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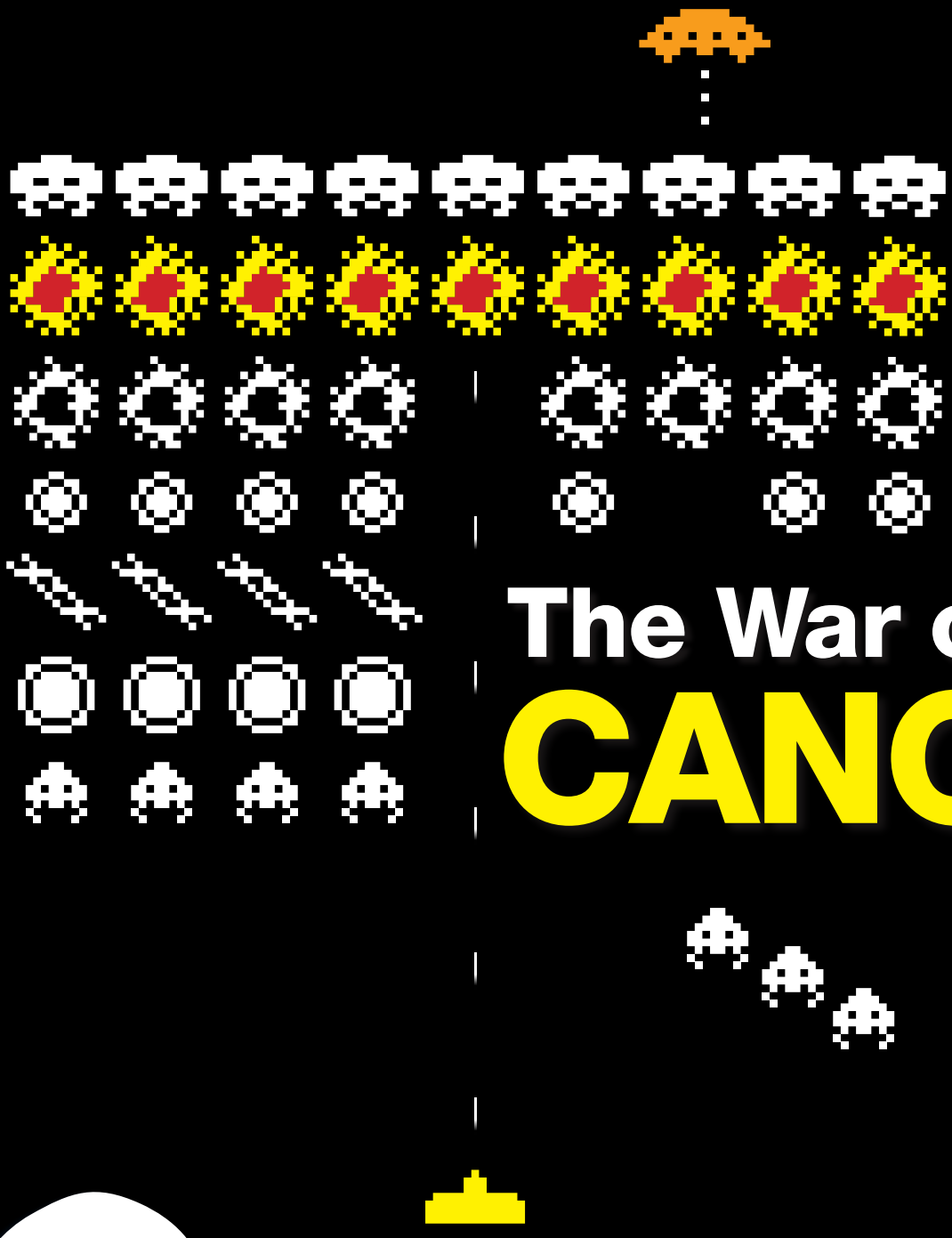

The War on CANCER

INTERVIEW

Michel Spiro
New president of the CERN Council

cnrs
advancing the frontiers

LANDSCAPE ARCHAEOLOGY
EGYPT AND THE MEDITERRANEAN WORLD

International Colloquium on Geoarchaeology
Cairo (Egypt), 19th-21st September 2010

The international colloquium "Landscape Archaeology" will be dedicated to Egypt, but will also provide a general overview of the entire Mediterranean basin.
Within the framework of human-environment relations, the conference's primary objective is to throw light on the evolution of the River Nile, a major component of the Egyptian landscape, and its impact on the peripheral spaces. The conference aims to enlarge the scope to the entire Mediterranean basin by welcoming additional case studies that will complement the Egyptian findings.

The topics addressed will relate to all aspects of landscape archaeology:

> River and coastal landscapes
> Desert landscapes
> Archaeology and climatic changes
> Archaeology and natural hazards
> Historical sources and landscapes

Information, registration and submissions:

www.ifao.egnet.net/geoarcheologie2010

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SCTE 2010

17th INTERNATIONAL CONFERENCE ON
SOLID COMPOUNDS OF
TRANSITION ELEMENTS

PROGRAM

- **Physical and chemical properties of solid compounds of transition elements**
  - Crystal structure
  - Phase diagrams
  - Magnetic and transport properties
  - Electronic structure
- **New materials**
  - Synthesis and characterization of new materials
  - New magnetic functional materials and thermoelectrics
  - Hydrids
- **Applications**

http://scte2010.grenoble.cnrs.fr

SEPTEMBER 5-10, 2010
ANNECY, France

Deadline for registration
June 1, 2010

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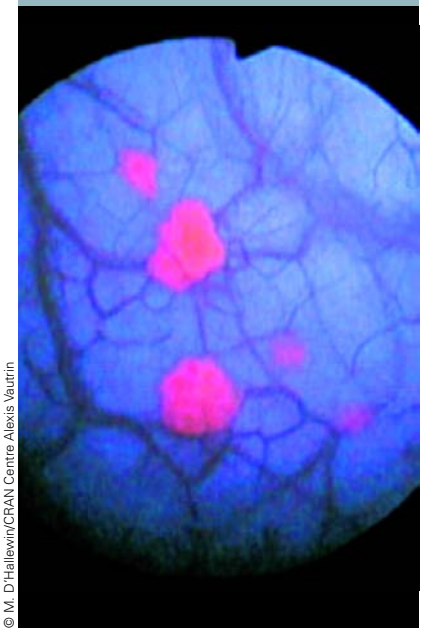

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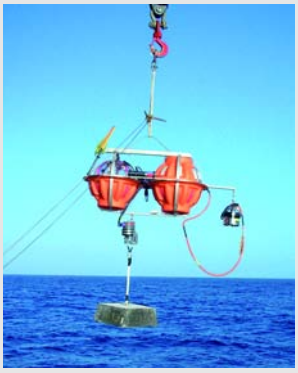

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Launch of a deep-sea Hippocampe OBS (Ocean Bottom Seismometer).

MISSION IN HAITI

After the devastating earthquake that hit Haiti on January 12th, several French laboratories, some linked to CNRS, have set up the Haiti-OBS oceanographic campaign to record the ongoing aftershocks. Some 21 seismometers were fixed on the seabed, and the seaward extension of the fault responsible for the earthquake will be accurately mapped.
This mission was launched in response to the specially commissioned report made by the intervention unit of CNRS's National Institute of Earth Sciences and Astronomy. Carried out on board Ifremer's oceanographic vessel–the Atalante–the mission should help evaluate risks in the region and improve our overall understanding of the mechanisms that cause earthquakes.

→ **APPOINTMENT**

A New President for CNRS

On January 20th, 2010, chemist **Alain Fuchs** was appointed President of CNRS by the French Council of Ministers. A professor at Pierre and Marie Curie University and former CNRS senior researcher, he had been director of the National Graduate School of Chemistry of Paris (ENSCP) since January 1st, 2006. Founder of Orsay's Laboratory of physical chemistry (LCP), which he directed until 2006, Dr. Fuchs has focused his research on the modeling and molecular simulation of confined fluids. He was president of the National Committee for Scientific Research's Section 13 (Physical Chemistry: Molecules, Environments) from 2004 to 2007, and of the physical chemistry division of the French Chemical Society (SFC) and the French Physical Society (SFP) from 2002 to 2005. A knight of the Order of Academic Palms, he is also a member of the board of directors of the International Adsorption Society, and fellow of the Royal Society of Chemistry. Dr. Fuchs, 57, takes over from Catherine Bréchignac, who has been appointed Ambassador for Science, Technology and Innovation. In accordance with the organization's new decree, the new CNRS president will also take on the role of director general of the organization, a position held until now by Arnold Migus.

AWARDSAWARDSAWARDSAWARDS

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Earlier this year, three major distinctions were awarded to French researchers. **Alain Aspect,** CNRS senior researcher and winner of the 2005 CNRS Gold Medal, shares the 2010 **Wolf Prize in Physics**[1]–one of the world's most prestigious prizes–with two other scientists, John F. Clauser (US) and Anton Zeilinger (Austria), for their work in quantum physics. The prize will be formally awarded by Israeli President Shimon Peres during a ceremony at the Knesset on May 13th, 2010.

© B. Derrida

Bernard Derrida, also a physicist, and a professor at UPMC,[2] was the 2010 recipient of the **Boltzmann Medal.** Awarded every three years, this medal represents the highest distinction in statistical physics. Derrida will receive the prize in Australia this July.

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Finally, CNRS Senior Researcher **Isabelle Rico-Lattès** received the 9th **Chéreau-Lavet engineer-inventor prize.** A 2006 CNRS Silver Medalist, she is rewarded for her major contribution to a new generation of therapeutic formulations with applications in cosmetics and ophthalmology, among others.

1. http://www2.cnrs.fr/en/1695.htm
2. Laboratoire de physique statistique de l'ENS (CNRS / Universités Paris-VI and VII / ENS Paris).

New European Commissioner for Research

© European Union

The Irish Máire Geoghegan-Quinn, 59, has been named new European Commissioner for Research and Innovation. After serving her country in several ministerial posts, notably as Minister for European Affairs, for Education, and for Justice, she had held a position at the European Court of Auditors since 2000. She succeeds Janez Potocnik, who has taken up the environment portfolio.

CNRS Well-Funded by ERC

Thirteen CNRS staff members were selected for the "2009 Advanced Grants" of the European Research Council (ERC). They are among the 236 top-class European scientists whose projects will be financed by the ERC. These grants wish to encourage bold new projects and interdisciplinarity among experienced researchers.

> **http://erc.europa.eu**

editorial

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Alain Fuchs
CNRS President

CNRS's Global Agenda

As the new president of CNRS, I am deeply honored to be leading a world-renowned research organization uniting no fewer than 33,000 collaborators, and which has counted 16 Nobel Laureates and 9 Fields Medal winners in its 70-year history. In the course of my career as a chemist, I have worked in many different countries, and I can assert that CNRS has a strong international reputation for scientific work of the highest quality. I hope to consolidate this reputation during my term of office.

Today I find myself at the head of a newly restructured organization. The reform effort has resulted in the creation of 10 thematic national institutes covering every field of research including humanities and social sciences, biology, engineering, physics, particle physics, mathematics, chemistry, earth sciences and astronomy, and ecology and the environment. This diversity enriches CNRS, making it a unique and powerful entity in a highly competitive global context.

We must now commit wholeheartedly to the expansion and development of our partnership with France's universities. We are going to help them organize and unite in order to create–as rapidly as possible–six or seven large-scale, high-profile universities, with a new momentum that will put them on par with their foreign competitors. We can–and we must–help these institutions, because international collaborative research is one of the things we do best.

In its seven decades of existence, CNRS has indeed pursued a very successful international policy. Its strength in creating research networks and its capacity to develop tools for effective collaboration are often held up as an example.

I would like to illustrate this with specific initiatives that bear witness to our prowess in international cooperation. In January, we joined forces with the French chemical company Rhodia and the University of Pennsylvania (US) to set up an International Joint Unit (UMI) called COMPASS (Complex Assemblies of Soft Matter). In India, in March, we founded an International Associated Laboratory (LIA) on nuclear physics, in association with the French Atomic Energy Commission (CEA) and India's Bhabha Atomic Research Center. That same month, an LIA for fluid physics and mechanics was created in Argentina, at the school of engineering of the University of Buenos Aires. And these are just a few recent examples among the numerous structured collaborations in which CNRS is involved around the world.

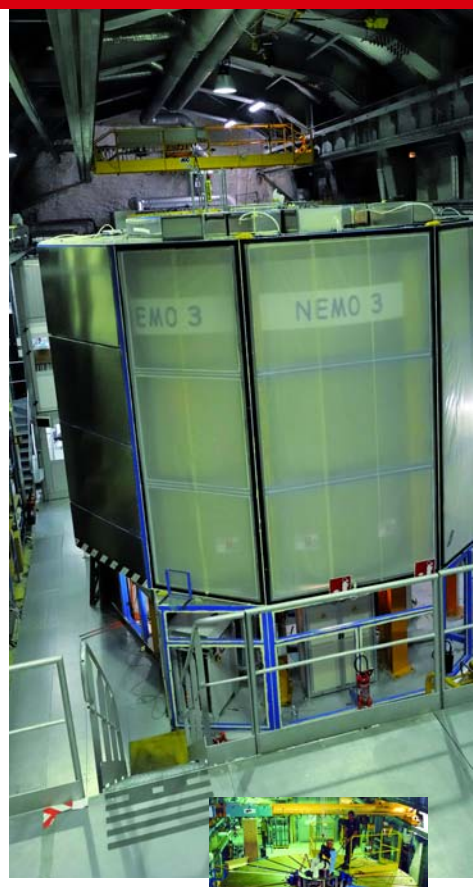
CNRS now has scientific agreements in place with 93 countries. Backed by its nine offices abroad, it conducts 304 International Programs for Scientific Cooperation (PICS), has formed 87 European and International Research Networks (GDRE/GDRI), and supervises 20 International Joint Units (UMI) in addition to 27 joint units in the humanities and social sciences. Our researchers take part in 52,000 research trips abroad every year. With these projects, many of which are at the initiative of researchers themselves, a global network of scientific collaborations is emerging in which CNRS plays a key structuring role. This network is especially powerful in Europe, largely thanks to our long-standing commitment to an active policy of intra-European cooperation. Today CNRS is Europe's leading scientific body in terms of collaborative projects backed by the European Commission, and is host to the largest number of European Research Council (ERC) grant winners.

Our network also operates effectively in the rest of the world, where for the past several years CNRS has been implementing a policy based on three objectives. First of all, we are consolidating our already strong relationships with industrialized nations like the US, Japan, Russia, South Korea, and Taiwan. Secondly, we are striving to gain a strong position in countries with high scientific potential, including China, India, Argentina, and Brazil. And lastly, we are developing targeted projects with several countries in specific fields–examples include biodiversity with Madagascar and Western Africa, mathematics and chemistry with Northern Africa, or transfer technologies with Southeast Asia.

I am very proud to be guiding this mission forward, and representing CNRS around the world. I intend to fulfill this responsibility with energy and determination.

PHYSICS

Catching Particles Underground



NEMO 3 is made up of 8000 particle detectors distributed in 20 segments and protected by a shielding made of iron and water.

From neutrinos to dark matter, the Modane underground laboratory (LSM)[1] is dedicated to exploring the properties of the infinitely small. It is currently the deepest European underground laboratory.

The Modane underground laboratory is accessed through fire refuge N° 6, located right in the middle of the Fréjus tunnel.

Put on this reflective vest. When I tell you, cross quickly. Don't run, but don't dawdle either!" It's safety first at the LSM. And with good reason: to get to the lab, you have to cross a road right in the middle of the Fréjus tunnel, dodging the traffic that roars through this 13 kilometer-long tunnel that links France to Italy. "On days of heavy traffic, we sometimes have to wait a while before we can get into the lab," says Fabrice Piquemal, the lab's director and also a researcher at the Center for Nuclear Studies at Bordeaux Gradignan (CENBG).[2] What we have to reach is a heavy fire door on the other side of the road, sporting the number six. "The laboratory is located behind the tunnel's sixth fire refuge," explains Piquemal, shouting to make himself heard above the traffic.

After walking through the fire refuge and then across a type of antechamber, we finally make it to the underground lab: a huge cave that was blasted out of the mountain with explosives. It lies under 1800 meters of rock, and it is stiflingly hot. Fortunately, the experiments are remotely controlled, and the offices are located down in the valley below, in a newly inaugurated building.

So just what kind of research needs to be buried this deep below the ground? "There are rumors that we're actually carrying out secret projects," Piquemal smiles. "But the truth is that we're buried down here to observe the universe." Or at least some of its most fundamental constituents.

The new LSM building in Modane includes an exhibition area open to the general public.

© Photos : B. Rajau/CNRS Photothèque

DEEP RESEARCH

The lab hosts a number of international particle physics experiments. Researchers have come here to study the highly elusive neutrinos to determine some of their physical properties, and above all their mass. They would especially like to find out whether neutrinos are their own antiparticles,[3] as was suggested by Ettore Majorana, a brilliant Italian physicist who mysteriously disappeared in the late 1930s.

They are also hunting down WIMPs,[4] massive particles predicted by some theories to be the constituents of dark matter, a type of invisible matter that could make up as much as one quarter of the universe. To have any chance of detecting these tiny objects, it is important to have as little interference as possible, which means hiding from the cosmic rays that constantly bombard our planet. "Of the eight to ten million cosmic particles per square meter that reach the Earth's surface every day, only four per square meter per day get through to our laboratory," Piquemal explains. So the most sensitive instruments are set up in the cave, where they run no risk of interference.

There is one instrument that stands out from the rest. Five meters high and four meters in diameter,

NEMO 3[5] is definitely a monster. It is encased in 200 tons of lead, water, and wood. Inside, measuring instruments wait for nuclei of molybdenum-100 to emit two electrons with a very precise energy. "These two electrons would be the sign of one of the rarest phenomena in the universe: a type of radioactivity called 'neutrinoless double beta decay,'" Piquemal explains. Observing this process would be experimental proof that the neutrino is actually its own antiparticle. Furthermore, this radioactivity's half-life, which largely exceeds the age of the universe (13.7 billion years), could give us information about the mass of the neutrino. But researchers obviously can't wait that long.

"To reduce the time required, you need a large number of nuclei, and the LSM has 7 kilos of 99.9% enriched molybdenum-100—which is only 10% enriched in nature," Piquemal explains.

In the detector, there are also other radioactive double beta sources—which are very rare—such as selenium-82, tellurium-130, etc. "We have eight grams of calcium-48," he says. "That's half the world supply!" Final results from NEMO 3 should be known later this year.

DARK MATTER PARTICLES

Behind this imposing machine hides another called EDELWEISS-II,[6] a dark matter particle detector which consists of around 30 germanium bolometers.[7] Much smaller than NEMO 3, it is located in a room that sits above an impressive refrigeration system. For if it is to have any chance of catching WIMPs, this detector has to be cooled down to -273.13°C, almost absolute zero. What researchers are looking for is a tiny rise in temperature produced by the collision between a WIMP and the germanium. Results are expected in a few months.

Germanium detectors are in fact one of the LSM's specialities. Pia Loaiza, the lab's physicist, is in charge of their development, in partnership with the firm Canberra, CENBG, and the Environmental and Climate Sciences Laboratory (LSCE).[8] "We are developing low-background gamma-spectrometers, which let us measure very low levels of radioactivity," she explains.

Such measurements are needed in many other fields besides fundamental physics. Indeed, the LSM has extended its activities and now hires out its services for sanitary control and environmental or nuclear research. "We host several spectrometers that belong to the environmental assessment and monitoring department (DASE)[9] of the French Atomic Energy Agency (CEA), but also to the LSCE, and to the National Institute for Radiological Protection and Nuclear Safety (IRSN),[10]" Piquemal says. The lab even provides assessments for France's General Directorate for Fair Trading, Consumer Affairs and Fraud Control (DGCCRF). For example, CENBG member and former LSM director Philippe Hubert invented a technique—based on caesium-137 measurement—that lets users determine the vintage date of a wine without opening the bottle.

NEMO 3, EDELWEISS-II, the spectrometers, and the host of other devices kept deep beneath this mountain obviously need regular maintenance. Since the scientific teams that use them are widely scattered throughout France and the rest of the world, five LSM technicians help set up the machines and maintain them. "Experiments run 24 hours a day," explains one of them, Jean-Lou Margueron. "We have rotating shifts where we're on call, ensuring that the instruments are monitored 24 hours a day, 7 days a week. They can be accessed very rapidly should anything occur."

Michel Zampaolo, LMS's technical and administrative director, makes a point of underlining the high expertise of these technicians, most of whom received on the job training on the scientific instruments.

Such skills will no doubt also come in very useful in the future when the experiments are gradually dismantled. This underground chamber will in fact eventually be emptied and replaced by an extension to the laboratory, which will be reached through the safety gallery running parallel to the tunnel, now under construction. Dubbed ULISSE, it will be ten to twenty times larger than the existing cavity, and will be able to host new experiments like SuperNEMO, NEMO 3's successor. "The decision to carry out the extension will be taken before the end of 2011, when the two tunneling machines boring the safety gallery meet up," Piquemal says. "So the new laboratory could be operational by 2013."

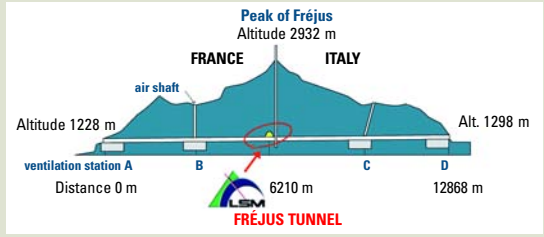
Fabrice Demarthon

1. Laboratoire souterrain de Modane (CNRS / CEA).
2. Centre d'études nucléaires de Bordeaux Gradignan (CNRS / Université Bordeaux-I).
3. Antiparticles make up antimatter, the opposite of ordinary matter.
4. Weakly interacting massive particles.
5. The NEMO experiment is a collaboration involving ten countries.
6. The EDELWEISS experiment is a collaboration between France, Germany, Russia, and the UK.
7. A bolometer detects and measures radiation by the heat that the radiation causes. The bolometers used in EDELWEISS also measure the electrical charge created by the interaction of the particles inside the detector.
8. Laboratoire des sciences du climat et de l'environnement (CNRS / CEA / Université Versailles-Saint-Quentin-en-Yvelines).
9. Département analyse, surveillance, environnement.
10. Institut de radioprotection et de sûreté nucléaire.

HISTORY OF THE LABORATORY

The idea of building a laboratory beneath the Alps was born in the late 1970s, when plans were made to create a tunnel linking Modane (France) to Bardonecchia (Italy). At the time, a group of French and German physicists were trying to find a way of shielding their research from cosmic radiation to determine certain properties of protons. After two years of construction, the laboratory was opened in 1982. The first experiment housed in the facility was the "τ_p" experiment, which continued until 1988. It was followed by NEMO 1 and 2, and EDELWEISS-I. The permanent staff of the Modane underground laboratory has grown from three when it first opened to ten today.

F.D.



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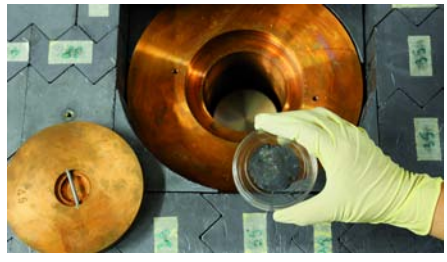
The LSM uses germanium gamma spectrometers to measure very weak levels of radioactivity.



The samples to be analyzed are placed on germanium detectors shielded with copper and lead. Researchers use very old Roman lead from the fifth century, which has lost its natural radioactivity.

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IN BRIEF

Obesity-linked Genes

An anomaly on chromosome 16 multiplies by 50 the risk of developing severe obesity. Achieved using DNA chip technology, this result was recently published in *Nature*[1] by CNRS researchers and their colleagues from 12 European teams. Though this defect is present in less than one person out of 1000, it is thought to explain close to 1% of common obesity cases. The anomaly is actually a microdeletion that results in the loss of 30 genes in that region of the chromosome, also known to be linked to the development of schizophrenia and autism, two diseases often associated with obesity. Although the precise genes involved have yet to be identified, researchers believe they are likely to be linked to brain development.

1. R.G. Walters et al., *Nature*, 2010. 463: 671-5.

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ECOLOGY

Nesting Farther North is Safer


© J.-L. Martin/CEFE/CNRS

Nest of a Black-bellied Plover at Arviat, in the Nunavut territory (Canada).

Migratory birds often fly hundreds–sometimes thousands–of kilometers as the seasons change. Birds that nest in the Arctic region are the leaders when it comes to long-distance flying, clocking more than 13,000 kilometers between their wintering areas in southern Africa, South America, and Oceania, and their breeding grounds up north.

Just why migratory birds risk the physical effort and severe weather conditions to go so far to breed has been the subject of several hypotheses. Now a group of Canadian and French researchers believes that reduced risk from predators is a likely factor.[1] "There are probably fewer predators as one moves north to the Arctic regions," explains Jean-Louis Martin, a researcher at the CEFE-CNRS[2] in Montpellier. He was one of the nine-member team conducting this research, which was supported by IPEV[3] and a number of ecology and wildlife research bodies across Canada.

