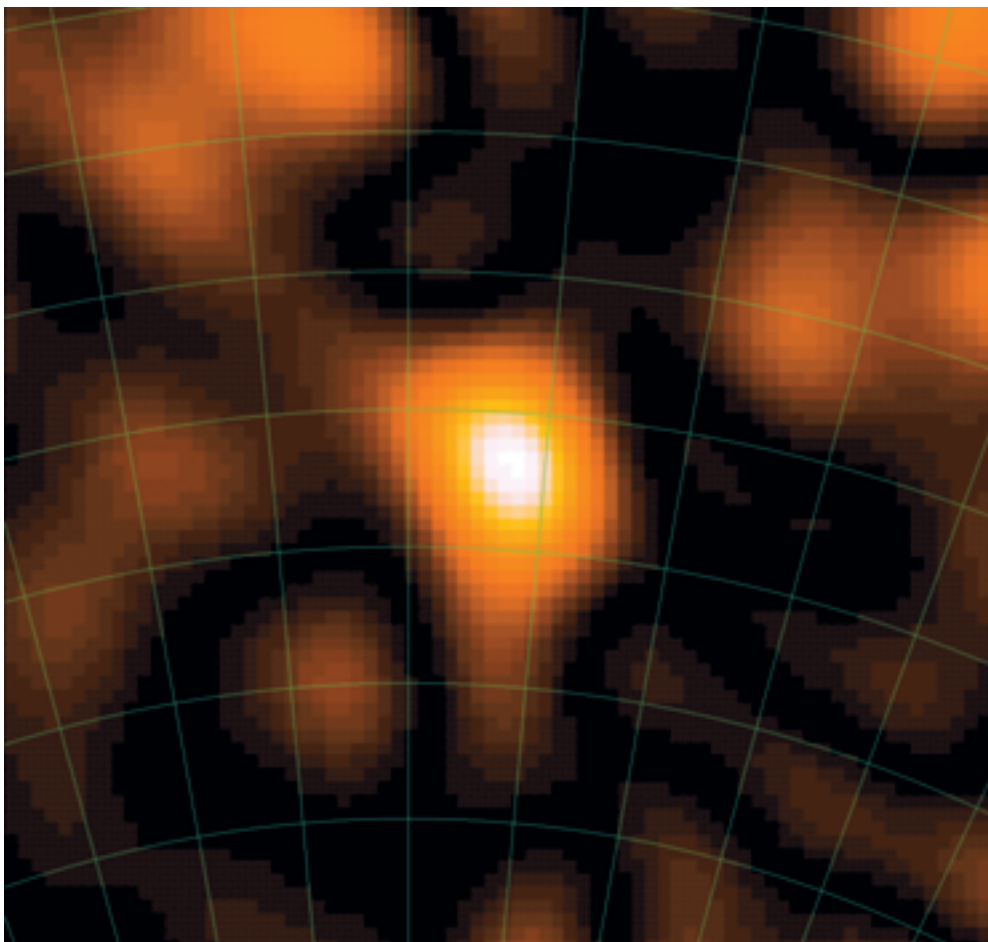




RESEARCH *in Brief*



Bull's eye: The bright spot in the center shows a radio flash after the LOPES experiment detected a cosmic ray particle. The corresponding film sequence is 100 nanoseconds long, in which the radio flash appears for about 30 nanoseconds.

ASTRONOMY

Sparks from Cosmic Particles

If humans could see radio radiation, every so often, they would be dazzled when gazing into the sky – by flashes that, despite being extraordinarily short, light up an area four times that of the full Moon to around 1,000 times brighter than the Sun. These radio flashes bear out the collision of extremely energetic cosmic ray particles with atoms and

molecules of the Earth's atmosphere. They come from subatomic debris showers, composed of particles of matter and antimatter generated during such collisions. These flashes have recently been detected by an international team, including astrophysicists from the Max Planck Institute for Radioastronomy in Bonn. (NATURE, MAY 19, 2005)

To make their discovery, the scientists used a battery of radio antennae and the large array of particle detectors from the KASCADE-Grande experiment at the research center in Karlsruhe. Both detector arrays were operated in parallel. This allowed radio signals to be detected every time a highly energetic cosmic ray particle entered the Earth's atmosphere. The researchers also created

PHOTOS: NATURE

Cosmic particle trap: The pyramid-shaped construction in the foreground is part of the LOPES experiment, a large array of radio antennae and particle detectors at the Karlsruhe Research Center.



film sequences of events using image-processing software from radio astronomy.

The intensity of the emitted radio signal is directly proportional to the energy of the cosmic radiation. "It's amazing that we can directly measure the energy of particles coming from the cosmos with simple radio antennae," says Heino Falcke, head of the experiment. "If we had radio-wave vision, we'd see the sky sparkling with radio flashes."

