RESEARCH in Brief

The illusion of happiness in the little round balls: Hitting the jackpot in the lottery is rare indeed. And not only that, Lotto players also finance projects from which they themselves rarely benefit.

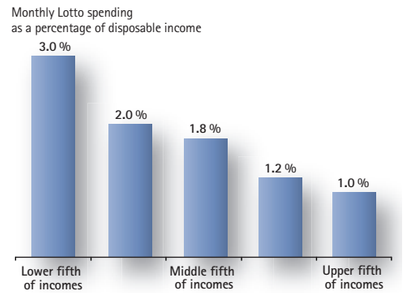
PHOTO: TOGETHER-IMAGES

STUDY OF SOCIETIES

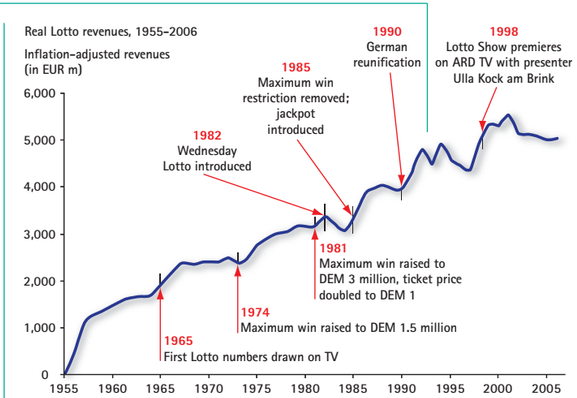
Six Winning Numbers – and Who Loses?

People who play the lottery finance the provision of activities in arenas such as amateur sports, art and culture – without profiting themselves. This is because the beneficiaries are overwhelmingly people who do not play the lottery. That is what a recent representative study conducted by Jens Beckert and Mark Lutter from Cologne's Max Planck Institute for the Study of Societies found.

It's the same old game, week after week: millions of Germans sit glued to their TV sets – only to crumple up their Lotto ticket in dismay once the numbers have been drawn. Once again, the dream of the lakeside house in Starnberg or the little sporty number parked out front goes up in smoke. Those who place their hopes in gambling may well despair. And not only that: gambling is also unjust. That's because national lotteries cause a fiscal redistribution that runs counter to the principle of fair taxation.



Individuals in low income brackets contribute a much higher proportion of their income to fiscal revenues from the lottery than people with higher incomes.



Sources: Revenue data from Lotto-Toto archive, Münster; inflation adjusted based on price indices from the Federal Statistical Office, Wiesbaden; historical information from the book "50 Jahre Toto-Lotto Baden-Württemberg," Staatliche Toto-Lotto GmbH Baden-Württemberg, published by Kohlhammer, 1998: 202 f.

The state lottery has seen revenues rise since the first drawing in 1955. New game elements have brought dramatic growth spurts and higher tax receipts.

ILLUSTRATIONS: CHRISTOPH SCHNEIDER, BASED ON SOURCE MATERIAL FROM THE MPI FOR THE STUDY OF SOCIETIES

Whereas the individuals who play Germany's Lotto tend to be lower middle class, less highly educated, older, or members of an ethnic minority, the beneficiaries of lottery funding are generally better educated, younger, and mostly German citizens. Lotto gambling thus gives rise to bottom-up redistribution, because people in the lower social strata play more than others. As Jens Beckert and Mark Lutter, two Max Planck scientists from Cologne, were able to demonstrate in their study, lotteries are more attractive to those in the lower social strata – leading to a situation in which lower income earners contribute more to government revenues in the form of taxes from the lottery than people with higher incomes do. This makes lotteries a form of regressive taxation.

With 39 percent of the price of each lottery ticket going to the government, lotteries are a very highly taxed economic transaction, contributing significant amounts to government coffers in each of Germany's federal states. Government revenues from gambling, including operation and concession activities, total approximately five billion euros per year in Germany. Half of this comes from Lotto alone. This amount – which mostly benefits the federal states – corresponds to about 18 percent of the annual tax revenues of each state. Approximately 1.1 percent of the national government's fiscal revenue comes from gambling sources – a considerable sum. This corresponds approximately to the annual volume of real-estate transfer tax, 1.2 times the revenue from inheritance tax, or 1.5 times the amount received from taxes on alcohol.

