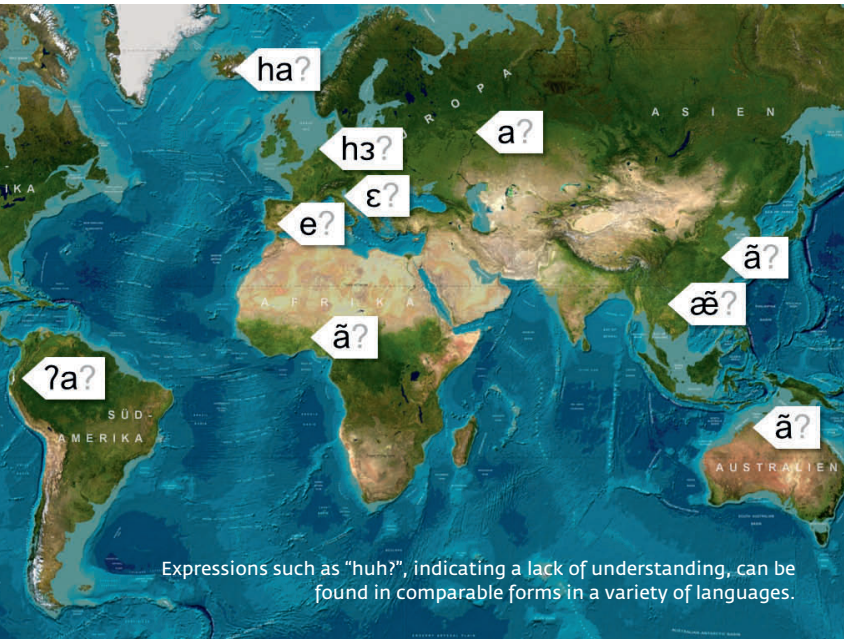
We Understand that We Don't Understand

The words used to express problems in understanding are similar in many languages



Expressions such as "huh?", indicating a lack of understanding, can be found in comparable forms in a variety of languages.

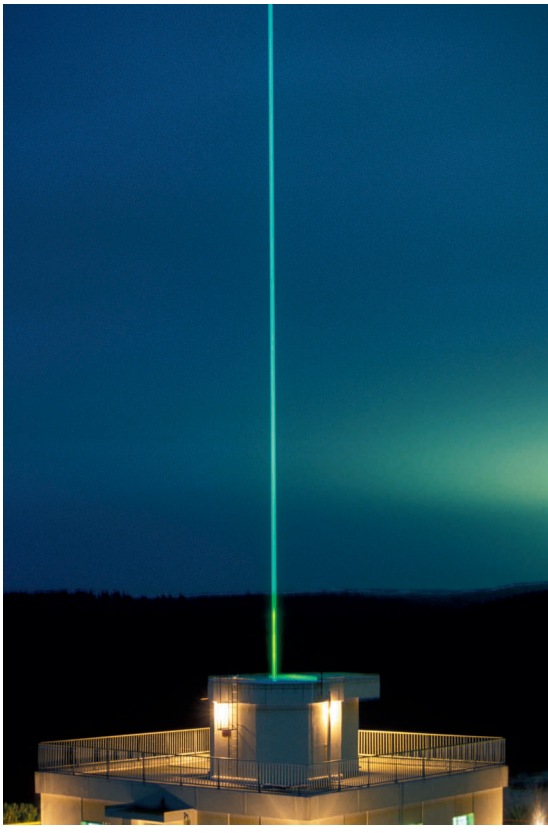
The expression "huh?" is perhaps not the politest way of telling someone you don't understand, but it's an indispensable instrument of human communication. Without it, conversation would falter as communication breaks down. Researchers at the Max Planck Institute for Psycholinguistics in Nijmegen in the Netherlands analyzed various languages from across the world and discovered that, in each of the languages they studied, there is a word more or less identical in sound and function to "huh?". Normally, words in unrelated languages sound different from one another. The scientists suspect, however, that every language needs to convey a lack of understanding in a manner that is quick and easy to express. That is why the expressions "huh?" in English, "häh?" in German, "a?" in Mandarin Chinese, "a?" in Laotian and "he?" in Dutch all sound very similar. Nevertheless, the expressions in different languages differ slightly, and shouldn't be compared with other universal, innate human sounds, such as sneezing or crying. This word must be learned with fine distinctions in each language. (PLOS ONE, November 8, 2013)