The team measured predation risk at high latitudes by monitoring 1555 artificial nests, complete with quail eggs, in the Arctic regions of Canada. The studies found nest predation risk reduced by 3.6% with each one-degree increase in latitude over the region covered by the research. This represented a total decrease of 65% over the 3500 km-long latitudinal transect that spans these birds' arctic breeding grounds.

"Our interest in conducting this research was evolutionary biology, not conservation," Martin stresses. "We wanted to find out what, during their evolution, had prompted the birds to fly thousands of kilometers north to nest."

Among the risks associated with long-distance migration are the metabolic and energetic requirements of flight, high mortality, and exposure to extreme weather. These can mean the birds arrive at their breeding grounds in poor physical condition, which can affect reproductive success. If the birds were to nest farther south, they would reduce the physiological costs of the journey. However, this research suggests that the risks of the flight may be outweighed by a decreased risk of losing their eggs to predators.

Elaine Cobbe

1. L. McKinnon, et al., "Lower Predation Risk for Migratory Birds at High Latitudes," *Science*, 2010. 327: 326-7.
2. Centre d'écologie fonctionnelle et évolutive (CNRS / Universités Montpellier-I, -II, and -III / Ensa Montpellier / CIRAD / EPHE Paris).
3. Institut Paul Emile Victor.

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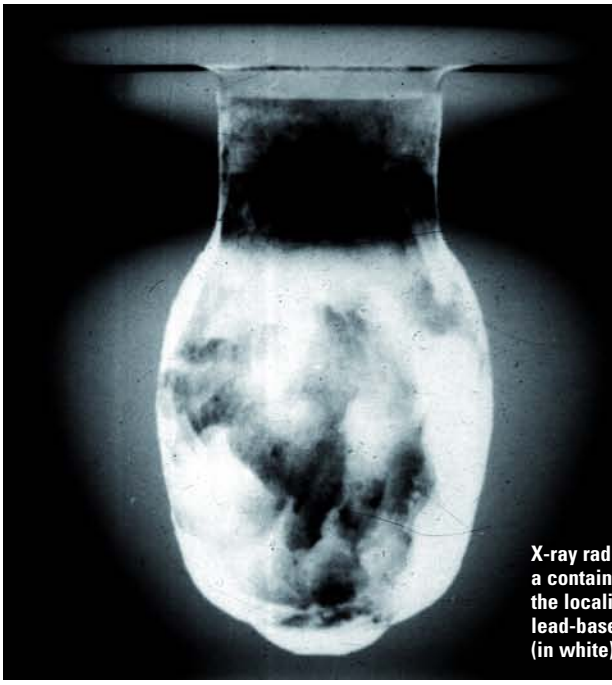

© T. Borel/C2RMF

X-ray radiography of a container showing the localization of lead-based makeup (in white).

CHEMISTRY

Egyptian Eyeliner Boosted Immune

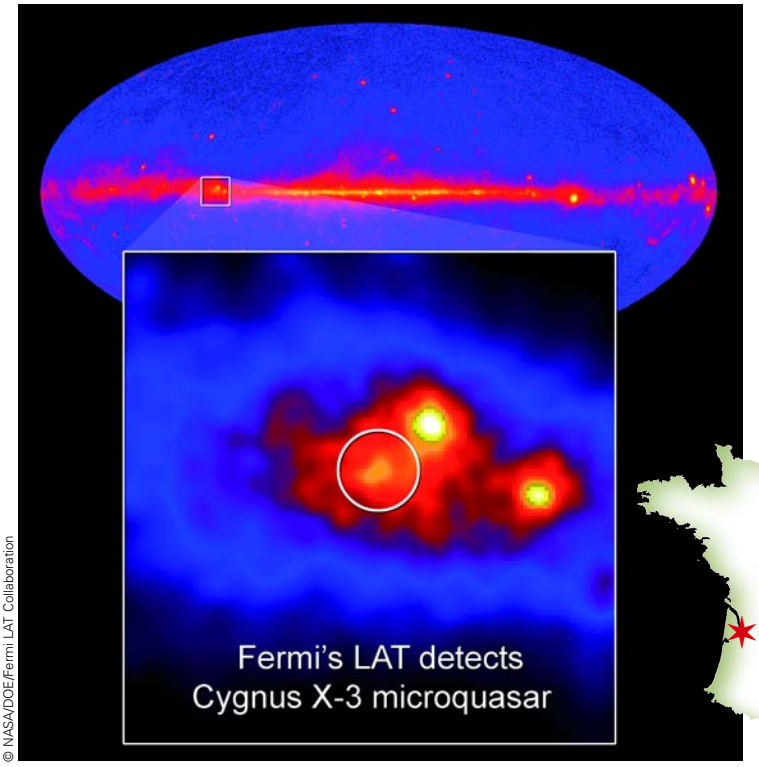
In Ancient Egypt–some 4000 years ago–people believed lead-based eye-black to have therapeutic properties. They were right, as shown by a new study[1] led by CNRS researcher Christian Amatore,[2] working with Philippe Walter from the C2RMF.[3]

That Egyptians were prolific physicians is no secret. They successfully used gold to bind loose teeth and perforated jaw bones to drain abscesses. "But that eye makeup based on lead salts–today considered toxic–had true medicinal properties came as a surprise," says Amatore. Previous research[4] had isolated two lead-based substances used in Egyptian eye-black specifically synthesized by chemists at the time: phosgenite ($Pb(OH)Cl$) and laurionite ($Pb_2Cl_2CO_3$). To investigate how these low concentrations of lead affected skin cells, Amatore's team deposited small quantities (up to 0.2 µM) of lead ions on a single skin cell. Using an ultramicroelectrode, they observed a 240% increase in the production of nitrogen monoxide molecules (NO), a known bactericide that triggers immune responses. Egyptian chemists must have deduced this effect empirically, launching what

ASTROPHYSICS

Fermi Finds Gamma Bonanza

Using the latest data available from the Fermi satellite, researchers are elucidating the mystery behind blazars and microquasars, and the gamma rays they send hurling through space.



© NASA/DOE/Fermi LAT Collaboration

In this Fermi LAT view of a region centered on the position of Cygnus X-3 (circled), the brighter colors indicate a greater number of detected gamma rays. The brightest sources are pulsars.

Blazars and microquasars are some of the most intriguing objects in the universe. Since its launch in June 2008, the Fermi satellite has monitored these high-energy gamma ray sources with unprecedented sensitivity.

A plasma jet emanating from the blazar galaxy 3C454.3, located 7 billion light years away, flared in December 2009 to briefly become the brightest gamma ray energy source in the sky, a title usually held by a neutron star in our own galaxy. It was detected by French researchers and their colleagues from abroad using the Fermi satellite and its Large Area Telescope (LAT). "Blazars are galaxies with active galactic nuclei (AGN)–supermassive black holes interacting with a disk of matter that has collected around it in space," explains Benoit Lott from CENBG,[1] part of the Fermi collaborative team.

"An AGN is a complicated system–it's like a giant machine. Black holes come in different sizes–this one is at the higher end of the spectrum, weighing up to 1 billion solar masses," Lott explains.

A subset of AGNs accrete matter in space, and expel it in jets. These jets accelerate plasma–to almost the speed of light–away from the black hole and, in the case of blazars, directly at us. Particles in the jet interact with surrounding radiation, emitting high-energy gamma rays of the sort detected by Fermi. The process through which all this happens is not well understood. "Our immediate aim is to understand the environment within the jet," says Lott.

Help might come in the form of a microquasar called Cygnus X-3, located 20,000 light years away in our galaxy. Microquasars act much like blazars, only scaled down from entire galaxies to single star systems. They are binary stars, with a very massive star orbited by a compact object–either a black hole or a neutron star. In the case of Cygnus X-3, the compact object orbits around the star in only 4.8 hours. "It's a baby compared to a blazar, but no less interesting," adds Corbel,[2] who, with Guillaume Dubus,[3] was part of the Fermi team that confirmed that the intriguing binary star is also a gamma ray source.[4]

Cygnus X-3 was first thought to be a gamma-ray source in the 1970s. As one of the first such objects, it generated much excitement, but proof had to wait for the Fermi LAT's sensitivity.

Like 3C454.3, Cygnus X-3 accretes matter and propels a jet at roughly half the speed of light. The gamma rays from Cygnus X-3 seem to have been caused by the interplay of ultraviolet radiation from the star and the disk of matter around the purported black hole.

Microquasars like this are like miniature blazar galaxies–closer, smaller, and with shorter lifespans. In addition to being fascinating in its own right, Cygnus X-3, now confirmed as a gamma-ray source, will make an excellent model for the behavior of supermassive black holes like 3C454.3.

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3. Laboratoire d'astrophysique de Grenoble (CNRS / Université Grenoble-I).
4. The Fermi LAT Collaboration, "Modulated High-Energy Gamma Ray Emission from the Microquasar Cygnus X-3," *Science*, 2009. 326: 1512-6.

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System

could have been the first large-scale chemical process in history.

Saman Musacchio

1. C. Amatore et al., "Finding Out Egyptian Gods' Secret Using Analytical Chemistry: Biomedical Properties of Egyptian Black Makeup Revealed by Amperometry at Single Cells," *Anal. Chem.*, 2010. 82: 457-60.
2. Processus d'activation sélective par transfert d'énergie uni-électronique ou radiatif" (CNRS / UPMC / ENS Paris).
3. Centre de recherche et de restauration des musées de France (CNRS / Ministère de la culture et de la communication).
4. P. Walter et al., "Making make-up in Ancient Egypt," *Nature*, 1999. 397: 483-4.

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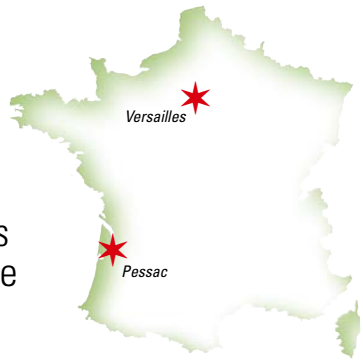
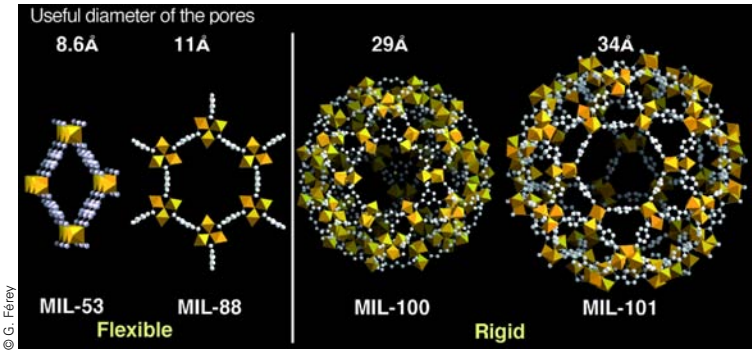
CHEMISTRY

Smarter Carriers



Great progress is being made in the synthesis of more sophisticated carriers to deliver substances in a controlled fashion. They could be used in medicine and a host of other fields.

In medicine, most of the carrier materials used today–liposomes or organic nanoparticles–have shown poor drug loading capabilities and rapid drug release. "When it comes to delivering fragile molecules, these carriers do not offer sufficient protection to let them travel inside the bloodstream. This translates in using large quantities of drugs," says Gérard Férey of the Institut Lavoisier,[1] whose team synthesized a new type of carrier that is both more effective and safer to use.[2]



© G. Férey

Crystal structures of the MOFs used in the study. The iron sites appear as octahedra and the organic ligands as white spheres.

A few years ago, Férey's team created hybrid porous solids, also called metal-organic frameworks (MOFs), which combine a hybrid structure (organic and inorganic units) and an important porosity. With such high porosity, MOFs have already garnered attention for their ability to entrap large amounts of gases such as carbon dioxide.

This time, the researchers synthesized MOF nanoparticles made of iron carboxylate, which is non-toxic, to test their use in drug delivery. "We tested molecules we know cannot be successfully entrapped using existing nanocarriers," says Férey, referring to anti-cancer and anti-HIV drugs busulfan, azidothymidine triphosphate (AZT-TP), cidofovir, and doxorubicin. "These molecules are either too insoluble or break down before reaching their target."

After injection into rats, the researchers followed the nanoMOFs' route using medical imaging. Results showed nanoMOFs can trap 40 to 60 times more drug than other carriers, and that drug-release is progressive. "This was pure luck," says Férey's colleague Patricia Horcajada, lead author of the study. Instead of witnessing the usual "burst effect"–a sudden release of the drug, often too rapid to be effective–the release lasted 3 to 12 days. "This could potentially increase drug efficiency and decrease toxicity phenomena," says Horcajada. The team is now working on creating MOFs with larger pores, to encapsulate higher amounts of medication.

In parallel, a team of researchers from the CNRS Paul Pascal Research Center in Bordeaux have invented "smart capsules" whose release is controlled by a change in temperature. Made from silica, these capsules are still unsuited to medical usage, but have great potential in other areas like food quality control, for example.

To create these capsules, the first step is to mix the molecules of interest with oil in a liquid state. "The agent to be delivered must be soluble in oil," says Véronique Schmitt, who co-authored the study.[3] The oil is chosen according to its melting temperature, which can range anywhere between 6°C and 65°C depending on the oil. The combination is then placed in water containing a silica precursor, at a cooler temperature than the oil's melting point. The droplets become solid, and the silica naturally polymerizes around their surfaces. When the product needs to be released, heating the capsules beyond the oil's melting point will trigger a 10% expansion of the oil's volume– enough to break the capsules' shells.

Several applications are already being investigated. For instance, smart capsules could be used to control the food industry's cold chain. "In food wrapping material for instance, added capsules that break at temperatures above 6-7°C and release some kind of staining material could make it easy to ensure that the cold chain wasn't broken," says Schmitt.

Clémentine Wallace

1. CNRS / Université de Versailles.
2. P. Horcajada et al., "Porous metal-organic-framework nanoscale carriers as a potential platform for drug delivery and imaging," *Nat. Mater.*, 2010. 9: 172-8.
3. M. Destribats et al., "Thermostimulable Wax@SiO2 Core-Shell Particles," *Langmuir*, 2010. 26: 1734-42.

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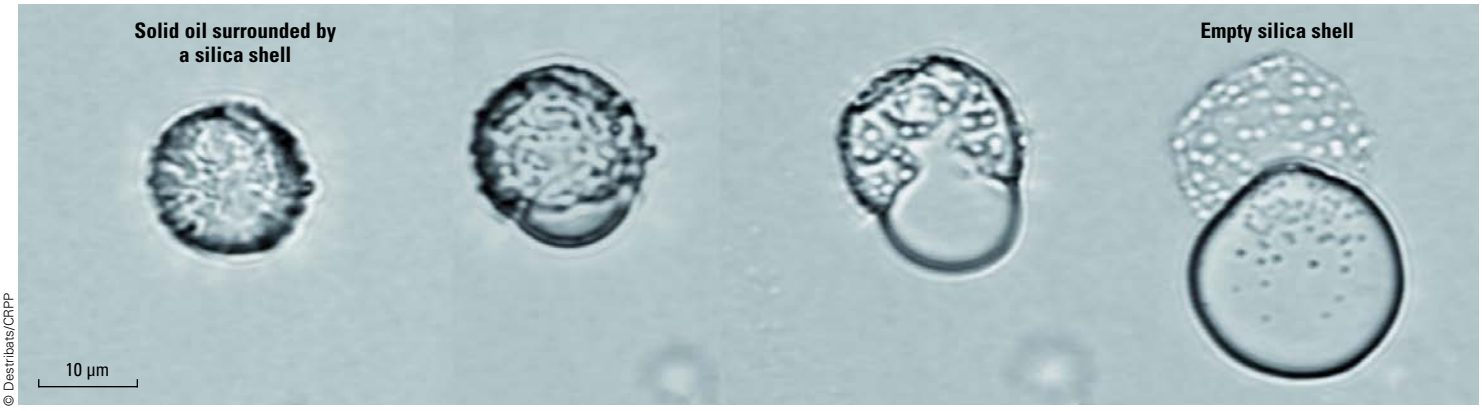

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From left to right: When the encapsulated oil is heated above the oil's melting point, it expands, breaks the silica shell and is released.

© ESO

Artist's rendering of a black hole giving birth to a galaxy.

ASTROPHYSICS

Witnessing the Birth of a Galaxy

Are galaxies devoured by the supermassive black hole (SMBH) at their core? Or conversely, do SMBHs actually give birth to their host galaxies? Although the first hypothesis is now commonly accepted, a team led by David Elbaz[1] reveals that star formation might actually be induced by SMBHs.[2]

It all started with the discovery, in 2001, of a peculiar object located 5 billion light years away: the quasar HE0450-2958. A quasar is a galaxy associated with a very bright SMBH, whose high luminosity is attributed to the continuous and massive accretion of matter. Surprisingly, when HE0450-2958 was first observed, no galaxy was found in its vicinity, which earned it the name of "naked" quasar. Various scenarios were imagined to explain this lone SMBH, including that it could have been ejected from its host galaxy.

The team led by Elbaz, an expert in stardust, used the data obtained with the infrared camera VISIR, at the Very Large Telescope (VLT) hosted by ESO,[3] to search for the companion galaxy of HE0450-2958, which they believed to be hidden in a gigantic cloud of dust. Though they failed in their search, they managed to make new observations in the area surrounding the naked quasar.

First, they detected a galaxy in its vicinity, made of young stars and showing an impressive rate of star production. Furthermore, using both infrared and radio wave detection, they observed a bridge of matter linking the naked quasar to the young galaxy.

"The proximity of two rare events, like a high production rate of stars and a naked quasar, suggests the two may be linked in some way," explains Elbaz. "The fact that the stars form at the same time as the galaxy is hit by the jets of matter from the quasar strongly suggests that star formation is induced by the quasar." This is further supported by evidence of shocks in the galaxy's optical spectrum. The speed and direction at which both objects are moving strongly suggest they will eventually merge, generating a classical quasar, with its SMBH and companion galaxy.

These results shed new light on our understanding of galaxy formation and evolution. "A classical quasar might actually be an intermediate stage between the birth of a galaxy, triggered by a naked quasar, and its final stage, when its central black hole is less active, and therefore less bright," explains Elbaz. Confirmation of this theory will have to wait for other similar observations. "We expect a lot from the development of high-resolution mid-infrared imaging in the near future, which should help in the search for other naked quasars associated to star formation activity," concludes Elbaz.

Isabelle Tratner

1. Astrophysique interactions multi-échelles (CEA / CNRS / Université Paris-VII).
2. D. Elbaz et al., "Quasar induced galaxy formation: a new paradigm?" *Astronomy and Astrophysics*, 2009. 507: 1359-74.
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EARTH SCIENCES

Our Alien Oceans

It has long been assumed that the Earth's water was created by vapor emitted by the huge volcanic activity that took place soon after our planet's formation.

But Francis Albarède, from the Earth Sciences Laboratory[1] in Lyon, is backing an alternative theory. For him, "the proportion of volcanic water in our known water is low," meaning that the bulk of the Earth's initial water had to come from elsewhere. "I am convinced," he says, "that it was brought by a small number of asteroids from the outer Solar System," during a late stage of planetary accretion–the violent process in which asteroids and protoplanets collided and fused to form the planets.

In a recent publication in *Nature*,[2] Albarède emphasizes that for millions of years after the planets were initially formed, any area between the Sun and Jupiter was simply too hot for water to condense. This is confirmed by the low concentration of water in the rocks that form the Earth's mantle, estimated at 0.02%. Temperatures in the outer solar system beyond Jupiter, however, were cool enough for water to condense as ice on "planet-like objects, such as asteroids and protoplanets." So when, approximately 50 million years after the Solar System was formed, Jupiter's strong gravity began to mop up the outer Solar System, some of this ice-rich debris was sent hurtling towards Earth. Albarède believes it could have been a single–albeit large–asteroid.

Based on the isotope composition of lead and xenon in the Earth and in meteorites, he dates this event to approximately 100 million years after the initial birth of the Solar System. Upon impact on the now-cooler Earth, the asteroid-borne water not only condensed, but formed deposits that penetrated the mantle, making it "softer and more fragile," says Albarède. This softening triggered the onset of plate tectonics which eventually led to the origin of life. "Without an asteroid, there could have been no ocean," he says, "therefore no tectonic plates, no submarine hydrothermal springs, and definitely no chance for life to appear."

Tom Ridgway

1. Laboratoire des sciences de la Terre (CNRS / ENS Lyon / Université Claude Bernard).
2. F. Albarède, "Volatile Accretion History of the Terrestrial Planets and Dynamic Implications," *Nature*, 2009. 461: 1227-33.

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PARASITOLOGY

A Mutation that Helps Resist Malaria

Among the 3.3 billion inhabitants of malaria-prone areas, a specific common genetic mutation affects a key enzyme in red blood cell metabolism, the glucose-6-phosphate dehydrogenase (G6PD), and leads to disorders such as jaundice and anemia.

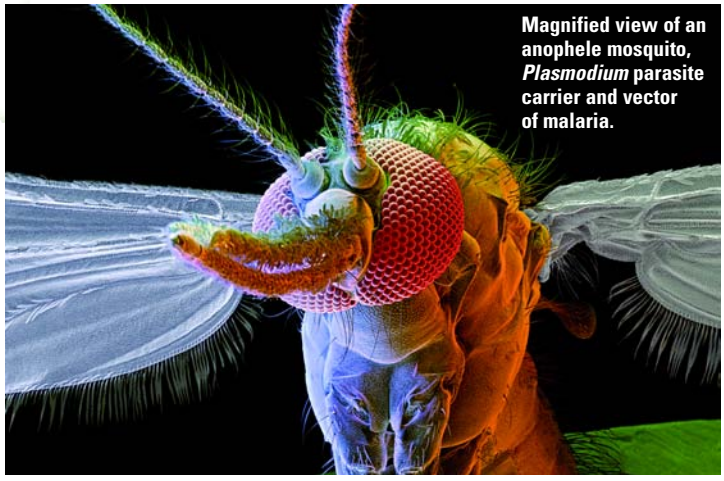
A team of French and Thai researchers has demonstrated that a Southeast Asian mutation of the G6PD also provides a significant advantage in fighting the potentially deadly disease caused by the mosquito-borne *Plasmodium* parasite.[1]

Focusing on the Thai district of Suan Phung, the team observed that 24% of a population sample, mainly from the Karen ethnic group, carried a genetic variant of the G6PD gene called "Mahidol." Such a high percentage of the Mahidol variant in the Karen population indicates this mutation has been positively selected. What's more, further tests revealed that this positive selection occurred in the last 1500 years. A significant time frame, since it was also 1500 years ago that the Karen, migrating from Tibet to Southeast Asia, brought rice farming to the region–the very activity responsible for spreading malaria as it increases human exposure to mosquitoes.

Former studies on G6PD and malaria focused on the lethal *P. falciparum* malaria, but widening their scope, the team also examined the effect of the Mahidol variant on the more benign *P. vivax* malaria. They observed that the Mahidol variant significantly reduces *P. vivax*–but not *P. falciparum*–density in human carriers. Because the G6PD gene is carried on the X-chromosome, this decrease is sex-dependent, ranging from 30% in men or women carrying just one copy of the mutated gene, to 61% in females carrying two mutated genes. The lower parasitic charge in the blood directly increases the resistance against a disease affecting both life expectancy and fertility.

The team leaders of the study, Luis Quintana-Murci,[2] Anavaj Sakuntabhai,[3] and Richard Paul[4] note that this protection is likely related to the effects of G6PD deficiency on red blood cell physiology. In particular, increased oxidative stress leads to increased red blood cell breakdown, making carriers less enticing hosts for the parasite.

Fui Lee Luk


Magnified view of an anophele mosquito, *Plasmodium* parasite carrier and vector of malaria.

1. C. Louicharoen et al., "Positively Selected G6PD-Mahidol Mutation Reduces *Plasmodium vivax* Density in Southeast Asians," *Science*, 2009. 326: 1546-9.
2. Human Evolutionary Genetics Unit (CNRS / Institut Pasteur).
3. Institut Pasteur / Mahidol University.
4. Institut Pasteur.

