Winter on the Balcony

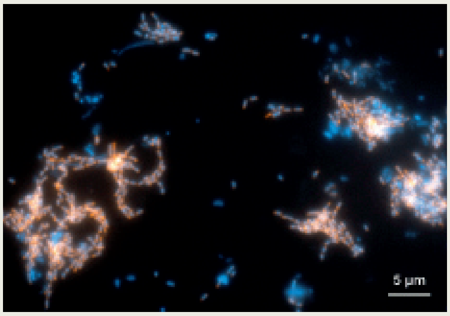
Some migratory birds are able to adapt their migration pattern rapidly to climate change

Migratory birds might bear the brunt of climate change. Not only do they have to undertake strenuous and dangerous journeys between their summer and winter quarters, they also fall behind in the competition with non-migratory birds for territory and nesting places. However, it is possible that, by changing their migratory behavior, at least some species are able to adapt to climate warming more rapidly than previously feared. Francisco Pulido and Peter Berthold from the Max Planck Institute for Ornithology in Radolfzell have discovered that migratory birds can become residents within a very short time, spending winter in their breeding area and no longer migrating. For this purpose, they mated in the laboratory black cap nestlings that were specifically selected for their low migratory activity (measured on the basis of “migratory restlessness”). The duration of migratory restlessness, which is expressed in nighttime flapping and hopping on the perch, is roughly equivalent to the time it takes to fly to winter quarters. As the researchers had deliberately chosen less restless individuals, their offspring exhibited progressively lower levels of migratory activity, and after just two generations, the first resident birds emerged from this population of originally fully migratory birds. A partially migratory population consisting of migratory and resident birds had thus evolved, which, within a few generations, can selectively become a fully resident bird population. Two evolutionary mechanisms are apparently key to the rapid adjustment of migratory behavior to new climatic conditions. First, the reduction (or increase) in the length of migratory activity, and consequently the distance migrated. Second, the shift in the proportions of resident and migratory birds in partially migratory populations to almost fully migratory or non-migratory populations. These mechanisms take effect fastest in short-distance migrants with high percentages of migratory and resident birds, but over time, also in long-distance migrants. (PNAS, April 6, 2010)

Migratory birds become residents: Black caps change their behavior within a very short time.

Oxygen from the Wonderful Methane Eaters

Up to now, plants and blue algae have had a monopoly on making oxygen. They now have competition – in the form of a recently discovered fresh water bacterium named *Methylomirabilis oxyfera* (which translates as “wonderful methane eater that produces oxygen”). An international team of scientists showed that this bacterium produces oxygen and does not even need light to do so. While plants and blue algae separate off the oxygen during the photosynthesis of water molecules, *Methylomirabilis* uses the nitrogen held in nitrite molecules. It does not, however, release oxygen molecules, but uses them to oxidize the slow-reacting methane and produce energy from it. *Methylomirabilis* benefits from the fact that there are large amounts of nitrite in fresh water from the intensive fertilization of agricultural land. “It is possible that this reaction path is the missing link that made it possible for photosynthesis and oxygen production to evolve billions of years ago,” says Marc Strous from the Max Planck Institute for Marine Microbiology in Bremen. (Nature, March 25, 2010)

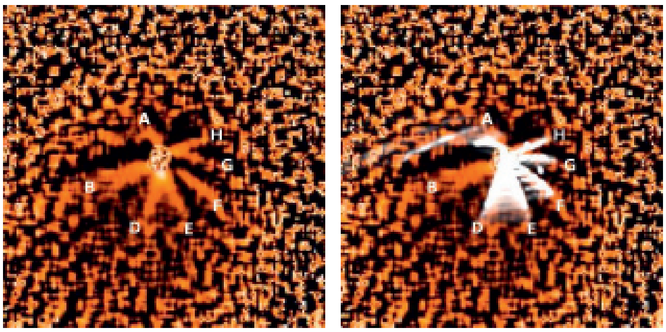


The newly discovered micro-organism *Methylomirabilis oxyfera* under a fluorescence microscope.