Photos: MPI for Psycholinguistics (top), SPL-Agentur Focus (bottom)

Light Observed in Transit

An atom in a resonator registers a photon without destroying it

Seeing light is trivial enough; seeing light in transit, however, is anything but trivial. Physicists working with Stephan Ritter and Gerhard Rempe at the Max Planck Institute of Quantum Optics in Garching managed to do just that. Our eyes are able to perceive a beam of light in the mist or a laser fired into the air only because the particles of light, called photons, are scattered and impinge on our retinas. But then these photons are gone. The ability to register a photon in transit is a helpful aid to quantum information technology, which uses the quantum characteristics of particles to increase the security with which information is transferred and the speed at which data is processed. To this end, the researchers in Garching caused a photon to interact with an atom that fixes a laser in a resonator comprised of two mirrors. They put the atom in a state whose phase can be shifted by a photon. If one imagines the atom as a clock, the phase is the angle between the hands. The photon passing by resets the clock, as it were, without altering its own characteristics or being lost. The physicists can then quite easily measure the phase shift with a laser. (Science Express, November 14, 2013)



Light flying past us is beyond our perception. We perceive only those photons that are scattered and deflected toward our eyes by dust, mist or molecules in the air. Observing these particles of light extinguishes them. Now Max Planck researchers have detected a light particle that subsequently continued on its flight path.

Gas Station in Space

Astronomers observe how primordial gas flows into a galaxy

Even galaxies need to fill up their fuel tanks. After all, especially at the beginning of their lives, huge numbers of new stars are created within them – and that requires the necessary substance. So when galaxies like our Milky Way were formed some ten billion years ago, they evidently drew in large quantities of cosmic matter from vast reservoirs of hydrogen. Since the dawn of the universe, this hydrogen has been present in the wilds of intergalactic space. But how does the matter find its way in to the Milky Way? Supercomputer simulations depict cold flows of gaseous matter flowing into the galaxy. To test this scenario, researchers – including some from the Max Planck Institute for Astronomy – focused on a galaxy whose light takes 11 billion years to reach us. And indeed, they found inflows of gas that show traces of heavy hydrogen, proving that it really is primordial matter. (Astrophysical Journal Letters, October 20, 2013)

Galactic currents: This supercomputer simulation shows cold gas flowing into a Milky Way system (center). One of the flows of matter is illuminated by a distant quasar (bottom left), its presence betrayed by the absorption lines in the light.

Music from the Rain Forest

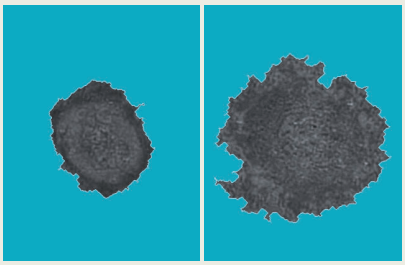
The song of the musician wren sounds like human music

Cyphorhinus arada is more commonly known in English as the musician wren. And with good reason, as composer and musicologist Emily Doolittle and biologist Henrik Brumm of the Max Planck Institute for Ornithology in Seewiesen discovered. This small brown bird, a denizen of the Amazon rainforest, sings perfect consonances such as octaves, fifths and fourths. As a result, it sounds very much like human music. Listening to the bird's song, the scientists found passages that bear a striking resemblance to motifs used by, for instance, Bach and Haydn in their compositions. However, the musician wren doesn't sing in a specific key, as a human singer would. Yet its preference for perfect intervals gives the impression that the sounds follow a musical scale. Its song makes the musician wren an exception among the 4,000 or so different species of song birds, since bird song isn't normally structured in the same way as human music. The researchers don't yet know why the musician wren sings as it does, or how it perceives its own song. (Journal of Interdisciplinary Music Studies, October 15, 2013)

The Geometry of Cancer Cells

Malignant cells could be identified more rapidly using characteristic fractal samples

Time is a decisive factor in the fight against cancer. If suitable treatment is to be initiated with greater speed, it is essential for the tumor to be characterized quickly. A new approach pursued by scientists working with Joachim Spatz, Director at the Max Planck Institute for Intelligent Systems in Stuttgart, could substantially accelerate the diagnosis. The researchers are using the fractal geometry of the cell border to identify tumor cells. Fractal structures on a small scale exhibit the same features as on a large scale. As the scientists have since discovered, the statistical distribution of irregularities in the cell border differs from one type of tumor to another. As a result, the cells can be identified at a glance through a particularly high-contrast microscope. Previously, a time-consuming immunohistological examination was required, which involved staining the cells different colors in several stages.
(Nano Letters, September 30, 2013)