The redistribution effect of lottery gambling is amplified by the way in which lottery revenues are applied. Some 20 percent of the income from lottery ticket sales is earmarked for various charitable institutions, the promotion of amateur sports, and even projects in the spheres of art and culture, such as financial support for museums or historic preservation.

Amateur sports, however, is the field that is most strongly subsidized by this kind of taxation. Looking specifically at the example of amateur sports, the sociologists from Cologne demonstrated that the population groups whose lottery ticket purchases help finance these activities are by no means the same groups that take advantage of the events created as a result.

This state monopoly on lotteries finds legitimation in the fact that it purports to curb gambling. According to the Interstate Gambling Treaty, the aim is to minimize the potential threat to society from gambling. Besides combating gambling addiction, this primarily concerns the provision of gambling itself, which, it says, must not be based on the principle of maximum profit. Fiscal revenue is a side effect of the monopoly. The way in which the government uses it sometimes leads to unjust redistribution, as the Cologne-based researchers found.

It would be possible to counteract this by, for example, lowering the jackpot, thus reducing the incentive to play. Another possibility would be to pay out more than the 48 percent currently distributed among the players in the form of prize money. Government revenues generated from lottery gambling could be used to specifically benefit the population groups that play Lotto the most. One way to achieve this, according to Jens Beckert and Mark Lutter, would be to fund educational establishments for socially disadvantaged schoolchildren. ●

@ **Contact:**
CHRISTEL SCHOMMERTZ,
Press and Public Relations
Max Planck Institute for the Study of Societies, Cologne
Tel.: +49 221 2767-130
Fax: +49 221 2767-430
e-mail: info@mpifg.de

ASTRONOMY

The True Color of Black Hole Disks

Black holes are seen as the engines of active galaxies. They suck in gas and stars from their surroundings and collect the material initially in the accretion disk, where most of the radiation produced by the galaxy comes from.
Up to now, the proof that these disks exist has been theoretical, but astronomers working with Makoto Kishimoto from the Max Planck Institute for Radio Astronomy in Bonn have now obtained very strong observational evidence for such disks. (NATURE, July 24, 2008)

If you want to take a photograph with strong colors or stop the glare from windows dazzling you while driving, you might try a polarizing filter placed in front of your camera lens – or on your nose, in the form of sunglasses. However, a polarizing filter had never been used to look at an active galaxy in exquisite detail, which was the idea of the international team working with Makoto Kishimoto. This trick allowed them to get an unadulterated view of quasars, the brightly shining core areas of very distant galaxy systems.

This was not previously possible because the central black holes are concealed by dense clouds of dust. The strong radiation of these clouds distorts the expected spectrum of the accretion disk, and the measurements for the light spectrum of the radiation from the core did not match the precalculated values.

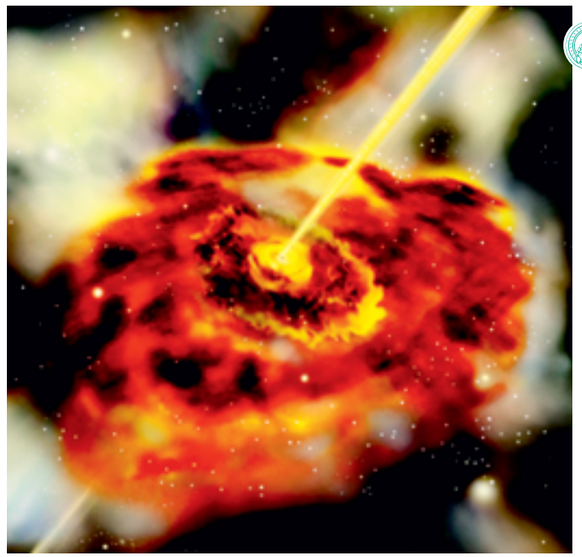
"Astronomers were mainly puzzled by the fact that the most extensively studied models of these disks couldn't be reconciled with some of the observations – particularly with the fact that these disks did not appear as blue as they should be in theory," explains Makoto Kishimoto. In order to clarify these conflicting findings, Kishimoto and an international team of scientists suppressed the disruptive radiation from the dust clouds.

To do this, they exploited a special characteristic of light: polarization. The radiation from the accretion disk is scattered in the immediate vicinity of the disk and thus appears polarized. In other words, the light waves propagate in only one plane. On the other hand, radiation from more distant parts of the dust cloud is unpolarized, and the light waves propagate in all directions. The polarizing filter allows the two radiation types to be separated and the astronomers can determine the true spectral shape of the central source.

