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**ROSETTA**
History in the Making

**Why Mangroves Matter**

Special Report on
SCIENTIFIC FRAUD

**Africa on the Move**

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On this cover:
Stilt roots of mangroves *(Rhizophora mucronata)* in Mayotte.

PHOTO: F. FROMARD/ECOLAB

The past year has provided evidence, if any were needed, of the strength of the foundations on which the CNRS is built, with the scientific advances achieved in 2014 further enhancing our organization's long-standing international reputation.

The French-Brazilian Fields Medal awarded to Artur Ávila, or Philae, which had the world spellbound as it landed on comet 67P after a ten-year voyage in space, are further proof that research can only thrive in a globalized organization, based on long-term investment. From an economic point of view, an in-depth survey enabled us to establish that the CNRS helped create a thousand businesses over 15 years, some of which are now listed on the stock exchange.

No doubt the 21st session of the Conference of the Parties, COP 21, will be one of the highlights of 2015. Scheduled in Paris from November 30 to December 11 under the auspices of the United Nations, this event is of vital importance for our planet. It will also provide an opportunity for scientists who are attempting to understand the mechanisms of climate change and assess its impact, to take center stage.

With less than a year to go until this decisive international meeting, the CNRS wants to play an active role and encourage all its institutes to share knowledge with the scientific community, both in France and abroad, as well as with society at large.

Several events are already in preparation. In addition to COP 21, the CNRS will be present at the scientific conference "Our Common Future Under Climate Change," organized at UNESCO from July 7 to 11. Changing climate conditions and weather events, melting glaciers, rising sea levels, ocean acidification, migration of species, health and environmental risks, impact on biodiversity, territorial planning, population displacements, resource management, the energy transition, new materials, the circular economy, social innovations: the challenges arising from global change involve every discipline.

*"The challenges arising from global change involve every discipline."*

On November 13 and 14, 2015, at the Sorbonne University in Paris, the CNRS's scientific forum *Les Fondamentales* will focus on these issues, which we hope to discuss with the general public. "What remains to be discovered?" will again be the theme of this forum, which will bring together more than a hundred scientists from around the world to exchange views on the climate of the future and the impact of global change. The CNRS will take an active part in the debate and propose solutions to address the crucial challenge of climate change. COP 21 will give scientists a platform. We must seize the opportunity.

Lastly, the recent terrorist attacks in Paris prompt us to reflect upon freedom of speech and the meaning of democracy, but also upon the values of an institution such as the CNRS. And our values are precisely those of freedom: freedom of expression, but also the freedom to discover, invent, acquire knowledge, and disseminate it.

*Alain Fuchs,*
President of the CNRS

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## IN DEPTH 18



6
Rosetta: History in the Making

© ESA/ATG MEDIALAB

A Tighter Grip on Light
10

© S. THIBAULT/ FEMTO-ST/CNRS PHOTOTHÈQUE

36
Africa on the Move

© S. CHERKAOUI POUR JEUNE AFRIQUE

## IN THE SPOTLIGHT 5



## SCIENCE AT WORK 6



## WORLDWIDE 36



## CLOSE-UP 43



These pictograms indicate extra content (pictures or videos) that can be accessed on the online version of the magazine
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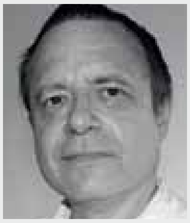
## *2015 ICIAM Awards*

The International Council for Industrial and Applied Mathematics (ICIAM), a global organization that promotes industrial or applied mathematics, has announced the winners of its five prizes for 2015, each carrying a $5000 cash award. The 2015 ICIAM Maxwell Prize rewarded **Jean-Michel Coron** (left), of the Laboratoire Jacques-Louis Lions at the Université Pierre et Marie Curie (UPMC), for his fundamental and original contributions to the study of variational methods for partial differential equations and the control of nonlinear partial differential equations.

The 2015 ICIAM Su Buchin Prize was awarded to **Li Ta-tsien** (right) in recognition of his outstanding contributions to applied mathematics and to the dissemination of mathematical sciences in developing countries. Currently a professor at the School of Mathematical Sciences at Fudan University (Shangai, China), Ta-tsien cofounded the Chinese–French Institute of Applied Mathematics (ISFMA)[1] in 1998 with the late French mathematician Jacques-Louis Lions. Every year, with the support of the CIMPA[2] and other organizations, the institute organizes highly-successful summer schools attended by students from across Asia. These have had significant impact on the dissemination of knowledge in the region.

The two researchers will receive their prizes at the next quadrennial ICIAM Congress, to be held in Beijing (China), on August 10–14, 2015, alongside other recipients Annalisa Buffa (Italy), Andrew J. Majda (US), and Björn Engquist (US). II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» **www.iciam.org**

1. Institut sino–français de mathématiques appliquées. 2. Centre international de mathématiques pures et appliquées.

## The CNRS, Global Leader in Publications

Once again, the CNRS tops the Scimago 2014 worldwide Institutions Rankings (SIR) by number of scientific publications, ahead of the Chinese Academy of Sciences, the Russian Academy of Sciences, and Harvard University (US). Among the 4800-plus universities and research organizations evaluated by the SIR, the Helmholtz Gemeinschaft and the Max Planck Institute in Germany, the Universities of Tokyo (Japan) and Tsinghua (China) respectively rank 5th, 6th, 8th, and 11th. The CNRS also comes first in the 2014 global Scimago innovation rankings, which list the number of scientific publications from patent-filing institutions. It is ahead of Harvard University and the National Institutes of Health (NIH) in the US.

# Jean Tirole

# A Winning Theory

The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel, commonly referred to as the “Nobel Prize in Economics,” was awarded to Jean Tirole on December 10, 2014, at the Stockholm Concert Hall in Sweden. Tirole, a 2007 CNRS Gold Medalist, follows Gérard Debreu (1983) and Maurice Allais (1988) as the third-ever French recipient of this highly-coveted prize. The 61-year-old economist, who has been conducting research at the Gremaq[1] in Toulouse, and has developed strong ties with the Massachusetts Institute of Technology (MIT) since the 1990s, is internationally renowned for his work on market regulation and the “new industrial economy.” He has explored a range of topics, from the regulation of network industries like telecommunications or electricity, to open-source software, tacit agreements between firms, asset market bubbles, tradable emission rights for greenhouse gases, and even the employment protection system in France. Accomplished in both game and information theories, Tirole has extended his research to political science, psychology, and sociology. CNRS President Alain Fuchs commended the work of “an exceptional theoretician, who succeeded in modeling key economic issues and broadening the international scope of this research.” Tirole is currently president of the Toulouse School of Economics (TSE), which he had helped launch with his colleague Jean-Jacques Laffont in 2006. II


Read our 2007 profile on Jean Tirole online:
**www.cnrs.fr/cnrsmagazine**

1. Groupe de recherche en économie mathématique et quantitative (CNRS / Université Toulouse-I Capitole / Inra / EHESS).

ESA/ATG MEDIALAB; COMET IMAGE: ESA/ROSETTA/NAVCAM

**Astronomy.**
ESA's Rosetta orbiter continues to change our understanding of comets as scientists wait for the Philae lander to come back online this year.

**BY** MARK REYNOLDS

# Rosetta: History in the Making

◥ The Philae lander detached from the Rosetta spacecraft on November 12, 2014. The image of comet 67P was taken with Rosetta's on-board camera.

When ESA's unmanned Rosetta spacecraft successfully intercepted comet 67P and landed the Philae probe, the world was transfixed—including the many CNRS scientists and engineers who contributed to the mission. Despite Philae's shaky landing, much has already been learned about the comet's composition.

"The CNRS contribution to Philae is significant, with two instruments under French supervision, the CIVA[1] camera array on one side and the CONSERT[2] radar-like probe on the other," explains IAS[3] astrophysicist Jean-Pierre Bibring, one of two scientific coordinators for Philae. Bibring, the lead scientist behind the CIVA camera that sent back close-up images of the comet, adds that CNRS labs also made important contributions to the OSIRIS,[4] VIRTIS,[5] and COSIMA[6] instruments as well as helping with technical aspects of the Rosetta mission, including its batteries, telemetry, and navigation.[7]

While Philae's position on 67P means that it has gone dark until its batteries can recharge when the comet nears the Sun early this year, the Rosetta orbiter still sends data—much of it from the ROSINA[8] mass spectrometer, VIRTIS thermal imaging spectrometer, and MIRO[9] microwave receptor. With these instruments, Dominique Bockelée-Morvan of the LESIA[10] and her colleagues have been observing 67P in detail since mid-2014.

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"We've succeeded in detecting water, as well as following the activity of the comet, and locating the main sources of the outgassing from the nucleus," she explains. Bockelée-Morvan expects that as the comet draws nearer to the Sun, and starts producing its atmosphere of vapor, the data will start streaming in even faster. It will then take years—possibly decades—to process it all. "Fly-bys of comets which took measurements for one hour have produced up to three or four years of work. With Rosetta, we have one and a half years of measurements from ten different instruments—it's amazing," she enthuses.

### Sleep tight and wake up bright

On landing, Philae bounced away from its intended resting spot, eventually settling into the shadow of a cliff. There, its primary batteries ran out and its solar array was starved of sunlight. Before it went to sleep, the multi-camera array of CIVA (pronounced "Shiva," like the three-eyed Hindu deity) managed to capture an image of the cracked and icy "Perihelion Cliff" next to the lander.

"The images that I am responsible for are a trove of new information. For instance, the building blocks for the ice and organics are very mixed up," says Bibring. This, he adds, gives us essential insight for understanding the comet's structure, especially when combined with data from the other instruments on board. "We already have results on the comet's magnetization, showing that there is no magnetization at all. That is important because it sheds light on how the solar nebulae—the material from which the Solar System was formed—was composed very early on." As comet 67P approaches the Sun, Philae should become active once more. At that point, Bibring says that the CIVA-M micro-cameras will be deployed to analyze pristine samples from below the surface.

### Water, water, everywhere

One hypothesis about the origin of water on Earth is that it might have come from ancient comets. One of the first questions the Rosetta team set out to answer was whether this was possible. Bockelée-Morvan explains that much of the "water outgassing" from comet 67P appears at its "neck" where VIRTIS suggests there may also be surface ice. Somewhat disappointingly perhaps, the ROSINA mass spectrometer debunked the myth that Earth's water was comet-borne—the ratios of deuterium to hydrogen isotopes on 67P are three times those of our oceans.[11]

On the other hand, we discovered that comet 67P originated in the Kuiper Belt, beyond Neptune. The migration of the giant planets perturbed other material in the interplanetary primordial soup. "Because of this shake-up of smaller bodies in the Solar System, you can expect some of these objects to have different compositions."

As comet 67P gets closer to the Sun and starts shedding vapor visible as a comet's characteristic tail, Bockelée-Morvan expects to see much more. The comet is likely to release a number of gases, including carbon dioxide and noble gases. Much of this activity, and the interaction of the comet's plume with the solar wind, are also of interest to the Rosetta team.

"Most of the observations made from ROSINA were meant to prepare for the Philae landing. Now the escort phase is beginning—and so, actually, is our scientific work."

◢ Rosetta's OSIRIS wide-angle camera image of 67P shows jets of cometary activity along the body of the comet.

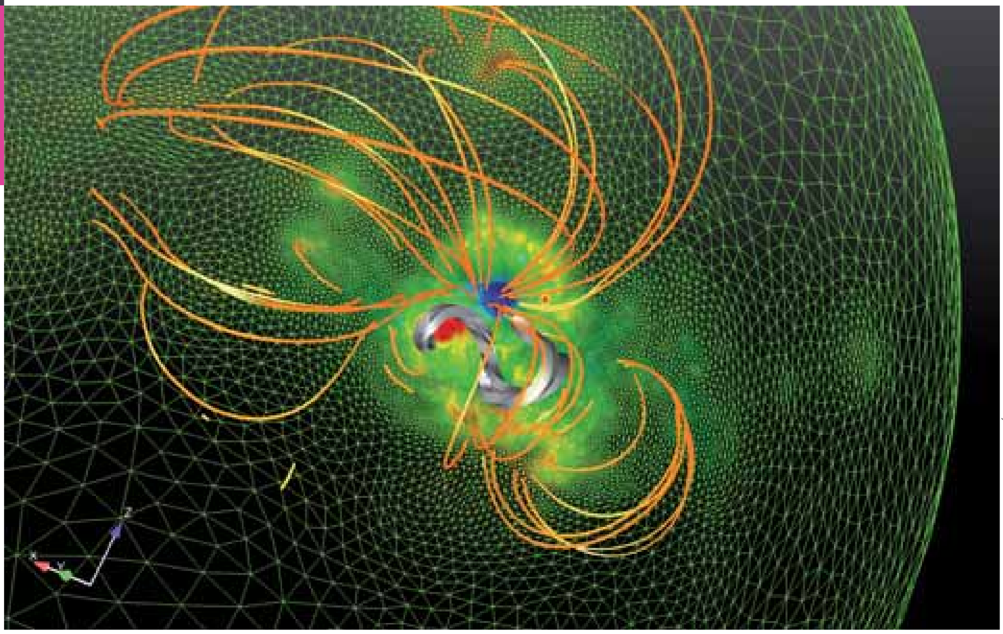


1. Comet Infrared and Visible Analyzer, developed by the Institut d'astrophysique spatiale (CNRS / Université Paris-XI). 2. COmet Nucleus Sounding Experiment by Radio wave Transmission, developed by the Institut de planétologie et d'astrophysique de Grenoble (CNRS / Université Joseph Fourier). 3. Institut d'astrophysique spatiale (CNRS / Université Paris-XI). 4. Optical, Spectrocopic and Infrared Remote Imaging System, developed with the Laboratoire d'astrophysique de Marseille (CNRS / Aix-Marseille Université). 5. Visible and Infrared Thermal Imaging Spectrometer, developed with the Laboratoire d'études spatiales et d'instrumentation en astrophysique, and the IAS. 6. Cometary Secondary Ion Mass Analyser, developed with the Laboratoire de physique et chimie de l'environnement et de l'espace (CNRS / Université d'Orléans) and the IAS. 7. Many of these through the Centre national d'études spatiales (CNES). 8. Rosetta Orbiter Spectrometer for Ion and Neutral Analysis (Universität Bern, Switzerland). 9. Microwave Instrument for the Rosetta Orbiter, (Jet Propulsion Laboratory, US). 10. Laboratoire d'études spatiales et d'instrumentation en astrophysique (CNRS / Observatoire de Paris / Université de Paris-VII / UVSQ / UPMC / CNES). 11. K. Altwegg et al., "67P/Churyumov-Gerasimenko, a Jupiter family comet with a high D/H ratio," *Science*, 2014. DOI: 10.1126/science.1261952.

## Astrophysics

# Predicting Solar Flares

BY FUI LEE LUK





◤ Model of the Sun's magnetic field shows the presence, several hours before the flare, of a magnetic rope (gray) maintained in a state of equilibrium by magnetic loops (in orange).

**Solar flares have long been observed as bright flashes on the Sun's surface, yet their origin is still somewhat obscure.** Using satellite data and models, CPHT[1] and AIM[2] scientists have now unveiled the cause of these emissions of light, particles, and hot gas bubbles: the emergence, from inside the Sun, of a magnetic rope—a set of current-carrying magnetic field lines entwined like hemp rope.[3]

Flare study has so far been hindered by the difficulty of measuring the magnetic field in the Sun's fiery corona (atmosphere) where flares erupt. But in 2006, breakthrough became possible when a Japanese satellite picked up data on the magnetic field of part of the Sun's cooler photosphere (surface) where a flare was brewing. From this data, the team built two models.

The first, which is based on equations governing magnetic fields, is like "an ultrasound of a flare's pregnancy," explains team leader Tahar Amari of the CPHT. Not only did it detect the growth of a magnetic rope a few days before the flare, but it also showed the rope's magnetic energy swelling as it emerged from the Sun.

Amari calls the second model "predictive" in that its numerical simulations forecast the result in the corona when the rope was at various stages of growth. It was when the rope exceeded given energy and altitude levels that it was freed from the Sun's bonds and ejected as a flare.

The researchers have developed "a useful method for space meteorology, namely flare prediction," says Amari. This is especially important since solar interference can disrupt key infrastructures like power grids and GPS systems.