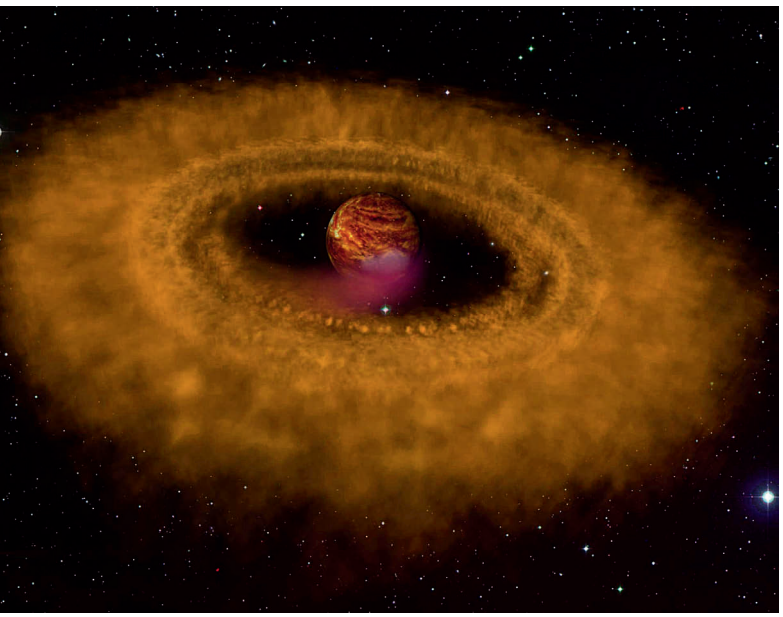


The more frayed, the more malignant: A tumor cell can be distinguished by its fractal geometry, or more precisely, its degree of fractality. The cell on the right displays a greater degree of fractality than that on the left, indicating that it is more aggressive.

Photos: G. Stinson, A.V. Maccio – MPI for Astronomy

Lonely in Space

Newly discovered planets without a host sun help us understand the origins of stars



Heavenly bodies with no host sun floating freely in space and with a mass similar to that of a planet can originate in the same way as stars, as researchers at the Max Planck Institute for Astronomy discovered. They investigated a variety of subjects, one of which can practically be considered a newborn, having originated just two million years ago. And just like a young star, OTS 44, as this lonely planet is called, is surrounded by a disk of gas and dust. What's more, its birth isn't yet complete: the astronomers found signs that OTS 44 is still drawing in matter from the surrounding disk and increasing in mass. The disk comprises at least 30 times the mass of the Earth and is regarded, like the incident matter, as a clear indication of a mechanism of origin that is typical of the birth of stars. They therefore concluded that the same processes that apply to stars also apply to individual objects with the mass of a planet.
(Astrophysical Journal Letters, October 9, 2013)

Solitary object in space: OTS 44 was evidently formed in the same way as a star. Even now, substantial quantities of matter are still falling onto it from the surrounding disk.

Bacteria and Rare Earths

Methane-decomposing microbes in hot springs need these valuable metals to produce energy

They are called rare earths, but they aren't really that rare: the 17 metals belonging to this group are fairly evenly distributed within the Earth's crust, with the result that there are only a few locations where extracting them is worthwhile. Without these metals, mobile phones, screens and computers wouldn't work. And it seems that some life forms can't do without them, either. In a hot volcanic spring, a team of researchers including scientists from the Max Planck Institute for Medical Research in Heidelberg are the first to have discovered a bacterium that needs rare earth elements to grow: *Methylacidiphilum fumariolicum* sources its energy from methane, and to do so, it needs lanthanum, cerium, praseodymium or neodymium. The metals act as cofactors for the enzyme methanol dehydrogenase, which processes the methanol produced as methane is broken down. This bacterium is thus far the only known organism that needs rare earth metals to live. However, genome and proteome analyses lead scientists to suspect that the new enzyme variant is widespread, particularly among bacteria in coastal waters.
(Environmental Microbiology, October 2013)

The methanol dehydrogenase of the bacterium *Methylacidiphilum fumariolicum* uses the rare earth metal cerium (Ce) instead of calcium as a cofactor.

