

# **Graph Representation and Graph Signal Analysis on Human Brain PET Images for Alzheimer's Disease Diagnosis**

Trong Lee Phan

Recent studies show that brain PET scans are effective to identify and predict progressive stages of Alzheimer's disease. The analysis on PET usually starts with the image segmentation technique AAL – a non-selective, also known as fixed, labeling of brain anatomical atlas. However, this labeling method may miss out some unique information for each individual brain. A selective labeling for individual brains therefore should be further investigated. To achieve this goal, how a label is defined in terms of size, shape and position should be stated objectively. In this work, we combine a region-based segmentation technique with scatter index ranking to find the selective labeling corresponding to individual brain. Then, we construct a graph model for each labeled brain and extract features based on graph theory in order to observe the behaviour of these features towards Alzheimer's Disease characteristics. Stage classification in ADNI<sup>(\*)</sup> dataset is our evaluation of performance.

(\*) Alzheimer's Disease Neuroimaging Initiative. <http://adni.loni.usc.edu>

# **Conditional generation of free radicals by peptide-bioconjugated alkoxyamines: towards more effective and less toxic targeting of brain tumors.**

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Glioblastomas, the most common intracranial tumors for adults, are aggressive tumors with unique therapeutic challenges.

Alkoxyamines have theranostic (therapeutic + diagnostic) properties. They generate highly toxic alkyl radicals, which trigger cancer cell death process, and non-toxic nitroxides, for MRI imaging. We improved their efficacy while controlling their activation by MMP, cancer-overexpressed enzymes.

We synthesized 85 novel alkoxyamines. The most efficient molecule was selected by cytotoxicity assays on different culture models of human glioblastoma cells. It was more active in glioblastoma than in other cancer cells, inducing oxidative stress, significant mitochondrial damages, ultimately triggering apoptosis of cells.

After bioconjugation with an MMP-specific peptide, it successfully inhibited survival, proliferation, migration and invasion of glioblastoma cells. The bioconjugate was very promising in inhibiting glioblastoma progression in ex vivo co-cultures (grafted fluorescent glioblastoma micromasses in mice normal brain slices).

These results were also extended to medulloblastoma, the most common malignant brain tumor in children.

# **Deep learning methods applied to large astronomical imaging surveys**

Quifan Lin

With the enormous amount of data brought by the upcoming generation of sky surveys, machine/deep learning will become a powerful aid for astronomers to analyze data and unravel cosmic mysteries. My thesis project is proposed to analyze astronomical images using machine/deep learning methods, aiming at understanding instrumental and observational effects associated with sky surveys, and extracting meaningful content for different science cases. The methods developed in this study will be useful for various science targets of future sky surveys, especially the study of galaxies and the detection/classification of transient objects (e.g., supernovae) as well as the study of cosmic evolution. Due to the shared features between astronomical images and submarine images, this work will also be applicable to underwater imaging analysis.

# **Ultrasound Stimulation of Bone Regeneration**

Meysam Majnooni

The first clinical observations of the effects of Ultrasound stimulation of Bone Regeneration (USBR) were reported in early 1950s. Since then, USBR has gained enormous attractions in the scientific community owing its acceptability to the numerous promising experiments and publications on the subject. In 1994, the U.S. Food and Drug Administration's confirmation added more credibility to the approach and provoked the industry to invest in development and commercialization of para/medical devices like e.g. Exogen®; however, the underlying multi-physical processes are yet poorly understood due to variety of parameters including complexity of the bone structure and characteristics of ultrasound waves. It is believed that the US stimulation at tissue scale exerts a mechanical stimulus on bone cells (osteocytes which are known to function as bone mechano-sensors) which in turn react biologically in form of bone regeneration. Since the osteocytes are immersed in fluid inside lacuna-canalicular network (LCN), it is hypothesized that the fluid shear stress can be the mechanical stimuli.