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1. Centre de physique théorique (CNRS / École Polytechnique). 2. Astrophysique, interprétation – modélisation (CNRS / CEA / Université Paris-VII). 3. T. Amari et al., "Characterizing and predicting the magnetic environment leading to solar eruptions," *Nature*, 2014. 514: 465-469.

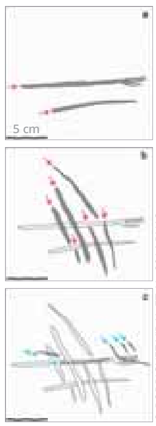
## Archaeology

# A Puzzling Discovery

BY EDDY DELCHER

◢ Analyses (a,b,c) show engraving episodes (gray) and breaks (white). Blue arrows indicate single-stroke lines, red arrows multiple-stroke lines in one direction.








A 39,000-year-old cave wall engraving, interpreted as the first known example of Neanderthal abstract representation, has been discovered in Gorham's Cave (Gibraltar) by an international research team.[1]

The invention of cave art has traditionally been attributed to modern humans, who settled in Europe around 40,000 years ago. The recent study,[2] however, supports the theory that our distant cousins, the Neanderthals, produced abstract representations on cave walls and were indeed capable of abstract thinking, a major step in the evolution of our lineage.

The cross-hatched engraving, whose overlaying sediments were dated by radiocarbon, was then analyzed by CNRS researchers Francesco

1. De la préhistoire à l'actuel: culture, environnement et anthropologie (CNRS / Université de Bordeaux / Ministère de la Culture et de la Communication); Gibraltar Museum. 2. J. Rodríguez-Vidal et al., "A rock engraving made by Neanderthals in Gibraltar," *PNAS*, 2014. 111(37): 13301–06.

# Inhibition Enhances Reading Skills

**BY** YAROSLAV PIGENET

**Psychology.** Reading requires the ability to distinguish letters. To achieve this, recent research shows that the brain must inhibit a primal cognitive mechanism.

Reading dates back to less than 10,000 years, making it a recent adaptation when compared to the millions of years it took the human brain to evolve. Cerebral imagery has shown that the recognition of letters and animals activates the same parts of the cortex. Based on this observation, neurobiologists like Stanislas Dehaene[1] have hypothesized that the ability to read stems from a kind of "biological trick:" the recycling of an ancient cognitive mechanism dedicated to the rapid identification of objects in the environment. "We know that children learning to read confuse mirror-image letters, like b/d and p/q," notes Grégoire Borst, a researcher at LaPsyDÉ.[2] This is due to the fact that the letter recognition process "repurposes" the neural circuitry that our distant ancestors used to rapidly detect the presence of threatening animals. While this strategy, called mirror generalization, was useful for spotting danger, it induces errors in differentiating words like "big" and "dig."


© LAPSYDÉ

Child asked to distinguish between mirror-image letters separated by a target cross.

### Consonants on the loose

To study the phenomenon, LaPsyDÉ researchers asked 79 students to differentiate pairs of letters and then pairs of images on a computer screen. The results[3] confirmed that these experienced adult readers needed more time to identify mirror-image than non-symmetrical letters. More importantly, participants took longer to determine that two animal images were indeed identical when preceded by mirror-image letters.

This increase in response time is called the negative priming effect. To distinguish symmetrical letters, the readers must inhibit the mirror generalization process. Yet when this process becomes useful again to identify images of animals, it takes more time to reactivate it.

### A weapon against dyslexia

A theory developed by LaPsyDÉ director Olivier Houdé, who co-authored the study with Borst, postulates that our brains rely on three systems for analyzing our environment.[4] "One is fast, automatic, and intuitive. The second is slow, logical, and thoughtful, while the third is used to decide, on a case-by-case basis, which of the first two should take precedence. In children, the first two systems develop in parallel, but the third and its inhibitive capacity come later." Processes like learning to read thus rely in part on the acquisition of an essential cerebral function: the ability to resist psychological automatisms when reasoning becomes necessary.

The researchers believe that children learning to read must be able to inhibit the mirror generalization process, and that some forms of dyslexia could result from a deficiency in cognitive inhibition. Should this be confirmed, new methods could be developed to help dyslexic children, including one that would trigger the process responsible for inhibiting the mechanisms inherited from neural recycling, Borst suggests. Training exercises would not necessarily involve reading and could benefit other skills, since this type of inhibition is a general cognitive capacity used in many intellectual tasks. II

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A photo gallery is available online: **www.cnrs.fr/cnrsmagazine**

**d'Errico and Alain Queffelec to ensure the lines composing it were not marks that could have inadvertently been made while cutting skin or meat. "We used Neanderthal tools with different techniques and motions on the same type of stone, and found the engravings were produced by passing a point into the grooves over and over again. Between 200 and 300 passages were necessary to create the pattern, which demonstrates it was intentional," explains d'Errico. "We do not know, however, what it represents. Although it looks abstract to us, this might not have been the case for them."**

**The next step will be to expand the experimental protocol and improve the quality of existing 3D reconstructions. This may provide additional information on how the engraving was made, and even find out whether the author was left- or right-handed. II**

1. Laboratoire de neuroimagerie cognitive (INSERM / CEA). 2. Laboratoire de psychologie du développement et de l'éducation de l'enfant (CNRS / Université Paris-V / Université de Caen Basse-Normandie). 3. G. Borst et al., "The cost of blocking the mirror generalization process in reading: evidence for the role of inhibitory control in discriminating letters with lateral mirror-image counterparts," *Psychonomic Bulletin & Review*, 2014. doi: 10.3758/s13423-014-0663-9. 4. Olivier Houdé, *Apprendre à Résister* (Paris: Le Pommier, 2014).

# A Tighter Grip on Light

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A photo gallery is available online: **www.cnrs.fr/cnrsmagazine**

**BY** BRETT KRAABEL

**Physics.** Two research teams make significant headway in the ongoing effort to miniaturize optical interconnections for integrated electronics and photonics.

By confining light into glass fibers 50 times smaller than a human hair, Jean-Charles Beugnot and Thibaut Sylvestre, of the FEMTO-ST,[1] detected for the first time light scattering from surface acoustic waves (phonons).[2] To obtain this result, the team injected a laser beam into silica fibers tapered down to 500 nanometers in diameter, which is several times smaller than the wavelength of the light. As the beam travels through the fiber, it induces infinitesimal vibrations in the wire, displacing its surface by a few nanometers. The distortions lead to phonons that travel along the fiber surface at 3400 m/s. These phonons in turn affect the propagation of the light because, in a process called "Brillouin scattering," part of the light is reflected with a change of color (i.e., a shift in frequency).

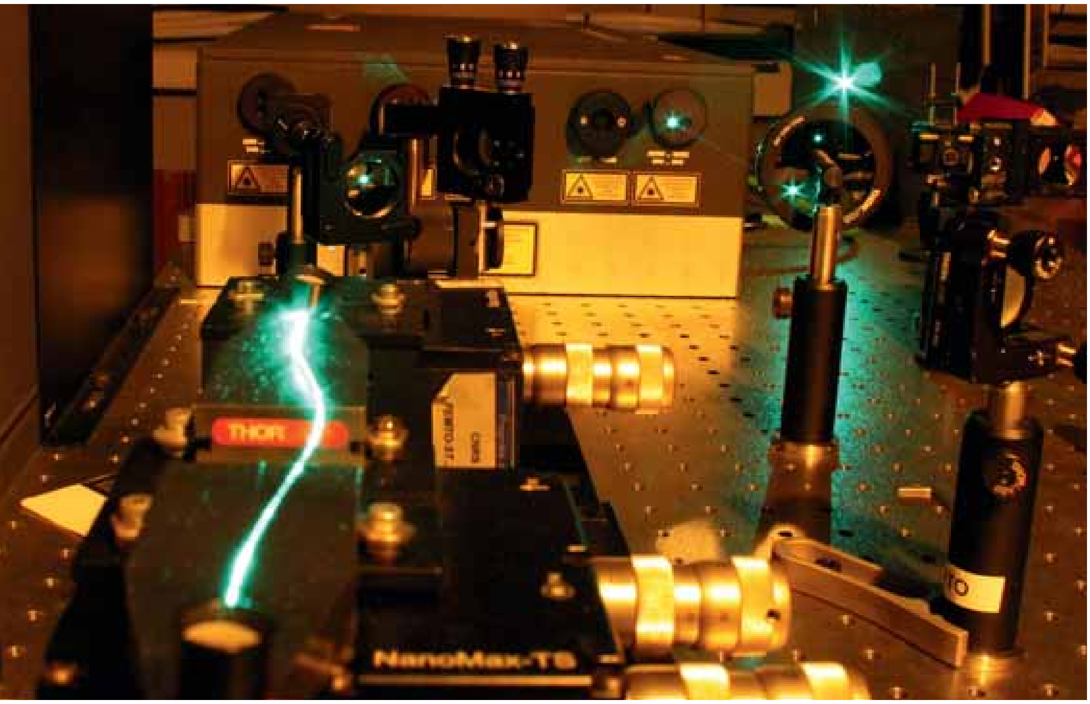
This is the first observation of surface Brillouin scattering in subwavelength optics. By exploiting the frequency shifts, these nanowires could be used for information processing or as microlasers. In addition, "because the fiber's surface is much more sensitive to its environment than the bulk of the wire, surface Brillouin scattering opens up new possibilities for sensing temperature, pressure, or even gas or biological molecules," concludes Sylvestre.

In another study,[3] Erik Dujardin and his team at CEMES,[4] along with colleagues in the UK and Singapore,[5] converted light into plasmons—collective oscillations of electrons that can be confined into much smaller conduits.

"Plasmons travel very fast and with very little energy loss compared with electrical signals," explains Dujardin. The nanowires on which the plasmons oscillate are hundreds of nanometers long and are obtained by stringing together crystalline gold particles 10 nanometers in diameter before fusing them with an electron beam. Scanning the beam over the nanowires, the researchers can detect where plasmons of certain frequencies transfer energy to their surroundings.

This method reveals that plasmons of various frequencies propagate or, conversely, concentrate their energy in different regions of the nanowire, which makes them interesting not only for information processing but also for collecting light energy. Such light-harvesting antennas could be used, for example, to significantly increase the efficiency of solar cells.

Another potential application comes from what was originally considered a defect. If a junction between nanoparticles is not fused, the plasmons lose energy at that particular spot. This provides an extraordinarily localized heat source that could be used to kill bacteria or biological cells. ‖




◢ Instruments at the FEMTO-ST, used to guide a laser beam (emitting at 500 nm wavelength) into the optical microfiber.



1. Institut Franche-Comté électronique mécanique thermique et optique–sciences et technologies (CNRS / Université de Franche-Comté / Université de Technologie de Belfort-Montbéliard / ENSMM). 2. J.C. Beugnot et al., "Brillouin light scattering from surface acoustic waves in a subwavelength-diameter optical fibre," *Nature Communications*, 2014. 5: 5242. 3. A. Teulle et al., "Multimodal Plasmonics in Fused Colloidal Networks," *Nature Materials*, 2015. 14(1): 87-94. 4. Centre d'élaboration des matériaux et d'études structurales (CNRS). 5. Centre for Organized Matter Chemistry, University of Bristol (UK) and Institute of Materials Research and Engineering, A*STAR (Agency for Science, Technology and Research) (Singapore).

## Biology

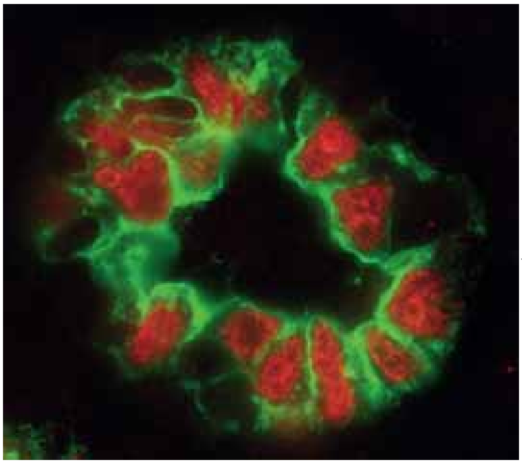
# Muffling a Whistleblower

BY CLEMENTINE WALLACE

Asthma, rhinitis, food reactions... The prevalence of allergic diseases has increased dramatically in the past two decades, especially among children. Yet existing medication is not effective in all patients and experts are seeking new therapeutic options.

About a decade ago, researchers from the IPBS[1] discovered a molecule, known as interleukin-33 (IL-33), essential in activating the cascade of immune responses observed in allergic reactions. Now, in a new study,[2] the team describes the mechanisms by which IL-33 transmits its alarm signal.

When the organism detects what it considers a harmful intruder—such as dust mites, pollen, or mold—tissues like the lung release IL-33 into the bloodstream. Working *in vitro*, the researchers demonstrated that certain white blood cells, called mast cells, then release enzymes, which cleave IL-33 into what the authors call its "hyperactive" form.



◢ Image showing the IL-33 protein (red) produced at high levels in blood vessels (green).



"We use the word 'hyperactive' because, in our lab experiments, it proved 30 times more potent than the initial form in activating cells of the type-2 immune system, whose role is to get rid of the allergen," says senior author Jean-Philippe Girard. "This activation is what triggers allergic symptoms like inflammation of the airways."

When using generic enzyme inhibitors *in vitro*, the team observed that mast cells could no longer trim away IL-33. When these inhibitors were injected inside living mice, the animals' immune reactions to a common fungal allergen were significantly reduced. "Targeting mast cell enzymes could be a new mechanism to prevent the outbreak of allergic reactions," concludes study co-author Corinne Cayrol.[1] II

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## Earth Sciences

# Tremors of the Deep

BY FUI LEE LUK

**Undersea earthquakes, which can cause devastating tsunamis, are set off by tectonic plate movement. But what mechanisms at work locally precede and trigger their shocks? To answer this question, a French-US team, including researchers from the CNRS, IFREMER,[1] and IFSTTAR,[2] used Northeast Pacific subsea data to build a theoretical model of fluids flowing in the seabed at a transform fault[3] as the latter evolves from stability to seism.[4] Not only do results explain the process leading to subsea quakes, they also point to a principle likely to apply to other terrains. According to the study, the timing of quakes relies on the properties of seabed fluids: specifically, shocks are triggered by a change in the compressibility of these fluids.**

**Seisms are in fact deferred as long as the tectonic stress that weakens the bedrock is offset by a suction-cup effect in the pores between the beds—an effect that study co-author Pierre Henry of the CEREGE[5] likens to the way "wet sand on a beach seems harder than dry sand because seawater fills the spaces between sand grains." This effect is strongest when fluids are hard-to-compress liquids, lowest when they are compressible gases.**

**Yet seabed fluids may also be supercritical, halfway between gas and liquid, due to the high pressure and heat of the magma rising from nearby mid-ocean ridges. In this state, their compressibility varies with pressure, and if such a shift occurs during a fault slip, the suction-cup effect will fail, causing a mainshock.**

**Venturing beyond the subsea quakes in the study, Henry suggests that "change in fluid compressibility is the phenomenon's key factor, independently of its marine context." His next challenge is thus to "hunt down and demonstrate the mechanism in non-marine environments," for example Iceland's supercritical geothermal zones.** II

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1. Institut français de recherche pour l'exploitation de la mer. 2. Institut français des sciences et technologies des transports, de l'aménagement et des réseaux. 3. Type of fault between two tectonic plates that slide horizontally past one another. 4. L. Géli et al., "Seismic precursors linked to super-critical fluids at oceanic transform faults," *Nature Geoscience*, 2014. 7: 757-761. 5. Centre européen de recherche et d'enseignement des géosciences de l'environnement (CNRS / Aix-Marseille Université / IRD / Collège de France).

## Biology

# Starve and Live Longer

BY CLEMENTINE WALLACE

Surprising though it may be, an extreme diet, bordering malnutrition, extends longevity and reduces age-related diseases in many species, including mammals. But it comes with a downside: fertility loss.

In a new study,[1] scientists explored the relationship between the two phenomena. “We discovered that, during extreme diet restriction, animals put their reproductive system to sleep as a protective measure. Their energy is thus spent on survival, probably with the goal of delaying reproduction to a more favorable time,” says senior author Hugo Aguilaniu, from the LBMC.[2] “If we can trigger one response independently from the other, we might come up with a way to live longer and better.”

Tests were performed on roundworms, whose life expectancy is about three weeks. When the researchers reduced the nematodes’ food intake, their lifespan increased by roughly 30%. *In vitro* experiments revealed that this restriction triggered the secretion of a hormone called “dafachronic acid” (DA).

