UNIVERSITÉ
CÔTE D'AZUR

ACADEMY OF EXCELLENCE

SPACE, ENVIRONMENT,
RISK AND RESILIENCE

Activity Report
2016-2020

Academy 3
Space, Environment, Risk and Resilience

Edited by

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Summary

1. The projects of Academy 3 for the period 2016-2020

The health of our planet and its broader ecosystems (natural environments, biodiversity, humans, cities, etc.) figures among the greatest concerns of our modern era. Natural and anthropogenic hazards are increasingly threatening the Earth and life upon it. Thus, a major challenge of the present century is to provide our societies with strategies to meet these threats and reduce the risks. Despite immense progress in our understanding of the world, much of our planet and Universe is still poorly understood while humans remain a partial mystery, and this represents yet another challenge, especially for future generations. How can we hope to achieve global sustainability in taking care of the Earth, the environment and humans if we do not know how they behave and interact? Our current challenges are thus great; on the one hand we must be far-sighted explorers of our own species, environment and Universe, and on the other hand we must face the hazards and risks that we have created or sustained at different temporal and spatial scales.

A few years ago, the concept of "planetary boundaries" was proposed to pave our way towards global sustainability[1]. A planetary boundary is a limit that must not be transgressed if humans aspire to live in balance with their Universe. Nine planetary boundaries were defined: climate change, ocean acidification, stratospheric ozone depletion, atmospheric aerosol loading, biogeochemical flows, global freshwater use, land-system changes, rate of biodiversity loss, and chemical pollution. All exhibit a threshold whose transgression might plunge humanity and Earth into an irreversible situation. In addition, most boundaries are inter-connected so they form an intricate pattern of interrelated hazards. The planetary boundary framework demonstrates that the current and future challenges we are facing are complex, diverse, and defined within an intricate four-dimensional system including space, time, type of risk, and resilience.

The Space, Environment, Risk and Resilience Academy (Academy-3 within the UCA structure) has a core interest in the relationships between humans and their broader environments from Earth to Space. The principal objective of Academy-3 is to improve our grasp of the natural and anthropogenic hazards that threaten the Earth and its ecosystems in order to help cope with their related risks. A second objective is to better understand the behavior of the Earth and of the Universe, as these are both the source and targets of the multiple hazards. The planetary boundaries described above are thus among the primary concerns of Academy-3. These two ambitious objectives break down into a broad range of issues that include the observation and study of natural, industrial, sanitary, ecological, and anthropogenic hazards, considered individually or together, and the observation and study of

[1] J. Rockström et al. Ecology and Society 2009, 14(2): 32

the Earth and the Universe. This large range of interests brings Academy-3 equally into the physical, natural and social sciences. It also makes it inherently transdisciplinary; as said earlier, most "planetary boundaries," and hence most hazards, are intricate and inter-connected, which requests more than mono-disciplinary research approaches. Hazards must be considered holistically, from biology to earth sciences, and from chemistry to economics, in order to create a new framework where risks can be described globally with all their components.

To achieve its objectives, Academy-3 has fostered and supported various types of actions (scientific and applied projects, training programs, workshops, etc.) dealing with five principal issues:

1) Assessing anthropogenic hazards on human health and environments;

2) Targeting the specific case of natural and anthropogenic hazards in the Mediterranean context, especially in South-East France;

3) Developing integrated research in the physics of large earthquakes and related hazards;

4) Understanding the origin and the physics of our Universe and of our Earth;

5) Developing innovative instrumentation and methodologies for Earth and Space observation, and hazard and resilience assessment.

Because these five issues link humans as actors in their planetary system, they are interconnected. As a consequence, Academy-3 spans the fields of astrophysics, geology and geophysics, chemistry, biology, medicine, geography, data sciences, social sciences, etc. in a way that is more interlinked than just multidisciplinary.

Over its four years of operation, Academy-3 has fostered the emergence of innovative interdisciplinary research in the five main axes described above. Thirty-two major projects were supported. About 28% of the projects address critical questions on relationships between anthropogenic activities and human health, 19% focus on hazards related to our Région Sud, 15% target seismic hazards approached in a generic manner, 16% address broad-scale questions of our Universe, and, finally, 22% of projects explore innovative approaches or instruments to best observe humans, the Earth or Space and to better cope with the intricate hazards that threaten them.

Altogether, the 32 projects involve about 200 UCA scientists and 100 students at various levels, including more than 30 PhD students. The projects have also attracted 10 young post-doctoral researchers from abroad. More than 80% of the projects have built new collaborations within UCA and abroad, and almost 60% of them have brought together 3 or more UCA laboratories or institutes in original collaborations. They are thus clearly transdisciplinary and "structuring". A quarter of the projects funded by Academy-3 have even brought together physical and social sciences, thereby paving the way towards a more complete hazard assessment.

While the 32 projects are clearly shaping a new landscape of research connections within UCA, they also extend abroad to the national and international communities. More than 70% of the projects have developed or strengthened international collaborations or networks while about 80% of them have already presented their results in international high-level publications or conferences. The significance of the results is also attested by half of the projects having received additional funding from external sources such as the ANR, Europe, CNES, etc.

The research produced with the support of Academy-3 is thus rich and diverse and scientifically and socially significant. Furthermore, it has opened the door to new collaborations outside the usual fields of expertise in France and internationally. As a result, a sense of collective concern has emerged which shows the necessity for innovative observations, research, instrumentation, and actions at various levels, from individuals to policy-makers, including scientists and the general population. This might be the only way to develop efficient resilience strategies for humans and their broader ecosystems.

The tight link that exists between Academy-3 and IMREDD (Institut Méditerranéen du Risque, de l'Environnement et du Developpement Durable) should help to further the development of initiatives connecting human beings with their natural and anthropogenic environments, especially their cities. The concept of «smart cities» is emerging as a new perspective for the forthcoming decades, and this will bring with it new challenges requiring the input of social sciences and legal experts.

The research fostered within Academy-3 has also led to the creation of the Environmental Hazards and Risk Management master's program, whose goal is to take advantage of the transdisciplinary richness in the Academy-3 community and provide innovative training on risk data analysis, representation and modeling and on risk management. This new degree will enable students to become knowledgeable experts in their future Earth, well-positioned to better anticipate and mitigate environmental hazards and risks.

We believe that the on-going synergy between various researchers and institutes of Université Côte d'Azur reported here would never have occurred without the support of Academy-3 and UCA^{JEDI}. Though still at an embryonic stage, the interdisciplinary approach we have promoted over the last 4 years paves the way to more integrated actions to come. These will help us to better assess and respect our "planetary boundaries". To reach this objective, local and national networks are necessary, and it is essential that this strategy be expanded to the international level. Synergy, transdisciplinarity and international networking are thus the key words for the future of Academy-3.

This booklet is organized in five chapters corresponding to the five axes of Academy-3, namely: Environment and health hazards; Natural and anthropogenic hazards in the Euro-Mediterranean region; Physics of large earthquakes and related hazards; Origin and physics of our Universe and of our Earth; Instrumentation and methodologies for Earth and Space observation and hazard and resilience assessment. For each project, a short summary of the project is presented together with its participants, budget, possible developments and actions for future work, and links for more information on the project. An individual comment is also provided to emphasize why Academy-3 chose to support each project.

In reading the brief description of these projects, we hope that you will find opportunities for new research ideas and collaborations, and even more, cause for optimism in the challenges that our planet and its inhabitants are facing.

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Environment and health hazards

BTSI2S - Bacillus thuringiensis var. kurstaki Sensing by the Innate Immune System: Impact on Non-target Animals and Human Health

Organic food might not be that healthy: the case of the Bt insecticide and its impacts on health and the environment.

Armel Gallet

Laurent Boyer

Academy 3 highlight

This project combines medicine, immunology, cell biology and ecotoxicology to investigate the impact and risks on human health and environment of a bioinsecticide, Bt, currently broadly used in agriculture. It thus addresses an important health hazard related to anthropogenic activities and the current transition to sustainable agriculture.

Scientific domain

Immunology, Microbiology, Agronomy & Sustainable Agriculture

Key words

Bioinsecticides
Bacillus thuringiensis (Bt)
Bacillus cereus
Innate Immune Response

PI laboratories

ISA, UCA
C3M, UCA

Partner laboratories

Laboratoire de Bactériologie Clinique, CHU-Nice – UCA
Anses

Total budget

405 k€ including 190 k€ from Academy 3

The project

The use of chemical pesticides is currently controversial and disputed in the public, mainly because of their detrimental effects on both the environment and human health. An emerging solution to limit these chemical pesticides is to replace them by biopesticides based on living organisms or natural products. Because the agricultural world is shifting towards more sustainable agriculture, sales of biopesticides are currently increasing at an extraordinary rate. Among these biopesticides, Bacillus thuringiensis (Bt) spores represent 50% of the current sales. Bt is a toxin-producing bacterium that specifically kills pests and is thus widely used in organic farming. Bt spores are therefore present in feed and food. Yet Bt belongs to the same family as the well-known food poisoning bacteria Bacillus cereus (B. cereus). Our hypothesis is that this resemblance could be indicative of potentially adverse effects of Bt on the environment and human health. To examine this hypothesis, we have gathered a large team of engineers, scientists and clinicians interested in agronomy, immunology, microbiology, environment and human health, and have been collaborating to analyse how the immune response of the host reacts to the presence of Bt. Our first data show that both Bt and B. cereus spores escape the innate immune system of the host so that the bacteria persist for a significant time in the host's digestive tract. This observation suggests that Bt biopesticides may have an impact on human health. We will expand these analyses, especially to address, for the first time, whether Bt could be confused with B. cereus and be responsible for pathologies mistakenly attributed to B. cereus. We will also assess the ratio of Bt involved in food poisoning and bacteremia. We anticipate that our results will be of prime importance in the current context of the transition to sustainable agriculture.

The +

This study is the first to address the ability of bacterial spores in general, and Bt in particular, to activate innate immune responses in vertebrates. This multidisciplinary project will be achieved thanks to the collaboration of three UCA research teams working in different fields.

What's next?

If our results demonstrate that Bt activates innate immunity in vertebrates, we will seek to investigate underlying molecular and cellular mechanisms. To do this, we will apply for additional funding from the ANR and the ERC.

CYTOPOL - To Investigate the Relationship Between In Utero Exposure to Endocrine Disruptors and Cytokine Levels in Umbilical Cord Blood

How does a mother's exposure to endocrine disruptors during pregnancy impact the neurodevelopment of her newborn? Insights from the French EDEN cohort.

Nicolas Glaichenhaus

Academy 3 highlight

Endocrine disruptors are currently found in manufactured goods and plant and animal-based foods. Most originate from the agrochemical industry and persist in the environment for many years. This project investigates the mechanisms through which endocrine disruptors have a detrimental impact on human health. As such, it fits one the major themes of Academy 3, i.e., elucidating mechanisms by which anthropogenic activities induce risks for society and the environment.

Scientific domain

Environmental Health

Key words

Endocrine Disruptors
Immune System
Neurodevelopment

PI laboratory

IPMC, UCA

Partner laboratories

INSERM
CESP, INSERM
Institute for Advanced Biosciences

Total budget

200 k€ including 15 k€ from Academy 3

The project

Epidemiological studies have demonstrated that children born to women who have been exposed to endocrine disruptors during pregnancy have an increased risk of exhibiting neurodevelopment alterations and behavioral abnormalities. However, the underlying mechanisms by which endocrine disruptors impact neurodevelopment are unknown. Cytokines are soluble molecules that are mainly produced by immune cells in blood and peripheral tissues, and act on many cell types including those of the central nervous system. Because endocrine disruptors are known to impact the immune system, we have hypothesized that endocrine disruptors may not act directly on the brain, but rather impact cytokine levels which would, in turn, affect neurodevelopment. To test this hypothesis, we have taken advantage of the large collection of biological samples and clinical variables that were acquired in the French EDEN mother-child cohort. EDEN was set up in 2003 in French maternity clinics in Nancy and Poitiers. Study participation was proposed to 3758 women before their 24th week of amenorrhea, and 2002 of them were eventually enrolled in the study between 2003 and 2006. Urine samples were analyzed at different times of pregnancy for the presence of endocrine disruptors in order to assess maternal exposure to these chemical compounds. Umbilical cord blood samples were collected at birth and analyzed for cytokines such as interleukin (IL)-6 and IL-17A, which are known to act on neurodevelopment (at least in rodents). Children were assessed periodically up to an age of 10 years to identify those exhibiting neurodevelopmental problems. Using multivariable statistical analysis methods, we analyzed these datasets to identify cytokines whose level in cord blood was associated with the level of endocrine disruptors in maternal urine. We found that IL-6 levels in umbilical cord blood were positively associated with exposure to Mono-3-Carboxy-Propyl-Phthalate (MCPP), a well-known endocrine disruptor present in the environment. For the next step, we will use a statistical method known as "mediation analysis" to determine whether the detrimental impact of MCPP on neurodevelopment is explained, at least in part, by the impact of MCPP on IL-6 levels. We will also conduct similar analyses on another independent dataset. Should our results be validated, they will provide novel insights into the mechanisms by which exposure to endocrine disruptors during pregnancy impacts the neurodevelopment of the fetus.

The +

This study is one of the first to investigate the mechanisms by which endocrine disruptors impact neurodevelopment in humans. It combines biology, medical sciences and statistical analyses to assess clinical variables and biological samples collected within the frame of the EDEN Mother-Child cohort.

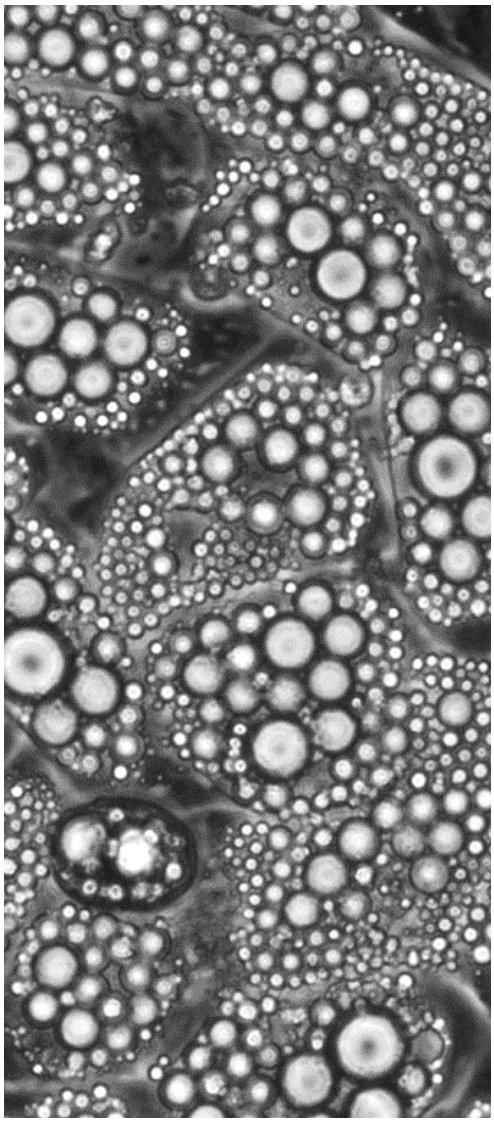
What's next?

If we demonstrate that the detrimental impact of endocrine disruptors on child behavior is mediated by cytokines in the EDEN cohort, we will seek to validate our results in the FinnBrain Mother-Child cohort that consists of 3808 mother-child pairs who have been enrolled and followed in Finland since December 2011. We will apply to the ANR and European funding agencies to pursue this more ambitious work.

PROSTADIPE - Impact of Endocrine Disrupting Compounds on Adipose Tissue Secretome and on Aggressiveness of Prostate Cancer

Exploring the causal relationship between chronic exposure to anthropogenic endocrine-disrupting chemicals and prostate cancer: a matter of adipose tissue.

Charlotte Hinault



Academy 3 highlight

ProstAdiPE gathers experts on hormone-dependent cancers, adipose tissue biology, and organic pollutants to investigate the human health risks posed by certain anthropogenic pollution compounds, the endocrine-disrupting chemicals. It specifically examines the possible causal relationship between these compounds and hormone-sensitive cancers, such as prostate cancer.

Scientific domain

Environment and Health

Key words

Endocrine Disrupting Chemicals
Low Dose
Chronic Exposure
Adipose Tissue
Prostate Cancer

PI laboratory

C3M, UCA

Partner laboratories

iBV, UCA
Observatoire du Développement Durable, Métropole NCA

Total budget

20 k€ including 10 k€ from Academy 3

The project

Persistent organic pollutants are lipophilic chemicals that are present in many industrial products and accumulate throughout the food chain. From fetal life to adulthood we are chronically exposed to these pollutants. Some of them, called endocrine disrupting chemicals (EDCs), have been shown to interfere with the body's endocrine system and produce adverse effects by modifying hormone regulation. In particular, EDCs seem to be implicated in the increased occurrence of some hormone-dependent cancers, including prostate cancers.

Due to their specific chemical structure, EDCs are not metabolizable and they thus accumulate in human adipose tissue. Doing so, they progressively make the adipose tissue a persistent internal source of systemic chronic exposure to EDCs. On the other hand, excess adiposity in obesity increases the risk of cancer development. In many tumors, the cells that form adipose tissue (adipocytes) are in close contact with the cancer cells. While adipocytes usually secrete various substances known as the "secretome" (which includes fatty acids, cytokines, exosomes, etc.), their secretion is modified in peri-tumoral adipose tissue. Moreover, the modified secretome seems to favor tumor growth. We hypothesize here that exposure to EDCs contributes to modify the secretome of peri-tumoral adipose tissue in case of prostate cancer. To examine this hypothesis, we are investigating: 1) the EDC storage and release capacity of human adipocytes; 2) how EDCs modify the secretome of human adipocytes; 3) whether the modified adipocyte secretome influences the aggressiveness of prostate cancer tumoral cells.

To address these questions, we use human adipocytes (differentiated adipose-derived multipotent stem cells) and human prostate cells affected by cancer (carcinoma type), and put them in contact with different EDCs. Our preliminary results show that one of the EDCs is stored in the adipocytes in less than 24h, after one or more nanomolar doses. In the case of two EDCs, we observe increased prostate cancer cell proliferation when the cells are incubated with the supernatant from EDC pretreated adipocytes (conditioned media). We are in the process of analyzing the adipocyte secretome to identify how it has been modified. So far, we have shown that neither of the two EDCs modified fatty acid release by the adipocytes. Therefore, the EDC-induced secretome changes are to be found in other substances.

The +

In contrast to most projects that have investigated the impact of high doses of EDC on cancer, our study is one of the first to focus on low doses of EDC. If successful, our project could allow for the identification of biomarkers in adipose tissues associated with exposure to EDC.

What's next?

Should biomarkers of exposure to low doses of EDC be identified, biological samples could be assessed for these biomarkers on a large scale in routine clinical settings. We will apply for additional funding from ANSES and the ANR to undertake the subsequent proof-of-concept studies.

NUTRINEURO - Nutritional Lipids, Neuroinflammation and Obesity: The Deleterious Role of Industrial Fatty Acids

“Seeking to prevent obesity and related diseases through identification of causal relations between the nature of ingested lipids and early glial activation in the hypothalamus.”

Carole Rovere

Academy 3 highlight

Diseases and complications related to nutritional problems are a major current health issue in France and around the world. By addressing this critical issue, the NutriNeuro project addresses one of the major concerns of Academy 3, i.e., the impacts and risks of anthropogenic actions on human health.

Scientific domain

Life Sciences

Key words

Nutritional Lipids
Obesity
Neuroinflammation
Hypothalamus
Glial Cells

PI laboratory

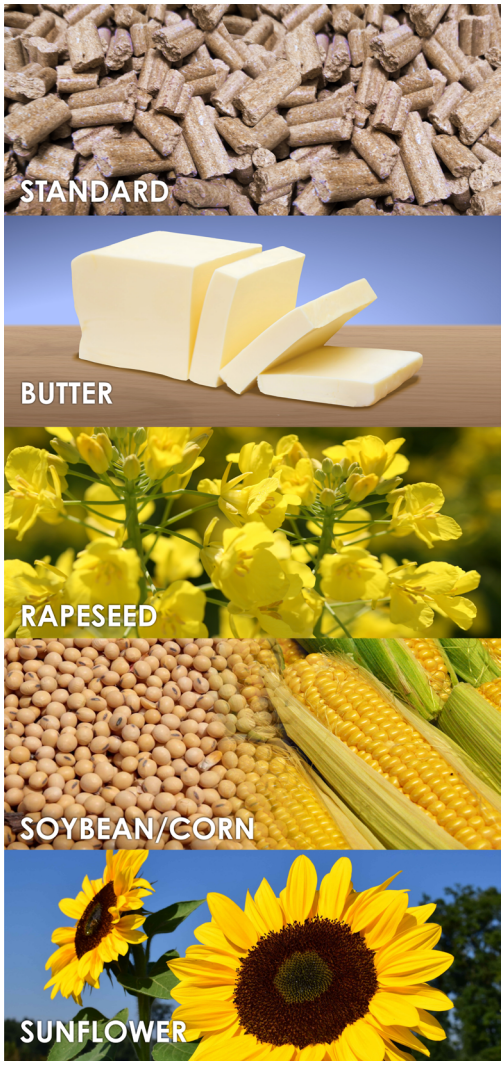
IPMC, UCA

Partner laboratories

I3S, UCA
CSGA, CNRS
ICAN

Total budget

60 k€ including 10 k€ from Academy 3



The project

The consumption of "Western" diets with high sugar and fat content combined with a decrease in the consumption of vegetables, fiber, cereals and bread and a generally low level of physical activity, has led to an increased prevalence of obesity in Western countries (Europe, USA, etc.). These Western obesogenic diets are dangerous to health because they have excessive amounts of saturated and polyunsaturated fatty acids (PUFAs), such as the deleterious pro-inflammatory omega-6 type (Ω-6). The Ω-6 fatty acid can indeed dramatically alter the integrity of the coronary artery walls, while the lack of omega-3 (Ω-3), an anti-inflammatory fatty acid, can increase the deleterious action of Ω-6. The past 40 years have been marked by a drastic increase in the Ω-6/Ω-3 ratios in the diet of the French and Western populations which now stands at around 8; an ideal ratio would be less than 5. The failure to respect a certain Ω-6/Ω-3 balance could predispose people to inflammatory developments which generally initiate a variety of diseases including obesity and associated problems (cardiovascular disease, stroke, etc.).