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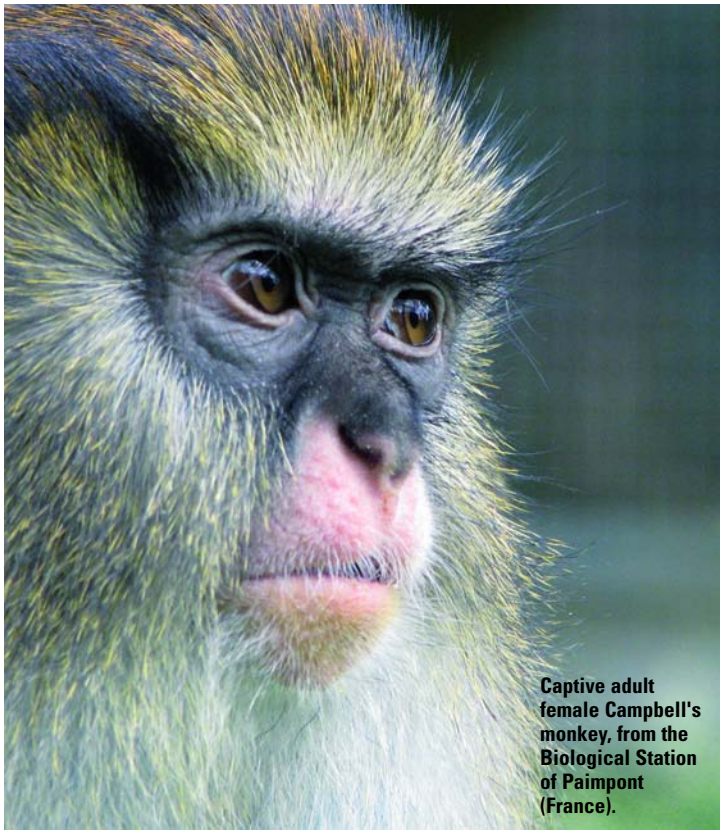
Captive adult female Campbell's monkey, from the Biological Station of Paimpont (France).

ETHOLOGY

Monkey Talk

Scientists have long believed that non-human primates could not "converse" with one another, using syntax in the same way that humans do.

New research, however, shows that a forest-dwelling species of monkeys, called Campbell's monkeys, are able to combine alert calls into long vocal sequences that allow them to convey messages to other monkeys. The results reveal the most complex example yet of "proto-syntax" discovered in a non-human species.[1]

The studies showed that the males of the species have a repertoire of six types of alert calls (Boom, Krak, Hok, Hok-oo, Krak-oo, Wak-oo). However, these are only rarely used in isolation. Most of the time, they are combined in long vocal sequences of an average of 25 successive calls.

Researchers at the Animal and Human Ethology laboratory[2] joined forces with the universities of St Andrews (Scotland) and Cocody-Abidjan (Ivory Coast) to carry out their two-year study in Ivory Coast.

The study concentrated on the males of the species. "Campbell's monkeys live in harem groups with just one adult male and several females, making it easy to distinguish each male caller," explains Alban Lemasson, who co-supervised the study. "We found out that males emitted sequences composed of 2 to 40 calls," he continues. "We wondered whether this was their way of overcoming anatomical limitations, using varying combinations of calls for different messages."

Although the actual number of distinct alert calls was limited to the six they identified, the monkeys were found to combine those calls

PHYSICS

Multiferroic Materials Could Boost Computer Power

Computers consume massive amounts of energy, much of it wasted in the form of heat. A team of French researchers[1] has developed a complex material that could revolutionize computing and make digital devices smaller and more energy efficient than previously imaginable.

The breakthrough came in multiferroic materials. Ferromagnetic materials only have magnetic properties, just as ferroelectric materials only have electric properties. As Alexandra Mougin (LPS)[1] explains, the multiferroic material she and her colleagues developed has the rare ability to exhibit both properties simultaneously at room temperature. "To obtain ferroelectric materials, you have a condition of symmetry in the crystals, in the way atoms are arranged to achieve polarity. Other conditions are required for magnetism, but most of the time magnetism and ferroelectricity exclude each other," she adds.

To overcome these constraints, chemists first grew a crystal of multiferroic material ($BiFeO_3$). The crystal was then coated with a ferromagnetic film; by manipulating the crystal state with an electric field, they were able to control the preferential orientation of the magnetization of the device.[2]

"This proves that there is interaction between the multiferroic crystal and the ferromagnetic layer, that a magnetoelectric coupling occurs inside the structure, and that the electric field can be used to tune the ferromagnet," says Mougin.

Such a material could revolutionize computers. In computers, the zero and one of a digital information "bit" are represented by the two magnetic polarities. A multiferroic material has the potential to double the bits stored within a single device by adding a new zero and one of electric polarities.

The next step will be to attempt to control all four of these potential polarities–electric and magnetic–in a computer, using an electric field (rather than a magnetic one, as in current devices). If the researchers are successful, computers could not only become more powerful, but also less energy intensive.

Mark Reynolds

1. Laboratoire de physique des solides (CNRS / Université Paris-Sud 11); Institut Néel (CNRS); Institut rayonnement-matière (CEA Iramis).
2. D. Lebeugle et al., "Electric field switching of the magnetic anisotropy of a ferromagnetic layer exchange coupled to the multiferroic compound $BiFeO_3$," *Phys. Rev. Lett.*, 2009. 103: 257601.

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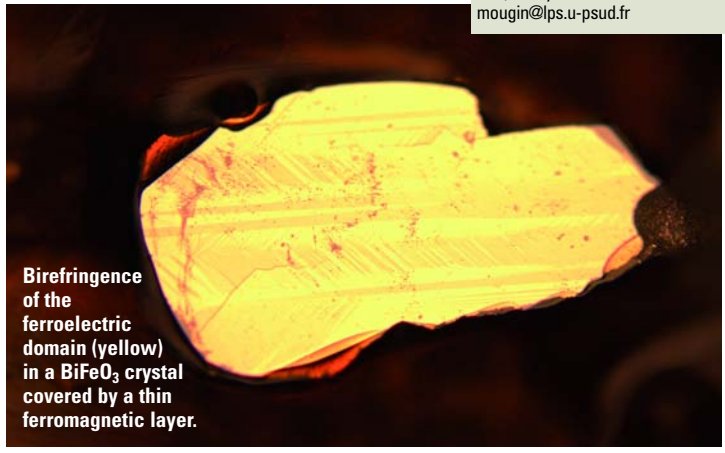

Birefringence of the ferroelectric domain (yellow) in a $BiFeO_3$ crystal covered by a thin ferromagnetic layer.

in different sequences under different circumstances.

Lemasson notes the monkeys were able to issue warnings about different predators with a different call sequence: a sighting of an eagle, for example, would result in a different vocal sequence than the one for a leopard. An alert to gather the group before moving to another area, on the other hand, would involve another sequence.

"We believe that non-human primates can only slightly modulate the sounds they make, and cannot articulate like humans, but the sounds they make are strongly genetically determined," explains Lemasson.

"However, if the composition of the sequence is linked to context, then we can draw a parallel with a primitive form of human syntax, because it involves a comparable principle of order," he continues. "Up to now, this field has been quite controversial. For example, birds or whales use a succession of notes, but strong evidence of semantic combinatorial rules is lacking. The basic rule of syntax requires that the order of different sounds determines meaning."

Lemasson believes the primitive similarities observed between non-human primate calls and our language could bring us closer to understanding the origins of human language.

Elaine Cobbe

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2. Ethologie animale et humaine (CNRS / Université Rennes-I).

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SCIENTIFIC FIRST

Viral Biofilms

Certain viruses are capable of forming complex biofilm-like assemblies, a property so far only attributed to bacteria. Researchers from CNRS and the Pasteur Institute observed for the first time these biofilm-like structures on the surface of cells infected with HTLV-1 (human T-cell leukemia virus type 1) retrovirus.[1] They are constituted of aggregates of viruses and extracellular matrix, a carbohydrate-rich structure secreted by the cell, whose synthesis is controlled by the virus.
HTLV-1 is a widespread virus causing various diseases, including leukemia, neuromyelopathies, and chronic inflammatory syndromes. Its dissemination was known to require infected cells and cell to cell contacts, but the transmission mechanism itself was still a mystery. The formation of a viral biofilm constitutes an effective protective and adhesive barrier which makes it easier for the virus to be transmitted than in its free, isolated state. By removing the viral biofilm from the surface of the infected cells, the researchers achieved an 80% reduction in infection rates, thus underlining the importance of this mechanism of transmission for HTLV-1.

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ENVIRONMENT

CO_2: Emission Vs Absorption

Controlling climate change can only be achieved through a drastic reduction of greenhouse gas emissions. Yet recent studies show that man-made emissions are accelerating worldwide, while carbon dioxide absorption by land and oceans might be decreasing.

Late 2009, an international group of experts from the "Global Carbon Project" published a study[1] revealing that worldwide man-made CO_2 emissions have accelerated by 30% in the past two decades.

The researchers, specialists in a number of fields, were able to construct a global CO_2 budget for each year from 1959 to 2008. They used known measurements to determine global increase in atmospheric CO_2, and the countries' energy statistics to assess emissions from fossil fuel combustion. CO_2 emission from land use was determined using deforestation and other land-use data.

According to the authors, man-made carbon emissions in 2008 equaled 1.3 tons per person per year. "This corresponds to the wort scenario that was anticipated by the Intergovernmental Panel on Climate Change in the late 1990s," says Nicolas Viovy, from LSCE,[2] who participated in the study.

Analyzing the underlying drivers of each component, the authors conclude that the majority of current emissions come from developing countries. While direct emissions from petrol consumption and deforestation have stabilized in OECD countries, fossil fuel consumption is increasing in emerging countries like China, where 50% of the rise in emissions between 2002 and 2005 can directly be attributed to the production of goods for these same OECD countries. "This shows we have just relocated emissions to other parts of the world," says Viovy.

On the other hand, a little more than one-half of man-made CO_2 emissions is currently absorbed by "natural carbon sinks"–the ocean and the terrestrial biosphere. Yet the researchers suggest that the amount of CO_2 these sinks reabsorb might be decreasing, because of climate change and saturation of the CO_2 fertilization effect on vegetation.[3] "The problem is that you can even end up with the opposite situation: sinks re-emitting their CO_2 into the atmosphere," warns Viovy.

© Carboeurope

Soil respiration measurements in a Hungarian grassland (part of the "CarboEurope" European project).

Current and past observations have been too sparse to accurately track changes in natural sinks' CO_2 uptake, and little is known on how they vary.

In this context, another international group of researchers has developed a method to quantify the oceans' carbon uptake. For their study recently published in *Science*,[4] the scientists began by mapping the amounts of CO_2 absorbed during the entire year of 2005 over the North Atlantic region.

To do so, they used oceanic CO_2 measurements taken on board a network of cargo vessels in transit between Europe and the US. Combining these results with other data–like satellite measurements of water temperature and chlorophyll concentrations–they were able to come up with precise estimates. "What is important is to evaluate where the carbon sinks and carbon sources are. These vary depending on the year, on the climate, on thermodynamics, on biological activity, etc.," says Nicolas Metzl, head of the French research group LOCEAN.[5] "Our model gave us an accurate map of these carbon sinks and sources." This tracking method could lead to the development of a warning system that would detect any drop in the ability of oceans to absorb CO_2, and could help validate current models used to make predictions.

In parallel, other scientists, working on the "Carboeurope" European project, lately investigated the various CO_2 fluxes at the terrestrial level on the continent.[6] They used recent estimates of European carbon dioxide, methane, and nitrous oxide fluxes between 2000 and 2005, using both "top-down" estimates based on atmospheric readings and "bottom-up" estimates derived from land-based measurements.

Combining these results, they showed that CO_2 absorption by European forests and lands is practically offset by the emissions of other greenhouse gases such as nitrous oxide and methane, from agriculture and fermentation.

"We always knew that other greenhouse gases had their part to play, but we hadn't accurately quantified how they relate to carbon emissions and absorptions," says Nicolas Vuichard from LSCE, who participated in the study. "The trend towards more intensive agriculture and logging could make Europe an even greater source of greenhouse gases. So our conclusion is that policies should also encourage studies that deal with the biogeochemical and physical aspects of land use and land management as a tool to mitigate climate change."

Clémentine Wallace

The Ship Skogafoss, regularly used between Iceland and Newfoundland to sample sea surface waters for ocean CO_2 analysis.

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2. Laboratoire des Sciences du Climat et de l'Environnement (CNRS / CEA / UVSQ).
3. The CO_2 fertilization effect stipulates that an increase in atmospheric CO_2 leads to an increase in plant photosynthesis which means more overall CO_2 absorption.
4. A.J. Watson et al., "Tracking the Variable North Atlantic Sink for Atmospheric CO_2," *Science*, 2009. 326: 1391-3.
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6. E. D. Schulze, "Importance of methane and nitrous oxide for Europe's terrestrial greenhouse-gas balance," *Nature Geoscience*, 2009. 2: 842-50

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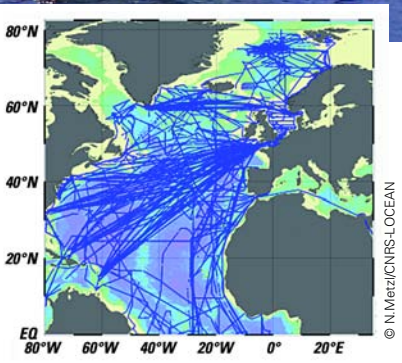

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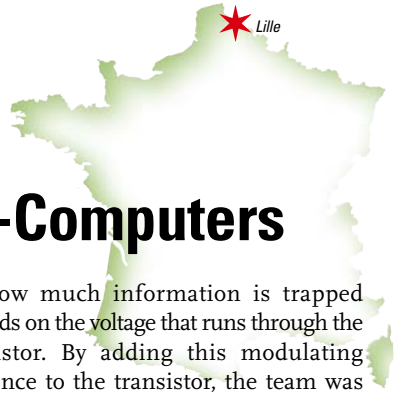
Map of the routes (blue lines) followed by the boats for ocean CO_2 measurements in the North Atlantic Ocean for the years 2000-2007.

PHYSICS

Organic Transistors Pave Way for Neuro-Computers



Artificial intelligence is gaining ground, thanks to the efforts of Dominique Vuillaume[1] and his colleagues, who have successfully created a transistor that mimics the human brain's synapse.[2] This development could help create powerful computers that would process information in much the same way we do.

"Our main objective was to build nanoscale devices that could be used in neuro-inspired computers," explains Vuillaume. In the brain, there are approximately 10,000 synapses for every neuron. So to build a neuro-inspired computer, "we need to create a nanoscale, low power, synapse-like device."

Previous attempts to build such a device required 7 transistors. Vuillaume's NOMFET device (for Nanoparticle Organic Memory Field-Effect Transistor) does it with a single "two in one" device that can both transmit and store information, much like a real synapse.

A transistor is a switch that can either block information, let it pass through, or modulate it. It consists of a source channel (input), a gate (modulator), and a drain (output). By embedding the source-drain channel with gold nanoparticles and coating it with a pentacene film–an organic semiconductor–Vuillaume's team was able to "trap" information (in the form of electrical signals) for brief periods of time–thus creating a short-term memory.

How much information is trapped depends on the voltage that runs through the transistor. By adding this modulating influence to the transistor, the team was able to make the electrical signals behave like chemical neurostransmitters in a synapse, mimicking their ability to increase and decrease signal strength.

These new properties give the transistor the capacity to evolve within the system in which they have been placed. Vuillaume cautions that NOMFET won't make computers "intelligent," but simply "smarter" –not necessarily leading to artificial intelligence, but probably to new computers with neural network architectures that can imitate some functions of the human brain.

"Neural networks are better suited for image processing and recognition, and any other applications that require processing large amounts of data," Vuillaume concludes.

Mark Reynolds

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2. F. Alibart et al., "An Organic Nanoparticle Transistor Behaving as a Biological Spiking Synapse," *Advanced Functional Materials*, 2010. 20: 330-7

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IN BRIEF

Alaskan Glaciers Melting

The melting of Alaskan glaciers has been overestimated, says a team of glaciologists from France, Canada, and the US.[1] Mass loss from these glaciers contributed to a sea-level rise of 0.12 mm/year between 1962 and 2006, rather than the 0.17 mm/year previously estimated. They compared data from the SPOT 5 and ASTER satellites to maps from the 1950-60s, which analyzed the size loss of three quarters of the Alaskan glaciers. A previous study[2] used an airborne laser to measure the surface elevation of 67 glaciers along longitudinal profiles, which were then compared to those mapped in the 1950-60s. But this study did not factor in the rock debris that cover certain glacier tongues and protect them from melting. Moreover, the sampling was limited to longitudinal profiles along the center of a few glaciers, which geometrically led to an overestimation of ice loss. Though ice loss since 1962 is lower than previously thought, there is still considerable thinning and glacial retreat, a worrying indication of future sea-level rise.

1. E. Berthier et al., *Nature Geoscience*, 2010. 3: 92-5.
2. Arendt et al., *Science*, 2002. 297: 382-6

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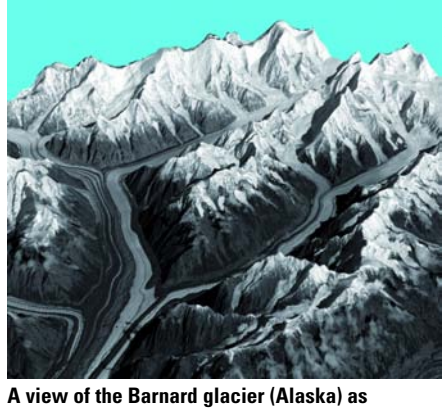

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A view of the Barnard glacier (Alaska) as deduced from the SPOT 5 satellite data.

Fraux cave: Panoramic view of the hall known as the "Pillar Chamber."

Samuel Guillemin (Insa) sets up the photon laser which will take 7 minutes to scan the immediate area.

© Photos : A. Burens - CNRS

ARCHAEOLOGY

A Cave Worth Saving

Last February, scientists continued the 3D scanning process of the Fraux cave. Located in France's Green Périgord region, it is one of the finest Bronze Age cave sites in Europe. A state-of-the-art terrestrial scanner was brought underground to record the 3000-year old archaeological remains and wall paintings.

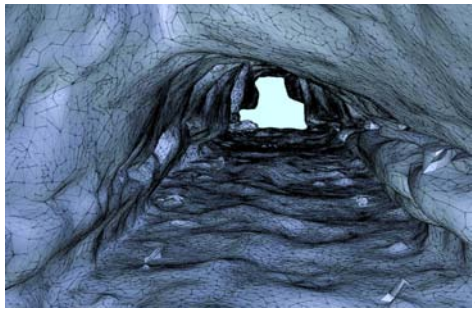
Once the head torches were turned off, the digitization process began in absolute darkness. For seven minutes at a time, under the attentive supervision of Pierre Grussenmeyer, a modeling specialist at INSA Strasbourg,[1] a gigantic scanning device recorded the exact position of some 42 million plots at the heart of the Fraux cave site.

This underground cave, decorated during the Bronze Age (approximately 1300 B.C.), will be entirely recreated as a 3D model. This work, which began at the end of 2008, was continued in February 2010. Albane Burens, a Mediterranean societies specialist,[2] and an apprentice speleologist, was the excavation co-leader, together with Laurent Carozza, from the GEODE laboratory.[3] They were accompanied by an engineer in charge of operating the scanner and by three cultural heritage documentation specialists from INSA.

This task was initiated because this exceptional site could soon collapse, a threat linked to the remarkable history of the cave's discovery.

One morning in 1989, a Périgord farmer named Edmond Goineaud noticed that the artificial basin that he had excavated several years earlier was draining away. A narrow gap had formed at the bottom of the basin. It was the ceiling of an underground cave that had collapsed. This opened the way to a network of subterranean galleries that had been sealed up for nearly 3000 years. "The state of conservation of the cave site was exceptional," says Burens. "A rockfall had severed all contact with the exterior and the clay walls on which people drew more than 3000 years ago were still fresh. The pottery remains were not even covered with dust and it felt that simply blowing on the hearths would get the embers glowing again..."

Now accessible, the cave is subjected to atmospheric changes, and the decorations that were preserved for three millennia are at high risk. Although more recent than its Lascaux and Chauvet counterparts, the Fraux cave is a unique testimony to the Bronze Age in Europe, on account of both the schematic and abstract works engraved in the walls, and the perfectly preserved traces of domestic life.



© B. Cazalet

Model (to the nearest millimeter) of the walls of the "dwelling gallery." The texture of these walls will be reconstructed from digital images.

Every morning for one week, the team descended into the cool, humid atmosphere of the cave, wearing neoprene slippers to limit the marks they left on the ground. Moving around was a delicate affair: "Some passages are very narrow, and we had to move along without touching the walls, to avoid destroying the finger drawings and other incisions made by the former occupants," explains Burens. "The working conditions were physically trying, but the hours went by in minutes underground and the atmosphere was so peaceful that it was easy to stay focused," she adds.

Faro, a company specialized in 3D scanning systems and a partner to the project, supplied the photon laser-scanner which can model voluminous objects to the nearest millimeter. The machine was precise enough to digitize the details of the cave, including the relief drawings on the walls.

The first step in the digitization of a gallery consisted in laying out small reference spheres specifically detected by the scanner across the site, that served as control points. The device would record the position of a scatter plot for seven minutes. It could then be moved to take a new set of readings, and so on... The reference spheres are essential to link together the different scatter plots captured at each position of the laser-scanner.

The 3D model will allow scientists to continue to study the cave even if it collapses, "as this technique incorporates all the available data into a single medium," explains Burens. And since this exceptional site will never be open to visitors, the general public will nevertheless be able to take a virtual tour.

Caroline Dangléant

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2009 CNRS SILVER MEDAL

The Games People Play

Françoise Forges has just been awarded a 2009 CNRS Silver Medal for her numerous accomplishments in game theory and its applications in microeconomics.

How about a little backgammon? Maybe a few hands of bridge? Françoise Forges will most likely decline. "I hate games," she insists. "I hate them so much I can't stand talking about them." And this reaction might come as a surprise considering the source: Forges is an economist, a mathematician, and above all one of France's foremost authorities on game theory. "To play actual games you have to be spontaneous, whereas I like to take plenty of time to think about any problem," she explains.

Reflecting on her career in science, Forges remains eminently modest, apologizing whenever her listener has trouble following the technical aspects of her work. Born in Brussels in 1958, she had a hard time deciding on a field of study because she had a keen interest in just about everything. The only certainty was that she would one day like to teach, to pass on what she had loved learning.

Ultimately she chose mathematics. "I was afraid of getting bogged down in my own subjectivity," she says. "Mathematics was a way of ensuring rigor and precision in my work, a field where I could, in a sense, get away from myself."

She began her academic career in her home country of Belgium, at the Catholic University of Louvain, specializing in probability and statistics. It was at UCL that she discovered game theory and its possible applications in microeconomics. The idea of creating mathematical models for decision-making processes that involve several agents (during business negotiations, for example) was taking shape at the time, and research in the field was booming.

Forges became a member of CORE (Center for Operations Research and Econometrics), a UCL laboratory that was a hive of activity in the early 1980s. "What an eye-opening experience!" she recalls. "I suddenly found myself in an incredibly dynamic environment, with a seminar every week that drew researchers from all over the world." Among those guest researchers were major figures like Robert Aumann, winner of the 2005 Nobel Prize in Economics.

Forges continued to work in Louvain until 1995, when she decided to move to France. She accepted a position at Cergy Pontoise University, which she held until 2003, and then joined the faculty of Paris Dauphine University.

How can one define the scientific context of her research? "Game theory is the theory of interactive decision-making," she explains. "We are interested in situations in which the outcome for each individual depends not only on his or her own strategies but also on those of others." This is an area where mathematics overlaps with microeconomics, which focuses on how firms and households make decisions to allocate resources. Game theory makes it possible to generate economic models that integrate the communication between agents and their expectations and doubts in situations like bid submissions or negotiations.

One of the many cases analyzed by Forges focuses on the interaction between a decision-maker and an expert who holds private information. The communication between these two agents can become highly complex if the expert, to cite one possibility, seeks to influence the decision-maker without revealing all of his or her information. "In this type of fundamental research," Forges comments, "we try to model the agents' behaviors within a framework that is abstract enough to make the conclusions applicable to a whole range of market interactions."

The role of communication among agents is a key aspect of Forges's research. In an article published in *Econometrica* in 1990,[1] she showed that when more than four agents with various interests and amounts of information are involved, they can reach over the course of a plain conversation all of the potential compromises that they could have achieved with the help of a planner who would have coordinated their decisions.

Alongside her research projects, the 2009 CNRS Silver Medal recipient continues to pursue her calling as a teacher. "Every two to three years, I go back to teaching introductory classes. I try to show first-year students how they can use math to tackle a concrete problem, going beyond the usual predefined methods."

Sebastián Escalón

1. F. Forges, "Universal mechanisms," *Econometrica*, 1990. 58: 1341-64.

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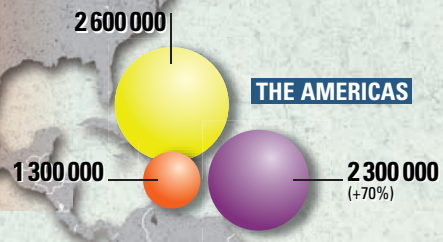
EPIDEMIOLOGY
RESEARCH
TREATMENT

The War on CANCER



In 2010, cancer will become the leading cause of death worldwide, according to the World Health Organization (WHO). Although significant progress has been made in the last few decades in terms of understanding the disease, its diagnosis, and its treatment, far more is needed. And laboratories around the world are committed to exploring all possible avenues of research. Could an anthropological approach help improve prevention? What information is still needed to understand the biology of cancer? And what will future treatments involve? CNRS International Magazine brings you an overview of the research currently underway in its laboratories to fight the disease.