According to the authors, DA then activated what is known as “the TOR pathway,” which regulates reproductive cell proliferation, among other functions. “When DA was secreted, gonads became smaller, as if they were going into hibernation,” says Aguilaniu. Working in mutant worms unable to secrete DA, the team witnessed that gonads were no longer affected by caloric restriction. Neither was life expectancy. If DA was provided externally, both responses reappeared. Even more interestingly, if the gonads were put to sleep artificially, DA was no longer necessary to increase survival. “This proves that both responses are dependent; we think that when gonads are silenced, they send a message to all the mechanisms involved in survival,” says Aguilaniu.

The team is now studying the nature of this signal, in the hope of finding a way of reproducing it artificially, and improving longevity without starvation and fertility loss. II

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◢ In this *Caenorhabditis elegans* worm, a fluorescent marker shows the nuclei of muscle cells, whose degeneration is slowed by caloric restriction.

1. M. Thondamal et al, “Steroid hormone signaling links reproduction to lifespan in dietary-restricted *C. elegans*,” *Nat Commun.*, 2014. 5(9): 4879. 2. Laboratoire de biologie moléculaire de la cellule (CNRS / ENS de Lyon).



◤ The EZ-10 autonomous shuttle vehicle developed by the Ligier Group.

## Transportation

# Driver not Needed

BY ARBY GHARIBIAN

**Although driverless cars are a long way off for both technical and regulatory reasons, driverless shuttles,** which travel a pre-determined path or within a designated area, are just around the corner. The EZ-10, developed by CNRS researchers[1] and the French car manufacturer Ligier, may soon make long walks at airports and hospitals a thing of the past.

What sets the EZ-10 apart is its innovative guidance system, which can direct the vehicle on a pre-arranged path, like a train, as well as on a varied itinerary, such as a taxi. “We improved our 2010 model, the Vipa, by adding a second camera for greater visibility, directional lasers to detect unexpected obstacles, and more powerful visual analysis software,” explains Michel Dhome, the project leader. The shuttle has now reached a level of maturity enabling its real experimentation on public or industrial sites.

The guidance system first requires a manual trip with a human driver to let shuttle cameras record the itinerary. In subsequent driverless trips, the cameras compare their surroundings with the master recording of the first drive, “replaying” it as closely as possible. This record and replay system is less costly and more reliable than other guidance technologies using Differential Global Positioning System (DGPS) or laser-based radar, which may not function in urban centers or indoors.

“For six months in Clermont-Ferrand (central France), the EZ-10 successfully transported passengers from the car park to the entrance of the CHU Estaing hospital 300 meters away,” Dhome adds. “A more ambitious test is underway at Michelin’s research and development center, where a fleet of five automated shuttles are in simultaneous operation, seamlessly deployed by a central computer based on passenger requests.”

The EZ-10 garnered excitement at the 2014 Michelin Challenge Bibendum in Chengdu (China) and could be used in a plethora of sites such as industrial centers, pedestrian zones, and amusement parks. II

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1. Institut Pascal (CNRS / Université Blaise-Pascal / IFMA).

# Dark Matter
## Detected at Last?



◤ An X-ray image of the Perseus Cluster taken by the Chandra space telescope.

**Astrophysics.** An unexplained signal from distant galaxy clusters may turn out to be the first detection of dark matter, a mysterious component of the Universe.

**BY** JULIEN BOURDET

Could astronomers finally have detected the first particles of dark matter, the invisible substance that makes up more than 80% of the mass of the Universe? The detection a year ago of a mysterious signal in the form of X-rays from distant galaxy clusters suggests it may indeed be the case. Having successively eliminated other possible causes, several teams of researchers reached the same conclusion: the signal can only be explained by the presence of dark matter in the clusters.

### A mysterious X-ray spike

The astronomers pointed the XMM-Newton and Chandra space observatories at the Perseus Cluster of galaxies, located 240 million light years away and thought to contain the largest density of dark matter in the Universe. To their surprise, they discovered an X-ray spike at an energy of around 3.5 kilo-electron volts (3.5 keV), which does not correspond to any known chemical element. "This makes dark matter the most convincing explanation to date," says Yann Mambrini from the LPT,[1] who co-authored the article supporting this bold hypothesis.[2]

So what do these particles look like? At the moment, two scenarios are put forward. In the model preferred by the teams that made the discovery,[3] the observed signal corresponds to the decay of a so-called sterile neutrino, a hypothetical particle whose existence was first postulated by physicists in the early 2000s. Unlike the three flavors of neutrinos already known,[4] this fourth potential neutrino does not interact with any other particle except through gravitation. Such sterile neutrinos may decay into an ordinary neutrino and a photon with an energy of 3.5 keV.

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### Lightweight particles

However, Mambrini and his colleagues believe that the signal is more likely to result from the annihilation of dark matter particles of a different nature. "When they collide, they could produce a sort of Higgs boson, but much lighter than the one discovered at the Large Hadron Collider (LHC)," the physicist explains. "This boson, already predicted by some models, would in turn decay into two photons of 3.5 keV each." These dark matter candidate particles are a hundred times lighter than an electron. This property is in sharp contrast with that of "weakly interacting massive particles," or WIMPs, the favorite candidates until now. Unlike WIMPs, these extremely lightweight particles could help explain why there are so few satellite galaxies orbiting the Milky Way.

But researchers remain cautious. "Even if the observed signal turns out to be statistically significant, a more mundane astrophysical explanation cannot be ruled out," says Gianfranco Bertone, an associate professor at the University of Amsterdam (Netherlands) on leave from the IAP.[5] New measurements of our own galaxy should settle the question. In particular, the launch next year of Japan's X-ray space telescope Astro-H, should provide new insights. II

1. Laboratoire de physique théorique d'Orsay (CNRS / Université Paris-Sud). 2. Y. Mambrini et al., "Generating x-ray lines from annihilating dark matter," *Physical Review D*, 2014. 90(3): 1-10. 3. E. Bulbul et al., "Detection of an Unidentified Emission Line in the Stacked X-Ray Spectrum of Galaxy Clusters," *Astrophysical Journal*, 2014. 789(1): 13-36 ; A. Boyarsky et al., "unidentified line in X-ray spectra of the Andromeda galaxy and Perseus galaxy cluster" (working paper, 2014). http://arxiv.org/abs/1402.4119. 4. Electron, Muon, and Tau neutrinos. 5. Institut d'astrophysique de Paris (CNRS / UPMC).



**Linguistics.** Should there be a single language for the human sciences? In her *Dictionary of Untranslatables,* first published ten years ago, philosopher and CNRS senior researcher Barbara Cassin[1] explains how eliminating language diversity would reduce the scope and powers of human thought.

**INTERVIEW BY** LAURE CAILLOCE

# Linguistic Diversity: Food for Thought

***The European Philosophical Lexicon*, known as the *Dictionary of Untranslatables*[2] was first published in France ten years ago. What was its objective?**

**Barbara Cassin:** When I launched this project in the late 1990s, we were in the early phases of a unified intellectual Europe. Although "United in diversity" was always the motto of the European Union, our national languages seemed threatened at the time by the sole universal *lingua franca:* "Globish," or the "global English" now spoken everywhere on the planet. To even be considered for EU funding, researchers in the social sciences had to—and still do—submit their applications in this form of Newspeak. Even the research institutions were pressuring us to publish our articles in English. But language is not only a means of communication; it also conveys a culture and a particular worldview. A language is not just a different way of designating the same things; it offers a unique perspective on these things. Take a simple, basic greeting like *bonjour*, which literally means "good day." It is not exactly the same thing as *khaire* (rejoice, enjoy) in Greek, *vale* (be well) in Latin, *shalom* in Hebrew or *salaam* in Arabic (peace)... Understanding this diversity contributes to preserving the complexity of human thought.

**Some say that certain languages lend themselves more easily to philosophy...**

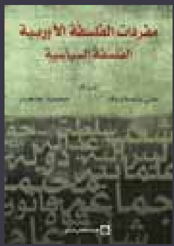
**B.C.:** This is a misconception that the book tries to dispel. In France—the Heideggerian France of my teachers—Greek and German (thought to be "more Greek than Greek!") were considered to be the only possible languages for real philosophical expression. While it is true that philosophy was born in Greece, and therefore in Greek, and that Germany has produced many great philosophers, I am not convinced of the so-called "genius" of languages. The purpose of our dictionary is not to establish a hierarchy among languages, but rather to say, "this is how it works in this language; this is how it works in this text," and to build bridges between these different worlds.

**How would you properly define an "untranslatable?"**

**B.C.:** An "untranslatable" is a symptom of the difference between languages. It can be semantic—"mind" is not quite the same thing as *Geist* or *esprit*—or syntactical and grammatical, like the gender of nouns and order of words. As I like to say, it is a word that never ceases (not) to be translated: one that is constantly translated, but badly, and needs to be retranslated. The Russian term *pravda*, which is usually rendered as "truth" in French, primarily means "justice" in Russian. Conversely, the French word for truth, *vérité*, evokes conformity and accuracy for which

1. Centre Léon Robin de recherche sur la pensée antique (CNRS / Université Paris-IV / ENS Paris). 2. Barbara Cassin, *Vocabulaire Européen des Philosophies: Dictionnaire des Intraduisibles* (Paris: Seuil, 2004). 3. A collection of the forewords from all versions accompanied by new articles specific to each translation-adaptation has just been released in France: Barbara Cassin (Ed.), *Philosopher en Langues. Les Intraduisibles en Traduction*, (Paris: Editions rue d'Ulm, 2014). 4. Barbara Cassin and Danièle Wozny (Eds.), *Les Intraduisibles du Patrimoine en Afrique Subsaharienne* (Paris: Editions Démopolis, 2014). 5. *Les Intraduisibles des Trois Monothéismes.*

## Translating the *Untranslatables*

*The 3rd volume of the Ukrainian version (Editions Duh i Litera) was published in 2013. The 1st volume of the Arabic adaptation was published in 2012 (Editions al-markaz al-thaqafi al-arabi).*

*The American English edition was published in 2014 with new contributions from philosophers and leading experts (including Judith Butler, Daniel Heller-Roazen, Ben Kafka, Kevin McLaughlin, Kenneth Reinhard, Stella Sandford, Gayatri Chakravorty Spivak, Jane Tylus, Anthony Vidler, Susan Wolfson, or Robert J. C. Young).*

For the latest about the project and upcoming editions in other languages:

» **www.intraduisibles.org**

B. Cassin, E. Apter, J. Lezra, M. Wood (Eds.), *Dictionary of Untranslatables: A Philosophical Lexicon*, (Princeton: Princeton University Press, 2014).

Russian has another word, *istina*. In the original French publication, a total of 1500 words commonly used in philosophy, considered within their terminological networks, are explored in their polysemy and correlated from one language to another. It took more than 15 years to achieve this result, with the help of 150 fellow philosophers and translators, all, of course, multilingual.

**What has happened since the original French publication of the *Untranslatables* ten years ago?**

**B.C.:** In fact, a lot has happened. After a first print run of only 1500 copies, the dictionary did very well in the bookshops—in that specific category—and ultimately sold nearly 15,000 copies. We would like to see a paperback edition in France, but nobody knows except the editor how long it will take. Most importantly, the *Dictionary of Untranslatables* proved popular outside the country and now boasts translations into nearly ten languages. A Ukrainian version, an American English, and an Arabic version have already been published. Others are underway, including Hebrew, Romanian, Brazilian Portuguese, Mexican and Argentine Spanish, Russian, Italian, Greek, and soon Chinese.[3] Strictly speaking, we should refer to these editions as adaptations rather than translations. For example, the *Untranslatables* in Arabic focus on political terms, such as "people," "law," "state," "secularization," and add a new article on "Charia."

**Are there other things you are currently working on?**

**B.C.:** In addition to the dictionary itself, other projects have been undertaken, which tackle similar issues. Supervised by directors of cultural heritage and linguists, a recently-published book exploring untranslatables linked to heritage in Africa[4] explores the different ways of saying "heritage" and "museum," not only in French or English, but also in Fulani and Bambara. This project stems from the observation that Africa has very few UNESCO heritage sites, and that the vocabulary used during the application process could be a part of the problem. Another book,[5] still in the works, sets out to identify the core words of each of the three Holy Scriptures and the correlations, where they exist, among these terms. A much-needed initiative in this day and age. II

# *In brief*

### LUCY FINDS A NEW HOME

**On the 40th anniversary of the discovery in Ethiopia of humankind's most famous fossil representative, Lucy, the little 3.2 million-year-old Australopithecus was put on display at the National Museum of Ethiopia's new Gallery of Paleontology and Prehistory, which opened on December 3, 2014, in Addis Ababa. This permanent exhibition is the result of a scientific and logistic collaboration between two CNRS laboratories,[1] with support from the French embassy in Ethiopia, and under the auspices of the Authority for Research and Conservation of Cultural Heritage.[2] The exhibit features other astounding discoveries, including Ardy, the oldest (4.4 million years) hominid skeleton known to date and Selam, a 3.4 million-year-old baby Australopithecus found in the vicinity of Lucy.**

### SEEING THE BIG PICTURE

**When we first see an image, do we analyze it as a whole and then focus on its elements, or do we pay attention to the details before reconstructing the entire picture? Researchers at the CRCA[3] have shown that, unlike most animals , honeybees prioritize global configurations, like humans.[4] The results show that, when they have to choose between the details or the global shape of an image to recognize a food source, bees tend to rely on the latter. Aurore Avarguès-Weber, first author of the article, will receive a fellowship L'Oréal – UNESCO *Pour les femmes et la science* for her work on cognition in bees.**

1. Centre français des études éthiopiennes (CNRS / Ministère des Affaires Étrangères et du Développement International) and the Institut de Paléoprimatologie, paléontologie humaine: évolution et paléoenvironnements (CNRS / Université de Poitiers). 2. Ethiopian Ministry of Culture and Tourism. 3. Centre de recherches sur la cognition animale (CNRS / Université Toulouse III-Paul Sabatier). 4. A. Avarguès-Weber et al., "The forest or the trees: preference for global over local image processing is reversed by prior experience in honeybees," *Proc. R. Soc. B*, 2014. doi.org/10.1098/rspb.2014.2384

**Technology transfer.** New data on the number of CNRS-generated companies shows a narrowing gap between basic research and industry.

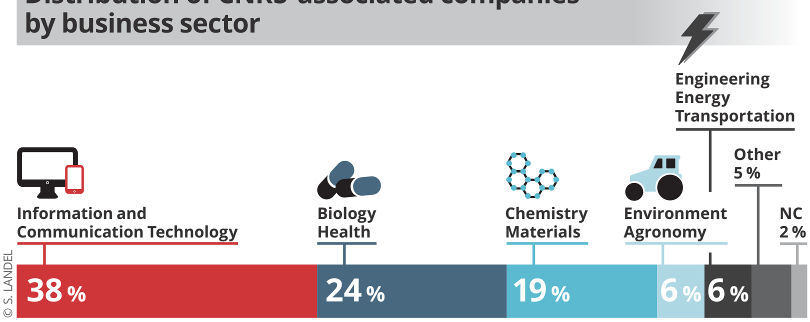
**BY** SAMAN MUSACCHIO

# 1000 Start-Ups and Counting

McPhy Energy, a leader in solid hydrogen storage technology, was launched in 2008 following 8 years of research at the CNRS.

Good news all around for the CNRS. For the fourth consecutive year, the French organization was among Thomson Reuters' top 100 Global Innovators,[1] alongside industry leaders like GE (US), Roche (Switzerland), or Samsung Electronics (South Korea). Moreover, the number of scientific research institutions featured in the 2014 index increased from four to six (including three from France: the CNRS, CEA,[2] and IFP[3]).For the study's analysts, "this reflects the fact that innovation from the academic sector is on the rise, and underscores the importance of collaborative or open innovation, which is the partnering of the public and private sectors, corporate and academia, to innovate and bring new ideas to market." And such interactions—structurally integrated at the CNRS for many years—are bearing fruit.

