2018
A YEAR AT THE CNRS
IN ALSACE
With this new publication, I would like to invite you to find out about the vitality of the research carried out in CNRS laboratories in Alsace in 2018. This selection of highlights will take you from the seabed to the edge of the stars, from Luxor to French Guiana, via a plunge into the heart of fascinating systems which may be living or not.

We need to bear in mind that this research at the frontiers of knowledge is carried out in close, regular contact with our academic partners - first and foremost universities - and that this research is constantly supported by local authorities, research actors and other support structures. Every year, CNRS medals are awarded to scientists at different stages of their careers. In 2018 the CNRS in Alsace had the opportunity to organize a collective awards ceremony and thus reveal the talents in research in Alsace along with their teams, laboratories and the discipline in which they work. At the time of writing this editorial I am delighted to hear that Professor Thomas Ebbesen has been awarded the 2019 CNRS Gold Medal. This is a further demonstration of the excellence of research in Alsace.

As we celebrate our establishment’s 80th anniversary in 2019, we can be sure that the scientists in our units will continue to make advances in knowledge for the good of society. We would like to thank all those who contributed to the production of this document. I hope you enjoy reading this brochure.

Strasbourg, August 2019

Dialogue is essential with our partners, the universities, schools and so forth with whom we share scientific priorities and resources or with local authorities with whom we have initiated new forms of collaboration. We must strengthen and improve this dialogue.

Antoine Petit, CNRS President and CEO
The CNRS bronze medal is awarded in recognition of the initial work of a promising researcher in their field.

CHRISTINE CARAPITO

“The protein mass spectrometry classes during my biotechnology engineering course fascinated me. The idea was to be able to characterize a protein to obtain a molecular image of a living system using data from a mass spectrometer which is rather like doing a puzzle. This science is at the interface of analytical chemistry and biology and has undergone a real revolution requiring the development of bioinformatics tools adapted to Big Data. I am currently working at this crossroads of disciplines on the development of mass spectrometry and bioinformatics methodologies for proteome analysis. Integrating proteome data with genome sequencing data will pave the way for the personalized medicine of tomorrow.”

Institut pluridisciplinaire Hubert Curien

SILVER MEDAL

The CNRS Silver Medal is awarded to researchers at the beginning of their careers who are already recognized at national and international levels.

BRUNO KLAHOLZ

“I was fascinated in secondary school by the structure of DNA and first became interested in chemistry which forms the basis of reactivity and molecular recognition. I later began working on X-ray crystallography to study interactions between ligands and therapeutic targets and then cryogenic electron microscopy to study large macromolecular complexes. This makes it possible to address structure-function relationships within the various nucleoprotein complexes which regulate gene expression. As I studied multi-scale integration and was involved in technological advances in electron cryomicroscopy, it was a joy to see the first side chains of amino acids and nucleotides appear on the human ribosome in 2014 (a study which began in 2003) and then to be able to visualize the chemical modifications of ribosomal RNA in 2016.”

Institut de génétique et de biologie moléculaire et cellulaire

THE WORDS OF TALENTS

JEAN-FRANÇOIS LUTZ

“The main objective of my work is to study and define the molecular structure and properties of synthetic polymers in as much detail and as easily as possible. Very early on in my research career, I realized that there was still a huge gap between the biological polymers forged by billions of years of evolution and human plastics, which are as yet unachievable with synthetic macromolecules. I apply a watchmaker’s precision to selecting simple forms of chemistry which could perhaps make it possible to make human polymers as elaborate as living polymers or even more so.”

Institut Charles Sadron
**FOCUS**

**IBMC : INAUGURATION OF THE INSECTARIUM**

(October 1st) The Institute for Molecular and Cellular Biology has inaugurated its new extension – the Insectarium – in the presence of many scientific and institutional personalities including three Nobel Prize winners Jules Hoffmann, the project’s initiator, Jean-Marie Lehn and Jean-Pierre Sauvage who work close to the site. This infrastructure is located on the Épishano campus in Strasbourg and has been designed to study mosquitoes, Man’s natural “enemies”. Although mosquitoes are only slightly larger than a centimetre in size they are still responsible for around 700,000 deaths every year from the germs they transmit and the diseases they cause (yellow fever, chikungunya, dengue fever, the Zika virus, etc.). In the Insectarium’s bioscience laboratories, biologists can closely study malaria, the most widespread parasitic disease in the world transmitted by females of the Anopheles genus. It is too simplistic a view to reduce mosquitoes to the role of passive vectors for disease because mosquitoes defend themselves against parasites and viruses with some species managing to eliminate these so that they therefore no longer transmit pathogens. Researchers aim to understand these defence mechanisms and identify the molecules involved in order to develop new prophylactic or therapeutic strategies. With this Insectarium and its investment of 9 million euros financed by the State as part of its Campus operation and the Investments for the Future programme, the CNRS and the University of Strasbourg are building a modern infrastructure on site which is unique throughout Europe in terms of size and expertise in immunology and molecular biology.

**ADVANCED GRANT**

Paolo Samori
**SUPRA2DMAT**

Objective: to implement supramolecular approaches to modulate and improve the properties of 2D layered materials to provide them with sensitivity and targeted functionalities.