Some of the recorded radio flashes were actually intense enough to distort reception of conventional radio and television. To illustrate this effect, the researchers converted the cosmic radiation signal into an audio recording that revealed that, for a brief moment, the cosmic spark is actually much louder than standard television or radio sound. But since the radio flashes from space last only 20 to 30 nanoseconds, and as the most intense events of this sort occur on average just once a day, they are hardly likely to have any effect on our everyday life.

The experiment also demonstrated that the radio wave intensity depends on the direction of the incoming particles with respect to the Earth's magnetic field. This finding and other measurements confirm predictions from earlier theoretical calculations by Heino Falcke and doctoral student Tim Huege, as well as Peter Gorham of the University of Hawaii.

Energetic cosmic ray particles bombard the Earth's atmosphere, creating tiny storms of elementary particles – which, in turn, generate a stream of matter and antimatter particles. The geomagnetic field deflects the lightest charged particles (electrons and positrons), creating radio waves. The same mechanism produces synchrotron radiation in particle accelerators at laboratories here on Earth. Astrophysicists thus refer to this as geosynchrotron radiation, emphasizing the interaction with the Earth's magnetic field. The experiment is called LOPES, which stands for LOFAR Prototype Experimental Station.

The system utilizes prototype antennae for LOFAR, soon to be the world's largest radio telescope. The telescope will be set up in the Netherlands and in part of Germany beginning in 2006. The LOPES receivers are simple antennae pairs – very similar to those used in normal radio receivers. "The main differences compared with normal radios are the digital electronics and broadband receivers, which enable a large number of different frequencies to be recorded simultaneously," explains Andreas Horneffer, a doctoral student at the International Max Planck Research School for Radio and Infrared Astronomy at the University of Bonn. Horneffer constructed the antennae as part of his doctoral project.

The LOPES antennae are integrated into the KASCADE-Grande experiment to detect atmospheric cosmic ray showers. "This illustrates the advantage of having a large particle astrophysics experiment in our backyard; it gives us the flexibility to also investigate unusual ideas," says Andreas Haungs, spokesman for the KASCADE-Grande experiment. And Harvey Butcher, Director of the Netherlands Foundation for Research in Astronomy in Dwingeloo, adds: "LOPES anticipates the first important scientific results of the LOFAR project in its developmental phase. This gives us confidence that LOFAR will indeed turn out to be as revolutionary as we have been hoping."

LOFAR combines a completely new design with a multitude of inexpensive low-frequency antennae that can record radio signals from all directions in the sky. The individual stations are connected via a high-speed network; using a supercomputer, unusual signals can be discovered and radio images of wide-ranging regions of the sky can be established without the movement of any mechanical parts.

"It really is an unusual combination: nuclear physicists and radio astronomers working together to set up a unique particle astrophysics experiment," muses Anton Zensus, Managing Director at the Max Planck Institute for Radioastronomy. ●

@ Further information from:
PROF. DR. HEINO FALCKE
 Max Planck Institute for Radioastronomy, Bonn
 ASTRON, Dwingeloo, Netherlands
 Tel.: +31 651 433-474
 Fax: +31 521 595-332
 e-mail: falcke@astron.nl

DR. ANDREAS HAUNGS
 Institute for Nuclear Physics, Karlsruhe Research Center
 Tel.: +49 174 3010601
 Fax: +49 7247 82-3321
 e-mail: Andreas.Haungs@ik.fzk.de

PHOTO: LOPES COLLABORATION

GEOCHEMISTRY

Volcanoes in Threads

For many years, an international consortium of geoscientists has been drilling deeper and deeper into the Mauna Kea volcano on Hawaii. Thanks to highly precise measurements of lead isotopes formed by radioactive decay over millions of years, researchers from the Max Planck Institute for Chemistry have now discovered that the flow of rock from deep within the Earth's mantle (mantle plumes) is composed of vertical, elongated threads of varying isotopic composition. The scientists have also developed a model of melt formation in the Earth's mantle that ex-

plains the unusually high magma production of Hawaii's volcanoes. (NATURE, March 31 and April 14, 2005)

"Our observations indicate that Mauna Kea's mantle plume is composed of vertical, elongated threads that are considerably less than 50 kilometers in diameter and several hundred kilometers long," explains Wafa Abouchami from the Max Planck Institute for Chemistry. "The plume thus resembles striped, Signal-brand toothpaste."

This refutes the conventional theory, according to which such columns of rock have a tree-ring-like, concentric structure. When a hot mantle plume rises from deep within the Earth, it was expected that the surrounding rock would slowly heat and gradually be driven upwards. This would give the plume a concentric chemical structure, similar to tree rings.

However, the Max Planck researchers have uncovered two new facts. First, as expected, the lavas from the deeper section of the borehole do indeed have different ratios of lead isotopes than higher up – yet they correspond with isotopic data from the younger volcano Kilauea, which is almost exactly at the spot over the plume where Mauna Kea was 500,000 years ago. The plume has therefore produced isotopically identical lavas at exactly the same spots over a period of half a million years, while above it, the Earth's crust and the fiery mountains have continued to move.