The purpose of this project is to characterize the impact of different lipid categories on obesity development and the associated occurrence of inflammation. For 4, 8 and 16 weeks, we fed mice with different hyperlipidic diets (enriched in butter, rapeseed, soybean/corn, or sunflower) containing a range of Ω-6/Ω-3 ratios (2.3-17.5), and compared this to a standard diet. From the analyses of inflammatory profiles, we could show that it was not only the amount but also the nature of the lipids contained in the hyperlipidic diets that affected the inflammatory molecule production in both peripheral circulation and the hypothalamus (brain region involved in feeding behavior regulation). Using an innovative pharmacogenetics approach (DREADD technology) made to specifically inhibit the two major brain cells involved in feeding behavior (glial cells, and more specifically astrocytes and microglia), we also revealed the implication of the hypothalamic activation of those cells in the development of obesity. However, this brain cell activation seems to be reversible, which suggests that resilient strategies will be possible.

The +

In addition to its innovative technological approach, this project is novel because it addresses the impact of fasting on brain cells, a scientific question that has rarely been studied before. If successful, it may contribute to a better understanding of the detrimental impact of Western high-fat diets in human populations.

What's next?

Should our project be successful, it will pave the way for the identification of molecular and cellular pathways that could be targeted by pharmaceutical drugs to prevent the detrimental impact of Western high-fat diets on human health. We therefore plan to initiate a partnership with industrial partners working in this field.

NR2P2 - Nuclear Risk, from Radioisotope (Bio) Chemistry to Public Perception

Is nuclear power your concern? A comparative analysis of the perception of nuclear risk among two populations in France.

Academy 3 highlight

Social concern about the possible impacts of nuclear energy has increased worldwide. Knowing how individuals and populations perceive nuclear risk is key to the development of appropriate prevention and resilience strategies. This interdisciplinary project brings together geographers, radiochemists, lawyers, biologists, and rescuers around this issue of nuclear risk perception.

Scientific domain

Social Sciences and Chemistry

Key words

Nuclear
Risk Assessment
Radioactivity
Public Perception

PI laboratories

ICN, UCA
ESPACE, UCA

Partner laboratories

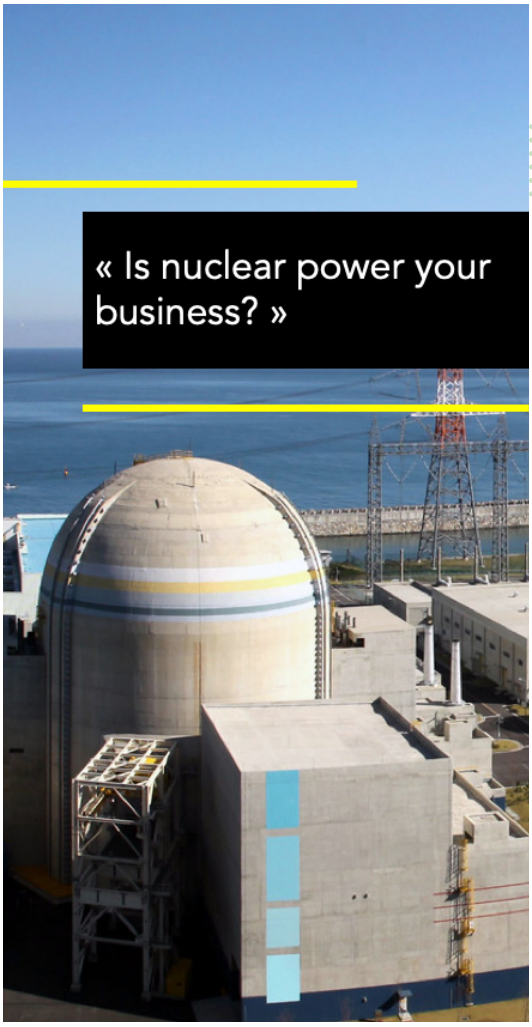
GEOAZUR, UCA
TIRO-MATOs, UCA
GREDEG, UCA
IPMC, UCA
Service de Santé et de Secours Médical (SDIS06)

Total budget

20 k€ from Academy 3

Christophe Den Auwer

Sandra Perez



The project

Since the end of the Second World War, the significant development of the civil nuclear industry in Northern Hemisphere countries, and elsewhere, has raised new issues in terms of environmental impact, long-term management and defense. However, the nuclear sector is an industrial field that is subject to controversy and which induces diverse and varied fears that blur both the actual risks and the actual perception of these risks. We have thus built an interdisciplinary consortium of researchers (geographers, radiochemists, lawyers, and biologists) and rescue professionals to specifically address the question of nuclear risk and its public perception.

Our analysis is based on an internet survey of two populations in France having different profiles regarding nuclear risk and perception: one population of "experts" composed of firefighters, and one population of "non-experts" composed of Université Côte d'Azur students. To these two populations we posed a series of similar questions relating to their knowledge and perception of nuclear risk, and gathered a total of 2300 responses. Among the results, the analysis revealed that firefighters' confidence in the nuclear industry is twice as high as that of students (50%, compared to 22% for students). We also found that students who study the basic sciences are more in favor of a partial exit from nuclear power (55% compared to less than 20%) and more open to changing their mind if they were to receive more relevant information on the subject (55%) than students in other domains of study (10-15%).

We are now in the process of initiating pedagogical and information outreach actions for the general public.

The +

In the social sciences, perception has long been a useful concept for understanding risk situations, distinguishing between perceived risk and actual risk. Although surveys on nuclear risk perception are not new (see "IRSN barometer" https://barometre.irsn.fr), our study is unique in that biologists, radiochemists, geographers and rescuers address social science issues to develop adapted tools and acquire a shared knowledge on the public perception of nuclear impact.

What's next?

Initially funded as a "small" project by the Academy 3, this study will become a component of the larger METARISK project to study the impact of chemical and radio-toxicological risks on human populations. In the next few years, we will contribute to the "laradioactivite.com" CNRS website, enhancing public knowledge and perception of radioactive phenomena by providing information to general public and conducting pedagogical actions with public stakeholders such as the Parc National du Mercantour.

More info at
http://univ-cotedazur.fr/en/idex/academies/

ELSE Workshop - European Leadership for Safety Education Workshop

A new research-based approach to safety leadership education in nuclear and other high-risk sectors.

Catherine Thomas

Academy 3 highlight

By training professionals and students in safety leadership, the ELSE project will contribute to the development of resilience strategies at both individual and collective levels. ELSE is complementary to other projects studying risk perception and risk management in the nuclear sector.

Scientific domain

Management, Psychology, Sociology and Civil Engineering

Key words

Managed Safety
Resilience
Mindfulness
Safety Culture

PI laboratory

GREDEG, UCA

Partner laboratories

ENSTTI

Total budget

33 k€ including 7 k€ from Academy 3

The project

Major accidents in the last few decades have questioned the reliability and performance of industrial safety, and evidenced the foremost role played by human and organizational issues. In that context, the concept of "safety leadership" has emerged. It describes how leaders influence the way individuals and groups understand and adhere to organizational safety goals and the means to achieve them, through the interactions those leaders establish with their socio-technical environment. The International Atomic Energy Agency (IAEA) and its member states have since recognized the importance of safety leadership and included it in their fundamental safety principles. In 2016, the IAEA General Conference adopted a resolution calling for the development of specific training on safety leadership. The European Union is committed in this call, especially through its Instrument for Nuclear Safety Cooperation (INSC). The ELSE project fits into this context and aims to develop a new research-based approach for education in the domain of safety leadership. ELSE has two objectives: 1) to develop a certified university diploma in the field of safety leadership aimed at professionals in the nuclear sector; 2) to develop a specific training module at Master level and make it accessible to all university students through a network of "implementing European Universities". No such diploma and module currently exist in Europe or elsewhere. The ELSE project will thus create innovative training at UCA on safety leadership. To reach this objective, ELSE brings together management schools and technical universities specialized in education for the nuclear industry and other high-risk sectors. ELSE also intends to develop innovative research on organizational safety leadership. This research includes a variety of themes such as safety culture, organizational resilience, high reliability organizations, and organizational mindfulness, and is thus interdisciplinary. It targets new critical questions, such as: How can values related to safety culture be transformed into operational behaviors? How to manage tensions between "regulated" (i.e., based on predefined rules) and "managed" (i.e., based on proactive human behavior) safety? To address these questions, we propose in ELSE to gather the national and international community working on these topics. This community includes both researchers and industry experts. We thus plan to organize during the first year of ELSE an international workshop gathering about 25 confirmed experts. Beyond fostering research collaborations among experts from different disciplines (psychology, sociology, management and civil engineering) and between scientists and nuclear industry operators, the workshop will allow discussing and building the pedagogical approaches best suited to the training objectives of ELSE.

The +

ELSE proposes an innovative training program on safety leadership that is unique on the national and international scenes. It will also foster innovative, interdisciplinary research involving both international researchers and industry experts.

What's next?

Over the duration of the ELSE project, the international network of researchers and experts initially built at the workshop will be strengthened and will include a growing number of UCA researchers from different disciplines (risk perception and management, resilience, safety leadership in the nuclear sector and other high-risk environments). These interactions should initiate new, interdisciplinary research projects in UCA and abroad.

Gredeg Groupe de recherche en Droit, Economie et Gestion

enstti TRAINING & TUTORING NUCLEAR SAFETY

More info at
http://univ-cotedazur.fr/en/idex/academies/

METARISK - Metabolomics for Exposure to Chemical or Radiological Risks

Developing new metabolomics methods to detect and measure toxicological contamination in a human population.

Academy 3 highlight

Metarisk brings together chemists, biologists, physicians, mathematicians, and risk management professionals to develop a new method to measure toxicological risks in a population and to help manage crisis situations.

Scientific domain

Toxicology

Key words

Metabolomics
Spectrometry
Big Data
Machine Learning

PI laboratory

TIRO-MATOs, UCA

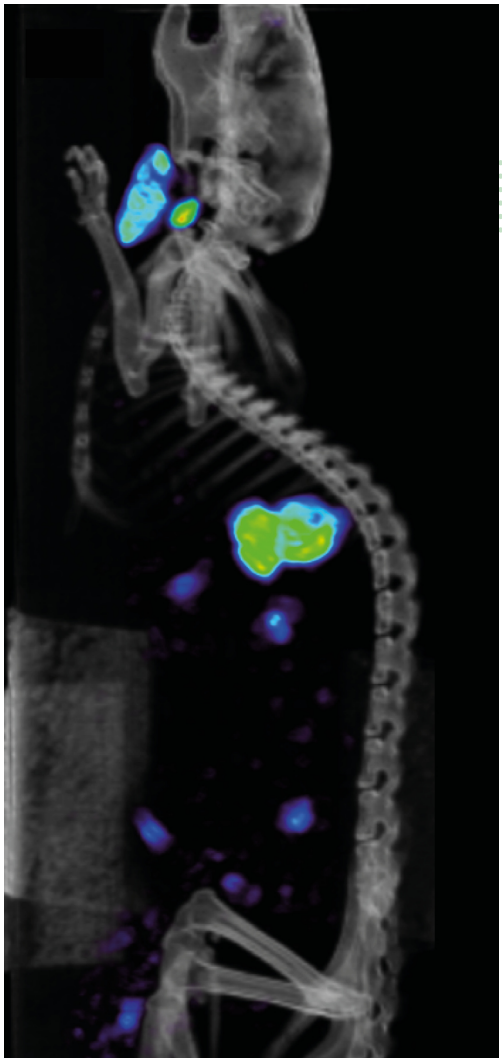
Partner laboratories

ICN, UCA
IPMC, UCA
ESPACE, UCA
GEOAZUR, UCA
GREDEG, UCA
INRIA
Centre Antoine Lacassagne (CAL)

Total budget

175 k€ including 170 k€ from Academy 3

Thierry Pourcher



The project

Metarisk aims to develop new metabolomics methods to assess a population's exposure to chemical or radiotoxicological contaminations. Our strategy does not aim to identify exposure sources (such as toxic chemical agents) but, rather, to identify metabolomics biomarkers of exposure. Metabolomics yields qualitative and quantitative information on the nature and abundance of specific small organic molecules in biological samples that can attest to their contamination. The identification of these specific molecules should then enable discrimination between exposed and non-exposed individuals in a given population. The Metarisk project was launched recently: Our objective is to identify and characterize urinary metabolomic signatures of specific biological effects following exposure to different chemical sources.

To best benefit from the combined expertise of the Metarisk team, we are initially focusing on chemical compounds that induce thyroid disruptor effects, radioactive iodine from nuclear industry accidents, and low-dose natural uranium. Meanwhile, we are developing methods for metabolomic analyses (LC-MS/MS) and for post-processing of metabolomics data (machine and deep learning). The work is in progress. We expect that the new metabolomics methods will become a useful tool for contamination tracking in a human population.

As such, they would be helpful for population treatment, crisis management, and legal determination of individual exposure. The new metabolomics methods should also be useful for fundamental research in biology, toxicology and clinical research.

The +

If successful, this project should allow for the rapid identification of individuals who have been exposed to chemical or radiological contamination. These individuals could therefore be treated by health care professionals using appropriate crisis management procedures.

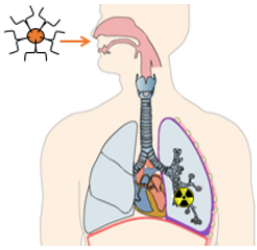
What's next?

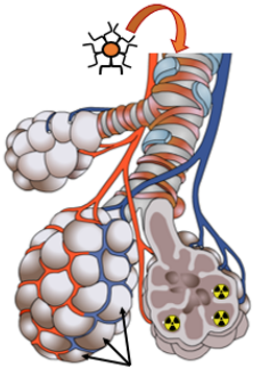
The capacity to detect and monitor biological effects of contamination using metabolomics should prove useful to optimize the management of related risks by crisis managers. To generalize and expand the scope of our results, we will build on the data obtained within the frame if this project to apply for additional funding from the European Union.

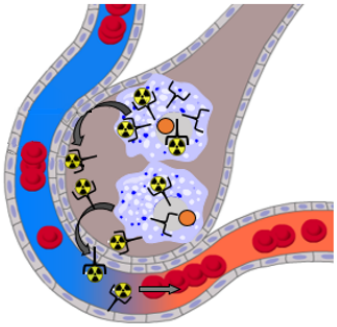
PLUTOPOLY - Chelating Polymers for Plutonium Decorporation

“A new decontamination strategy for people irradiated by radionuclides through inhalation.”

Christophe Di Giorgio







Academy 3 highlight

This project gathers experts in synthetic chemistry, biology, and actinide chemistry to develop a new strategy to recover from radionuclide contamination. This new approach thus contributes to lower the risks for humans associated with the use or misuse of radioactivity.

Scientific domain

Chemistry, Physico-chemistry, Biology

Key words

Radioactivity
Contamination
Human Health
Actinides
Inhalation
Targeting Polymers

PI laboratory

ICN, UCA

Partner laboratories

LRT, IRCM
Direction Générale de l’Armement (DGA)

Total budget

125 240 € including 28 500 € from Academy 3

The project

Nuclear contamination of humans can occur in different contexts, such as nuclear plant accidents (such as the Chernobyl event), military conflicts, terrorism, etc. The problematic radioactive elements that may be released include the "actinides", among which plutonium is one of the most harmful to human health. In case of accidental plutonium contamination, almost half of the contamination occurs through inhalation, and the lungs eventually retain more than 90% of the inhaled radioactivity. Currently, there is no efficient treatment to prevent and cure such contamination of the lungs. This project aims at developing a new class of compounds for treatment purposes, to help patients recover from plutonium lung contamination.

Lungs preferentially retain radioactive contamination because they have specific cells, the alveolar macrophages, which capture and retain toxic elements that enter the lungs. We have thus developed new molecules that are able to bind (i.e., chelate) the plutonium atoms trapped in the alveolar macrophages. These chelating molecules are polymers made from amino-carboxylates. We have developed several forms of polymers, each consisting of a branched polyethylenimine bearing three chelate groups per monomer.

We performed a series of dose-response tests in vitro (tests for toxicological assessment), putting together different amounts of polymers with lung macrophages. Transmission Electronic Microscopy images of the tested macrophages revealed massive phagocytosis (capture) of the polymers by the macrophages. Other tests showed that the chelating polymers successfully bound actinides in vitro, and plutonium in particular. We are now in the process of developing a more complete biological test to analyze the ability of the new chelating polymers to capture actinides inside macrophages. Overall, these tests will be crucial to determine the abilities of the new chelating polymers to (i) penetrate the lung macrophages, (ii) form complexes with actinides, and (iii) escape the lung system to be eliminated by urinary excretion.

The +

If successful, this multidisciplinary project will allow for the production of new chelating polymers with "decorporation" (decontamination) capabilities. These compounds would be a major breakthrough for the treatment of individuals who have been exposed to accidental nuclear contamination.

What's next?

We will seek to apply a similar approach to target other actinide entrapment sites such as in the liver or bones. Also, the new chelating polymers that we will produce may prove to be useful in radiotherapy clinical settings for the high-precision targeting of therapeutic molecules.

Institut de Chimie de Nice

cea

DGA

More info at
http://univ-cotedazur.fr/en/idex/academies/

CONTAMINYAQUI - Assessment and Dispersion of Contaminants in the Yaqui River (Sonora State, Mexico): Evaluation of Environmental Risks

Anthropogenic pollution of a hydrosystem in a mining and agriculture context: from chemical analyses to development of a new optical fiber-based sensor.

Academy 3 highlight

By measuring chemical pollution in water and sediments, the project contributes to the evaluation of natural and anthropogenic hazards related to pollution. The new sensor developed in the project to measure arsenic pollutants in water should significantly assist environmental monitoring.

Scientific domain

Earth Sciences, Environmental Chemistry

Key words

Pollution
Contamination
Arsenic
Hydrosystem
Sediment
Optical Fiber Sensors

PI laboratory

GEOAZUR, UCA

Partner laboratories

INPHYNI, UCA
ILM, UCBL
Instituto Mexicano de Technologia del Agua (IMTA)
Universidad Autonoma del Estato de Mexico (UAEM), Centro Interamericano de Recursos del Agua
Indian Institute of Technology-Roorkee (IIT-R, India)

Total budget

98 k€ including 20 k€ from Academy 3

Christophe Renac

The project

The Yaqui River (Sonora state, Mexico) is the longest and most important river in the "world belt of deserts" where the hydrographic system is highly sensitive to climatic changes. Anthropogenic activities along the river have induced high levels of contamination of the Yaqui waters due to metals and metalloids, either naturally present or added by mining activities, and pesticides related to agriculture. Chemical contaminants enter in the Yaqui hydrosystem and are transported by the river to a lagoon in the Gulf of California, and then to the Pacific Ocean. This contamination can have harmful effects on biodiversity and human health all along the river.

In the first part of the project, we sought to identify the major pollutants in the Yaqui hydrosystem. We found that the main inorganic pollution is carried by Fe, Mn, Zn, Cu, Cr, and As in the waters, by Cd and Hg in the sediments, and by Fe, Zn, and Cu in biota (clams in Tobari lagoon). We evaluated the mobility of each of these pollutants, focusing on their chemical forms both in water and sediments. One of the main forms of pollution in the water appears to be related to arsenic, in the form of arsenate species, a soluble and highly toxic form that can be transported over long distances. In contrast, the bioaccumulation of As in marine organisms is not very significant (low bioconcentration factors of 1.7-2.5). For the next step, we will examine the chemical forms of pollutants and the physico-chemical conditions in the river to estimate their transport in the Yaqui hydrosystem. Stable isotope measurements in water samples will also be performed to determine the origin of the nitrate contamination (e.g., agriculture).

In the second part of the project, we have developed an innovative sensor to detect and measure arsenic in rivers and ground water at trace concentrations (< 1 µg.L-1), in a continuous manner, and over large distances (> 100 m). This new sensor is based on optical fibers that are sensitive to arsenate species. The new Optical Fiber Sensor (OFS) will provide instantaneous measurements of As content in water, and hence will greatly assist pollution detection and monitoring.