To conduct these observations, polarizing filters attached to some of the largest telescopes in the world were used – on one mirror of the Very Large Telescope at the European Southern Observatory, and the United Kingdom Infrared Telescope on Mauna Kea in Hawaii. This allowed the part played by the hot dust clouds outside of the accretion disk to be suppressed and to show that the spectral shape of the radiation from the accretion disk is indeed as blue as the theory predicts.

Robert Antonucci from the University of California at Santa Barbara is also involved in the research project. "Our understanding of the physical processes in the accretion disk is still very incomplete," he says, "but at least we now have a reliable idea of the overall picture."

The observational data indicates that the measured radiation originates from the outer regions of the accretion disk. However, important questions remain unanswered, such as how and where the disk ends and how it is supplied with matter. Makoto Kishimoto is optimistic: "In the near future, our new method might make it possible to find answers to these questions." ●



A powerhouse in the center: This artist's impression shows the core of an active galaxy. The supermassive black hole is surrounded by an accretion disk and dust clouds. Energy in the form of jets radiates perpendicular to the accretion disk.

IMAGE: NASA E/PO – SONOMA STATE UNIVERSITY, AURORE SIMONNET

@ **Contact:**
DR. MAKOTO KISHIMOTO
Max Planck Institute for Radio Astronomy, Bonn
Tel.: +49-228-525-186
Fax: +49-228-525-229
e-mail: mk@mpifr-bonn.mpg.de

DR. NORBERT JUNKES, Press and Publicity Department
Max Planck Institute for Radio Astronomy, Bonn
Tel.: +49-228-525-399
Fax: +49-228-525-438
e-mail: njunkes@mpifr-bonn.mpg.de

Migration began sooner with pied flycatchers that were kept under changed daylight conditions for their first year, and they were also ready to mate considerably earlier.

PHOTO: MPI FOR ORNITHOLOGY – ROEMHILD

ORNITHOLOGY

Climate Change Is Taking Its Toll on Migratory Birds

Global changes in day-length conditions are profoundly affecting the timing of migration and reproductive maturation in at least one long-distance migratory bird – the pied flycatcher. This discovery was made by Tim Coppack from the Max Planck Institute for Ornithology, in collaboration with an international team. The researchers tested how flexibly this bird, which overwinters in tropical Africa, would react if climate change were to shift its overwintering areas northward. (GLOBAL CHANGE BIOLOGY 14/2008)

Pied flycatchers, just like many other organisms, use the changing day length over the year as a guide in synchronizing their life cycles with the seasons. However, rapidly changing climate conditions can mean that these light-dependent organisms get out of step. Therefore, displacement of their habitats caused by climate change has a drastic effect on their scheduling and their ability to reproduce and survive.

One way of escaping increasingly inhospitable living conditions would be to move to more northerly overwintering areas. However, as seasonal day length would also change, the birds would have to respond flexibly to a wide range of daylight conditions. In an experiment, hand-reared pied flycatchers were kept, for their first year, under daylight conditions that simulated five possible overwintering areas between central Africa and central Europe. Tim Coppack from the Max Planck Institute for Ornithology and his colleagues wanted to test whether and how the annual cycle of this migratory bird was affected. The researchers found that, even with a shift of the overwintering areas from the African Ivory Coast to the Sahel, migration started earlier and the birds were ready to mate almost a month sooner – solely as a response to the change in day length.

The pied flycatchers, which would have had to travel 1,100 kilometers fewer over the Sahara, as simulated in Coppack's experiment, would thus have arrived in the northern breeding areas much earlier. "This reaction might seem to be an advantage in view of the increasingly early start of spring and earlier availability of insects for rearing the young," says Tim Coppack.

However, climate change is worsening conditions in the Sahel for the insectivorous songbirds that overwinter there. This means that, for pied flycatchers and other long-distance migrants, there are limited opportunities to gradually shorten their migration in order to arrive in the breeding areas early and enjoy a better range of available food. In addition, the fact that the day length close to the equator changes only slightly over the course of the year worsens the situation. This means that pied flycatchers escaping to the south are not sufficiently stimulated, remain in their winter molt and would not embark on the return to the breeding grounds. ●

@ **Contact:**
DR. TIMOTHY COPPACK
Zoological Museum, University of Zurich-Irchel
Tel.: +41 44 635-4766
Fax: +41 44 635-4780
e-mail: coppack@access.uzh.ch