Photos: Wildlife (top), MPI for Marine Microbiology

Where Comets Spew Dust

Scientists identify the active regions on the surface of comets

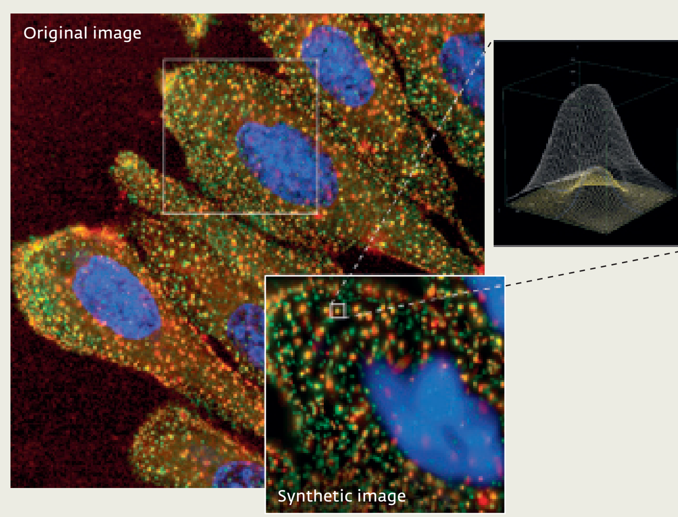


A view of the comet Tempel 1 through a telescope. The active regions show up as bright streaks (left). The Max Planck researchers' computer simulation can be used to reconstruct the image taken from Earth (right).

Comets are dangerous objects to research – at least close up. This is because tiny dust particles that flow into space from the active regions on the surface can damage space probes. It is not easy to determine from the Earth exactly how these fountains originate. Scientists at the Max Planck Institute for Solar System Research in Katlenburg-Lindau have now developed a computer model that locates these regions using photographs taken from the Earth's surface. They chose an indirect approach that, for the first time, took into account the three-dimensional structure of the comet's core, and they relied on a standard procedure. Telescope observations of the changes exhibited by the light of a comet as it orbits allow conclusions to be drawn about the shape of the core. The researchers then fed an initial assumption about the locations of the active regions into their program. They also made assumptions about a few physical parameters of the dust particles, such as their size and the speed at which they leave the surface of the core. The computer delivered results in the form of an image similar to one provided by a telescope from Earth. Comparing this with the real telescope image allows the modeled images to be refined until the simulation and the real photograph are the same. This new process could assist in calculating a safe route for the ESA space probe *Rosetta*, which is expected to encounter the Churyumov-Gerasimenko comet in 2014. (Astronomy & Astrophysics, 512, A60, 2010)

A Fingerprint for Genes

Although cells do not have mouths, they can ingest substances from the external environment. They pick up material from the outside by pinching off bubbles of their cell membrane with which they have enclosed the substances. Depending on the substance they contain, these vesicles, which are also called endosomes, are transported to different locations within the cell, where they are processed or broken down. Scientists working with Marino Zerial at the Max Planck Institute for Molecular Cell Biology and Genetics in Dresden have used a new strategy to identify around 4,000 genes that are directly or indirectly involved in endocytosis. When individual genes malfunction, vesicles remain in the periphery of the cells and do not reach the center. It appears that different materials are directed to their destination by different genes. The enormous number of genes involved reflects the significance of endocytosis in the organism. For example, the production of important metabolic substances such as insulin depends on endocytosis, and viruses use endosomes to infect cells – findings that were made possible through combinations of different techniques. The scientists in Dresden blocked each of the 24,000 or so human genes in turn, using RNA molecules (siRNAs) that attach themselves to specific sections in the DNA and silence the gene in question. With the aid of fluorescent dyes and automatic image analysis, they were able to assign each gene a specific function in endocytosis and create a quantitative profile of each gene – thus giving each gene an individual fingerprint. (Nature, February 28, 2010)

