

A vibrant, multi-colored cosmic background image featuring a dense field of stars in various colors (yellow, orange, red, blue, green) and several prominent galaxies, including a large, bright, yellowish-white galaxy on the left side. The overall scene is a rich, multi-wavelength astronomical image.

**2018**  
**A YEAR AT THE CNRS**  
**IN ALSACE**



# 2018 A YEAR AT THE CNRS IN ALSACE

is a regional addition to the activity report **2018, a year at the CNRS**

A number of facts published in this report, results of scientific equipment, came to be thanks to the support of the European Union, the Région Grand Est, the Conseils départementaux du Bas-Rhin et du Haut-Rhin, the Eurométropole de Strasbourg and the Mulhouse Alsace Agglomération, as well as numerous academic, industrial and nonprofit partners. They are hereby thanked for their support to the CNRS unit's research excellence in Alsace.

Publisher  
Editorial director  
Chief editor  
Scientific committee

**Antoine Petit**  
**Patrice Soullie**  
**Céline Delalex-Bindner**  
**Dominique Badariotti**  
**Rémi Barillon**  
**Pierre-Alain Duc**  
**Vincente Fortier**  
**Jean-Luc Galzi**  
**Christian Gauthier**  
**Frédéric Leroux**  
**Frédéric Masson**  
**Sylviane Muller**  
**Jean-Serge Rémy**  
**Vincent Roucoules**

Coordination, writing and iconography  
Layout and realisation  
Graphic design

**Antoine Rigaud**  
**Olivier Fély**  
**Céline Hein**

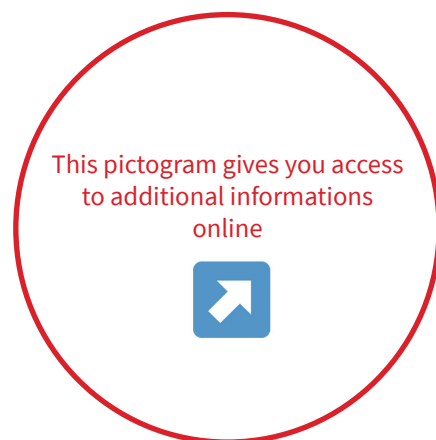
Acknowledgements : **Anne Bresson, Thomas Grutter, Pascaline Toutois**

Translation : **Katherine Kean** and **Richard Dickinson** from the Inist-CNRS Translation Service

Legal deposit: november 2019 - ISSN : 2270-4876

**CNRS délégation Alsace**  
23 rue du Loess - BP20  
67037 Strasbourg Cedex 2  
03 88 10 63 01

[www.alsace.cnrs.fr](http://www.alsace.cnrs.fr) | [CNRS\\_Alsace](https://twitter.com/CNRS_Alsace)



## TABLE OF CONTENTS

	2	2018 in figures
	3 > 5	Talents & Highlights
	6 > 10	
<b>THE LIVING WORLD</b>		
	11	
<b>SOCIETES</b>		
	12 > 13	
<b>MATTER</b>		
	14 > 15	
<b>ENGINEERING AND DIGITAL SCIENCES</b>		
	16	
<b>EARTH AND ENVIRONMENT</b>		
	17 > 19	
<b>THE UNIVERSE</b>		
	18 > 19	Science without borders
	20	List of laboratories



## EDITORIAL

**PATRICE SOULLIE**  
regional delegate 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



# 2018

## IN FIGURES

december 31th

**1 619** STAFF MEMBERS

**518**  
researchers

**739**  
engineers and  
technicians

**362**  
contractual  
employees

### RESSOURCES

**39** RESEARCH AND  
SERVICE UNITS

85% are in partnership with the Université de Strasbourg, the Université de Haute-Alsace, the Insa, the Institut franco-allemand de Saint-Louis, the Institut national des sciences appliquées de Strasbourg

**34**

research units

**5**

service units

an average of  
**2 563**  
SCIENTIFIC  
PUBLICATIONS  
per year

of wich **65,8%**  
are co-signed with a foreign  
laboratory for the period  
2016-2017

### RESEARCH

A BUDGET OF **156** MILLION EUROS  
of wich **35,7 M€**  
come from self-generated income

**96 000 m<sup>2</sup>**  
OF REAL ESTATE  
MANAGED BY THE CNRS  
on **3 SITES**

### FINANCING

**607**  
SIGNED  
CONTRACTS  
in 2018 for **33,8 M€**  
d'ont

**571**  
CONTRATS  
managed by the CNRS  
for **32,6 M€**

**244**  
PATENT FAMILIES  
**28** NEW PRIORITY  
PATENT APPLICATIONS

### ESTABLISHMENT

**3** START-UP  
FOUNDED IN 2018  
**54** START-UP  
FOUNDED SINCE 1999

### VALORISATION

Data sources :

Ressources CNRS Alsace/DRH | Recherche données SCI Expanded (moyenne 2016-2017) - CPIC-S (Clarivate Analytics) - Traitement CNRS/SAP2S et INIST

Financement CNRS Alsace/SFC/SRH | Implantation CNRS Alsace/STL | Valorisation CNRS Alsace/SPV

## THE WORDS OF TALENTS

### Bronze medal

The CNRS bronze medal is awarded in recognition of the initial work of a promising researcher in their field.

#### CHRISTINE CARAPITO



© N. Busser

— "The protein mass spectrometry classes during my biotechnology engineering course fascinated me. The idea was to be able to characterize a proteome 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 bioinformatic 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

### Crystal medal

The CNRS crystal medal rewards CNRS engineers and technicians who contribute to making scientific discoveries and progress in knowledge.

#### CHRISTINE HU GUO



© N. Busser

— "I first got a taste of the adventure of the CERN's Large Hadron Collider when my team of engineers and I designed the HAL25 chip which reads the signals from the ALICE experiment's trajectometer. Following on from this success, we began work on the idea which most appealed to us - to invent CMOS sensors with integrated pixels which would go beyond the limits of detecting charged particles. After 10 years of enthusiastic research, a 360 megapixel detector for the STAR experiment in the United States was launched in 2013. This was a world first and has indeed become the reference in the field. It validated our ideas and convinced members of the particle physics community to use this kind of detector for their own large-scale instruments. In this way with ALICE which was rightly acknowledged by research history and CBM at FAIR, we have continued to open up new fields of study of the sensors of the future."

Institut pluridisciplinaire Hubert Curien

### SILVER MEDAL

The CNRS Silver Medal is award 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



© L. Velasquez

#### 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 that have only been produced on earth for a century. DNA and proteins are, for example, biopolymers which can be used for tasks that 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



© N. Busser

A collective medal award ceremony was organised for the first time in Alsace and provided an opportunity to bring together our medal winners along with representatives of the units, the CNRS and our partners.



From left to right: Jean-Marie Lehn, winner of the 1987 Nobel Prize in Chemistry, Christian Gauthier, director of the Institut Charles Sadron, Jacques Maddaluno, director of the CNRS Institute of Chemistry, Patrice Soullie, CNRS regional delegate, Jean-François Lutz, Christine Carapito, Christine Hu Guo, Bruno Klaholz, Bernard Poulain, deputy scientific director of the CNRS Institute of Biological Sciences (ISB), Bertrand Séraphin, director of the Institute of Genetics and Molecular and Cellular Biology (IGBMC) and Sarah Cianferani, head of the Laboratory of Bioorganic Mass Spectrometry at the Hubert-Curien multidisciplinary research institute (IPHC).

© N. Busser



# HIGHLIGHTS

## SCIENTIFIC AND INSTITUTIONAL



From left to right: Michel Deneken, president of the University of Strasbourg, François Werner, vice-president of the Alsace Region, Catherine Jessus, director of the ISB, Robert Herrmann, president of the Eurometropolis, Frédéric Bierry, president of the Conseil départemental (Regional Council), Jean-Luc Marx, Regional Prefect, Jules Hoffmann, Nobel prize winner, Jean-Luc Imler, director of the IBMC.