DR. SABINE SPEHN
Press and Publicity Department
Max Planck Institute for Ornithology, Seewiesen
Tel.: +49 8157 932-421
Fax: +49 8157 932-344
e-mail: sspehn@orn.mpg.de

MICROSTRUCTURE PHYSICS

Giant Memory from Tiny Capacitors

We want the electronic gadgets of tomorrow to be smaller and lighter, but also faster and more powerful. Researchers at the Max Planck Institute of Microstructure Physics, at Pohang University of Science and Technology (POSTECH) in Korea, and at the Korea Research Institute of Standards and Science (KRISS) have now developed a method that might be helpful, enabling the manufacture of extremely densely packed data storage devices. (NATURE NANOTECHNOLOGY 3, 2008)

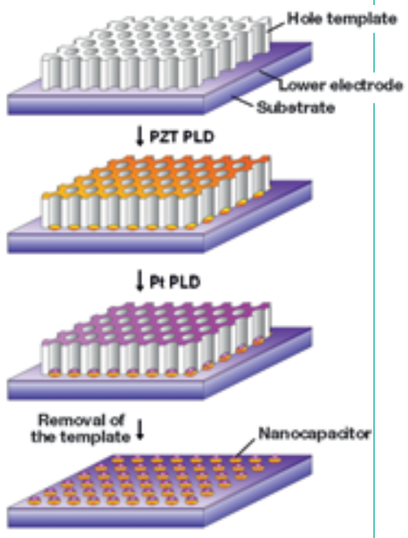
"Our method might make it possible to manufacture non-volatile memories particularly easily and efficiently," says Dietrich Hesse. As a scientist at the Max Planck Institute of Microstructure Physics in Halle, he played a significant part in the work of the team. Using an extremely finely perforated template, the team accommodated 176 billion capacitors made of platinum and lead zirconate titanate (PZT) on a square inch – a world record for this material.

This level of density is necessary if permanent memories are to be used more widely. For example, it could make hard drives and tedious booting of PCs a thing of the past. The nanocapacitors also meet another condition for use as memory: each memory point can be addressed separately, even though they are only just over 60 nanometers (a millionth of a millimeter) apart.

These special characteristics are due not only to precision in the memories' manufacture, but also the principle on which they work. Lead zirconate titanate is a ferroelectric ceramic material. In every unit cell, which is the smallest component of a crystal, these materials have a permanent electric dipole similar to the magnetic dipoles in iron. Like the north and south poles of a magnet, the positive and negative poles of the permanent electric dipole can be deliberately switched over. This allows these materials to store data permanently, like a hard drive, while they are also capable of handling data just as quickly as working memories.

In order to construct 176 billion capacitors on a square inch of this ferroelectric material, the scientists first made a 100-nanometer-thin template out of aluminum oxide with the appropriate number of holes. To do this, they electrochemically oxidized aluminum foil. By carefully selecting the temperature, pH value and chemical composition of the oxidation media, the scientists forced the pores into a hexagonal arrangement, with each pore being surrounded by six others. The pattern was still slightly distorted in some places, which is a drawback for data storage. "However, if we first shape the aluminum with a punch, the pores arrange themselves in a completely regular pattern," says Woo Lee from KRISS.

The finely perforated template does not complete the process. The scientists in Halle place the template on a carrier wafer of magnesium oxide coated with platinum and heat it to 650 degrees Celsius. They then vaporize PZT in a perfectly balanced ratio with a laser until it has deposited a 30- to 50-nanometer-thick layer on the platinum. A thin cover of platinum completes the capacitor, in which the two precious metal layers act as electrodes and the ceramic acts as a dielectric. "This work shows that unconventional and previously overlooked production methods from associated fields in electronics research can contribute significant progress to the search for ideas for high-density, solid-state memory," says Ulrich Gösele, Director at the Max Planck Institute of Microstructure Physics.



Capacitors in the template: With an aluminum oxide template just 100 nanometers thick (top), the team of German and Korean researchers first deposits ceramic components (PZT) on the platinum layer. They then deposit some more platinum to create an electrical contact with the ceramic.