Institut de science et d’ingénierie supramoléculaires

**CONSOLIDATOR GRANT**

Wiebke Drenckhan
**METAOAF**

Objective: to gain better understanding of the process of assembling bubbles in polymer foams to obtain new innovative structures and bring foams into the field of “metamaterials”.

Institut Charles Sadron

**STARTING GRANT**

Zacharie Duputel
**PRESEISMIC**

Objective: to understand how earthquakes start thanks to a new generation of probabilistic models.

Institut de physique du globe de Strasbourg

**STARTING GRANT**

Pawel Dydio
**REVERSE&CAT**

Objective: to develop a strategy to modify molecules’ reactivity scheme using a new concept: the temporary creation of the non-inherent reactivity of a substrate.

Institut de science et d’ingénierie supramoléculaires

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**PRICES AND DISTINCTIONS**

- Prix Fondation Uniistra-Ourisson
  - Cercle Gutenberg
  - Raphaël Côte - IRMA
  - Thomas Hermans - ISIS
  - Albert Weisbaumer - IGBMC

- Nobel Prize in Chemistry
  - François-Joseph Amiel
  - François-Joseph Amiel

- First Prize of the CNRS
  - Nicolas Martin - Observatoire astronomique de Strasbourg

- Prix de la Fondation André-Roman Pineau
  - Les Espoirs de l’Université de Strasbourg
  - Julia Autin - IGS

- Prix de la Fondation Samor - IGBMC
  - Christine Carapito - IFPC
  - Anaïs Collet - SAGI

- Prix de la Fondation Lemaître-LEO - IPSMS
  - Emilia Delahaye-Lemo - IPCMS

- Prix de la Fondation Lemaître-LEO - IPSMS
  - Nicolas Martin - Observatoire astronomique de Strasbourg

- Prix de la Fondation Beauséjour
  - Les Espoirs de l’Université de Strasbourg
  - Julia Autin - IGS

- Prix de la Fondation de l’Institut de France
  - Nicolas Martin - Observatoire astronomique de Strasbourg

- Prix de la Fondation Lemaître-LEO - IPSMS
  - Marcela Szopos - IGBMC

- Prix de la Fondation Lemaître-LEO - IPSMS
  - Pierre Chambon - IGBMC

- Prix Infosys Prize in Mathematical Sciences
  - Nanli Anantharaman - IRMA

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**CYRÈCE IS 10 YEARS OLD!**

The cytosol provides researchers and clinicians with radioisotopes-tracers used for molecular monitoring, medical diagnosis and so forth. This 24 MeV particle accelerator is unique in Europe and is now beginning to be used for clinical research and industrial collaboration projects. Cyrècil will soon benefit from a new extension so this is not the last people will hear about it.

- © N. Busser

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**GENERAL PUBLIC**

**“ÉTONNANT VIVANT”, LIFE SCIENCE IN THE 21ST CENTURY**

What is Life? What are its origins, its history? What is the specific nature of Man? Over the last twenty years, biology has undergone a major turning point with the development of technological tools, the multidisciplinary approach implemented in research and the discoveries these have both already led to. In the context of the CNRS Institute of Biological Sciences’ collective project, the CNRS Regional Delegation in Alsace organized a series of events aimed at the general public based on the theme of the "The Astounding Living Dimension". The "Brain Week", conference cycles and film screenings followed by debates were among the many events which took place throughout the year. One of the highlights was the "Science Village in Strasbourg" and Kilikur which featured the re-construction of a unique space to celebrate life sciences focussing on research in Alsace. There were four main themes – What is the living dimension?, The Diversity and Complexity Of Living Things, Living Beings In Their Environment and Complexity Of Living Things – which brought together 17 participating laboratories and 130 people who shared their enthusiasm for science with an equally enthusiastic audience from the public at large.

- © N. Busser

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**HIGHLIGHTS**

**SCIENTIFIC AND INSTITUTIONAL**
King penguins, future climate change exiles

King penguins are among the first victims of global warming. As they are faced with changes in their natural environment, they have no choice but to take evasive action.

One of the key steps in the expression of our genes is the transcription phase, i.e. the synthesis of RNA molecules from DNA, the gateway to protein production. This synthesis mechanism is carried out by a complex enzyme, RNA polymerase, which moves along the DNA like a sensor head, and copies it into RNA. This essential process in all forms of life is regulated by many factors. To better understand the dynamic nature of this mechanism, researchers used cryogenic electron microscopy coupled with 3D reconstructions and succeeded in obtaining a “snapshot” of this machinery in “pause” mode for the first time.

The aggregates responsible for Charcot disease...

Charcot disease - or amyotrophic lateral sclerosis - is a neurodegenerative disease that leads to muscle paralysis which is generally incurable and fatal. The causes of this pathology remained a mystery for researchers until recently, but now they have managed to identify the molecular mechanism responsible for its development. In all living cells, proteins are synthesized by complex molecular machines called “ribosomes”. Patients with the disease have blocks of sequences in a particular gene that are repeated in an abnormal fashion. These repetitions “attract” ribosomes and cause their cell death.

AIDS: how HIV modifies the way in which healthy cells function

HIV-infected cells secrete a protein called “Tat” which enters and builds up in healthy cells. Tat acts as a toxin and its accumulation damages previously uninfected cells. This Tat protein must be modified to get it out of some diseased cells. This mechanism has been clarified. It consists of a process involving the aggregation of Tat-modifying molecules within HIV virus particles. Researchers have also shown the harmful effects of this protein on certain lipids in neurons and macrophages which become unable to function because of the sequestration of these essential lipid molecules.