© N. Busser

### - FOCUS -

## IBMC : INAUGURATION OF THE INSECTARIUM

[October 1<sup>st</sup>] 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 Esplanade 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 750,000 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 biosecure 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.

## PRICES AND DISTINCTIONS

### Prix Fondation Unistra-Ourisson Cercle Gutenberg

- Raphaël Côte - IRMA
- Thomas Hermans - ISIS
- Albert Weixbaumer - IGBMC

### Prix Fondation de l'Institut de France

- Michel Barrot - INCI  
*Prix de la Fondation Unité-Guerra-Paul-Beaudoin-Lambrecht-Maiano*
- Damian Brotbek - IRMA  
*Prix Charles-Louis de Saulses de Freycinet*
- Bill Keyes - IGBMC  
*Prix de cancérologie de la Fondation Simone et Cino Del Duca*
- Pascale Romby - ARN  
*Médaille Louis Pasteur de la Fondation André-Romain Prévot*

### Les Espoirs de l'Université de Strasbourg

- Julia Autin - IPGS
- Christine Carapito - IPHC
- Anaïs Collet - SAGE
- Émilie Delahaye-Leroi - IPCMS
- Nicolas Martin - Observatoire astronomique de Strasbourg
- Marcela Szopos - IRMA

### Prix Louisa-Gross-Horwitz

- Pierre Chambon - IGBMC

### Infosys Prize in Mathematical Sciences

- Nalini Anantharaman - IRMA



### CYRCÉ IS 10 YEARS OLD!

The cyclotron 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. Cyrcé will soon benefit from a new extension so this is not the last people will hear about it.

© N. Busser

Research structures are far from remaining static and are evaluated every 5 years by the High Council for Evaluation of Research and Higher Education (HCERES) which leads to reorganizations or theme-based changes in direction. This process is one of the factors which enables the CNRS and its partners to maintain dynamic research that is always in tune with important current scientific issues. In the Académie of Strasbourg, the process took place in 2017 with the results implemented on January 1<sup>st</sup> 2018. Here we focus on two changes:

### THE BETA HAS INTEGRATED THE DIMENSION OF FOREST ECONOMICS

The Bureau of Theoretical and Applied Economics (BETA) has a new supervisory authority, the National Institute for Agricultural Research (INRA) and a new partner, the AgroParisTech school. The Bureau is thus developing the transversal theme "Forestry Economics" to strengthen its environmental economics pole with the addition of an application to forests and the forest-wood sector.

### THE LIMA, A KEY ACTOR IN MOLECULAR CHEMISTRY

The objective of the Laboratoire d'innovation moléculaire et applications (Laboratory for Molecular Innovation and Applications, LIMA) is the development of innovative methods in the field of molecule synthesis for end-uses ranging from synthesis to applications in the fields of health and materials. The LIMA is the result of the merger of the Laboratory of Molecular Chemistry (Strasbourg) and the Laboratory of Organic and Bioorganic Chemistry (Mulhouse) and is now the largest laboratory dedicated to molecular chemistry in the Alsace region.

### - GENERAL PUBLIC -

## "ÉTONNANT VIVANT", LIFE SCIENCE IN THE 21<sup>ST</sup> 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 different events which took place throughout the year. One of the highlights was the Science Village in Strasbourg<sup>2</sup> and Illkirch which featured the co-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 Bioinspiration* – 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.

<sup>1</sup> with the Inserm Est | <sup>2</sup> with the Jardin des sciences - Unistra

© N. Busser



### ADVANCED GRANT

#### Rodrigo Iбата GREATDIGINTHESKY

Objective: to use astronomical data from the Gaia programme to identify stellar structures from small ancient galaxies torn apart by the gravitational attraction of the Milky Way and thus trace its turbulent history (see page 17).

Observatoire astronomique de Strasbourg

### ADVANCED GRANT

#### Paolo Samorì 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 METAFOAM

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 PREISEISMIC

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

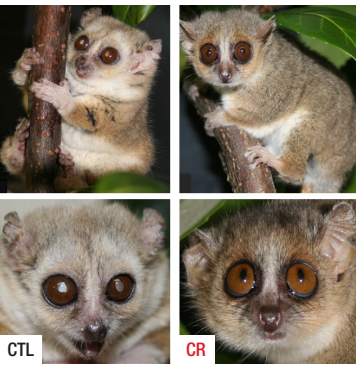


## ETHOLOGY

### Eat less to live longer

...What if diet were the key to long life? Studies have already shown that cutting calorie intake in monkeys led to an increase in their lifespan but these results remained controversial. New research on small mouse lemurs has now confirmed this hypothesis. For 10 years, a group of primates were given reduced but balanced food rations. These creatures were found to have a 50% longer lifespan than their counterparts on a normal diet. Dieting lemurs were found to retain their motor skills and have fewer age-related diseases. The next step for scientists is to study calorie restriction mimetics such as resveratrol and combining dietary restriction and physical exercise.

*Communication Biology*, april 2018...  
Institut pluridisciplinaire Hubert Curien



Two 9-year-old mouse lemurs who were fed from adulthood onwards. On the left, a mouse lemur on a normal diet (control group). The animal weighs about 100g and presents characteristics which are common in older mouse lemurs such as cataracts, fur going white, etc. On the right, a mouse lemur on a diet with 30% less calories. The animal weighs about 70g and has the morphological characteristics of a younger animal.  
© CNRS/MNHN

### 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 exile in more favourable climates to avoid extinction. Almost half of the world's population of king penguins lives on the sub-Antarctic islands of Crozet and Kerguelen but their current habitats are becoming increasingly less hospitable which is causing them to migrate South. Penguins have already overcome environmental crises in the past but now researchers fear that climate change may be occurring too quickly and intensely for them to find a new living environment with sufficient resources for their colonies to survive. It is therefore a matter of extreme urgency to take measures to prevent the extinction of such endemic and emblematic species in the polar regions.



A colony of king penguins in the baie du Marin on Possession Island, in the Crozet Archipelago.  
© C. Le Bohec

*Nature Climate Change*, february 2018...  
Institut pluridisciplinaire Hubert Curien

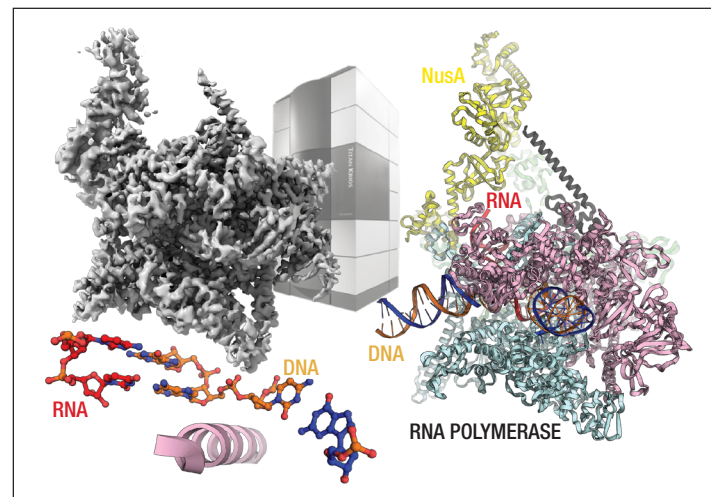


## GENETICS

### "Photographing" is a key mechanism in the expression of genes

...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 wire 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. This state was stabilized by the NusA protein transcription factor.

*Molecular Cell*, march 2018...  
Institut de génétique et de biologie moléculaire et cellulaire



The reconstructions (left, in grey) obtained using electron microscopes (Titan KRIOS) enabled researchers to build atomic models (right). The reconstruction of a paused RNA polymerase showed how the active site of the enzyme is blocked and cannot continue to transcribe DNA (orange) into RNA (red).  
© A. Weixlbaumer

## GENETICS

### 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 (i.e. populations isolated from each other) of the same yeast species, *Saccharomyces 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 gene gain or loss as compared to natural environments and provides new insights into the relationships between information encoded by genomes (the genotype) and the expression of characteristics (the phenotype).