# **ANALYSIS AND MODELLING OF PHASE RESPONSE CURVES TO STIMULATION AND CROSS-FREQUENCY COUPLING IN COMPUTATIONAL MODELS**

Sophie Benitez Stulz

The dynamics of the brain can be measured by invasive (electrophysiology) as well as non-invasive recording and imaging techniques (EEG, fMRI, fNIRS). These dynamics are complex in nature since neurons/ regions form a network that influences the dynamics between as well as within scales. The brain can also be stimulated experimentally with different stimulation methods (sEEG, TMS) which can have far-reaching effects on the dynamics of the brain and have been used in clinical settings such as depression. The mechanism underlying these complex effects remain poorly understood and should be examined with computational models. The recent decade saw the emergence of mathematical network models reproducing functional brain imaging signals. The advantage of such models is that they account for the interaction between single neurons/ regions and the network which pairwise analysis cannot. A better understanding of the mechanisms underlying the far-reaching effects of stimulation on brain dynamics could give rise to more efficient clinical applications in the future.

# **Bola-amphiphilic dendrimers as modular vectors for nucleic acid delivery in gene therapy**

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Gene therapy aims to treat various diseases via specific modulation of gene expression using nucleic acid therapeutics. However, safe and effective delivery of nucleic acid therapeutics is essential in gene therapy because nucleic acid is not stable and cannot readily cross cell membranes due to its instability and abundant negative charges. Dendrimer, by virtue of the well-defined structure and unique multivalent cooperativity, constitutes a promising non-viral vector for nucleic acid delivery. Here we report our design and synthesis of bola-amphiphilic dendrimers for nucleic acid delivery. These bola-dendrimers bear a long hydrophobic alkyl chain as the core and positively charged poly(amidoamine) dendrons at the two extremities. Remarkably, these dendrimers can specifically deliver large DNA and small interfering RNA (siRNA) respectively by modulating generation. Consequently, our bola-amphiphilic dendrimers constitute smart modular vectors for the delivery of various nucleic acid therapeutics in future gene therapy.

**DNA damage after in vitro exposure to very low concentration of aged cerium nanoparticles (CeO<sub>2</sub>NPs) and to CeO<sub>2</sub>NPs + Benzo(a)pyrene in murine and human gametes**

Martina Cotena

Cerium dioxide nanoparticles (CeO<sub>2</sub>NPs) are widely used as diesel additive and are released in the atmosphere after engine combustion. The OECD included CeO<sub>2</sub>NPs in the priority list of nanomaterials requiring urgent evaluation. Benzo(a)pyrene (BaP) is also released in the air by diesel combustion and is known to induce DNA damage in sperm and COC. The impact of aged CeO<sub>2</sub>NPs exposure and of aged CeO<sub>2</sub>NPs+BaP remains unexplored. Human and rat sperm and cumulus oocyte complexes (COC) were exposed in vitro to very low concentrations of CeO<sub>2</sub>NPs [1 to 1.103 µg.l<sup>-1</sup>] and to 1 µg.l<sup>-1</sup> CeO<sub>2</sub>NPs + 1.13 µM BaP during 1 hour in Fertilcult© Medium + 1% DMSO at 37°C, 5% CO<sub>2</sub>. DNA damage was analysed by alkaline comet assay (ACA). In human sperm, rat sperm and follicle cells co-exposure to 1 µg.l<sup>-1</sup> aged CeO<sub>2</sub>NPs + 1.13µM BaP induced significantly higher DNA damage compared to 1.13µM BaP alone and to 1 µg.l<sup>-1</sup> CeO<sub>2</sub>NPs alone (p < 0.001).

# **IMAGING 3D ORIENTATION AND WOBBLING OF SINGLE FLUORESCENT EMITTERS BY POLARIZED SUPER- RESOLVED MICROSCOPY**

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Measuring 3D orientational properties of single fluorescent emitters, as well as their position, is a challenge that would enrich single molecule super-resolution imaging techniques such as PALM or STORM with structural molecular information. The measurement of orientational behaviour of single fluorophores, in addition to their localization, can report protein organization at the nanoscale and conformational changes.