The +

This project should result in the development of new innovative hydrogeochemical models for assessing pollutant transport while taking their chemical speciation and physicochemical conditions into account. In contrast to existing sensors, the new sensor we have developed is based on a new optical fiber sensor (OFS) that is sensitive to the arsenic content in water.

What's next?

If we can obtain the Proof-of-Concept that our new optical fiber sensor can be used to monitor the arsenic pollution level in rivers and groundwater, we will validate these sensors by performing additional environmental studies. To this end, we will strengthen and expand our local, national (University of Lyon) and international collaborations (Mexico and India) and seek additional funding by applying for ANR grants.

MANTRA - Magnetic Nanoparticles for Environmental Applications and Risk Assessment: Towards a "Zero Waste Principle" Paradigm

An innovative approach for water depollution using magnetic nanocomposites.

Claire Lomenech Charlotte Hurel

Academy 3 highlight

This project addresses a critical environmental problem: the anthropogenic pollution related to organic and inorganic compounds released in the environment, especially water. It brings together physicists, chemists, and ecotoxicologists to develop and test new and innovative adsorbents for water depollution.

Scientific domain

Physics, Chemistry, Biology

Key words

Water Depollution
Adsorption
Nanoparticles
Nanocomposites
Magnetic Filtration

PI laboratory

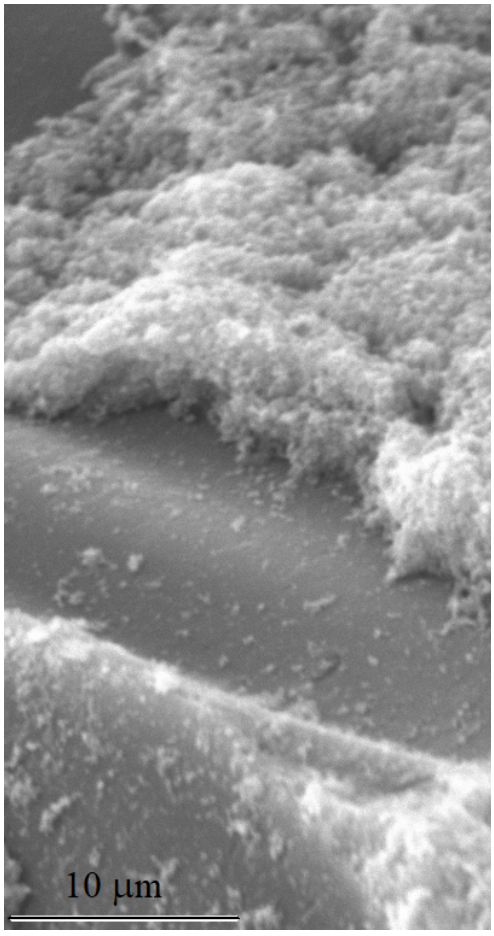
INPHYNI, UCA

Partner laboratories

ICN, UCA
ECOSEAS, UCA
PHENIX, CNRS

Total budget

27 k€ from Academy 3



The project

Every year, huge quantities of organic and inorganic compounds are released in the environment as a consequence of human activities. Current water treatment technologies are designed for the removal of most metals, sulfates and phosphates but are not efficient regarding other classes of pollutants (such as organic pollutants, including pesticides or pharmaceutical compounds). As an alternative, we are investigating here a new process based on new materials: green hybrid composite materials made of biorefinery by-products and biopolymers. To these materials, we have added a magnetic iron oxide. The physical processes of removal are then, firstly, entrapment (adsorption) of the pollutant compounds onto the magnetic biobased nanocomposites, and secondly, recovery of the adsorbed pollutant by application of an external magnetic field; the later attracts and isolates the magnetic nanocomposite, and with it, the pollutant it carries. We chose dyes as models for hydrophilic organic pollutants and cesium as an example of radioactive pollutant (produced for instance in the Fukushima accident). Adsorption processes were studied as a function of parameters such as pH (i.e., acidity of the water), contact time between pollutant and composite surface, and initial concentration of pollutants.

Among the major results, the magnetization of biorefinery by-products and biopolymers has been successful. We could determine the optimal external magnetic field to be applied for a complete removal of the pollutants. Adsorption of pollutants was revealed to be dependent on pH (in range of 2-6) and on contact time. The adsorption process was found to operate even at low pollutant concentrations (lower than 10^{-4} mol/L). For example, 100% of the dye was removed after 24h, at pH 6. The use of magnetic biopolymer and biorefinery by-product nanocomposites might thus be a powerful way to depollute water at low cost and with minimal operational management.

The +

The project fits with both the green circular economy concept and the zero-waste principle. It brings together, for the first time, hybrid green materials and magnetic filtration to improve water treatment technology. This new approach should be valuable for pollution assessment and management.

What's next?

If this project is successful, we will seek to produce biorefinery by-products with reinforced surface stability in an aqueous medium and enhanced adsorption properties. We will apply this process to other pollutants, including endocrine disruptors, and attempt to produce a pilot water treatment system (that could eventually result in a patent).

Natural and anthropogenic hazards in Euro-Mediterranean domain

NAUTILUS - Marine Noise in the Ligurian Sea: From Systematic Signal Analysis to Impact on Marine Species

Anthropogenic noise in the Ligurian Sea threatens marine species.

Academy 3 highlight

The NAUTILUS project brings together experts in marine biology and ecology, geosciences, acoustic signal processing and artificial intelligence to observe and evaluate a major ecological hazard: marine noise, and its impacts on key marine species in coastal and offshore habitats in the Ligurian Sea.

Scientific domain

Biology, Ecology, Marine Seismology, Data Science

Key words

Marine Noise, Human Activity, Acoustic Signal, Fishes and Fin Whales

PI laboratories

ECOSEAS, UCA
I3S, UCA
GEOAZUR, UCA

Partner laboratories

iBV, UCA
CHU de Nice
CHORUS
LOV
CIRM
Stanford University

Total budget

99 k€ including 93 k€ from Academy 3

Paolo Guidetti Audrey Galve Jerome Lebrun

The project

The undersea environment has long been described as a silent world. Research carried out in recent decades, however, has raised a growing awareness about sounds and noises as important components of the marine environment. Marine noise consists of biotic (produced by animals such as fish and mammals), abiotic (e.g., breaking waves, currents, ice breaking), and anthropogenic sounds (e.g., sonar, seismic prospecting, drilling, recreational and fishing vessels, shipping). The sum of these noise sources is referred to as the soundscape. The rise of global urbanization, industrialization and trading has resulted in a dramatic increase in anthropogenic noise, recognized as a major global pollutant in the 21st century. Anthropogenic noise may impact a large variety of marine animal species, with consequences ranging from no effect to major repercussions (e.g., behavioral alterations or stress induction, negatively impacted co-specific interactions, survival and reproduction) or even immediate death.

The NAUTILUS project builds upon a multidisciplinary collaboration among researchers in marine biology and ecology, geosciences and acoustic signal analysis to provide essential information on the soundscape in the Ligurian Sea and its impacts on marine organisms that play key roles in the local marine ecosystems (i.e., bony fish and cetaceans). The project started recently, and in the summer 2019, we deployed two types of instruments (some of which are usually used for earthquake recording), offshore Villefranche-sur-mer, Saint-Jean-Cap-Ferrat and Eze: short-term listening and high frequency hydrophones, and long-term listening, lower frequency hydrophones. These instruments recorded the soundscape (i.e., acoustic waves) for the first time in the Ligurian Sea, at sites that were Natura 2000 labeled by the EU. Meanwhile, we collected juvenile sparid fish data and samples in the three sites. Based on these data and on earlier seismological datasets (acoustic and seismic waves), we are currently developing machine-learning-based algorithms to automatically extract the signal information from marine noise and marine mammal activity in the Ligurian Sea (along with other type of relevant information in the recordings). This automatic extraction should help us to discriminate, estimate and map the various sources of marine noise in the Ligurian Sea, and examine their local impact on key species.

The +

At a time when the Nice metropolitan area is trying to establish policies for the preservation of nature, we totally ignore whether the noise produced by summer recreational activities has any negative impact on key organisms in our marine ecosystems. NAUTILUS tackles this critical question for the first time. NAUTILUS integrates expertise and cutting-edge science in biology, marine geosciences and artificial intelligence to both record the marine noise in the Ligurian Sea and to examine its impact on key species such as seabream and fin whale.

What's next?

We will use the approach pioneered in the NAUTILUS project to investigate the impact of marine noise on other species and in other geographical areas. To enhance recorded signals, we will use cutting edge marine instruments such as OBS, optical fibers and MERMAIDs. If we can obtain additional funding from the ANR or European funding agencies, we will create a living multidisciplinary library of marine noise signals that could be used by both public and private stakeholders.

ECOSEAS · i3S · GeoAzur · Institut Valrose Biologie · Centre Hospitalier Universitaire de Nice · CHORUS · Stanford University

More info at
http://univ-cotedazur.fr/en/idex/academies/

HYPER3D - Monitoring of Substrate Colonization by Hyperspectral Camera

A hyperspectral camera to monitor the restoration of destructed marine habitats.

Academy 3 highlight

In the present context where anthropogenic activities dramatically alter many natural marine habitats, HYPER3D addresses a critical ecological question, i.e., whether hand-made and hence artificial marine habitats such as artificial reefs promote efficient re-colonization and restoration.

Scientific domain

Marine Ecology

Key words

Habitat Restoration
Benthic Assemblage Monitoring
Species Diversity
Hyperspectral Camera
Spectral Diversity

PI laboratory

ECOSEAS, UCA

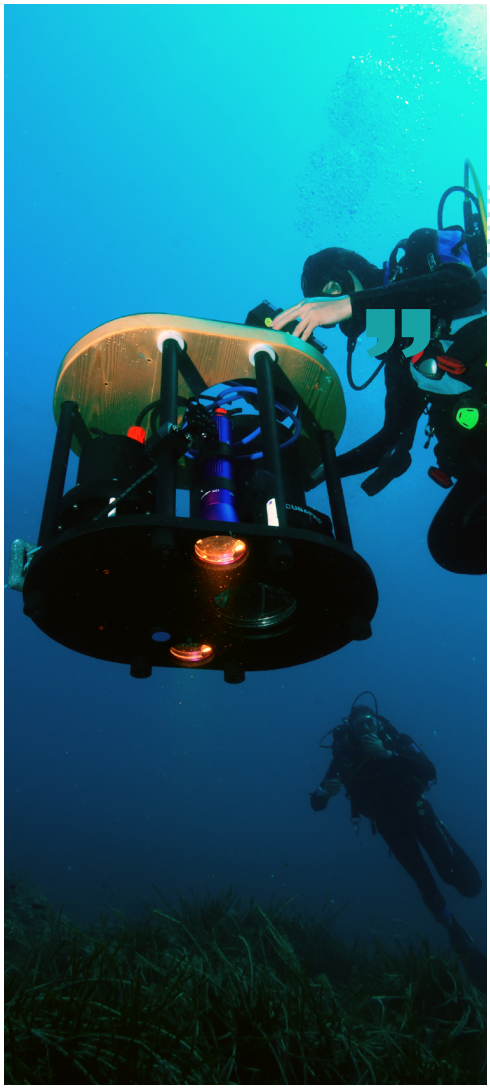
Partner laboratories

PlanBlue
Association Monégasque pour la Protection de la Nature (AMPN)
Fondation Prince Albert II de Monaco
BOREA

Total budget

7k € from A3

Patrice Francour*



The project

Artificial reefs are now considered to be a valuable tool to restore destructed reef habitats. 3D printers allow artificial reefs to be built with a high three-dimensional complexity, which mimic the complexity of natural habitats. A successful restoration then supposes that the progressive colonization of the artificial reef has a food web organization and ecosystem functions close to those observed in natural habitats. Therefore, once installed, artificial reefs need to be monitored to make sure that the colonization operates in a natural way. In this project, we are developing and testing an innovative tool: a hyperspectral camera to monitor the very first stages of colonization and food web development (macrofouling). Each underwater species is indeed characterized by a unique set of multi-spectral colors that the human eye cannot accurately perceive, whereas a hyperspectral camera can record the entire spectrum from the visible to the invisible.

We acquired an underwater hyperspectral camera that was being developed by a start-up, Plan Blue (https://www.planblue.com/). We tested it in 2018 in the Larvotto marine protected area (Monaco), conducting the first hyperspectral camera analysis in the Mediterranean Sea. The preliminary results revealed the large spectral diversity in the protected area, which we interpret as a valuable proxy for its species richness. The individual species identification was more difficult however, calling for further improvement of the camera to succeed discriminating the individual signals. We are therefore in the process of guiding the improvement of the camera to make it more sensitive to individual species. Meanwhile, total spectral diversity can now be used as a valuable proxy to monitor the growing colonization of artificial reefs.

The +

The main strength of this project is the development of a new underwater hyperspectral camera for ecological monitoring. Should we be able to improve its ability to discriminate individual species, such a camera could be a valuable tool for monitoring the ecological restoration of artificial habitats, and for health surveys of natural habitats.

What's next?

The camera we used in this project was a prototype. The start-up, Plan Blue, is now building a new version, based on our guiding following our preliminary 2018 results. We are planning to test the improved version of the camera in 2020. We anticipate that it will be an efficient tool for monitoring substrate colonization.

*Our fellow, P. Francour passed away unexpectedly in the fall 2019 and the editors would like to acknowledge his contribution to our university.

PACA-TRENDS - Mapping Historical Trends in Land Cover and Climate to Monitor Changes in Flooding and Forest Fire Risks

Mitigating forest fire and flooding hazards with appropriate land cover planning.

Academy 3 highlight

This project gathers experts in climatology, hydrology, economics, and physical geography to analyze the interactions between climate, land cover, forest fires, and floods. It provides a novel vision of the trends in forest fire and flooding hazards in South-East France that should help mitigate forest fire and flooding hazards with appropriate land cover planning.

Scientific domain

Environmental Sciences and Geography

Key words

Flooding
Forest Fires
Climate Change
Land Use / Cover Change (LUCC)

PI laboratory

ESPACE, UCA

Partner laboratories

GEOAZUR, UCA
GREDEG, UCA
LJAD, UCA
ARMINES, MINES ParisTech

Total budget

20 k€ from Academy 3

Dennis Fox

The project

The PACA-TRENDS project investigates forest fires and flooding hazards in South-East France. Forest fires depend on both weather conditions and housing densities in the Wildland Urban Interface (WUI). It is commonly expected that forest fire hazard will increase in the Euro-Mediterranean zone with warmer weather conditions and WUI expansion. However, previous studies have shown that the WUI-fire related risk has remained unexpectedly stable in South-East of France since about 1990. This is due to an increase in housing density over time: progressively, high risk isolated and scattered housing has evolved into denser, lower risk communities. In addition, firefighting efforts have had a major positive impact on fire occurrence despite warmer and drier summers. Big fires do still occur, however, in conditions of high winds, as was the case in 2003 and again in 2017. Although wind speed is of critical importance for the occurrence of large fires, nothing is known about how wind speeds have been evolving with climate change in South-East France. We thus tackle this question here. Daily wind speeds were obtained for the months of July and August for 5 weather stations located in the PACA region of France between 1960 and 2017. Wind speeds were classified into 3 categories: Low (<5 m/s), Moderate (5-10 m/s), and High (>10 m/s). We show that the number of days with High and Moderate wind conditions has decreased over time in SE France since 1960. Our results thus suggest that even though global warming might lead to more frequent fires overall, the number of very large fires in South-East France might not increase as dramatically due to fewer windy days in summer.

The recent catastrophic floods in Draguignan (2010) and Cannes-Biot (2015) have once again raised the question of the role of urban planning in flood severity. As natural areas are converted to impervious surfaces, infiltration of rainwater into the soil diminishes and runoff increases, thereby potentially contributing to a greater flood risk. To examine this common hypothesis, we studied 2 catchments in South-East France (Frayère and Mourachonne). Building extent and imperviousness were mapped for each catchment for 3 dates: 1988, 1999, and 2014. Runoff simulations were performed using the HEC-HMS hydrologic model. We found that changes in imperviousness over the 26-year interval increased storm runoff only marginally (about 5%). However, the built area in the flood plain increased substantially, almost twice as fast as in the catchments as a whole. We thus conclude that urban development in the catchments had little impact on flooding hazard but exposed far more buildings and people in the flood plain to potential damage, injury and loss of life.

The +

To our knowledge, this study is the first to examine how wind speeds are evolving with climate change in South-East France and to assess the relative role of imperviousness in generating runoff and increasing vulnerability. PACA-TRENDS thus provides a novel vision of the trends in forest fire and flooding hazards in South-East France that should help future planning.

What's next?

A follow-up study, financed by the PACA region, began in September 2019 to create a real-time forest fire risk map that takes into account both climate and land cover variables. This should be a valuable alternative to the current fire weather index used to predict the likelihood of fire occurrence since the latter is based on weather data alone with no spatial representation of fire ignition probability.

MEDRIVER - Definition of a Set of Ecological Indicators to Assess the Health of Restored Mediterranean Braided Rivers

Assessing the health of Mediterranean braided rivers, as a key step towards their protection and restoration.

Academy 3 highlight

MedRiver addresses two questions of interest to Academy 3: How do the combined effects of climate change and anthropogenic activities impact the behavior, evolution and resource capacity of rivers? How can we restore those rivers that are out of equilibrium? To tackle these questions, the project gathers experts in environmental (geography, hydrology and ecology), legislative and regulatory sciences.

Scientific domain

Environmental Sciences

Key words

Braided Rivers
River Restoration
EU Water Framework Directive
Ecological Functionality
Ecohydrology

PI laboratory

ESPACE, UCA

Partner laboratories

GREDEG, UCA
INRA
Politecnico di Milano
Free University of Bozen-Bolzano
Università di Firenze

Total budget

106 k€ including 10 k€ from Academy 3

Margot Chapuis

The project

The European Water Framework Directive (WFD) of the European Union aims at improving the quality of European water bodies and resources by 2027. Concerning rivers, a first step is to make a diagnosis of the ecological and chemical "health status" of the rivers, which is then used as a base to restore, if necessary, the degraded water bodies.

However, establishing rigorous criteria to estimate whether a river is in "good health" is challenging. It is especially difficult in the case of braided rivers, which are common in South-East France. Braided rivers are characterized by strong hydrodynamics that induce rapid space-time changes in their morphological pattern and biological content. On the one hand, their rapid changes make them difficult to monitor, while, on the other hand, they generally quickly recover from a disturbance, which may hide their actual "health level". Therefore, robust diagnosis tools are needed to properly assess the actual ecological status of braided metastable river systems. The MedRiver project aims at developing such tools, specifically targeting braided rivers in a Mediterranean context. Some of these tools already exist, but most are mono-discipline, addressing either the biological, the ecological, or the geomorphological context of the river. We have thus developed an original set of multi-parameter "good status" indicators for braided rivers. One of those new indicators links geomorphic and vegetation pattern evolution. We have started to use it to examine, in historical and remote sensing data, the temporal and spatial evolution of four braided river systems in Southern France (Var, Durance, Bléone, and Drac) and one in Italy (Mareta, Bolzano region) following their restoration which was conducted from 2008 to 2019. The analysis of the data is in progress. Meanwhile, we have also shown that some of the existing indicators (such as BRI* and W*) originally developed on pristine rivers, also apply successfully to channelized braided rivers; they well document their evolution subsequent to their restoration. Finally, we have developed another set of indicators that combine geomorphic and ecological parameters (such as aquatic macro invertebrate and terrestrial invertebrate content). Those should allow us to examine the spatial and temporal variability of braided river habitats.

We are still in the process of collecting data to quantify the new indicators and analyze the information they carry on the health level of the rivers under study. The new diagnosis tools will ultimately be provided to the river managers to help them plan and prioritize the restoration operations in the Mediterranean braided rivers.

The +

The MedRiver project addresses critical environmental and resource issues and meets operational needs, at the local, national and European level. It is strongly anchored in the PACA territory and has links with Italy. The transdisciplinary approach enables the development of innovative environmental indicators and opens the way towards more realistic systemic modeling of complex hydrosystems to better assess their health, to protect them, and to restore them.

What's next?

France has a leadership role in the long-term management and restoration of braided rivers in Europe. Our project will contribute to this on-going leadership position. The European interest in braided river preservation and restoration should positively impact an expanded version of our proposal, which will be submitted to the European funding agencies. In addition, it is expected that the project will strengthen partnerships with regional authorities involved in water management.

More info at
http://univ-cotedazur.fr/en/idex/academies/

ACT - A Study of Public Perceptions of Climate Change Risks and the Propensity to Act on Them in France

Public behavior in face of climate change.

Academy 3 highlight

The project brings together economists, psychologists, communication and marketing scientists to study individual perceptions and adaptation to climate change risks. This knowledge is key for the development of efficient strategies to commit individuals to relevant green actions.

Scientific domain

Social Sciences (Economics, Psychology, Marketing), Environmental Sciences

Key words

Climate Change
Risk Perception
Green Behavior

PI laboratory

SKEMA Business School

Partner laboratories

LAPCOS, UCA
Griffith University
University of Michigan
Michigan State University

Total budget

42 k€ including 30 k€ from Academy 3

Zakaria Babutsidze

The project

We aim to understand how French residents comprehend and adapt to increasing risks associated with climate change. To do so, we have investigated the public's behavior from a novel, inter-disciplinary angle involving economics, marketing, social psychology and communication studies.