*Nature*, april 2018...  
Génétique moléculaire, génomique et microbiologie



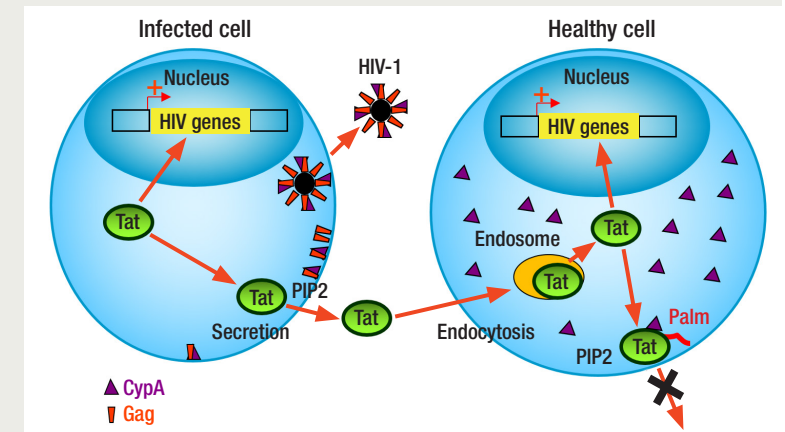
## FOCUSSING ON AGGREGATES

*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.*

### 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 neurones and macrophages which become unable to function because of the sequestration of these essential lipid molecules.

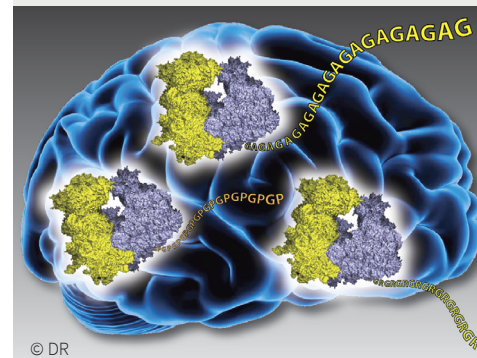
*Nature Communications*, june 2018...  
Institut des neurosciences cellulaires et intégratives  
Institut pluridisciplinaire Hubert Curien



A model showing the mechanisms of Tat secretion by HIV-infected cells and how Tat is captured and accumulates in uninfected cells. Tat affects different cellular processes like neurosecretion or phagocytosis by aggregating with a high affinity for the lipid PI(4,5)P2.  
© N. Vitale

### 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



© DR

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 the aberrant synthesis of dipeptides which are highly toxic because they form long aggregates in movement and motor neurones and cause their cell death.

*Nature Communications*, january 2018...  
Architecture et réactivité de l'ARN



### ... and for myotonic dystrophy

...Myotonic dystrophy, also known as Steinert disease, is the most common form of muscular dystrophy in adults. This rare genetic disease affects one in 8,000 people and causes myotonia, atrophy and muscle weakness, heart problems and cognitive problems. The origin of this pathology lies in the repetition of a sequence of three nucleotides (CTG) in a gene. This repetition leads to the production of abnormal RNAs, which form aggregates and trap a protein called MBNL1. The decrease in the level of available MBNL1 leads to impaired muscle and neural cell function and then to the symptoms of myotonic dystrophy.

*Nature Communications*, may 2018...  
Institut de génétique et de biologie moléculaire et cellulaire



@INC\_CNRS

[CHEMISTRY] A team from the #InstitutDeChimie de #Strasbourg (@CNRS\_Alsace @unistra) has characterized the structure of a key molecule in the development of #Alzheimer: the amyloid precursor protein. ACS Omega

@INC\_CNRS

[CHEMISTRY] Why not use #MolecularProbes specifically directed towards amyloid structures? This is an idea to study to treat illnesses caused by the "incorrect folding" of proteins! #ISIS & @IGBMC (@CNRS @Unistra @Inserm) Chemical Science



HEALTH

### 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.

*Journal of Medicinal Chemistry*, september 2018...  
Laboratoire d'innovation thérapeutique



### Using gene therapy to combat Friedreich'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 with a viral vector was found to reverse cardiomyopathy. Thanks to the creation of a new model, the researchers were able to correct neurological symptoms in a few days, demonstrating the potential of gene therapy in the treatment of this disease.

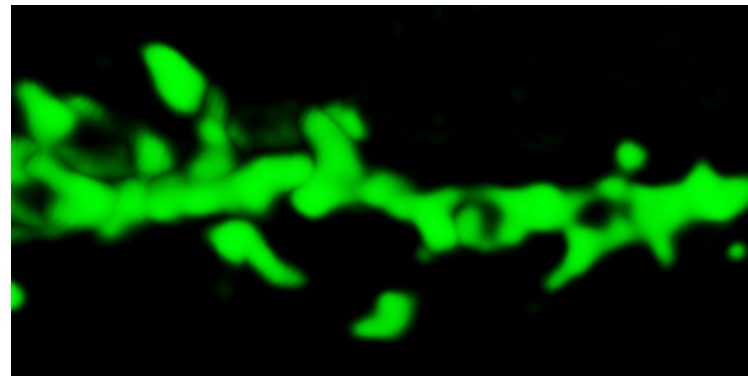
*Molecular Therapy*, may 2018...  
Institut de génétique et de biologie moléculaire et cellulaire



### 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. Neuro-epigenetics is a recent 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.

*EMBO Molecular Medicine*, october 2018...  
Laboratoire de neurosciences cognitives et adaptatives



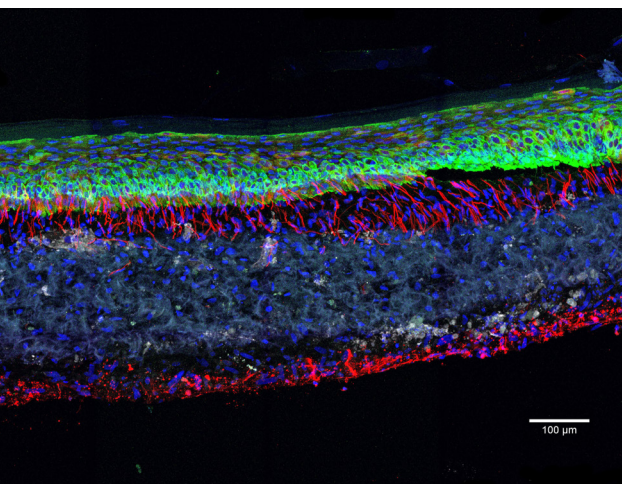
Dendritic spines treated with a lentivirus expressing GFP and observed by confocal microscopy. The injection of the activator restores the formation of the spines present on neurone extensions thus re-establishing neuronal activity in injured brains.  
© A-L. Boutillier

SKIN

### 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 neurones derived from human stem cells in a 3D model of reconstructed skin. This new 100% human in vitro system will pave the way for studies of how the skin's immune system communicates with the sensory nerve network.

*Acta Biomaterialia*, december 2018...  
Immunologie, immunopathologie et chimie thérapeutique  
In collaboration with the Centre de recherche en organogénèse expérimentale (Québec)



Cross-section view of the reconstructed innervated skin model showing cell nuclei (blue), endothelium (white), epidermis (green) and sensory neurone axons (red) which require the presence of Schwann cells for optimal growth.

© Acta Materialia Inc., 2018

### 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.

*Nature Communications*, july 2018...  
Institut de génétique et de biologie moléculaire et cellulaire



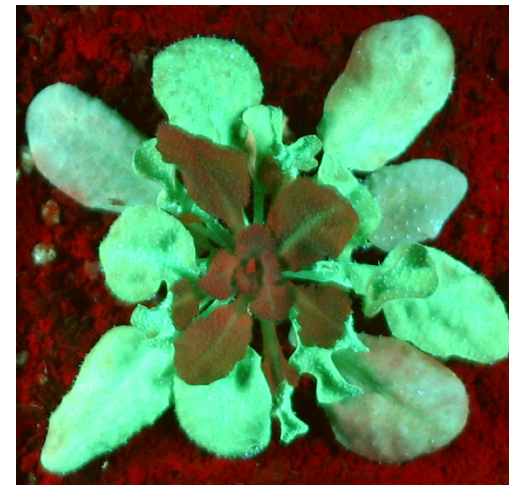
© CNRS Images - P. DE PAISCAU

VIRUS

### 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 rapeseed 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.