Second, the scientists have discovered that almost all the lava from volcanoes on the northeast side of the island of Hawaii – Kilauea, Mauna Kea and Kohala – have lower lead isotope ratios than the volcanoes on the southwest side of

the plume (Loihi, Mauna Loa, Kahoolawe, Lanai and Koolau). This has led the researchers to the conclusion that two volcanoes coming to rest in the course of their history over the same thread must produce chemically identical lavas. The second observation indicates that the vertical threads on the southwest side of the plume have a generally different composition than those on the northeast side – in other words, no concentric tree rings can be seen.

Meanwhile, a second group from the Max Planck Institute in Mainz has been taking a closer look at Mauna Loa, Hawaii's largest volcano. By measuring the nickel content of lava samples, the team has established that this lava forms primarily without olivine, the most common mineral in the Earth's mantle. The researchers have therefore developed a new model of melt formation that also explains the enormous magma production of the mantle plume of these volcanoes.

Thanks to their relatively low melting point, the lenses of recycled oceanic crust incorporated in the rising mantle plumes already begin to melt at around a depth of 170 kilometers. This melt transforms the mineral olivine from the surrounding rocky mantle into another silicate mineral, pyroxene. Pyroxene rock formed in this way melts considerably better than the original olivine-rich mantle rock as the plume continues to rise. This is the reason for the large increase in Mauna Loa's magma production. Were the plume under Mauna Loa composed only of normal olivine-rich mantle rock, the melt volumes would have been enough to form only one fiery mountain just above the ocean floor. ●

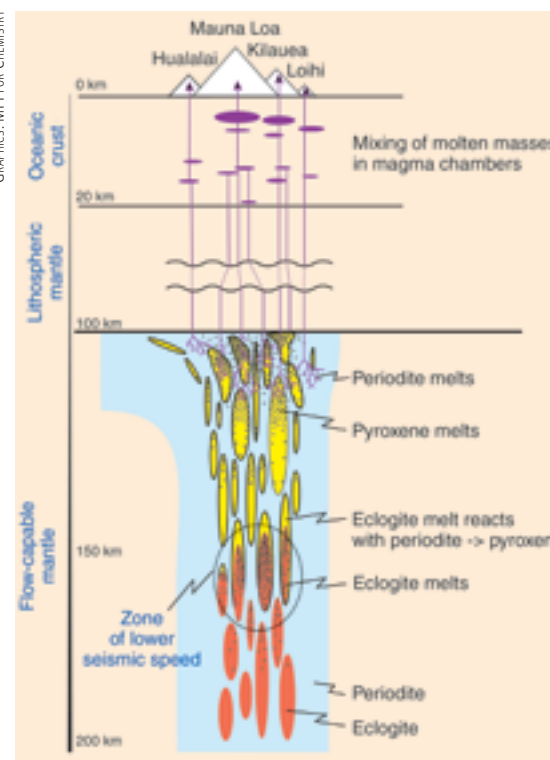


@ Further information from:
PROF. DR. ALBRECHT W. HOFMANN
 Max Planck Institute for Chemistry, Mainz
 Tel.: +49 6131 305-281
 Fax: +49 6131 305-388
 e-mail: hofmann@mpch-mainz.mpg.de

PROF. DR. ALEXANDER V. SOBOLEV
 Max Planck Institute for Chemistry, Mainz
 Tel.: +49 6131 305-275
 Fax: +49 6131 305-388
 e-mail: asobolev@mpch-mainz.mpg.de

DR. Wafa ABOUCHAMI
 Max Planck Institute for Chemistry, Mainz
 Tel.: +49 6131 305-260
 Fax: +49 6131 305-388
 e-mail: wafa@mpch-mainz.mpg.de

GRAPHICS: MPI FOR CHEMISTRY



Hawaii's volcanoes, for instance Kilauea, produce enormous volumes of magma. The model conceived by the Max Planck scientists explains this high rate. The lenses of recycled oceanic crust (eclogite) incorporated in the rising mantle plumes already melt at a depth of 170 kilometers. This melt reacts with nickel-rich periodite and transforms the mineral olivine in the surrounding mantle rock into pyroxene. Rock formed in this way melts considerably better than the original olivine-rich mantle rock as the plume continues to rise, greatly increasing the production of magma.