### Distribution of CNRS-associated companies by business sector




### Researcher-entrepreneurs

In France, existing ties between academia, fundamental research, and the industrial world were significantly bolstered by the Law of July 12, 1999. This "Innovation Law," to which a number of additions were made over the years, allowed French universities and research institutes to set up technology transfer offices to facilitate exchanges with other institutions, and manage research contracts directly with private companies. For the first time also, public sector researchers and engineers could take a temporary leave (of up to six years) to develop and market applications of their research in the private sector—by founding or joining a company. They would then have to choose between reintegrating their institution or taking a permanent leave.

### A start-up boom

And CNRS researchers did not sit idly by, as shown by a recently-published study[4] detailing the intricate bonds between the organization and the private sector. With 4535 patent families (1438 active licenses), the CNRS is France's 7th patent holder.[5] It has allocated more than €3M via its investment subsidiary FIST SA[6] to help young companies expand, and has contributed to the launch of 1026 start-ups since 1999, creating some 7000 jobs. "This is a pleasant surprise, as we tend to underestimate the role played by the CNRS in business creation," says Philippe Baptiste, CNRS Chief Research Officer. "On average, 80 companies spring up each year from joint

1. http://top100innovators.com/pdf/Top-100-Global-Innovators-2014.pdf 2. Commissariat à l'énergie atomique et aux énergies alternatives. 3. IFP Énergies nouvelles. 4. http://www2.cnrs.fr/sites/communique/fichier/dp_cnrs_liens_monde_ecov2.pdf 5. INPI, 2013. www.inpi.fr 6. Created in 1992, FIST SA is a subsidiary of the CNRS (70%) and Bpifrance (30%), a public investment bank. 7. Source: 2000, Ministère de l'écologie, du développement durable et de l'énergie. 8. Lumilog by Saint-Gobain, Varioptic by Parrot, Photline Technologies by iXBlue, and Sensitive Object by Tyco Electronics. 9. Innoveox, McPhy Energy, Supersonic Imagine, Quantum Genomics, Integragen, ImmuPharma, and Carbios. 10. Institut de chimie de la matière condensée de Bordeaux (CNRS). 11. Laboratoire ondes et acoustique, now Institut Langevin (CNRS / ES-PCI Paristech / UPMC / Université Paris Diderot / Inserm).

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laboratories between our organization and public or industrial partners."

Over the 1999-2009 period, these start-ups have had a survival rate of 90% after five years, compared to a national average of 52.6% for businesses created in 2000, all sectors combined.[7] In fact, 80% of all CNRS-associated start-ups are still active today, and operate in a variety of industries (*see diagram for full breakdown*). And success stories abound. To date, four of these companies have been acquired,[8] generating a return on investment (ROI) of 535% for the CNRS. Seven are now publicly-traded,[9] including three—Supersonic Imagine, Innoveox, and Integragen—in which the CNRS has a stake through its subsidiary FIST SA.

But there is room for improvement. "Many companies still find it difficult to grow," warns Marie-Pierre Comets, director of the CNRS Innovation and Business Relations Department. Today, the majority are microenterprises: 75% employ fewer than 10 people, and 46% earn under €100,000 a year. This is due to a variety of factors. Some CEOs may find that they are more researchers than entrepreneurs, less focused on business development. Others may be operating in niche markets—or in a crowded space. Hence the need to identify industrial potential at a very early stage. "Last year, we tested a 'pre-development system' in the laboratories to detect, nurture, and push to market basic research showing promise," says Comets. With a €2M budget already earmarked for this project in 2015, the CNRS increases its capacity for launching innovative start-ups. II

## *Innoveox*

**This Bordeaux-based company, launched in 2008, specializes in the treatment of all forms of organic waste, including hazardous industrial waste such as oils, solvents, and pesticides, as well as complex, corrosive, and resistant waste. Its unique technology, Supercritical Water Oxidation, is the result of more than 20 years of research at the ICMCB.[10] In 2014, the two patent families that protect this technology were fully transferred to the company, in which the CNRS became an active shareholder. Innoveox has just raised €15M, and is now publicly traded with a valuation exceeding €40M.**

## *Supersonic Imagine*

**Founded in 2005 in Aix-en-Provence, SuperSonic Imagine markets the Aixplorer, an extremely fast and accurate medical imaging system able to detect and characterize palpable and non-palpable masses. To develop this technology, the company first licensed and then acquired several CNRS patents resulting from the research conducted by Mathias Fink and Mickaël Tanter at the LOA.[11] The CNRS became a stakeholder in the firm five years ago via its subsidiary FIST SA. Today, SuperSonic Imagine exploits and develops 14 CNRS patents in total, employs 130 staff, is listed on the stock exchange, and valued at more than €140M.**

## *Watchfrog*

**This innovative start-up was founded in 2005 by two CNRS researchers and a marketing strategy expert. Based on research carried out at the CNRS on endocrine disruptors, the company uses amphibian larvae to detect *in vivo* pollutants or toxic molecules in the environment. With clients like Veolia or Sanofi already on board, Watchfrog is set to raise €2M in capital and launch a new product: the Frogbox.**

**» www.innoveox.com**
**» www.supersonicimagine.com**
**» www.watchfrog.com**


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◣ On May 7, 2015, Innoveox became a listed company on the Paris Alternext index.

© ILLUSTRATION : J. GERNER POUR CNRS LE JOURNAL

# *The Battle against Scientific Fraud*

**A SPECIAL REPORT BY** YAROSLAV PIGENET AND LYDIA BEN YTZHAK, ASSISTED BY LUCIENNE LETELLIER

On the morning of August 5, 2014, Yoshiki Sasai, a pioneer in stem cell research who was once considered for the Nobel Prize, was found hanged in his laboratory at the RIKEN Center for Developmental Biology in Kobe (Japan). His suicide was motivated by a suspicion of fraud, widely discussed on the Web. The case had started five months earlier and just led to the retraction of two articles he co-signed in *Nature* magazine. An internal investigation at RIKEN had in fact proven Sasai innocent, but found his colleague and article co-author Haruko Obokata guilty of manipulating data. Sasai still came under severe criticism for not properly supervising the research carried out within his own laboratory. Beyond the scandal, shock, and sense of waste, the tragic outcome of this affair highlighted two important facts: first, that science is not immune to fraud, and second, that the phenomenon, sometimes exacerbated by the competitive nature of research, can have consequences that far exceed the mere retraction of an article. While not all incidents of scientific misconduct end in the death of one of the protagonists, “repeated revelations of fraud in the media, especially the rare but sensational cases of falsified results, are detrimental to the scientific community in terms of image and credibility,” points out Michèle Leduc, chairperson of the CNRS Ethics Committee (COMETS), which has just published a guide to promote good practice and scientific integrity.[1] Worse still, fraud undermines the very purpose of science, which is to build a body of reliable knowledge. And yet, despite a genuine awareness of the problem, silence is still golden whenever a laboratory is suspected of fraud. The presumption of innocence, fear of scandal, or will to preserve their institution’s reputation, prevent many researchers from discussing incidents of misconduct that they have witnessed. With rare exceptions, those who do either do so anonymously or come forward long after the facts have been disclosed by others. The following report investigates the causes, extent, and consequences of this shameful dysfunction of science, as well as the measures being implemented to eradicate it. II Y. P.

**RETRACTION**
A public statement by the author of a published article and/or its publisher, repudiating all or part of its content.

1. http://www.cnrs.fr/comets/IMG/pdf/guide_promouvoir_une_recherche_inte_gre_et_responsable_8septembre2014.pdf

## Cyril Burt
### Ideology over Honesty

***Once regarded as Britain's greatest psychologist, Cyril Burt spent part of his career attempting to prove the heritability of intelligence by comparing the IQ test scores of identical twins. Among other assertions, he claimed to have established a strong correlation between the IQs of identical twins, including those who had been separated at birth. These results, combined with Burt's academic reputation and ideological activism, exerted a strong influence on public education policies in both the UK and the US. But following his death in 1971, an investigation revealed that the correlation rates he had recorded were far too stable from one study to another to be statistically credible. It later emerged that some of the twins had never existed—their IQ scores and related correlations were thus complete fabrications.***

The past 15 years have been marked by a series of revelations of major scientific fraud published in prestigious journals and involving reputable researchers working in highly-promising fields like cloning, cellular reprogramming, and nanoelectronics. Enough to raise doubts as to whether this apparent wave of misconduct is actually a media illusion, blown out of proportion by the echo chamber of the Internet, or whether the proliferation of such scandals is only the tip of the iceberg, suggesting that something is deeply amiss in the realm of global scientific research.

Long downplayed or even denied, fraud is now taken very seriously at all levels of research. Scientists, host institutions, funding bodies, scientific publishers are well aware that failing to address the problem puts them at risk of being discredited in the eyes of both the general public and decision-makers. As far back as 1992, the Canadian sociologist of science Serge Larivée observed in a report on fraud[2] that "despite constant emphasis on the integrity and objectivity of researchers, and the existing safeguards built into the scientific process, fraud does exist."

2. Serge Larivée and Maria Baruffaldi, *Les fraudes scientifiques-Rapport préliminaire* (Montréal: Université de Montréal et Conseil de Recherche en Sciences Humaines du Canada, 1992). 3. L. Letellier, "Sur l'intégrité de la recherche: quelques considérations éthiques sur l'organisation et les pratiques de recherche," *Revue Prétentaine n°27-28*, 2011. 4. Z. A. Bhutta and J. Crane, "Should research fraud be a crime?" *British Medical Journal*, 2014. 349: 4532. 5. B.C. Martinson, M. S. Anderson, and R. de Vries, "Scientists behaving badly," *Nature*, 2005. 435(7043): 737-738. 6. M. Leduc and L. Letellier, "Sommes-nous toujours honnêtes dans nos pratiques de la recherche?" *Reflets de la Physique*, 2014. 37: 44-45. 7. http://pmretract.heroku.com 8. Visiting Professor at EBSI–École de bibliothéconomie et des sciences de l'information, Université de Montréal. 9. D. Fanelli, "The Black, the White and the Grey Areas: Towards an international and interdisciplinary definition of scientific misconduct," in *Promoting Research Intergrity in a global environment* (Singapore: World Scientific Publishing, 2011). 10. X.Bosch, "Safeguarding good scientific practice in Europe," *EMBO Reports*, 2010. 11(4): 252–257. 11. Délégation à l'intégrité scientifique. 12. Agence nationale de la recherche.

### What is scientific "fraud?"

An international consensus defines fraud as a "serious and intentional violation in the conduct of research and the dissemination of results," with the exclusion of "errors made in good faith or honest differences of opinion."[3] The international scientific community identifies three main types of fraud, known by the acronym FFP: fabrication, falsification, and plagiarism (*see box, right*). Fabrication consists in making up research data from scratch; falsification means manipulating it intentionally to make it match the desired hypotheses; and plagiarism is the use of another researcher's findings or ideas without their knowledge and without giving them proper credit.

But these serious breaches of scientific ethics, which some would like to be made liable to criminal prosecution,[4] must not completely overshadow what a notable article published in *Nature*[5] in 2005 called "misbehavior" and "carelessness"—in other words, the more or less conscious violation of good scientific practice. Albeit less obvious, at least in terms of their immediate effect, and thus more difficult to detect, such examples of unethical behavior nonetheless amount to scientific misconduct. As Michèle Leduc and Lucienne Letellier of the COMETS explain,[6] "there is a continuity between outright fraud and manipulated results. Data is 'cooked' so as to keep only the desired findings; images are altered with Photoshop; results are hastily published without proven reproducibility; researchers remain evasive on their experimental protocols so that they cannot be verified or copied; results are covered up; single experiment data is spread out over several articles, making them incomprehensible individually, etc." Such breaches of good practice never make headlines, but they create bad habits which, in the long run, have lasting consequences on the overall quality of accepted scientific knowledge.

### Malpractice on the rise

The general media is definitely devoting more coverage to scientific scandals, but is fraud, large or small, really such a common phenomenon? And more importantly, is it really getting worse? In his 1992 report, Larivée and co-author Maria Baruffaldi compiled a list of more than 200 known frauds committed between 1800 and 1992 (before the widespread adoption of the Internet) by researchers in five fields covering 40 different disciplines. They noted that 73% of cases took place after 1950, and somewhat more surprisingly, that 58.9% of them were in medical research.

The development of online bibliographic databases that track published scientific articles and retractions, like *PubMed* or *Web of Science*, now makes it possible to monitor this type of statistics in real time.[7] These sources seem to confirm that the incidence of fraud has increased and is even accelerating: the proportion of retractions ...

## *Crossing Borders*

One of the main obstacles to drafting a common international policy against scientific misconduct is the wide-ranging definitions (if any) that individual countries may have adopted over the years—depending on their culture, or on the very nature of their respective languages. As an illustration, Daniele Fanelli,[8] an authority on the issue, explains that if English distinguishes between "ethics" and "integrity," equivalence for the latter does not exist in Finnish, which hinders the proper translation of official documents.[9] Finland, through its National Advisory Board on Research Integrity was in fact the first country to have created—in 2002—two distinct categories separating "fraud," the equivalent of fabrication, falsification, or plagiarism (FFP), from "misconduct," which involves gross negligence and irresponsibility in the conduct of research. In China on the other hand, scientific misconduct covers FFP, but also the submission of false curriculum vitae and violations of rules pertaining to human or animal research. In Australia, it includes the failure to declare a serious conflict of interest. Some countries have debated whether scientific misconduct should go as far as addressing issues of social responsibility. Fanelli argues that a possible explanation for this wide range of definitions may be their intended objective: if it is to hold researchers accountable, then a narrow and closed definition is preferred (such as strictly FFP), but if it is to promote responsible research or foster research integrity, then definitions must enter a broader "grey" area with lower threshlods of intent. To further complicate matters, some countries entirely lack documented and formalized processes for dealing with scientific misconduct.

### But nation-bound

The US Congress was the first—as early as 1989—to address the issue by creating the Office of Scientific Integrity, now Office of Research Integrity (ORI), funded by the Department of Health and Human Services. Like the National Science Foundation (NSF), the ORI can push for legal sanctions when fraud is identified in publicly-funded medical research, with results accessible on its website. In Europe, the Scandinavian countries took the initiative in the 1990s, with Denmark leading the way through the creation of a Committee on Scientific Dishonesty, able to conduct investigations in both private and publicly-funded research. Yet models vary throughout Europe, from Danish-like centralized models (Norway) to a mix of decentralized and centralized structures (Sweden), to fully decentralized systems (Finland), or ones solely monitored by national research organizations and funding bodies (France and Germany).[10] In France, the medical and health-related research agency INSERM was the first to set up a Committee on Scientific Integrity (DIS)[11] in 1999, followed by the Institut Pasteur (2004) and more recently, by the ANR.[12] The CNRS has also put in place safeguards and disciplinary measures, and can call upon external experts to assess the nature of misconduct should it not be properly handled by the laboratory. Yet many countries solely rely on independent bodies, mediators, and advisors with little legal authority over laboratories, research institutions, or universities (India's Society for Scientific Values, for example).

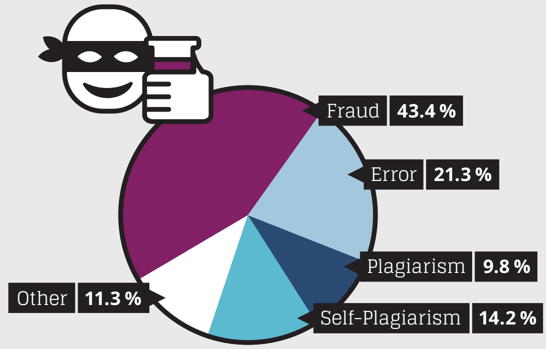
> The few incidences of large-scale fraud should not overshadow the many minor misdeeds committed on a daily basis.