*Nature Plants*, march 2018...  
Institut de biologie moléculaire des plantes



The recovery of a plant infected with rapeseed mosaic virus. While older leaves present strong symptoms of the disease, the newly developed upper leaves are free of it. A fluorescent marker was used to demonstrate that the completion of the tolerance state correlates with the inactivation of a viral protein.  
© C.J. Körner, M. Heinlein

PAIN

### A new approach to pain relief

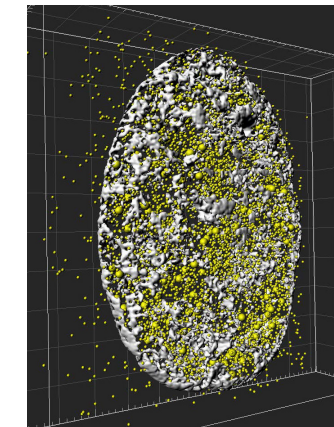
—The objective of many research teams around the world is to develop pain control medications with no side effects. Doctors still often prescribe opiates such as morphine which is addictive and has many harmful effects. This may soon change thanks to an international collaboration project that has identified a new dual-action compound with a powerful analgesic effect and reduced side effects: KGFF09.

*Pain*, september 2018...  
Biotechnologie et signalisation cellulaire  
Laboratoire d'innovation thérapeutique



CELL

### Observing the activity of proteins inside cell nuclei



Three dimensional representation of a cell nucleus after electroporating the cells with fluorescently labeled antibodies binding to RNA Polymerase II (green spheres) visualized using 3D SIM super-resolution microscopy.  
© A-L. Boutillier

—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.

*Journal of Cell Biology*, february 2018...  
Institut de génétique et de biologie moléculaire et cellulaire  
Biotechnologie et signalisation cellulaire



NEUROLOGY

### Stimulating the same synapses several times can transform inhibition into excitation

—Neurobiologists have studied the modus operandi of Purkinje cells which are neurones in the cerebellum and observed a phenomenon of "instant plasticity" in the integration of excitatory and inhibitory messages received by these cells for the very first time. The same synapse chains, i.e. the contact areas between neurones, inhibitors and excitors, can inhibit or excite these cells depending on the conditions under which they are activated. When synapses are activated several times, they do not have time to recover between two discharges. Research shows that a wave of three stimuli has an inhibitory effect on Purkinje cells and that inhibitory synapses prevail whereas with a wave of seven stimuli, excitation was found to win out. Researchers will continue this very promising work by tracing the entire chain of neural action starting with sensory stimulation.

*The Journal of Neuroscience*, may 2018...  
Institut des neurosciences cellulaires et intégratives



### 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 works more slowly and inhibits the neuroinflammation associated with nerve damage over a period of one or two weeks.

*The Journal of Neuroscience*, september 2018...  
Institut des neurosciences cellulaires et intégratives





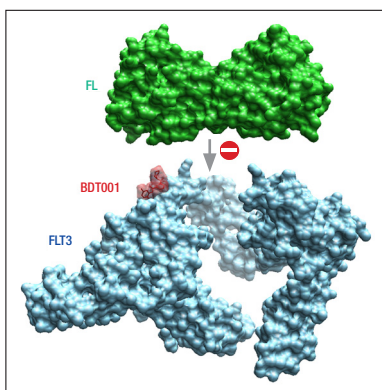
### 3 million molecules analyzed to try to relieve neuropathic pain

— 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 FLT3 in the induction and maintenance of pain. Their detailed study of FLT3 has led to the creation of an anti-FLT3 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.

*Nature Communications*, march 2018...  
Laboratoire d'innovation thérapeutique



The anti-FLT3 molecule selected by computer screening and then optimized using medicinal chemistry.  
© D. Rognan



### Enhancing the effectiveness of antibiotics

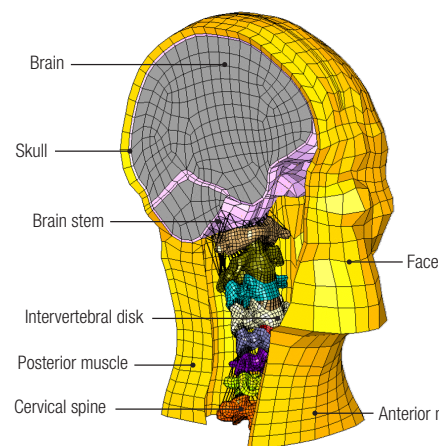
— Bioinformatics is a discipline that has grown considerably in recent decades. It combines biology, computer science, medicine and mathematics and is an integral part of a wide range of research. Pathogenic bacteria develop resistance to antibiotics at an alarming rate particularly through the misuse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

*Proceedings of the National Academy of Sciences*, august 2018...  
Institut de science et d'ingénierie supramoléculaires



### 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.



*Journal of the Mechanical Behavior of Biomedical Materials*, october 2018...  
Laboratoire des sciences de l'ingénieur, de l'informatique et de l'imagerie  
collaboration with the Medical College of Wisconsin

Illustration of the finite element model of the Head and Neck system.  
© ICube

### 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 diameter that can diffuse into living cells and then cross the nuclear pore. Neither of these processes affect cell viability. Thus, these small balls made up of 102 atoms and covered by bioactive molecules that functionalize them could be used in electronic cryomicroscopy to explore biological mechanisms with unequalled precision.

*ACS Applied Nano Materials*, july 2018...  
Biotechnologie et signalisation cellulaire  
Laboratoire de conception et application de molécules bioactives  
Institut pluridisciplinaire Hubert Curien  
Institut de chimie et procédés pour l'énergie, l'environnement et la santé  
Institut de génétique et de biologie moléculaire et cellulaire

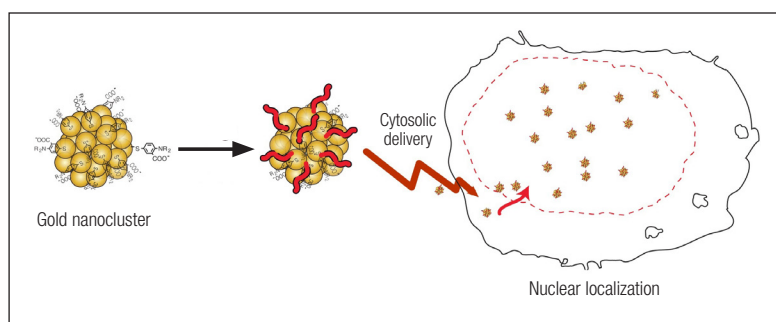


Illustration of the golden sphere, its reaction with a peptide which assists nuclear importation and the results obtained after it is liberated into the cytosol.  
© G. Zuber

### Observing lipid droplets more effectively

— Lipid droplets are organelles which make up a reserve of lipids in living cells. They are involved in many physiological processes but also in diseases such as diabetes. To track and locate these droplets, biologists use "fluorophores" which are molecules capable of emitting light. A new family of fluorophores, statomercyanins, has just been developed. These are ultra-bright with a broad colour palette and high selectivity which means they therefore have low background noise. They have already enabled researchers to observe an exchange of lipid droplets between cells which indicates the intercellular communication of lipids.

*The Journal of the American Chemical Society*, february 2018...  
Laboratoire de bioimagerie et pathologies



### An exceptional discovery in Luxor

— 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 particularly 15th century BC 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 Pouyou. 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.