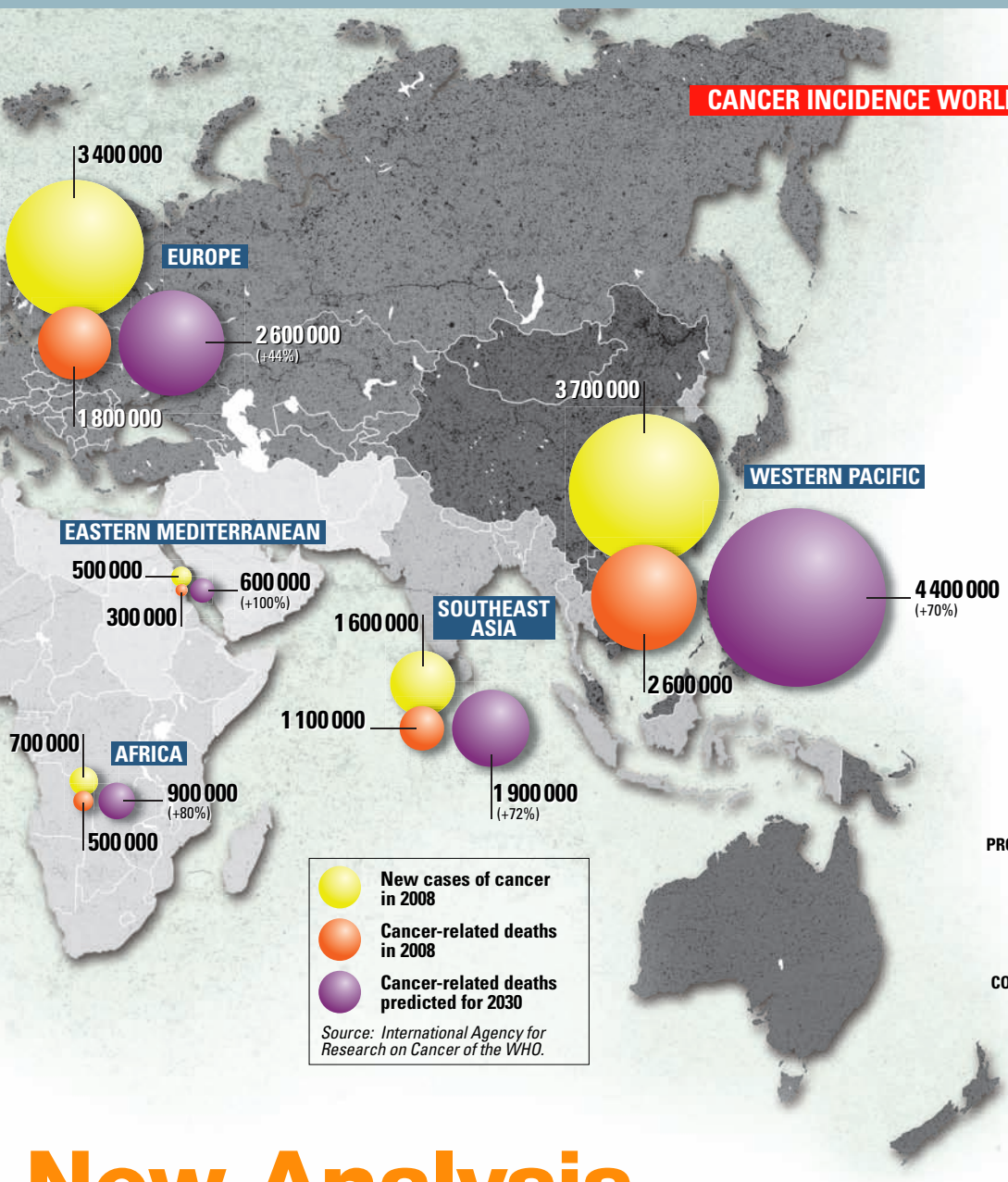
In 2008
Number of new cases worldwide: 12.4 million
Number of people living with cancer worldwide: 25 million
Number of deaths worldwide : 7.6 million

Old Epidemic,

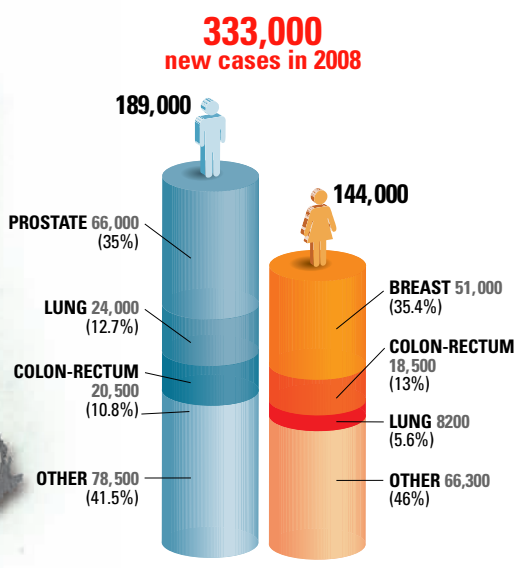
Across the world, 25 million men and women are affected by cancer, and 30 new cases are diagnosed every minute. The most common type is lung cancer (1.2 million new cases per year), followed by breast (just over 1 million cases), colorectal (940,000), stomach (870,000), and liver cancers (560,000).[1] In France alone and at a time when the country's Cancer Plan 2009-2013 (*see box p. 21*) is being implemented, 1.2 million people live with or have survived cancer, now the leading cause of mortality, taking more than 145,000 lives in 2008.[2] We are indeed a long way from beating cancer. Western countries are even facing a cancer "epidemic," which can partly be explained by the fact that we are living longer–long enough to develop a cancer. Half of all cancer cases in France occur after the age of 61.

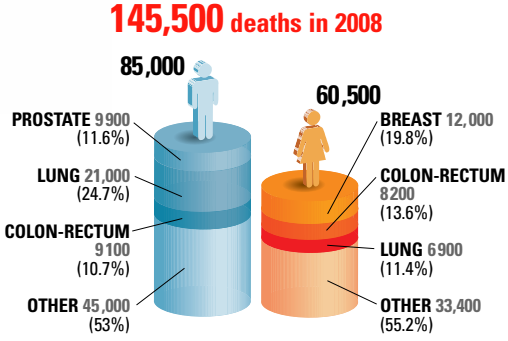
CANCER INCIDENCE WORLDWIDE

Cancer is today more prominent in developed countries, but the mortality rate linked to cancer is set to decrease by 2030. Conversely, this rate will increase in developing countries for that same period. Anthropologist Annie Hubert believes this is due in part to the poor hygiene conditions found in these countries, which favor infection-associated cancers (e.g., cervical cancer or rhinopharyngeal cancer). The developing world is also rapidly adopting "bad habits" from industrialized countries, such as smoking and a fat-rich diet, which turn into new risk factors. For example, cases of breast, colon, and lung cancers were observed in Japan only after the Americans occupied the country following the Second World War.



CANCER IN FRANCE *(source: INVS)*





In France, as in all developed countries, three types of cancer account for over half of all new cases in 2008. According to the Eurocare-4 study carried out in 23 countries, France, in 2008, ranked well above the European average in terms of cure[1] rates: 58.6% for women, for all cancer types, and 57.9% for men, for prostate cancer–these being the highest cure rates in Europe.

1. In this case, cure means that the mortality rate equals that of the general population of the same age and sex.

New Analysis

DANGEROUS LIFESTYLES

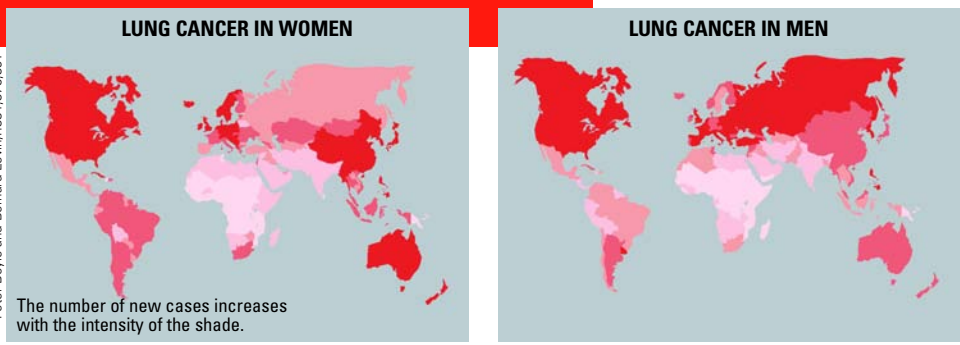
Experts believe that if 15% of cancers can be attributed to genetics, a whopping 85% are linked to environmental factors (e.g., smoking, alcohol, pollutants, and diet) and therefore to lifestyle. Further research is needed into socio-cultural epidemiology to untangle the causes that trigger the majority of cancers, and to plan preventive measures on a case-by-case basis with public health authorities.

This is what anthropologist and CNRS Emeritus Senior Researcher Annie Hubert[3] is pushing for. "This type of research would add to the quantitative epidemiological studies which can only identify at-risk populations," says Hubert, an expert in the field. In the 1980s, she was the first to demonstrate that the presence of certain chemicals, especially in the diets of people from Southern China, young people from North Africa, and people from Greenland, could explain the high frequency of rhinopharyngeal cancer (linked to the Epstein Barr virus) in these three populations (*see map p. 21*). "Anthropology applied to cancer prevention sheds light on the customs and behaviors of individuals from the same culture. This field, which is still emerging in France, could help us understand why some populations develop certain types of cancers more frequently than others. Examples vary from cervical cancer among the Vietnamese, to lung cancer among the Scots, and colon cancer among the Argentines," explains Hubert.

The fact remains that, with more frequent screening, earlier diagnosis, and more effective treatment protocols, an increasing number of people can ward off cancer for longer. Today in France, 52% of people with cancer are still alive five years after the illness is diagnosed, >

GLOBAL CROSS SECTION OF VARIOUS CANCERS

(source: 2008 IARC report, 2002 data)



The number of new cases of lung cancer–which kills the most people worldwide–is significantly higher in developed countries. It is also higher for men than for women, especially in Eastern Europe.

> compared to 20% in 1920, 39% in 1960, and 43% in 1970. The remission rate can exceed 90% for testicular cancer or thyroid cancer.[4] Cancer was for a long time "demonized" and seen as "the worst case scenario." The reasons for this were straightforward: cancer was something we did not understand and could not cure. It has now emerged from this ghetto of "shameful and deadly diseases," though Hubert admits that it still remains the most dreaded disease in the Western world. In a growing number of countries, cancer is now regarded as a curable disease, "due to the medical and pharmacological advances made in the 20th century, which show no sign of abating in the early 21st century.

Cancer has acquired the status of a chronic disease, the course of which can last for many years–even decades–interspersed with short bursts of treatments," adds Martine Bungener, director of the medical research center CERMES.[5] "Once the treatment phase is completed, doctors speak of 'being in remission' rather than 'being cured.' And as the periods of remission get longer, the perception of cancer itself is changing. Given this new perspective, doctors can tell their patients that they can now live longer with the disease and with a better quality of life."

MORE HUMANE TREATMENT

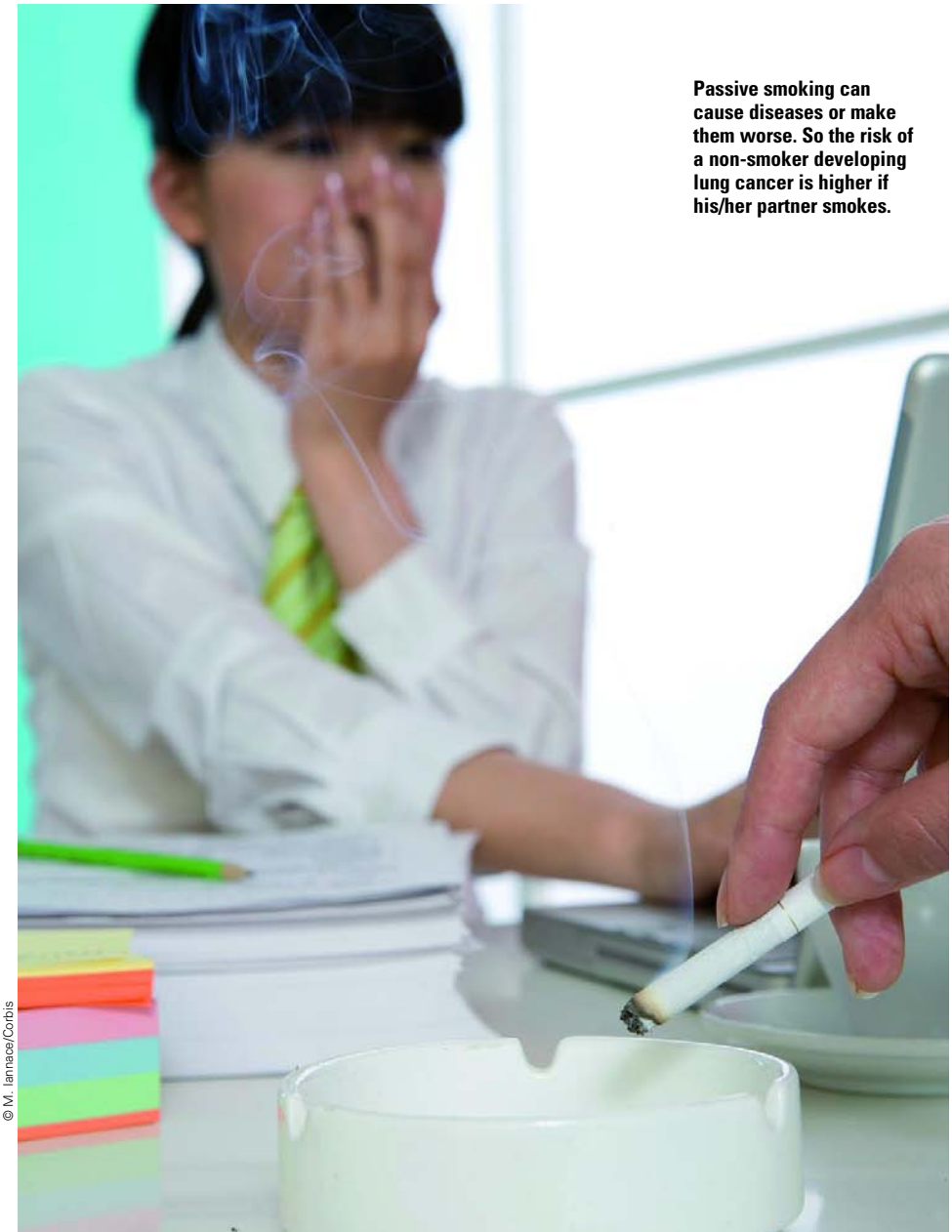
The doctor-patient relationship has also changed. The days when doctors gave diagnoses layered with medical jargon in a quick, often brutal and inhumane manner are nearly over. A few years ago, "the world that the clinical doctors operated in became more open," says Hubert. Until then, it had been quite rigid and contrived, almost indifferent to the emotional well-being of patients and their families," she adds. "We are finally making up for lost time in this area and are now catching up to Anglo-Saxon countries in this respect."

In hospitals today, oncologists–particularly the younger generation–have a new way of looking at their practice. "Many expect that social sciences will help them discover what they don't see, or what they can no longer see, in order to improve current methods, particularly for the organization of care, the design of wards, or end-of-life care."

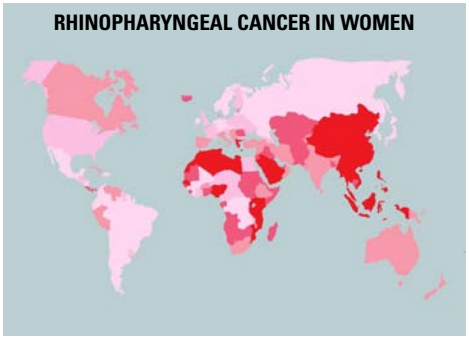
Significant progress has been made to customize patient care at the individual level, to create private areas for patients, to provide individual rooms in outpatient departments, to put together decision trees for patients and work out treatment plans with them if they wish to do so."

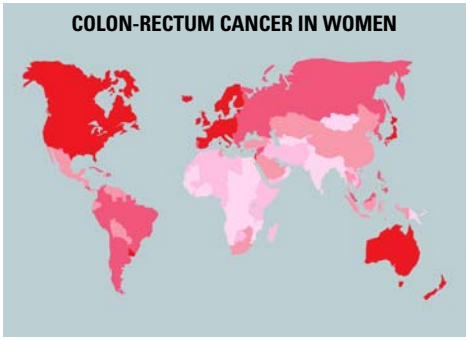
War lingo, which can be very distressing and tiring for patients already burdened by complex treatments, is now being replaced by information, dialog, more patient involvement in the decision-making process, and increasing attention given to the needs of both patients and their families. The well-known "you have to fight!" has evolved into "this is what we can do to treat you."

Bungener recently carried out a study on the role of general practitioners (GPs) and their relationships with the specialist care teams in the management of cancer patients. "We found out that GPs are highly involved in explaining the diagnosis to their patients. And patients consider them to be competent mediators in this process," says Bungener. "Once they have seen the oncologist, patients often feel the need to



Passive smoking can cause diseases or make them worse. So the risk of a non-smoker developing lung cancer is higher if his/her partner smokes.





Rhinopharyngeal cancer, which seems specific to Africa and Asia, shows a very different distribution from that of colorectal and lung cancer. Anthropology offers insight into this kind of unequal distribution by identifying local factors. The distributions in the male population (maps not shown) are very similar.

have their GP explain the situation more clearly." On the other hand, GPs are acquiring new skills and knowledge to be able to follow their patients. For example, some can now prescribe morphine if the patient wants end-of-life care at home. "This is a new development which creates a better balance between the roles of general and specialized medicine," she adds. In the end, this study–the first of its kind–suggests that the majority of French GPs, although conscious of their limits, "want to remain as involved as possible in the treatment of their cancer patients," no matter the stage of the disease.

Philippe Testard-Vaillant

1. Source: World Health Organization.
2. Source: Institut national du cancer (INCa), France.
3. Laboratoire Anthropologie bioculturelle (CNRS / Université Aix-Marseille-II / Etablissement français du sang).
4. Source: "Cancers: long term prognosis," INSERM report, 2006.
5. Centre de recherche médecine, sciences, santé et société (CNRS / INSERM / Écoles de hautes études en sciences sociales / Université Paris-XI).

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THE SECOND NATIONAL CANCER PLAN

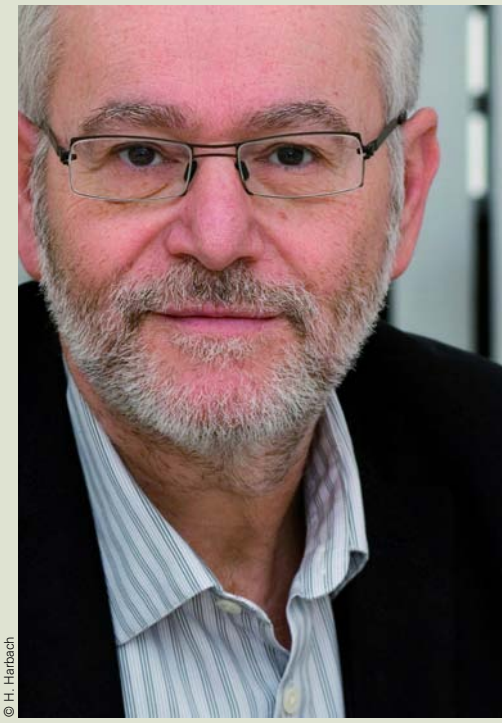
Earlier this year, French President Nicolas Sarkozy announced the launch of the second national Cancer Plan (2009-2013). Professor Fabien Calvo, scientific director of the French National Cancer Institute (INCa) goes over the plan's raison-d'être and research objectives.

What is the national Cancer Plan?

Fabien Calvo: It is a nationwide program designed to help mobilize structures and funds to fight cancer in focused and effective ways. The first Cancer Plan was launched in 2003 for 5 years. Cancer is the leading cause of death in France. Although overall cancer mortality rates are steadily dropping, the number of new cases, on the other hand, has grown by 60% in the past 30 years. It has thus become a major public health concern.

What was the focus of the first plan?

F.C.: The first plan revolved around seven objectives, including catching up on prevention and screening techniques, and creating cancer research clusters. These are continuums between research and care–involving physicians, researchers, and patients–to encourage technology transfer and collaboration between public and private research. The INCa was created in 2005 to coordinate all the actors involved in fighting the disease and finance competitive calls.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What were the outcomes of this first plan?

F.C.: Overall, the outcome was positive. Two-thirds of the 70 measures initially planned were realized or are underway. Significant advances have been made in information and prevention, in particular for early detection of certain cancers, like breast and colon cancer. Although it will still take a few years to evaluate the impact of the smoking ban in public places, introduced in 2007, a drop has already been observed in the number of hospital admissions for cardio-vascular and respiratory diseases. On the other hand, one-third of the measures were only partially achieved. This second plan aims at consolidating some of these achievements, but also focuses on new avenues.

What are the new priorities?

F.C.: The government has earmarked €750 million for the new 5-year plan, which includes 30 measures and 118 concrete actions organized along five lines: research, observation, prevention, care, and life during and after cancer. Research is at the forefront of all actions, and we must reaffirm the central importance of fundamental research, at the core of all scientific progress.
We identified three research priorities. First, we must focus on "translational research," and accelerate the transformation of scientific discoveries and knowledge into therapeutic applications. Second, the causes underlying the nationwide health disparities must be identified. Some are geographical: northwestern France, for example, is marked by high death tolls in several types of tumors. Others have to do with socio-economics: cigarettes and alcohol, for example, at the same level of consumption, kill more among blue collar than among white collar workers. Understanding the origins and mechanisms of these disparities is still at an embryonic stage. This is why sociologists, psychologists, economists, clinicians, and geneticists must work together to identify the causes, and design appropriate policies.
The third priority focuses on the relationship between the environment (air, water, but also our working environment and habits) and cancer. We will have to identify the risks, especially the small cumulative risks, before drawing up effective measures. In the long run, we hope that this new Cancer Plan will help us tackle this disease at the root.

Interview by Clémentine Wallace

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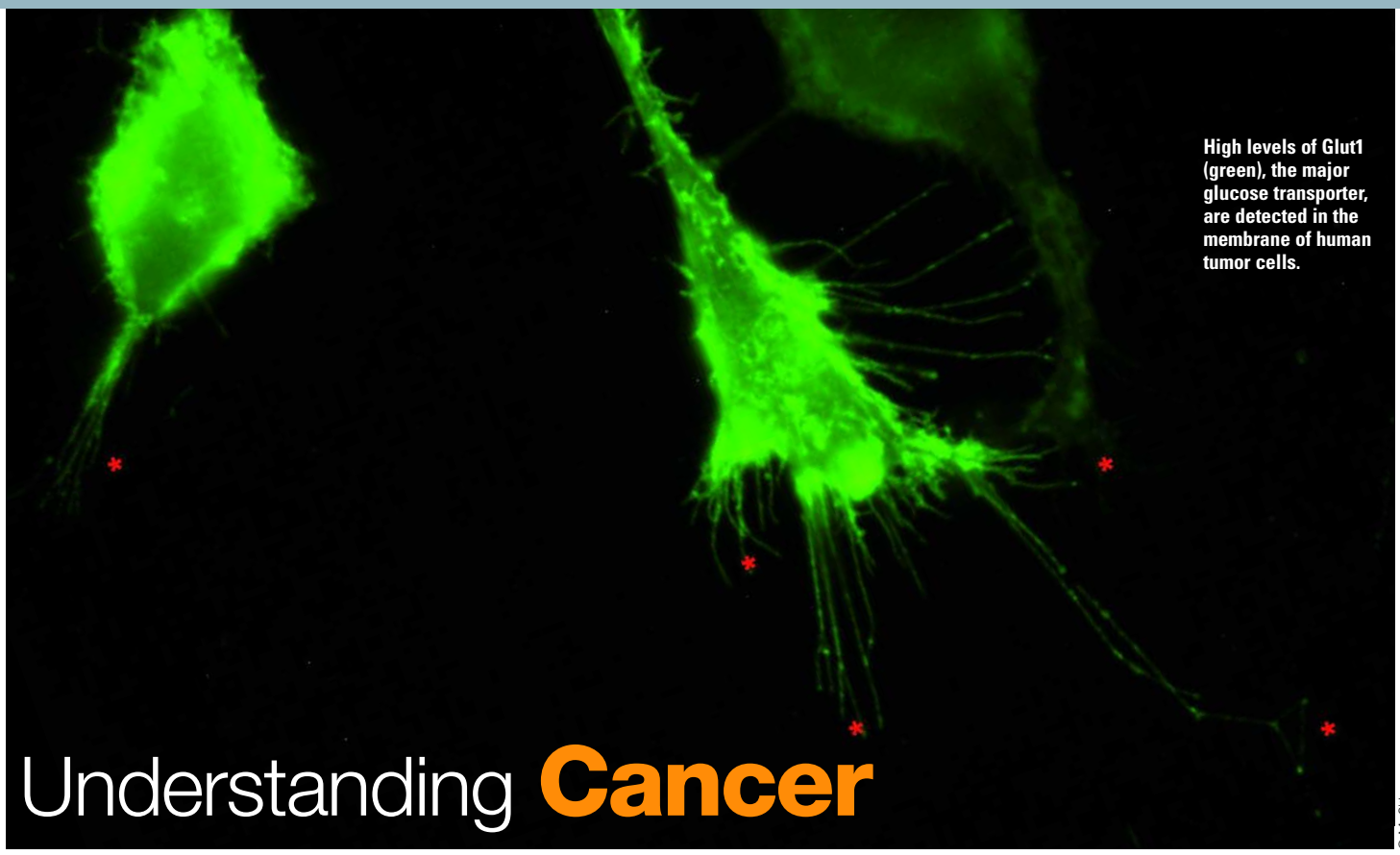


High levels of Glut1 (green), the major glucose transporter, are detected in the membrane of human tumor cells.