Some pathologies are caused by the accumulation of aberrant deposits of poorly folded or aggregated proteins in tissues. This phenomenon is common to Alzheimer’s disease and inflammatory or infectious diseases like AIDS. Affected cells are invaded by such toxic clusters and this affects how organs function. Scientists study these aggregation mechanisms to understand their origins and mechanisms and identify new therapeutic pathways. These proteins are studied from every angle including genetic analysis, structural and functional studies, chemical synthesis of analogs and so forth. Illustrations.

Focussing on aggregates

Two young old mouse lemurs who were fed from adulthood on a diet with 30% less calories. On the left, a mouse lemur on a normal diet (control group). The animal weighs about 70g and has the morphological characteristics of a younger animal. On the right, a mouse lemur on a diet with 30% less calories. The animal weighs about 55g and has the morphological characteristics of a young animal.

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Genetic mapping

What is the origin of the very high genetic diversity which can be observed within one species? A new step has been taken towards solving this major issue with the complete sequencing of 1,011 natural isolates of S. cerevisiae. This unprecedented genetic map makes it possible to trace the history of this model organism from its appearance in Asia to its use by humans in alcohol fermentation or making bread. It shows that anthropogenic environments promote genetic gain or loss as compared to natural environments and provides new insights into the relationship between information encoded by genomes (the genotype) and the expression of characteristics (the phenotype).
Autism: re-establishing social interaction

Oxytocin is a peptide which is known to improve the symptoms associated with autism. However, researchers were faced with an obstacle namely that oxytocin cannot cross the blood-brain barrier. An alternative has just been discovered, a molecule called LIT-001 which activates the same receptors as oxytocin without having this problem. This compound has been tested on mice with autistic disorders and was found to help re-establish their social interactions. This is an encouraging result which supports the idea of using this approach for the development of a new drug treatment.

An artificial model of innervated skin

A great deal of research focuses on obtaining relevant in vitro skin models which imitate the irritation or inflammation reactions observed in vivo. Innervation seems to play a central role in skin diseases such as psoriasis. A new step forward has just been taken in this field of research. Researchers succeeded in integrating functional sensory neurons derived from human skin cells in a 3D model of reconstructed skin. This new 100% human in vitro system could pave the way for studies of how the skin’s immune system communicates with the sensory nerve network.

Epigenetics, a source of hope for those with Alzheimer's disease

Epigenetic mechanisms control gene-environment interactions by modifying the way genes are expressed without affecting their DNA sequence. Neuroepigenetics is a new discipline and could lead to new applications in the treatment of Alzheimer’s disease. Researchers have shown that epigenetic changes in chromatin, the structure for controlling DNA compaction and gene regulation, are altered in mouse models of the disease. They were able to restore memory and neural plasticity in brains damaged by Alzheimer’s disease by restoring these changes in the brains of mice with a new activator, a strategy that had not previously been explored.

Living together to survive

Animals are not alone in being affected by viral diseases; plants also have to deal with many viruses. Some plants have a rather particular technique for recovery. Instead of getting rid of the virus by excluding or inhibiting it, they live with it in a tolerant state where plant and virus coexist without triggering disease. Biologists observed arabidopsis thaliana plants infected with represses mosaic virus and found that healthy leaves on such plants nonetheless contained active viruses. Researchers have found that this form of tolerance is enabled by a complex mechanism involving the production of a specific form of RNAs - siRNAs.

An innovative new technique has now made it possible to observe the activity of proteins inside the nuclei of living human cells. An immunofluorescence method already existed but involved “freezing” the cell with a risk of damaging it which thus prevented researchers observing biological mechanisms in action. With this new method, researchers introduce fluorescent compounds into cells which will bind to nuclear factors. These naturally go into the nucleus and take these small fluorescent “backpacks” with them which can then be identified using microscopes. This makes it possible to directly observe the dynamics of living cells and learn more about how nuclear proteins work.

Why do antidepressants also provide relief for neuropathic pain?

...Why can some antidepressants also be used to treat chronic pain associated with nerve damage such as sciatica? This is the question researchers have been studying in order to better understand how these drugs work. They identified two independent processes in the pain relief effect. The first allows pain to be quickly relieved through the spinal cord while the second acts more slowly and inhibits the neuronal inflammation associated with nerve damage over a period of one or two weeks.

Cross-section view of the reconstructed innervated skin model housing cell nuclei (blue), endothelium (red), epidermis (green) and sensory neuron axons (red) which require the presence of Schwann cells for optimal growth. © Acta Materialia Inc., 2018

Using gene therapy to combat Friedrich's ataxia

Friedreich’s ataxia is a rare neurodegenerative disease caused by a gene mutation: it also affects the heart and there is currently no treatment for the disease. However, geneticists are working on a promising research avenue involving gene therapy. Initial tests in 2014 showed that injecting a “normal” copy of the gene into mice significantly improved their heart function. However, the result was an elusive one: no treatment for the disease. However, geneticists are working on the development of a new drug treatment.