We present a polarized microscopy technique that provides the measurement of 3D orientation properties of single fluorophores including wobbling, as well as their localization, within tens of nm precision in position and degree's precision in angles. Our approach is based on splitting of the image plane in four distinct polarization projections, using adequate intensity filtering in the back focal plane. This approach is compatible with single molecule super-resolution techniques, including 3D localization approaches, in particular we applied this technique to the study of structural properties of fluorescently labelled F-actin filaments.



# How to stick together? Cellular epithelial adhesion in a marine sponge *Oscarella lobularis*

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Epithelia constitute a barrier between the external and the internal environment and maintain the integrity of the body. In an evolutionary context, although epithelia are considered ancestral features of metazoans, the question of the conservation of the mechanisms involved in cellular adhesion is still pending. To explore this evolutionary question, the comparative study of non-bilaterian animals is required, a way to answer at this question is to study one the two most basal lineages of the animal tree: sponges. Here we study a sponge, *Oscarella lobularis* (Homoscleromorpha), pertaining to the only class of sponges that possess epithelia similar to that of the other animals. This work provides a detailed description of the cell behaviour and phenotype at different time points of the dissociation/reaggregation process. Gene expression levels at key steps of the process were analyzed by RNA sequencing: these results enable us to identify actors involved in aggregation and adhesion in this species.

**A SIMPLE AND RAPID LIQUID CHROMATOGRAPHY-MASS  
SPECTROMETRY METHOD TO ASSAY CABOZANTINIB IN  
PLASMA: APPLICATION TO THERAPEUTIC DRUG  
MONITORING IN PATIENTS WITH RENAL CELL  
CARCINOMA**

Florent Ferrer

Cabozantinib is a new treatment recently approved in metastatic renal cell carcinoma (mRCC). Standard dosing is frequently associated with severe toxicities leading to post-event, empirical dose reduction. Therapeutic drug monitoring could help to predict the risk for severe toxicities by early identification of patients with plasma overexposure followed by prospective adaptive dosing strategy. To achieve this goal, a simple and rapid assay to monitor cabozantinib plasma concentration was developed and validated following current standards in bioanalysis. When tested in routine clinical practice in a subset of mRCC patients treated with standard 60 mg quaque die dosing, the method proved to be fully adapted and neither analytical interferences nor matrix effect was observed. Results showed that cabozantinib trough levels were highly variable among patients, calling for implementing TDM in patients with mRCC to monitor exposure levels and evaluate concentration-response relationship.

# **THE OFFICE OF JUDICIAL AND ADMINISTRATIVE JUDGES IN THE PROTECTION OF RIGHTS AND FREEDOMS IN FRANCE**

Josue Uriel Gbayoro

Following the overhaul of the French legal order to deal with the terrorist threat from 2015 to 2017, we are led to question the legal regime of the jurisdictional framework of rights and freedoms in France.

Indeed, voices are raised to denounce the marginalization of the judicial authority in the protection of rights and freedoms, while the administrative judge has been attributed many of skills in this litigation with as a final issue, the question of know who best protects liberties.

The demands of the fight against terrorism have led to a considerable development of the security arsenal resulting in a redefinition of the respective powers of the judicial and administrative courts. From where, the particular interest of this thesis to propose to highlight this new state of law resulting from the recent situation in France.

# **Measuring social networks in primates: wearable sensors vs direct observations**

Valeria Gelardi

Single interactions between individuals are the foundation of complex social structures in animals societies. Network analysis represents a valuable framework to understand the implications of these interactions, as it encodes the whole hierarchy of patterns, from individual-level interactions to complex population-level social structures.

Animal social relationships can be estimated using different methods, and depending on the method and the nature of data, a different image of the social bonds between individuals could come out. Here, we analyze and compare different data sets of dyadic interactions between primates, collected through two different methods: behavioral observations and an automatic logging infrastructure based on wearable proximity sensors combined with fixed readers.

We show that the systems in general don't detect the same interaction events. Despite that, it turns out that, at the network level, the information on the social group obtained by the two methods result remarkably similar, once aggregated over time.