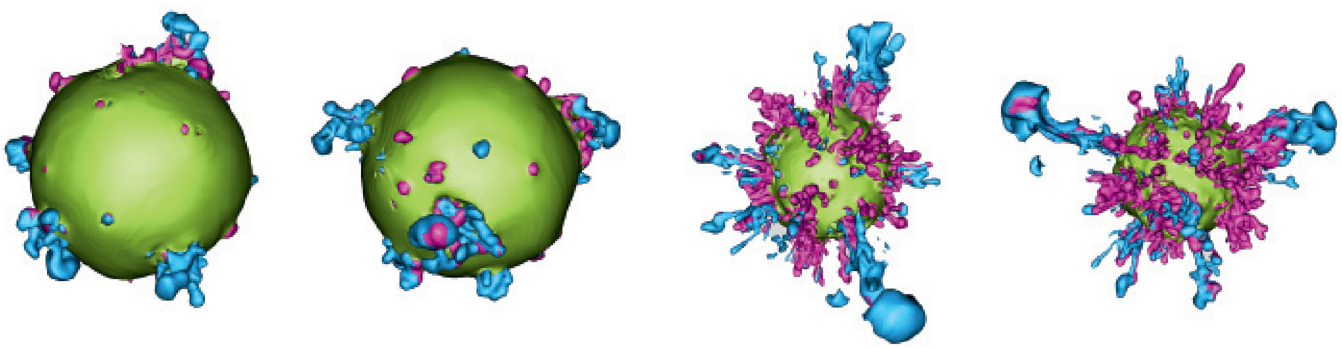


Cells with endosomes dyed red and green, and labeled cell nuclei (blue). A synthetic image is formed from the light intensity of the labeled cell organelles (small image below). The small image at the top right shows the computed 3-D model of a single endosome.

Photos and graphic: Instituto de Astrofísica de Andalucía (Luisa Maria Lara)-MPS (2, above), MPS

Death of a Star in Three Dimensions

New computer models show in detail how supernovae are shaped



A star dies in 3-D: These snapshots from two different angles show just how far certain elements in the explosion are transported away from the star. The two images on the left show the situation after 350 seconds; the two on the right show it after 9,000 seconds, shortly after the shock wave has broken through the star's surface. The colored surfaces represent the points furthest away from the star at which carbon (green), oxygen (red) and nickel (blue) are present in specific concentrations.

A star dies in 3-D – not in space, but on a computer screen. For the first time, complex calculations have been successfully used to recreate the death of a massive star in three dimensions. The simulations seamlessly cover the period from the beginning of the explosion to the point when the shock wave breaks out of the star's surface several hours later. The scientists at the Max Planck Institute for Astrophysics also show in the models how asymmetries arise in "real" supernovae. Previous simulations in two dimensions revealed that the spherical shell structure of the predecessor star is destroyed in the supernova explosion, and that mixing takes place on a large scale. The details, however, remained hidden. Supernova 1987A, probably the most examined stellar catastrophe, served as a test case. In future simulations, the researchers will examine a broader range of predecessor stars and initial conditions. They also want to formulate a model that explains all the characteristics of SN 1987A and find out how the stellar explosion begins and what triggers it. (Astrophysical Journal, May 10, 2010)

Nitrogen Binds Greenhouse Gas

Nitrogen in the soil reduces the greenhouse effect – and not only as a fertilizer that plants use as an aid to binding carbon dioxide from the atmosphere. At least in the forests of the temperate latitudes, fertilizer also slows the breakdown of organic material in the soil, so that less carbon dioxide is released from the Earth into the atmosphere. This is the conclusion reached by an international team of researchers including scientists from the Max Planck Institute for Biogeochemistry in Jena. The researchers compiled data from a number of different field studies and laboratory experiments. According to this data, the microorganisms in most soils release less carbon dioxide with a moderate discharge of nitrogen, partly because the abundance of nitrogen changes the microbial environment and the microorganisms are saved the effort of consuming woody plant waste that is hard to digest. On average, carbon dioxide emissions from the soil fall by 10 percent. This means that the effect is roughly as significant as that of increasing plant growth. The researchers warn that this effect is nevertheless being neglected in current models of the carbon cycle. (Nature Geoscience, May 2010)

A tray full of soil samples: The researchers in Jena collect the results of their analyses in the FluxNet database. The samples provide information about the carbon dioxide content of the soil.