EVOLUTIONARY ECOLOGY

Immune Scents Are Attractive

Odor decides the choice of partner: female mice and fish use this to recognize the immune genes of a potential partner. For instance, a stickleback female prefers a male whose immune genes, together with her own, will offer their offspring the best defense against pathogens. Scientists at the Max Planck Institutes of Limnology in Plön and of Immunobiology in Freiburg have demonstrated that small protein fragments that comprise a blueprint of immune genes can be used to manipulate the attractiveness of a stickleback male for a female. (PNAS online, March 8, 2005)

An enormous number of continually changing pathogens force most animals to reshuffle their immune genes again and again from one generation to the next. For most vertebrates, the T-cells of the immune system can effectively combat infectious agents only when their body's own so-called MHC molecules present protein fragments (peptides) derived from the pathogen. A variety of MHC molecules are needed so that the immune system can identify and combat different infectious diseases.

Every vertebrate population possesses hundreds of MHC molecules, but every human being – and also every stickleback – carries only a few of these trademarks, which vary from individual to individual. This diversity offers females great freedom of choice in the selection of a mate – but only if she can recognize each immune repertoire. This is achieved through the sense of smell: stickleback females prefer to pair with the partner that will ensure immunogenetic optimality. The evolutionary ecologists in Plön already



Photo: MPI of Limnology

A male stickleback circles a female about to spawn and envelops her in a cloud of scent.

proved this a few years ago. But what makes up this perfume packet that males use to signal their MHC individuality? If organisms need specific MHC molecules to transport peptides out of the cell, then the spectrum of these peptides must reflect the MHC molecules that the male possesses, and thus its genetic makeup, the scientists believe. The exported peptides could be the perfume that the female responds to.

The evolutionary ecologists are now trying to manipulate this perfume by introducing various peptides. "What determines whether a female reacts positively to a male is the combination of the MHC molecules of the pair, not of each individual," says Manfred Milinski, Director at the Max Planck Institute of Limnology.

The scientists chose stickleback males who leave no impression on the female due to their sub-optimal and therefore unattractive MHC combination, and provided them with additional synthetic peptides to make them more attractive. Conversely, adding the same peptide mixture to the scent of an optimally equipped, attractive male was expected to act as a repellent.

To test their assumption, the researchers let a fertile stickleback female in a flow channel choose between two parallel

streams of water, without letting her see the male partner. In one stream, a peptide mixture was added to the water coming from the male's aquarium; the other stream remained free of added peptides. As expected, the female chose the channel in which she detected the optimal peptide mixture for her.

Like sticklebacks, mice also react to the same immunogenetic signal molecules. "We can therefore assume that this signal system acts in a similar way in all vertebrates, including humans," reflects Thomas Boehm, Director of the Max Planck Institute of Immunobiology in Freiburg. "We are now looking at what role perfumes play here. They have been used by people for thousands of years, and their selection is influenced by a person's own MHC genes," adds Manfred Milinski.



@ Further information from:

PROF. DR. MANFRED MILINSKI
Max Planck Institute
of Limnology, Plön
Tel.: +49 4522 763-254
Fax: +49 4522 763-310
e-mail: milinski@
mpil-ploen.mpg.de

PROF. DR. THOMAS BOEHM
Max Planck Institute
of Immunobiology, Freiburg
Tel.: +49 761 5108-329
Fax: +49 761 5108-323
e-mail: boehm@
immunbio.mpg.de

MICROSTRUCTURE PHYSICS

A Mirage in a Quantum Corral

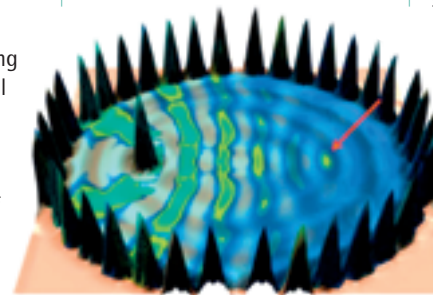
Using computer calculations, scientists at the Max Planck Institute of Microstructure Physics and Martin Luther University in Halle have deciphered how magnetic atoms in elliptical quantum corrals influence one another. In doing so, they found that it is possible to specifically couple the magnetic moments of these atoms in parallel or opposing orientations. In theory – and one day probably in practice, as well – based on this principle, it will be possible to construct atomic-scale binary data storage whose capacity is more than a million times greater than that of current computer hard drives. (PHYSICAL REVIEW LETTERS, MAY 11, 2005).

With a scanning tunneling microscope, individual atoms that are loosely attached to (adsorbed on) a metal surface can be arranged into systems of nearly any form. "This strategy offers fantastic possibilities to manipulate individual atoms and their interactions and dynamics," explain the scientists at the Max Planck Institute of Microstructure Physics. "Unlike in macroscopic objects, the atomic scale involves other forces and interactions – quantum effects." One example is the spin of electrons, which is classically equivalent to intrinsic angular momentum, but which can be quantitatively described and understood as an effect of relativistic quantum mechanics only on the atomic level.