As part of this effort, we conducted a nation-wide online survey of consumer risk perception, attitudes and behavior. 3500 French residents answered a pool of questions about their understanding of climate change, their perceptions of climatic risk and their behaviors. In addition, a more qualitative, interview-based approach was taken to complement the nation-wide data in a more local context centered on the Département Alpes Maritimes. In parallel, online experiments inferring people's intentions were implemented in order to study cross-national differences in consumers' reactions to the behavior of others with regard to environment.

From these three sets of data we have uncovered a number of intricate relationships between individual's perception of climate change risks, their level of psychological adaptation, and types of "green actions" that individuals may undertake. For example, it has been found that buying carbon offsets to compensate for the green-house-gas emissions due to travel is a surprisingly unpopular activity in France. It has also been established that "green action" is locally contagious, but only if this action is visible to neighbors. As a result, from the available data, we conclude that the main motivation to act "green" is tied to the willingness to fit in, rather than the willingness to take care of the environment.

The +

The project has kicked off significant complementary collaborations internally, as well as externally, in order to combine economics with psychology and marketing, and in doing so, to better address adaptation to climate change by jointly relying on individual and country-level characteristics of public behavior. The results will help politicians and stakeholders to develop strategies to more efficiently commit individuals to relevant green actions.

What's next?

We have produced new datasets that will be further exploited for years to come. The plan involves sets of researchers working on research questions using the common dataset across participating universities. This will further strengthen the collaborations that we have initiated and increase the visibility of the UCA team.

COM2SICA - Observation and Modelling of Human Behaviours in Disaster Prone Areas

A new approach to anticipate reactions of populations during natural or societal disaster in urban Mediterranean context.

Damienne Provitolo

Academy 3 highlight

Com2SiCa is an interdisciplinary project involving geographers, psychologists, mathematicians, computer scientists and policy makers to study the behavioural resilience of populations during sudden and unexpected disasters. It provides key information to anticipate human behaviours in response to catastrophic hazards, a prerequisite to better protect populations.

Scientific domain

Geography, Psychology, Humanities and Social Sciences, Mathematics, Computer Science, Geophysics

Key words

Human Behaviours
Catastrophic Events
Panic
Mediterranean Urban Context
Surveys
Mathematical Modelling

PI laboratory

GEOAZUR, UCA

Partner laboratories

ESPACE, UCA
LJAD, UCA
Géographie-cités, Université Paris 1, Panthéon-Sorbonne
LMAH, Université Le Havre Normandie
LITIS, Université Le Havre Normandie
LPPL, Université de Nantes

Total budget

598 k€ including 25k€ from Academy 3

The project

In the context of disasters, one of the major challenges is to understand the individual and collective behaviours, especially the displacement dynamics. When a sudden, dramatic event occurs, individuals react immediately for their self-protection and self-evacuation, which occur well before the arrival of rescue authorities. Understanding these reactions, at both the individual and collective levels, is key to anticipating the subsequent social behaviors when another event occurs. This anticipation is of the upmost importance because the actual impact of a given hazard is primarily controlled by the reactions of the population; those reactions can either reinforce or jeopardise the safety of the affected individuals, of their relatives, and of the collective population. This is especially true in the case of a sudden, unpredicted event, such as a strong earthquake, tsunami, nuclear accident, or terrorist attack. The Com2SiCa project seeks to document and understand human reactions in catastrophic situations by tackling three objectives. Our first objective was to acquire and analyze data in order to identify, describe and map human behaviours in the context of a tsunami scenario. We have developed an innovative survey protocol based on "sound immersion" to capture the population reactions to a simulated tsunami. The methods involve field studies (surveys, field observations), and data analysis is in progress. A second objective was to simulate the dynamics of human behaviours in an urban Mediterranean context. We have developed a mathematical model of the spatio-temporal dynamics of human behaviours in the face of a tsunami or terrorist attack. The first results reveal the influence of the spatial configurations on the pace of evacuation, and the influence of the "intermediate place capacity" (sites between dangerous and shelter places) on the evacuation dynamics. Finally, our third objective is to develop a graphical web interface where the modeling will be accessible to stakeholders who would need to anticipate human behaviours in the case of a catastrophic event.

The +

The Com2SiCa project addresses an important topic in a current context where growing populations are increasingly threatened by catastrophic events. Its importance is attested by the additional support it has obtained (from ANR, Direction Générale de l'Armement, label from Cluster Safe, etc.).

What's next?

Using Com2SiCa results, stakeholders will be able to integrate knowledge on human reactions into risk management plans (this is currently not taken into account in national plans). Com2SiCa should therefore improve risk management strategies, contingency plans and public awareness.

More info at
http://univ-cotedazur.fr/en/idex/academies/

Physics of large earthquakes and related hazards

NAO - North Andean Subduction International Observatory

Mitigating earthquake hazards requires transdisciplinary research from physical process analysis to social, environmental and development impacts' studies.

Philippe Charvis

Academy 3 highlight

The study, understanding and prevention of large earthquakes require a transdisciplinary approach involving scientists with various expertise (geology, seismology, physics, engineering, social sciences). NAO gathers these scientists and establishes new foundations for their cooperation on large earthquake studies.

Scientific domain

Earth Sciences

Key words

Earthquake
Seismic Risk
Transdisciplinary

PI laboratory

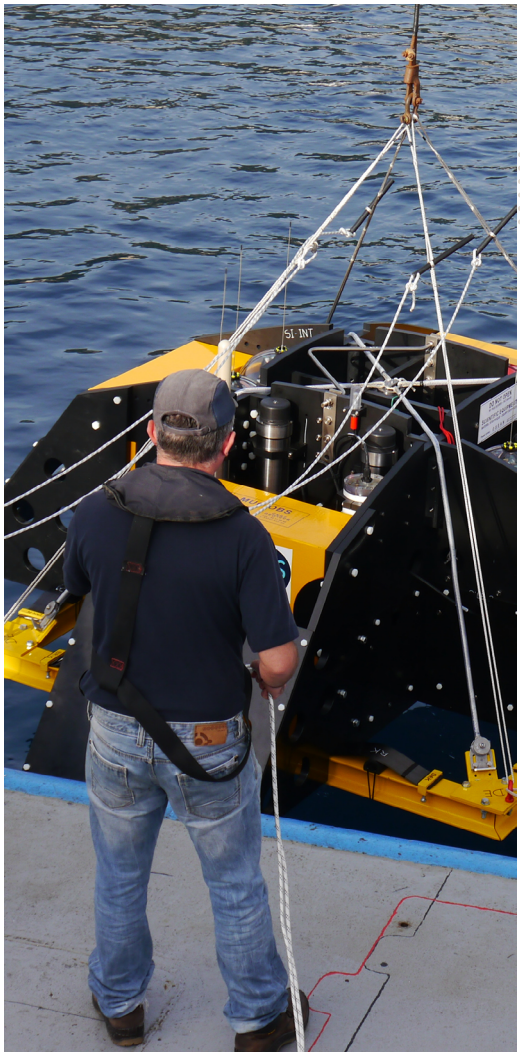
GEOAZUR, UCA

Partner laboratories

ESPACE, UCA
GREDEG, UCA
SKEMA Business School
CEREMA

Total budget

512 k€ including 30 k€ from Academy 3



The project

The NAO project focuses on the Andean subduction zone in South America where one tectonic Plate (Nazca Plate) that forms the floor of the Pacific Ocean slides and sinks below the continental South-American Plate. The sliding of the two plates generates frequent (every few decades) very large earthquakes (with magnitudes generally greater than 8), making the Andean subduction zone one of the regions in the world with the highest seismic hazard. This region is also densely populated and hosts huge cities along the coast, which are thus highly vulnerable to natural hazards, especially since they are part of developing countries. It is our responsibility to help the threatened western South American countries to build safe and resilient societies. This can furthermore teach us how to build safer cities in our regions where natural hazards, though generally lower, do exist.

The NAO project has led several initiatives to monitor and assess seismic hazard and vulnerability in the northern part of the Andean subduction zone. These initiatives have been co-funded by the ANR, IRD and the CNRS. As an example, immediately after the large Pedernales earthquake (magnitude 7.8) which struck Ecuador in April 2016, we deployed, as part of an international collaboration, an array of ~80 onshore-offshore sensors (seismometers and GPS) to monitor the ongoing seismic activity and the immediate deformations following the main shock. The data analysis revealed that the post-earthquake deformations are mainly controlled by the topography of the sinking plate (Agurto-Detzel et al., 2019). We are now testing an innovative in situ seabed instrument system off the coast of Nice to observe and measure with higher resolution the accumulating telluric deformations. Once the tests are successful, we will deploy these instruments in the Andean subduction zone.

The +

Within the frame of this project, UCA researchers had the opportunity to attend an international workshop that was held in September 2017. Several prominent scientists contributed, addressing a wide variety of topics including flood risk management, climate change adaptation, local disaster risk reduction, and transdisciplinary relations between different groups of people involved in disaster prevention and response phases.

What's next?

Funding of this project by Academy 3 has already enabled the leveraging of additional funding from the ANR, IRD and CNRS. In future years, we will expand our activities by leading a marine geophysics campaign to image with seismic instruments the rupture zone of the 2016 Pedernales earthquake in Ecuador. We will coordinate an international network to study the Andean subduction zone and associated hazards. We will also organize a summer school entitled « Risks and knowledge » in July 2020 aimed at scientists and PhDs from France and developing countries.

More info at
http://univ-cotedazur.fr/en/idex/academies/

ITEC - Ionospheric Total Electron Content Tsunamimeter

A new GNSS-based technology to observe tsunamis from space and better warn the threatened populations.

Lucie Rolland

Academy 3 highlight

The ITEC project is at the intersection of the two main ambitions of Academy 3, "monitor and better observe Space and the Earth" and "evaluate natural and anthropogenic hazards on land and at sea". It develops a new space-based technology to more accurately assess ocean tsunami hazards and warn the population in real time.

Scientific domain

Geosciences and Environment

Key words

Tsunami
Satellites
GPS/GNSS
Natural Hazards and Risk

PI laboratory

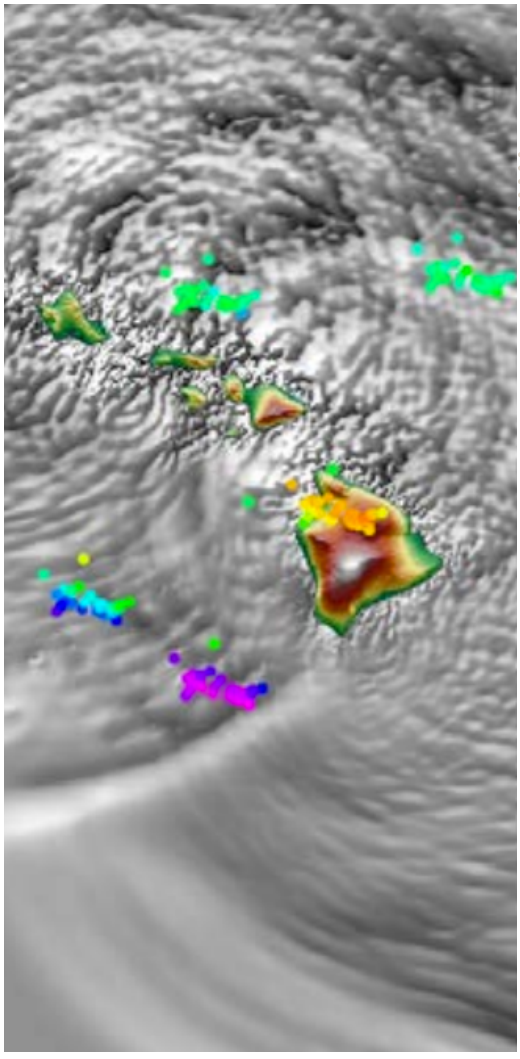
GEOAZUR, UCA

Partner laboratories

IPGP, Université de Paris
Boise State University, USA
Indian Institute of Geomagnetism, India

Total budget

400 k€ including 5 k€ from Academy 3



The project

Tsunamis cause dramatic numbers of casualties, massive economic losses and extensive destruction of coastal environments. The giant tsunami that occurred in 2011 in Japan devastated a thousand km of the Japanese coastline, claimed almost 20 000 lives, and induced more than 200 billion dollars of economic losses. Yet, even though the 2011 Japanese tsunami was one of the largest ever recorded on Earth, with wave heights up to 40 m, the forecasting systems operating in real-time failed to predict its magnitude. Eight years later, even with all the data now available on the earthquake and tsunami (seismological, geodetic, tsunami gauge data, etc.), the scientific community is still unable to accurately reproduce the actual height of the 2011 tsunami before it reached the coast.

One major reason for our current inability to model and monitor tsunamis properly is that oceans, where the tsunamis occur and propagate, are rarely instrumented, for obvious reasons: there is no emerged site on which to install permanent instrument networks.

In this project, we propose to counter this problem by developing a new technology to monitor tsunamis from Space, based on the Global Navigation Satellite System (GNSS). Indeed, scientists have demonstrated in recent decades that the vertical motions produced by tsunami waves are powerful enough to create atmospheric vibrations that propagate all the way from the ocean surface up to the ionosphere, 300 kilometers up in the atmosphere, where they form a specific physical imprint. Even small tsunamis with waves only a few centimeters high imprint the ionosphere. Because the ionospheric tsunami imprint is a variation in the atmosphere electron content, it can be detected with existing GNSS networks, and thus detected all over the world, including oceans. The GNSS signals are then tracked from land with permanent or portable geodetic stations.

Our project is underway, and for the first phase we are developing the theoretical and software framework. With our US partner, we are consolidating our modeling package, IonoSeis, dedicated to the modeling of the very first ionospheric signal coming from the tsunami initiation zone (PhD work in progress). We will then design and test a GNSS-based tsunamimeter: it will be lightweight, low-power consuming, and multi-GNSS based (i.e., tracking not only GPS but also Galileo and other constellations). We anticipate that this new "instrument" will forge the way to an efficient and low-cost tsunami early-warning system.

The +

The innovative use of modern GPS/GNSS technology to better cover the oceans and help to mitigate tsunami risk from Space.

What's next?

Initially funded by Academy 3, this project has evolved into a larger project to be funded by the ANR for four years (2020-2023). The main objective of this project is to build a prototype of tsunamimeter based on GNSS technology, designed to be integrated into future tsunami worldwide Early-Warning Systems.

More info at
http://univ-cotedazur.fr/en/idex/academies/

PERFAULT-3M - Physics of Earthquake Rupture and FAULT Growth: Multi-scale Modeling of Material failure

How do geological and industrial materials fail, from the tiniest cracks to the largest tectonic faults?

Academy 3 highlight

Earthquakes are a major natural hazard that require transdisciplinary research at the junction between geosciences, material sciences and computational physics. This project, initially focused on great earthquakes and fault growth, will build a collaborative environment and modeling framework that will enable the study of material failure in other contexts.

Scientific domain

Geosciences and Environment

Key words

Material Failure
Earthquake Modeling
Fracture Mechanics
Damage Mechanics
Friction

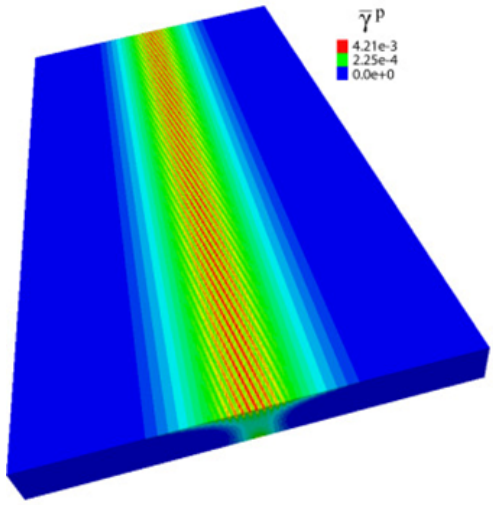
PI laboratories

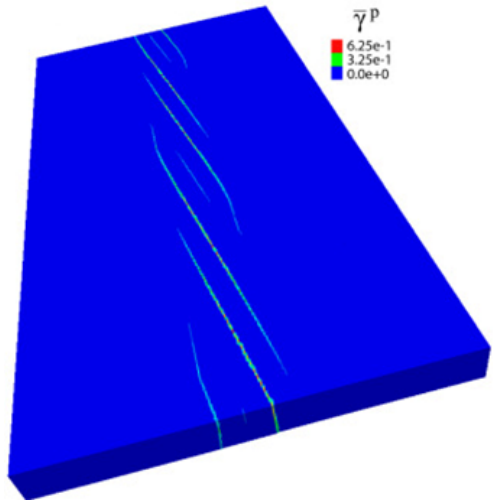
GEOAZUR, UCA
LJAD, UCA
MSI, UCA
CEMEF, MINES ParisTech

Total budget

168 k€ including 160 k€ from Academy 3

Jean-Paul Ampuero | Daniel Pino Muñoz | Stéphane Descombes





The project

How do things break? Material failure (commonly called "damage") poses major hazards in many contexts: industrial (from nanomaterials to nuclear plants, biological materials), environmental (fracture of geological reservoirs, dams, ice-caps) and geological (landslides, earthquakes and causative tectonic faults). Modeling the physics of material failure is an important research goal that poses stimulating scientific challenges. The problem involves a wide range of scales in space and time, from the centimeter scale of laboratory rock samples breaking in controlled conditions to the 1000 km scales of the largest natural earthquakes and faults, and from the few seconds duration of failure during one earthquake to the centuries of formation of large open fractures in concrete or the million years of growth of the tectonic faults that produce earthquakes. What are the relationships between processes at the microscopic and the large fault and earthquake scales? What is the role of short-duration fracture (seconds to minutes) in the long-duration process (years to millions of years) of material failure?
UCA concentrates outstanding expertise in various aspects of the physics of material failure in a close perimeter, which allows transdisciplinary collaborations: geophysics, geomechanics and geology at GEOAZUR; physics of materials at CEMEF; mathematics of complex systems at LJAD; high-performance computing at MSI. The PERFAULT-3M project federates this expertise at UCA to develop models of fracture and damage processes across multiple scales with solid constraints from natural and laboratory observations. The project started recently, and a post-doc researcher will join the team in the fall of 2019 to start developing the first experiments and models.

The +

The new models built in this project will contribute to the generation of earthquake, tsunami and landslide scenarios that can be eventually applied to any region in the world, including the Mediterranean region, Chile and, more broadly, the South America subduction zone. The project outputs will also inform the training of students at various levels and will create synergies between UCA researchers.

What's next?

The results of this project will contribute to the preparation of ERC Starting and Advanced proposals that should place UCA at the forefront of research in earthquake dynamics and material failure. The project will also launch an international workshop with the aim of becoming a regular venue to advance the topic. The new models should be applicable to various types of material failure, and thus potentially interest industrial partners.

FAULTS_R_GEMS_pilot: Properties of FAULTS, Key Information to Produce Realistic Generic Earthquake Models and Hazard Simulations (Pilot, starting phase)

“Earthquakes, the fault is in the faults...”

Academy 3 highlight

Large earthquakes are one of the most damaging and least predictable natural phenomena on Earth. Academy 3 encourages projects that might contribute to a better understanding of this natural hazard. To reach this objective, FAULTS_R_GEMS_pilot fosters new collaborations in UCA among geologists, geophysicists, data science and image processing experts, and mathematicians.

Scientific domain

Earth Sciences

Key words

Faults
Earthquakes
Remote Sensing
Deep Learning
Scaling Relations
Fault and Earthquake Modeling

PI laboratory

GEOAZUR, UCA

Partner laboratories

INRIA, UCA
LJAD, UCA
Thales Alenia Space (TAS)
CNES
Geosciences Montpellier
Arizona State University
UNAVCO
Université de Pise

Total budget

950 k€ including 30 k€ from Academy 3

Isabelle Manighetti

The project

Tectonic faults are large "fracture planes" cutting through the Earth's crust from the ground surface down to a few (1-10) kilometers depth (general case) or even more. At depth in the crust, faults cannot be observed directly and hence are difficult to analyze. By contrast, as their plane generally intersects the Earth surface, they form clear traces in the ground, generally of 1-1000 kilometers length, which can be observed on the field or from airborne and satellite sensors. Faults are the Earth features that produce earthquakes; an earthquake is the sudden displacement along a fault of the two rock blocks it separates. Yet, surprisingly, although faults are the source of earthquakes, current earthquake models hardly consider them: the fault source is simplified as a 2D, planar, homogeneous surface with no thickness, embedded in an homogeneous, unfractured medium. This dramatically differs from reality since natural faults are non-planar, 3D zones embedded in intensely fractured rock volumes. The FAULTS_R_GEMS_pilot project proposes that intimate relations exist between faults and earthquakes, which implies that earthquake modeling cannot be successful until it properly integrates fault properties. We have two objectives: firstly, identify and quantify the fault properties which most strongly impact the earthquake behavior; secondly, develop a new generation of earthquake models that integrate these fault properties. During the 3 years of the FAULTS_R_GEMS_pilot project, we have worked on the first objective. Meanwhile, the second task has started in the framework of the larger project FAULTS_R_GEMS since funded by the French National Agency ANR. To address the first objective, we have 1) acquired large volumes of field, airborne and satellite imaging and topographic data documenting multiple natural fault zones of various scales and earthquake behaviors; 2) adapted deep learning tools to automate the identification and measure of the faults in the image and topographic data; 3) started the analysis of some of the fault properties in the measurements. Among preliminary results, the new deep learning tools seem efficient at automatic fault identification in image data; scaling relations exist between important constitutive fault elements (such as fault length and thickness), proving the genetic and generic link between those elements. These scaling relations, key to understand the fault physics, will feed physical and mathematical fault models developed by our partners from LJAD laboratory (project DEFIDEF). Ultimately, these fault models will be integrated into the new generation of earthquake models we are developing.