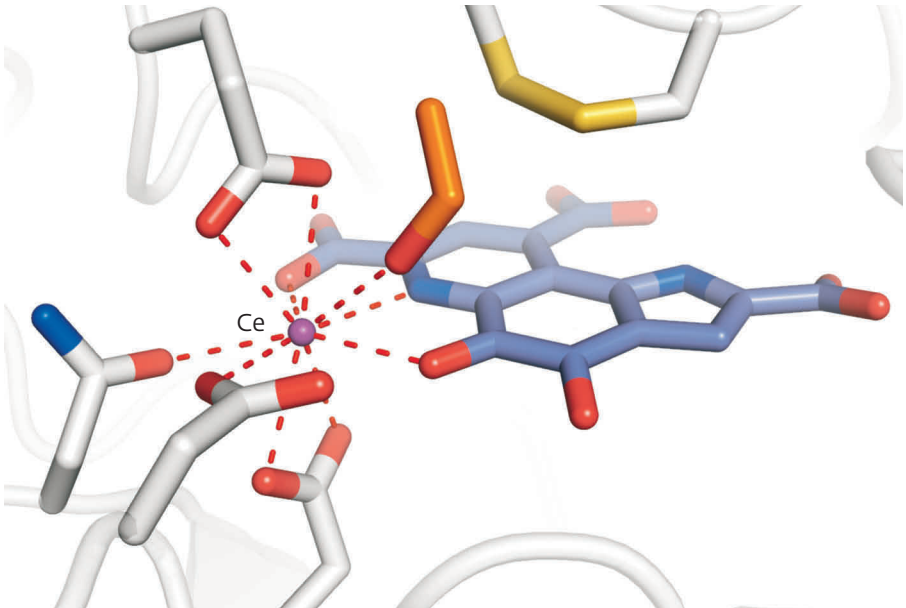
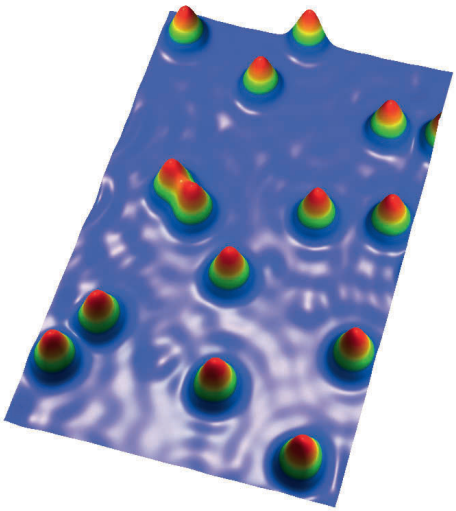


Photo: MPI for Astronomy – A.M. Quetz, graphic: F. Bahrends – MPI for Medical Research

The World's Smallest Memory

Controlling the magnetic moment of individual atoms opens up new possibilities for compact data memories

One bit per atom: A team including Arthur Ernst and other researchers at the Max Planck Institute of Microstructure Physics in Halle succeeded in storing information in such a small space. The scientists fixed a single holmium atom on a platinum surface and were able to prove that the spin of an electron on the rare earth atom remained stable for more than ten minutes. The spin can be imagined as the direction of rotation of the electron, to which it imparts a magnetic moment than can be oriented in two directions in an external magnetic field. Until now, the spin of an individual atom hasn't retained its orientation for more than a millionth of a second, with the result that, at present, a cluster of several million atoms is required to ensure that one magnetic bit remains safely stored on a hard disk over a long period. This current work represents a major step toward the goal of storing data permanently in individual atoms. (Nature, November 14, 2013)



Individual atoms can store data: This image taken by a scanning tunneling microscope shows holmium atoms on a platinum surface. In this quantum system, the spins, and thus the magnetic moments of individual holmium electrons, remain stable for more than ten minutes.

Pit of Bones

Max Planck researchers decode the oldest mitochondrial DNA ever of our prehistoric ancestors

The "bone pit" at Sima de los Huesos in northern Spain is an Eldorado for archaeologists. A team of Spanish researchers discovered and reassembled almost 30 skeletons here. Scientists at the Max Planck Institute for Evolutionary Anthropology in Leipzig have now extracted the DNA from two grams of powdered bone and decoded the mitochondrial genome. From the differences when compared with the genomes of Neanderthals, Denisova hominins and humans alive today, the scientists calculate that the prehistoric skeletons from Sima are around 400,000 years old. They and the Denisovans – a recently discovered Asian relative of the Neanderthals – also shared a common ancestor some 700,000 years ago. It's possible that the prehistoric dwellers in Sima were related to the population from which both the Neanderthals and the Denisovans were subsequently descended. (Nature, December 4, 2013)

The skeletons from the Sima de los Huesos "bone pit" have so far been classified as *Homo heidelbergensis*.