One example of this is the "nano-whisper gallery," the first of its kind, realized by Hari C. Manoharan, Christopher P. Lutz and Don Eigler from the Almaden Research Center in

San Jose, California. Using 36 carefully arranged cobalt atoms, the US physicists built an elliptical quantum corral on a crystalline copper surface. When, in addition, they placed a single magnetic cobalt atom at one focus, a surprising thing happened: a clear signal appeared at the second focus – although this spot was empty.

This mirage disappeared when a non-magnetic cobalt atom was used, as well as when the individual cobalt atom was placed away from the focus point. Theoretical studies qualitatively explained this phenomenon with resonant scattering of surface electrons on the magnetic atom at the focus and on the atoms of the corral wall.



An elliptical fence of cobalt atoms, adsorbed on a crystalline ordered copper surface, forms a quantum corral surrounding a cobalt atom at a focal point of the ellipse: The spin polarization of this atom generates a clear polarization signal at the other focal point (marked by a red arrow).

Researchers at the Max Planck Institute of Microstructure Physics and at Martin Luther University in Halle have now obtained a detailed picture: using *ab initio* calculations that were carried out for the first time, they were able to quantitatively comprehend the diverse interactions within elliptical quantum corrals, and to calculate, among other things, the electronic states of the individual atoms and their influence on their environment.

Ab initio means 'from first principles' and, in this case, that solely the basic equations of quantum mechanics and the chemical composition of the system form the basis for cal-

culating the interplay between the individual atoms and their electrons and, from this, their local magnetic properties. The goal of these highly intricate calculations was to be able to compute the magnetic orientation of each individual atom in the area of the quantum corral and change it in a controlled manner. This magnetic moment depends on the orientation (the spin) of the electrons in the electron shells, which can align themselves in only two opposing directions, up or down. And only when a majority of electrons of an atom spin in the same direction of rotation – known as spin polarization – does an atom become magnetic.

The *ab initio* calculations showed that magnetic atoms adsorbed on a substrate of crystalline ordered copper

atoms influence each other's spin polarizations. On bare copper surfaces, this influence depends inversely proportionally on the distance between the two atoms. It is, however – and this is the key result of the calculations – significantly intensified by an elliptical quantum corral, which forms a sort of atomic fence around the two atoms at the focal points of the ellipse. In addition, the magnetic interaction between the two adsorbed magnetic atoms can be modified within broad limits by the geometry of the quantum corral. Thus, it is quite possible that we will, in the future, be able to use such nano-whisper galleries for data processing.



@ Further information from:
DR. VALERI
S. STEPANYUK
MPI of Microstructure
Physics, Halle
Tel.: +49 345
5582-537
Fax: +49 345
5582-765
e-mail:
stepanyu@mpi-
halle.de

PROF. DR.
PATRICK BRUNO
MPI of Microstructure
Physics, Halle
Tel.: +49 345
5582-763
Fax: +49 345
5582-765
e-mail:
bruno@mpi-halle.de

EXPERIMENTAL MEDICINE

Myelin Made from Cholesterol

Cholesterol is vital for humans and animals. It is produced in all organs and found all over the body – most abundantly in myelin membranes, which form an insulating layer surrounding nerve fibers. Researchers at the Max Planck Institute for Experimental Medicine in Göttingen are investigating what function cholesterol fulfills in these myelin membranes. Using genetically modified mice, they proved that the integration of cholesterol is essential for myelin formation and thus nerve fiber function. (NATURE NEUROSCIENCE, April 8, 2005)

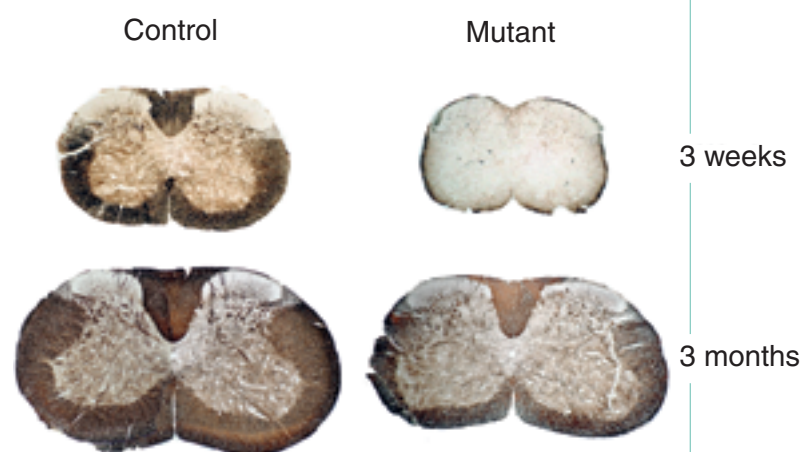
Humans take up one third of this life-essential cholesterol from their food, while two thirds is produced in the body. In mammals, every membrane contains a specific amount of cholesterol, and that is what determines their physical and biological characteristics. That is why the synthesis and distribution of cholesterol is strictly regulated.