The +

Deep learning tools are adapted for the first time to automate identification, mapping and measure of faults in remote sensing and airborne data. This is also the first time that actual generic fault properties will be integrated into earthquake models. This new approach, coupling faults and earthquakes intimately, should decrease discrepancies between model outputs and natural earthquake behaviors.

What's next?

If the results we obtain in the next few years (FAULTS_R_GEMS ANR project) confirm that fault properties are primarily generic, their integration should push forward generic earthquake models that could be run for the vast majority of faults and earthquakes worldwide. These new models might thus open a novel avenue in earthquake modeling and hazard assessment.

More info at
http://univ-cotedazur.fr/en/idex/academies/

DEFIDEF - Determination of the Elastic Properties Around Seismic Faults Integrating DEFaults

How tiny faults and fractures alter integrity of rock and material volumes.

Academy 3 highlight

DEFIDEF involves mathematicians, numerical analysts and geologists to decipher how small-scale fracturing of rocks might impact earthquake behaviour. The new models developed should also apply to material failure in general, and thus go beyond Earth Sciences.

Scientific domain

Mathematics, Numerical Analysis, Geology

Key words

Fractured Rock Masses
Stochastic Homogenization
Elasticity
Numerical Simulations

PI laboratory

LJAD, UCA

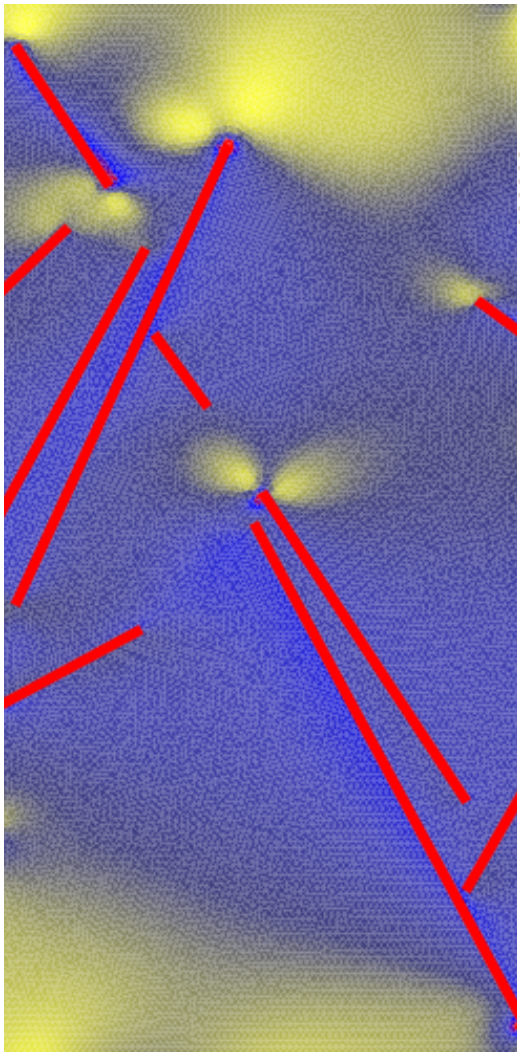
Partner laboratories

GEOAZUR, UCA

Total budget

51 k€ including 27k€ from Academy 3

Olivier Pantz



The project

Earth rocks and man-made materials always contain defects, commonly in the form of small fractures of various sizes, often hardly visible to human eyes. Where the fracturing is dense, it modifies the mechanical properties of the rocks or materials, and these modifications can have critical consequences: weakening and even disruption of the materials (building walls, container walls, etc.), leakage of fluids they might host (water, oil, gas, radioactive elements, etc.), amplification of the waves they might be crossed with during an earthquake, etc. While research in material sciences has advanced our knowledge of the mechanical properties of man-made materials, little is known on the mechanical properties of natural fractured Earth rocks. The DEFIDEF project tackles this issue, focussing on the case of intensely fractured rocks around tectonic faults. The latter are those producing earthquakes, and therefore, quantifying the physical properties of the rocks that host them is of utmost importance to anticipate their rupture behaviour during an earthquake. The objective of DEFIDEF is thus to derive a mathematical model for fractured rock volumes around faults. This remains a challenge, on the one hand because the natural fracture networks are dense and complex, and on the other hand because fracturing occurs over a wide range of spatial scales. To derive the elastic properties of the fractured rock masses, we modelled their overall mechanical behaviour by a homogenized macroscopic equivalent medium (i.e., a small volume in which homogeneous mechanical properties can be assumed). The modelling is calibrated with field observations and measurements (from the FAULTS_R_GEMS_pilot project). To deal with the variable scale challenge, we currently use an empirical statistical scaling model based on a double power law describing local fault density and length. Although a simplification of natural systems, this empirical model allows the description of complex fracture systems with a single set of statistical data. We are now in the process of making numerical tests to estimate the efficiency of the new method. The fracture and fault measurements that will be soon provided through the FAULTS_R_GEMS_pilot project will help us improve and validate the method.

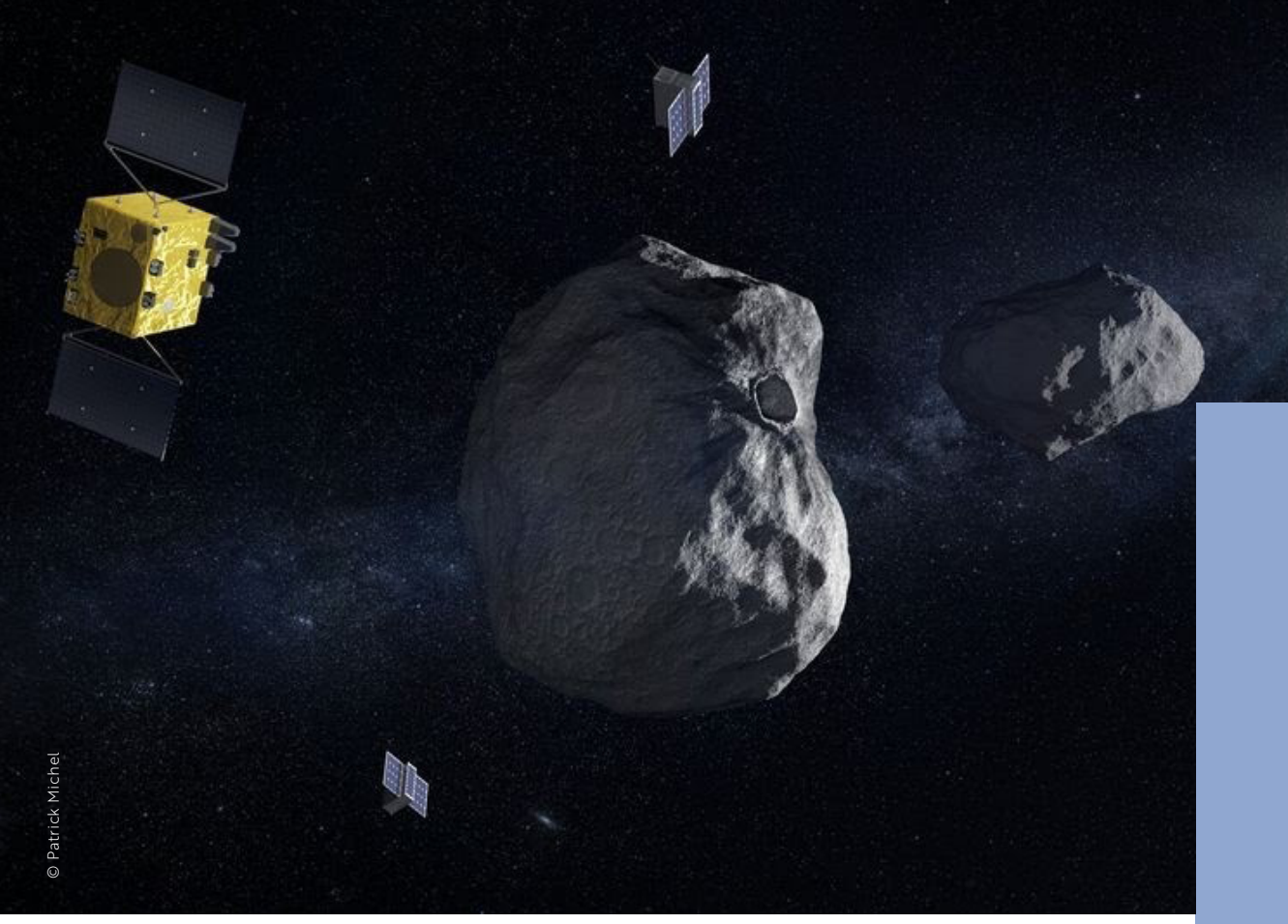
The +

This project aims at developing new mathematical tools to model fracture and fault networks while considering their actual geometric complexity and broad range of lengths scales. This new modelling, based on natural fractures and faults, should produce realistic estimates of earth rock mechanical properties.

What's next?

We will apply the new mathematical model to real large natural faults in order to anticipate how the modified mechanical properties of the fractured rock volumes around the faults modify the behaviour of large earthquakes on these faults. We will also adapt the new model to rapidly and efficiently determine the mechanical properties of any rock or material area. Application of the new model should thus go much beyond Earth Sciences.

More info at
http://univ-cotedazur.fr/en/idex/academies/



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Origin and Physics of Universe and Earth

C4PO - Center for Planetary Origin

Our Solar System is not the typical planetary system: new astronomical discoveries help us to develop a new multi-disciplinary approach to planet formation.

Academy 3 highlight

C4PO builds a multidisciplinary synergy among planetary science, geophysics and material science to improve our understanding of the formation of planets and planetary systems, including the Earth and the Solar System.

Scientific domain

Astrophysics

Key words

Solar System
Extrasolar Planets
Protoplanetary Disks
Small Asteroid and Comet Bodies
Meteorites and their Components:
Chondrules and CAIs

PI laboratory

LAGRANGE, UCA

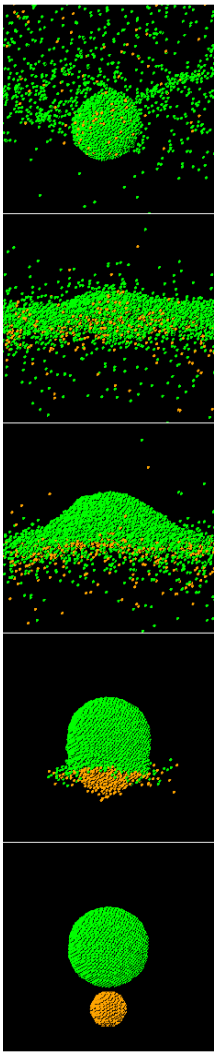
Partner laboratories

GEOAZUR, UCA
CRHEA, UCA
CEMEF, MINES ParisTech
PERSEE, MINES ParisTech
JAXA (missions Hayabusa II, MMX)
NASA (missions Osiris-Rex, Juno)
BGI - Université de Bayreuth
Université de Münster
MPIA Heidelberg

Total budget

545 k€ including 230 k€ from Academy 3

Alessandro Morbidelli



The project

The discovery of extrasolar planetary systems has revealed a great diversity of orbital architectures and physical properties of planets in the galaxy. In particular, it has been found that most stars have planets that have different orbital or physical properties from the planets in our own system. Therefore, our Solar System is not the typical planetary system. Consequently, the models of planet formation developed in the twentieth century, with the underlying principle that other planetary systems are similar to our own, are now invalidated. This calls for the urgent need to develop new models that can explain the observed diversity of systems and help us to understand our Solar System as one of the possible end-states that would have resulted from complex formation/evolution processes. The Center for Planetary Origin project tackles this objective and proposes a new interdisciplinary approach to planet formation. Theoretical models and ground/space-based observations are combined with advanced knowledge in geophysics and material science available within our research consortium and the international community to generate a comprehensive understanding of the physical evolution of Solar System bodies. Among the major results so far, using a technique typical of material science, we have deciphered the internal structure of chondrules, one of the major building blocks of asteroids, unveiling important clues on their original formation. We have also developed an innovative instrument of optical interferometry (MATISSE) which, when fully achieved (it is currently in its commissioning phase), will allow us to probe the inner structure of protoplanetary disks, the birthplace of planets. The preliminary first-light observations with MATISSE demonstrated its exceptional angular resolution. MATISSE indeed succeeded in measuring, for the first time, the actual infrared radius of the supergiant star Betelgeuse (which is expected to explode as a supernova in a few hundred thousand years). The extreme power of MATISSE will thus be of upmost help to decipher planet formation and evolution.

The +

C4PO has already produced major advances on the formation/evolution of the regolith at the surface of small bodies, and on the formation of the first solids of the Solar System. We are also developing a new concept for a "fringe tracker" to correct for the turbulence of the atmosphere (MATISSE instrument). These results better constrain the physical conditions at the origin of our planetary system and allow us to address whether the diversity of planetary systems started at the very initial disk level.

What's next?

The Center for Planetary Origin project has created a synergy among researchers of different laboratories and disciplines who had never collaborated before. International interest in the results ensures this collaboration will be long-lasting and continue to be supported by additional funds, e.g. from ERC, ANR, CNES, ESA, etc.

More info at
http://univ-cotedazur.fr/en/idex/academies/

PRIM - Are Primitive Meteorites so Primitive?

What the primitive matter in the Solar System tells us about its original nature and formation.

Clément Ganino

Academy 3 highlight

PRIM combines up-to-date geochemical techniques and thermodynamic modelling to probe and decipher the oldest witnesses of our primitive Solar System. Its results help better understand the history of the early Solar System.

Scientific domain

Petrology

Key words

Secondary Minerals,
Chondrite,
Parent Body

PI laboratory

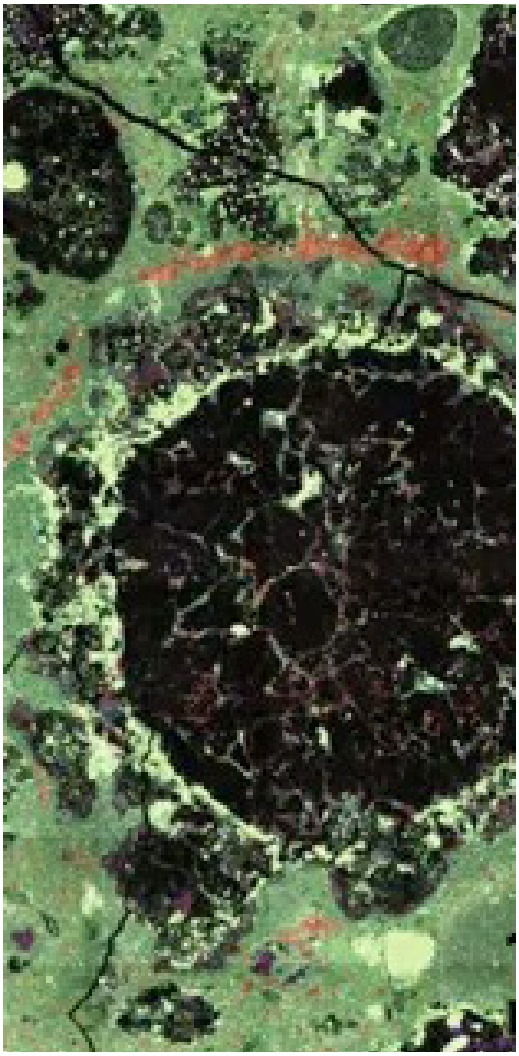
GEOAZUR, UCA

Partner laboratories

LAGRANGE, UCA
Université Libre de Bruxelles

Total budget

32 k€ including 15 k€ from Academy 3



The project

How did our solar system form? Even though this question has motivated intensive research in recent decades, it is still posed and debated. PRIM tackles this question, and proposes new answers, based on ultra-high resolution mineral analysis of some of the most pristine material of our Solar System: the carbonaceous chondrites. These are pieces of the earliest small planets (planetesimals) that were forming our Solar System in the very first moments of its history. These small planets broke at a later time of their evolution, and some of their pieces, the carbonaceous chondrites, reached the Earth in the form of meteorites. We have gained access to ten of these primitive meteorites (Vigarano-like "CV" carbonaceous chondrites) that have been discovered on the Earth. Using modern instruments such as a scanning electron microscope and an electron probe micro analyser, we analysed the secondary minerals that exist throughout the chondrites. Because those secondary minerals likely formed in their "parent body" (i.e. the small planet – now destroyed – from where these meteorites were extracted), they provide invaluable information on the planetesimals that were forming our Solar System. Our analyses revealed mineralogical assemblages whose formation required much higher temperatures than previously proposed. The thermodynamic modeling of the stability conditions for these mineralogical assemblages confirmed the high temperatures. Furthermore, the analyses revealed that the minerals formed from hot H_2-rich fluid phases, and not from low temperature precipitation in aqueous solutions as previously thought. Through the PRIM project, we have thus demonstrated that the parent bodies in our primitive Solar System were hot (fluids at T>350°C thus in gas form) and reduced (conditions allowing stability of both iron and magnetite). These are new important constraints to understand the original accretion scenario of our Solar System and the dynamics of the early Solar System. In particular, our new results call for the need to understand which accretional rates were able to produce such high temperatures.

The +

The high resolution of the modern geochemical probing instruments combined with an up-dated thermodynamic database allows us to decipher our very oldest past – the birth of our Solar System about 4.56 billion years ago – in just a few sample rocks that travelled through the solar system and reached our Earth. This opens a promising avenue to understand the biggest question –where we come from – from small elements– the chemistry of the earliest rock remnants.

What's next?

We will check if the unexpected results on the thermal history of the primitive "CV" carbonaceous chondrite are unique and due to a peculiar parent body, or can be generalized to other primitive chondrite groups and hence generalized to most early planetesimals. Altogether, these results will help to build new physical and thermal models taking into account all known possible heat sources. We anticipate that these new models will be a significant step towards a better understanding of the early Solar System history.

BETAPIC - Observing BetaPic and Exoplanets from Antarctica

Discovery and study of exoplanetary systems with the ASTEP telescope in Antarctica during the polar winter.

Academy 3 highlight

The BetaPic project provides unprecedented observations that help us better understand exoplanets and planet formation. It involves a variety of expertise from electronics, operations in extremely cold environments, optics, data analysis and astrophysics.

Scientific domain

Astronomy, Planetary Science

Key words

Exoplanets
Telescopes
Antarctic

PI laboratory

LAGRANGE, UCA

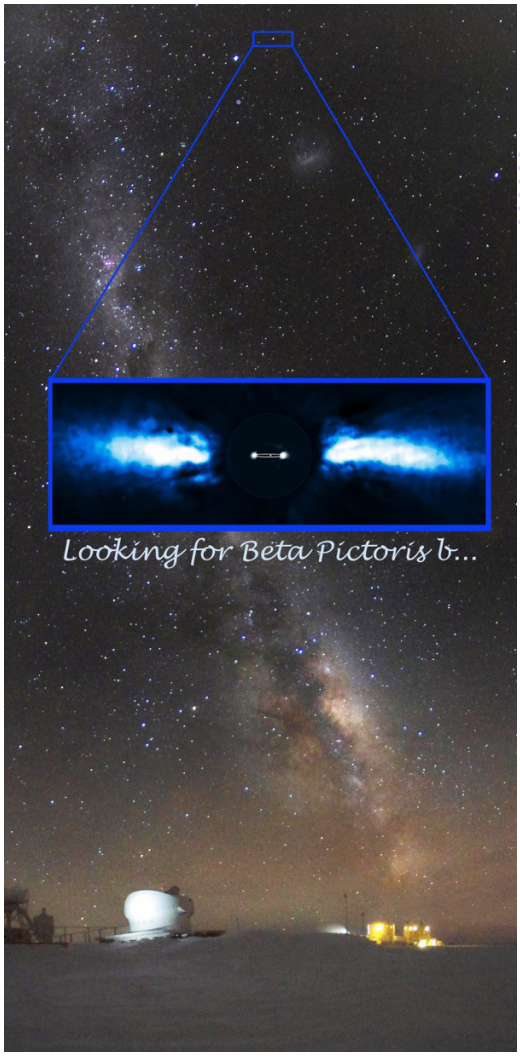
Partner laboratories

OCA, UCA
IPEV
IPAG, OSUG
University of Birmingham
European Space Agency (ESA)
Berkeley University
Leiden University

Total budget

214 k€ including 20 k€ from Academy 3

Tristan Guillot



The project

Exoplanets are planets around stars other than the Sun. Their characterization is one of the major goals of Astronomy, on the quest for Life in the Universe. The French/Italian Concordia base, at 3200m elevation in the middle of the Antarctic continent is a unique vantage point for Astronomy and particularly for the observation of exoplanets. In 2009, our team built ASTEP (Antarctic Search for Transiting Extrasolar Planets), a 40 cm automatic telescope that is able to operate continuously in the extreme southern Antarctic winter, under temperatures that can reach -80°C. The nearly-continuous 3 month-long night represents a considerable advantage to study exoplanets, in particular to examine changes in the light they reflect towards us as they move around their star.