ILLUSTRATION: MPI OF MICROSTRUCTURE PHYSICS

@ Contact:
PROF. DIETRICH HESSE
Max Planck Institute of Microstructure Physics, Halle (Saale)
Tel.: +49 345 5582-741
Fax: +49 345 5511-223
e-mail: hesse@mpi-halle.de

NEUROBIOLOGY

Calcium – Food for Thought

Contacts between nerve cells are constantly being built up and then dismantled again. In the process, cells determine very quickly which connections are useful and which are not. But how do they accomplish this? Christian Lohmann and Tobias Bonhoeffer from the Max Planck Institute for Neurobiology in Martinsried have described a technique with which the nerve cells are able to save time and energy in evaluating the quality of the partner cells they contact. (NEURON, July 31, 2008)

The human brain consists of a hundred billion nerve cells. What is more, each of these cells is linked to its neighbors by many thousands of contact points. As the brain develops, young nerve cells must come into contact with the correct partner cells so that it can carry out its complex functions. Contacts between nerve cells are also constantly being set up and dismantled in adults. It is this continuous restructuring of the brain that allows us to learn and to forget.

Building and rebuilding the brain requires a great deal of energy – after all, the brain is the organ with the highest energy consumption. This is because both young and adult nerve cells allow hundreds of cell extensions to grow toward their neighbors. If the cells make contact, they must exchange information about the value of the connection. If the cells do not fit as well as they might, the extension is dismantled again after a few seconds or minutes.

It was previously assumed that nerve cells can exchange information only through special contact points called synapses. However, it can take up to two days before a synapse is fully functional – a waste of time and energy if the contact is dismantled again. The brain could take almost 1,000 years to develop if a synapse had to mature at each cell contact. So it appears that nerve cells can collect information about their neighbors without synapses. Neurobiologists Christian Lohmann and Tobias Bonhoeffer have now discovered how they do this. They labeled individual nerve cells with fluorescent dyes and observed them under a special microscope. In this way, they found the secret of how the information is exchanged: local calcium signals quickly transmit all the necessary information to the cells. A synapse actually develops only when the cell and the contact point prove to be suitable candidates for long-term contact.

How does this work in concrete terms? When a lengthening extension encounters a neighboring cell, a release of calcium is triggered at its base. This calcium signal can act like a stop sign: the extension immediately ceases to grow. At the same time, this signal already contains all the important information about the quality of the new contact: it remains intact only if the calcium signal is significantly higher than the surrounding calcium level of the cell. Otherwise, the extension is withdrawn and the nerve cell searches for a suitable partner cell at another point.

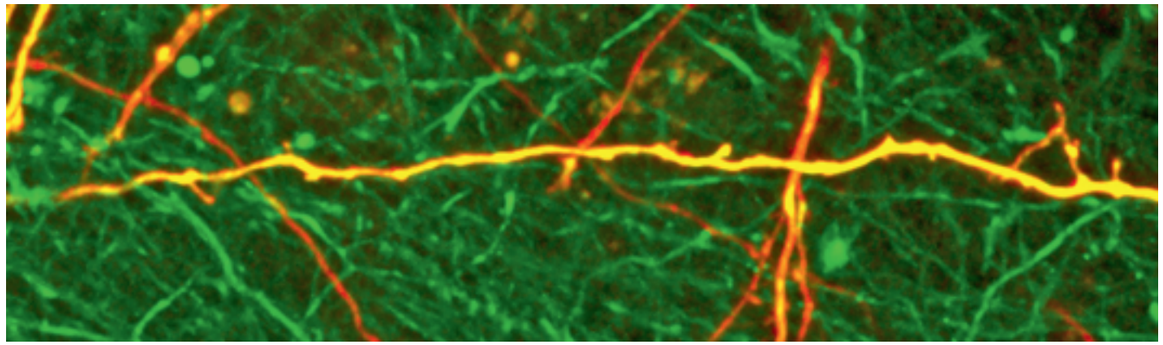


IMAGE: MPI FOR NEUROBIOLOGY – LOHMANN

Thought is enabled by constantly changing contacts between cells. Scientists at the Max Planck Institute for Neurobiology have now shed light on why this process does not take hours.

"We were astounded by the efficiency of this technique," says Tobias Bonhoeffer. "It saves the brain time and energy and, at the same time, collects important information – in passing, so to speak." The scientists assume that nerve cells in adult brains use the same method to weigh up their partner cells. This allows the correct partner cell to be found quickly and a thought to be completed.