Children of the night: a mutation found to be the origin of the disease

Children of the night have a rare genetic disease, xeroderma pigmentosum, which makes them intolerant to sunlight and greatly increases their risk of developing skin cancer. This pathology is linked to the mutation of the gene encoding the XPC protein. Normally, this protein is responsible for repairing lesions on DNA produced by the sun’s ultraviolet rays. A new study has shown that XPC plays another unknown role, in initiating the transcription of DNA into RNA which is a fundamental mechanism in gene expression. This finding provides better understanding of this hereditary disease for which there is currently no effective treatment.

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3 million molecules analyzed to try to relieve neuropathic pain

...Neuropathic pain receives little media coverage but is nonetheless a chronic disabling disease affecting 7 to 10% of the French population. Researchers have just succeeded in demonstrating the unexpected role played by a molecule called FL3T in the induction and maintenance of pain. Their detailed study of FL3T has led to the creation of an anti-FL3T molecule which cancels out its effects. Bioinformatics was essential in this work because nearly 3 million candidate molecules were analyzed by computer to obtain the compound. As a result of this discovery, a treatment prototype has been developed which was found to provide an immediate and lasting therapeutic effect on painful symptoms in animal models.

Researchers have found because of its physical-chemical properties gold can even be used to explore, to develop an inhibitor for this protein which is essential in this work because nearly 3 million candidate molecules were analyzed by computer to obtain the compound. As a result of this discovery, a treatment prototype has been developed which was found to provide an immediate and lasting therapeutic effect on painful symptoms in animal models.

Digital models for the study of head-on collisions

...To optimize the effectiveness of protective equipment, better understanding is needed of the traumatic effects of head-on collisions on the body and in particular the neck. Researchers at the Icube laboratory have developed a digital model of the “head and neck” system to calculate the forces exerted on the cervical spine. This model has been developed over a period of several years for various applications and takes many parameters into account including the mechanical properties of the cervical vertebrae, intervertebral discs, muscles and ligaments.

What was the place of music in ancient civilizations? An exhibition and its award-winning catalogue were interested in this question. The exhibition was conceived by 8 specialists including one from RUMA, Archimède (GCNS Alsace) while it was presented at MUA, Aix en Provence, then at Barcelona and Madrid.

Antiquity

...New archaeological treasures have been discovered in a vast necropolis near Luxor, an Egyptian city known as Thebes in ancient times. Two sarcophagi have been found which are nearly intact and a funerary stele depicting scenes of offerings being made. These remains date back to the early days of the New Kingdom of Egypt and more precisely to the 19th dynasty, at the highpoint of ancient Egypt. One of the sarcophagi has yet to be identified but inscriptions on the second show that it belonged to a woman named Poo-ya. The sarcophagi were opened in autumn 2018 in the presence of the Egyptian Minister of Antiquities and the creation of a multidisciplinary team will be required to study them.

Ecology, economy, societies

The social pillar is often forgotten in this triptych of sustainable development. Here are some projects that highlight this essential dimension:

...“Greening society and materialising politics,” the SYMBIOS project aims to recognize and analyze social movements engaged in the ecological transition in Europe. The goal of this collective research is to draw a map of the main networks of actors proposing alternative socio-economic models, at a distance from state and governmental actors. It proposes an identification of the issues and themes dealt with, their dissemination methods, and their uses of scientific knowledge.

...Zero waste, gleaners, repair-cafés, eco-joining... Civil society is mobilized against waste. RELGA (Réseaux Émergents de Lutte contre le GAspillage) research focuses on forms of activism and collective action centred on waste.

...The health and local environment observatory identifies, quantifies and reduces social and environmental inequalities in health of the newborn.” This is a collaborative project between researchers (geographers, epidemiologists), local actors, the town of Strasbourg and the Eurometropolis. The aim is to supply and document the link between the environment and health via a unique, shared information system.

Books

...Laughter is common to all human beings, throughout societies and eras. Whether it be hearty, nervous, ironic, mirthless, or uncontrollable, laughter shows that we are all joined to one another by intangible links. The author of this book examines seriously all facets of this transient turbulence. He shows how important laughter is for the fluidity of the social bond, and how indispensable it is to overcome the inconveniences of everyday life. He also analyzes ambivalences, and the ambiguities of laughter that sometimes fuel harassment, racism, or even laughter in tragic situations.

University teaching of Muslim Theology: a book to take stock of the content of the training of Muslim religious leaders through a comparative and historical approach.

...© F. Colin

A sarcophagus found during a dig in El-Assasif.

© G. Zuber

Illustration of the fletest element model of the Head and neck system. © Icube

Societes

ANTIOQUITY

An exceptional discovery in Luxor

THE LIVING WORLD

Enhancing the effectiveness of antibiotics

...Bioinformatics is a discipline that has grown considerably in recent decades. It combines biology, computer science, medicine and mathematics and is an integral part of a wide range of research. Pathogenic bacteria develop resistance to antibiotics at an alarming rate particularly through the misuse of these drugs. For example, the Escherichio coli bacterium over-expresses a protein called EmrF. Bioinformaticians have used numerical models and simulations to develop an inhibitor for this protein which will help make existing antibiotics even more effective.