In 2016, our team joined an international campaign to observe an iconic system: the young star Beta Pic. Beta Pic is the first star known to possess both a disk of dust where planets may form, and a planet, called Beta Pic b. The star is also pulsating. In 2017, the planet Beta Pic b passed, for the first time in 18 years, extremely close to its star, enabling the detection of moons or rings, expected in such a system but never detected unambiguously in any exoplanet.

We thus observed Beta Pic and its planet continuously during the 2017 and 2018 polar winters with the ASTEP telescope. We obtained a unique set of light curves of both high accuracy and long duration that revealed 31 pulsation modes of the star, of which only 3 were previously known. The analysis of the data covering years 2017 and 2018 is still ongoing. We hosted an international workshop on Beta Pic science in September 2018 at the Observatoire de la Côte d'Azur, gathering astronomers from institutes all over the world.

The +

This project has allowed the complete pulsation modes of the Beta Pic star to be observed for the first time, and permitted the discovery of a new planet - called Beta Pic c - in the Beta Pic system.

What's next?

The ASTEP telescope is pursuing its observations of stars with candidate exoplanets such as those discovered by the NASA TESS space mission. Thanks to the support of Academy 3, the project has been funded by the French polar Agency up to 2022. We will develop new cameras with increased sensitivity that could provide simultaneous observations in the red and in the blue. The system should permit the discovery of small planets around red dwarf stars and characterize these systems more efficiently than ever before.

More info at
http://univ-cotedazur.fr/en/idex/academies/

GRADYN - Granular Material Dynamics and Space Missions to Celestial Bodies: A Transdisciplinary Approach

Analyzing the surface of asteroids to better understand planet formation and the emergence of life on Earth.

Academy 3 highlight

The GRADYN project gathers astrophysicists and material physicists from Observatoire de la Côte d'Azur and Ecole des Mines ParisTech to study the behavior of granular materials on asteroid surfaces. It contributes to asteroid space missions in which project members are highly involved.

Scientific domain

Planetary Science

Key words

Granular Materials,
Asteroids,
Space Missions,
Numerical Modeling,
Low-gravity Environments

PI laboratory

LAGRANGE, UCA

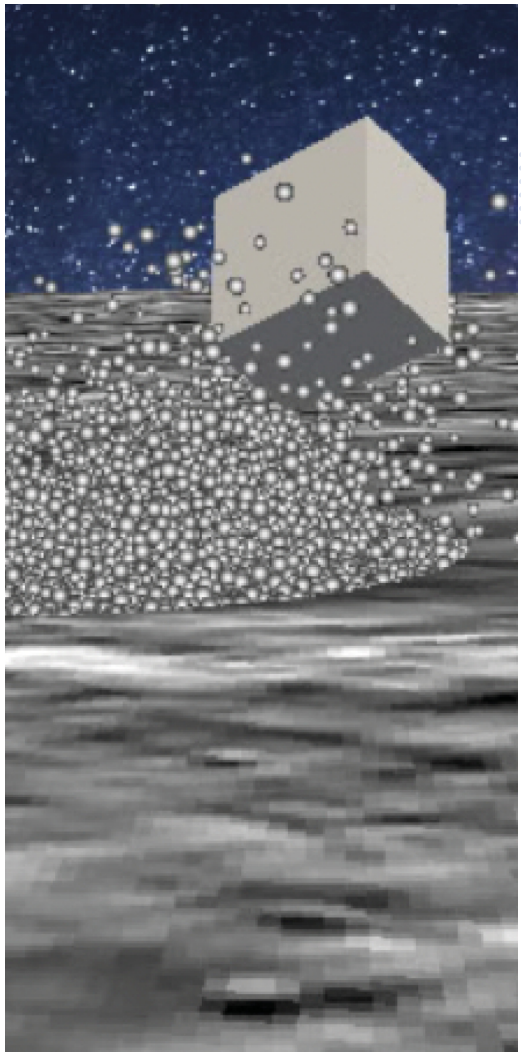
Partner laboratories

MINES ParisTech
NASA (US)
JAXA (Japan)
ESA (Europe)
DLR (Germany)
University of Maryland (US)
University of Tokyo (Japan)
University of Arizona (US)

Total budget

40 k€ including 10 k€ from Academy 3

Patrick Michel



The project

Hayabusa2 (JAXA) and OSIRIS-REx (NASA) are space missions currently visiting two small carbon-rich asteroids for the first time. They will return to Earth with samples in 2020 and 2023, respectively, allowing the international community to make a big step in the understanding of the role of asteroids in planet formation and in the emergence of life on Earth. Our team and project contribute to important activities related to these space missions. Small asteroid surfaces are usually covered with a layer of granular material called regolith. Regolith properties and behavior in the low-gravity conditions of a small asteroid are poorly understood. Our project combines the expertise of research teams from Observatoire de la Côte d'Azur and Ecole des Mines ParisTech to study the behavior of granular materials in conditions approaching those of asteroids and comets. It relies on different modeling approaches and their validation by comparing computer simulations with laboratory experiments. We address various important issues related to the formation and evolution of asteroids, the modeling of interactions between space instruments (lander, sampling instruments, rovers, etc.) and asteroid surface, and the characteristics of the surface. The GRADYN project has thus contributed to space mission activities (design, and data interpretation) and to improved knowledge of small asteroid bodies, both of which are a prerequisite to decipher planet formation and emergence of life on Earth.

The +

The project brings together astrophysicists and material physicists. It allows UCA to contribute greatly to on-going and future space missions, in the framework of intensive international collaborations with American, Japanese and European organizations.
These results have been published in high impact scientific journals such as Science, Nature Astronomy and Nature Geoscience.

What's next?

We will combine our discrete and continuum approaches to improve the modelling of granular materials on asteroids in order to understand their surface history. This should pave the way for improved rover wheel design on the Martian moon Phobos that will be visited by the JAXA MMX mission.

LAGRANGE · MINES ParisTech · NASA · JAXA · esa European Space Agency Agence spatiale européenne · DLR · University of Maryland · 東京大学 The University of Tokyo · The University of Arizona

More info at
http://univ-cotedazur.fr/en/idex/academies/

ROCSS - Reconnaissance, Origin, and Characterization of Small bodies of our Solar System

What is the surface of atmosphere-less bodies of our solar system made of ?

Academy 3 highlight

ROCSS forges expertise in planetary sciences, material sciences and High Performance Computing to understand the nature and origin of the surfaces of atmosphere-less bodies of our Solar System. ROCSS is part of the Center for Planetary Origin project (C4PO).

Scientific domain

Physics and Astrophysics

Key words

Planetary Sciences,
Numerical Modelling
Asteroids
Space Missions

PI laboratories

LAGRANGE, UCA
CEMEF, MINES ParisTech

Partner laboratories

LPL, University of Arizona

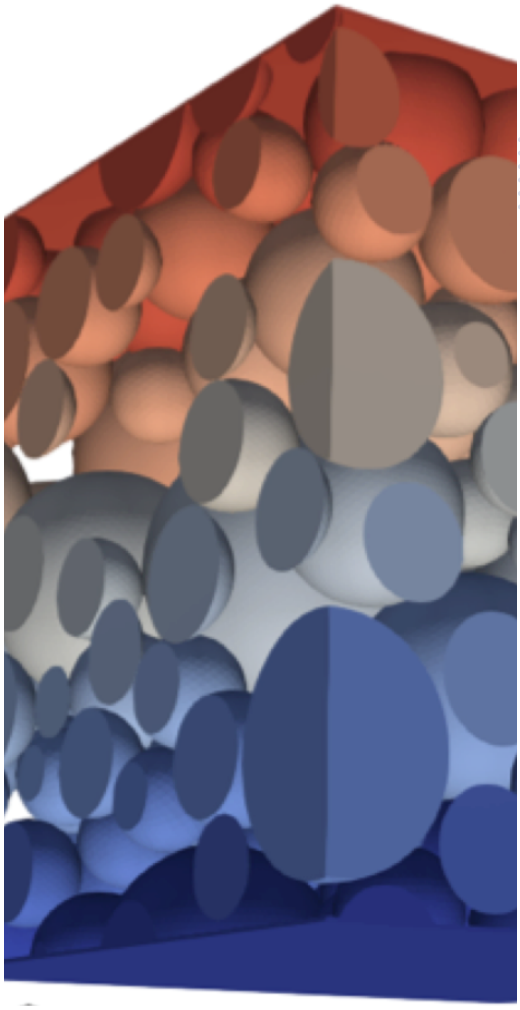
Total budget

265 k€ including 13 k€ from Academy 3

Marco Delbo

Daniel Pino Muñoz

Marc Bernacki



The project

Space bodies without atmosphere are numerous in our solar system, including asteroids, several natural satellites and one planet. Yet we still do not fully understand how and where these bodies formed and how their formation is related to the evolution of our solar system. In this project, we hypothesize that part of the formation and evolution mysteries of the atmosphere-less bodies may be deciphered in their outermost surface. That surface is generally made of multi-minerallic rocks and regoliths (layer of unconsolidated rock fragments). Understanding the physical mechanisms that created these materials is crucial to understand the processes that created the atmosphere-less bodies and contributed to their evolution over the last 4.5 billion years. ROCSS thus focuses on the characterisation (i.e., analysis of conductivity, density, porosity, degree of roughness, etc.) of the surface of atmosphere-less bodies and on the processes that sculpted it. For that, we developed a new method to better analyse the astronomical infrared observations of planetary surfaces that are acquired with large telescopes from the ground, from space, and by in situ space missions such as OSIRIS-REx (NASA) and Hayabusa2 (JAXA). The method is a novel numerical model allowing the analysis of both the solid and the radiative conductivity of complex materials, such as those expected to form the surface of atmosphere-less bodies. Using this new model, we could for instance estimate for the first time the radiative thermal conductivity of polydisperse particulates (Ryan et al. 2019). We are now using the model to characterize the surface of the asteroid (101955) Bennu, target of the NASA's sample return mission OSIRIS-Rex in 2019 and 2020.

The +

Our new model is now being used by several international organizations such as the NASA's mission OSIRIS-Rex to characterize the surface material of several asteroids. The modelling results should provide new insights into the geology of these asteroids and eventually provide some guidance when selecting the most appropriate sample sites.

What's next?

We obtained 2 years of post-doc funding from NASA's OSIRIS-REx asteroid sample return mission, to apply the ROCSS new model to thermal infrared observations of the asteroid (101955) Bennu, which is the unique target of the OSIRIS-REx mission. The ROCCS model might also be used in the near future to analyse the infrared observations of the planet Mercury acquired in the Bepi Colombo mission (ESA) in 5 years.

Instrumentation and methodologies for Earth and Space observation and hazard and resilience assessment

CSU Côte d'Azur, a Student Space Center in Côte d'Azur

"Students building a satellite? Yes we can!"

Florentin Millour

Academy 3 highlight

This project combines research and training in Space observation. It aims to make students of different levels build a nanosatellite to observe the Earth from the Space. It gathers a consortium of 6 laboratories from Université Côte d'Azur, a private company and 4 academic training programs.

Scientific domain

Aerospace

Key words

Master's Student Training
Satellite
Optical
Communications
CubeSat

PI laboratory

LAGRANGE, UCA

Partner laboratories

GEOAZUR
LEAT
INRIA
CEMEF
INPHYNI
I3S
Polytech Nice
École des Mines de Paris

Total budget

The total budget of the satellite is close to 300k€. Academies 2 and 3 have contributed more than 30k€, mainly in the setup of the CSU and students' stipends.

The project

More than 60 years ago, the space race started with the launch of the Sputnik satellite, which beamed its radio messages from Space to Earth. Since that pioneering epoch, the space domain has slowly shifted from military to institutional actors, and more recently from institutional to private actors. This shift, usually called the "New Space era", is accompanied by standardization, miniaturization, and a decrease of the cost of access to space. The present time offers more opportunities than ever, especially for universities, to train students in the aerospace context and its associated techniques. In that framework, we have launched the CSU project in 2017. Its objectives are two-fold. A first goal is to design a nanosatellite of "CubeSat" format, called "Nice Cube", at Université Côte d'Azur, to monitor and hence better understand the perturbations that affect optical links between satellites and ground stations. Those perturbations (atmospheric turbulence, aerosols, etc.) can indeed dramatically affect communication systems in the optical domain. A second specification of this project is that this new Nice Cube nanosatellite is entirely built by students, in order to train them to the New Space era technologies. Over the first two years of the project, 25 students of master level and various nationalities have already been involved in the Nice Cube satellite design. The construction of the instrument is progressing satisfactorily. As a matter of fact, Nice Cube is already at the end of "phase 0", meaning that its dimensioning and agenda of forthcoming missions are well achieved. The nanosatellite will eventually host an optical communication payload that will allow the measurement of atmospheric perturbations. Meanwhile, we have also made progress on designing two associated ground stations, one operating in radio waves, and the other in optical.

The +

The CSU project builds a strong link between academic and private actors on the one hand, and graduate students on the other hand. The proposed training is innovative and unique on the international scene. The instrumental and research objectives are of great interest for the international community. The CSU project thus strengthens the expertise and visibility of Université Côte d'Azur in the domain of aerospace and access to space.

What's next?

The CSU project has fostered new collaborations within UCA, which we plan to continue strengthening and enlarging. As a matter of fact, we are in the process of developing a new collaboration with Thales Alenia Space to work on novel payloads for atmospheric characterization that will be integrated to a new nanosatellite in CubeSat format.

More info at
http://univ-cotedazur.fr/en/idex/academies/

MATISSE - The Birth of Telluric Planets with MATISSE (Multi-AperTure Inteferometry and SpectroScopic Experiment)

“MATISSE, a giant and sharp eye on the Universe.”

Bruno Lopez

Academy 3 highlight

MATISSE is a unique Space observation instrument on the international scene that will provide unprecedented high-resolution data on Stars and Galactic Nuclei allowing a huge step forward in our understanding of the Universe.

Scientific domain

Astrophysics and Optical Instrumentation

Key words

Stellar Physics
Young Stellar Objects & Protoplanetary Disks
Disks
Active Galactic Nuclei
Long Baseline Optical Interferometry
Planetary Bodies and Embryos

PI laboratory

LAGRANGE, UCA

Partner laboratories

INSU, OCA, Lagrange, UCA
MPIA
NOVA and University of Leiden
ESO
University of Vienna
University of Cologne
The Konkoly Observatory
University of Kiel

Total budget

Total budget allowing development and installation of MATISSE: ~16 million euros.
Academy 2 and Academy 3 contribution: 10 k€.

The project

After 15 years of work, our group has successfully built a unique space observation instrument: MATISSE (Multi-AperTure mid-Infrared SpectroScopic Experiment). MATISSE combines the beams of four of the telescopes of the "Very Large Telescope Instrument" (VLTI) of the European Southern Observatory (ESO), one of the most prestigious optical observatories in the world (Chile). It operates in the L, M and N emission bands, thus from 3 to 13 microns of wavelength, with spectral resolutions ranging from 30 to 4500, and provides polychromatic images. Altogether these make MATISSE a unique instrument in the world with unprecedented spectroscopic capabilities and extended spectral coverage. These specifications allow MATISSE to observe and characterize simultaneously both the spatial distribution and the chemical characteristics (composition, grain size, crystallinity, etc.) of the warm dust and gas material that surround many astrophysical sources such as young stars and active Galactic Nuclei. More, MATISSE allows us to explore for the first time the closest environments of the stars, less than 10 Astronomical Units wide (1 AU = the Sun-Earth distance), and to perform this exploration at the currently highest possible resolution (a fraction of an AU).

MATISSE has been installed in the Atacama Desert in Chile. It started to operate in April 2019. The Academy 3 support allowed us to conduct some of the first observing sessions, and to lead training sessions for a few French observers including students.

MATISSE is now ready to observe the Universe. Therefore, over the next decade, MATISSE will provide unprecedented observations addressing many critical scientific questions such as the structure of Active Galactic Nuclei, the origin of dust in our Universe, the imaging of planet-forming regions around solar system analogs, etc. MATISSE is thus on its way to generate new important data and science that will make a large step forward in our understanding of the Universe.

The +

MATISSE is a unique worldwide instrumentation achievement. Its construction relied on a large multidisciplinary and international effort. It is currently the only space observation instrument operating in the mid-infrared, while combining the observation capacity of 4 telescopes. This makes it the most accurate observation instrument at the present moment. It is open to the entire scientific community.

What's next?

Tens of PhD students will be involved in these projects. Breakthrough scientific results are thus expected in the next decades thanks to MATISSE. In early 2020 more than 150 international observing proposals have already been submitted through the ESO calls, to use MATISSE to observe different parts of our Galaxy and the Universe.

More info at
http://univ-cotedazur.fr/en/idex/academies/

METEOSPACE - Meteorology of Space

An automated space weather station at Calern Observatory to monitor solar activity and mitigate related risks on worldwide satellite and communication systems.

Thierry Corbard

Academy 3 highlight

Solar activity can disrupt the Earth's ionosphere and induce some risks to our worldwide satellite and communication systems. Studying these space risks and their physics is the field of "space weather". The MeteoSpace project involves research in solar physics and image processing techniques, and provides new technical developments and data that will contribute to real-time space weather monitoring and mitigation of related risks.

Scientific domain

Astrophysics

Key words

Space Weather
Instrumentation and Observation
Sun
H-alpha
Calern Observatory

PI laboratory

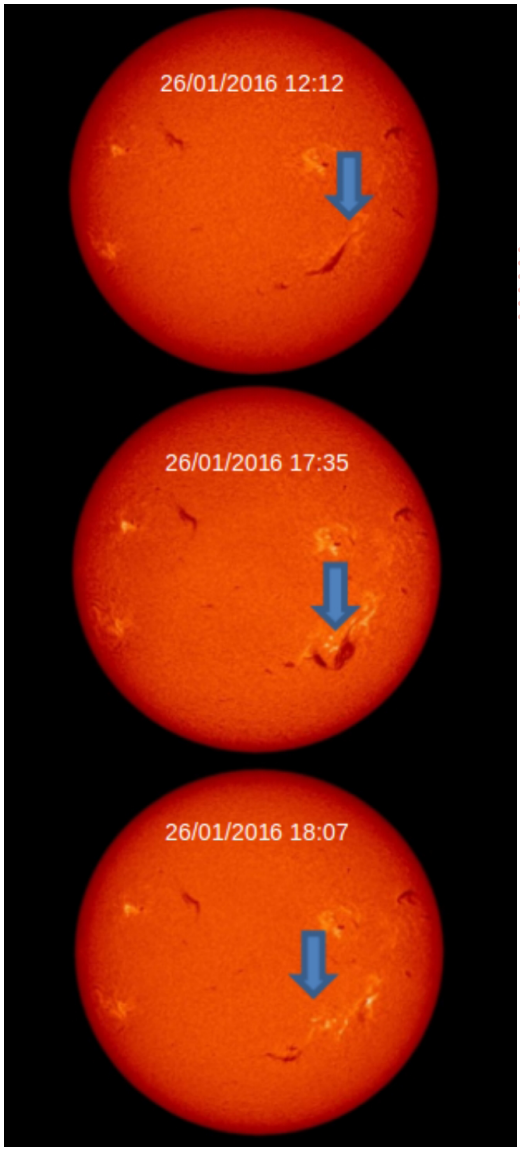
LAGRANGE, UCA

Partner laboratories

LESIA, OBSPM
Armée de l'Air Française CDAOA
LUNA technology

Total budget

600 k€ including 41 k€ from Academy 3



The project

Solar activity is responsible for disturbances in our space environment, called space weather. In particular, solar activity produces specific structures, "filaments", which are plasma prominences. These prominences sometimes erupt and eject particles at high energy in the heliosphere that can eventually reach the magnetosphere of the Earth. Their interaction with the magnetosphere disrupts the ionosphere and causes damage to our satellite and GPS communication systems. Space weather thus poses some risks to the Earth. To be prepared for and mitigate those solar risks, France joined the European Space Situational Awareness (SSA) program of ESA in 2016, and created the OFRAME group (French Organisation for Applied Research in Space Meteorology) in June 2017 to coordinate actions related to space weather. MeteoSpace is a project that contributes to these new French actions. It aims to develop and operate an automated instrument to observe the lower solar atmosphere (chromosphere) where the solar erupting filaments originate. The instrument is made of three telescopes that will be installed at Calern Observatory in Southeastern France (the site of Observatoire de la Côte d'Azur). It is conceived to operate at high cadence and in wavelengths corresponding to those of ionized calcium and hydrogen H-alpha spectral lines which are formed specifically at temperatures and densities reached in the chromosphere. As Calcium and Hydrogen create different degrees of opacity, the solar structures revealed by these two electronic emissions are seen at different heights in the chromosphere and hence can be discriminated. Two H-alpha filters centered at slightly different wavelengths will be used to provide two synchronous images of the filaments at different heights. This will improve the accuracy of their detection. Movies of the difference between two successive images will depict the chromosphere dynamics and might thus reveal the large-scale shock waves (Moreton waves) that are sometimes induced by solar eruptions. This would be the first time that an H-alpha instrument provided movies, continuously and in real time, where those waves were observed.