Archéologie et histoire ancienne : Méditerranée et Europe  
En collaboration avec l'Institut français d'archéologie orientale



A sarcophagus found during a dig in El-Assasif.  
© F. Colin

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 #UMR\_Archimède (@CNRS\_Alsace @unistra). It was presented at @MuseeLouvreLens, then at #Barcelona and #Madrid.



— **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.

*Rire, une anthropologie du rieur* by David Le Breton  
Édition Métailié, novembre 2018  
Dynamiques européennes



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. By Francis Messner and Moussa Abou Ramadan  
#DRES (@CNRS\_Alsace @unistra)  
@EditionsduCERF



### 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<sup>1</sup>.

— Zero waste, gleaners, repair-café, 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<sup>1</sup>.

— "**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<sup>2</sup>.

<sup>1</sup> Sociétés, acteurs, gouvernement en Europe  
<sup>2</sup> Project supervised by the laboratoire Image, ville, environnement and financed by the Institut de recherche en santé publique in collaboration with the École des hautes études en santé publique, l'ORS Grand Est and ATMO Grand Est



NEW PROCESSES

## 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

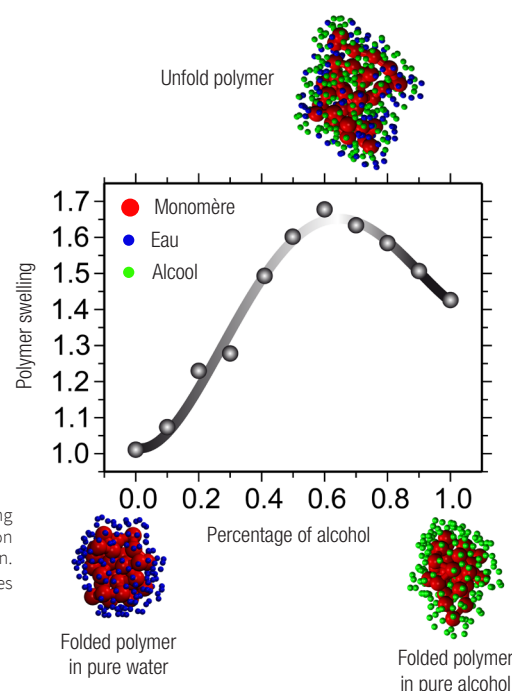


## Implants: biocompatibility of materials

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 characterizing 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 2018—  
Institut de science des matériaux de Mulhouse

Relative variation of the swelling of a polymer model depending on the solvent composition.  
© C. Marques



## Imitating the "skeleton" of cells

Living cells have a cytoskeleton to maintain their structure and properties. Unlike our bone skeleton, this consists of molecules such as actin filaments that can expand or contract. Researchers have succeeded in developing a synthetic molecule that has the same oscillation characteristics. This can spontaneously form fibres whose assembly and disassembly is controlled by simple chemical reactions. This advance has allowed artificial materials that are similar to living ones to be imagined, with applications in medicine or soft robotics.

*Nature Nanotechnology*, october 2018—  
Institut de science et d'ingénierie supramoléculaires



## 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.

*Angewandte Chemie International Edition*, october 2018—  
Institut Charles sadron



## 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 photoreaction 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 be used to develop photoreactive molecular systems capable of efficiently converting light energy into mechanical energy at the nanoscale.

*Nature Communications*, january 2018—  
Institut de physique et chimie des matériaux de Strasbourg



PROCESS OPTIMIZATION

## Mimicking enzymes to pollute less

One of the major challenges of our century is to optimize industrial processes to make them respect the environment more. It is possible to take inspiration from molecules that already exist in nature to attempt to improve oxidation reactions. For example, enzymes have a catalyst facilitator capacity that is very interesting for many applications in chemistry. Researchers have managed to increase the yield of reactions by creating an artificial enzyme that mimics the biological activity of natural ones, including in aqueous media.

*Angewandte Chemie International Edition*, october 2018—  
Laboratoire d'innovation moléculaire et applications



BIOLOGIC APPLICATIONS

## Cells: follow the curve!

At the interface of materials and life sciences, researchers have discovered a novel biological phenomenon: curvotaxis. This is the ability of cells to migrate depending on the curvature of their environment. The researchers showed that cells moved towards the nearest minimum curvature thanks to pressure and tension inside the cell. And this is so even if it goes against gravity! The study of this phenomenon will allow much to be learned about stem cell differentiation or the propagation of cancer cells.

*Nature Communications*, september 2018—  
Institut de science des matériaux de Mulhouse



## See better with nanotubes

In recent years retinal prostheses have been considerably improved. However, they are still extremely expensive and only provide images of limited value, and insufficient to recognize a face, read or move independently. Researchers have been interested in titanium dioxide nanotubes amongst the materials envisaged to develop more powerful implants. Titanium dioxide is used in film form and is well-tolerated by the organism. It has enabled activation of the neuronal network in the mouse retina, even in the absence of photoreceptors, the light-sensitive cells. These experiments pave the way for more efficient and economical prostheses, which will be useful in the treatment of retinitis pigmentosa, a genetic eye disease.

Film of titanium dioxide nanotubes.  
© F. Gelb

*Advanced Functional Materials*, october 2018—  
Institut de génétique et de biologie moléculaire et cellulaire  
Institut de chimie et procédés pour l'énergie, l'environnement et la santé



FUNDAMENTAL PHYSICS

## Observing a molecule in all its "states"

Molecules can enter different excitation states (electronic, vibrational, charge, etc.) depending on the way they are stimulated. For the first time, researchers have developed a device allowing these states to be observed simultaneously. A tunnelling microscope was used to achieve this unprecedented result. On a single occasion, the optical spectrum obtained has the characteristics of several states. What is the use of this? The transition of one molecular state to another intervenes in many biological processes, such as photosynthesis, or industrial ones, like the field of organic photovoltaic panels.

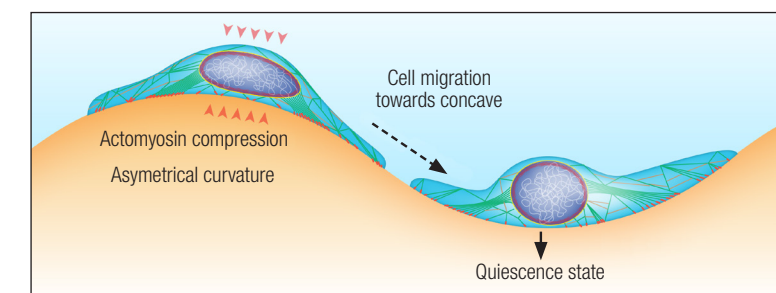
*Science*, july 2018—  
Institut de physique et chimie des matériaux de Strasbourg



## 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. Up 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.

*Angewandte Chemie International Edition*, january 2018—  
Institut de physique et chimie des matériaux de Strasbourg



Cells respond to curvature variations by positioning themselves on the concave regions of their substrate. © L. Pieuchot

## A unique three-dimensional skeleton

Chiral objects are identical but not superimposable, like left and right hands. In pharmacology, drug molecules are often chiral and can thus exist in two forms called "enantiomers". Only one enantiomer is active, the other may be toxic. The challenge to optimize drug production is to be able to make asymmetric syntheses leading preferentially to the formation of the active enantiomer. Thanks to a new protocol, chemists have managed to develop a chiral skeleton of unprecedented architecture that mimics a scallop's cavity. This is suitable for performing stereo-selective reactions to generate a single enantiomer of a candidate drug.

*Angewandte Chemie International Edition*, february 2018—  
Laboratoire d'innovation moléculaire et applications







## NEW INSTRUMENTATIONS FOR NEW RESEARCHES

### Searching 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 (DROne 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



DJI Drone Matrix 210-RTK is equipped with a magnetic measuring system.  
© P. Le Marie

### Simplified integration of pressure micro-sensors

The integration of metal oxides at micro- and nanoscales plays an essential role in numerous domains such as health or 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 the properties of the material created (crystalline form, conductivity, etc.) can be modulated until a piezo-resistive behaviour is conferred on it. Researchers were thus able to create a miniaturized pressure sensor. The next step will be to propose novel devices for robotics and flexible electronics.