## David Baltimore
### *Wrongly Accused*

*In 1986, a young postdoctoral fellow working as a laboratory trainee at the Massachusetts Institute of Technology (MIT) accused her director, Thereza Imanishi-Kari, of falsifying the results of a study published in* Cell *and co-signed by the Nobel laureate David Baltimore. Two initial investigations, one conducted internally by MIT and the other by the National Institutes of Health (NIH), concluded that the article contained only minor errors that did not warrant sanctions or retraction. However, the incident was widely reported in the US press, and a congressman, John Dingell, convinced that the powerful Baltimore had used his influence to smother up a scandal reported by a lone young researcher, convinced the US Office of Research Integrity (ORI) to reopen the case. Without being given a proper chance to respond to the charges, Imanishi-Kari was declared guilty in 1991 and again in 1994. Meanwhile, Baltimore was forced to resign as president of the Rockefeller University. Finally, an appeal in 1996 cleared Imanishi-Kari and Baltimore of all charges of misconduct. The episode, which put the careers of two outstanding researchers on hold for ten years based on unfounded accusations, illustrates the risk of letting the media and politicians investigate suspicions of scientific fraud.*

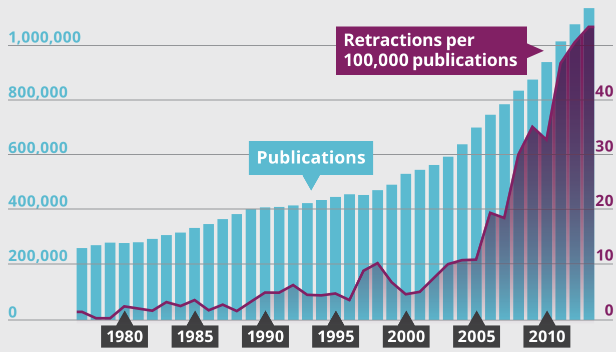
## Biomedical fraud in figures

### Cause of retraction **1977 to 2012**




SOURCE: FANG ET AL. (2012) PNAS

### Number of publications and retractions
**1977 to 2013**




SOURCE: PUBMED VIA PMRETRACT.HEROKU.COM

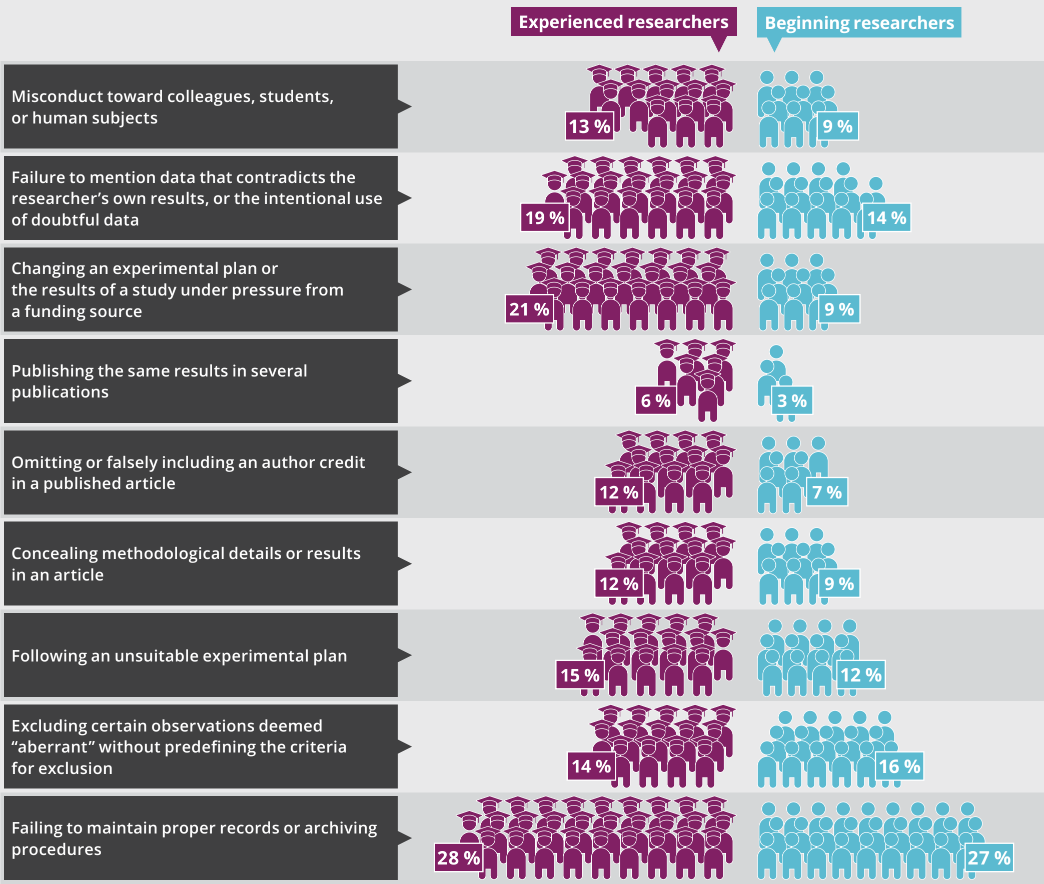
... of published articles rose between 1977 and 2013, from one in 100,000 articles in 1977 to more than 50 in 2013. Furthermore, a study published in 2012[13] showed that 67.4% of retraction requests were attributable to misconduct.

Yet as the French philosopher of science Anne Fagot-Largeault points out, "since successful fraud is never detected, it is illusory to rely on established cases (one in 100,000 researchers in the US) or the number of articles withdrawn from the *PubMed* database for ethical violation to evaluate its frequency."[14] In an effort to determine the actual incidence of scientific misconduct more clearly, a handful of studies have been carried out based on responses to anonymous questionnaires. Their findings are worrisome, to say the least. According to a meta-analysis combining the results of 18 surveys conducted in UK and

13. F. C. Fang, R. G. Steen, and A. Casadevall, "Misconduct accounts for the majority of retracted scientific publications," *PNAS*, 2012. 109(42): 17028-17033. 14. Anne Fagot-Largeault "Petites et grandes fraudes scientifiques: le poids de la compétition" in Gérard Fussman (dir.), *La Mondialisation de la recherche: compétition, coopérations, restructurations* (Paris: Collège de France, 2011). 15. D. Fanelli, "How many scientists fabricate and falsify research? A systematic review and meta-analysis of survey data," *Plos One*, 2009. 4(5): e5738.

**Because of their importance to public health and the availability of virtually exhaustive databases, the biomedical sciences have the greatest number of objective indicators for evaluating fraud.** This has made it possible to observe a sharp increase in the number and proportion of retractions over the past 30 years. It has also shown that, of the 2047 biomedical articles retracted between 1977 and 2012, only 21.3% were discredited due to simple error, while 53.2% were found to be fraudulent or plagiarized. In 2002, 3247 US- and UK-based researchers in the early to middle years of their careers agreed to answer a questionnaire on the types of misconduct that they had committed or witnessed. The graph on the right shows that, while serious fraud is relatively rare, incidents of misconduct are quite common among both beginning and experienced researchers.

Misconduct admitted by researchers in the past three years **In 2002**




SOURCE: MARTINSON ET AL. (2005) NATURE



US laboratories between 1986 and 2005,[15] 1.97% of respondents confess that they have personally falsified their experimental data at least once, and 14.12% report having witnessed this type of misconduct among their colleagues. Moreover, while 33.7% of researchers admit to other types of unethical behavior, as many as 72% state that they have seen others indulge in such practices. In short, although evaluation methods are approximate by nature, the frequency of fraud, big and small, seems to have significantly increased in recent years.

Some scientific misconduct is committed for personal gain (professional advancement, a prize, or peer recognition) or for ideological reasons (to justify or promote a policy) and amounts to simple fraud and/or manipulation. Such incidents, once discovered, have given rise to the most widely publicized scandals of the past decade. In addition to the stigma cast on the laboratories concerned, they have destroyed the careers and reputations of the perpetrators.

But the damage caused by scientific fraud goes far beyond the fate of those more or less directly involved. It can lead other researchers astray and invalidate entire theses based on false data. It also tarnishes the image of research as a whole and jeopardizes its funding. As Larivée notes, "it may not take much, especially during an economic recession, for taxpayers, influenced by the sensationalist media coverage of a few notorious cases, to start questioning the government budget allocated to scientific research in a given field or even in its entirety."[2]

**Could science as a whole fall into disrepute?**

From a strictly scientific point of view, the worst consequence of fraud is the suspicion that it casts on the body of knowledge acquired through research. The repercussions of this uncertainty are not just epistemological, but also have far-reaching social effects. "If researchers no longer trust the validity of their colleagues' findings, they are faced with a choice of either working full time reproducing their experiments—or live with constant, disquieting doubt," warns Larivée. "Given the preponderant role of science in our modern-day societies, the political ...

## Andrew Wakefield
### *Fabricating Doubt*

*In 1998, the British surgeon Andrew Wakefield published a study in* The Lancet *asserting that some children out of a test group of 12 had developed a form of autism following the administration of the measles, mumps, and rubella vaccine (MMR). The publication led to a sharp drop in vaccinations in the UK—and a substantial increase in the number of measles cases. Yet no other research team was able to replicate this result. Finally, in 2004,* The Sunday Times *revealed that the children presumed to have developed autism were autistic before being vaccinated. Worse still, the newspaper revealed that Wakefield had been bribed by a lawyer who wanted to sue the laboratory that produced the vaccine—the results of the study had been completely fabricated for that purpose. Subsequent articles in the* British Medical Journal *reported that Wakefield had planned to launch a business based on an anti-vaccine propaganda campaign. In January 2010, a tribunal of the UK General Medical Council found the surgeon guilty of fabricating data and permanently revoked his right to practice medicine in the country. Still, the public continues to harbor unfounded suspicions about the MMR vaccine. And Wakefield, who has always denied any wrongdoing, now practices in the US, where he supports anti-vaccination lobbies, pursuing his career as a "merchant of doubt."*

... and social consequences of fraud are immeasurable," he adds.[2] The British psychologist Cyril Burt's falsifications on the IQs of twins (*see box, p.20*) are often cited as an example. His research on the heredity of intelligence was used to justify the highly elitist education policies adopted in the UK from the 1930s. Another more recent example is the very real public health hazard caused by the publication of a study, based on fabricated data, asserting that the measles vaccine favored the onset of autism in vaccinated children (*see box, left*).

Considering the risk incurred in case of fraud, as well as the potential discredit to science as a whole, "no researcher would consciously want to see their career ruined or reputation tarnished," Fagot-Largeault stresses. "Consequently, either the perpetrators are not aware that they are cheating or, if they are, they believe that the advantages of the fraud significantly outweigh the chances of being caught.[14] In fact, the few incidences of large-scale deliberate fraud should not overshadow the many minor misdeeds committed on a daily basis. With modern technology, altering an image, streamlining data, or finding and copying information—in short, "crossing the red line"—has become child's play. According to Letellier, "more of concern is how researchers today, consciously or not, are increasingly adopting ethically questionable practices which, insidiously, pollute the world of research." For this prominent senior researcher, this results from insufficient knowledge of good practice (due to inadequate ethics training for young researchers), combined with a sense of relative impunity, fostered by a code of



16. Montreal statement on research integrity in cross-boundary research collaborations, 2013. www.wcri2013.org/doc-pdf/MontrealStatement.pdf
17. Singapore statement on research integrity, 2010. www.singaporestatement.org

silence that permeates the scientific community. Insufficient protection for whistleblowers, who expose themselves when they report fraud, adds to the problem. These factors are exacerbated by ever-increasing pressure on researchers to "publish or perish," i.e., to produce results or risk losing their funding or even their jobs—enough to wonder whether the constant assessments and fierce competition among researchers haven't contributed to creating this "culture of fraud."

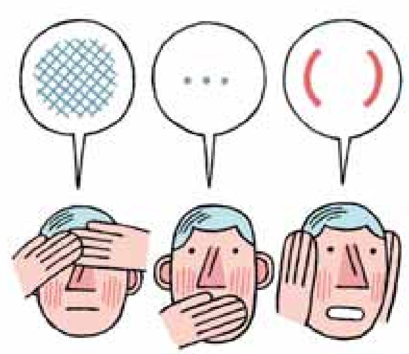
**A global response**

Growing awareness of the perils of fraud, stirred by the outcry over a number of much-publicized cases, has prompted several national and international scientific organizations to address the problem. Three World Conferences on Research Integrity have been held since 2007, with the next taking place this year in Rio de Janeiro (Brazil). These events bring together researchers, administrators, funding institutions, scientific publishers, and representatives of learned societies to "discuss strategies for harmonizing misconduct policies and fostering responsible conduct in research." They have led to the drafting of summary statements that spell out the responsibilities of researchers as well as the principles of governance for promoting ethical research practice.[16] These documents instruct researchers, among other things, to keep a record of their work—including all raw data and any changes of plans or hypotheses during the experiment—and make it readily accessible. They also specify the obligation of researchers to notify competent authorities of any misconduct that they may be aware of, without running the risk of being sidelined or, worse, punished, as is unfortunately often the case. The statements also call upon scientific institutions and journals to implement "procedures for responding to allegations of misconduct and other irresponsible research practices and for protecting those who report such behavior in good faith."[17] All countries and research organizations are encouraged to adopt and apply this "Hippocratic Oath" for scientists.

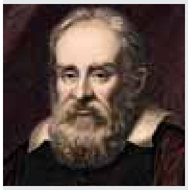
As for the CNRS, following the publication of its guide to promote good practice, the COMETS has also been discussing the issue with representatives of important institutions in France—a collaborative effort which should soon lead to the definition of a national charter on integrity in research. The manual has been distributed to unit directors and all research and higher education institutions in the country. Its main conclusion is that, while charters and guides are essential, one cannot, as former COMETS chairman and member of the Académie des Sciences Pierre Léna puts it, "continue to flood the system with more barriers, rules, and regulations. In most cases, we simply have to rely on the conscience of the researcher." II **Y.P.**

## Jan Hendrik Schön — the Art of Falsification

*In the early 2000s, the young German physicist Jan Hendrik Schön emerged as the rising star in his discipline after making a series of apparent breakthroughs in the field of condensed matter and nanotechnology. He had been recruited by the prestigious research center Bell Labs in 1997, immediately after completing his PhD. In 2000, he published eight articles in* Science *and* Nature*, and produced more than one article a week in 2001. That same year, he announced in* Nature *that he had successfully designed a molecular transistor, which could have been the first step toward the development of silicon-free organic nanoelectronics. Schön was awarded several scientific prizes for this achievement, but his meteoric rise came to a sudden halt in May 2002. Following a series of complaints filed by research teams who could not reproduce his published results, Bell Labs opened an investigation—and found that Schön, acting under false pretenses, had destroyed his raw experimental data and could not even provide a logbook. In September 2002, the investigation concluded that at least 16 of the 24 allegations of fraud were valid. At first, Schön claimed to have made an honest mistake, but ultimately admitted that he had manipulated his results to make them more convincing. Most of his articles were retracted and his PhD was revoked. He now works for a private company. As for the researchers who had co-authored the fraudulent articles, their integrity was never put in doubt. The case triggered a heated debate on the relevance of the traditional peer review system for evaluating the accuracy and originality of scientific papers.*



## *Famous Incidents of Scientific Fraud*



**Galileo** famously fell foul of the Inquisition for his contribution to the downfall of the Ptolemaic model. He is also often presented as one of the founders of the modern scientific method, which holds that "the ultimate arbiter of truth is experiment." However, none of those who tried to reproduce the results of his experiments on falling bodies ever succeeded, at least not with Galileo's claimed level of precision. It seems as though, convinced of the soundness and elegance of his mechanical theory, Galileo presented what was actually a brilliant and far-reaching thought experiment as a set of concrete empirical observations. In other words, he fabricated his data.

**Claudius Ptolemy** is remembered as the greatest astronomer of ancient Greece. In his magnum opus, the *Almagest*, he describes a geocentric model of the movement of the stars that would later be called into question by Copernicus, Kepler, and finally Galileo. Ptolemy based his model on astronomic measurements that he claimed to have performed on the Egyptian coast in the 2nd century AD. However, these measurements had actually been made 300 years earlier on the island of Rhodes, by the Greek astronomer Hipparchus. It was plagiarism pure and simple, but it nonetheless enabled astronomers to predict the precise position of the Sun and planets for nearly 1400 years.

The Czech monk **Johann Gregor Mendel** is regarded today as the "father of modern genetics." By crossing different strains of peas in his garden and observing the frequency of seven hereditary characteristics, he established the laws of gene transmission as they are still accepted today. Yet the results he published, largely ignored at the time, are statistically too perfect to be true, at least given the size of his sample groups. It is therefore highly probable that he "enhanced," and thus falsified, his data.

# *Plagiarism*

The third type of "major" fraud, plagiarism, is not only damaging to those whose work is copied. It encourages inaction and discredits all researchers.