The +

This project contributes to the currently increasing research momentum in France on the theme of space weather. The new instrument and its data should give tremendous international visibility to UCA activities in observing programs for near-space risk management.

What's next?

In 2018, the MeteoSpace project answered a call initiated by the OFRAME group in order to be recognized as a future provider of valuable data for space weather studies from continuous solar monitoring. In forthcoming years, we plan to join the existing international networks providing H-alpha images and to apply to ESA calls to become an official data provider of the SSA program.

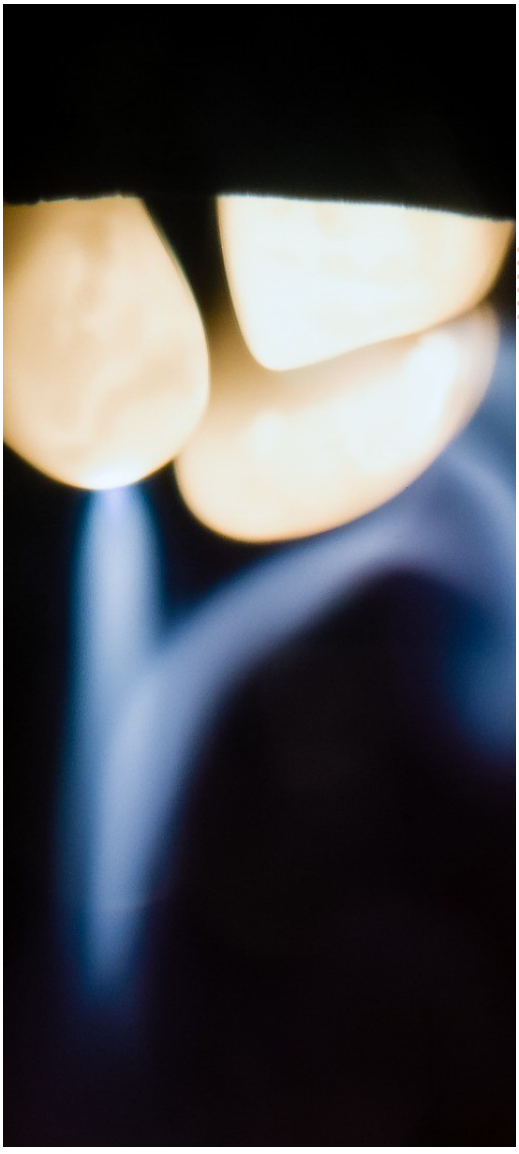
LAGRANGE · l'Observatoire de Paris – LESIA · ARMÉE DE L'AIR · LUNA TECHNOLOGIES

More info at
http://univ-cotedazur.fr/en/idex/academies/

FLEXTOR - A Flexible Plasma Torch

A new plasma torch as a "clean" alternative to harmful combustion industrial processes.

François Cauneau



Academy 3 highlight

The FLEXTOR torch is devoted to material synthesis in new extreme conditions. FLEXTOR thus provides a unique opportunity to develop new industrial processes for material design, and to study extreme natural phenomena and conditions such as those encountered near stars.

Scientific domain

Plasma Physics, Thermochemistry, Condensed Matter Physics, Cosmochemistry and Astrophysics

Key words

Plasmas
Thermochemistry
Stellar and Circumstellar Condensation Processes

PI laboratories

LAGRANGE, UCA
PERSEE, MINES ParisTech

Partner laboratories

PLENESYS
Washington University in St. Louis, USA.

Total budget

15 k€ from Academy 3

The project

In industry, many processes make use of combustion, which is becoming increasingly recognized as harmful for the environment, climate, and life. One of the most common combustion processes is oil cracking achieved by bringing hydrocarbon to flame temperature to obtain new chemical components of interest. This involves the combustion of part of the hydrocarbon, and this combustion leads to harmful CO2 emissions in the atmosphere. Therefore, for environmental and economic reasons, industrial processes originally based on classical combustion are progressively being replaced by processes based on electricity.

The goal of this project is to set up a new experimental facility using new plasma technology to bring various materials to high temperature. Plasmas are the fourth state of matter. They can be described as a gas where some of the atom electrons are free. This makes those electrons capable of reaching very high temperatures when an electric field is applied. The new plasma torch we are building, FLEXTOR, uses this technology. It will thus provide an efficient alternative to combustion that will be useful in many situations. For example, it should provide for the first time the opportunity to crack fuels and produce electricity by using only the hydrogen they contain. It should also allow us to directly synthetize nanomaterials from various elements (Carbon, Silicium, Titanium, etc.). So far, we have used it to bring meteorite components to plasma temperatures of 3000-5000°C. This original experiment at extremely high temperatures close to those in stellar environments allowed us to reproduce the dust and mineral formation processes observed in the surrounding of some types of stars.

FLEXTOR thus provides new possibilities for academic and industrial research on advanced plasma processes. We plan to share the new FLEXTOR instrument with the PLENESYS start-up which is working on electrification and decarbonizing processes in industry. FLEXTOR will allow that company to extend the conditions of their experimental tests to extreme situations.

The +

The originality of the project is to combine different scientific fields and different applications, industrial and academic. This allows the FLEXTOR plasma torch to address various problems involving materials of anthropogenic or inorganic origin, as well as terrestrial and extraterrestrial materials and processes.

What's next?

We have achieved the first phase of the project which was to bring together the components allowing the setup of FLEXTOR. We will then conduct the first tests during the year beginning in 2019. We anticipate breakthrough results in the domains of advanced materials and energy transition, on topics such as power to gas cycles, new processes for liquid biofuels synthesis, and creation of new materials.

WIMAG - WaveIMAginG

“The power of waves to image complex features and processes of critical importance for human beings and the environment.”

Claire Migliaccio

Victorita Dolean

Academy 3 highlight

WIMAG gathers 5 UCA laboratories in mathematics, informatics, signal processing, electronics, and earth sciences to develop innovative wave-based methods to image hazardous features and processes.

Scientific domain

Applied Mathematics, Computer Science, Geosciences and Electromagnetism

Key words

Wave Imaging
Inverse Problems
Direct Problems
Seismic Imaging
Electroencephalogram (EEG)
Microwave Imaging

PI laboratories

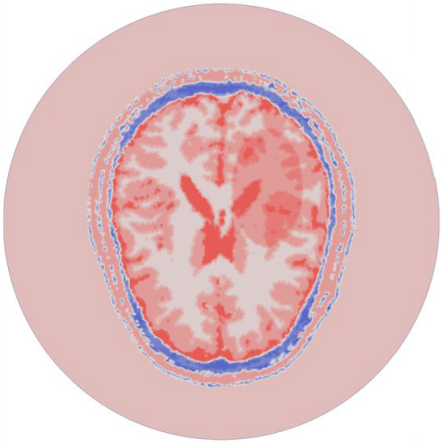
LJAD, UCA
LEAT, UCA

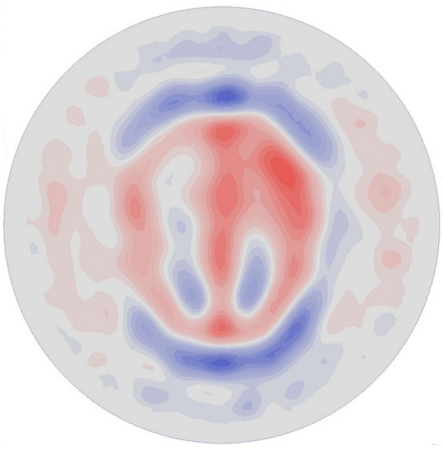
Partner laboratories

I3S, UCA
GEOAZUR, UCA
CREMANT, UCA
INRIA
Université de Téhéran
Lincoln Agritech NZ

Total budget

56 k€ including 13 k€ from Academy 3





The project

A prerequisite to assess most natural and anthropogenic hazards is to describe accurately the features that induce these hazards. This description generally relies on imaging the features in three dimensions. The imaging is commonly done by extracting the information which acoustic or electromagnetic waves traveling through the features carry on their 3D shape and properties. Wave imaging is thus of upmost importance for a wide range of fields including medicine, telecommunications, environment, Earth and planetary sciences, material sciences, transportation, defense and security. Enhancing the performance of wave imaging devices is particularly important to improve our understanding of many specific features and phenomena in the above-mentioned areas. However, significant advances are still currently required in the modelling, analysis, computer-aided design, optimization and manufacturing of such devices, together calling for a broad range of expertise in engineering, physics and mathematics. In this context, the WIMAG project aimed, as a first step, to identify and gather the research and development, industrial teams and partners of Université Côte d'Azur involved in wave imaging systems. We thus gathered 5 different laboratories of UCA. WIMAG then focused on theoretical developments related to three applications: seismic imaging of the Earth, imaging of Electroencephalograms (EEG), and detection and identification of strokes by microwave tomography. All of these theoretical developments share a common thread, which is to tackle the difficult challenge of wave-based inverse problems: recover the real 3D shape and properties of the feature under study by matching complex, incomplete, oscillating and generally fuzzy signals acquired with various experimental devices. For comparison, this is like recovering the exact proportion of the various ingredients used to make a cake, just by tasting the cake.

This led us to develop new methods to image the target features accurately. In particular, we developed a novel seismic-wave-based imaging method of Earth rocks. In addition, from recordings of the electrical potential, we implemented a rapid and efficient method to locate brain sources on the scalp. We also demonstrated that haemorrhagic brain stroke can be automatically identified with microwave tomography in less than 5 minutes.

The +

We have unified the broad range of expertise on wave imaging in UCA, spanning from medicine to mathematics through Earth and material sciences. This transdisciplinary effort has led us to perform important new research and to reach new findings, such as the development of a wavefield reconstruction inversion (WRI) method for seismic imaging of shallow Earth rocks, development of a new rapid and efficient method to locate brain sources on the scalp, and demonstration that haemorrhagic brain stroke can be automatically identified with microwave tomography in less than 5 minutes.

What's next?

The project has created new collaborations at UCA, national and international levels that should go on and be long-lasting. The work on microwave imaging for medical applications will be pursued via a grant from New Zealand. The creation of an academic/industrial Consortium between GEOAZUR, Total and Shell is in progress and a grant was obtained with Great Britain for applied mathematics to geosciences.

More info at
http://univ-cotedazur.fr/en/idex/academies/

TERM - Transdisciplinary Extreme Risk Modeling

“Towards a generic modeling of extreme events in a broad range of domains, from social to life and planetary sciences.”

Bertrand Groslambert

Academy 3 highlight

TERM proposes an integrative approach across disciplines to model extreme events occurring in a broad range of domains and to understand their generic determinants. The new modeling approach should help manage extreme risks and improve resilience strategies.

Scientific domain

Transdisciplinary

Key words

Space Plasma Extreme Events and Astrophysics
Extreme Geo-hazards, Climate and Weather
Financial Market Bubbles, Crashes and Crises
Material Failure, Extreme Events in Laboratory (Fusion) Plasma
Biophysics, Evolutionary Ecology

PI laboratory

SKEMA Business School

Partner laboratories

Strathclyde University
Royal Belgian Institute for Space Aeronomy
ENEA
IKI Space Research Institute
Technical University of Denmark
ETH Zurich

Total budget

20 k€ from Academy 3

The project

Extreme events are described in fields as diverse as climate, telluric hazards, astrophysics, economy and finance markets, material sciences, evolutionary ecology, etc. There is growing evidence that these various extreme events share common features, such as developing in complex systems and jointly with other events. However, their driving mechanisms seem to involve ingredients that, in some cases, produce events that are even more extreme than predicted by classical power laws. Understanding such deviations is key to understanding the phenomenology and physics of extreme events and to model them accurately.

Our ambition is to develop an integrative approach to better understand the determinants of extreme events and to model them in a generic manner. The generic models could be applied to a variety of domains and help to improve the management of the extreme risks associated with extreme events and resilience strategies.

As a starting step, we have organized two transdisciplinary workshops featuring experts in physics, geosciences, economics, finance, mathematics and other disciplines, from both within Université Côte d'Azur and external institutions, all focused on extreme risk modeling. During the workshops, differences and similarities between various extreme events and phenomena were identified, specifically in regard to the statistical probability of extreme event occurrence, and that of their energy release. Transdisciplinary international collaborations were initiated and several working papers were written.

The +

This project has gathered 40 participants from seven countries (Belgium, France, Italy, Russia, Switzerland, UK, and USA) and five principal disciplines (Economics, Finance, Mathematics, Physics, and Space Science). It has initiated some discussions, joint presentations, and starting collaborations among various UCA Labs (LJAD, ESPACE, INRIA, GEOAZUR).

What's next?

We are planning a new international workshop in The Netherlands in July 2019, co-organized by Université Côte d'Azur (Nice, France), the Royal Belgian Institute for Space Aeronomy, the ENEA (Italy), the IKI Space Research Institute of Russia, the Technical University of Denmark, and ETH Zurich (Switzerland). The workshop will strengthen the new collaborations and launch ambitious federative research projects to be submitted to European and international calls for proposals.

More info at
http://univ-cotedazur.fr/en/idex/academies/

2. Academy 3 summary in a few figures

KEY FIGURES

3	48	€1,552,561	7	1
calls for proposals, 1 ongoing funding process and 1 call for additional funding	funded projects including 18 co-funded with other academies	total allocated to research and scientific outreach projects	organized or co-organized outreach events	international Master's degree of excellence created in 2019

ACADEMY 3 CALLS FOR PROPOSALS

The first two calls (AAP1 2016 and AAP2 2017) aimed to build the foundation for collaboration within the UCA community on the themes of Academy 3. These wide-ranging calls for proposals for research or outreach projects were launched with the aim of gaining a vision as complete as possible of all the research themes and collaborations already ongoing at UCA on the themes of Academy 3. The two calls targeted core projects associating at least two UCA laboratories, preferably interdisciplinary, of international scope, and associating students. More than immediate scientific excellence, the goal was to encourage and lay the foundation for new inter-disciplinary collaborations within UCA.
Twenty projects received between 10 k€ and 60 k€ for a period ranging from 1 to 3 years and for all types of expenses (operations, payroll, investment).

In 2018, we launched a third call for proposals (AAP 3 2018) with a different objective. After following the progress of projects completed by the end of 2017, we decided to provide additional support to a few ongoing projects that were clearly creating new inter-disciplinary collaborations within the UCA community. The aim was to enforce these collaborations, and to guide the projects towards more ambitious European or international calls for proposals. Meanwhile, we wanted to continue supporting more modest growing projects. Therefore, the 2018 call offered funding to two types of proposals: major "federative" projects and more modest "open" projects.
As a result, we funded 7 "open" projects and 4 large "federative" projects, two under the theme "Impacts of anthropogenic actions on the environment and health", one on the "Physics of earthquakes and related hazards" and one on the theme "Origin and physics of the universe". To strengthen the core actions of the Academy, at the end of 2018 the steering committee launched the development of a fifth major "federative" project (Nautilus) with the collaboration of 3 laboratories, on the theme of marine noise. This project was funded in early 2019.

In 2017, along with the calls for proposals, we launched an ongoing funding scheme for projects submitted throughout the year with a budget request not exceeding €10K. This system was ideal to meet the needs of researchers who could not fit their work in the deadlines or the framework of the other calls for proposals. The proposals submitted had to be urgent and be part of an existing project. This ongoing call was closed in December 2019 to coincide with the end of the IDEX probationary period and of the Academy 3 budget.

In 2020, Academy 3 decided to allocate the obtained additional funds to increase its support to the most strategic ongoing projects. We thus informed the project leaders and invited them to inform the Academy of their results since the last assessment in spring 2019 and of their possible needs. Our priority was to respond to Human Resources needs because Ph.D. students and young post-doctoral researchers are essential to the success of a project. As a result, 7 projects obtained additional funding for personnel, with a total of 118 k€ for 28 months of fixed-term contracts and 9 months of Ph.D. extension grants and post-doctoral fellowships. The 8 other projects received additional funding for a total amount of 59 k€ for operating expenses.

Several projects have been selected for further national or international funding. To date, **37%** of the funded projects have had a leverage effect and have generated an approximate total amount of **4.5 M€**.

Table 1 : Summary of the calls launched by Academy 3

Date	Funding procedure	Number of proposals submitted	Number of projects funded	Assigned budget
Sept. 2016	Call for Proposals #1 - AAP1	38	17	€353,000
March 2017	Call for Proposals #2 - AAP2	9	4	€90,400
Jan. 2018	Call for Proposals #3 - AAP3 "Open" and "Federative" Projects	19	7+4	€704,500
Apr. 2017 Dec. 2019	Ongoing grant	23	16	€227,737
Feb. 2020	*Call for Additional 2020 funding*	*18*	*15*	*€176,924*
		89	**48**	**€1,552,561**

The repartition of project size over the 4 calls and the ongoing funding, is presented in Figure 1. The list of all projects funded is given in Table 2.

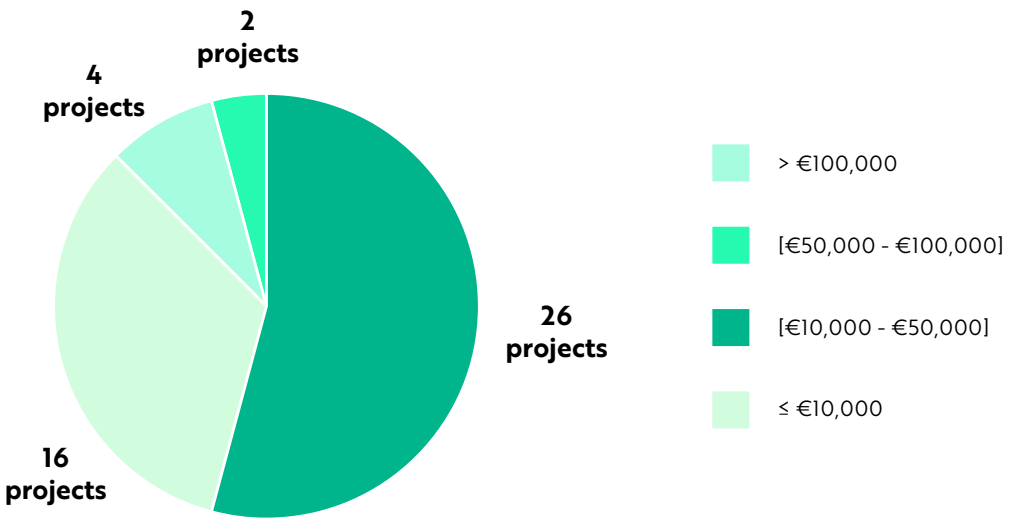


Figure 1 : Financial repartition of the 48 projects funded over the 4 calls and ongoing funding of Academy 3

*Table 2 : Exhaustive list of the 48 projects funded by Academy 3**

	Project name	Title of the project funded by Academy 3	Name of the project leader	Laboratories and partners	Funding allocated
AAP1	ACT	A study of public perceptions of climate change risks and the propensity to act on them in France	Zakaria BABUTSIDZE	SKEMA *LAPCOS, Griffith Univ., Univ. of Michigan, Michigan State Univ.*	€30,000
	ASTERISM	Astrometry for stellar to terrestrial reference [frame]	Agnès FIENGA	GEOAZUR *LAGRANGE, Obs. Turin*	€4,000
	BetaPic	Characterization of beta Pic b from Antarctica	Tristan GUILLOT	LAGRANGE *IPEV, IPAG, Birmingham Univ., ESA*	€16,000
	BiBES	"Transcriptokinetomic" analysis of the impacts of Bt bioinsecticides on intestine physiology	Armel GALLET	ISA *IPMC*	€25,000
	Com2SiCa	Observation and modeling of human behavior in disaster prone areas	Damienne PROVITOLO	GEOAZUR *ESPACE, LJAD, Géographie-cités, LMAH, LITIS, LPPL*	€25,000
	CSUCA	A satellite for UCA	Florentin MILLOUR	LAGRANGE *LEAT, INPHYNI, I3S, Polytech Nice, INRIA, CEMEF, École des Mines de Paris*	€30,000 + €20,000 (add. funding in 2020)
	CytoPol	To investigate the association between in utero exposure to environmental pollutants and cytokine levels in umbilical cord blood.	Nicolas GLAICHENHAUS	IPMC *CESP, INSERM, IAB*	€15,000
	FAULTS_R_GEMS_pilot	Properties of FAULTS, key information to produce realistic generic earthquake models and hazard simulations	Isabelle MANIGHETTI	GEOAZUR *INRIA, LJAD, Thales Alenia Space, CNES, LUXCARTA, IPGP, Geosciences Montpellier, Pisa Univ., Arizona State Univ., UNAVCO*	€30,000 + €1,800 (add. funding in 2020)
	GRADYN	Granular material dynamics and space missions to celestial bodies: a transdisciplinary approach	Patrick MICHEL	LAGRANGE *MINES ParisTech, NASA, JAXA, ESA, DLR, Univ. of Maryland, Univ. of Tokyo*	€10,000
	MANTRA	Magnetic nanoparticles for environmental applications and risk assessment: towards a "zero waste principle" paradigm	Claire LOMENECH	INPHYNI *ICN, ECOSEAS, PHENIX*	€27,000 + €20,000 (add. funding in 2020)
	METEOSPACE	METEOSPACE, an automated space weather station at Calern observatory	Thierry CORBARD	LAGRANGE *LESIA- OBSPM, Armée de l'Air Française CDAOA, LUNA technology*	€25,000 + €16,000 (AAP2 funding)
	NAO	North and central Andean subduction international observatory: From physical processes to social, environmental and development impacts of large earthquakes	Philippe CHARVIS	GEOAZUR *ESPACE, GREDEG, SKEMA, CEREMA, Instituto Geofísico de la Escuela, Politécnica Nacional, Escuela Superior Politécnica del Litoral, Distrito Metropolitano de Quito, Instituto Geofísico del Perú, Univ. de Chile*	€30,000
	NR2P2	Nuclear risk, from radioisotope (bio)chemistry to public perception	Christophe DEN AUWER Sandra PEREZ	ICN, ESPACE *GEOAZUR, TIRO-MATOs, GREDEG, IPMC, SDIS06»*	€20,000
	PRIM	Are primitive meteorites so primitive?	Clémend GANINO	GEOAZUR *LAGRANGE, Univ. Libre de Bruxelles*	€15,000