Advanced materials, october 2018—  
Institut de science des matériaux de Mulhouse



### 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 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.

Institut pluridisciplinaire Hubert Curien in collaboration with Subatech



DOM optic module (modelization).  
© KM3NeT



## ARTIFICIAL INTELLIGENCE

### When traders will be robots

Artificial intelligence has already transformed our daily lives by automation in the home, automatic translation, medicine etc.. This has been so with one of the most sensitive fields: that of finance and banking. For lawyers, especially, to address this delicate issue, MISHA organized the "digitalization of the banking relationship: practices and uses of artificial intelligence" congress. A banking advisor, robo-advisors, high-frequency trading, etc. there are many subjects to debate that are addressed during this conference day.

Droit, religion, entreprise et société  
Laboratoire des sciences de l'ingénieur, de l'informatique et de l'imagerie

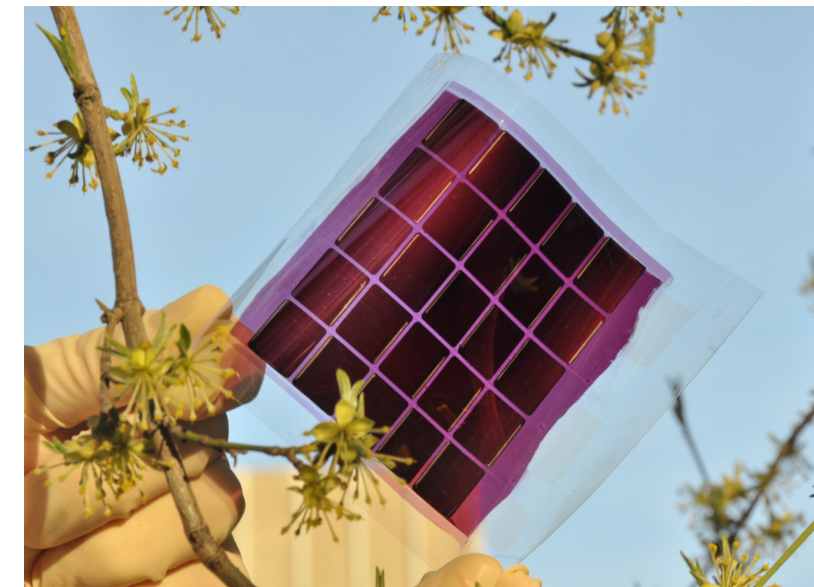


## PHYSICS FOR ENGINEER

### Increased efficiency of organic photovoltaic cells

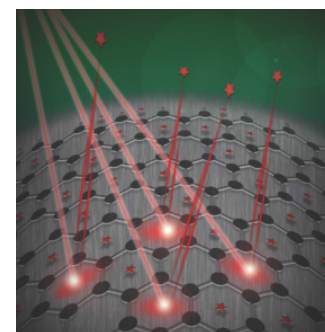
Organic solar cells made of semiconducting polymers have recently crossed the barrier of 10% photovoltaic conversion, thus approaching the value of conventional cells. When these results are associated with the flexibility and low weight of organic photovoltaic panels they contribute to the development 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.

Journal of Materials Chemistry A, july 2018—  
Institut de physique et chimie des matériaux de Strasbourg  
Institut de chimie et procédés pour l'énergie, l'environnement et la santé  
Laboratoire des sciences de l'ingénieur, de l'informatique et de l'imagerie  
Institut de science des matériaux de Mulhouse



© Karlsruhe Institute of Technology

### Using light to deliver drugs



The principle of photothermic coupled to drug delivery; by excitation of a carbonized material, infrared radiation allows the release of the molecules contained in the nanomaterial.  
© Advanced Functional Materials



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.

Advanced Functional Materials, february 2018—  
Institut de physique et chimie des matériaux de Strasbourg  
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 amine and 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.

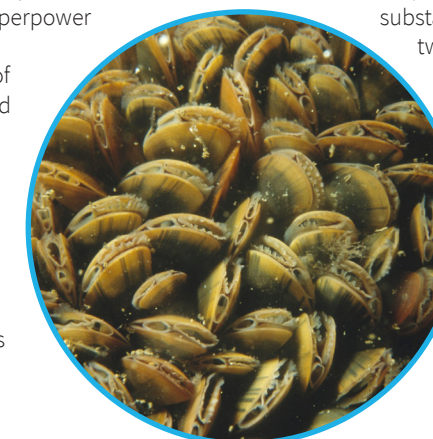
ACS Applied Materials & Interfaces, may 2018—  
Institut Charles Sadron



### ... 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, antifouling, 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.

ACS Applied Materials & Interfaces, august 2018—  
Laboratoire de conception et application de molécules bioactives



Mussels from the bay of Arcachon.  
© Ph. Garrigues/CNRS Photothèque





## HYDROLOGY IN ALSACE

### Long-distance monitoring of a river

For over 30 years, the hydro-geochemical Observatory of the environment (OHGE) has collected data on the Strengbach, a mid-mountain river. The OHGE especially studies the chemistry of waters from the watershed, i.e. the zone where rainfall feeds the Strengbach. This study has been ongoing for several decades and is combined with digital modelling. Thus, researchers have been able to trace the geochemical variations of the waters of this basin. They have highlighted the link between the stability of the chemical composition of the water and the time it spends in the geological strata.

Laboratoire d'hydrologie et de géochimie de Strasbourg



## 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 between 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.

Geophysical Research Letters, november 2018... Institut de physique du globe de Strasbourg



### 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

Crater of the Saint Paul Island (© J. Chappellaz - Institut polaire français). Seismometer (under the black bell) and acquisition equipment (on the box) (© A. Bernard).

autonomous station resumed its recordings in April 2018, allowing the study of the Southeast Indian oceanic ridge. This station should be fully operational in 2020.

Ecole et observatoire des sciences de la Terre



### 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.

Ecole et observatoire des sciences de la Terre Instruments acquired in the framework of EquipEx Critex



@WeAreVolcania

A new scientific journal specialized in #volcanology in open access. <http://jvolcania.org> @PUStrasbourg @ecole\_terre



## GLACIOLOGY

### Tuning in to the Argentière glacier

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.

Institut de physique du globe de Strasbourg Ecole et observatoire des sciences de la Terre In collaboration with the Institut des géosciences de l'environnement and the Institut des sciences de la Terre



ESOT interferometric radar "Spatial Observation Platform" installed on the left bank of the Argentière glacier. These geodetic measurements complete seismological and hydrological ones. © J-P. Malet

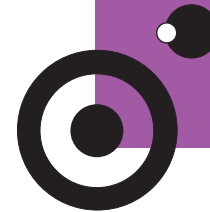
## REMOTE SENSING

### 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 SERTIT'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.

Laboratoire des sciences de l'ingénieur, de l'informatique et de l'imagerie

Maps available on the website of the Minister of Agriculture



## GALACTIC ARCHEOLOGY



### 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-Hawaï telescope (CFHT) revealed structures that were hitherto unknown to researchers. Notably, a large halo of old stars highlights the role of an elliptical 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.

Monthly Notices of the Royal Astronomical Society, Letters, january 2018... Observatoire astronomique de Strasbourg

Stephan's Quintet in visible light. © CFHT, P-A. Duc, J-Ch. Cuillandre (CEA Saclay/Obs. de Paris).