@ Contact:
DR. STEFANIE MERKER, Press and Public Relations
Max Planck Institute for Neurobiology, Martinsried
Tel.: +49 89 8578-3514
Fax: +49 89 8995-0022
e-mail: Merker@neuro.mpg.de

QUANTUM PHYSICS

Sociable Particles on an Ego Trip

In the quantum world, particles take on all sorts of roles. Researchers at the Max Planck Institute for Quantum Optics have provoked another astonishing behavior in an experiment: fragile molecules stay frozen to the spot to prevent collisions with other molecules that would destroy them. In this context, the molecules are behaving like fermions, even though they belong to the family of bosons. (SCIENCE, June 6, 2008)

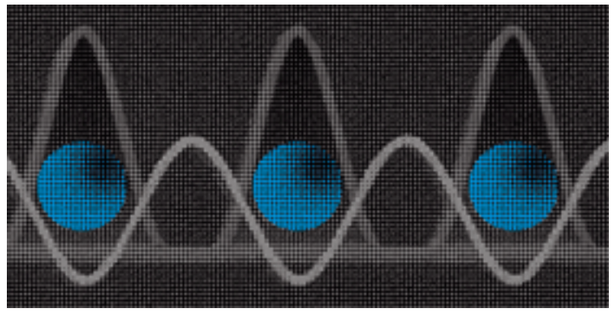


IMAGE: MPI FOR QUANTUM OPTICS

Rubidium molecules (blue) are held in a periodic potential. When the potential is removed, the molecules would normally move around freely. However, in order to not destroy each other, they remain frozen in their initial state.

The difference between fermions and bosons can be illustrated with the example of two different types of people going to a bar. Some sit together in groups, chatting impulsively and loudly about football or playing cards. Others head straight for the last remaining empty table to sit alone. Bosons behave like the sociable group, and the fermions correspond to the solitary types.

In the same way as the card players like to sit together, the bosons like to occupy the same quantum states at very low temperatures. In extreme cases, they form a Bose-Einstein condensate, in which around 100,000 atoms merge to form a kind of giant atom. All the single atoms in it have the same quantum characteristics, but are relatively independent of the others in terms of their location.

Fermions in a closed system, on the other hand, must differ from each other in at least one quantum number. Their state is very dependent on the quantum numbers of the other fermions. In the bar analogy, as the solitary guests only ever sit at empty tables, their location is dictated by the other people at the bar.

Now imagine that one of the sociable guests has cheated at cards. Nobody admits to it and all of them are so offended that they all go and sit at separate tables – despite the fact that they are basically sociable. They do this in self-defense, because if they were to get too close to one another, a dispute would rapidly flare up between them and they would presumably be thrown out of the bar.

Something similar happened in the experiment at the Max Planck Institute for Quantum Optics – with bosonic molecules. Instead of moving around independently, as is their nature, they keep away from each other, showing exactly the same behavior as fermions. This prevents them from destroying each other: if the fragile molecules moved vigorously, they would collide and decay.

The physicists observed the effect in rubidium molecules, which count as bosons. In the experiment, the particles are distributed in a three-dimensional optical lattice. This lattice is a kind of crystal of light that is created by superimposed standing light waves from all three spatial directions. The resulting laser light field is similar to a stack of egg boxes with a single molecule in each hollow. The hollows are initially so deep that the molecules are trapped and cannot move to the adjacent hollows.

What happens, however, when the laser lattice is then altered so that it is shaped like a stack of corrugated metal? The molecules now sit like a row of pearls in a gutter and, in principle, could move in one dimension – along the gutter.

Therefore, it might be expected that the molecules would now collide with their neighbors and, because they are so fragile, be destroyed. The binding energy that is released by this collision is sufficient to expel the colliding molecules from the gutter so that they disappear from the field of observation. The number of molecules in the gutter rapidly falls.

In the experiment, however, this expectation is not met: the particles hardly move from the spot at all, and collide significantly less frequently than independent particles. Obviously, they have a mutual influence. "Actually, you can picture the molecules like fragile soap bubbles," explains Dominik Bauer, the second author of the paper. "If they collided with a neighbor, they would both decay, but since the molecules are controlled by quantum mechanics, they don't." ●

@ **Contact:**
DOMINIK BAUER, Dipl. Phys.
Max Planck Institute for Quantum Optics, Garching
Tel.: +49 89 32905-379
Fax: +49 89 32905-395
e-mail: dominik.bauer@mpq.mpg.de

DR. OLIVIA MEYER-STRENG, Press and Public Relations
Max Planck Institute for Quantum Optics, Garching
Tel.: +49 89 32905-213
Fax: +49 89 32905-200
e-mail: olivia.meyer-streng@mpq.mpg.de