© M. Sitbon

> Understanding Cancer

Knowing your enemy is crucial. With cancer, researchers already have some certainties which draw a conceptual framework: a cell becomes unstable, it divides in a random manner, and a cancer is formed (*see diagram p. 24-25*). But there are still many unclaimed pieces in this complex biological puzzle. To complete it, all avenues of research are being explored, from the role of the immune system to genetic mutations, including the cancer cells' need for glucose, and how cancer stem cells and the tumor environment are involved. "Progress in all these areas is essential if we are to make headway in cancer treatment," comments Urszula Hibner, coordinator of the research on cancer at CNRS.

IMMUNE SYSTEM FAILURE

Let's start with the immune system and the theory that has prevailed since the early 20th century: the immune system's job is to detect and destroy cancer cells as soon as they appear, as it does for viruses. So a failure of the immune system would explain how cancers first appear. But David Klatzmann, who heads the I3[1] laboratory in Paris, has recently revisited this theory.

During the first few days after a tumor appears, two types of immune cells spring into action: regulatory lymphocytes, which protect the normal cells in the organism, and effector lymphocytes, which destroy foreign bodies. "Tumor cells can be seen as abnormal cells: they have some altered or mutated genes, which make them malignant," says Klatzmann. As such, they could be recognized and destroyed by effector lymphocytes. But all their other genes are normal and regulatory lymphocytes recognize them as normal cells, and protect them from being destroyed by the effector lymphocytes. "In this process, regulatory lymphocytes always win," Klatzman explains. In other words, the immune system is paradoxically protecting the diseased cells.

Based on these observations, Klatzmann now wants to revisit the idea of a preventive cancer vaccination. "Like in traditional vaccinations, effector lymphocytes would be trained to recognize the antigens[2] specific to a particular cancer–antigens of prostate cancer tumors, for example–so that they can act more quickly against this antigen when it appears at the cell surface of a developing tumor."

STARVING CANCER

Most researchers don't expect to find a single flaw that could be applied to all types of cancer. Except those scientists who have focused their research on metabolism, because they know that all tumors have one thing in common: they all crave sugar.

The reason for this is that many cancerous cell types do not produce energy normally via the mitochondria (oxidative phosphorylation), but rely on sugar breakdown (glycolysis) as their main energy supply. Since this mechanism is considerably less efficient than oxidative phosphorylation, the cells need a lot of glucose. This addiction to glucose is used to visualize tumors directly in patients, using sophisticated imaging tools that detect glucose transporters at the surface of the cells. Many research teams are trying to understand these changes in metabolism and hope to use them to inhibit cell proliferation.

Marc Sitbon's group at Montpellier's IGMM[3] came across this issue indirectly by studying virus entry into the cells. "We know that cancer cells consume a lot of sugar, so a lot of glucose transporters are found on their surface," he explains. "We have recently discovered that one of these transporters, Glut1, is used by HTLV–a human retrovirus known to induce leukemia–to enter the host cells. Because this virus can recognize the glucose transporter, we used a fluorescent virus fragment as a metabolic marker to identify cancer cells."

Moreover, Sitbon's team has extended this concept to other retroviruses that recognize nutrient transporters (amino acids, phosphate, vitamins, etc.) and generated a battery of new metabolic biomarkers. In the short term, one of their goals is to use this new panel of biomarkers to distinguish different cancer cell types and stages of the oncogenic processes. Anticancer treatments could then be adapted to the metabolic status of cancer cells. Ultimately, these new biomarkers could be adapted to bind and block the transporters, thus preventing glucose or other essential nutrients from reaching the tumor cells, which would literally be starved to death.

RECALCITRANT CELLS

Another promising field of research concerns cancer stem cells. "A number of studies man-

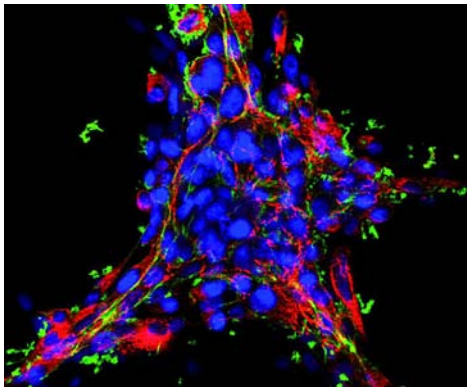
aged to establish the presence of a minute amount of stem cells (only a few percent of the tumor's cells) within the cancerous lesions in the breast, colon, prostate, and brain," explains Daniel Louvard, director of the cancer-dedicated Curie Institute Research Center.[4]

"We believe these cells could be directly responsible for cancer cell proliferation. If this proves correct, we'll have to drastically reshape our interpretation of cancer development and progression." Though the role of these cells is not yet fully understood, we do know that they behave like normal stem cells: they multiply indefinitely and can then differentiate themselves to make different tumor cells.

This little group of stem cells is a major problem: "Cancer stem cells, like normal stem cells, may stay quiescent, and not multiply for months–or even years. Cancer drug treatments, which often target proliferating cells, would be ineffective against such quiescent stem cells," explains Paul-Henri Roméo, director of the LRTS.[5]

The objective of researchers is now to isolate and study these recalcitrant cells. The challenge is to develop new treatments that would destroy cancer stem cells without harming normal stem cells. "But there may be different types of cancer stem cells within one tumor. So even if we manage to characterize one type of stem cell, eradicating the entire population is not guaranteed," says Roméo, who believes it would still represent "a significant step in the right direction."

Progress could also come from research on normal stem cells, as recent results obtained by Jean-René Huynh's group at the Institut Curie[6] suggest. Their findings uncovered one of the mechanisms that regulate the balance between cellular proliferation and differentiation. "When a stem cell divides, the machinery that synthetizes ribosomes –the cell components responsible for protein synthesis–divides unequally between the two daughter cells," explains Huynh. "If there are not enough ribosomes in the cell assigned to become a stem cell again, it differentiates. If, on the other hand, there are too many ribosomes in the cell which has to differentiate, it continues to divide, which can, in certain circumstances, lead to a tumor."



© E. Van Obberghen-Schilling

Network of fibronectin (red), a component of the extracellular matrix, assembled by human glioblastoma cells (blue nuclei).

MIGRATING CELLS

Another field of research is the microenvironment in which the tumor cells live and which undergoes many changes as the cancer progresses. Of particular interest is the extracellular matrix, which has many effects beyond providing support and structure to the tissues, and "whose importance has been largely underestimated," says Ellen Van Obberghen-Schilling of IBDC,[7] a cancer institute based in Nice.

The cells in and around the tumor send signals that lead to a reorganization of the matrix. These structural changes have a major impact on cell proliferation and spread of metastases.

Interested in these signal exchanges, her team has studied integrins, adhesion receptors that work as anchors that mediate signaling between tumor cells and their environment. "Integrins enlist intracellular proteins, the ILK protein for example, to turn signals into action. We have shown that ILK plays a key role in the assembly of fibrillar networks that direct cell migration and regulate their function," explains Van Obberghen-Schilling.

Stéphane Noselli, IBDC director and 2009 CNRS Silver Medalist, believes that the drosophila model can do a lot to understand cancer cell migration, a capital event in the development of the disease. "In a model like drosophila, which is simple and easy to manipulate, genes can be mutated at will in a specific tissue. The >

INCONSIDERATE VIRUSES

If smoking, hereditary factors, and ultraviolet rays, among others, are well-known instigators of cancer, infectious agents, which cause nearly 20% of cancers, are often overlooked.

To name only the most frequent infectious agents that cause cancer, *Helicobacter pylori* is responsible for 50% of all cases of stomach cancer, the hepatitis B and C viruses for 80% of liver cancers, and the human papillomavirus (HPV) for 95% of cervical cancers.

And these microorganisms work in very different ways. Some introduce oncogenes (*see diagram p. 25*) directly into the host cell, while others have a less direct approach.

Jean-François Delfraissy, director of the French National Agency for Research on AIDS and Viral Hepatitis (ANRS),[1] explains that "some pathogens, for example, increase the risk of cancer by suppressing the immune response or by causing a chronic inflammation, as is the case with the hepatitis B virus or Helicobacter."

Suppressing the immune system facilitates infection by other carcinogenic viruses, and inflammatory tissue provides an ideal environment for cancer cell proliferation.

For over 10 years, the Oncoprotein group at the Strasbourg-based school of biotechnology (ESBS)[2] has been studying the human papillomavirus, which causes cervical cancer by expressing the two small viral proteins E6 and E7 in the host cells. Researchers already knew that E6 triggered the degradation of the protein p53–a central tumor suppressor protein that biologists call the "guardian of the genome." Using their knowledge of the 3D structure of the E6 protein, they modified its surface and produced an inactive protein. "When this mutant protein was expressed in cervix cancerous cells, p53 degradation was stopped, and cell senescence–characterized by arrest of cell division–was triggered," says Murielle Masson, a researcher with the Oncoprotein research group. "Our results show that cancer cell division can be stopped."

Biologists hope that these studies on viruses will lead to new treatments and preventive vaccination. "Vaccines against the papillomavirus and the hepatitis B virus are the two major success stories of preventive vaccination," says Delfraissy. "Many research teams are currently working to develop a vaccine against hepatitis C and Helicobacter."

Laurianne Geffroy

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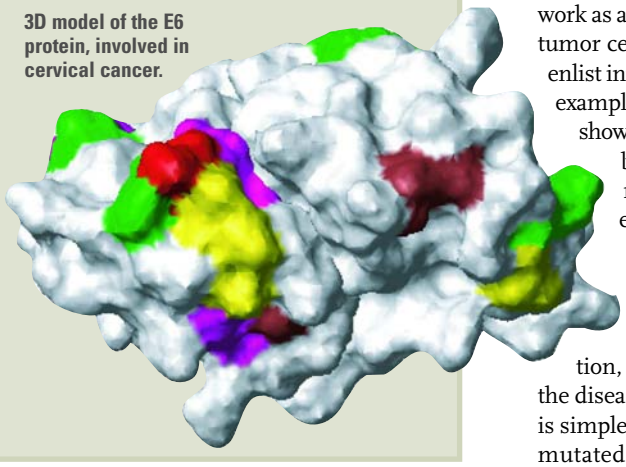


© M.Masson & G.Trave

3D model of the E6 protein, involved in cervical cancer.

HOW A TUMOR IS FORMED

Cancer starts when a mutant cell appears, a cell whose DNA has been altered in a gene involved in controlling cell proliferation. **A single mutant cell** of the 60,000 billion cells that make up the human body is enough to trigger a cancer.

The DNA mutation causes the cell to ignore some of the signals that usually limit its proliferation. The cell divides too quickly, and the daughter cells inherit the mutation. Months or years later, one of the daughter cells undergoes **an additional mutation**.

The additional mutation lets the cell escape even more from the tight control of its environment. Proliferation increases and produces daughter cells that carry both mutations. DNA repair mechanisms are impaired and **cells accumulate mutations**.

BLOOD VESSELS

The mutant cells pack tightly together and start to form a **tumor**. The tumor may not spread any further than the tissue of origin, unless one of the tumor cells undergoes **another mutation**…

TUMOR BEING FORMED

… which results in a **loss of anchorage** to neighboring cells letting it slip through the **blood vessels**. The blood vessels then become increasingly ramified around the tumor. They provide the cancer cells with glucose, thus enabling active proliferation.

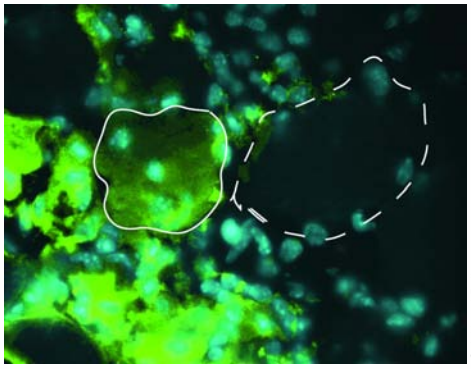
TUMOR

METASTASES

> behavior of the resulting mutant cells can be easily followed using *in vivo* imaging techniques. Using this technique, we have identified new genes that are involved in cell detachment and in cell migration to other tissues."

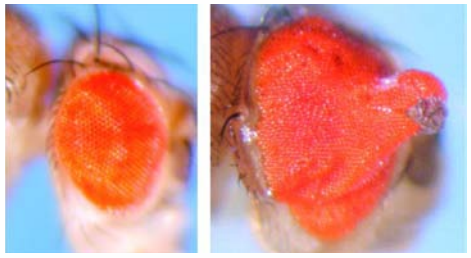
THE IMPORTANCE OF GENE REGULATION

The mutated or deregulated genes found in tumors are obviously a major focus in cancer research. But the factors that govern the expression or silencing of genes, known as "epigenetic factors," are just as important. One example is the mechanism that governs DNA's spatial organization. If DNA is packed too tightly, some genes, whose expression is required to maintain DNA stability, for example, may be repressed. This would generate the accumulation of DNA mutations and could ultimately lead to cancer. Another regulatory mechanism uncovered in the last decade is that which uses microRNAs. These short pieces of RNA can "inhibit the expression of certain genes by pairing with messenger RNA[8] and blocking their translation into proteins," explains Annick Harel-Bellan, from the Andre Lwoff Institute in Villejuif.[9] MicroRNAs are involved in the control of cell proliferation and differentiation. "And it is precisely this control function which is disrupted in the first stages of cancer." Her team has recently shown, using mouse muscle, that the microRNA miR-181 is involved in cell differentiation. By binding to messenger RNA, it silences the genes that inhibit differentiation, thus blocking cell division and leading to differentiation. The research team now wants to catalog all the other microRNA involved in these processes. Researchers can now also synthesize custom-made RNA to block the messenger RNA of their choice and silence the corresponding gene. "It's obviously an extraordinary weapon against cancer," says Harel-Bellan. A weapon that scientists from the PARi research platform,[10] a technical support near Paris, are bringing into play. They are using artificial microRNAs to identify the genes involved in cell proliferation in lung cancer. They hope to use them *in vivo* to neutralize these genes within the tumors themselves.



© A. Harrel-Bellan

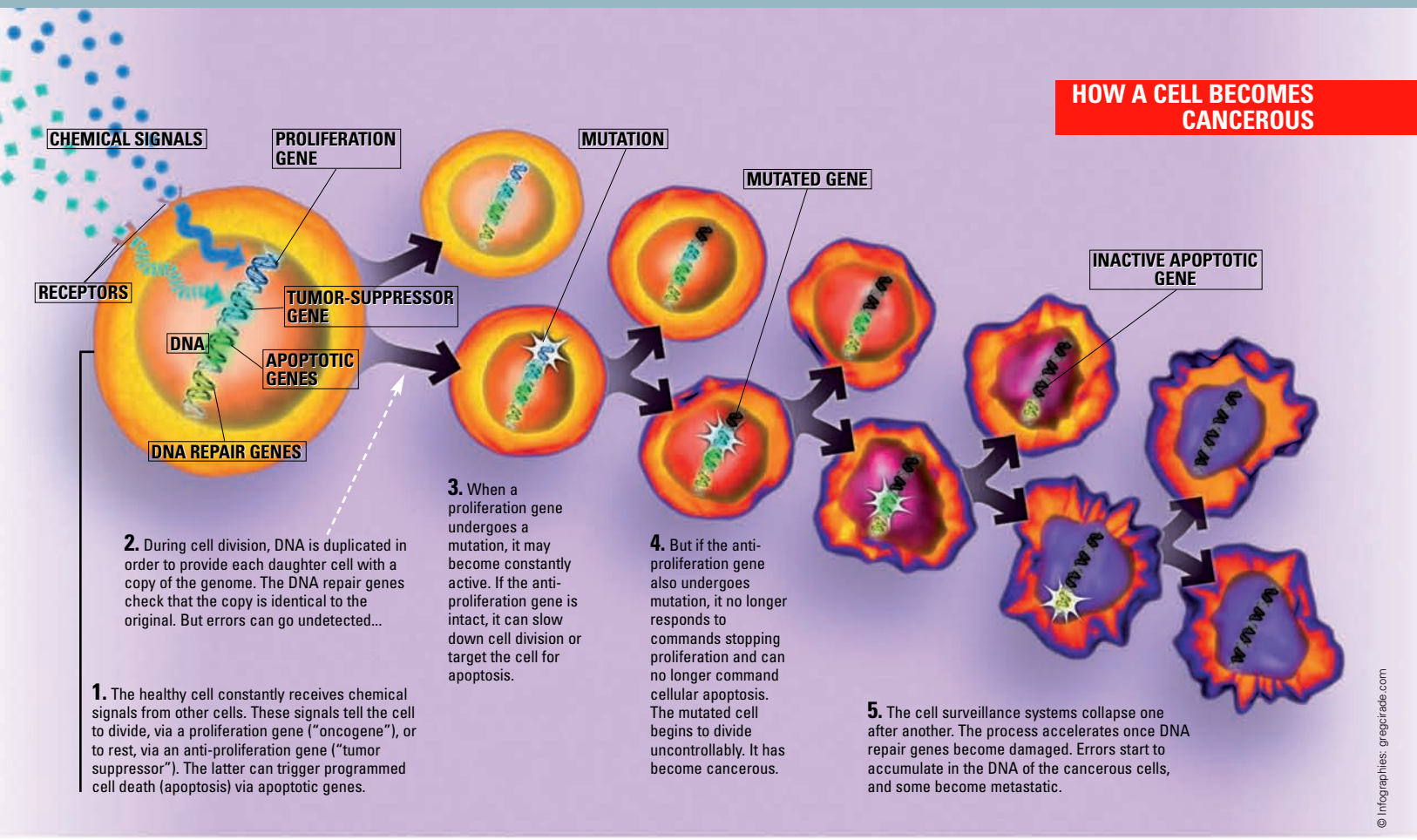
The microRNA miR-181 (green) is involved in cell differentiation. It is expressed in mouse regenerating muscle fibers (circled) *in vivo*, but not in mature fibers (dotted line).



© G. Cavalli

Left: eye of normal drosophila. Right: eye of a drosophila in which the protein that usually prevents cell proliferation has been mutated. A distinct growth, caused by uncontrolled cell proliferation, can be seen.

Found in a mutated or altered form in cancers of the prostate, breast, lung, and brain are another type of gene regulators: the Polycomb proteins. They repress the expression of certain genes by binding to them. Working with drosophila, Anne-Marie Martinez and other members of Giacomo Cavalli's team at the Institute of Human Genetics (IGM) in Montpellier[11] have shown that one of these proteins acts as a tumor suppressor. "When a mutated Polycomb protein is expressed in a fly's eye, the cells lose their capacity for differentiation and proliferate in an uncontrolled manner. The tissue loses



its shape, invades the neighboring organs and eventually destroys the fly, all distinctive characteristics of a tumor," explains Cavalli. His team dissected the different stages of the process: the normal Polycomb protein represses proliferation and tumor formation by binding to the Notch gene, a well-known regulator of the human cell cycle. When the protein is mutated, expression of the Notch gene is unleashed and the cell cycle machinery loses control.

To control cell proliferation, the genes and their regulators very often act together. This is why an increasing number of scientists are interested in networks of genes and epigenetic factors. As Laurent Journot, a senior researcher at the IGF[12] explains, "some groups of genes are subject to genomic imprinting. In some cases, it is always the maternal allele[13] that is expressed and the paternal allele repressed, in other cases, it is the other way round. Until very recently, we couldn't find a functional link between these genes. We have now shown that they are involved in the control of normal cell proliferation, but also when they are mutated in the growth of tumors." This approach points to groups of genes involved in cell proliferation that need to be closely monitored.

Given the many avenues that research can take in the field of cancer, the exchange of information between researchers is of crucial importance. As Journot concludes, "cell biology isn't complicated, it's complex! The mechanisms are relatively easy to understand, but there are an infinite number of possible scenarios."

Laurianne Geffroy

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2. A substance (molecule, microorganism) that generates an immune response.
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4. Centre de Recherche de l'Institut Curie.
5. Laboratoire de recherche sur la réparation et la transcription dans les cellules souches (CEA / INSERM / Université Paris-VI).
6. Laboratoire Génétique et biologie du développement (CNRS / INSERM / Institut Curie / Université Paris-VI).
7. Institut de signalisation, biologie du développement et cancer (CNRS / Université de Nice).
8. Messenger RNAs are the molecules that transfer information from genes (made of DNA) to ribosomes, the protein synthesis factories.
9. Laboratoire Épigénétique et cancer (CNRS).
10. The automatic PARi platform is located at the André-Lwoff Institute (CNRS / INSERM / Université Paris-XI / Paris Hospital Network AP-HP).
11. Institut de génétique humaine (CNRS / Universités Montpellier -I and -II).
12. Institut de génomique fonctionnelle (CNRS / INSERM / Universités Montpellier-I and -II).
13. Alleles are different versions of a gene.

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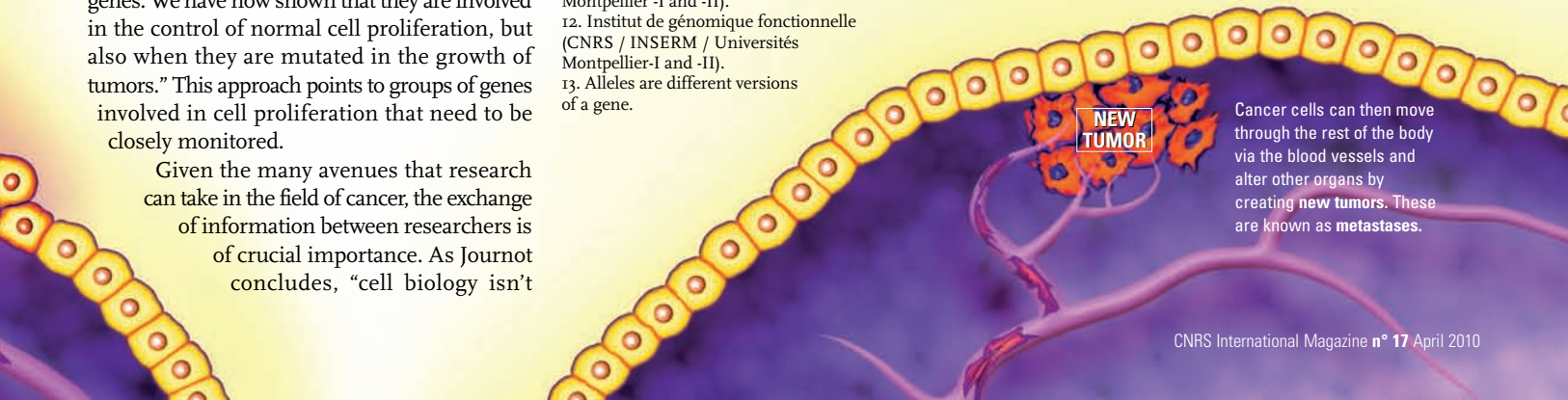


Towards Customized Treatment

Conventional anti-cancer treatments like chemotherapy, radiotherapy, or surgery are still regarded as "crude" with numerous side effects. But change is on its way. New treatments are being developed, more precise in the dosage administered and the way they target cells. Moreover, in the near future, these treatments will be adapted to individual patients and to the type of cancer involved.

BETTER DIAGNOSIS

Improving cancer treatment starts with improving diagnosis. The X-ray scanner, so far the main tool for diagnosis, has its drawbacks. It requires a minimum threshold of density contrast between the healthy tissue and the tumor tissue. For some women with breast cancer, this threshold isn't reached, making it difficult for the radiologist to interpret the images.

The new type of ultrasound developed by Mathias Fink and his team at the Langevin Institute[1] should significantly improve early screening and diagnosis of breast cancer. This new instrument is the first ever to observe the propagation of shear waves,[2] a type of waves that ultrasound equipment has so far overlooked. To detect these waves, the equipment first sends ultrasounds to the tumor area, where the waves create a "microseism" which triggers the emission of shear waves. A time reversal processor analyzes these waves to draw up a quantitative map–precise to the nearest millimeter–of the tissue elasticity, the parameter that doctors try to evaluate by breast palpation.