Illustration: MPI for Astrophysics (top, 4), photo: Sven Döring

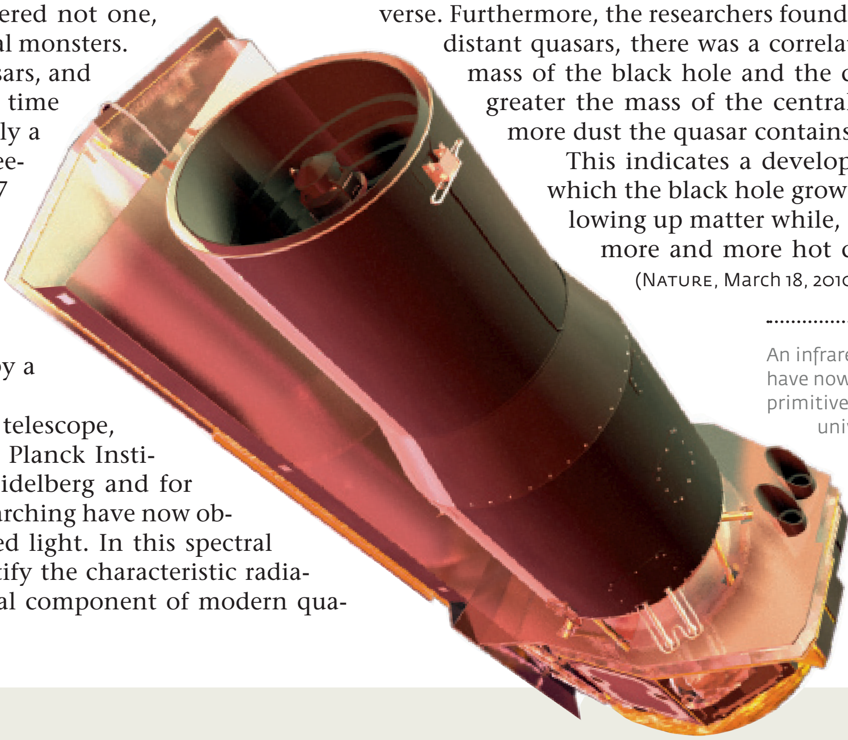
First-Generation Cosmic Power Stations

Astronomers are finding primitive quasars with the Spitzer space telescope

Previously, they existed only in astronomers' models: primitive black holes that populate the cores of active galaxies and that were already present in the young universe. Researchers have now discovered not one, but two of these gravitational monsters. They are revealed to be quasars, and their light originates from a time when the universe was barely a billion years old – we are seeing them as they were 12.7 billion years ago. A quasar is the central region of a galaxy that contains an active black hole. This lies in a brightly shining disk which itself is surrounded by a huge ring of dust.

Using the Spitzer space telescope, astronomers from the Max Planck Institutes for Astronomy in Heidelberg and for Extraterrestrial Physics in Garching have now observed 20 quasars in infrared light. In this spectral range, it is possible to identify the characteristic radiation from hot dust, a typical component of modern quasars. On examination, however, two of the quasars showed no signs of hot dust. This means that they must be early primitive examples, as there was no dust in the early universe. Furthermore, the researchers found that, in the most distant quasars, there was a correlation between the mass of the black hole and the dust content: the greater the mass of the central black hole, the more dust the quasar contains.

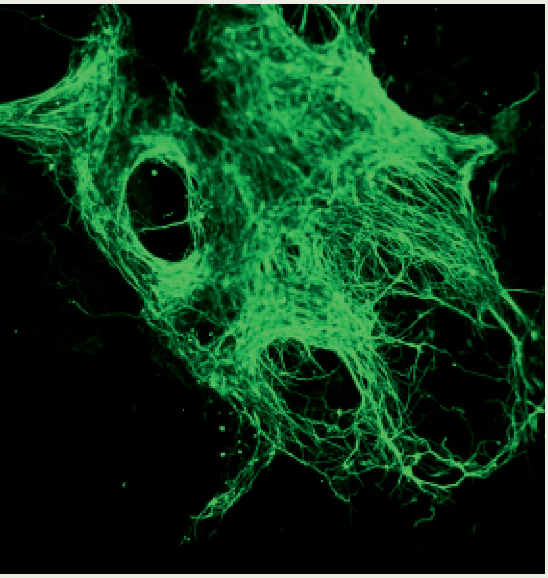
This indicates a development process in which the black hole grows rapidly by swallowing up matter while, at the same time, more and more hot dust is produced.
(Nature, March 18, 2010)



An infrared eye: Astronomers have now discovered the most primitive black holes in the universe with the Spitzer space telescope.

