQUALITIES

Should the global economy not recover to the extent expected, the entire system is in imminent danger. The government in Beijing has recognized this fact, and has been attempting for some time to reduce lending levels. However, in accordance with the laws of physics, the Chinese locomotive has a long braking distance.
The huge social inequalities in this, the world’s most populous country could also prove to be a wrench in the works. Measured by GDP, China has overtaken Japan as the world’s second-largest economy. However, given that income differentials play no part in its calculation, GDP alone tells us nothing about the distribution of prosperity within the country. “According to recent estimates, 0.4 percent of households hold over 70 percent of the wealth. Wages as a proportion of GDP have fallen from 53 percent in 1992 to around 40 percent in 2006,” says ten Brink.

Thus, in China, there are a comparatively small number of people from the economic and political elites ranged against millions of ordinary workers. Many of the latter are low-paid migrant workers wandering in search of work. For decades, they formed the backbone of Chinese economic development, silently laboring on assembly lines, making goods for the West for a pittance in wages.

**INJUSTICES PROVOKE RESISTANCE**

But now the locomotive is no longer running so smoothly. People are hitting the streets with ever greater frequency to let off steam and to protest prevailing injustices. In Tobias ten Brink’s view, the awakening of resistance goes hand in hand with a behavioral change at the grassroots level in society. “Migrant workers are settling in the cities and developing social aspirations,” he says. “During the wave of strikes in Guangdong province in the summer of 2010, there were aggressive demands for better pay; the striking workers held meetings and elected their own delegates.” The government is evidently
Even if China were to achieve the goal of 4 percent inflation in the current year by the skin of its teeth, Tobias ten Brink does not see this as the end of the Chinese success story.

aware of the risk of destabilization resulting from such tendencies. However, its reactions illustrate the deep dilemma in which it finds itself.

Caught between public promises to increase consumption and expand the social security system to satisfy the growing aspirations of the working population on the one hand and the continuing belief in the competitive advantages of low wages on the other, the government’s approach to crisis management oscillates between firm-but-fair authoritarianism and disorganized despotism.

It responds to pressure by exerting counter pressure, but also with laws and real programs designed, for example, to raise the minimum wage and expand social infrastructures. “According to official figures, 20 percent of the economic stimulus package valued at the equivalent of 460 billion euros has been invested for such purposes,” adds ten Brink. Government maintains that the money has been used to pursue social security programs based on Western models. In Tobias ten Brink’s opinion, these efforts to create a social partnership founded on a balance of interests “pay more than just lip service” to the state’s ideal of a harmonious society.

Then again, such measures do not go far enough. “They were insufficient either to stem the wave of protests or to guarantee a stronger domestic market.” The scientist also doubts whether the regulations that raise the minimum wage will be universally implemented in the provinces. Against this background, he considers it “less than likely” that social injustices will be checked.

Above all, however, there is a lack of any functioning workers’ representation. Where such a thing even exists on the factory floor, the representatives of the state trade unions are more likely to act as “co-managers and organizers of leisure activities” than as upholders of workers’ interests. Their close ties to the party state in any case impede any independent trade union work. Higher minimum wages have also caused major foreign businesses to transfer parts of their production to provinces in the interior in order to profit from the lower labor costs they find there.

Even if China were to achieve the goal of 4 percent inflation in the current year by the skin of its teeth, the end of the Chinese success story may not yet be in sight. “Growth in China, as in other economies, follows a cyclical course,” explains ten Brink. It is entirely normal that periods of high GDP growth should be interspersed with periods of lower growth.

**NO CAPITALISM WITHOUT CRISES**

“Nevertheless, the dangers are real,” ten Brink emphasizes. “Just as many favorable circumstances combined to dynamize the economy, there are also downsides that could trigger the opposite effect.” The factors that have powered the Chinese economic miracle could, in the end, prove to be centrifugal forces that send it off at a tangent. Besides the dependence on exports and fluctuations in the global market, Tobias ten Brink sees social injustices as a particular source of risk.

All in all, he believes that China is by no means a unique exception: “The argument that China is China and, as such, cannot be compared with anywhere else is a myth.” Accordingly, he regards it as an important part of his task as a political scientist to seek comparisons with other manifestations of capitalism. He is not just interested in exciting details; he is also looking for evidence that the universal features of capitalist modernization can be identified in China. This would once again prove that there can be no capitalism without crises and social contradictions. “That is equally true of the new Chinese capitalism.”