Using gold to explore cells

...Gold has many applications including in currency, electronics, jewellery but now researchers have found because of its physical-chemical properties gold can even be used to probe inside human cells! Researchers have developed gold spheres of 1.4 nanometres in probe inside human cells! Researchers have found because of its physical-chemical properties gold can even be used to probe inside human cells! Researchers have developed gold spheres of 1.4 nanometres in...
Polymers in a controlled state of intoxication

Polymers are molecules made up of a chain of basal motifs – monomers. To be soluble, such a chain must be able to "unfold" itself, thanks to repulsion between its monomers. A strange observation: polymers that are insoluble in either water or alcohol become so in a water-alcohol mixture. Why should this be? Chemists have just found the key to the mystery. Everything depends on a balance of power between solvents and monomers. In a pure solvent, the repulsion between monomers and the solvent is greater than that between monomers: they do not unfold. In a water-alcohol mixture, the two solvents repel each other, allowing polymers to expand. The understanding of this phenomenon of "co-solubility," which has often been observed but never explained, provides a guiding principle for the design of "smart" polymers, such as hydrogels responding to external stimuli.

Nature Communications, February 2018, Institut Charles Sadron

Implants: biocompatibility of materials

A material with similar mechanical properties to those of biological tissues must be used to produce a medical implant, otherwise there is a risk of inflammation or necrosis. However, implants are mechanically complex to reproduce. For example, heart muscle tissues stiffen when they are stretched. An international consortium of chemists and medical practitioners has succeeded in synthesizing and characterising a polymer that mimics the deformation of skin tissue which is stable in contact with biological fluids and therefore biocompatible. A surprise is that in addition, it changes colour as it deforms, paving the way for unexpected applications.

Science, March 2016, Institut de physique et chimie des matériaux de Mulhouse

Reproducing nature to better understand it

Vertebrate vision is possible thanks to a photosensitive protein, rhodopsin. The activity of this protein is triggered by a photo-reaction with exceptional performance. To better understand the properties of rhodopsin, researchers have reproduced its mechanism with a synthetic molecule. By studying the latter, they have identified how rhodopsin is so effective. These results will provide a guiding principle for the design of "smart" polymers, such as hydrogels responding to external stimuli.

Nature Communications, January 2018, Institut Charles Sadron

A mille-feuille to store information

From a sheet of paper to a CD, information is stored in 2D. However, it would be much more efficient to use 3D supports, for example as nature does to store DNA in our chromosomes. Taking this as a source of inspiration, chemists have developed macromolecules containing perfectly defined sequences of binary information and stacked them on top of each other. Now that this new process has been perfected, it remains to develop a technique to read these thousands of pieces of information stratum by stratum.


Novel polymerization method

Polymerization in emulsion is a method that is widely used in industry to produce various materials, such as latex. This type of reaction is inexpensive and does not require solvents. Until now, it has been triggered thermally or by oxidation-reduction. This was before researchers developed a third promising technique: the photochemical pathway. The new approach makes it possible to work at room temperature and to accurately control the reaction in space and time, since it only takes place in the illuminated area and stops as soon as it is no longer irradiated. These are good reasons to open new possibilities in the world of chemical industry.

Exploring the earth... from the sky!

...Exploring the sub-strata of our countryside from the sky was not the most obvious option. Archaeologists were already using aerial images to detect traces of ancient foundations that have disappeared, but the recent DROMMA (DROite de Mesures Magnétiques pour l’Archéologie) project goes further. Its aim is to develop an airborne magnetic measurement solution using drones. This method is much faster, more efficient and economical than bird’s eye view measurements carried out to date. Indeed, measuring the earth’s magnetism makes it possible to discover new archaeological remains by revealing the magnetization contrast between artefacts and the layers where they are buried. This technique will most probably allow us to demonstrate many forgotten parts of our past.

Institut de physique du globe de Strasbourg, in collaboration with Archéologie Alsace and the Terremys start-up

Simplified integration of pressure micro-sensors

...The integration of metal oxides at micro- and nanoscales plays an essential role in numerous domains such as microelectronics. Nevertheless, this process remains tricky as it generally requires high heat treatments. By exploiting light matter interactions between a laser source and a titanium dioxide formulation researchers have succeeded in producing such microstructures at room temperature in a single step. By controlling the power of the laser and the surrounding atmosphere heat treatments. By exploiting light-matter interactions between a laser source and a titanium dioxide formulation researchers have succeeded in producing such microstructures at room temperature in a single step. By controlling the power of the laser and the surrounding atmosphere researchers have delivered the first two Digital Optical Modules (DOM) during the summer of 2018. These are the centrepieces of the ORCA detector, one of the two that comprise KM3NeT. Sixteen other DOMs remain to be produced and then the first French “line” of the detector will be operational.

Institut de physique du globe de Strasbourg, in collaboration with Subatech

Exploring the stars... from the depths!

...KM3NeT is a strange acronym that hides an even stranger project: that of a second-generation neutrino telescope installed in the depths of the Mediterranean. The neutrino is an elementary particle that is very difficult to observe because it barely interacts with the matter that surrounds us. To hope to understand this cosmic traveller, researchers delivered the first digital optical modules (DOM) to the depths of the Mediterranean. The neutrino is an elementary particle that is very difficult to observe because it barely interacts with the matter that surrounds us. To hope to understand this cosmic traveller, researchers delivered the first two Digital Optical Modules (DOM) during the summer of 2018. These are the centrepieces of the ORCA detector, one of the two that comprises KM3NeT. Sixteen other DOMs remain to be produced and then the first French “line” of the detector will be operational. This novel glue could be used for example in the production of bio-batteries or subcutaneous drug delivery.