"Used with traditional ultrasound, this elasticity image makes breast tumor detection 99% specific," adds Fink. Only MRI scanners can compete with this degree of specificity, but running costs are significantly higher. This time reversal multi-wave ultrasound equipment is being marketed by the company Supersonic Imagine (of which CNRS is a shareholder). In less than a year, 50 of these new ultrasonic scanners have been delivered around the world, and another 25 have been ordered. Market authorization in the US was granted in August 2009, which should speed up their availability to patients. Meanwhile, Supersonic Imagine is investigating how the same principle could be used for diagnosing other types of cancer.

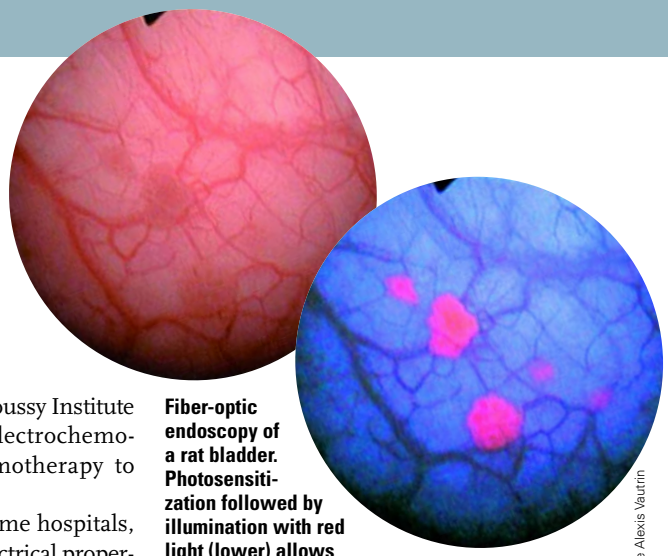
BOOSTING DRUG EFFICIENCY

Lluis M. Mir, from the Gustave-Roussy Institute in Villejuif,[3] has developed electrochemotherapy, another way for chemotherapy to specifically target tumor cells.

Already routinely used in some hospitals, electrochemotherapy uses the electrical properties of cell membranes. When an electrical field is applied to a cell, the permeability of its membrane is increased, allowing the drugs dissolved in the extracellular fluid to penetrate the cell more easily. And the effect is astounding. By placing an electrode close to a tumor, Mir multiplied the efficiency of a conventional anti-cancer drug (Bleomycin) by as much as a thousand. During clinical trials at the Gustave-Roussy Institute, and then at other European centers, electrochemotherapy sent 75% of the tumors treated into complete remission in a single session. Increasing the effect of the active substances, the technique achieves great results even when low concentrations of the drug are used. It therefore also reduces the risk of the nasty side effects associated with the high doses used in classical chemotherapy. In fact, no side effects were detected during clinical trials.

More than 60 cancer treatment centers in Europe currently use electrochemotherapy. At this time, and since the electrode needs to be close to the tumor, "the technique is only used for superficial and accessible tumors, mainly cutaneous and subcutaneous," says Mir. "But technological and clinical research is focusing on the development of more sophisticated electrodes to treat tumors lodged deep inside the body."

Finally, the latest improvement to chemotherapy uses light, and is known as photochemotherapy or photodynamic therapy. In this case, an inactive drug becomes active upon exposure to light. The drug is not ingested, like in traditional chemotherapy, but applied to the tumor area in liquid or cream form meaning that only tumor cells are targeted. This considerably reduces side effects and ensures that only tumor cells are targeted. Because it uses light, this method is mainly applied to external cancers, in dermatology.



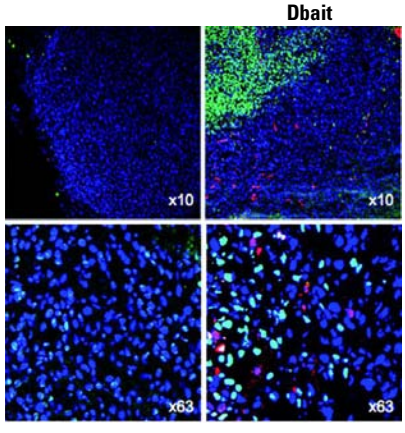
Fiber-optic endoscopy of a rat bladder. Photosensitization followed by illumination with red light (lower) allows precise detection and elimination of tumors barely visible with white light (upper).

© M. D'Hallewin/CRAN Centre Alexis Vautrin

But a fiber-optic endoscope can be used to direct a laser beam towards an internal organ. "Using fiber optics to treat cholangiocarcinoma (cancer of the bile ducts) not only increases life expectancy by more than a year, but also makes the patient more comfortable," explains Marie-Ange d'Hallewin from the Research Center for Automatic Control in Nancy (CRAN).[4] But due to high costs and complex dosimetry, this technique is still limited to a few hospitals, contrary to its use in dermatology, which only requires an ultraviolet red lamp. However, the CRAN researchers continue to investigate the possible applications of photodynamic therapy. In particular, they have shown that applied to patients who have had endoscopic bladder surgery, it limits the release of tumor cells during the operation and therefore reduces the risk of recurrence.

TRICKING CELLS

Besides chemical methods, scientists are also focusing on physical methods to destroy tumor cells. The best-known method is radiotherapy, which uses X-ray irradiation to treat the patient. Although widely used and quite effective, it can still be improved. A single session of radiotherapy will only kill 30-50% of the cancer cells. This relatively low success-rate translates in a longer treatment, which increases side effects. So the question is how to make radiotherapy more effective. Marie Dutreix's team at the Institut Curie[5] suggests using DNA baits molecules. When this technique was tested on animals, the molecules were able to improve the effect of radiotherapy by 75 to 100%.



The Dbait molecules (in red) lead the cells (in blue) to "believe" that their genetic material has been damaged. The molecules that have been tricked (in green) undergo apoptosis. Associated to radiotherapy, this mechanism could double the effectiveness of ionizing radiation.

© M.Dutreix

The DNA baits–called Dbaits–are actually artificially-created DNA fragments. When injected into a tumor cell, they trigger DNA repair mechanisms within the cell because they mimic genetic material damage. By irradiating the cell with X-rays, which introduce breaks into the cellular DNA, the DNA repair mechanisms are called on once again. This massive call on DNA repair mechanisms triggers "cell suicide," also known as apopotosis. The final outcome is therefore that the cancer cells begin a process of self-destruction.

Dbait molecules are currently in regulatory preclinical development and the first clinical trials using radiotherapy and Dbait molecules are due to start at the end of 2010 on patients suffering from local cutaneous metastases. "We have tried hard to find tumors resistant to this combined treatment: but to date, all tumors grafted onto mice have responded to the double treatment," says Dutreix.

Radiotherapy has also gained in precision. X-rays, when applied to a tumor, can cause general damage. They burn the healthy tissues on their way to the tumor and around it. To treat tumors in sensitive areas, like the eye or the brain, biologists and physicists have developed an alternative, more precise, technique, called proton therapy. In theory the technique is flawless: it involves replacing the X-rays with a flux of protons. In terms of precision, it's like trading in a shotgun for a sniper rifle. What's more, the proton beams generally release their energy at the end of their journey, and are thus harmless to the tissues they pass through.

The only downside–and it is a considerable one–is that producing a proton flux involves installing a large and expensive particle accelerator in the hospital. This is why there are currently only three proton therapy centers in France, with a fourth one currently being built in Lyon.

The research of Julien Fuchs and his colleagues at LULI,[6] may make proton therapy more accessible in the future. Their work is based on a discovery made in 2000: when a short intense laser pulse crosses a very thin metal sheet, it knocks off protons from the far side of the metal. By focusing these protons, a reasonably large "proton factory" could be built.

But don't expect to find such equipment in hospitals in the near future. "The powerful lasers with high repetition rates needed for this technique have yet to be developed," explains Fuchs. "Our first aim is to build a laser that can deliver tens of Joules of energy at a high repetition rate (10 Hz)."

Be that as it may, many theoretical and technical advances are emerging for cancer treatment: the arsenal of treatments available to oncologists is expected to increase considerably over the next decade.

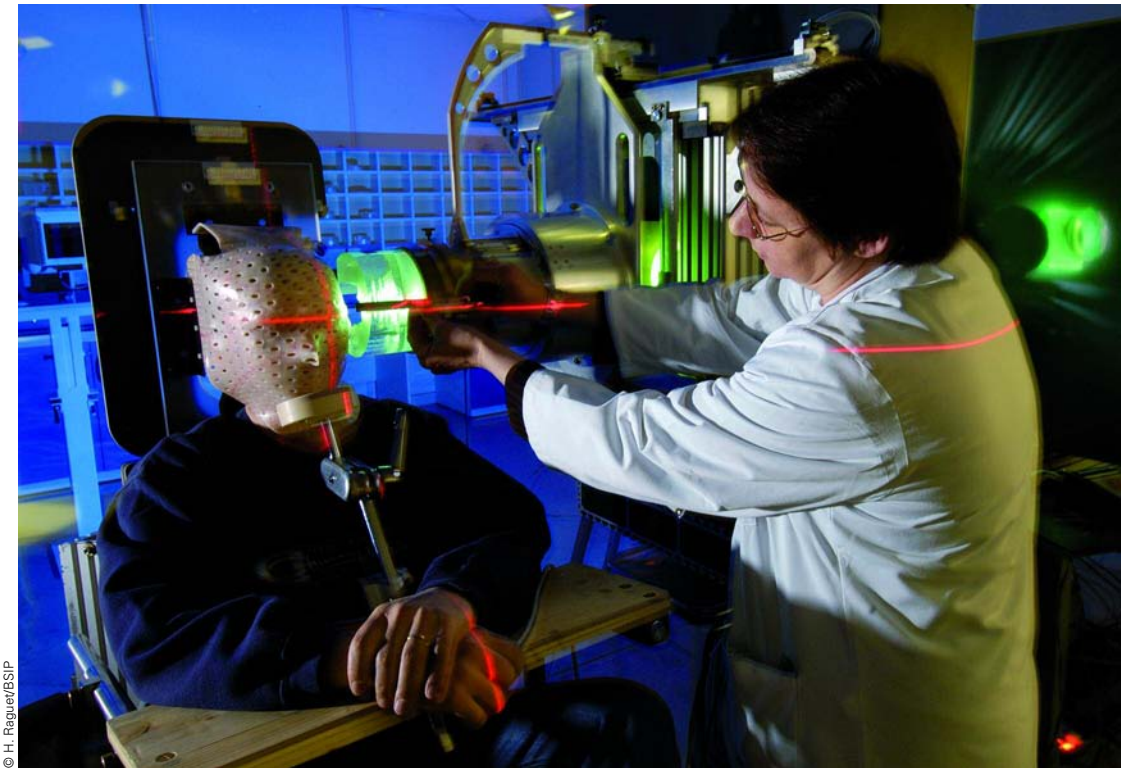
Xavier Müller

SEQUENCING CANCER

In 2008, eleven countries (Australia, Canada, China, France, Germany, the UK, India, Japan, Singapore, Spain, and the US) joined forces to launch the International Cancer Genome Consortium (ICGC). The aim of this Consortium is to improve our understanding of the genetic changes that tumor cells undergo. The Consortium is committed to sequencing the genome of 50 types of tumors, listed because they are common cancers or of particular clinical interest. Understanding the ways in which the genetic material of a tumor cell differs from that of a healthy cell should help design new diagnostic tools, as well as new treatments. In France, a dozen hospitals and laboratories –involving CNRS researchers–are contributing to the project. The findings are to be published in the next five or six years.

Xavier Müller

1. CNRS / École supérieure de physique chimie industrielle de Paris / Universités Paris-VI and -VII.
2. Shear waves are tissue vibrations perpendicular and not parallel to the direction of propagation.
3. CNRS / Université Paris-XI / Institut Gustave-Roussy.
4. Centre de Recherche en Automatique de Nancy (CNRS / INPL / Université de Nancy).
5. CNRS/ Institut Curie.
6. Laboratoire pour l'utilisation des lasers intenses (CEA / Université Paris-VI / École polytechnique).



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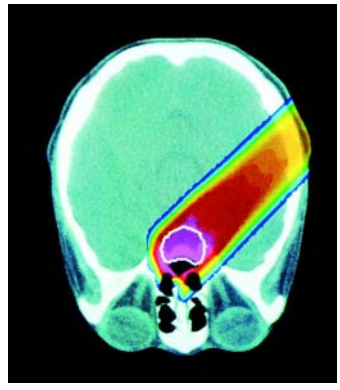
A patient treated by proton therapy. Large synchrotrons are currently needed to create a proton flux. A less expensive technique using lasers is currently being developed.



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During a session of proton therapy, the tumor cells (pink) are destroyed by a proton flux (red) with extreme precision and no damage to the cellular environment.

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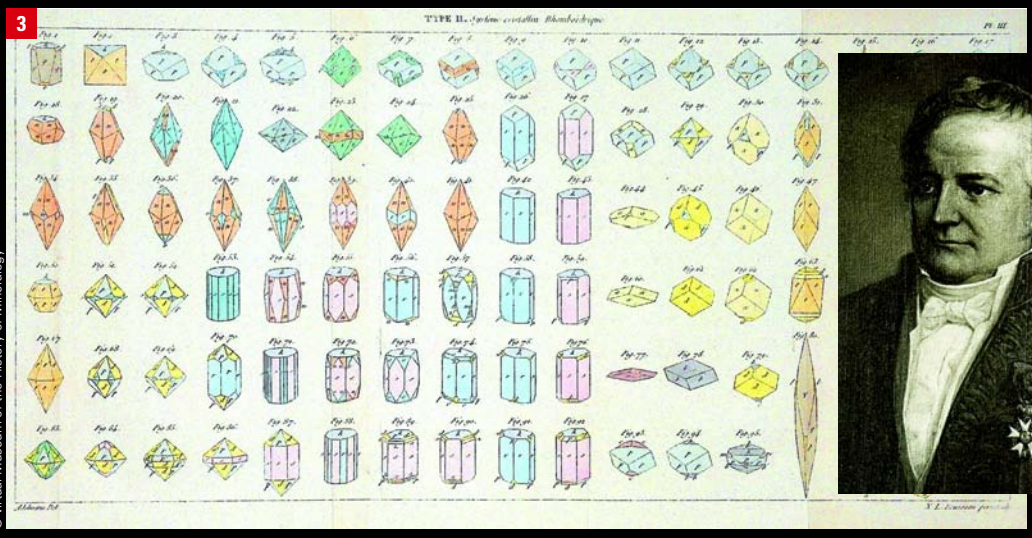
MINERALOGY

Priceless Gems
in the Heart of Paris

1

2

One of the finest collections of mineral specimens in the world is on display in Paris, right beneath the Jussieu campus. Apart from its historical and museographic interest, this collection, which belongs to Pierre and Marie Curie University (UPMC), is a treasure trove of information for scientists from various disciplines. As keeper of these treasures, Jean-Claude Boulliard is constantly searching for new jewels from the entrails of the Earth.



3 © Virtual Museum of the History of Mineralogy

4 © Bibliothèque MINES ParisTech

5 © ND / Roger-Viollet

6

7

1 The mineral collection of Pierre and Marie Curie University (UPMC) counts 15,000 specimens. Only the 1000 most exceptional are on display.

2 Jean-Claude Boulliard has been curator of this minerals collection since 1998. With the photographer Orso Martinelli, he has just published a remarkable book that describes the outstanding items in the collection.

3 The collection is now 187 years old. It was started in 1823 by François-Sulpice Beudant. This illustration is taken from his "Elementary Treatise on Mineralogy" (1830-1832).

4 François-Sulpice Beudant remained at the head of the minerals collection for 24 years. Almost none of the specimens he originally acquired still exist.

5 The Mineralogy Laboratory at Sorbonne University (Paris), around 1900.

6 The display techniques used for the Iranian Crown Jewels have inspired the staging of this collection.

7 This is a gypsum stalactite extracted from a Moroccan mine. The origin of its curvatures is not yet fully understood.

8 This rhodochrosite is one of the most beautiful minerals ever discovered. It comes from the N'Chwaning mine in South Africa.

Some 1000 specimens on show, more than 500 different mineral species protected by 24 panoramic display cases and bathed in gentle golden light: this is the minerals collection displayed in the basement of Pierre and Marie Curie University (UPMC). Visitors will be dazzled by stunning objects: a twisting, pearly white helix that could decorate a delicate pastry, small black and golden fans on a foamy white bed, or a formation of stalactites in different shades of luminous green.

Jean-Claude Boulliard, CNRS researcher and UPMC professor at the IMPMC[1] and director of the collection, leads us enthusiastically through this treasure-filled cave. "Minerals are classified according to their crystallochemistry–the organization of their atoms and their chemical formula. Alongside 'native' elements like gold, copper, or diamond (made up of a single element), the main families are the halides, oxides, sulfides, carbonates, organic compounds, phosphates, and silicates. These families are further divided into sub-families, within which each specimen is unique. Indeed, pressure, humidity, temperature, and oxygen levels are never identical from one site to another, creating specific conditions for each mineral specimen."

Considered one of the best in the world, this collection has a colorful history. In 1823, François-Sulpice Beudant, holder of the Mineralogy Chair at the Paris Faculty of Sciences, purchased 1146 minerals for a total of 5526.50 Francs,[2] almost the entire faculty budget. The collection was born.

In 1847, his successor Gabriel Delafosse added another 5000 specimens. At the end of the 19th century, while awaiting construction of the new Sorbonne University, the collection was stored in a warehouse in appalling conditions. Not better looked after in its new home, and open to the general public, the collection further deteriorated. Few of the originally acquired specimens survived this ordeal. Finally, in 1969, the collection was transferred to the newly created UPMC on the Jussieu campus. >

8

© Photos : O. Martinelli

9 This piece of pure silver comes from Kongsberg in Norway. In the 18th century, King Christian VII of Sweden presented the mine's best specimens to different sovereigns throughout Europe.

10 It took four years for Jean-Claude Boulliard to acquire these magnificent rutiles on hematite crystals.

11 This aquamarine specimen, called "Manhattan," was acquired in 1989.

12 Specimens of calcite and sphalerite.

13 This fluorite, with its electric-blue crystals, comes from Beix in France's Puy-de-Dôme region.

14 This is a rare specimen because it combines both vanadinite and goethite. It was extracted from a deposit in Taouz, Morocco.

> When he became director of the collection in 1998, Boulliard "dusted it down" and transformed it into a department comparable to a research laboratory, where rock samples are made available to researchers. Dozens of scientists are granted access to the collection every year. Of course, the items on display are much too precious to lend out, so to meet researchers' demands, Boulliard draws on the collection's reserves: 15,000 specimens which represent 1600 of the 4400 species currently known. These minerals are a valuable research tool for scientists in a number of disciplines: solid-state physics, spectroscopy, archaeology, and even biology. "The first life forms are believed to have developed in rock layers from which they fed to survive," explains Boulliard.

He regularly refreshes the collection, both the items on display and those in the reserve, "otherwise it would soon become outdated." But this task is far from simple. "Long gone are the days when you could launch an expedition and dig on target sites," he explains. "Today, the deposits are exploited by professionals who sell what they find on the minerals market." And this market has literally exploded in recent years, especially online.

Today, good specimens will often sell for over €100,000 each. Yet Boulliard's annual specimen purchasing budget is just €15,000. "To make the best of this limited budget, I look for bargains, and speculate on specimens that are likely to become more valuable when their source deposit closes." He leads us to his office–which extends into an enormous workshop–and carefully opens a cardboard box sitting on top of a naturalist's cabinet, revealing a forest of mauve and purple crystals. "This is a fluorite that I purchased for a very reasonable price from a trader who appreciates our collection." Will it be cleaned or cut to enhance its natural beauty? "Our specimens are cleaned in an ultrasonic bath, but they are never cut; they are all displayed in their natural state."

The estimated value of the treasure guarded by Boulliard is tens of millions of euros. But its scientific, historical, artistic, and sentimental value is priceless.

Emilie Badin

1 Institut de minéralogie et de physique des milieux condensés (CNRS / Universités Paris VI and VII / IPGP/ IRD).
2. Approximately €12,000 in today's currency.

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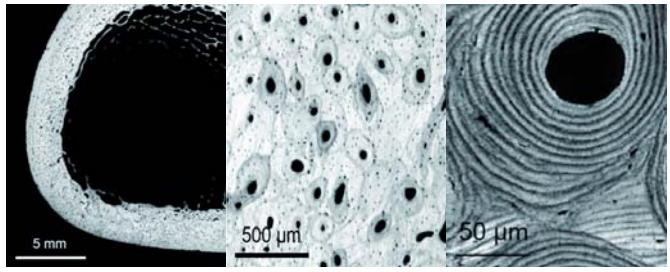
ULAB

Franco-German Cooperation to Fight Osteoporosis

To better understand and detect osteoporosis, French and German researchers are developing ultrasound-based scanners that are both more efficient and less harmful to patients.

Bone ultrasound microscopy at various scales can determine bone structure at the micron level.



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© LIP et Q-BAM, Berlin

This device uses ultrasounds to predict the risk of osteoporosis-related fractures.

By 2015, newly developed ultrasound scanners could make osteoporosis-related fractures preventable. This is the main objective of the European Associated Laboratory ULtrasound Assessment of Bone (LEA ULAB), which was created in 2008. It brings together the Parametric imaging laboratory (LIP)[1] in Paris and two German laboratories, Q-BAM in Berlin and MPRG in Kiel,[2] and formalizes collaborations initiated as early as 2002 by LIP's director Pascal Laugier. In France, three million women–half of all women over 50–suffer from osteoporosis, a disease that affects bone mineral density and leads to increased risk of fracture. Even worse, 20% of osteoporotic women with a fractured hip die in the year following diagnosis usually from complications related to surgery. Osteoporosis has thus become a major public health concern, with hospitalization and healthcare costs running into the millions of euros.

Faced with this increasingly widespread disease, part of the solution is of course to develop more effective treatment. But early detection can also play a significant role to prevent future fractures whenever possible. Over the past few years, the Franco-German team has been developing a new generation of screening tools that could facilitate this process. Current diagnosis techniques based on X-rays can rapidly test for bone fragility. But X-rays are ionizing radiation, both toxic and carcinogenic. New medical imaging techniques based on ultrasound offer two major advantages that hold great promise. First, they use sound waves, which are non-invasive and perfectly harmless. And second, they reveal the elastic properties of matter, which enables early detection of subtle weaknesses of bone structure. This significant improvement in testing and screening offers unparalleled scope for bone research.

LIP has already created two patented ultrasound systems, one for the calcaneus (heel bone)–1000 of which have been sold in some 40 countries–and a second for the forearm bones. A third device should soon be available for the femur neck. Currently undergoing clinical trials, its development was part of a European project (between 2003 and 2007) associating MPRG in Kiel, a world leading group expert in clinical transfer, LIP and Sulzer, a Swiss SME.

Despite their high performances, these devices are still unable to probe matter at the submillimeter scale, which would help us understand how the tiny alterations that may occur at the level of the fundamental constituents of bone tissue affect the entire bone. This is where Kay Raum, from the Julius Wolff Institute in Berlin, and his specialized acoustic microscopy team come in. By using high-frequency ultrasound waves from 200 Mhz to 1 Ghz, they can probe the elastic properties of matter right down to the components of bone tissue.

The new information obtained at this scale is giving researchers a better understanding of the origin of the mechanical resistance properties of bones, and thus is helping them optimize diagnostic systems. This method, combined with others developed by LIP, makes it possible to investigate bone structure at different scales.

ULAB, which involves 16 researchers and PhD students, already has 20 publications and 2 filed patents to its name. This Franco-German collaboration is already set to develop new ultrasound systems to complete the set of diagnostic tools already available to understand bone's complex structure. Bone is a composite material, mineral, porous, elastic, hierarchically organized, continuously renewed, and able to curb the propagation of micro-cracks and biomechanical stress to protect its overall biomechanical competence. The interactions that connect each hierarchical level to the upper scale level, taking into account mineralization, porosity, stiffness, and structural aspects are still to be fully elucidated to optimize ultrasound-based models that predict the risk of fractures.

Progress in this field could be accelerated by federating existing European research on osteoporosis. ULAB, as the first European associated laboratory on osteoporosis, is definitely leading the way.

Séverine Lemaire-Duparcq

1. Laboratoire d'imagerie paramétrique (CNRS / Université Paris-VI).
2. The B-Bild-Sonographie und akustische Mikroskopie (Q-BAM) laboratory of the Julius Wolff Institute & Berlin-Brandenburg School for Regenerative Therapies at the Charité Universitätsmedizin in Berlin, and the Medical Physics Research Group at the University of Kiel (MPRG).

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Doyle McKey
Interaction Explorer

From the forests of Cameroon to the savannahs of French Guiana and cassava fields of Amazonia, Doyle McKey's "playgrounds" are never far from the equator. For this evolutionary ecologist, the tropics are a treasure trove of biodiversity. "You can sometimes find as many as 30 species of the same genus in the same place. This wealth makes comparative biology possible on a level that cannot be achieved in other ecosystems," he explains.