**GLOSSARY**

**OECD**
The Organization for Economic Cooperation and Development has a membership of 34 states. The objectives of the OECD, founded in 1961 with headquarters in Paris, include contributing to optimum economic development, higher employment and a rising standard of living in member states and developing countries and expanding world trade on a multilateral basis.

**Socialist market economy**
The official term used by the leadership of the Chinese communist party to express its doctrine that the People’s Republic, with the aid of a partial relaxation of the market, is in a transitional stage on the way to becoming a fully developed socialist society. Accordingly, the market is merely an instrument in the development of the national economy and is kept under control by the party state.

**Comparative political economics**
Comparative political economics is concerned with the interactions between the economy, politics and society in different countries and regions. In order to achieve a better understanding of the causes, forms and mechanisms of the change that is taking place in economic institutions under conditions of increasing internationalization, this discipline studies the role of national politics and other social institutions in the creation of diverse manifestations of capitalism.
A century has passed since the German science world underwent rapid development in conjunction with the then-booming chemicals industry. The two chemistry institutes of the newly founded Kaiser Wilhelm Society were officially opened by the Kaiser himself in 1912. The first Director of the Institute for Physical Chemistry was Fritz Haber – a brilliant scientist whose achievements, however, were not without controversy.

The Kaiser was punctual, but the weather left something to be desired for the guests who had gathered in pastoral Dahlem on October 23, 1912. The occasion was the official opening of the Kaiser Wilhelm Institute for Physical Chemistry and Electrochemistry and the Kaiser Wilhelm Institute for Chemistry. According to the official program, the distinguished persons from the fields of business, science and politics were to assume their standing places in the narrow library of the Institute for Chemistry by 9:45 a.m. sharp to await the arrival of the Kaiser, who would make his way by car to Dahlem, which, back then, was still a rural village enclave on the outskirts of Berlin.

Although the ceremony took only half an hour to complete, great hopes and aspirations were riding on the event. The new institutes aspired to expand knowledge and expertise in two scientific fields in which German research already enjoyed world renown and which, based on their practical applicability, were expected to yield very concrete gains for the country’s booming industrial sector. Both institutes operated in accordance with the principles of the Kaiser Wilhelm Society (KWS), which had been established in 1911 as an innovative association for the advancement of science, and which had also resolved to establish two research institutes of its own within the first year of its existence.

Following the rapid construction of the institute buildings, which took just 11 months, the scientists quickly settled into their, for the time, technically sophisticated laboratories and offices. Ernst von Ihne, an architect already renowned for the design of such prestigious buildings as the Königliche Bibliothek (later known as the Berlin State Library), also designed the new institute buildings. Despite their distance from the center of Berlin, he gave them quasi-palatial façades to lend them a representative grandeur.

Enormous expectations rested on the Directors of the new institutes. The KWS succeeded in recruiting chemist Fritz Haber for the Institute of Physical Chemistry. Haber was responsible for the research carried out there over the following two decades and, in memory and honor of this brilliant – but also controversial – scientist, the institute has borne his name since its incorporation into the Max Planck Society in 1953.

The son of a Jewish paint and chemicals merchant, Haber was born in Breslau in 1868 and completed his doctorate in chemistry in Berlin in 1891. He embarked on his career as a scientist at Karlsruhe Technical University, where he made a name for himself with the publication of the first textbook on electrochemistry, a subject which was then emerging as a separate scientific discipline that combined innovative methods from physics and chemistry. He achieved his scientific breakthrough with the ammonia synthesis process, which he developed in 1908 and later perfected for industrial production together with Carl Bosch. The process enabled the cost-effective synthesis of ammonia from hydrogen and atmospheric nitrogen.

Given that ammonia was the basic component of artificial fertilizer, the process had a wide range of potential applications. At a time of expanding cities, declining child mortality and the general mobilization of resources, the resulting increases in agricultural yields provided a solution to looming social problems. Thanks to the Haber-Bosch process and the ability to make “bread from air,” famine revolts became a thing of the past.

Leopold Koppel, a Jewish banker, was a key supporter of Haber’s appointment to the institute. Koppel had had the foresight to invest in the light bulb industry, and his company had made enormous profits from the rapid spread of artificial lighting to roads, railway stations, factories and homes. Koppel’s bank also invested in the iron industry, safe and bank vault construction, and in the Berlin hotel sector, including the prestigious Grand Hotel Bristol. Shortly after the turn of the century, he was one of the richest men in Prussia. Awestruck visitors reported that his villa in Tiergarten, Berlin’s posh embassy quarter, contained “rooms full of Rembrandts, Rubens and Van Dycks.”
A new campus on the green field: The Kaiser Wilhelm Institutes for Chemistry (second building from the left) and for Physical Chemistry and Electrochemistry (second building from the right) following their official opening in 1912.