Plagiarism is by definition the appropriation of content (an idea, text, photograph, illustration, etc.) without giving its author proper credit. It can be the result of simple negligence or genuine scientific dishonesty and takes many forms, ranging from self-plagiarism (which is quite common but whose consequences only affect the perpetrator) to the actual theft of intellectual property, which constitutes a fraud as serious as the fabrication or falsification of data. If new technology makes it easier to track ethical breaches, it is also at the heart of the problem: the Internet gives everyone access to a plethora of data that can be cut and pasted in an instant, while the increased use of anti-plagiarism software by institutions and publishers makes it possible to detect the most blatant violations. Yet all cannot be identified, as perpetrators can evade the detection algorithms by using synonyms and circumlocutions, adding non-breaking spaces and typographical errors, or citing sources in deceptive ways.

### Strange coincidences

The Forget/Pangou case[18] offers a recent and particularly devious example of plagiarism. Reading a manuscript that had been sent to him for review, the Dutch researcher Patrick Jansen thought it seemed familiar. For a good reason: 90% of it had been plagiarized from an article that he had co-written in 2007 with Pierre-Michel Forget, a professor at the French Natural History Museum and a specialist in tropical forest ecosystems. The original article described how the hunting of frugivorous animals affected the dispersion of the seeds of an Amazonian tree. The plagiarist was writing about a different region and a different tree, but described the exact same mechanism word for word, backed with the same tables and diagrams, while omitting to mention a source. After this

\+ related websites

- **http://retractionwatch.com**
- **http://publicationethics.org**
- **http://www.wcri2015.org**

18. P. A. Jansen and P.-M. Forget, "Predatory publishers and plagiarism prevention," *Science*, 2012. 336(6087): 1380. 19. J. D. Watson and F. H. C. Crick, "Molecular Structure of Nucleic Acids," *Nature*, 1953. 171:737–738. 20. Centre d'études et de recherches de sciences administratives et politiques (CNRS / Université Paris-II). 21. Gilles J. Guglielmi and Geneviève Koubi (dir.), *Le Plagiat de la recherche scientifique*, LGDJ Collection (Paris: Lextenso Éditions, 2012).

# *in the Age of Digital Reproduction*

blatant case of data theft combined with falsification was uncovered, it emerged that the same author had published a number of fraudulent articles in the past, all of which were eventually retracted.

**Little protection for the victims**

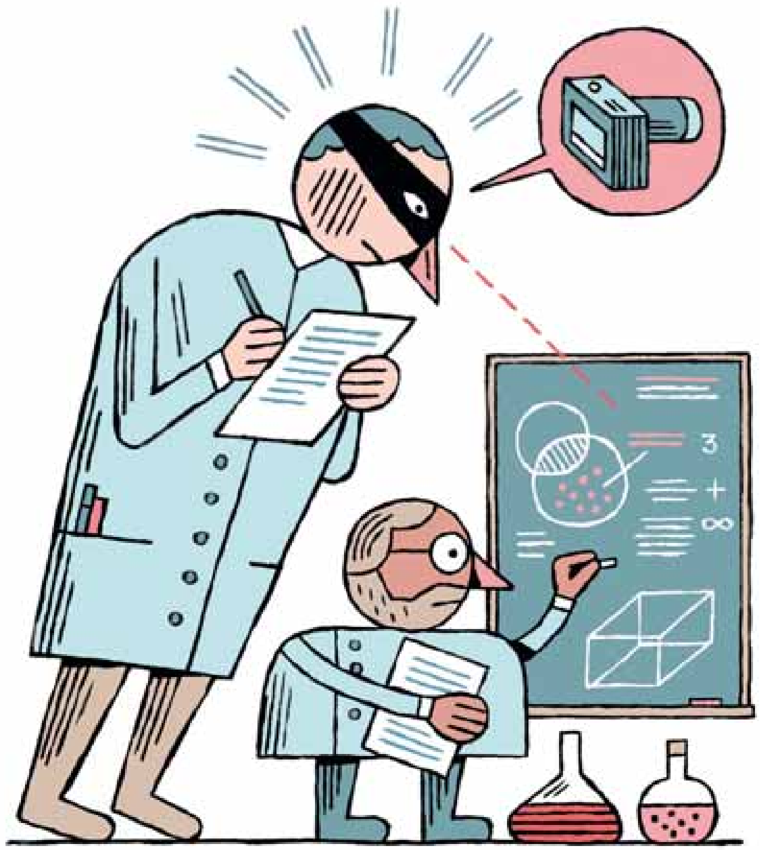
Cutting and pasting a text without citing its source is only the most obvious form of plagiarism, and the easiest to track down. There are other, much more insidious ways to steal an idea, especially when the source is not public, such as research projects presented to small groups or results discussed at informal conferences but not yet submitted for publication. One of the most outrageous examples of this kind of plagiarism was the publication in 1953 of an article in which James Watson and Francis Crick[19] revealed the double-helix structure of DNA. It turned out that the two researchers owed this discovery to images of DNA obtained by Rosalind Franklin using X-ray diffraction. The images were used without her knowledge, and she was not credited. Watson and Crick went on to win the Nobel Prize in Medicine in 1962, after Franklin's death. Her contribution to the discovery was eventually revealed by the third laureate, Maurice Wilkins. "The impact of such deceptions far exceeds the harm caused to the plagiarized party," insists Geneviève Koubi, a legal expert and member of the CERSA.[20] "The damage done to research as a whole is even more significant, as it encourages inaction and casts suspicion on all researchers."

Passive complicity can also be found in cutting-edge research fields, due to excessive interdependence. The collective nature of scientific research and the very process of peer review make it difficult to denounce fraud, especially if the "borrowing" relates to work in progress, in other words, ideas that are not yet published and protected. In particular, while plagiarists may face disciplinary or even legal action, including the invalidation of a thesis or retraction of an article, the whistleblowers often find themselves in the hot seat as well. The time lost in detecting plagiarism, compounded by the complexity and potential cost of the procedures for reporting it, all tend to prevent victims from taking action.

**An individual and collective responsibility**

Another problem is that intellectual property law cannot formalize various and distinct levels of plagiarism. Surprisingly, the French justice system makes plagiarism a commercial matter: to be punishable by law, it must be considered as "counterfeiting." Would a new law solve the problem? "Things aren't that simple," for Koubi and Gilles Guglielmi, who co-authored a book on the subject in 2012.[21] In their opinion, it is preferable to appeal to individual and collective responsibility, considering that professional ethics and good practice will be more effective than adding more laws to an already complex legal code.

How, then, should the associated psychological damage be addressed in such a specific field as research, and the "intellectual crime" codified in the statute books? "France still lacks a full-proof academic mechanism for detecting and punishing plagiarism, as is the case for example in Luxembourg and Switzerland," the international expert on academic plagiarism and University of Geneva professor Michelle Bergadaà, points out. For Letellier, "it is the entire structure of research that must be reassessed, as the pressure to publish inevitably exacerbates this phenomenon. Career vulnerability and the extent of interdependence also need to be re-examined. But in the past few years, institutions have become more aware of the problem, which has led to preventive and repressive measures." Nonetheless, fraud has not been eradicated, affecting public perception of the role of research in society. Proper guidelines can help raise awareness among scientists, but will this be enough to change the status quo? II **L. B. Y. AND Y. P.**



# Gérard Berry, Computer Conductor

BY LAURE CAILLOCE

**CNRS 2014 Gold Medal.** Gérard Berry is awarded France's highest scientific distinction, for his pioneering work on real-time programming languages.

Being slightly late for our appointment, Gérard Berry apologizes. He has just received a call from a French daily, eager to know his opinion on computer science education in the country. As a CNRS Gold Medal winner, the computer scientist is much sought after—and only too happy to oblige. Lively and outgoing, he belies the stereotype of the "computer nerd" living in his own world. He welcomes us to his spacious office at the Collège de France, where he created the first permanent chair in computer science in 2012—an impressive record for an unconventional researcher who successfully forged a career at the interface of pure theory and industrial innovation. The Esterel language, which made him famous, is now used to operate real-time systems as complex and sensitive as airliners, trains, and nuclear power plants.

### A youthful passion

He could have very well become a chemist. He learned to read from the chemistry books of his mother, a professor, and spent many hours of his teenage years manipulating beakers and reagents in the basement of his family home in the outskirts of Paris. He discovered computers at the age of 19. "I saw my first computer—an old Seti PB250—in 1967, when I started out at the École Polytechnique," Berry recalls. "They had just begun offering a computer class and I took to this emerging discipline immediately: it combined the experimental aspect that I loved with pure logic, which I found highly stimulating." The young student was instantly fascinated with the man-machine dichotomy: an odd couple in which man, "clever but slow," tries to give instructions to a computer, "quick but brainless, since it only does what it is told to do."

After the École Polytechnique, Berry completed his training working as an engineer in the Corps des Mines, a French public service inter-ministerial institution where he began conducting research in computer science in 1970. It soon occurred to him that the programming language was the stumbling block in the man-machine relationship, and solving it became the work of a lifetime. "I understood immediately that it was very difficult to get it right," he admits. His first research focus, also the subject of his thesis, was at the interface of mathematics and computer science: lambda calculus, a mathematical language that serves as the basis for many programming languages. This choice of a purely theoretical subject might have also been borne out of necessity.

"Back then, no research laboratory in France had a computer worthy of the name," Berry recalls. "At least until the launch of IRCAM[1] in 1977, when the composer Pierre Boulez rang the alarm bell loud and clear. He subsequently obtained the first machine suitable for proper research. The other laboratories, including mine, were not equipped until 1982." Working in computer science without a computer had its advantages, though: the experience made Berry an exceptional theoretician and laid the foundation for a French school of computer science, which is now recognized around the world for its power of abstraction.

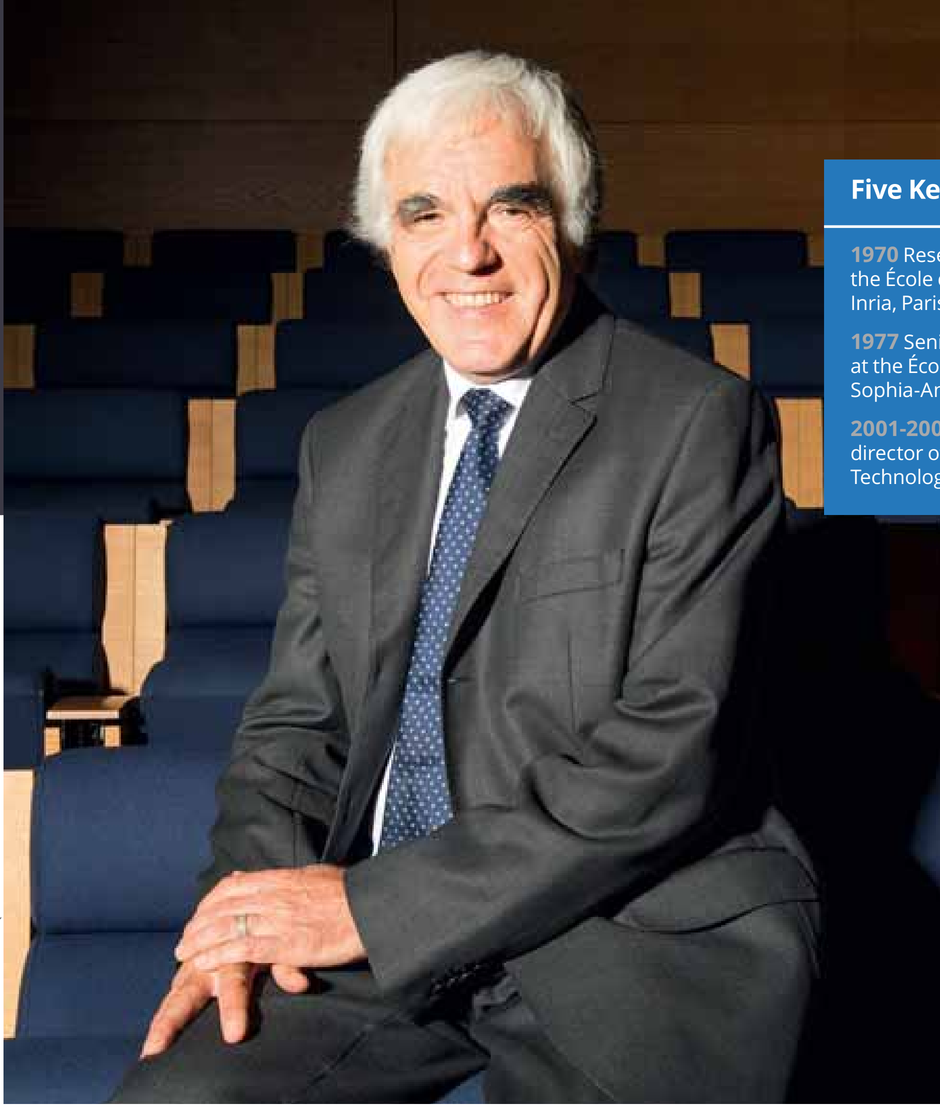
### Esterel: a brilliant intuition

In 1977, Berry moved from Paris to Sophia-Antipolis in southeastern France, where the École des Mines had just opened the automation control theory and computer science research unit, which it soon shared with Inria.[2] The turning point of his career came in 1982, when *Microsystems,* one of the world's very first trade magazines, launched a competition for robot cars. "My colleagues in control engineering had produced an ultra-sophisticated vehicle but

> The Esterel language is now used to operate real-time systems as complex and sensitive as airliners, trains, and nuclear power plants.

weren't sure how to program it," the researcher says. "Until then, I had always dealt with programs that simply involved some input data, a calculation, and an output result. Yet this particular machine needed to react constantly to its surrounding environment. This is how we devised a language that would be totally different from what everyone else was doing. That language would eventually become Esterel."

1. Institut de recherche et coordination acoustique / musique. 2. Institut national de recherche en informatique et en automatique.




### Five Key Dates

**1970** Researcher at the École des Mines and Inria, Paris

**1977** Senior researcher at the École des Mines, Sophia-Antipolis

**2001-2009** Scientific director of Esterel Technologies, a corporate venture created to market the Esterel language

**2002** Member of the Académie des Sciences

**2012** Holder of the "Algorithms, machines and languages" Chair, Collège de France

In those days, methods for programming cyber-physical devices were hampered by the presence of two seemingly conflicting time scales: the physical time at which the process that needs to be controlled operates and the computer's own calculation speed. Berry took a bold approach by putting himself in an ideal world where calculation times are irrelevant and all reactions are supposed to be instantaneous. "When they write symphonies, composers do not take into account the time needed for the sound of the instruments to reach the listeners' ears," this music enthusiast explains. "Esterel is based on the same principle."

The world of research seemed somewhat dubious, and with good reason: in the 1980s, computers were 200 times slower than they are today. But, because of its simplicity, clarity, and implantation efficiency, a number of manufacturers showed a keen interest in this programming language for real-time systems. French aircraft manufacturer Dassault, to start with, saw it as a way to expand the limited possibilities of automatic control and computerize the instrument panels of its Rafale jet fighters. Moreover, Esterel gave the company another significant advantage: the formal verifications performed while writing the program make the resulting systems more secure.

In addition to the aeronautics industry, which gradually adopted embedded systems for all aircraft functions (automatic pilot, braking, air conditioning, etc.), other users of so-called critical IT systems—telecommunication protocols, nuclear power plants, robotics, etc.—also became early adopters. The Esterel Technologies company was founded in 2000 to market the Esterel programming language, and Berry served as its scientific director from 2001 to 2009. The firm's client portfolio included Dassault and electrical systems specialist Thales, but also semiconductor giants Intel, Texas Instruments, and ST Microelectronics. One of the company's earliest developments was a special version of Esterel for designing electronic circuits. "We were very fortunate to work with such scientifically-advanced manufacturers," Berry says. "The problems we had to solve for them were much more complex than our laboratory hypotheses."

### A remarkable teacher

Today, Berry devotes most of his energy to preparing his lectures at the Collège de France—not so different a task, he says, from his teaching experience at Les Pouces Verts, a Montessori school near Sophia-Antipolis where he spent several years teaching computer classes for young children. And he is not done with programming languages either. The boom in Internet use and the rampant proliferation of mobile apps have pushed him in a new direction: in collaboration with Inria researcher Manuel Serrano, Berry is developing HipHop, a language aimed at facilitating communication with connected objects. He is also working with IRCAM on the transposition of Esterel to the world of electronic music and the development of algorithmic scores. Despite a hectic schedule, this father and stepfather of three adult children still finds the time to enjoy his stepdaughter's acrobatic prowess as a circus performer. The pioneer of synchronous languages and computer science magician seems to have unlocked the secrets of time. II

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A video interview of Gérard Berry is available online: **www.cnrs.fr/cnrsmagazine**

# CERN: A Journey through Time

**Particle physics.** Backed by 21 countries and involving researchers from 100 nationalities, CERN, the European Organization for Nuclear Research whose Large Hadron Collider (LHC) is today the largest and most powerful particle accelerator in the world, recently celebrated its 60th anniversary. We look back at a few momentous achievements of this improbable journey into the deepest structure of matter, an exemplary lesson in international scientific collaboration, which is only just beginning.