The 60-year old American is a specialist in plant-animal co-evolutionary interactions at the Center for Functional and Evolutionary Ecology (CEFE)[1] in Montpellier. Over his career, he has developed three major research topics: the association between plants and ants, the evolution of manioc (or cassava, as it is also widely known) under domestication, and lastly the archaeological and ecological study of the coastal savannahs of French Guiana.

As a boy, this native of Texas dreamed of becoming an explorer, like his heroes Davy Crockett and Daniel Boone, or a naturalist like his scoutmaster at the time. When it came to choosing the university he would attend, McKey gave preference to those programs that promised the most field training, and eventually leaned towards wildlife management. There, he discovered tropical ecology and "took the bait," in his own words. Internationally-renowned ecologist Daniel Janzen[2] became his thesis supervisor. While McKey was learning Spanish and planning work in Costa Rica, Janzen suggested a different research project in Cameroon. "Five weeks later, I took off for Africa with two books: 'Teach Yourself French in 90 days' and 'The Three Musketeers.'" He mischievously adds that "these were quickly replaced by the San Antonio detective novels." He began seven years of doctoral work, including four years in the field. "The years spent in Cameroon gave me research ideas for the rest of my life!"

His French considerably improved, he became an "avid Francophile," married a Frenchwoman, and in 1995 landed a position with Montpellier-II University at CEFE, where his wife was already employed.

When he arrived in France, he began research on manioc alongside his studies on ant-plant interactions, which he had been pursuing relentlessly for several years. The scientist and his students empirically demonstrated how Amerindian farmers sustainably manage their manioc fields by combining clonal propagation of the plant and its sexual repro-

WORKING IN A FRENCH LAB, PRACTICAL INFORMATION:

The Kastler Foundation (FNAK): Helps foreign researchers settle in France and maintains contact after their departure.
→ www.fnak.fr

Foreign embassies and consulates in France:
→ www.diplomatie.gouv.fr/annuaire/

French embassies and consulates abroad:
→ www.expatries.diplomatie.gouv.fr/annuaires/annuaires.htm

Association Bernard Gregory: This association helps young PhDs from any discipline make the transition into business.
→ www.abg.asso.fr

France Contact will help you plan and arrange your stay in France:
→ www.francecontact.net

Edufrance: Information on France's higher education programs–course enlistment, grant and fellowship applications.
→ www.edufrance.fr

GRANTS/FELLOWSHIPS

EURAXESS
This portal provides information on grants, fellowships, or positions available throughout Europe as well as practical information (accommodation, childcare and schools, healthcare...) for each country.
→ **http://ec.europa.eu/euraxess/**

5TH STIC-AMSUD CALL
Calls for submission of research-development projects in all topics related to Information and Communication Sciences and Technologies were just issued. Projects must include at least two participating South American countries, and one French scientific team.
→ **Deadline:** May 15, 2010.
→ **www.sticamsud.org**

ÉGIDE
Égide is a non-profit organization that manages French government international mobility programs. Many funding opportunities are listed on the website, and most content is in English.
→ **www.egide.asso.fr**

CNRS AGREEMENT WITH DENMARK
CNRS and the Danish National Research Foundation (DNRF) have signed an agreement to strengthen scientific cooperation between France and Denmark. It includes a mobility program that provides funding for travel expenses, accommodations, and running costs. Applications can start as early as three months after submission throughout the year.

duction (by incorporating volunteer seedlings as new clones) to conserve the diversity and adaptive potential of manioc. This research won him the Terra Ficaria[3] prize in 2006. The following year, he launched an extensive interdisciplinary project on the coastal savannahs of French Guiana.[4] This landscape is characterized by a multitude of small mounds, remnants of pre-Columbian raised fields. These mounds have survived 800 years of neglect and tropical rain. McKey suspects this is because "these man-made landscapes were maintained by ecosystem engineers such as plants, earthworms, termites, ants, and others; yet another story of interaction."

Caroline Dangléant

1. Centre d'écologie fonctionnelle et évolutive (CNRS / Université de Montpellier-I, -II, and -III / Ensa Montpellier/ Cirad / École pratique des hautes études, Paris).
2. Daniel Janzen received the Crafoord Prize in 1984, the equivalent of the Nobel Prize for Ecology.
3. Awarded by the Fondation Yves Rocher/ Institut de France.
4. The coastal savannah project, funded by CNRS within the framework of the interdisciplinary program "Amazonie II," brings together biologists, ecologists, soil scientists, anthropologists, archeobotanists, and archaeologists.

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→ **Deadline:** December 31, 2010.
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→ **www.dg.dk**

INTERNATIONAL REINTEGRATION GRANTS (IRG)

Marie Curie's IRGs offer financial assistance to researchers who wish to return and find a job in Europe after having held a research position in a country not part of the EU and not associated to FP7. The duration of these grants is between 2 and 4 years. This is a continuous call with cut-off dates.

→ **Deadline:** Sept. 7, 2010.
→ **http://cordis.europa.eu**

Rachel Sherrard
An Englishwoman in Paris

When she began her medical studies at the University of Sheffield (England) in 1977, Rachel Sherrard could never have guessed that this was just the start of a long journey, not only in science, but across the world.

Originally from the British spa town of Bath, this neuroscience expert has just spent nearly 20 years in Australia, where she carried out most of her original work on repair of the damaged cerebellum. Since 2007, she has settled at Pierre and Marie Curie University, on the Jussieu campus in Paris.

During her medical coursework, Sherrard completed a degree in cell biology, a doctorate in neuroscience on the development of the cerebellum, and a three-year internship in a clinic. As she was coming to the end of these studies, her husband, also a medical researcher, was offered a position in Brisbane, Australia. The two took up the challenge, and from then on, moved every five to seven years from one part of the country to the other.

"It was definitely tough!" she exclaims. Particularly in Townsville (northeast) and in Perth (southwest), two universities where the couple was involved in setting up new medical curricula. In both cases, Sherrard found funding to set up a new laboratory and managed both research teams and students, while at the same time pursuing her own work on the cerebellum and a brain protein called Brain-derived neuro-trophic factor (BDNF). "This protein facilitates connections in the brain and hence assists essential activities like learning, memory, emotions, and motor skills," she explains.

"When the brain is damaged by cranial trauma, stroke, tumor, or degenerative disease, this affects intercellular connections and causes functional deficit." Therefore a rat with a damaged cerebellum displays poor synchronization when walking during tests on an exercise wheel, and in a swimming pool, it is unable to learn how to find an escape platform and has to keep swimming. "My hypothesis was that injection of this natural brain protein could let the rat repair its damaged neuronal circuits, and then recover better motor coordination." And this proved correct: experiments showed that the rat's motor skills did improve. An initial article on the effects of BDNF injections was published in 2001. "It was a real first. The protein enabled the recreation of a natural circuit, the drawing of a new map between previously isolated cells," Sherrard explains. "Using these newly developed connections, the rat recovered the chain of commands leading to a coordinated movement." Yet the mechanisms by which these connections choose the right path to the correct target cells remain a mystery. "It is now up to us to explain this delicate equilibrium."

Twenty-five articles later, she is still looking for answers. "In Australia, I no longer had any time for my research. So in 2006, I applied for a European Commission Marie Curie fellowship to work at the Neurobiology of Adaptive Processes Unit[1] led by professor Jean Mariani on the Jussieu campus, with whom I had been collaborating on a regular basis. I have just been awarded a position to lead a research program called 'Repairing an Aging Brain.'"

On such a drastic change from Australian to French culture, Sherrard is unfazed. "My husband and I have spent many holidays in France and I love this country."

Camille Lamotte

1. Neurobiologie des processus adaptatifs (CNRS / Université Paris-VI).

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Spain Invests in Scientific Research

In terms of research and development, Spain's ambition has recently moved up a notch. During the 1990s, the implementation of a proactive scientific policy had helped the country catch up with its European neighbors, by developing skills in highly competitive research avenues.

In 2007, the Spanish education system underwent a major reform as part of the "2015 University Strategy" aimed at greater autonomy and specialization of the country's 77 universities.

Today, at both the state and regional levels (Spain holds 17 regions), there exists an unprecedented ambition to boost R&D. The percentage of GDP devoted to R&D is set to increase from 1.35% in 2008 to 2.2% in 2011 and 2.6% in 2015. Backing these promising figures, this ongoing research drive aims to fuel first and foremost the government's new economic model, in particular through a triple alliance between science, society, and technology transfer.

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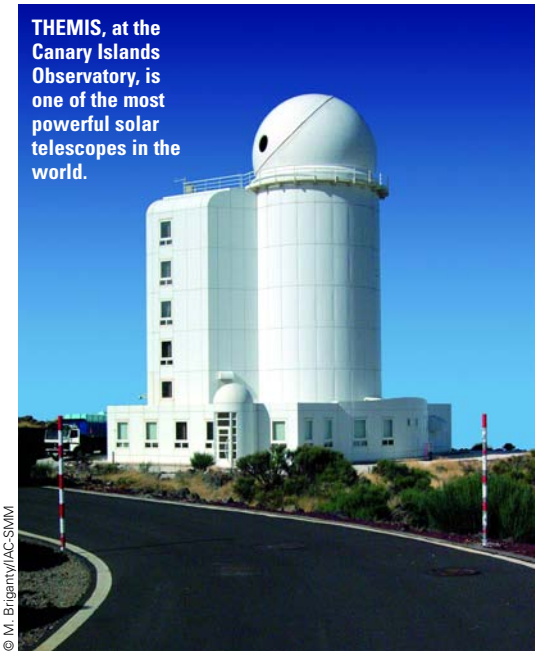
IN FIGURES

- **46,661,950** inhabitants (2009)
- **1.35%** of GDP allocated to R&D (2008)
- **193,024** researchers in 2006
- **32,275** scientific publications in 2007 (Sources: SCI (DVD Edition; Thomson Reuters)
- **1320** co-publications with CNRS (2/3 with the CSIC)
- **3290** CNRS research trips to Spain in 2008 (5th foreign destination for CNRS researchers)



THEMIS, at the Canary Islands Observatory, is one of the most powerful solar telescopes in the world.

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A National Science and Technology Strategy (ENCYT)[1] has been designed, and planned up to 2015. The first part of this strategy, the VIth National Plan for the 2008-2011 period, has already been allocated a total budget of €48 billion. During the past two years, priority was given to health, biotechnology, the relationship between energy and climate change, and to telecommunications and information technology.

Despite the current economic crisis in the country, the Spanish government is counting on the full commitment of the seven public research organizations[2] under the authority of the Ministry of Science and Innovation, and in particular on the Consejo Superior de Investigaciones Cientificas (CSIC), the country's most important research organization.

This Spanish equivalent of CNRS employs over 12,000 people in 128 intramural or joint research institutes and 152 associated laboratories, mainly in Madrid, Andalusia, and Catalonia. With more than 3000 researchers and an annual budget of nearly €880 million (2008), the CSIC, a state-owned agency since 2008, covers most research fields and has been CNRS' historic partner since 1957. But the government is also relying on the R&D activities of its university network which comprises 49 public and 19 private universities. Of particular importance are the Polytechnic Universities of Madrid and Barcelona, the Autonomous University of Madrid, and the universities of Barcelona, Salamanca, and Santiago de Compostela, which stand out by the quality of their PhD courses and by their research and technology transfer programs.

On the world stage, Spain intends to strengthen its relationships with its main partners. In that regard, the country takes part in the operation of 11 very large-scale research facilities in the fields of astronomy, botany, oceanography, and micro- and opto-electronics. These facilities are the subject of various collaborations with the country's three major partners: the US, followed by the UK and

© IRAM/Rebus

The 30-meter telescope located on Pico Veleta, near Granada in Spain.

ERC REWARDS CATALAN EXCELLENCE

A striking example of a prolific new generation of researchers, Spain ranked fourth in the second Starting Grants competition of the European Research Council (ERC) in 2009 with 17 grants, behind the UK (43), France (31), and Germany (28). Among these, nine were granted to the region of Catalonia. Similarly, six of the ten Advanced Grants awarded to Spain in February 2010 went to research teams in Catalonia. This shows the major role this region is playing as a window of Spanish excellence within the European Research Area.

France tied in second position.

The current collaborations with France involve new fields like oceanography and computing grids. Both countries are members of the European Consortium for Ocean Research Drilling (ECORD), along with 14 other European Member States.

CNRS and CSIC are also key players in the implementation of the European Grid Infrastructure, a powerful grid computing system eagerly awaited in disciplines ranging from biology/medicine to thermonuclear fusion and astronomy.

Besides, CNRS and Spain are pursuing their close collaboration on very large-scale research facilities. The international research institute for radio astronomy (IRAM),[3] for example, located in France (Grenoble), is using the Pico Veleta Telescope (near Granada), and the Plateau de Bure Interferometer, in the French Alps. Other collaborations involve the Canary Islands Observatory, the Paul Langevin Institute, the European Synchrotron Radiation Facility, and the underground laboratories of Modane and Canfranc. Both countries are also members of the European Organization for Astronomical Research in the Southern Hemisphere (ESO) and the European Space Agency (ESA), which involves collaborating on focal instruments for both ground and space telescopes.

In addition to these major international projects, Franco-Spanish collaboration includes bilateral agreements between CNRS and the Spanish Ministry of Science or the CSIC to promote exchanges between researchers in all fields. This allows a number of researchers from both countries to work in partner labs across the border.

Moreover, for research areas that were made a priority by both countries, Spain contributes to the success of cooperation tools developed by CNRS. Nine International Projects for Scientific Cooperation (PICS) were created in 2010, four of which are based on life sciences, one of the four strategic priorities of the VIth National Plan. The two Franco-Spanish European Associated Laboratories (LEA) in chemistry and social sciences and humanities will soon be joined by the all-new LEA "TALEM," dedicated to nanomaterials–another emerging field ripe for collaboration (*see box*). As for the 10 European and International Research Networks (GDRE/I) in which Spanish laboratories participate, they are mostly part of a longstanding partnership in social sciences and humanities, physics, and life sciences. CNRS also contributes to the Picasso mobility program as part of the Hubert Curien partnership, which funds researcher travel expenses involved in Franco-Spanish projects. In 2009, 34 joint research projects were selected, 8 of which are in life sciences and involve teams from CNRS and Catalonia.

Séverine Lemaire-Duparcq

1. Estrategia Nacional de Ciencia y Tecnología.
2. Organismos Públicos de Investigación (OPI).
3. Institut de radioastronomie millimétrique.

PARTNERSHIP

A FRANCO-SPANISH NANOSCIENCE PLATFORM

The Franco-Spanish Transpyrenean Associated Laboratory for Electron Microscopy (TALEM) currently being set up will bring together approximately 50 researchers and engineers from both CEMES[1] in Toulouse and the Institute of Nanoscience of Aragon (INA)[2] in Saragossa, in the field of nanoscience and nanomaterials.
This should create a unique technological platform in Europe, where the two partner countries can pool their resources. Researchers there will have access to the latest in high-resolution imaging techniques, electron energy loss spectroscopy (EELS), Lorentz imagery, and electronic holography.

1. Centre d'élaboration des matériaux et d'études structurales (CNRS).
2. Instituto Universitario de Investigacion en Nanociencia de Aragon.

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AIRBUS

CNRS Takes Off with the A380

Last November, Air France became the first European airline to operate the Airbus A380, the largest passenger airliner ever built. From parts-assembly to on-board software, CNRS and Airbus are working hand in hand to develop tomorrow's airplanes.

© G. Rolle/RÉA

Photographed for posterity at the controls of the A380 flight simulator, Ali Zolghadri is all smiles, and with good reason. Tested under operational conditions (real-time takeoff, terrain avoidance, and landing), the two algorithms for diagnosing flight control system failures, developed by his team at the IMS laboratory,[1] have given very satisfactory results. "Flight control system failures have to be dealt with very carefully," Zolghadri explains. "Any failure must be detected and neutralized as fast as possible, because in certain circumstances they may have an influence on structural loads and handling."


© ARIA team Airbus 3

Ali Zolghadri in the cockpit of the A380 simulator.

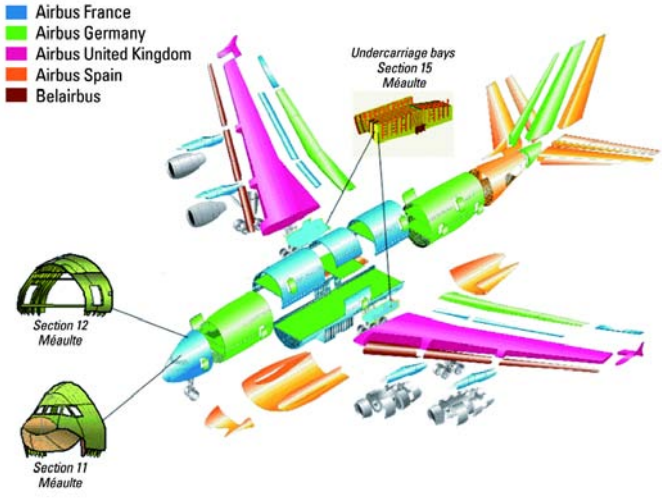
International airworthiness regulations, applied worldwide by all aircraft manufacturers, require rigorous design precautions to be taken in order to detect these failures at a very early stage and be able to neutralize their effects. The A380's on-board software fully complies with current regulations. This software could be adapted for the next aircraft models that Airbus[2] is scheduled to roll out, keeping up with technological innovations and any change in regulations. "Protected by patents jointly held by Airbus, CNRS, and the University of Bordeaux, these two robust and high-performance algorithms will perhaps be used in Airbus's future airplanes like the A350 XWB or the A400M," Zolghadri hopes.

Already moving forward, CNRS and Airbus are now working together within a new European research program dubbed ADDSAFE,[3] in which IMS is the only French lab involved. The main objective of ADDSAFE is to support, in the context of overall aircraft design optimization, the application of innovative technologies for model-based fault detection and flight control system diagnosis. This will help make future airplanes lighter, a key objective for manufacturers to limit both fuel consumption and environmental impact.

The assembly process is another crucial step that can always benefit from new improvements. This is where LAMFA[4] comes in, and especially a young researcher named Benoît Bartoux, who has created an algorithm that can optimize the assembly of one of the A380 fuselage's forward sections. "The current decision-support software used to assemble this section doesn't take into account the technical distances required between each part, which guarantee the aerodynamic properties of the entire plane," he explains. "This has to be checked manually, which can take anywhere between several hours to two days, in a context where production rates are sometimes based on the assembly of a plane in a single day."

It is easy to see the potential of this new algorithm, which could entirely automate the assembly process. After a successful test on the A380's section 12 assembly line, this algorithm is now ready to tackle the assembly of an entire plane–like the future A350. "We also see potential applications for car and train assembly lines," adds Bartoux.

Other joint CNRS/Airbus projects for the A380 are under way. The LAAS[5] in Toulouse has, for instance, found a way to optimize the route used to transport parts of the airplane. The VERIMAG[6] laboratory has developed a specific programming language for most of the onboard software. And in Paris, the LIENS[7] manufactured the ASTRÉE[8] static analyzer, which Airbus



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The parts of the A380 are manufactured at various European sites. A collaboration between Airbus and CNRS related to the assembly of one section. The tests, which were successful, were carried out on section 12 at the Méaulte site (northern France).

With its 850 passenger capacity, the A380 is the largest commercial airliner ever built.

uses to demonstrate the absence of errors when running the electrical flight control software.

More generally, Airbus and CNRS are working together on many aspects related to the development of next-generation aircraft. The effect of environmental radiation sources on onboard electronics, weight and noise reduction, research on trailing vortices, materials, aerodynamics, combustion, and the impact of aircraft on the upper atmosphere are just some of the topics they'll be exploring.

Jean-Philippe Braly

1. Laboratoire de l'intégration du matériau au système (CNRS / Institut Polytechnique de Bordeaux / Université Bordeaux-I).
2. Based in Toulouse, Airbus is a subsidiary of the EADS group, and is a world leader in aircraft construction.
3. Advanced fault diagnosis for safer flight guidance and control.
4. Laboratoire amiénois de mathématiques fondamentale et appliquée (CNRS / Université de Picardie Jules-Verne).
5. Laboratoire d'analyse et d'architecture des systèmes (CNRS).
6. CNRS / Université Grenoble-I / Grenoble-INP.
7. Laboratoire d'informatique de l'École normale supérieure (CNRS / École normale supérieure).
8. Analyse Statique de logiciels Temps-RÉel Embarqués.

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DENDROTECH

There's History in Wood

Dendrochronology, a method of dating wood by analyzing growth ring patterns in trees, is a powerful means for understanding historical wooden structures and buildings. Yet professionals in monument restoration are still far from making use of all its potential, perhaps because of its somewhat outdated image," says Yannick Le Digol. To put this right, the young archaeologist co-founded the start-up Dendrotech in 2006 with Vincent Bernard, a researcher at the CREAAH.[1]

Hosted by the University of Rennes-I, this start-up uses the synergy between archaeology and dendrochronology for research into the history and restoration of France's national heritage. "Dating is just the first step, but it needs to be correctly interpreted to reconstruct the history of a building," explains Le Digol. "To do this, we carry out a thorough investigation in the field, gathering as much information as we can about the way the wood was cut up, the types of tools that were used, etc."

To reliably date wood, it is necessary to compare its growth pattern with a known sample from the same period, the same species and, if possible, the same region. A scientific cooperation and technology transfer agreement with the University of Rennes-I and CNRS gives Dendrotech access to the most advanced technologies in wood sampling and dating, as well as to the most recent reference data on the growth rate of trees, through historic and prehistoric periods.

In return, the company enriches CNRS' reference data with all the measurements it collects on growth rings found in the wood of historical structures.

In August 2008, Dendrotech went live with Dendrabase, a public-access online database on the company's website.[2] "For every site we work on, we incorporate the dating measurements and their interpretation, provide graphics about the architecture of the building, and the contact details of our colleagues," Le Digol explains. "There is also a geolocation system that can be used to locate the sites. With all this in place, we're hoping to contribute to the dissemination of knowledge and strengthen the network of all those involved in the preservation of the built environment."

Since its launch, Dendrotech has worked on over a hundred publicly-owned sites. The company has used dendrochronology to date buildings like the La Psalette cloister in Nantes (built between 1462 and 1465), the Norman keep in Chambois, Normandy (1159-1192), and the Drezeux mill, in western France (1394-1417, for the oldest part). Today, the company is trying to break into the private real estate market with the same goal: to help preserve our heritage, and focus efforts on what's really worth saving.

Marie Lescroart

1. Centre de recherche en archéologie, archéosciences, histoire (CNRS / Universités de Rennes-I and -II / Ministère de la Culture et de la Communication / Université de Nantes).
2. www.dendrotech.fr

In the Château de Médavy (Normandy), the roof timbers were dated using dendrochronology. This cast fresh light on the building's history.

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PARTICLE PHYSICS

CERN Paves the Way for New Physics

The Large Hadron Collider (LHC), the most powerful particle accelerator in the world, was re-started November 20th, 2009, at CERN. Michel Spiro, former director of CNRS's National Institute of Nuclear and Particle Physics (IN2P3), has just been elected president of the CERN Council.

What is CERN and what role does its Council play?

Michel Spiro: CERN is the European Organization for Nuclear Research. It has 20 Member States (18 countries in the European Union, plus Switzerland and Norway). The CERN Council sets the overall scientific strategy and allocates funding to the laboratory, located under the Franco-Swiss border near Geneva. The laboratory employs 2250 people, hosts 10,000 users from across the world, and has an annual budget of €650 million. As the Council's president, my job is to ensure that the Member States reach decisions and adopt joint resolutions at the four annual Council meetings.

What will you be focusing on during your mandate?

M.S.: My mandate, which lasts three years, comes at a crucial time for CERN: it coincides with the launch of the LHC, the largest and most ambitious machine ever built for particle physics. The first scientific results, which should come in during my mandate, will influence the future of the discipline in Europe and the world for the next two decades. As you can imagine, these results are eagerly awaited by every physicist on the planet.

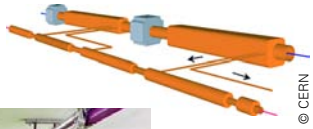
After a one-year delay, the LHC began operation at the end of 2009. What is the revised schedule and when can we expect the first results?

M.S.: In the coming year, we will gradually increase the accelerator's energy until the end of 2010, when it will reach half its nominal energy–in other words, 7 teraelectron volts (TeV=10^{12} eV).[1] At that stage, the LHC will officially become the most powerful particle accelerator in the world–pushing further the high-energy frontier. This will be followed by a one-year break during which modifications will be made on the equipment. It will enable us to reach the nominal energy–14 TeV–by the end of 2012. From then on, new results will start rolling in.

The LHC's first results are highly anticipated by the entire physics community. In what way will this revolutionize the field?

M.S.: The primary objective is to discover the famous Higgs boson. This particle is currently the missing piece in the Standard Model (the theoretical basis for particle physics), which is needed to explain how particles get their mass. But the LHC might also open up entirely new areas of physics by discovering unknown constituents of matter that are even more elementary than those discovered so far, and which don't fit into the Standard Model. That would be a genuine scientific revolution and a powerful argument for building a successor to the LHC. Going beyond particle physics, the LHC could provide us with a better understanding of the entire universe. It may shed light on the disappearance of antimatter in the early universe, or on dark matter, which makes up most of the matter in the universe but whose nature is still a mystery. It could even shed light on the puzzling dark energy, which is accelerating the expansion of the universe.