But vast reserves of money and education did not automatically equal social recognition, as the influential German middle class was unwelcoming and even blatantly hostile in its attitude toward Jews. Moreover, baptism, for which Haber opted as a young man, no longer provided unrestricted access to German-Christian society. Endowments therefore provided an effective means of securing a foothold on the social ladder. Science offered wide-ranging possibilities in this context since, even though it was viewed as the field of the future, it was still struggling for recognition and thus welcomed the support of wealthy, upwardly mobile outsiders.

Based on its mission of making scientific insights profitable through industry-oriented synthesis and catalyst research, Koppel was persuaded to donate a large sum of money to Haber's Institute for Physical Chemistry. The expectation of the Institute's rapid success was further cemented by Haber's reputation for burning the midnight oil. With 700,000 marks – the equivalent of around 3.5 million euros today – Koppel donated the lion's share of the funding for the construction of the institute building. The fact that his desire for social recognition was an important motivation for this generous donation is substantiated by the program for the ceremony of October 23, 1912: the tightly scheduled proceedings allowed time for a brief personal encounter between the Jewish banker and the Kaiser. Having been honored in this way, Koppel did not hesitate to provide a further 300,000 marks.

The practicality of the research carried out at the institute was clearly demonstrated to the Kaiser during his tour of the laboratories. He inspected an innovative gas interferometer that could accurately detect the presence of hazardous mine gas in the air and prevent explosions underground. The Kaiser also praised as "colossal" the testing of gas and water pipes that were under strong attack from the corrosive effects of "vagabonding tram currents."

However, no one could have predicted on that day in October 1912 that gas research would ultimately shape the institute's early years of activity. World War I broke out just two years after the opening and, like most German intellectuals, Haber welcomed the conflict with open arms.

In accordance with his motto "In peace for humanity, in war for the Fatherland," Haber placed his scientific talents entirely at the disposal of the national cause of German victory in the war. Beginning in 1916, his institute was under the Supreme Army Command, and Haber himself was appointed Director of the Central Office for Chemistry at the War Ministry in 1914.

Fritz Haber viewed the use of poison gas by the artillery as a particularly promising addition to modern weaponry. Contrary to expectations, the German advance had ground to a halt just two months after the start of the war, and the fighting on the western front had stagnated into trench warfare. This put the Germans under considerable stress, as ammunition was running low due to problems with nitrate imports. Although Haber's ammonia synthesis opened the door to the artificial production of this basic material, large volumes of poison gas weapons could be produced faster and more cheaply from industrial waste products.

Thus, the new weapon was used for the first time on Haber's advice when the Germans launched a renewed attempt to break through the front in Flanders in April 1915. The resulting breach of the laws of war, which prohibited the use of chemical weapons, was accepted with the fatal consequence that their use quickly became established on all sides of the conflict.

Fritz Haber and his institute became the driving force behind the development of this new war technology. The institute developed gas weapons and respiratory filters for masks to protect the soldiers and military horses against chemical attacks from both their opponents and their own weapons in the event of a change in wind direction. Haber, who was appointed a captain, led the frontline action himself. Despite establishing his public credentials as a patriot, in moral terms, his involvement in the war effort proved fatal. His wife, Clara Immerwahr, a chemist and pacifist, shot herself in 1915 using Haber's service weapon. At the end of the war, Haber had the distinction of being honored by the 1918 Swedish Academy of Sciences with the Nobel Prize in Chemistry, while simultaneously being vilified as a war criminal by the Allied victors.

After the war, the focus of the work carried out at Haber's institute shifted to basic research. X-ray crystallography and theoretical chemistry, which availed of the insights and approaches developed by the recently emerged discipline of quantum mechanics, became important research fields for the institute. Subsequently, such renowned scientists as James Franck, Michael Polanyi and Herbert Freundlich all started out as members of Haber's team at the institute.

Among the researchers from all over the world who frequented the social circle at Haber's villa was Albert Einstein who, despite his pacifist beliefs that contrasted starkly with Haber's nationalistic and conservative views, had been a close friend of Haber's since 1911. Haber's institute enjoyed an excellent reputation throughout the world. In the late 1920s, almost half of its employees came from abroad, including – as had been the case even before 1914 – Japan, a country in which Haber had a particular interest.