Photos: NASA-JPL-Caltech (top), MPI for Molecular Biomedicine – Boris Greber

Human Stem Cells Remain Indispensable



The mouse is one of the most important model organisms in stem cell research. Scientists in Germany are permitted to use human embryonic stem cells for research only when they have previously examined animal cells. However, such tests are frequently of no use because, despite all the similarities, findings from examinations of the embryonic stem cells of mice cannot simply be applied to humans. A current study by researchers working with Hans Schöler from the Max Planck Institute for Molecular Biomedicine in Münster shows that epiblast stem cells from mice react differently than human embryonic stem cells to the growth factor FGF. While FGF actively supports renewal of human cells, this is not the case in the mouse epiblast cells. "This means that many preliminary investigations using animal cells, particularly projects relevant to medicine, might not only be of no use, but the results of such advance tests can even be misleading," warns Hans Schöler. Human cells will therefore remain essential for stem cell research in the future. (Cell Stem Cell, March 5, 2010)

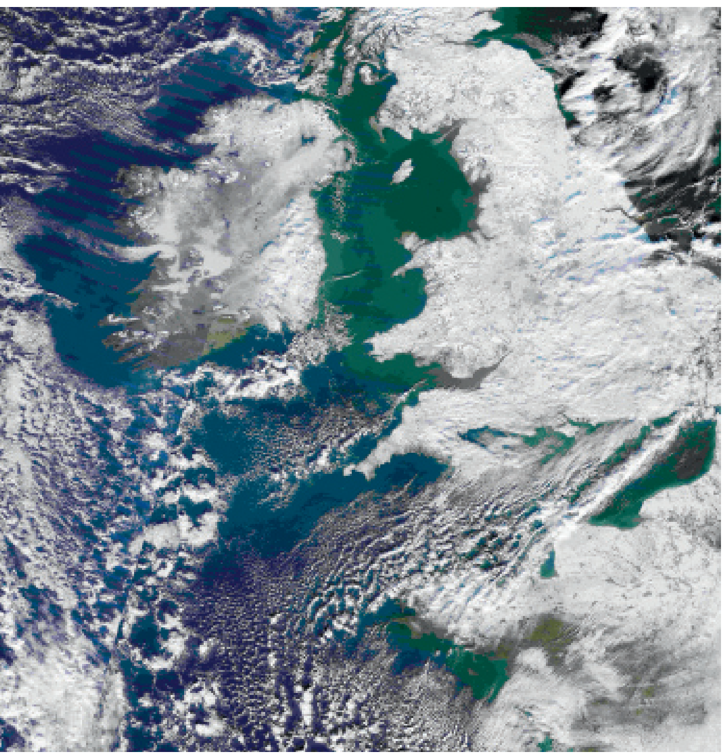
The illustration shows nerve cells (green) from the epiblast stem cells of a mouse. They are created four days after FGF and other growth factors have been blocked. It is also possible to create nerve cells from human stem cells in this way.

Are Winters Becoming Colder in Europe?

Low solar activity could affect the regional climate in Great Britain and Central Europe

Despite the trend toward global warming, people in Great Britain and Central Europe might experience cold winters more frequently over the next few years. This is the conclusion drawn from a study by scientists from the University of Reading, the Rutherford Appleton Laboratory in Oxfordshire in the UK, and the Max Planck Institute for Solar System Research in Katlenburg-Lindau. The researchers examined British weather records going back to 1659 and compared them with solar activity over the same period. The strength of the solar magnetic field was used as a measure of the Sun's activity. As sufficiently reliable data is available only for the years after 1900, the researchers reconstructed older values with computer simulations. The statistical comparison of the magnetic "fever curve" of the Sun with the weather database paints a very clear picture: after decades of high solar activity and comparatively mild winters, cold winters are becoming more frequent in Europe.

When there is low solar activity, the average winter temperature in the UK is around half a degree lower than usual. The reason for this very regional effect of low solar activity could be attributed to wind changes in the troposphere, the lowest layer of our atmosphere. If the stratosphere that lies over it heats up only slightly, the mild strong winds from the Atlantic are blocked. Instead, the UK and Central Europe are exposed to the effects of cold winds from the northeast. The exact mechanism for this is, however, still unclear. (Environmental Research Letters, April 15, 2010)



A sight that we might have to get used to: Large parts of the UK and Central Europe were covered by snow last winter, as this satellite photo of January 7, 2010 shows.