**BY** AUDREY DIGUET
**PHOTOS BY** CERN AND CYRIL FRESILLON/CNRS PHOTOTHÈQUE



1 2

1. Following WWII, the weakened nations of Europe, fearing that their best physicists would leave for better research facilities elsewhere, and anxious to foster peace in the region, decide to build a common European physics laboratory. On October 1, 1952, during the third session of the provisional council in Amsterdam, the canton of Geneva is selected as its future site.

2. Construction officially begins on the Meyrin site in Switzerland on May 17th, 1954.

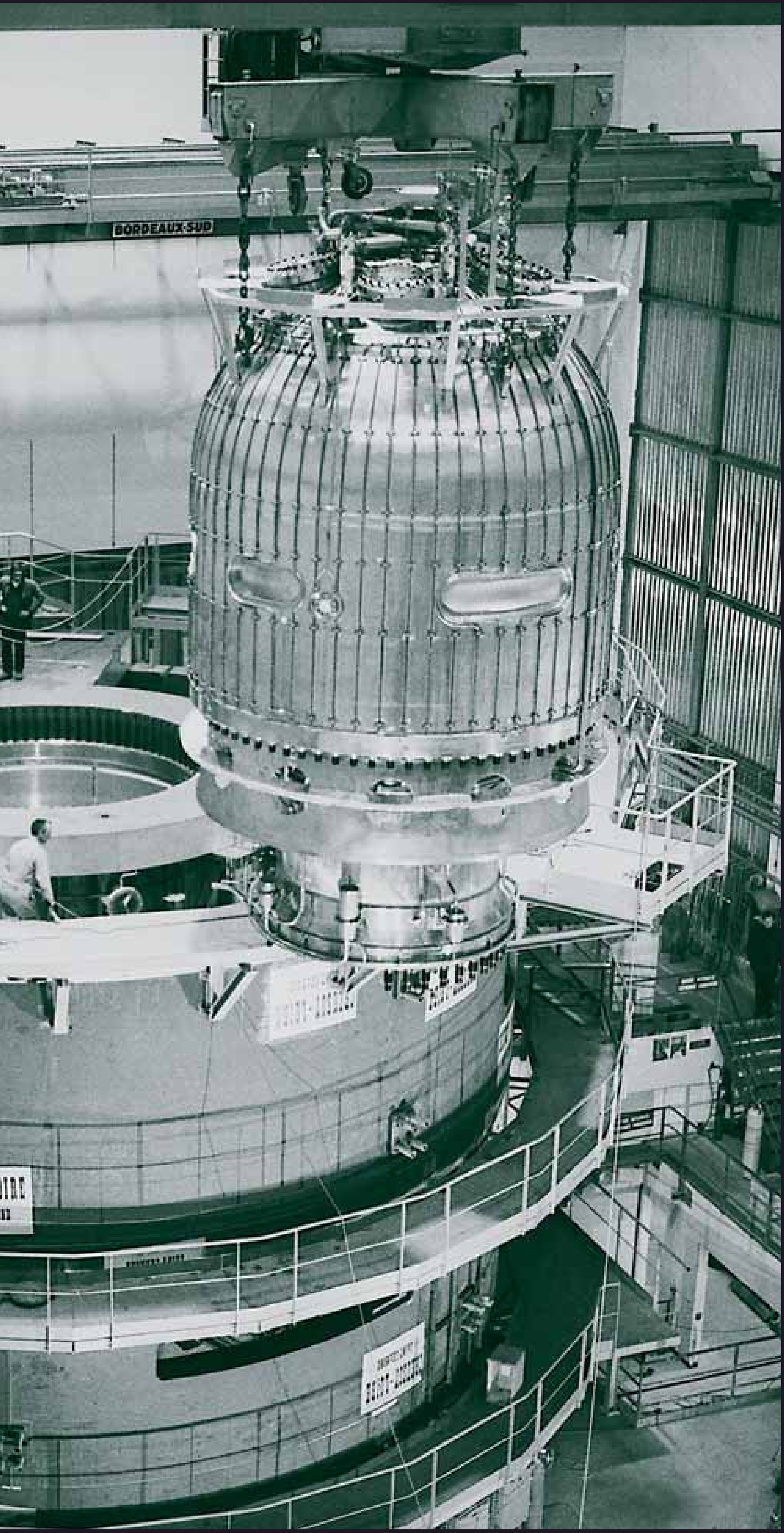

3

4

3. CERN's first accelerator, the 600 MeV Synchrocyclotron (SC) comes into operation in 1957. It will provide beams for particle and nuclear physics experiments until 1990.

4. The ring-shaped Proton Synchrotron (PS), which becomes operational in 1959, is the most powerful proton accelerator of its time. Still active today, it continues to supply particle beams to the Large Hadron Collider (LHC).


5




5. 6. For decades, studying particle trajectory at CERN relied on examining by hand millions of photographs from bubble chambers like the Big European Bubble Chamber (pictured here). In 1968, Nobel prizewinner Georges Charpak (below, left) brings particle detection into the electronic age with his "Multiwire Proportional Chamber" (MWPC). Using transistor amplifiers and linked to a computer, his invention allows for a 1000-fold increase in detection rate.

6

7


7. The Intersecting Storage Rings (ISR)—the first proton collider in the world—operated between 1971 and 1989. Made up of two identical 300-meter rings that intersect at 8 points, the machine, whose beams were supplied by the Proton Synchrotron (PS), helped provide hints that protons were composed of smaller parts.

8


9


8. 9. Completed in 1976, the 7 km-long Super Proton Synchrotron (SPS) was the first giant underground ring to cross the Franco-Swiss border. Today, it accelerates particles before feeding them to the Large Hadron Collider (LHC): a 27 km ring buried 100 m below ground, housing two high-energy particle beams travelling in opposite directions.

**A crowdsourcing project**

CERN has accumulated about a quarter of a million hard-copy images that are currently being digitized, but which often lack information. It has asked its community to help tag people, instruments, and dates.

» **http://cern.ch/go/tG03Ta**

The entire photo gallery *60 years of instruments at CERN* is available online:
**www.cnrs.fr/cnrsmagazine**



10. In 2012, the LHC's ATLAS and CMS (pictured here) experiments observe a new particle consistent with the Higgs boson, a key elementary particle in the Standard Model of particle physics. The LHC's other two large experiments (LHCb and ALICE) are also contributing significantly to our understanding of the infinitely small.

10

# Africa on the Move

BY ARBY GHARIBIAN

**Environment, Health, Society.** An interdisciplinary collaboration looks at environmental transformation and its impact on health and society in West Africa.

In its sixth year of existence, the mission of the ESS[1]—the only CNRS International Joint Unit (UMI) in sub-Saharan Africa—has become increasingly urgent due to global warming acceleration and demographic evolution. With unique North-South and South-South research profiles, the UMI's 60-plus researchers in France, Senegal,[2,3] Mali,[4] and Burkina Faso,[5] are conducting research on human health in this rapidly-changing region.

"Five different teams are exploring the relationship between health, society, and the environment, doing so from a broad range of interdisciplinary approaches," explains unit director Gilles Boëtsch. "Anthropologists and ecology experts are working alongside doctors and chemists to find out how human health is impacted by a host of fluctuating factors. Although new challenges unfold every day, we are very pleased with the significant progress that has been achieved in understanding chronic illnesses, disease vectors, and ecological degradation."

◢ ESS researcher Deborah Goffner speaking about biodiversity in a Great Green Wall plant nursery in Widou Thiengoly (Senegal).



### The Great Green Wall of Africa

Key to the health issue is the natural environment, which has seen considerable deterioration due to global warming and desertification. CNRS and UCAD [2] researchers joined forces in 2009 to launch the OHMi Téssékéré,[6] a CNRS observatory in northern Senegal dedicated to the complex social-ecological interactions resulting from the Great Green Wall (GGW), the monumental ecological restoration project stretching 7000 kilometers from the west to the east coast of Africa.

"We are using 'applied ethnobotany,' or the understanding of the interactions between people and plants, to solve social and ecological issues in a sustainable fashion," explains Deborah Goffner, local team leader and CNRS senior researcher. "For instance, we urged decision-makers to plant more species than the three envisioned, not only to maximize the biodiversity potential of the GGW, but also to meet the needs of local populations, who use different trees for fuel, food, construction, or medicinal purposes."

1. Environnement, santé, sociétés (CNRS / UCAD / USTTB / UGB / Aix-Marseille Université / CNRST). 2. Centre Université Cheikh Anta Diop (UCAD) (Senegal). 3. Université Gaston Berger (UGB) (Senegal). 4. Université des sciences, des techniques et des technologies de Bamako (USTTB) (Mali). 5. Centre national de la recherche scientifique et technologique (CNRST) (Burkina Faso). 6. Observatoire hommes-milieux international de Téssékéré. 7. Agence Française de Développement.

© A. DUCOURNEAU/CNRS PHOTOTHÈQUE

A team of microbiologists collect soil samples on a parcel of land allocated for the Great Green Wall project.

gilles.boetsch@gmail.com

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ESS research also focuses on improving the quality of child care in the region.

### Changing social dynamics

The ageing population is central to many of West Africa's societal issues. "Ageing is a physiological process experienced within an environmental and social context," says Enguerran Macia, a member of the unit based in Dakar (Senegal). "It was first studied in western societies in the 1960s, but the phenomenon is more recent in Africa, and much of the research groundwork is still underway."

While better healthcare can explain this demographic shift, urbanization and modernization have also contributed to higher obesity rates, which can be related to a more sedentary lifestyle and non-traditional diets rich in complex sugars. This has led to an increase in cardio-vascular diseases such as hypertension in older age groups. "We are watching the epidemiological transition unfold before our eyes," adds Macia, referring to the shift from infectious to chronic, non-contagious diseases as the primary cause of mortality. "Much work remains to be done, as only half of those suffering from hypertension are aware of their condition, and only 6.7% undergo regular treatment."

### Rapid urbanization

As part of West Africa's ongoing rural exodus, people are leaving the countryside for cities, settling in shantytowns. As a result, a number of essentially rural infectious diseases have cropped up in large cities like Bamako, the capital of Mali, where a team of researchers[1,4] is busy tracking how urbanization affects the frequency and distribution of these diseases.

"Newcomers from areas of the country with endemic parasitic conditions settle along the Niger River and near its tributaries in the city's outskirts," explains team member Abdoulaye Dabo. "As a result of this rapid urban expansion, people live in unfinished homes near open sources of polluted water, were they run an increased risk of infection from malaria-carrying mosquitoes, as well as insects responsible for the cutaneous disease leishmaniasis, or freshwater mollusks that cause schistosomiasis, also known as snail fever."

To contain the spread of such infections, researchers used satellite imagery to generate specialized maps, each focusing on a separate component of the urban landscape such as waterways, vegetation, and buildings. They combined the data collected on vectors and parasites to identify hot spots for transmission. The mapping of these zones subsequently makes it possible to combat—more effectively and at lower cost—both the vectors and parasites in the district of Bamako.

### Delivering health

A final challenge is to deliver healthcare, especially to pregnant women and infants. Nearly 320,000 women worldwide fall victim to maternal mortality each year, 200,000 of whom in sub-Saharan Africa. Many of those deaths occur in hospitals and are due to eclampsia, infection, or hemorrhage. Improving hospital care is thus a priority, notably through qualitative studies of maternal deaths, analysis of interactions between patients and hospital staff, and on-site training.

"Yet maternal mortality also occurs outside the hospital, during secret abortions," says France-based ESS anthropologist Yannick Jaffré. "Further social initiatives are needed to prevent unwanted pregnancies, by educating local women about their bodies and the use of contraceptives."

Jaffré also studies child health, and recently took part in a study where children in eight West African countries were asked about their illnesses and hospital treatment. "We used the results to draft policy manuals for pediatricians to improve the quality of child care. Combining the fundamental with the practical is an important aspect of our research, and it has been made possible by financial support from the AFD[7] and UNICEF," he concludes.

# Mangroves: An Asset to Treasure

**Ecology.** Research teams are studying mangroves across the globe to explore the crucial role these ecosystems play for the well-being of local populations and the planet.

**BY** ARBY GHARIBIAN

© F. FROMARD/ECOLAB

◤ Malamani test site (Mayotte), where researchers study mangroves exposed to domestic wastewater.

On December 9, 2014, a tanker carrying 350,000 liters of bunker oil collided with a cargo vessel in the Sundarbans region of Bangladesh, threatening part of the world's largest tidal mangrove forest, a UNESCO World Heritage Site. Mangroves are forest ecosystems that cover nearly three quarters of the world's tropical coastlines, where their ability to adapt helps them flourish in intertidal zones with large variations in water flow, sediment flux, and saline content. They offer invaluable ecosystem services by limiting coastal erosion, acting as a buffer zone against cyclones and tsunamis, and by trapping and storing carbon. They are rich in young shrimp and fish that eventually migrate to nearby coastal waters, thus providing an important source of food for local populations. Despite their importance, they have shrunk by 30% over the last two to three decades, and continue to decline at an alarming rate of one to two percent each year, primarily due to shrimp farming in many parts of the world.

Surprisingly, there have been few detailed studies of mangrove forests, and growing international interest in recent years has not succeeded in slowing the retreat of these ecosystems. CNRS and IRD[1] teams have acted to fill this informational gap by investigating mangroves from various scientific perspectives. They have also helped launch the CNRS/IRD's 2015 Year of the Mangrove initiative, to raise public awareness of their importance, both in France and its tropical overseas territories, which boast some of the world's best-preserved forests.

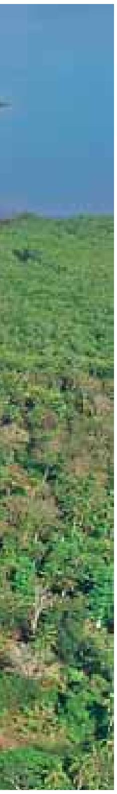
### Eco-engineering in Mayotte

The French island of Mayotte, located in the Comoro Archipelago off the coast of Madagascar, is home to extensive mangrove forests, which are, however, subject to considerable strain from increased urbanization and population density. To help balance the island's demographic expansion with the preservation of its natural habitat, researchers from the EcoLab[2] worked with local authorities to set up a large-scale experiment aimed at testing the depolluting capacity of mangroves.

"We established a network of homes to collect domestic wastewater," explains EcoLab researcher and group leader François Fromard. "We then introduced this water into different plots of mangroves to track how they filtered out pollutants such as phosphorus and nitrogen, and the effect this has on the ecosystem in general."

Scientists observed that the mangrove plots exposed to wastewater

1. Institut de recherche pour le développement. 2. Laboratoire Écologie fonctionnelle et environnement (CNRS / Université de Toulouse-III / INP Toulouse). 3. Laboratoire des sciences de l'environnement marin (CNRS / IFREMER / IRD / Université de Bretagne occidentale). 4. Agence nationale de la recherche. 5. Biodiversité et fonctionnement des écosystèmes dans les mangroves de Guyane française. 6. Institut de minéralogie, de physique des matériaux et de cosmochimie (IMPMC) (IRD / CNRS / UPMC / MNHN).



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In Mayotte, the experimental plot of mangroves (*Rhizophora mucronata)* is criss-crossed by a network of pipes that release wastewater under controlled conditions.

© H. BRETON/COLLÈGE VICTOR SCHOELCHER

The *Uca maracoani* crab contributes to mangrove biodiversity by boring holes into the mud, thus oxygenating the ground.

actually grew faster than other plots, as the forests were able to capture and integrate the pollutants into their biomass. Researchers are now conducting microbiological research to determine how pollutants such as nitrogen are absorbed, and what effect increased levels will have on the sediment, water, and fauna living within the ecosystem.