**MULTIDRUG RESISTANCE MARKS THIS DECADE!**  
**ANTIBIOTIC ADJUVANTS TO RESCUE *PSEUDOMONAS***  
***AERUGINOSA* FROM RESISTANCE**

Troudi Azza

Multidrug resistant (MDR) bacteria are one of the major current threats to public health. The incidence of nosocomial infections caused by MDR has increased dramatically in the community and is associated with a terrifying rate of morbidity, mortality and antibiotic use.

The molecular mechanisms by which bacteria, particularly Gram-negatives, became resistant to antibiotics are diverse and complex. Nowadays, Bacteria have developed resistance to all different classes of antibiotics discovered.

Without an innovative strategy to combat MDR pathogens, many fields of medicine will be severely affected, thus, new solutions are required to enhance the antibiotic efficiency and/or reduce the mechanism of resistance. In this context, we aim to develop an attractive strategy consisting in the synthesis of new polyaminisoprenyl molecules. These chemo-sensitizers are readily prepared from farnesol in a two steps synthesis with moderate to excellent yields and they are able to restore the activity of doxycycline against *pseudomonas aeruginosa* bacterial strains.

# Microwave Oppenauer Oxidation: Revival of an Old Reaction

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In 1937, Rupert Viktor Oppenauer found that in presence of aluminum tert-butoxide, acetone acts as a hydrogen acceptor for the oxidation of primary and secondary alcohols leading to the corresponding aldehydes or ketones.

In the last decades, Microwave Assisted Organic Synthesis (MAOS) have attracted the attention of chemists who have begun to apply this unconventional technique of material heating as a routine in their practice. Microwave heating is found to be faster and more effective than conventional methods.

In our hands, Oppenauer oxidation performed under microwave conditions was used to synthesized ketosterol on a selective way. Then, this strategy was applied to the synthesis of a key intermediate involved in the synthesis of a polyaminosterol compound demonstrating antibacterial activity against a large panel of both Gram-positive and Gram-negative bacteria.

<sup>1</sup> Oppenauer, R. V., Recl. Trav. Chim. Pays-Bas, 1937, 56, 137-144

# CATALYTIC SCANNING PROBE NANOLITHOGRAPHY FOR SELF-ASSEMBLED MONOLAYERS AND GRAPHENE MODIFICATION

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Graphene takes pride of place among 2D materials due to its properties: it is the strongest, thinnest and stiffest material with high electrical and thermal conductance, which enables its applications in electronics, energy and biotechnology. Nevertheless, graphene's zero band gap and chemical inertness complicate diverse applications. The functionalization of graphene layers permits to overcome these difficulties by introduction of defects in graphene structure, which allows controlling chemical and electronic properties. Many methods of graphene functionalization were reported, but only few of them provide spatial and chemical control. Scanning probe nanolithography (SPL) is a suitable approach to achieve this goal, but until today rarely used for graphene.

We apply SPL for graphene structure modification. Nanomechanical single-layer graphene folding to obtain weakly interacting multilayer graphene (wi-MLG) was made by cut and push zigzag movements of an AFM tip. The stacked MLG was characterized by AFM and Raman spectroscopy, which evidenced its intermediate behavior between graphite and well-stacked graphene and confirmed the weak interaction of the layers. This work completes the field of graphene origami/kirigami.

# **3D optical computational microscopy for quantifying T lymphocyte activation**

Md Rasedujjaman, Guillaume Maire, Philippe Robert

My PhD thesis is about building a label-free optical imaging technique based on tomographic diffraction and targets medical diagnosis applications by characterizing sub-micrometer conformational changes of T lymphocyte. T lymphocyte activation is a key feature of the immune response, during which the adaptive immune system detects specific non-self antigens prior to induce targeted responses. Presently, no technique permits to perform a fast detection of T lymphocyte activation at an early stage, which is detrimental for the diagnosis of numerous diseases (from infection diseases to allergy). T lymphocyte activation is triggered by several signals exchanged between T lymphocyte and an antigen presenting cell. After the very early steps of activation, a highly organized inter-facial structure appears between the two cells called an immunological synapse. We propose a new approach for quantification of T lymphocyte activation based on the early detection of these immunological synapses. Presently no standard optical microscopy technique has the necessary 3D resolution to tackle this issue. Very recently our research team have shown that optical tomography coupled to sophisticated inversion schemes could be a good candidate for this task.