Institut de physique du globe de Strasbourg, in collaboration with Subatech

Using light to deliver drugs

...Nanomaterials are a research field in the process of rapid expansion, and they are finding more and more applications in medicine. Researchers have managed to design a new class of nanocomposites that release drugs to order highly precisely under the action of near infrared light. These nanocomposites are made up of carbon nanotubes or graphene sheets covered by porous silica, which act as drug reservoirs. When these are excited they release the molecules they contain, allowing future plans for the delivery of an anti-tumour drug directly in the proximity of a tumour. This is an important step towards the development of personalized treatment.

Institut de chimie et procédés pour l’énergie, l’environnement et la santé

Physics for Engineer

Increased efficiency of organic photovoltaic cells

...Organic solar cells made of semiconducting polymers have recently crossed the barrier of 10% photovoltaic conversion, thus approaching the value of conventional cells. When these results are associated with the flexibility and low weight of organic photovoltaic panels they contribute to the development of this emerging technology. Physicists have been able to clarify several physical mechanisms that are at the origin of these performances. Firstly, the presence of fluorine atoms on polymers improves their organization and thus the transport of an electric charge. Secondly, a part of the polymers can be orientated relative to the substrate. In this way, the transport of the latter is made even easier. Armed with this new knowledge, researchers will be able to further optimize this new type of solar panel.

Institut de chimie et procédés pour l’énergie, l’environnement et la santé

Chemistry for Engineer

When it needs to stick...

...Fishermen know perfectly well that mussels do not only become attached to rocks. They can stick equally well onto the smooth metal hulls of boats. This adhesion superpower is conferred on mussels by the production of dopamine. Dopamine is a protein composed of an amino acid that is a catechol. The catechol inspired researchers to synthesize a special glue that binds proteins such as enzymes to metals without denaturing the proteins. A bonus is that catechol binds to proteins by a simple oxidation reaction, allowing total control of the process by electrochemistry. This novel glue could be used for example in the development of bio-batteries or subcutaneous detectors.

Institut de chimie et procédés pour l’énergie, l’environnement et la santé

Or not!

...Some areas need the strongest glues possible, whereas others require the exact opposite: a completely non-adhesive substance. To meet this need, researchers have combined two bio-based polymers, chitosan and alginate, to form a novel biomaterial. This is obtained due to ultracentrifugation and is biocompatible, anti-fouling, anti-inflammatory and above all prevents attachment of cells and bacteria. All these characteristics make the novel biomaterial the ideal support for the delivery of active ingredients to be used in future treatments of inflammatory diseases such as arthritis or Crohn’s disease.

Institut de chimie et procédés pour l’énergie, l’environnement et la santé
The OHGE has new equipment

...To increase its abilities to monitor water in the Strengbach watershed even further on. June 7th 2018 the OHGE inaugurated two new pieces of measuring equipment. The first of these, River Lab, is a field laboratory that allows in situ measurements of water’s physical-chemical parameters every 15 minutes. The second is a state-of-the-art gravimeter, used to monitor the stocks of underground water at the scale of the watershed.

Earth and ocean sciences

New youth for the seismological station on Saint Paul Island

...The small island of Saint-Paul that is lost in the middle of the Indian Ocean has sheltered an EOST seismological station for the last thirty years. A break of two years was needed to relocate the station so that its environmental impact would be limited and its instruments could be replaced by new, more powerful ones. The autonomous station resumed its recordings in April 2018, allowing the study of the Southeast Indian oceanic ridge. This station should resume its recordings in April 2018, allowing the study of the Southeast Indian oceanic ridge.

SEISMOLOGY

First observation of recurrent slow earthquakes

...There are two major distinct families of earthquakes: classical earthquakes and slow ones. The former last from several seconds to several minutes and produce seismic waves that can be devastating, whilst the latter last a week and several months. These do not generate seismic waves and can be repeated regularly over time. It is this type of phenomenon that geophysicists have identified in Chile due to studies of 15-years-worth of GPS data. The scientists hope to be able to determine whether these slow earthquakes can trigger more dangerous classical earthquakes.

THE UNIVERSE

Galactic cannibalism is on the menu

...Some 300 million light-years from us, an extraordinary pileup is occurring. The 5 galaxies that make up Stephan’s Quintet are merging to give a single giant galaxy, a “case study” of “Galactic cannibalism.” A new, extremely deep image of the Canada-France-Hawaii telescope (CFHT) revealed structures that were hitherto unknown to researchers. Notably, a large halo of old stars highlights the role of an elliptic galaxy that had previously seemed innocent. This discovery was all the more unexpected since at its origin the image was merely intended to illustrate...a calendar.


First observation of recurrent slow earthquakes

...From May to July 2018, the Argentière glacier in the Mont Blanc massif was the most monitored glacier worldwide. On site, at an altitude of 2,400 m, researchers combined many methods (geodetic, seismological, hydrological) to understand the mechanisms of ice deformation. Their results should allow simulation of glacier flow along with the formation of crevices and subglacial channels. This will make a better anticipation of the effects of global warming possible.

ESOT interferometric radar ‘Spatial Observation Platform’ installed on the left bank of the Argentière glacier. These geodetic measurements combine seismological and hydrological ones.