**French Guiana's endless cycle**

Fromard and his colleagues are also studying the mangroves of French Guiana, another overseas territory, but in South America. The mangroves here have experienced little human impact, but are subjected to a very active coastline that can advance or recede by two to three kilometers a year. This is due to the huge amounts of sediment deposited at the mouth of the Amazon River, which extend the coastline until erosion allows the sea to move inland.

"This pattern of expansion and retraction works roughly in 30-year cycles," notes Fromard. "We therefore created a database of coastal images, using aerial photography and satellite images going back to the 1950s, to determine how this cycle is being affected by climatic factors such as global warming, and how much carbon is released during periods of retraction."

The vitality of local mangroves also applies to the rich biodiversity that thrives in the ecosystem. Emma Michaud and her colleagues from the LEMAR,[3] a partner lab in the ANR[4] Biomango project[5] which aims to study and preserve the mangroves of French Guiana, and observe the fauna that lives in sediments of mangrove forests, such as small shellfish, worms, and crabs.

"Crabs are abundant, around 100-500 per square meter, and play an important role through their bioturbation activities, boring into the mud on the floor of the mangrove forests," points out Michaud. "Water passes through the holes they create, oxygenating the environment, which in turn allows other organisms to grow—and local biodiversity to expand."

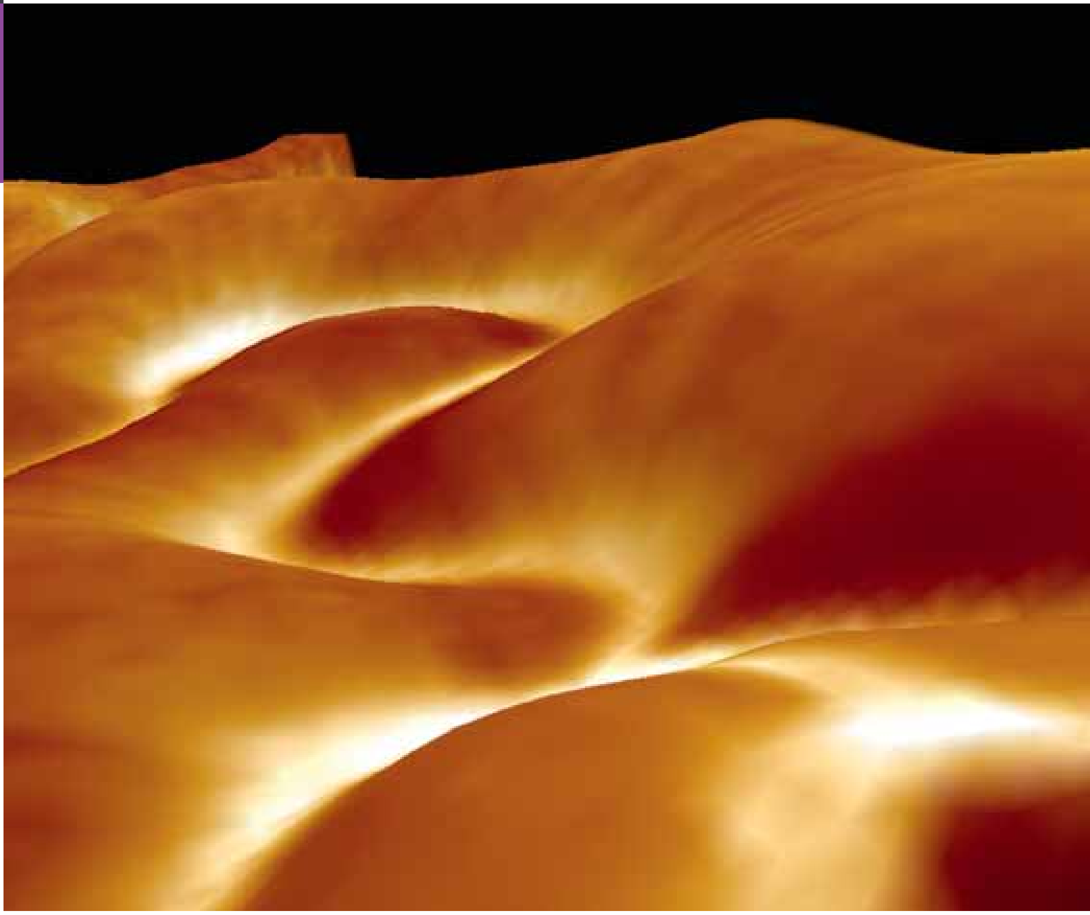
The increased oxygen also gives rise to certain types of bacteria that can rapidly decompose organic elements such as fallen leaves. "We do not yet know what overall impact these bacteria have on the ecosystem's dynamics, including carbon sequestration or mineralization," concludes Michaud. "However, projects are underway to shed more light on this area, as well as to list the ecosystem's various species, about which there is little information."

**Carbon sinks of New Caledonia**

IRD and CNRS researchers based in New Caledonia have been studying local mangroves to improve understanding of their carbon sequestration capacity, and how this capacity is evolving in the face of climate change. "New Caledonia is an ideal location to study," notes team leader Cyril Marchand,[6] "because its mangroves are well-preserved—some enjoying UNESCO World Heritage status—while being subject to significant human pressure such as deforestation, aquaculture, and mining."

Marchand and his colleagues set up measurement equipment in mangrove forests, including ultrasound detectors mounted on tripods to gauge rising water levels and sediment flow, and an eddy covariance tower to record gas concentrations and 3D wind patterns. The measurements allowed them to calculate $CO_2$ flux from the ecosystem to the atmosphere, and isolate the factors contributing to carbon sequestration, such as sediment water content, and temperature.

The resulting data sets also helped researchers identify a new factor, that of sediment surface biofilm. Consisting of plant-like microorganisms, it reduces the flow of $CO_2$ from sediment to the atmosphere, thereby increasing the mangrove's carbon sink effect. Further studies of the impact of the biofilm could help establish more accurate carbon budgets.



**Europe.** The Seventh Framework Programme for Research and Technological Development (FP7) came to a close just over a year ago. With many projects still ongoing, we look back at France's participation in this ambitious €50 billion scheme.

**BY** MATHIEU GROUSSON

# Assessing the EU's 7th Programme for Research

Launched in 2007, the Seventh Framework Programme for Research and Technological Development (FP7), the EU's main research funding mechanism, ended in 2013. While many projects are still ongoing, Horizon 2020 (H2020), its successor for the period 2014-2020, is already underway. Time has come to evaluate the FP7, in which French researchers—especially from the CNRS—made a good showing. With 5721 projects selected, France participated in 28.7% of all schemes, behind the UK and Germany, and coordinated 37.2% of those it was involved in, ranking third in terms of coordination rates. Moreover, the 25.3% success rate of projects involving French scientists is higher than the European average of around 20%.

## First in line

The CNRS participated in 1258 projects, or 22% of France's selected programs and 6.3% of the total, which makes it the FP7's leading recipient organization. It is involved in all ten themes chosen for research actions under the "Cooperation" programme—the FP7's largest project—which oversees transnational cooperation for priority research activities. French researchers also fared well in the IDEAS-ERC programme, focused on supporting exploratory research "at the cutting edge of knowledge."

The PhyMorph project aims to elucidate morphogenesis in plants like *Arabidopsis*, seen here under the microscope.

With 494 projects selected, or 14.1% of the total, France ranks third in Europe in this category and the CNRS is involved in 5.5% of all IDEAS-ERC projects.

"France and the CNRS are well positioned," points out Günther Hahne, director of the CNRS Brussels office and CNRS representative to the European Commission. "This is all the more important since, beyond the financial aspect, European projects offer great networking potential and provide significant international visibility. They also ensure greater influence on how research develops in a given field." One example is the UrbaChina project, which received a €2.7 million grant for the 2011-2014 period. Coordinated by François Gipouloux, director of the Centre for Studies on China, Korea and Japan[1] in Paris, it brings together some 40 scientists from 11 European and Chinese research institutions. Its objective is to analyze the main trends that

1. Centre Chine, Corée, Japon (CNRS / EHESS). 2. Laboratoire de Reproduction et développement des plantes (CNRS / ENS Lyon / Inra / UCBL). 3. CNRS / ENS Lyon. 4. Mission pilotage et relations avec les délégations régionales et les instituts du CNRS. 5. Service du partenariat et de la valorisation. 6. Dispositif Ingénieurs de projets européens (CNRS).

will shape China's urbanization in the coming decades and design models for sustainable urbanization. As Gipouloux puts it, "it is quite simply the first-ever large-scale European collaboration program with China in social sciences and the humanities. This is certainly a badge of excellence for our laboratory." Arezki Boudaoud, from the RDP[2] and Joliot-Curie[3] laboratories in Lyon, received a European Research Council (ERC) grant for the PhyMorph project, which studies the process whereby a living organism acquires its shape. For Boudaoud, "this type of European funding has several advantages: it offers the financial means to purchase sizeable equipment, but also makes it possible to tackle highly-specific research topics, since it supports single teams. Moreover, the project's five-year timeframe provides a certain degree of stability and long-term vision of the work being carried out."



### More applications needed

Despite these numerous advantages, there is room for improvement in terms of French researchers' applications to European programs. All disciplines combined, France ranks fifth in number of project submissions, behind Germany, the UK, Italy, and Spain. This performance is slightly down on previous years, as the funding obtained by French participants made up 13% of the total allocated by the EU for the FP6, compared to 11.6% for the FP7. These figures should also be weighed against France's contribution to the EU budget, which was of 16.4% over the 2007-2013 period.

Hahne believes that this relative lack of interest stems from the fact that "with the exception of ERC grants, all other calls for proposals are theme-driven, often according to economic or industrial innovation objectives. Some find this limiting. Certain researchers also feel that the coordination of a large European project does not weigh much in the balance when it comes to career advancement." Cédric Bosaro, head of the "Europe and contracts" service of the Mission for the Monitoring of and Relations with CNRS Regional Offices and Institutes (MPR),[4] points out that "applications are often more complex and detailed than for other national sources of funding, especially for projects that involve a broad consortium of European partners."

### Facilitating European projects

Europe is now a non-negligible source of research funding, representing 18.3% of the CNRS-generated resources and 2.34% of its total funding in 2013. For this reason, French scientists can now rely on a special task force set up by the CNRS to help them through the intricacies of European projects. Under the joint authority of the CNRS Resources Office (DGDR) for administrative matters and the European Research and International Cooperation Department (DERCI) for scientific issues, the task force notably takes the form of a partnership and technology transfer service (SPV)[5] in each regional office. Its role is to "help researchers set up projects, draft contracts, and ensure they are properly monitored throughout a program," says Bosaro. "Provided we can give guarantees to funding bodies that our projects are carefully managed, the scientists can concentrate on their work, knowing that their funding is secured and that they will get assistance with administrative procedures." In addition, the pool of European Project Engineers (IPE)[6] has recently been enlarged to offer more specific and personalized support for applicants in charge of collaborative projects, which are the most complex. Their watchword? The success of French researchers in H2020. II

*"European projects offer great networking potential and provide significant international visibility."*



◥ Shanghai is one of four Chinese cities studied by the UrbaChina program, dedicated to sustainable urbanization in China.

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» **http://ec.europa.eu**

» **www.urbachina.eu**

## Canada

# Securing a Bright Research Future



CNRS President Alain Fuchs and Bernie Boucher, Chair of the Board of Directors of ArcticNet, signing the letter of agreement on November 3, 2014.

On the occasion of France's official state visit to Canada last November, CNRS President Alain Fuchs further strengthened ties between the organization and its transatlantic partner, which already share three International Joint Units (UMI) in Quebec. Five new agreements were signed, including a letter of intent to set up a theme-based network between CNRS and Quebec researchers from several institutions[1], in the field of controlled multifunctional materials. The projects borne out of this agreement will help secure the creation of a joint laboratory housed in the future Advanced Materials Institute on the Outremont campus in Montreal (Canada). Another milestone was the signing of a letter of agreement between the CNRS and Canada's network of universities and laboratories dedicated to Arctic research, ArcticNet. This will bolster the French Arctic Initiative,[2] spearheaded by the CNRS.

1. Université de Montréal, Ecole Polytechnique de Montréal, Institut National de Recherche Scientifique. 2. www.chantier-arctique.fr

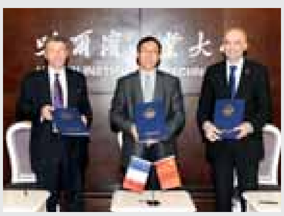
# *In brief...*

**POLAND / RUSSIA**

On October 14, 2014, the CNRS welcomed Russian and Polish delegations at its Paris headquarters for the launch of the International Associated Laboratory (LIA) TERAMIR, which will focus on the study of collective phenomena in semiconductor nanostructures appearing in the Terahertz and Mid-IR ranges of the electromagnetic spectrum. This LIA, which brings together three French laboratories[1] and three foreign institutes,[2] will help facilitate exchanges in this highly-promising field. Potential applications include new semiconductors built with nanostructures that have graphene-like transport properties.

**CHINA**

On November 12, 2014 in Harbin (China), the French laboratory CREATIS[3] signed the creation of the International Associated Laboratory (LIA) Metislab[4] with China's Harbin Institute of Technology (HIT) and the Harbin Medical University (HBU). The collaboration will focus on three themes: image and signal (theory), high-performance computing platforms in biomedical imaging, and new imaging modalities in medicine. The INSA Lyon and HIT now also offer an international double degree program.





Left to right: Antoine Mynard (CNRS Office China), Zhou Yu (HIT president), and Eric Maurincomme (INSA Lyon Director).

**US**

In October 2014, CNRS President Alain Fuchs and Gene Block, chancellor of UCLA,[5] inaugurated a new International Joint Unit (UMI) called EpiDaPo.[6] It will be housed at the UCLA Institute for Society and Genetics, to carry out research on epigenetics and its social and political implications. This UMI will facilitate high-level international synergies among researchers in the life, social and environmental sciences, on issues with far-reaching social impact, such as diet, age and gender.

**JAPAN**

Last October, the French multinational Saint-Gobain, the CNRS, and the NIMS[7] launched the Laboratory for Innovative Key Materials and Structures (LINK) in the presence of the French ambassador to Japan, Thierry Dana. The aim of this new International Joint Unit (UMI) will be to develop materials that could be used by Saint-Gobain for its industrial activities, such as ceramics, grains, powders, crystals, glazing and abrasives. LINK will be housed at the Tsukuba-based NIMS, one of the world's leading materials research laboratories.

1. Laboratoire Charles Coulomb (CNRS / Université Montpellier-II), Laboratoire matériaux et phénomènes quantiques (CNRS / Université Paris Diderot), Laboratoire national des champs magnétiques intenses (CNRS / UJF / UPS / INSA). 2. Poland's Institute of High Pressure Physics, and Russia's Institute for Physics of Microstructures (Novgorod) and Rzhanov Institute of Semiconductor Physics (Novosibirsk). 3. Centre de Recherche en Acquisition et Traitement de l'Image pour la Santé (CNRS / Inserm / Université Claude Bernard Lyon-I / INSA Lyon). 4. Medical Engineering and Theory in Image and Signal Laboratory. 5. University of California, Los Angeles (US). 6. Epigenetics, Data & Politics. 7. National Institute for Materials Science (Japan).

**BY** MATTHIEU RAVAUD

# *Scanning a Temple*

*In 2013, researchers from the MAP*[1] *laboratory were able to render a 3D model of the Tholos of Delphi, a one-of-its-kind Greek temple at the base of Mount Parnassus. Using a portable scanner, they made eleven successive scans of the monument, which dates back to 380-370 BC. Able to perform 360º rotations of five minutes each, this scanner emits a laser beam and detects its reflection against surrounding objects to create a point cloud. In this case, the eleven point clouds were then assembled into a single 3D space using post-processing software, subsequently rendering an image of the Tholos with a precision of the order of 2 millimeters. MAP researchers are not new to 3D models of historical monuments as they have already tackled, among others, the Arc of Triomphe in France and the theaters of Pompeii in Italy. 3D scanning of monuments is useful for archiving, cataloguing, and disseminating information to cultural institutions, which can then use it in their research.*

1. Modèles et simulations pour l'architecture et le patrimoine (CNRS / MCC) in partnership with the French School at Athens which will soon publish the 3D sculpted decoration of the Tholos, under the direction of Philippe Jockey from the Centre Camille Jullian (CNRS / Aix-Marseille Université / Ministère de la Culture).

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A photo gallery is available online: **www.cnrs.fr/cnrsmagazine**

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