For the LHC's successor, CERN is busy developing CLIC, a new particle acceleration technology.



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Is CERN already preparing for the post-LHC era?

M.S.: Yes, of course. At the moment, the scientific community is looking at a machine, which, by 2030, could possibly collide electrons and positrons (the LHC can only collide protons). Unlike the LHC, which is circular, this new machine would be linear and 30 km long. Dubbed the ILC (International Linear Collider), it could be used to study the Higgs boson in detail, provided the LHC finds it, of course. If the LHC were to discover other particles with even higher energies, then we would have to design a machine able to accelerate electrons and positrons to an even higher energy. CERN is currently working on the development of such a technology, dubbed CLIC (Compact Linear Collider). Three years from now, we should know whether it is a viable and affordable project.

Would this machine also be built by CERN?

M.S.: CERN is good candidate. Its principal asset is that it has already built the LHC and turned it into an international collaboration. Besides the 20 CERN Member States, some 80 other countries took part in the project in one way or another, by contributing researchers or supplying some of the machine's components. What's more, CERN is planning to collaborate with even more countries. Five new countries (Cyprus, Slovenia, Serbia, as well as Turkey and Israel) are currently applying for membership in the

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organization. And the possibility of opening up to countries that are even further away from Europe (Brazil, India, China, South Korea, and Canada) is being considered. All this gives CERN a head start over its main competitors–the US and Japan–and will keep it the world capital of particle physics for some time to come.

Interview by Julien Bourdet

1. One TeV is equivalent to the energy of a mosquito in flight. However, in the LHC all this energy is concentrated into one proton, which is a thousand billion times smaller than a mosquito.

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ENVIRONMENT

How Floods Affect Water Quality

In all agricultural regions, the drinking water supply is subject to various contaminations, ranging from nitrates to pesticides. Flash phenomena such as floods intensify these risks by rapidly increasing contaminant levels. This pollution, which can last anywhere from a few hours to several weeks can impact not only the drinking water supply, but also the local aquatic ecosystems. Until now, it has been impossible to convincingly link this pollution to the different processes at work during a flood.

AguaFlash, a SUDOE[1] project coordinated by CNRS and financed by the European Development Fund (FEDER) of six French, Spanish, and Portuguese teams, aims to evaluate the impact of floods on water quality and provide tools to help manage catchment areas and reduce the risks of pollution.

In its first phase, a 24-month period, the AguaFlash project will analyze water samples from four different catchment areas: the Save basin in France, the Flumen and Alegria basins in Spain, and the Enxöe basin in Portugal. It will assess both the specificity of these catchments (topography, sediment remobilization, and potential contaminant usage in local agriculture) as well as the hydromorphology of the rivers.

During the project's second phase, the data previously analyzed will be used to pinpoint the area most likely at risk of pollution during flood periods. Researchers will thus be able to create a simulation model that duplicates what happens to the watershed during flood events. This model could then be applied to any watershed, taking into context its local specifications, to determine the areas most at risk of pollution during floods.

The third phase of the project will involve studying the toxic effects of contaminants on aquatic ecosystems, using ecotoxicology tests on organisms (in this case, freshwater fish) *in situ* and in the laboratory. This is expected to provide a generic tool that would use toxicity levels in fish as an indicator of water quality everywhere.

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Spring flood of the Save river (France).

"These new AguaFlash tools will be able to factor in all the various parameters involved in agricultural watershed degradation during flooding events," explains José-Miguel Sánchez-Pérez, member of the ECOLAB[2] in Toulouse, and AguaFlash project manager. "AguaFlash will not only provide diagnostic means to predict the areas that will be most affected by pollution, but will also identify the sources of this pollution." This project could indeed revolutionize the management of drinking-water catchments.

Marion Girault-Rime

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IN BRIEF

GUINEVERE

Nuclear Waste Treatment

GUINEVERE, a low-power test reactor for accelerator-driven systems (ADS) was inaugurated in March at the Belgian Nuclear Research Centre (SCK•CEN) in Mol (Belgium). GUINEVERE was built through close cooperation between SCK•CEN, CNRS, and the CEA (Commissariat à l'Énergie Atomique) as a test model for MYRRHA, a future multidisciplinary research infrastructure in the field of nuclear science. Scheduled to begin operation in 2022-2023, MYRRHA will be dedicated, for the next 40 years, to the processing of depleted nuclear waste, to the supply of medical radioisotopes, and to the provision of doped silicon–an essential component of electronic circuits used in renewable energy applications and hybrid vehicles.

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BIODIVERSITY

A Green Wall to Stop the Desert

It could be the most ambitious eco-project ever devised: a wall of trees 7000 kilometers long and 15 wide, from Saint-Louis (Senegal) to Addis Ababa (Ethiopia), to curb the desert's spread.

Dubbed the Great Green Wall, this forest is also expected to improve living conditions in the Sahel. This project, already under way, was launched by the Community of Sahel-Saharan States (CEN-SAD). Initially constituted of just four tree species (including two species of acacia), the forest corridor should gradually be invaded by new plant and animal species, and eventually be home to rich biodiversity.

The Green Wall should also provide local inhabitants with new resources such as wood, medicinal plants, acacia resin (from which incense is produced), and even boost tourism. What's more, by limiting the spread of the sand, the wall should improve soil quality, regenerate grazing land, and thus enable farming.

The idea is to slow down the ecological migration that plagues these regions. But how will this gigantic project really impact the region? To find out, French and African researchers have come together to form an observatory of human-environment interactions.

"Our goal is to collect as much information as possible about this area, and use interdisciplinary analysis to understand the impact of such anthropogenic action on the environment and on humans," explains anthropologist Gilles Boëtsch, director of the Environment, Health and Societies Joint Unit (ESS),[1] the first Franco-African CNRS International Joint Unit.

The observatory will focus its attention on the Ferlo Valley, in Senegal, a region mainly inhabited by Fulani shepherds. The 20 or so researchers taking part in the project come from various disciplines. Anthropologists, doctors, botanists, biochemists, ecologists and modeling specialists will try to give as rich and precise an image of this valley's evolution as possible. "The data we produce will be made available to other researchers, and of course, to the local governments. In addition, we'll be collaborating closely with Senegal's Environment Ministry," says Boëtsch.

The first trees were planted four years ago. They are not very tall yet, but according to Boëtsch, within four or five years, the first social and environmental changes should be visible.

Sebastián Escalón

1. Environnement, santé, sociétés (CNRS / Université Cheikh Anta Diop de Dakar (Senegal) / Université de Bamako (Mali) / Centre national de la recherche scientifique et technologique (Burkina Faso)).

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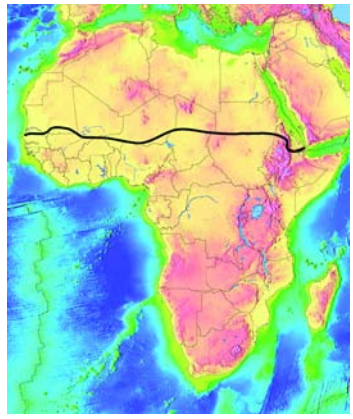
Borehole in the Ferlo region (Senegal), on the path of the Great Green Wall.



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A 7000 km Green Wall across Africa.

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INTERNATIONAL COOPERATION

Argentina

Two major collaborations with Argentina were just inititated. This March, the International Joint Unit (UMI) IFAECI[1] was inaugurated at the French embassy in Argentina. Its objectives are to observe, understand, and predict the evolution of climatic systems. Located at the Research Center of the Sea and the Atmosphere (CIMA) on the campus of the University of Buenos Aires, it will mainly associate meteorologists and oceanographers, but will also be open to all other disciplines used for climate characterization such as ecology, hydrology, and air quality analysis.

Simultaneously, an International Associated Laboratory in fluid physics and mechanics (LIA PMF) was inaugurated at the Faculty of Engineering of the University of Buenos Aires. It formalizes 25 years of scientific cooperation between French and Argentine laboratories in the field of complex flows. It involves three laboratories on the Argentine side, and four French labs. Created for a duration of four years, the LIA PMF will pool human and material resources around research areas related to flow mechanics and physics, with industrial applications in the environmental field as well as in the automotive, aeronautics, and aerospace sectors.

1. Institut franco-argentin sur l'étude du climat et ses impacts.

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USA

CNRS, the Rhodia chemical company, and the University of Pennsylvania have created an International Joint Research Unit (UMI) named COMPASS, for "Complex Assemblies of Soft Matter." This UMI will facilitate collaboration between French and North-American researchers working in the field of soft matter. The aim of this unit is to develop innovative solutions in line with the foremost standards governing environmental protection and hygiene in the area of consumer goods and industrial formulations.

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India

France and India have just signed into existence an International Associated Laboratory (LIA) in nuclear physics. It brings together CNRS, the CEA (French Atomic Energy Commission), and the BARC (India's Bhabha Atomic Research Center) for collaboration in the field of accelerators and associated instruments. One of the LIA's main projects will be to work on the construction of Spiral2, a linear particle accelerator which will produce high intensity heavy and light exotic nuclei, scheduled for launch in 2012.

2010 FRANCE-RUSSIA YEAR

France and Russia, a Very Active Partnership

Strong links already exist between France and Russia in terms of research. But with the 2010 France-Russia year and the creation of a number of new structured collaborations, the two countries are reaffirming their commitment to share scientific development and discoveries for years to come.

A major event this year, the France-Russia year will be held in both countries simultaneously. Launched on January 25th, it will involve an extensive lineup of cultural events in both countries, in which education, science, and research will hold pride of place. Research organizations and universities from both countries will organize conferences, forums, festivals, and exhibitions, with a total of 37 events scheduled.

"A wide variety of topics will be addressed including climate change, energy, health, or heritage and the study of megaregions," explains Martine Bonin, head of the Russia and New Independent States division within CNRS's Office of International Relations. "It will above all demonstrate the strong interest and willingness for cooperation in both countries."

Building on its successful collaborations with Russia in all fields, CNRS is actively participating in these events. In March, representatives of CNRS and the French Academy of Sciences participated in a formal session of the Russian Academy of Sciences' Presidium. Representatives of the latter will in turn be received, on September 28, at a session of the French Academy of Sciences. On this occasion, CNRS will organize a two-day conference (September 29-30, 2010) that will bring together French and Russian researchers using CNRS tools for advanced collaboration (International Joint Units, International Research Networks, and International Associated Laboratories). The conference will include lectures, round table discussions, and the premiere of a film on scientific cooperation between the two countries co-produced by the Russian Academy of Sciences and CNRS. For Vladimir Mayer, head of CNRS's Moscow office, "these sessions will help review and increase the visibility of collaborations between the two countries."

The relationship between climate and the environment, for example, is one of many fields in which strong cooperation already exists between France and Russia, and between CNRS and Siberian laboratories in particular. A series of conferences on this theme, centered on human activity and its economic and social impact on Siberia and the rest of the world, will be organized in the three main university centers of western Siberia: Tomsk, Novosibirsk, and Krasnoyarsk. In France, a conference involving the cities of Evian and Irkutsk will be held in Evian in May, to explore the various strategies to combat climate change.

Space research, another area of Franco-Russian cooperation, will be the subject of an international conference in October, held in Moscow. Open to the media and involving about 60 participants on the French side, this conference will be dedicated to making results of space research accessible to a large public.

Finally, in Toulouse this fall, an archaeological exhibition entitled "Crossed perspectives on the heritage of Yakutia," organized by the French Archaeological Mission in West Siberia (MAFSO) and Yakutsk State University, will present the traditional culture of the Yakut people to the general public.

Marion Papanian and Adeline Marquis

NEW AGREEMENTS

Cooperation between CNRS and Russian scientists is very active. It has recently been further strengthened with the signature of several agreements in Moscow in December 2009. On this occasion, 6 new cooperative agreements were signed, and 4 existing collaborations renewed. On the Russian side, they involve the Academy of Sciences in Moscow, Saint Petersburg, Nizhny Novgorod, and Novosibirsk, as well as laboratories from different universities and research centers.

To begin with, the Poncelet Laboratory,[1] which was created in 2002 and has been an International Joint Unit (UMI) since 2006, was renewed. It brings together in Moscow several French and Russian researchers working on a wide spectrum of mathematical problems.

Newly created collaborations include 3 International Associated Laboratories (LIAs)–2 in physics and 1 in spatial medicine. The existing LIA in environmental geochemistry was renewed. Thus CNRS will now count 13 LIAs in Russia, of the 90 or so worldwide.

Finally, 3 new International Research Networks (GDRIs) were signed in mathematics, physics of extreme light, and separative chemistry for 4th generation nuclear plants. Besides, 2 GDRIs were renewed in solid-state physics and cosmophysics. Altogether, Russia is involved in 23 of the CNRS's 100 GDRIs.

For these numerous cooperative projects, the Russian Foundation for Basic Research (RFBR) is a key partner, co-funding Russian teams. The French Embassy in Moscow offers key backing by providing PhD fellowships.

1. http://www.mccme.ru/poncelet/

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CNRS in Brief

The **Centre National de la Recherche Scientifique** (National Center for Scientific Research) is a government-funded research organization under the administrative authority of France's Ministry of Research.

Facts…

Founded in 1939 by governmental decree, CNRS has the following missions:
- → To evalulate and carry out all research capable of advancing knowledge and bringing social, cultural, and economic benefits to society
- → To contribute to the application and promotion of research results
- → To develop scientific communication
- → To support research training
- → To participate in the analysis of the national and international scientific climate and its potential for evolution in order to develop a national policy

CNRS research units are spread throughout France, and employ a large body of permanent researchers, engineers, technicians, and administrative staff. Laboratories are all on four-year, renewable contracts, with bi-annual evaluations. There are two types of labs:
- → **CNRS labs:** fully funded and managed by CNRS
- → **Joint labs:** partnered with universities, other research organizations, or industry

As the largest fundamental research organization in Europe, CNRS is involved in all scientific fields, organized into the following areas of research:
- → Life sciences
- → Physics
- → Chemistry
- → Mathematics
- → Computer science
- → Earth sciences and Astronomy
- → Humanities and Social sciences
- → Environmental sciences and Sustainable development
- → Engineering

CNRS conducts some twenty interdisciplinary programs in order to promote exchange between fields, ensure economic and technological development, and solve complex societal problems.
- → www.cnrs.fr/prg/PIR/liste.htm

The CNRS annual budget represents one-quarter of French public spending on civilian research. This funding comes from various sources:
- → Government and public funding
- → CNRS funds, primarily from industrial and EU research contracts and royalties on patents, licenses, and services provided

… And Figures

Budget for 2010
€3.11 billion of which €605 million comes from revenues generated by CNRS contracts

Personnel
33,300 employees: 11,500 researchers, 14,200 engineers and technical staff, and 7600 non-permanent employees

Organization
- > 10 thematic institutes
- > 19 regional offices, ensuring decentralized direct management of laboratories
- > 1067 research units–90% are joint research laboratories with universities and industry

Industrial Relations (2009)
- > 1663 contracts signed by CNRS with industry in 2008
- > 27 current agreements with major international industrial groups
- > 3765 patent families
- > 828 licenses and other financially remunerating active acts
- > €58.2 million in royalties
- > 503 companies created between 1999 and 2008

DAE AND DRI, TWO OFFICES DEVOTED TO INTERNATIONAL RELATIONS

CNRS carries out research activities throughout the world, in collaboration with local partners, thus pursuing an active international policy.

The Office of European Affairs (DAE) and the Office of International Relations (DRI) coordinate and implement the policies of CNRS in Europe and the rest of the world, and maintain direct relations with its institutional partners abroad. The DAE and the DRI promote cooperation between CNRS laboratories and foreign research teams through a set of structured collaborative instruments developed for this purpose. At the same time, they coordinate CNRS actions with those of other French and international research organizations as well as the activities of the Ministries of Research and Foreign Affairs.
To carry out their mission, the DAE and the DRI–with head offices in Paris–rely on a network of eight representative offices abroad, as well as on the science and technology offices in French embassies around the world.

IN NUMBERS:

Exchange agreements: 85 (with 60 countries)

Foreign visiting scientists: 5000 (PhD students, post-docs, and visiting researchers)

Permanent foreign staff members:
> About 1700 researchers of whom more than 1200 come from Europe

> **International Programs for Scientific Cooperation (PICS):** 304
> **International Associated Laboratories (LEA + LIA):** 102
> **International Research Groups (GDRE + GDRI):** 87
> **International Joint Units (UMI):** 20

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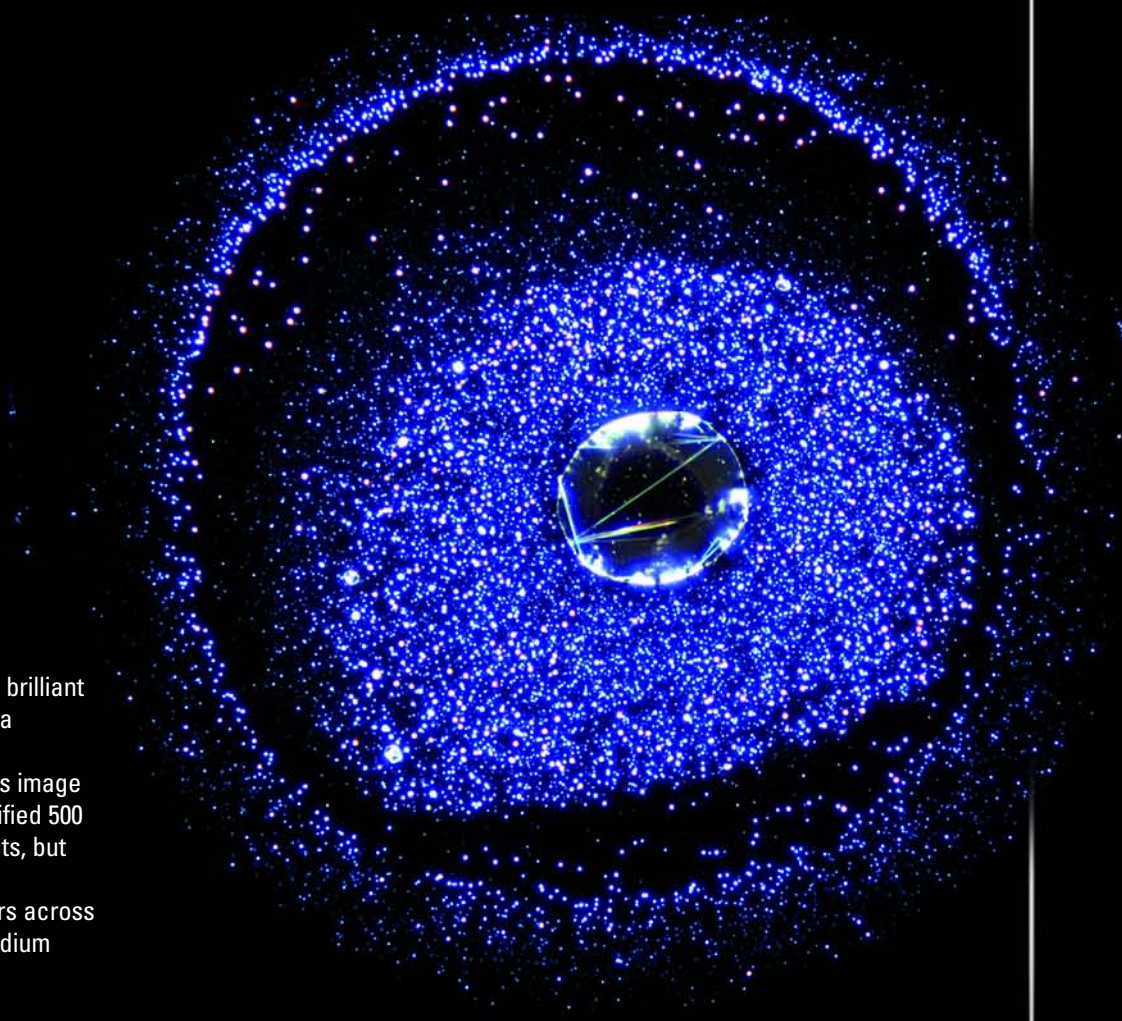
AMAZING IMAGES



Nano-Galaxy

The universe never fails to surprise: look at this perfectly circular galaxy of brilliant stars surrounding what appears to be a supermassive interstellar diamond.

The surprise is that the scale of this image is not galactic, but microscopic, magnified 500 times. The "stars" are not single objects, but rather aggregates of hundreds of nanoparticles, each only 30 nanometers across and composed of gold cores and palladium shells.

The particles were applied to the background field using ink-jet technology–used everyday in our computer printers. The crystal in the center of the dark field image is a chemical salt left over after the evaporation of the "ink" solution. The shining gold and palladium particles are designed to absorb hydrogen from the atmosphere, which causes them to swell like a sponge. This property changes the electrical conductivity of the aggregates in a way that can be measured, thus making them ideal for hydrogen detection devices. Since hydrogen is highly explosive, and likely to become more common in clean-energy cars and power stations, our future safety may well lie in these "stars."

Mark Reynolds

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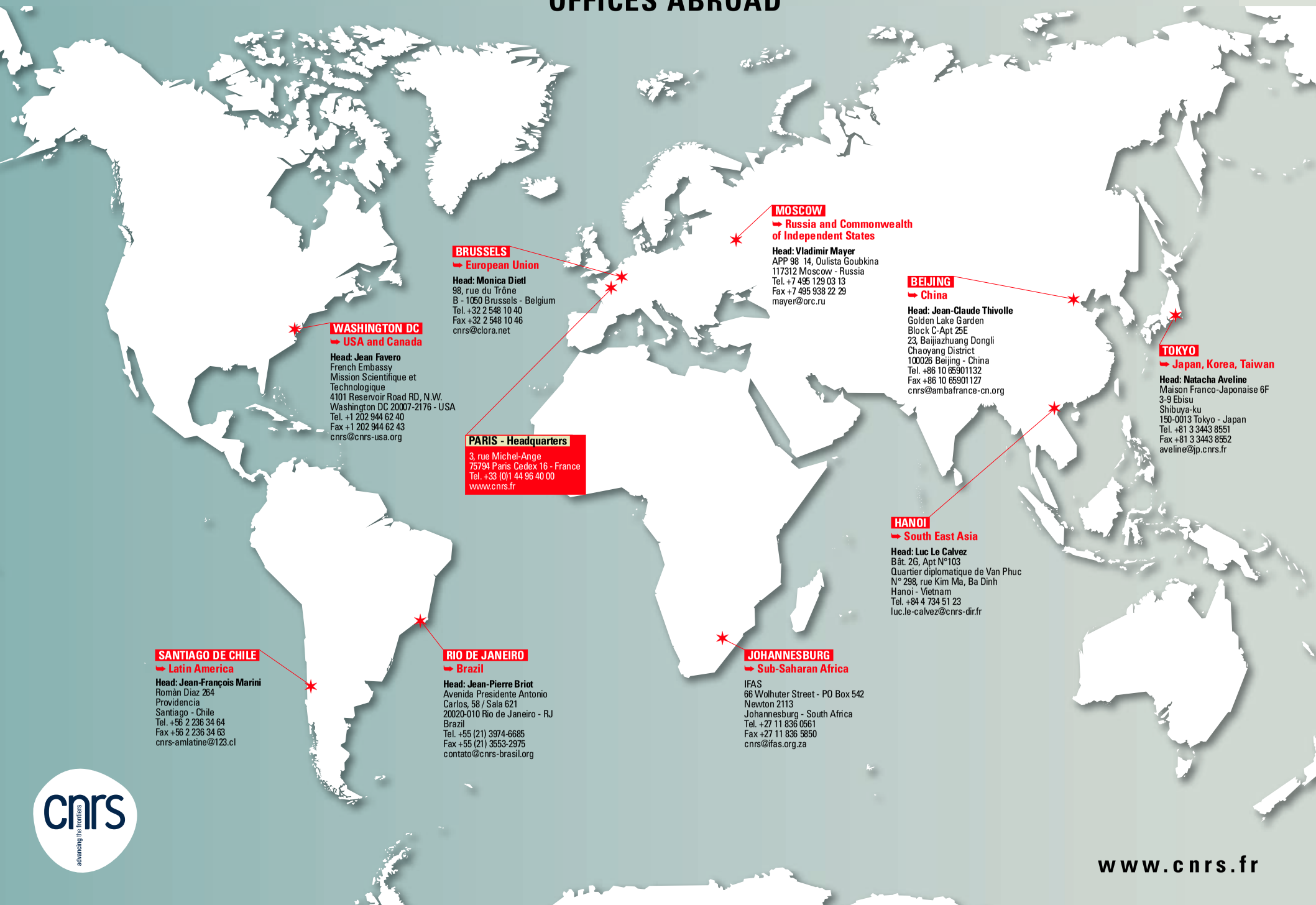
FRENCH NATIONAL CENTER FOR SCIENTIFIC RESEARCH

OFFICES ABROAD



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