"Understanding how cholesterol acts in the body's various organs and how its self-regulation functions in the organism are central issues in the search for risk factors for such diseases as arteriosclerosis," says Gesine Saher from the Max Planck Institute for Experimental Medicine. Cholesterol metabolism disorders are also thought to be linked to strokes and Alzheimer's disease.

"The brain represents a special case. It synthesizes its entire cholesterol requirements by itself and is therefore completely independent from cholesterol metabolism in the rest of the body, including food intake," explains Saher. In addition, the brain is the most cholesterol-rich organ in the human body. In the brain, cho-

lesterol is especially enriched in the myelin sheaths of nerve fibers. Myelin is produced by a special cell type in the central nervous system, the so-called oligodendrocytes. It is mainly synthesized during the first weeks of life. "Myelin exists as densely packed membrane layers surrounding the nerve fibers and acts as electrical insulation. This allows efficient control of

In the course of their investigations, the researchers came across a previously unknown mechanism – a kind of neighborly assistance between brain cells. The oligodendrocytes, whose cholesterol synthesis was turned off in the mouse mutants, apparently drew cholesterol from outside. "This help," according to Gesine Saher, "is provided by other brain



Cross section through the spinal cord of mice, in which myelin is stained brown. In young mutant mice (above right), very little myelin is visible, while in older mutants (below right), considerable amounts of myelin have formed. Left, as a comparison, normal myelin amounts in the "white matter" from control litter-mates.


body movements and is also important for higher cognitive functions," explains the Max Planck researcher.

Using genetically modified mice, the neurogeneticists in Göttingen have now shown that the incorporation of cholesterol is absolutely essential for the formation of myelin membranes. Cholesterol synthesis in the test animals' oligodendrocytes was switched off – with the result that there was almost no myelin covering the nerve fibers. As a consequence, the mutant mice suffered from permanent tremors and disturbed coordination; a third of the animals even died.

cells that we did not genetically alter."

In the end, the handicapped oligodendrocytes were so richly supplied with cholesterol through this process that myelin production returned to normal. Through this internal brain redistribution of cholesterol production, the test animals could compensate and overcome their severe genetic defect as they aged.

Spurred on by this first discovery, the Göttingen-based scientists hope their mutant mice will help them gain further – and at some point also clinically relevant – insight into the role of cholesterol in our bodies. ●

 Further information from:
PROF. KLAUS-ARMIN NAVE
Max Planck Institute for Experimental Medicine, Göttingen
Tel.: +49 551 3899-757
Fax: +49 551 3899-758
e-mail: nave@em.mpg.de


 DR. GESINE SAHER
Max Planck Institute for Experimental Medicine, Göttingen
Tel.: +49 551 3899-751
Fax: +49 551 3899-753
e-mail: saher@em.mpg.de

PHOTO: MPI FOR EXPERIMENTAL MEDICINE/GESINE SAHER

EVOLUTIONARY ANTHROPOLOGY

Protein Reveals the Menu

A team led by scientists from the Max Planck Institute for Evolutionary Anthropology in Leipzig has extracted a protein from the 75,000-year-old bones of a Neanderthal and determined the sequence of its amino acids. This has provided clues concerning the dietary evolution of the hominid line. (PNAS, March 7, 2005)

"Our laboratories have decoded the oldest fossil protein to date," says Christina M. Nielsen-Marsh from the Max Planck Institute for Evolutionary Anthropology. Protein molecules are composed of building blocks – amino acids – linked together in a row, like a chain. There are 20 types of such building blocks to choose from – and their order along the chain determines their subsequent folding, and thus the three-dimensional structure and function of the finished protein.

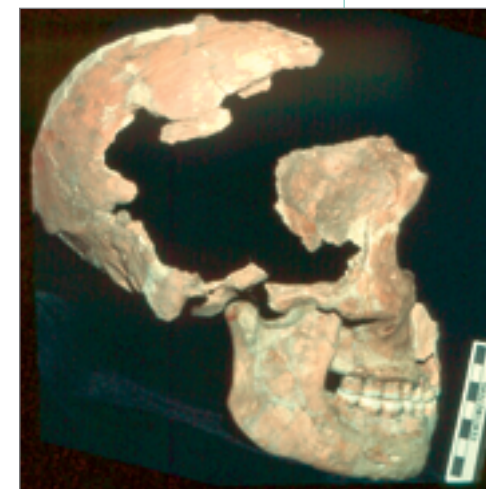
Similar to genetic analyses, amino acid sequences can provide information on the relationship between extinct and living species. "Sequencing amino acids in a protein enables us to determine genealogical relationships and obtain behavioral information, even from fossils that contain no DNA," explains Nielsen-Marsh.

The fossils analyzed by archaeological scientists from the Department of Human Evolution come from the Shanidar caves in Iraq. The researchers isolated a protein known as osteocalcin from one of the Neanderthal bones found at the site and compared its amino acid sequence with the corresponding sequences from living primates – humans, chimpanzees, gorillas and orangutans.