Cracking Wood

In a simple parallel process, the components of lignin can now be extracted for practical use

It looks like it could one day be easier to exploit wood as a source of raw materials. A team of chemists working with Roberto Rinaldi at the Max-Planck-Institut für Kohlenforschung (coal research) in Mülheim an der Ruhr found an efficient way to render the components of the biopolymer lignin usable. Lignin stabilizes plant cells and contains organic compounds that are of great value to the chemical industry, for example for the manufacture of biofuels. Until now, however, it has been difficult for the industry to access the component parts. The chemists in Mülheim developed a method by which to split the tightly interwoven chain molecules of lignin, while at the same time benignly removing the oxygen from its components. They are then left with aromatic substances that are easy to separate.
(Angewandte Chemie International Edition, September 12, 2013)

Photos: Karlsruhe Institute for Technology/KIT (top), Javier Trueba, Madrid Scientific Films

Flies Prefer Oranges

Drosophila's preference for citrus fruits protects it against parasites

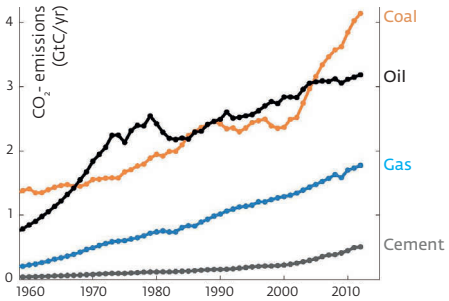
Fruit flies love orange peels because their enemy, the parasitic wasp *Leptopilina boulardii*, loathes the citrus scent.

If there are tiny flies circling over the fruit bowl in the kitchen, it's the oranges they're heading for. The fruit fly *Drosophila melanogaster* prefers to lay its eggs on these citrus fruits, as researchers at the Max Planck Institute for Chemical Ecology in Jena observed. When the larvae hatch, they feed on the microscopic yeast fungi on the orange peel. The researchers' findings indicate that the aroma components limonene and valencene are key in the flies' choice of where to lay their eggs. They detect the aromas with a single odorant receptor. This preference on the part of the fruit flies is a defense against one of their greatest enemies, the parasitic wasp *Leptopilina boulardii*, which lays its eggs on the fly larvae. The same scent that attracts the flies also repels the wasps. Why the wasps avoid citrus fruits is puzzling, given that their scent should really act as a signpost to the source of food. (Current Biology, December 2013)

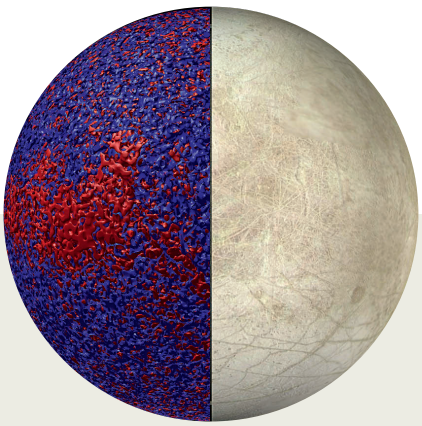
More Greenhouse Gas than Ever

The atmosphere contains more carbon dioxide than at any time since measurements began

Mankind is pumping more and more carbon dioxide into the atmosphere: Measurements by the Global Carbon Project in which Sönke Zaehle of the Max Planck Institute for Biogeochemistry is participating show that, in 2012, burning fossil fuels and other human activity released 35 billion tons of the climate-warming gas. Annual emissions have increased by 58 percent since 1990 and are now higher than ever. As a result, in May 2013, the carbon dioxide content in the air rose above 400 ppm (parts per million) for the first time. Analyses of ice cores from Antarctica show that the atmosphere has never contained so much greenhouse gas in the past 800,000 years as it does now. Given the projections for global economic growth, the researchers expect emissions to increase still further to 36 billion tons in 2013. (Earth System Science Data Discussion)



Development in CO_2 emissions from various sources between 1960 and 2012.