The first phase in the history of today's Fritz Haber Institute came to an abrupt end a good 20 years after its establishment with the coming to power of the National Socialists. Affected both personally and as Director of the institute by the new anti-Semitic laws, which excluded Jews from public appointments, Fritz Haber applied for retirement in 1933. Profoundly depressed at the developments there, he turned his back on Germany and died in Basel, Switzerland in 1934 at the age of 65.
Quotation Marks and Gut Instinct?

Workshop on good scientific practice reveals uncertainties

“Listing your sources is not as simple as many think. There’s a lot of advice to be had, but what is correct and useful?” Lea Heimbeck doesn’t generally give the impression of being clueless, but the doctoral student’s account at the MPI for European Legal History was received with widespread nodding. At least 20 budding junior scientists attended the workshop on “Good scientific practice?” with an intentionally provocative question mark in its title. The workshop was organized by the MPI in response to the call issued by the MPS ethics council following the Guttenberg affair to increase training efforts in this area.

There is a great deal of uncertainty, although one might think that many of the rules for scientific work must be established in writing somewhere. However, Volker Rieble, a labor law and plagiarism expert from Munich, confirms this: “I receive 150 e-mails every week with the words ‘I’ve got a citation problem.’” Skillfully approaching science as a social practice and pointing to blind spots in the current debate, separating legal and moral considerations from one another and looking at manners, conventions, trends and styles of the jurist as a solitary researcher, Miloš Vec offered a rousing tour de force through the thicket of standards, covering both quality and originality. The legal expert from the MPI, who also regularly works as a journalist, did not leave out the “attention industry of the media.” He described the academic discourse as a personal source of socialization, and proved that he himself is professionally adept at acting according to his own advice: thinking from a perspective of everyday work.

But how far will it get you? Is “ethics” even the correct word to use in connection with quotation difficulties, or should one rather speak of “techniques of the trade?” What is proper, what is correct? Are the “Rules of Good Scientific Practice” of the Max Planck Society useful? Miloš Vec would at least like to see rules adapted to the different fields of research, and Volker Rieble, who considers the MPS rules “too general,” advocated minimum standards when it comes to citations.

The difficulties that doctoral students struggle with in practice were underscored by the survey Lea Heimbeck carried out ahead of the workshop — “in a desperate attempt to find clarity.” She asked 15 doctoral colleagues to mark the places in one and a half pages of text taken from her thesis that they thought required footnotes. The result was astonishing. “Some people expect footnotes in places where I state my own thoughts, sometimes even if I state my own thoughts in several students’ papers is ‘we worked on it together in the team.’”

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In a short lecture about the problems involved in inter-disciplinary collaborative research, Thomas Duve explored the increasingly confused concept of authorship. Volker Rieble concluded the day with an evening lecture on the debate about scientific plagiarism and made a prediction: “There will eventually be consensus in this matter, because the scientific community is professional.”
Twittering from Space

Tweeters in a typing frenzy: MPS makes use of DLR and ESA social media campaign

For German Aerospace Day on September 18, the European Space Agency (ESA) and the German Aerospace Center (DLR) invited 60 tweeters to Cologne. Michael Frewin, who is responsible for the Max Planck Society’s Twitter channel, reported live @maxplanckpress.

The universe: Infinite space. Unbroken silence. And then it goes “ping.” When astronauts twitter, they have many readers on computers and mobile phones. The messages, phrases and images from space are distributed in a matter of seconds via social networks to the online community of aeronautics and aerospace buffs. There is not a rocket launch at NASA that is not reported live. Of course it is broadcast on TV, but it is also on Twitter, Facebook, etc.

The PR and communication strategists of the US space agency target nerds and journalists, who are usually active users of the social networks, and provide them with information. In Europe, this new type of corporate communication is still in its infancy, but it is growing fast. For example, in mid-September, the social media managers of ESA and DLR sent out invitations to the first European aerospace Tweetup. Of the 418 who registered their interest, 60 were given the opportunity to conduct exclusive interviews with astronauts in Cologne, listen to talks and visit, among other things, the Stratospheric Observatory for Infrared Astronomy (SOFIA), the Airbus 380 prototype and the European Astronaut Center (EAC).

An Aerospace Tweetup? It sounds very hip, and it follows a simple recipe: “You put 60 space freaks in a tent and feed them information,” explains Michael Frewin, who twittered mainly about missions in which Max Planck took part. “The tweeters hardly speak to each other. They all try to report any news as it happens.” Many of the participants had already attended similar events. To Michael Frewin, it was uncharted terrain: “serious geek territory.”