## SIMULATION

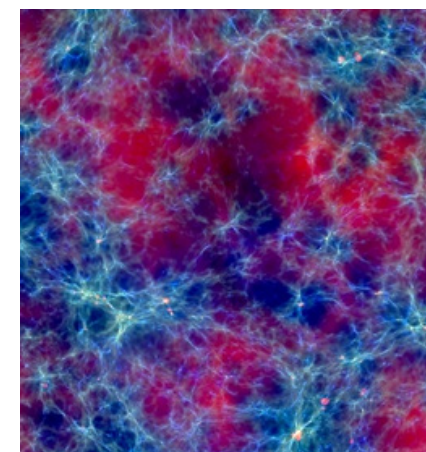
### Discovery of a primordial star

Stars have a life cycle, just like living beings. They are born in nebulae, shine for a few billion years and die in blazing explosions, creating new nebulae... Over successive stellar generations, stars evolve and become rich in heavy elements. An international team has discovered a star that is extremely rare, being poor in heavy elements. This indicates that it is very old, even primordial. This cosmic vestige of the youth of the Universe should inform us about the very first stars to have illuminated the cosmos.

Monthly Notices of the Royal Astronomical Society, august 2018... Observatoire astronomique de Strasbourg



### Simulating 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 smaller galaxies.

The Astrophysical Journal Letters, march 2018... Observatoire astronomique de Strasbourg



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

© N. Deparis, D. Aubert

## GAIA

### 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.

Observatoire astronomique de Strasbourg



### ...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.

Monthly Notices of the Royal Astronomical Society, september 2018... Observatoire astronomique de Strasbourg





## 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, analyzing, 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 figuratively, with the **Gaia** programme that is currently analyzing the characteristics of 1.7 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 KM3NeT (see page 14), **ELT\*** and **EGO-VIRGO\***, 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-coordinator 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 Interuniversity 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 extensively to promote the use of quantitative survey data in HSS.
- Another symposium, called "From Data to Knowledge", was the occasion to showcase ArkeoGIS. This application allows archaeologists to access a large amount of georeferenced 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-VIRGO: European Gravitational Wave Observatory  
 \* EOSC : European Open Science Cloud  
 \* RDA : Research Data Alliance

Observatoire astronomique de Strasbourg  
 Maison interuniversitaire des sciences de l'Homme-Alsace  
 Archéologie et histoire ancienne : Méditerranée et Europe

### ECONOMY

#### A life-sized test for ORRAP



—Optimal In the frame of the ORRAP project – *Optimal recycling of reclaimed asphalt pavement* – two one-kilometre portions of an experimental pavement were built on part of the RD129 north

of Selestat and on a secondary road south of Basle. The experiment focuses on the use of coated aggregates without the addition of bituminous binders and at room temperature. This is a new strategy to recycle these compounds arising from maintenance of the road network. The structure will be monitored over a period of 5 years. ORRAP has a total budget of 1.48 million euros and is co-financed by the Upper Rhine INTERREG V programme arising from the European Regional Development Fund.



© D. Untereiner



### ECONOMY

#### Dynacure: exceptional fundraising

—The Dynacure start-up in Alsace specializes in the treatment of rare neuromuscular diseases. It was created in 2016 and has benefitted from record French fundraising - 47 million euros! This success is a spin-off of IGBMC and is based on the scientific excellence of the laboratory, resulting from a mobilization of the actors (SATT Conectus, the Kurma Partners investment fund, the Californian Ionis Pharmaceutical firm, etc.). The funds will be used for the clinical development of Dynacure's main product, an antisense oligonucleotide to treat myotubular myopathy and autosomal dominant centronuclear myopathy, diseases for which there is currently still no treatment. Research is carried out in IGBMC in this field. Firstly, researchers identified Dynamin 2 as a potential therapeutic target for these myopathies and they were able to specifically modulate its level by means of antisense oligonucleotides. Secondly they developed an alternative strategy using a small non-pathogenic DNA virus as a vector to deliver another inhibitor of Dynamin 2 to the interior of cells.

*Molecular Therapy*, february 2018...  
 Institut de génétique et de biologie moléculaire et cellulaire

### EUROPE & INTERNATIONAL

#### INTERNATIONAL COLLABORATIONS IN 2018

- 17** International projects of scientific co-operation (PICS), of which 5 were created in 2018
  - 11** International associated laboratories (LIA), of which 4 were created in 2018
  - 9** Joint research projects, of which 4 were created in 2018
  - 1** International research group
- Countries involved: Germany, Brazil, Canada, China, South Korea, Denmark, Spain, USA, Hong Kong, Israel, Japan, Norway, Poland, Russia, Vietnam.

### SCIENCE & SOCIETY

**@MT180FR** Regional final co-organized by @CNRS and @unistra\_JDS Clarisse Quignon, PhD student at the #INCI, won the #PrixDuJury with her melatonin molecules 🕒 | Florian Kletty of @IPHC\_Strasbourg, the #PrixDuPublic for his presentation (in alexandrins!) concerning the large hamster 🐹 | Santiago Salazar Botero of #ICube, the #PrixDesLycéens for speaking about nervous system reconstruction. 🧠

**@pintofscienceFR** 20 conferences by 40 PhD students and researchers 🧑🏫 from 12 Alsatian research Units in #Strasbourg and #Mulhouse: CNRS scientists answered yes to talk science over a drink! 🍷🍷

**physiquepourtous67** Launch of @physicpourtous! Do you understand the physical phenomena that surround you? 🧠🔥🔥 This is the aim of these extraordinary "evening classes" organized by lecturers from @IPHC\_Strasbourg. Everyone from senior school students to retired people are welcome!

#### Spinofrin

—The *Spray Flash Evaporation* process allows the ultra-rapid transformation of a liquid of importance into fine sub-micron particles. This technology interests the pharmaceutical, cosmetic and agro-alimentation sectors. Backed by the NS3E laboratory, the Spinofrin start-up relies on this technology and works in partnership with Technnofounders, a "studio" company that provides the developmental arm (fundraising, market research, etc.).

**IPGS** #MarginResearchM5 | this consortium was launched between the #IPGS (@CNRS @Unistra) and 11 industrial and academic partners. On the programme are: a field study 🏔️ in the Alps and modelling of processes linked to the formation of passive margins. #geology #rift #continental\_plates #oceanic\_plates

**Startup Generation #1** Le @CNRS\_Alsace participates in this 1<sup>st</sup> edition devoted to the creation of companies and the world of the start-up (@Unistra).

#### Make Our Planet Great Again

—In the framework of the MOPGA programme, the Greek researcher Konstantinos Christoforidis is the winner of the 2nd wave of the call to tender with his SunCO2H2Energy project. He has joined the ICPEES laboratory. Moreover, the IPHC hosted the Brazilian PhD student Camila Stefanne Dia Costa for 4 months to work on trapping toxic metals in industrial effluents thanks to brown algae.

**ICM\_2018** Nalini Anantharaman, a researcher in #IRMA (@CNRS @unistra), is the recipient of the silver medal of #CNRS\_Talents. She gave a keynote speech at the International Congress of Mathematicians 2018 in #Rio\_de\_Janeiro 🇧🇷, one of the most important symposium in the world.