GLACIOLOGY

Tuning in to the Argentière glacier

...To map and measure the deformation of glaciers is not an easy matter. These vast masses of ice are located high in the Alps, far from any roads or buildings, and their thickness is usually greater than the distance separating them from the nearest towns. They are born in nebulae, shine for a few billion years and die in blowing explosions, creating new nebulae. The study of these very low-frequency earthquakes has allowed scientists to understand the processes that control glacier flow – called crevassing – and to simulate it. Studying slow earthquakes will allow us to better anticipate the effects of global warming. The Argentière glacier is one of the most monitored in the world.

REMOTE SENSING

Crisis situation in the Grand Est forests

...2018 was a particularly devastating year for the forests of Northeast France. Firstly, there was an exceptionally long drought, but secondly the forests were ravaged by bark beetles. These are small xylophagous beetles. Faced with this crisis, the government turned to SEFRIT’s skills to map the regions that were affected. This inventory covers a fifth of the metropolitan territory. It was established using remote sensing data from Sentinel-2 satellites and was shared with all stakeholders in the wood sector. The maps are available via the website of the Ministry of Agriculture.

Gaia: mapping our galaxy...

...The aim of the European Gaia programme is to map our Galaxy as precisely as possible. This is a Herculean mission – our Milky Way has more than a hundred billion stars. The programme began in 2013 with the launch of the Gaia satellite. It reached a new milestone when the second version of the Gaia catalogue (DR2) was placed online. This lists 1.7 billion stars from our galaxy, giving their characteristics: brightness, speed, trajectory, temperature, etc. Astronomers from all over the world have been waiting for this catalogue, which is the result of an international collaboration.

...and its loosely bound stars

...Groups of stars in arcs of a circle that we call star streams lie around our galaxy. All evidence suggests that these stars come from small galaxies that, in the past, were too close to our Milky Way and had been “torn to shreds” by its gravitational attraction. Astrophysicists from Strasbourg have developed a new algorithm called Streamfinder to analyze the data collected by Gaia and so better identify the star streams. Streamfinder allows these traces of the complex and eventful history of our galaxy to be mapped.


Discovering the first glimmers of the Universe

...For the first time, astrophysicists have managed to predict the moment when the galaxies that surround us were initially illuminated. Their simulation demonstrated that not all galaxies were illuminated at the same time. The largest galaxies were illuminated 300 million years after the Big Bang (13.8 billion years ago), but we had to wait 750 million years before the same thing happened to the smallest galaxies.


Simulation of the state of the Universe one billion years after the Big Bang shows the heterogeneity of the cosmos: the blue areas are in such a matter and were the first to be illuminated, whereas the red areas are extremely hot (20,000 °C), and were only recently illuminated. Each side of the image represents 300 million light-years, i.e. approximately 30 billion light-kilometres.

GAIA

Galactic cannibalism is on the menu

...Some 300 million light-years from us, an extraordinary pileup is occurring. The 5 galaxies that make up Stephan’s Quintet are merging to give a single giant galaxy, a “case study” of “Galactic cannibalism.” A new, extremely deep image of the Canada-France-Hawaii telescope (CFHT) revealed structures that were hitherto unknown to researchers. Notably, a large halo of old stars highlights the role of an elliptic galaxy that had previously seemed innocent. This discovery was all the more unexpected since at its origin the image was merely intended to illustrate...a calendar.


Stephan’s Quintet in visible light. © CFHT, P-A. Duc, J-Ch. Tsai (Endre (CSA Saray/Obs. de Porto).
A FOCUS ON SCIENTIFIC DATA

It is estimated that in 2018 the volume of information created worldwide each day is the equivalent of 2.5 trillion gigabytes. With the boom in new technologies, digitalization and the establishment of scientific programmes that are ever more ambitious, the world of research is not immune to this massive production of data that researchers must learn to master.

A genuine revolution is taking place in the world of data. With the arrival of Big Data and free access to unprecedented amounts of raw data, new horizons are opening for the entire scientific community. It is becoming essential to increase the recognition of research into data science as this has potential for innovation. However, the challenge of processing, analysing, storing, archiving and sharing these Big Data is also crucial.

From researchers to states, everyone recognises that these challenges are inseparable from the quest for scientific excellence in an Open Science context. In this respect, different reflections, actions and structuring events have been implemented at different scales. Several illustrations are listed here:

- These harvests of data are astronomical, both literally and metaphorically, with the Gaia programme that is currently analyzing the characteristics of 1.3 billion stars in our galaxy (see previous page).
- The European ESCAPE* project announced in November 2018 addresses the challenges of open science at the intersection of two disciplines: astronomy and particle physics. The Strasbourg Astronomical Data Centre will thus have the task of connecting European research infrastructure projects such as KINNET (see page 14), ELT* and EGO-VRGO*, to the future European cloud EOSC*. This latter will provide universal access to research data via the Virtual Astronomical Observatory. With EOSC, the major laboratories of the continent will be able to join forces to make their data FAIR: FINDABLE, ACCESSIBLE, INTEROPERABLE, REUSABLE.
- The RDA* alliance aims to construct social and technical bridges at the world-wide scale to enable the free exchange of data. The CNRS is in charge of developing the national RDA-France node in the context of the RDA Europe 4.0 project started in March 2018. Françoise Genova of the Strasbourg Astronomical Observatory is the co-ordinator of this.
- The human and social sciences are also extremely concerned by these new issues.
  - The University Data Platform of Strasbourg (UDP-S) is a service of the Alsace Interveruniversity House of Sciences of Man. It organized a study day in 2018 on the use of census data in HSS with questionnaires concerning the production, use and processing of the data. UDP-S is working more intensively to promote the use of quantitative survey data in HSS.
  - Another symposium, called “From Data to Knowledge”, was the occasion to showcase ArkenGIS. This application allows archaeologists to access a large amount of geonreferenced historical, geological and geographical data. This is an additional example of data sharing at the intersection of disciplines.