Ocean beneath the surface: New simulations show that the water in Europa's equatorial region is warmer than at the poles. In the left half of the image, red indicates a relatively high temperature, blue a lower one.

Europa's Ocean Heat Pump

Researchers are modeling currents beneath the frozen surface of Jupiter's moon

Jupiter's moon Europa is a bizarre and quite literally cool beauty: A delicate network of furrows several kilometers long cuts through its outer ice shell like the cracks in an old oil painting. The unusual pattern is particularly pronounced around the equator. But how did it originate? Researchers have long suspected that an extensive ocean of saltwater lies beneath the moon's surface. And this ocean could just be the key to the puzzle. Scientists at the University of Texas and the Max Planck Institute for Solar System Research discovered that, in the vicinity of the equator, warmer water is rising from deep within Europa. Their model calculations show that movements in the water are driven by temperature differences. These convection currents are stronger in the equatorial region than at the poles, and the ice cover is more effectively heated at lower latitudes. However, just how this heat causes the cracks in the ice layer has still not been fully explained.
(Nature Geoscience, December 1, 2013)

Photos: Marcus C. Stensmyr – Lund University (top left), JPC/NASA/MPS (top right), graphic: Global Carbon Project

Working to the Beat

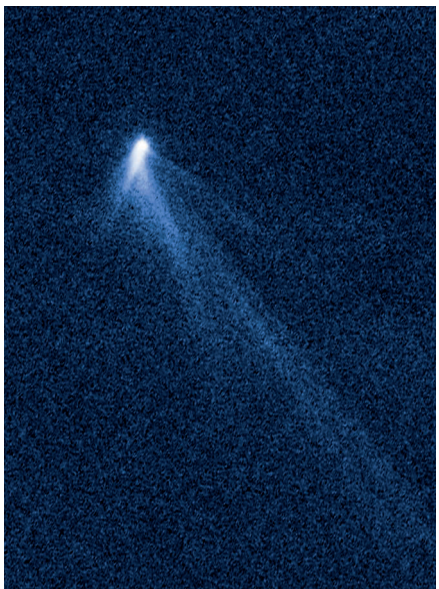
Making music aids physical effort

At first sight, music and hard physical work don't appear to have much in common. Yet the origins of blues and gospel show that that's not true: slaves in the cotton plantations and prisoners sentenced to hard labor sang as they worked, and integrated the sounds of their exertions into their music. In the past, it was supposed that music was simply a distraction. However, scientists at the Max Planck Institute for Cognitive and Brain Sciences in Leipzig have now discovered that music also reduces the actual effort. They made their discovery with the aid of what is known as jymmin technology, using fitness equipment that turns movements into music. The effect is to allow sports participants to make music interactively. In the studies conducted by the researchers in Leipzig, the majority of subjects not only felt the effort less keenly when the jymmin machines were making music, but their muscles also consumed less energy and were therefore more effective. It's possible that the musculature is better controlled at an emotional level as a result of the music-induced ecstasy. This effect of music could even be a previously undiscovered reason for its very origins. (PNAS, October 14, 2013, published in advance online)

"Jymmin" is a combination of "jamming" and "gym", a mixture of free musical improvisation and sport. Training with jymmin machines is more effective than with traditional fitness machines.

Cosmic Oddball

An atypical asteroid is rotating so fast that it is losing mass and forming several tails



An eccentric: Images taken by the *Hubble* space telescope on September 10, 2013 show P/2013 P5 with several tails that surround it like the spokes of a cartwheel.

There are some bodies that have a very disturbing effect on the order in the planetary system – P/2013 P5 is one of them. With at least six tails, it may look like a comet, but it orbits the Sun within the asteroid belt between Mars and Jupiter, and it can't be unequivocally assigned to either category. An international team including scientists at the Max Planck Institute for Solar System Research has been taking a closer look at this puzzling object through the *Hubble* space telescope. Their diagnosis is that P/2013 P5 is an active asteroid that rotates so rapidly under the radiation pressure of the Sun that it emits matter into space. Normal asteroids, in contrast, are robust celestial bodies that already lost their volatile components, such as water, billions of years ago under the influence of the Sun, and now hardly change in appearance. (Astrophysical Journal Letters, November 7, 2013)

Photos: MPI for Human Cognitive and Brain Sciences (top), NASA/HST (bottom)