**FET-OPEN** [Europe] #FET-OPEN # H2020 @fet\_eu @EU\_Commission  
 Projet #MAGNIFY : Nicolas Giuseppone of the #InstitutCharlesSadron (@CNRS) won a European call to tender to work on a new generation of artificial muscles for robotic systems. #innovation #molecular\_machines @univgroningen @StampaCnr @UniboMagazine

**LIVE** A Human-Environments Observatory was created in July 2018 (#OHM @INEE\_CNRS @unistra) to study the ecological, economical and social impacts of closure of the nuclear power plant of #Fessenheim. #LIVE



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](http://alsace.cnrs.fr) | [Twitter](https://twitter.com/CNRS_Alsace) CNRS\_Alsace or [journal.cnrs.fr](http://journal.cnrs.fr)

## INSB

— **Architecture et réactivité de l'ARN**  
ARN, CNRS - [www-ibmc.u-strasbg.fr/spip-arn](http://www-ibmc.u-strasbg.fr/spip-arn)

— **Biotechnologie et signalisation cellulaire**  
BSC, CNRS/Unistra - [bsc.cnrs.fr](http://bsc.cnrs.fr)

— **Centre d'investigations neurocognitives et neurophysiologiques**  
CI2N, CNRS/Unistra - [ci2n.fr](http://ci2n.fr)

— **Centre de neurochimie**  
CNRS - [inci.u-strasbg.fr/fr/ups.html](http://inci.u-strasbg.fr/fr/ups.html)

— **Chronobiotron**  
CNRS/Unistra - [chronobiotron.u-strasbg.fr](http://chronobiotron.u-strasbg.fr)

— **Génétique moléculaire, génomique et microbiologie**  
GMGM, CNRS/Unistra - [gmgm.unistra.fr](http://gmgm.unistra.fr)

— **Immunologie, immunopathologie et chimie thérapeutique**  
I2CT, CNRS - [www-ibmc.u-strasbg.fr/spip-ict](http://www-ibmc.u-strasbg.fr/spip-ict)

— **Institut de biologie moléculaire et cellulaire** - IBMC, CNRS - [www-ibmc.u-strasbg.fr](http://www-ibmc.u-strasbg.fr)

— **Institut de biologie moléculaire des plantes** IBMP, CNRS - [ibmp.cnrs.fr](http://ibmp.cnrs.fr)

— **Institut de génétique et de biologie moléculaire et cellulaire**  
IGBMC, CNRS/Inserm/Unistra - [igbmc.fr](http://igbmc.fr)

— **Institut des neurosciences cellulaires et intégratives** - INCI, CNRS - [inci.u-strasbg.fr](http://inci.u-strasbg.fr)

— **Laboratoire de bioimagerie et pathologies**  
LBP, CNRS/Unistra - [www-lpb.unistra.fr](http://www-lpb.unistra.fr)

— **Laboratoire de neurosciences cognitives et adaptatives** - LNCA, CNRS/Unistra - [lnca.fr](http://lnca.fr)

— **Modèles insectes de l'immunité innée**  
M3I, CNRS  
<http://ibmc-m3i.cnrs.fr/fr/accueil-ridi>

— **Plateforme de chimie biologique intégrative de Strasbourg**  
PCBIS, CNRS/Unistra - [pcbis.fr](http://pcbis.fr)

## INC

— **Chimie de la matière complexe**  
CMC, CNRS/Unistra - [complex-matter.unistra.fr](http://complex-matter.unistra.fr)

— **Institut Charles Sadron**  
ICS, CNRS - [ics-cnrs.unistra.fr](http://ics-cnrs.unistra.fr)

— **Institut de chimie et procédés pour l'énergie, l'environnement et la santé**  
ICPEES, CNRS/Unistra - [icpees.unistra.fr](http://icpees.unistra.fr)

— **Institut de chimie de Strasbourg**  
[institut-chimie.unistra.fr](http://institut-chimie.unistra.fr)

— **Institut de science des matériaux de Mulhouse**  
IS2M, CNRS/UHA - [is2m.uha.fr](http://is2m.uha.fr)

— **Institut de science et d'ingénierie supramoléculaires**  
ISIS, CNRS/Unistra - [isis.unistra.fr](http://isis.unistra.fr)

— **Laboratoire de conception et application de molécules bioactives**  
CAMB, CNRS/Unistra - [camb.cnrs.fr](http://camb.cnrs.fr)

— **Laboratoire d'innovation moléculaire et applications**  
LIMA, CNRS/Unistra (ex LCM) - [lima.unistra.fr](http://lima.unistra.fr)

## — Laboratoire d'innovation thérapeutique

LIT, CNRS/Unistra - [medchem.unistra.fr](http://medchem.unistra.fr)

— **Nanomatériaux pour les systèmes sous sollicitations extrêmes**  
NS3E, CNRS/Unistra /ISL - [ns3e.cnrs.fr](http://ns3e.cnrs.fr)

## INSHS

— **Archéologie et histoire ancienne : Méditerranée et Europe**  
Archimède, CNRS/Unistra - [archimede.unistra.fr](http://archimede.unistra.fr)

— **Bureau d'économie théorique et appliquée**  
BETA, CNRS/Unistra/Université de Lorraine  
[beta-umr7522.fr](http://beta-umr7522.fr)

— **Droit, religion, entreprise et société**  
DRES, CNRS/Unistra - [dres.misha.cnrs.fr](http://dres.misha.cnrs.fr)

— **Dynamiques européennes**  
DynamE, CNRS/Unistra - [dynamie.unistra.fr](http://dynamie.unistra.fr)

— **Maison interuniversitaire des sciences de l'Homme-Alsace**  
Misha, CNRS/Unistra - [misha.fr](http://misha.fr)

— **Sociétés, acteurs, gouvernement en Europe**  
Sage, CNRS/Unistra - [sage.unistra.fr](http://sage.unistra.fr)

## INSU

— **École et observatoire des sciences de la Terre**  
EOST, CNRS/Unistra - [eost.unistra.fr](http://eost.unistra.fr)

— **Institut de physique du globe de Strasbourg**  
IPGS, CNRS/Unistra - [ipgs.unistra.fr](http://ipgs.unistra.fr)

— **Laboratoire d'hydrologie et de géochimie de Strasbourg**  
LHyGeS, CNRS/Unistra - [lhyges.unistra.fr](http://lhyges.unistra.fr)

— **Observatoire astronomique de Strasbourg**  
CNRS/Unistra - [astro.unistra.fr](http://astro.unistra.fr)

## INSMI

— **Institut de recherche mathématique avancée**  
Irma, CNRS/Unistra - [irma.math.unistra.fr](http://irma.math.unistra.fr)

## INSIS-INS2I

— **Laboratoire des sciences de l'ingénieur, de l'informatique et de l'imagerie**  
ICube, CNRS/Unistra/Engees/Insa  
[icube.unistra.fr](http://icube.unistra.fr)

## IN2P3

— **Institut pluridisciplinaire Hubert Curien**  
IPHC, CNRS/Unistra - [iphc.cnrs.fr](http://iphc.cnrs.fr)

## INEE

— **Laboratoire image, ville, environnement**  
LIVE, CNRS/Unistra - [live.unistra.fr](http://live.unistra.fr)

## INP

— **Institut de physique et chimie des matériaux de Strasbourg**  
IPCMS, CNRS/Unistra - [ipcms.unistra.fr](http://ipcms.unistra.fr)

## The CNRS Institutes

— **Institute of Biological Sciences (INSB)**

— **Institute of Chemistry (INC)**

— **Institute of Ecology and Environment (INEE)**

— **Institute for Humanities and Social Sciences (INSHS)**

— **Institute for Information Sciences and Technologies (INS2I)**

— **Institute for Engineering and Systems Sciences (INSIS)**

— **National Institute for Mathematical Sciences and their Interactions (INSMI)**

— **Institute of Physics (INP)**

— **National Institute of Nuclear and Particle Physics (IN2P3)**

— **National Institute for Earth Sciences and Astronomy (INSU)**

## Liste des sigles

**CNRS**

— **INIST** : institut de l'information scientifique et technique

— **OMES** : observatoire des métiers et de l'emploi scientifique

— **SAP2S** : service d'appui à la politique et à la prospective scientifiques

## Services de la délégation Alsace

— **SFC** : service financier et comptable

— **SPV** : service partenariat et valorisation

— **SRH** : service ressources humaines

— **STL** : service technique et logistique

— **MESRI** : ministère de l'Enseignement supérieur, de la recherche et de l'innovation

— **SATT** : société d'accélération de transfert de technologies





The picture is of an extremely deep multi-coloured image of the Canada-France-Hawaii telescope.

**SEE PAGE 17**

© CFHT, P-A. Duc, J-Ch. Cuillandre (CEA Saclay/Obs. de Paris).

## CNRS délégation Alsace

23 rue du Loëss - BP20 - 67037 Strasbourg Cedex 2 - 03 88 10 63 01

[www.alsace.cnrs.fr](http://www.alsace.cnrs.fr) | [CNRS\\_Alsace](https://twitter.com/CNRS_Alsace)