* ESCAPE: European Science Cluster of Astronomy and Particle Physics
* ELT: Extremely Large Telescope
* EGO-VRGO: European Gravitational-Vacuum Observatory
* EOSC: European Open Science Cloud
* RDA: Research Data Alliance
The scientific results presented in this booklet are the result of research carried out in the CNRS, Inserm, University of Strasbourg, Université de Haute-Alsace, with higher education and research establishments, national and international research organizations or partner companies. Below is the list of research units following assessment by the High Counsel of Assessment of Research and Higher Education (HCERES).

CNRS scientific news is found on alsace.cnrs.fr | CNRS_Alsoce or journal.cnrs.fr

| INSB | _Architecture et réalité de l’ARN_ | CNRS, CNRS-Ulmerta: malmem.unistra.fr |
| INSHS | _Archéologie et histoire ancienne : Méditerranée et Europe_ | Archémed, CNRS-Ulmerta: archemed.unistra.fr |
| INSIS | _Bureau d’économie historique et appliquée_ | BETA, CNRS-Ulmerta: Université de Lorraine etat-universitaire.fr |
| INSU | _Droit, religion, entreprise et société_ | CNRS, CNRS-Ulmerta: durel.unistra.fr |
| INSMI | _Dynamiques européennes_ | CNRS, CNRS-Ulmerta: dyme.unistra.fr |
| INSU | _Ecole et observatoire des sciences de la Terre_ | IGSST, CNRS-Ulmerta: - osg.unistra.fr |
| INSMI | _Ecole et observatoire des sciences de la Terre_ | CNRS, CNRS-Ulmerta: - osg.unistra.fr |
| IN2P3 | _Institut pluridisciplinaire Hubert Curien_ | IPHC, CNRS-Ulmerta: - iphc.cnrs.fr |

The CNRS Institutes

| INSB | _Institute of Biological Sciences (INSB)_ | CNRS, CNRS-Ulmerta: malmem.unistra.fr |
| INSHS | _Institute of Chemistry (INSHS)_ | CNRS, CNRS-Ulmerta: archemed.unistra.fr |
| INSIS | _Institute of Ecology and Environment (INEE)_ | CNRS, CNRS-Ulmerta: dyme.unistra.fr |
| INSU | _Institute of Humanities and Social Sciences (INSU)_ | CNRS, CNRS-Ulmerta: dyme.unistra.fr |
| IN2P3 | _Institute for Information Sciences and Technologies (IN2P3)_ | CNRS, CNRS-Ulmerta: dyme.unistra.fr |
| INEE | _Institute for Information Sciences and Technologies (IN2P3)_ | CNRS, CNRS-Ulmerta: dyme.unistra.fr |
| INSHS | _Institute for Mathematical Sciences and their Interactions (INSHS)_ | CNRS, CNRS-Ulmerta: dyme.unistra.fr |
| INSMI | _Institute for Physics (INSMI)_ | CNRS, CNRS-Ulmerta: dyme.unistra.fr |
| INS2I | _Institute for Particle Physics (IN2P3)_ | CNRS, CNRS-Ulmerta: - osg.unistra.fr |
| INSU | _Institute for Earth Sciences and Astronomy (INSU)_ | CNRS, CNRS-Ulmerta: dyme.unistra.fr |
| INSIS | _Institute for Information Sciences and Technologies (IN2P3)_ | CNRS, CNRS-Ulmerta: - osg.unistra.fr |
| INSHS | _Institute of Chemistry (INSHS)_ | CNRS, CNRS-Ulmerta: archemed.unistra.fr |
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LIST OF LABORATORIES AS OF JANUARY 1ST 2018

| INSHS | _Archéologie et histoire ancienne : Méditerranée et Europe_ | Archémed, CNRS-Ulmerta: archemed.unistra.fr |
| INSIS | _Bureau d’économie historique et appliquée_ | BETA, CNRS-Ulmerta: Université de Lorraine etat-universitaire.fr |
| INSU | _Droit, religion, entreprise et société_ | CNRS, CNRS-Ulmerta: - durel.unistra.fr |
| INSMI | _Dynamiques européennes_ | CNRS, CNRS-Ulmerta: - dyme.unistra.fr |
| IN2P3 | _Institut pluridisciplinaire Hubert Curien_ | IPHC, CNRS-Ulmerta: - iphc.cnrs.fr |
| INP | _Institut de biologie et chimie des matériaux de Strasbourg_ | INC, CNRS-Ulmerta: - inc.unistra.fr |
The picture is of an extremely deep multi-coloured image of the Canada-France-Hawaii telescope.

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