# **Interdisciplinary approach for the characterization of ceramics in the Roman city of Thaenae (Tunisia)**

Reve Rémi

In this PhD, a combined archaeological and archaeometrical study on the production of African amphorae and imported Inland African Red Slip Wares on the city of Thaenae (Tunisia) is experimented. This study combines three complementary approaches: ceramological, petrographical and geochemical. This latter approach is based on the use of portable XRF, a nondestructive methodology, to characterize the productions of Thaenae.

The combination of these three approaches aims to create a referential on Thaenae's ceramics, in order to distinguish roman amphorae produced in Thaenae from other African production, as well as for the Inland African Red Slip Wares imported in the city.

This referential is also applied on consumers sites, such as Rome and Athens, to identify if Thaenae was an exporting port. This is to determine its importance and role in the economy of southern Byzacenia during the Antiquity, but also in the exchange networks of the Mediterranean basin.

# Functionalized-cucurbit[7]uril: a promising macrocyclic molecular carrier

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Cucurbit[7]uril, as a famous member of the novel macrocyclic molecule family – cucurbit[n]uril (CB[n], n=5-8,10), possess promising properties for biological applications such as good biocompatibility and high recognition abilities enabling to form stable inclusion complexes with different kinds of bioactive compounds.

Based on the original skeleton of CB[7], our aim is to graft relevant functional groups to construct smart targeted delivery systems benefiting from the versatile cavity of CB[7].

At first, we introduced a hydroxyl group on CB[7] via a photochemical reaction. Based on the monohydroxy-CB[7] (CB[7]-(OH)1), we've prepared mono-allyloxy- (Fig.2(a), yield ~70%) and mono-propargyloxy CB[7], yield ~60%). Then we validated the feasibility of further CB[7] functionalization by grafting some small model molecules. After the validation, further chemical conjugate between CB[7] and targeting peptide are now under way.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No713750.

# **Research methods and features of greigite producing magnetotactic bacteria**

Yeseul Park

Magnetotactic bacteria(MTB) is a type of aquatic microorganisms which have the ability to swim according to surrounding magnetic field and use the Earth magnetic field to find optimal living conditions. For this purpose, they produce intercellular magnetic nanoparticles that make the bacteria's cell body to align passively to the magnetic field. There are two types of nanoparticles that MTB can produce, which are iron oxide ( $\text{Fe}_3\text{O}_4$ , magnetite) and iron sulfide ( $\text{Fe}_3\text{S}_4$ , greigite). Some of the bacteria can produce just one of the particles but a few species can produce both particles. My research topic is about the mechanism and application study of greigite producing bacteria, particularly with the strain BW-1 (*Desulfamplus magnetovallimortis*). This study involves research on optimal conditions for bacteria to produce certain particles and on the particle transformation. In order to study on this topic, electron and synchrotron X-ray techniques and measurement on magnetic properties are currently in use.

# **Study of Cs soil-to-plant transfer mechanisms for phytoremediation and safe-food techniques enhancement**

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Radiocesium has only anthropogenic sources such as atmospheric nuclear weapon tests and accidents at nuclear facilities. As <sup>137</sup>Cs has a half-life of 30,2 years and was largely spread following the Fukushima Daiichi Nuclear Power Plant disaster, it raises major concerns about its potential uptake by edible plants. In order to manage potentially contaminated sites and reduce risks, innovative remediation techniques such as phytoremediation are developed. The aim of this research is to study coupled interactions between soil (solid and liquid compartment) and plant on Cs environmental availability and bioavailability. Preliminary experiments shown that Cs sorption onto soil solid compartment (vermiculite) depends on Cs concentration in soil solution. Therefore, addition of cationic competitors (K<sup>+</sup> and H<sup>+</sup>) reduces Cs adsorption onto vermiculite by cationic exchange. Next experiments will be focused on effects of K depletion and root exudates on Cs environmental availability.