The scientists were primarily interested in the genealogical relationship between Neanderthals and modern humans (*Homo sapiens*). DNA comparisons with early modern humans had already shown that, genetically, Neanderthals contributed very little to living humans, even though they could theoretically have interbred to produce mutual descendents. The two groups populated the Earth at approximately the same time: the Neanderthals lived 150,000 to 300,000 years ago in Europe, parts of Asia and the Middle East, while modern humans first appeared in Africa around 100,000 to 200,000 years ago.

The Leipzig-based anthropologists discovered that the Neanderthal osteocalcin amino acid sequence largely matched that of modern humans. "However," says Nielsen-Marsh, "that doesn't mean that Neanderthals and modern humans interbred, as this protein plays a role in the metabolism of bone and could never provide us with that kind of information." The identical sequences could have been inherited independently of one another, or they could have originated from a mutual ancestor. The osteocalcin sequences from Neanderthals, humans, chimpanzees and orangutans do, however, differ markedly from those in gorillas and other mammals. At one particular locus, for instance, the amino acid hydroxyproline can be found in gorillas and most other mammals, while the amino acid proline, on the other hand, is present in Neanderthals, humans, chimpanzees and orangutans.

"This may be a result of their diet," speculates Christina M. Nielsen-Marsh. "Vitamin C is needed to form hydroxyproline from proline – and this is abun-



The skull of the 75,000-year-old Neanderthal from the Shanidar caves in Iraq. The Max Planck scientists isolated a fossil protein from the bones of this hominid.

dantly available in the diet of herbivores, such as gorillas, but can occasionally be lacking in those of the omnivorous primates such as humans, Neanderthals and orangutans." The ability to form proteins in the absence of vitamin C may have been an advantage in primates that rarely had this nutrient on the menu.

"Sequencing the osteocalcin protein thus also tells us about the nutritional behavior of primates," says the Max Planck researcher. "It opens up the fascinating possibilities of uncovering phylogenetic relationships, as well as gaining new insights into behavioral research." Although protein sequencing will never be able to provide as much phylogenetic data as DNA analysis, proteins such as osteocalcin can survive for 500,000 years – under good conditions, perhaps even as long as several million years. "And that is why we are hoping to soon expand our investigations to include very early hominid finds," explains Nielsen-Marsh. ●

 Further information from:
DR. CHRISTINA M. NIELSEN-MARSH
Max Planck Institute for Evolutionary Anthropology, Leipzig
Tel.: +49 341 3550-361
Fax: +49 341 3550-399
e-mail: nielsen@eva.mpg.de

PHOTO: ENIK TRINKEAUS

BIOPHYSICAL CHEMISTRY

How Flies Lose Weight

When food supplies are abundant, an organism selectively creates reserves – fat stores it can fall back on during times of hunger. When this regulation derails, the result is obesity or emaciation. Researchers at the Max Planck Institute for Biophysical Chemistry in Göttingen have been searching for the genes in the fruit fly *Drosophila* that influence lipometabolism. During their investigations, they came across the *brummer* gene, whose product – a fat storage cleaving enzyme – apparently plays a key role in deciding between fat and thin. (CELL METABOLISM, May 11, 2005)

If the *brummer* gene is missing, fruit flies become fat; if the gene is overactive, the insects become lean. That, in essence,

summarizes the latest results from the Molecular Physiology research group led by Ronald P. Kühnlein in Göttingen. The team is investigating genetically determined differences in body fat content in the model system *Drosophila*. Although there is no visible difference between fat and thin fruit flies, the body fat content – which depends on the *brummer* gene – is 15 times higher in fat flies than in their lean relatives. Since the *brummer* gene has a human counterpart, it is believed that this gene family could also be involved in pathological forms of obesity – adiposity – in humans.

Adiposity is the result of malregulation of energy homeostasis, a regulatory network that, on the one hand, stores body fat when food is in excess supply, and, on the other hand, controls body fat mobilization when the cupboards are bare. Physiological control of this energy balance is a universal trait of all animals. In humans, adiposity was long considered to be the consequence of excess and prosperity. However, according to estimates by the World Health Organization (WHO), more than a billion people now suffer from

overweight, and 300 million are considered clinically obese.

The Göttingen researchers have now identified the *brummer* gene in *Drosophila*; it codes for an enzyme that binds to intracellular lipid storage droplets in the fly's fatty tissue and ensures that these assembled energy carriers are available for metabolism. Relatives of this fly enzyme also work in mammals. Previous investigations by the group had found the first clue to this surprising evolutionary conservation of fat storage regulation tools and mechanisms between insects and mammals when analyzing the fly gene *Lsd-2*, a relative of the adiposity gene *perilipin* in mammals.