Firm Footing for Mussels

Mussels have an iron grip on stones and rocks – and that's not just figuratively speaking. The byssus, the threads with which mussels hold fast to the ground, hardly ever wears out, although waves constantly pull at it and it is abraded again and again by stones. Scientists at the Max Planck Institute of Colloids and Interfaces in Potsdam-Golm have found that the fibers owe this resistance to iron atoms in their cuticle, over which the proteins in the mussel form a network. Bonds form on the iron atoms, which, in some cases, break under stress so that the material can stretch further. These fractures then close again. This means that nature achieves what materials scientists hardly ever succeed in: making a material stretchable and hard at the same time. The researchers are hoping that nature's principle can be used to make technological materials with similar properties.

Secured for life in a strong current: Mussel shells hold onto rocks with byssus threads. Strengthened by iron, the fibers are resistant to abrasion.

Photos: NASA (top), MPS

The Call of the Horseshoe Bat

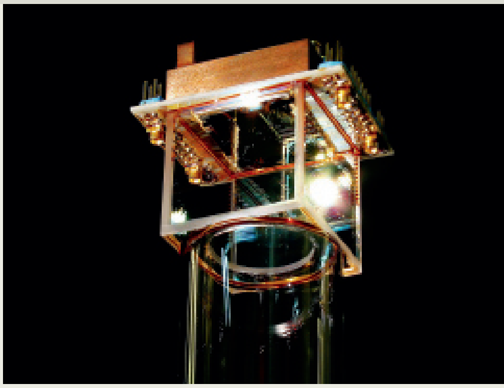
Bats recognize the calls of other bat species

The echo location calls of bats hold more information than was previously thought. Not only can bats distinguish their calls from the calls of other species, but they can also recognize the different calls made by other species – similar to the way in which we humans differentiate between different languages. Maike Schuchmann and Björn Siemers from the Max Planck Institute for Ornithology in Seewiesen played echo location calls produced by their own species and by three other species through a loudspeaker to two species of horseshoe bat, and analyzed their reactions. Both bat species made almost no mistakes when distinguishing between their own and the other species, or between different calls by the other species. The scientists now want to move on to finding out how bats use this capability. The animals might profit from this, for example, when they stay out of the way of the hunting area of a stronger competitor. It would also be of benefit to follow other species with similar habitat requirements when they are searching for new places to roost. (The American Naturalist, May 11, 2010)

The Meheley horseshoe bat (*Rhinolophus mehelyi*) can even identify closely related species from their calls.

Bringing Turbulence Under Control

A method of controlling turbulent flows is helping to save energy. Whether it is oil or water being pumped through a pipe, turbulence often consumes ten times as much energy as a calm flow traveling at the same speed. Scientists at the Max Planck Institute for Dynamics and Self-Organization in Göttingen and at Harvard University in the US have found a way to calm relatively slow-moving turbulence in a glass tube. Using simulations, they found that they can halt turbulence by changing the speed profile of the flow behind it. They slow the flow in the middle of the tube and speed it up on the edge by deliberately creating turbulence in the middle of the flow. Unlike other attempts at calming, they also save energy in this way – five times as much as they need to trigger the turbulence. (Science, March 19, 2010)



Measuring beyond the quantum limit: Using the atomic chip on the upper side of the cube-shaped vacuum chamber, physicists in Munich trap atoms in order to improve the accuracy of atomic clocks.

Squeezing Quantum Noise

Compact and seemingly more precise than quantum physics permits – this is how the atomic clock of the future might tick. A team working with physicists from the Max Planck Institute of Quantum Optics and Ludwig Maximilian University in Munich has contrived a way to improve the accuracy of measuring instruments that work with quantum particles on a microchip. Moreover, it goes beyond the quantum limit. This limit exists because the behavior of quantum particles is subject to probability. The quantum noise that results manifests itself when a measuring point becomes a patch, for example. The researchers have now squeezed this round measuring patch into a cigar-shaped structure, which increased the accuracy in one direction, but at the price of lowering the accuracy in the other direction. They achieved this by trapping rubidium atoms on a microchip. The behavior of one atom determines what happens to the partners trapped with it. The researchers take advantage of this effect in a clever procedure. In this way, it is possible to increase the accuracy of chip-based atom clocks and also atom interferometers. The latter can detect very weak force fields and thus measure rotation or help to search for ore deposits that change the gravitational field of the Earth around their location. (Nature, March 31, 2010)

Photos: Philipp Treutlein – MPI for Quantum Physics (top), MPI for Ornithology – Stefan Greif (center)