Besides the technical details of an expedition, many people want to know more about everyday life in space. What does a flute sound like on the ISS? What does a normal workday look like? Spellbound, the audience listens to the stories. “Astronauts have the same status as Nobel Laureates,” Michael Frewin says. During the event, Michael Frewin sent 167 tweets, 43 of which were forwarded. In 54 cases, other tweeters replied, starting a conversation. During the campaign, around 35 new tweeters subscribed to the Max Planck Society’s channel.

“The objective of the Society’s participation in the SpaceTweetup was to get an idea of the utility of such social media campaigns for internal communication and events organized by the Max Planck Society,” explains Felicitas von Aretin, Head of Corporate Communications. “In the future, we will incorporate small-scale social media reporting in our portfolio.” It is especially useful for events that target young, media-savvy interest groups, and for dealing with highly newsworthy topics.
14 ERC Starting Grants awarded to Max Planck researchers

An application to the research council is well worth the effort. Each Starting Grant recipient will receive up to two million euros over a period of five years. But the competition is stiff: the number of applications to the three ERC fields Life Sciences, Physical Sciences & Engineering, and Social Sciences & Humanities rose by 42 percent over the previous year, to 4,080 in 2011 (there were 2,873 applications in 2010). Nevertheless, Max Planck researchers performed above average. A total of 14 Starting Grants (including one that was awarded to a young female researcher at the Dutch MPI for Psycholinguistics, which is not listed in the German grant statistics) make for a success rate of 22 percent, thus beating the EU average of 12 percent for successful applications.

This result puts the Max Planck Society right at the top in Germany. Other successful institutions include the Helmholtz Association (7 grants), University of Freiburg (5), TU München (4) and the Universities of Hanover and Bonn (3 grants each). Within the MPS, the MPI für Kohlenforschung and the Fritz Haber Institute did best: two scientists at each of these institutions secured the sought-after distinction: Martin Stetter and Alexandre Tkatchenko (FHI), and Manuel Alcarazo and Nuno Maulide (MPI für Kohlenforschung). The other recipients were: Elisabeth Binder (MPI of Psychiatry), Mirjam Ernestus (MPI for Psycholinguistics), Rando
dolf Pohl (MPI of Quantum Optics), Paulo Freire (MPI for Radio Astronomy), Peer Fischer (MPI for the Science of Light), Stephan Grill (MPI of Molecular Cell Biology and Genetics), Frank Jenko (MPI for Plasma Physics), Andrew Pospisilík (MPI of Immuno

Following its fourth call for applications, the European Research Council (ERC) selected 480 talented young investigators who will receive research grants totaling around 670 million euros. Of these so-called Starting Grants, 64 were awarded to scientists working in Germany; 14 of them went to junior researchers at Max Planck Institutes.

Broadening Horizons, Making New Friends

“I loved the conference! Thank you for a great time.” This quote comes from the feedback form of a doctoral student who took part in this year’s international Ph.D. student symposium “Horizons in Molecular Biology” in Göttingen – and it sums up the impression of many of the 200 participants. Almost a bit sad, like parents saying goodbye to their children, the organizational team, consisting of about 20 doctoral students from the International Max Planck Research School for Molecular Biology, waved to the last departing speakers. They had all grown quite fond of each other during the mid-September conference.

Scientific exchange was at the heart of the symposium, and was ensured through lectures by renowned scientists, by the doctoral students themselves, and in poster sessions. Some of the speakers were delighted to be able to broaden their horizons in different areas of molecular biology, and many doctoral students initiated cooperation projects that will be valuable to their own scientific work, returning home full of new ideas.

The most important thing about Horizons, however, is that it is a conference by Ph.D. students for Ph.D. students. Communication between students and speakers is thus stimulated through the many social activities. For example, they all met up in the free and easy atmosphere of a pub, and also went bowling together. The last evening of the conference was devoted to the traditional final party. Two further events characterized the symposium: on the initiative of immunobiologist Jon Yewdell, the wine and cheese soirée was accompanied by a jam session. “Connectomics,” a special activity for promoting the exchange of ideas between young researchers and “old hands,” provided around 50 doctoral students with the opportunity to chat with professors and receive some first-hand career advice.

After a year of preparations once the laboratory work of the day was finished, breakfast meetings in the still-empty cafeterias, and sometimes tattered nerves – when every hotel room in Göttingen appeared to be booked, for instance – the organizers can now relax and look back on the conference with satisfaction, thanks to the feedback forms. But the rest period is brief, as the preparations for 2012 will begin shortly: next year’s conference is scheduled for September 10–13.
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