For Ronald P. Kühnlein's research group, functional characterization of the *brummer* gene does even more than considerably broaden their understanding of body fat storage in insects. More importantly, the existence of the related *ATGL* gene (*adipocyte triglyceride lipase*) in mammalian fat storage cells suggests that this gene family plays an evolutionarily preserved key role in regulating body fat content in animals.

The Göttingen-based Max Planck scientists now hope they can use the fruit fly model, a highly accessible genetic and molecular system, to also reveal new approaches to the treatment of adiposity in humans. Until then, a carefully balanced diet and regular exercise remain the only effective measures against overweight and obesity. ●



Further information from:
DR. RONALD P. KÜHNLEIN
Max Planck Institute
for Biophysical Chemistry,
Göttingen
Tel.: +49 551 201-1049
Fax: +49 551 201-1755
e-mail: rkuehnl@gwdg.de



The fruit fly *Drosophila melanogaster* has long been the favorite pet of geneticists. Now it is helping in the search for genes that regulate fat metabolism. The picture shows a fly with its fat storage tissue stained green.

PHOTO: MPI FOR BIOPHYSICAL CHEMISTRY

Panorama

MICE LOSE THEIR SENSE of time when a gene known as *Ear2* is repressed during their development. This gene encodes for a protein that, during embryogenesis, acts as a transcription factor in the *Locus coeruleus* – a small area of the mammalian brain that functions as the source of the neurotransmitter noradrenaline in adult animals. In mouse mutants that lacked *Ear2*, researchers at the Max Planck Institute of Experimental Endocrinology in Hanover can now study the importance of this gene, and thus of a functioning *Locus coeruleus*, to the rodents. For example, the *Locus coeruleus* in mice that grew up without *Ear2* exhibited around 70 percent fewer nerve cells than that in animals that developed normally. The concentration of noradrenaline in the cerebral cortex of the defect mutants was also correspondingly low, at just a quarter of the normal level. This deficiency was expressed in increased susceptibility to impaired functionality of their internal clock – in other words, the circadian regulation of their behavior – and in increased sensitivity to pain. Further studies will be aimed at clarifying whether and to what extent the *Locus coeruleus* also influences fear and learning behavior, as well as memory performance.

GAMMA QUANTA PRODUCE GLOWING TRAILS when they shoot out of space and crash into and shatter atoms and molecules in the air. This creates fast-moving particles (air showers) that, through bluish light cones, betray their direction of incidence, and thus the origin of the cosmic gamma rays. Using this so-called Cherenkov radiation, an international team led by the Max Planck Institute for Nuclear Physics in Heidelberg has now located eight new sources of high-energy gamma radiation at the core of the Milky Way. The researchers used the four HESS telescopes that have been operating in the Khomas Highland of Namibia since December 2003. Not only was this a great and unexpected addition to the dozen known high-energy gamma sources, but some of the new objects themselves also harbored surprises, such as their expanse covering several light years. In addition, they can be detected only through high-energy gamma radiation, but not through visible light, or radio or X-ray radiation, making them a completely new and initially puzzling type of cosmic radiation source.

CORN ROOTS CRY FOR HELP when attacked by pests. They secrete a semiochemical that attracts tiny worms (nematodes) that, in turn, attack the aggressors. In this way, as researchers at the Max Planck Institute for Chemical Ecology in Jena and the Swiss University of Neuchâtel discovered, European maize varieties defend themselves against

the larvae of the corn rootworm *Diabrotica virgifera*. So what has long been known to take place above ground also works under ground, in the soil: plants that have been nibbled on use signaling substances to call the enemy's enemies to their aid. Furthermore, it was shown that the ancestor of corn, Mexican teosinte, releases the same chemical through its roots that the corn varieties used in North America, bred for high yield, have apparently sacrificed, necessitating pesticides to protect them. According to the researchers, it should be worthwhile to examine more wild plant varieties for such natural defense mechanisms. This would aid in developing strategies for the biological protection of cultivated plants that, under human care, have forgotten how to independently defend themselves against their enemies.



A rootworm larva attacks corn roots. In the background are nematodes that are quite interested in the insect.

GLIAL CELLS STOP LEAKS in brain vessels and clean up the surrounding areas that have suffered damage from bleeding. For the first time, scientists at the Max Planck Institutes for Experimental Medicine in Göttingen and for Medical Research in Heidelberg have observed this directly in mice. To do so, a gene was transferred to the lab animals, causing the microglia to produce a green fluorescent protein that allowed the activity of this immunocompetent glial cell type to be tracked through the mice skull using laser light and two-photon microscopy. This revealed that the microglia cells are continuously active, even in healthy brains, and use protrusions to scan their surroundings. If a brain vessel bursts, these cell fingers make their way within minutes to the site of the wound and try to limit the damage. The scientists now want to clarify whether other defects, such as those that appear during the course of Alzheimer's disease, also call the microglia cells into action. ●



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