Panorama

EVENTS THAT HAPPEN ON A COSMIC SCALE are sometimes barely noticeable on Earth. This is why astronomers cannot say with 100-percent certainty at present that the expansion of the universe is accelerating; verification of planets that are orbiting other stars is also largely indirect. An international team of researchers at the Max Planck Institute for Quantum Optics in Munich has been testing a principle that should make it possible to measure these observations. In order to determine the color of light from celestial bodies with extreme accuracy, the scientists have built a frequency comb that contains rows of spectral lines, the colors of which can be determined very precisely. The physicists compare these lines with the lines in the spectra of astronomical sources. In the future, this will allow them to determine changes in the speed of celestial bodies to an accuracy of one centimeter per second. This would make their method about 1,000 times more sensitive than other currently available procedures and would both facilitate the search for Earth-like planets and prove conclusively that the expansion of the universe is accelerating.

SOLAR ERUPTIONS announce their arrival some days in advance through fluctuations in the local magnetic field in the Sun's atmosphere. Scientists at the Max Planck Institute for Solar System Research in Katlenburg-Lindau discovered this when they analyzed in detail for the first time the magnetic field anomalies that occur before an eruption and the progress of the eruption itself. They found that, for several days before an eruption, energy builds up locally in the magnetic field of the corona – the outer solar atmosphere – where it is stored in strong electrical currents. This energy then discharges in the eruption and is converted partly into the kinetic energy of the particles that are hurled out, and partly into radiation. After this discharge, the local magnetic field exhibits a lower energy level and weaker electrical currents, while the energy released in the course of the eruption through the particles and the radiation triggers magnetic storms in the Earth's atmosphere and has the potential to cause power failures and damage satellites.

IT MIGHT BE POSSIBLE to read the biological age of a person from a group of proteins that circulate in the blood. Scientists in the Max Planck Research Group for Stem Cell Aging in Ulm came across this biomarker while examining telomeres, the end pieces on human chromosomes. Telomeres stabilize the chromosomes and protect them from damage. However, they become shorter each time the cell divides, and thus lose their protective function as the person ages. The chromosomes become less stable, and more and more errors occur when the cell divides, until finally, it dies. It has now been shown that certain marker proteins arise in parallel with the shortening of the telomeres, and that these proteins can be found in human blood. Their concentration rises with age and age-related disease. Using these markers, it might be possible to individually adjust the medical treatment older people receive to account for their biological age. The markers might also help test whether and to what extent certain modes of behavior, foods and therapies delay (biological) aging.

REPROGRAMMING the body's own cells to create embryonic stem cells: Scientists at the Max Planck Institute for Molecular Biomedicine in Münster are now a significant step closer to this holy grail of fundamental research in medicine. They have managed to return neural stem cells from the brain of adult mice to their original embryonic state by splicing in just two genes. To date, at least four genes have been required for this kind of reprogramming. Although it is difficult to isolate neural stem cells in humans, and they are therefore unlikely to be used for future therapeutic purposes, the knowledge that has now been acquired by using them makes it possible to systematically search for other types of cells in which the

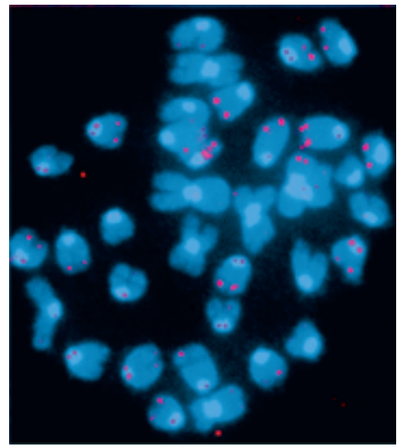


PHOTO: K. LENHARD RUDOLPH

The telomeres (dyed red) form the end pieces of the chromosomes. They become shorter as the person ages. Individual chromosome ends are finally completely lost, and the cells lose their ability to divide.

embryonalization process is equally simple, but which can be obtained more easily. Furthermore, the researchers want to use the neural stem cells to help them find substances to replace the genes that initiate the reprogramming. They have already discovered one molecule of this kind and are optimistic that others will follow. Then they will no longer need to use viruses as "ferries" to splice the genes. The latter could wreak havoc in reprogrammed cells by switching on tumor genes.

www
Please visit www.maxplanck.de for more information on these topics