AAP1	ROCSS	Reconnaissance, origin, & characterization of small bodies of our solar system - uncovering the nature of celestial bodies with methods of material sciences Co-funding of a post-doc fellowship (Andrew Ryan) with Academy 2 (post-doc extended for 2 years and paid by NASA - $234,000) - February 2018 to February 2019 at OCA/CEMEF	Marco DELBO	LAGRANGE *CEMEF, LPL*	€13,000
	WIMAG	Wave imaging Step 1 Co-funding with Academies 1 and 2 of a post-doc fellowship (Michel Leguèbe - LJAD/LEAT/Geoazur who along the way was recruited by INRIA Bordeaux as a Researcher)	Claire MIGLIACCIO	LEAT/I3S *LJAD, GEOAZUR, CREMANT, INRIA*	€13,000 + €8,000 (add. funding in 2020)
AAP2	ContaminYaqui	Assessment and dispersion of contaminants in the Yaqui River (Sonora State, Mexico): evaluation of environmental risks	Christophe RENAC	GEOAZUR *INPHYNI, ILM-UCBL, IMTA, UAEM, IIT-R*	€20,000 + €5,000 (add. funding in 2020)
	CONVOST	State of preservation of marine vegetation and hazards associated with Ostreopsis	Luisa PASSERON-MANGIALAJO	ECOSEAS *LOV, NCA, Ville d'Antibes*	€15,000
	JUNO	Use of Cassini and Juno raw radio measurements to improve planetary ephemerides and determine constraints on the localization of planet P9.	Agnès FIENGA	GEOAZUR *Univ. of La Sapienza*	€19,200
	PACA TRENDS	Historical trends in land cover and climate in order to predict the evolution of flooding, forest fire, and soil erosion risks	Dennis FOX	ESPACE *GEOAZUR, GREDEG, LJAD, ARMINES*	€20,200
Ongoing projects	CellUSIm	In cellulo uranium speciation and imaging after contamination	Gaëlle CREFF	ICN *MATOs*	€3,800
	DEFIDEF	Determination of the elastic properties around a seismic fault integrating defaults. 100% funding of a 1-year post-doc fellowship (MEJRI Bochra) from December 15, 2019 to December 14, 2020 at the LJAD (plus one year co-funded by Academy 2 and ANR)	Olivier PANTZ	LJAD *GEOAZUR*	€50,000 + €12,500 (add. funding in 2020)
	HYPER3D	Monitoring of substrate colonization by hyperspectral camera: an innovative technique applied to 3D printed artificial reefs in the Larvotto marine protected area (Principality of Monaco)	Patrice FRANCOUR	ECOSEAS *PlanBlue, AMPN, Fondation Prince Albert II de Monaco*	€7,000

Ongoing projects	MATISSE	Assistance provided to observation missions using the MATISSE instrument during periods P103 and P104. Training for the observers	Bruno LOPEZ	LAGRANGE *MPIA, MPIfR, Univ. of Kiel, NOVA, Univ. of Leiden, ESO, Univ. of Vienna, The Konkoly Obs., Cologne Univ.*	€5,000 + €24,000 (add. funding in 2020)
	MEDFEUX	Multicriteria mapping of forest fire hazards in the PACA region	Dennis FOX	ESPACE *I3S, IRSTEA*	€5,000
	MHPPDIL	High precision metrology of photoreceptors dedicated to laser interferometry	Nicoleta DINU-JAEGER	ARTEMIS *OCA, CPPM*	€10,000
	MOFRAC	3-D numerical modeling of fracturing and its precursor processes leading to the formation of faults: Acquisition of calculation resources	Alexandre CHEMENDA	GEOAZUR *LAGRANGE, Géosciences Montpellier*	€10,000 + €12,500 (add. funding in 2020)
	NautILUS (project initiated by the Academy)	Marine noise in the Ligurian Sea: from systematic signal analysis to the impact on marine species	Audrey GALVE Paolo GUIDETTI Jérôme LEBRUN	GEOAZUR, ECOSEAS, I3S *iBV, CHU de Nice, CHORUS, LOV, CIRM, Standford Univ.*	€93,350
	NutriNeuro	Does the nature of lipids influence brain inflammation and the development of obesity? Deleterious role of industrial fatty acids. Co-funding of a post-doc fellowship with the Signa-Life-A4 LABEX (3 ½ months of salary for Katharina Stobbe, from April 1, 2019 to July 15, 2019) at the IPMC	Carole ROVERE	IMPC *I3S, CSGA, ICAN, UQAL*	€10,147 + €15,000 (add. funding in 2020)
AAP3	BIOVIT	Sustainable green, recyclable and reprocessable vitrimers for a circular economy	Véronique MICHELET	ICN *CEMEF*	€5,000 + €4,000 (add. funding in 2020)
	BtSI2S	Bacillus thuringiensis var. kurstaki sensing by the innate immune system: impact on non-target animals and human health 100% funding of a doctoral student (Salma Hachfi) from October 1, 2018 to September 30, 2021 at ISA	Armel GALLET Laurent BOYER	ISA C3M *CHU-Nice, ANSES*	€190,000 + €17,400 (add. funding in 2020)
	C4PO	C4PO initiative: investing in the future	Alessandro MORBIDELLI	LAGRANGE *GEOAZUR, CRHEA, CEMEF, PERSEE, JAXA, NASA, BGI, Univ. de Münster, MPIA Heidelberg*	€120,000
	FLEXTOR	A flexible plasma torch reactor for studying condensation in extreme condition	Francois CAUNEAU	MINES PARIS TECH *LAGRANGE, PERSEE, PLENESYS*	€5,000 + €8,000 (add. funding in 2020)
	ITEC	Locating the tsunami initiation region using GNSS ionosphere data	Lucie ROLLAND	GEOAZUR *IPGP, Boise State Univ., Indian Institute of Geomagnetism*	€5,000 + €9,000 (add. funding in 2020)
	MedRiver	Definition of ecological functionality indicators for Mediterranean braiding rivers	Margot CHAPUIS	ESPACE *INRA, GREDEG, Politecnico di Milano, Free Univ. of Bozen-Bolzano, Univ. di Firenze*	€10,000 + €3,850 (add. funding in 2020)

AAP3	METARISK	**Metabolomics for exposure to chemical or radiological risks** Co-funding of a Ph.D. (Simon Bayle) from December 3, 2018 to December 2, 2021 with the ICN, the CEA and SOLEIL	Thierry POURCHER Georges CARLE	TIRO MATOs *ICN, IPMC, ESPACE, GEOAZUR, GREDEG, INRIA, CAL*	€170,000
	PER-FAULT-3M	**Physics of earthquake rupture and fault growth: multi-scale modeling of material failure** 100% funding of a 2-year post-doc fellowship (Chao LIANG) from October 1, 2019 to September 30, 2021 at Géoazur + co-funding with A2 (50%) of a 1-year post-doc fellowship (Hans Agurto-Detzel) from November 1, 2018 to October 31, 2019 at Géoazur	Jean-Paul AMPUERO Stéphane DESCOMBE Daniel PINO-MUNOS	GEOAZUR LJAD CEMEF *MSI*	€160,000
	PlutoPoly	**Amphomorphic chelating polymers for pulmonary plutonium decorportation** Co-funding with the DGA, the ICN and the CEA of a Ph.D. (Jeanne-Marie Fèvre) from October 1, 2018 to September 30, 2021 at the ICN	Christophe DI GIORGIO	ICN *LRT, DGA*	€28,500 + €15,874 (add. funding in 2020)
	ProstAdiPE	**Impact of persistent organic pollutants on endocrine function of adipose tissue particularly in the context of cancer progression**	Charlotte HINAULT	INSERM *C3M, iBV, Obs. du développement dureble NCA*	€10,000
					€1,494,621

**The exhaustive list of publications and communications associated to the projects is provided in the project description, part 2.*

In the spring of 2019, Academy 3 auditioned all the leaders of research projects, in order to assess the progress achieved, guide them in boosting their projects (expand collaborations and submit the project to external, national or international calls for proposals), and identify any needs. These auditions were attended by representatives of the Europe and International Units of UCA.

SCIENTIFIC OUTREACH ACTIONS

Since 2016, Academy 3 has co-organized and co-funded a large number of scientific events designed to federate the UCA community (Table 3), but also to have an international outreach. **"Academy Days" were also organized in 2017 and 2018** to present the projects, to encourage interactions between members of the Academy 3 community, and to spark new collaborations.

*Table 3 : List of the 9 scientific outreach projects funded by Academy 3***

	Project name	Title of the project funded by Academy 3	Name of the project leader	Laboratory	Funding granted
AAP1	TERM	Transdisciplinary extreme risk modeling workshops	Bertrand GROSLAMBERT	SKEMA	€25,000
Ongoing projects	BetaPic Workshop	Beta Bic Workshop 2018	Tristan GUILLOT	LAGRANGE	€4,200
	COLT	Conference "A time for all" ("Un temps pour tous")	Alice GUYON	IPMC	€1,500
	ELSE	European Leadership for Safety Education Workshop	Catherine THOMAS	GREDEG	€7,000
	IESO2017	International Geosciences Olympiads	Jean-Luc BERENGUER	GEOAZUR	€8,000
	RADIOBRA	Education and training in the field of radioecology, Brazil	Herve MICHEL	ICN	€5,740
	SDS 2021	UNESCO Sound Week 2021	Renaud DAVID	IPMC	€2,000
	WaveCom-plexity	WaveComplexity	Stéphane BARLAND	INPHYNI	€5,000
AAP3	BAW@UCA	Brain Week on the Côte d'Azur	Carole ROVERE Jacques NOEL	IPMC	€1,000
					€57,940

***See bellow for detailed description and dates.*

The Academy has also organized or co-organized 7 outreach events:

Jul. 4, 2017: **First Academy Days**
http://web.univ-cotedazur.fr/fr/idex/academies/space-environment-risk-and-resilience/contents/agenda/projects-and-prototypes-student-work/@@highlight_view#.X2xtv4tBq71

Feb. 19, 2018: **2nd Regional Promotion and Study Day (Academies 3 and 5)**
http://univ-cotedazur.fr/archives/fr/idex-uca-jedi/academies/space-environment-risk-and-resilience/contents/news/2eme-edition-de-la-journee-etude-et-valorisation-du-territoire#.XLiLAKRBrb1

Oct. 30, 2018: **Academy Days of the UCA^{JEDI} Core Program "Environment, Health, Citizen"**
62 participants from 18 different entities
http://web.univ-cotedazur.fr/fr/idex/academies/space-environment-risk-and-resilience/contents/news/journee-du-programme-structurant-ucajedi-environnement-sante-citoyen#.X19dgotBpaR

Mar. 29, 2018: **Conference "Challenges for imaging and modeling complex media and processes: The Earth's interior and earthquake rupture"** (MSI, Academies 2 and 3)
http://univ-cotedazur.fr/fr/idex/academies/space-environment-risk-and-resilience/contents/news/mathematiciens-informaticiens-geographes-reunis-lors-dune-journee-scientifique-autour-de-la-sismologie#.XLiLnKRBrb0

> **May 31, 2018**: **Université Côte d'Azur "Business Meetings"** ("Rendez-vous Entreprises ») (IDEX structures)
http://univ-cotedazur.fr/contenus-riches/actualites/fr/rendez-vous-reussi-entre-universite-cote-dazur-et-les-entreprises#.XlkyS0qmlZI

> **Mar 19, 2019**: **Open day of the Core Program "Risks in the North-Mediterranean Zone"**
http://univ-cotedazur.fr/archives/fr/idex-uca-jedi/academies/space-environment-risk-and-resilience/contents/news/2eme-edition-de-la-journee-etude-et-valorisation-du-territoire

> **Academy project monitoring days** - from January to March 2019

The Academy 3 has also supported a number of events:

> **August 22-29, 2017**: **IESO2017 - 11th International Geosciences Olympiads** (Jean-Luc Berenguer, Géoazur)
http://univ-cotedazur.fr/events/ieso2017

> **Sept. 29 2017**: **Workshop "Interdisciplinarity and transdisciplinarity: from announcement to implementation"** (Philippe Charvis, Géoazur)
http://univ-cotedazur.fr/fr/idex/academies/space-environment-risk-and-resilience/contents/news/seminaire-interdisciplinarite-transdisciplinarite-de-l2019affichage-a-la-mise-en-oeuvre/@@highlight_view#.XicrOCOmnb0

> **June 7-9, 2018**: **Interdisciplinary conference "L'air du temps"** (Alice Guyon, IPMC) co-funded by the 5 Academies of UCA.
http://univ-cotedazur.fr/fr/idex/academies/space-environment-risk-and-resilience/contents/projects/projet-colt-colloque-un-temps-pour-tous/@@highlight_view#.XicqUiOmnb1

> **Jul. 5-6, 2018**: **Workshop "Climate change risk perception and propensity to act"** (Zakaria Babutsidze, SKEMA)
http://univ-cotedazur.fr/events/ccrppa
http://univ-cotedazur.fr/fr/idex/academies/space-environment-risk-and-resilience/recherche/publications/ouvrages/changement-climatique-perceptions-et-reactions-de-la-population-en-france

> **7 Sept. 2017 and 8 Sept. 2018**: **Transdisciplinary workshop on extreme risk modeling "Analyzing the various approaches to modeling extreme risk across the natural and social sciences"** (Bertrand Groslambert, SKEMA)
http://univ-cotedazur.fr/fr/idex/academies/space-environment-risk-and-resilience/contents/news/transdisciplinary-extreme-risk-modelling-workshop/@@highlight_view#.XicrxCOmnb0
http://univ-cotedazur.fr/events/transdisciplinary-extreme-risk-modelling-workshop-analyzing-the-various-approaches-to-modeling-extreme-risk-across-the-natural-and-social-sciences

> **Sep. 18-20 2018**: **International conference "Looking for Beta Pic b" at the Nice Observatory** (Tristant Guillot, Lagrange)
http://univ-cotedazur.fr/events-2/beta_pic_2018_nice#.XLh3wqRBrb0

> **March 9-19, 2019**: **11th Brain Week on the Côte d'Azur** (Carole Rovere and Jacques Noel), co-funded by the 5 Academies
http://univ-cotedazur.fr/fr/idex/academies/space-environment-risk-and-resilience/contents/agenda/la-semaine-du-cerveau-revient-du-09-au-19-mars-2019#.XigZASOmk2w

> **Since March, 2020** : **series of events and online seminars on Wave Complexity**
https://wavecomplexity.univ-cotedazur.fr/

CONTRIBUTION TO EDUCATION

Academy 3 has created a international **Master of Science (M.Sc.) "Environmental Hazards and Risks Management"** that benefits from the transdisciplinary of the Academy 3 community and provides an innovative education in risk management and in analysis, representation and modeling of data relating to risk factors. This new international degree trains students to become knowledgeable experts in risks and environmental management, well equipped to anticipate and mitigate environmental hazards and risks. The courses of this new Master's degree were designed by Academy 3 in 2016, and were perfected over the following years until the effective opening of the Master's degree in September 2019.
The teaching team is currently made up of 34 faculty members, researchers and external contributors from the private and public sectors drawn from 16 different UCA components or interacting with UCA (Espace, Inra, Géoazur, Gredeg, Icn, Ecoseas, Ljad, Inria, Cerema, Irstea, Mines ParisTech, PolytechNice, Skema, Thalès Alenia Space, TEC Conseil, and LuxCarta). The M.Sc. coordinators and lecturers maintain close collaborations with local public structures (Interreg ALCOTRA & MARITTIMO projects, Regional projects, etc.), including SMIAGE (floods), SDIS, and FORCE-06. The M.Sc. is also officially supported by ESRI France (Geographic Information Systems software) and by Thalès Alenia Space.
The first year it opened, more than 40 students from 25 different countries applied. In 2020, 179 applications were received and 12 students of 11 different nationalities were selected (M1).

A website presenting the M.Sc. was created to inform and guide students: http://univ-cotedazur.fr/en/idex/formations-idex/risks

Academy 3 is also involved in the SPECTRUM Graduate School (EUR, now SFRI) project. Members of the Academy's steering committee are part of the SPECTRUM executive bureau to ensure that Academy 3 projects and activities are tied to the research-based academic programs offered by SPECTRUM.

Table 4 : Actions of Academy 3 in education

Project name	Title of the project/action funded by Academy 3	Name of the project leader	Laboratory	Funding granted
MSc RISKS	Assistance in setting up the "M.Sc. ENVIRONMENTAL HAZARDS AND RISKS MANAGEMENT" that opened in September 2019	Dennis Fox Frédéric Grognard	ESPACE INRIA	/
EUR SPECTRUM	Funds for scholarships of excellence and scientific promotion of the academic program	Fabrice Planchon, then Médéric Argentina & Fréderic Cappa	INPHYNI GEOAZUR	€50,000
				€50,000

FOCUS ON DOCTORAL AND POST-DOCTORAL STUDENTS

In line with the 37% limit set by ANR for the payroll and considering the budget allocated to the Academy, less than half of the projects funded by the Academy 3 were able to receive funding for personnel. The 17 projects that obtained this type of funding mostly allocated it to fixed-term contracts, 2 Ph.D. scholarships and 4 post-doc fellowships. Only 1 Ph.D. and 2 post-doc fellowships were fully funded (Figure 2).

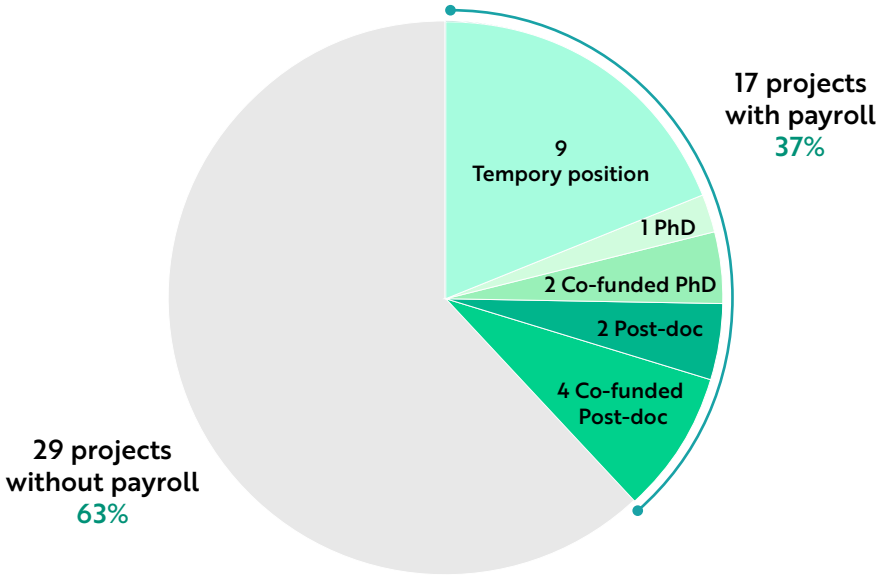


Figure 2 : Detail of projects with student and post-doc payroll.

The exhaustive list of students, post-docs and projects with payroll from Academy 3 is provided in Table 5.

Table 5 : List of doctoral and post-doctoral fundings (temporary contracts are not listed).

	Name	100% funding	Partial funding		Period funded by Academy 3	Affiliation
				Co-funder		
Ph.D. students	Salma Hachfi	x			3 years	ISA
	Simon Bayle		x	ICN, CEA, SOLEIL	9 months	ICN / Synch. SOLEIL
	Jeanne-Marie Fèvre		x	DGA, ICN, CEA	10 ½ months	ICN
Post-doctoral fellows	Bochra Mejri	x		after a year co-funded by Academy 2 and ANR	1 year	LJAD
	Chao Liang	x			2 years	GEOAZUR
	Michel Leguèbe		x	A1, A2	3 months	LJAD/LEAT
	Andrew Ryan		x	A2	3 ½ months	LAGRANGE
	Katharina Stobbe		x		3 ½ months	IPMC
	Hans Agur-to-Detzel		x	A2	6 months	GEOAZUR

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