# **Can vegetated urban soils mitigate run-off? A case study in Marseilles, France**

Jesus Diaz Sanz

In urban areas, extreme precipitations episodes may generate run-off floods. Our objectives were to assess the infiltration capacity of vegetated urban soils to mitigate run-off and the soil parameters controlling this infiltration under a Mediterranean climate. We sampled in the “urban” zone of the Marseilles’ 16th district (1) 14 plots that laid on former clay quarries, tile factories (T); (2) 13 plots in other soils (NT); (3) one control plot in a shrub-land non-urbanized (C). Our results found the infiltration capacity of 14.3 % of T and 69.2 % of NT soils was large enough to mitigate run-off. But historical background and organic matter influenced the infiltration.

# **Dynamic core-periphery structure of information sharing networks in entorhinal cortex and hippocampus**

Nicola Pedreschi

We study with a data-driven approach, based on models and methods used to analyse temporal networks, the dynamics of the structure of information sharing networks built from single units recordings in the entorhinal cortex and hippocampus in rats during anesthesia. We characterize the evolution of the networks as a sequence of connectivity states, defined by the core-periphery configuration of the network, and study the connectivity profiles of nodes within the connectivity states. We find general classes of connectivity profiles, *connectivity styles*, that are present across all the different recordings and study and discuss the tendency of neurons to switch from a connectivity style to another in subsequent connectivity states of the network.

# Compressive Raman microspectroscopy

Camille Scotté

Raman spectroscopy allows to identify chemical species. Spectroscopic images – that identify chemical species in different points in space – are usually acquired with hyperspectral imaging. It requires to measure the spectrum of every image pixel onto a camera. But this method leads to the generation of overwhelmingly large data sets and to lengthy acquisitions.

In many situations, the aim of hyperspectral imaging is simply to quantify or classify the chemical species given their spectra. Then, acquiring complete spectra is inefficient. In compressive spectroscopy, the measurement is designed to directly probe quantities of interest instead of deducing them from complete hyper-spectral measurements: Typically, a programmable optical filter displays optimized patterns to select wavelength combinations that efficiently estimate the quantities of interest.

We investigate the performances of compressive Raman spectroscopy. We experimentally validate the theoretical study on different samples including microcalcifications powders mimicking realistic biological samples. Comparison with conventional state-of-the-art spectrometers shows x10 to x100 reduced speeds.

# **DESIGN AND SYNTHESIS OF CHEMICAL TOOLS TO EARLY DETECT ANTIBIOTIC RESISTANCE IN CLINIC**

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Antimicrobial resistance (AMR) constitutes a major problem of Public Health. The 2014 WHO's global report outlined worrying levels of AMR worldwide involving therapeutic failure of the large classes of antibiotics especially in gram-negative bacterial diseases. Resistance is a natural response of bacteria allowing them to counteract pharmacological effects of antibiotic agents. A Lot of mechanisms occur in bacteria and contribute to Multi-Drug Resistance (MDR) phenotypes, especially efflux pumps overexpression which is an early stage trigger in the MDR setting up.

In this feature, we investigate the fluorescence capacity of naturally occurring molecules to detect bacterial resistance by the efflux mechanism that exports the cytotoxic agent and thus reduces its effective intracellular concentration. The final aim is to design a real-time fluorescent diagnosis for clinicians to identify and prevent early bacterial resistance and adapt infectious treatments. This can provide faster, more reliable and more informative results before antibiotic resistance becomes widespread.



# **The ethnomusicologist and the archivist: state of the art, comparative and transdisciplinary analysis of unpublished musical archives in the Mediterranean area (Aix-Marseille, Rome)**

Matteo Cialone, Olivier Tourny

The purpose of the research project is to study ethnomusicological documents collected by researchers on the Mediterranean and stored in local and national sound archive centers. The specific constitution of two archive centres (the Phonothèque de la Maison méditerranéenne des sciences de l'Homme - MMSH - in Aix-en-Provence, the Istituto Centrale per i Beni Sonori e Audiovisivi - ICBSA - in Rome) and their use for research will be questioned, in order to understand 1) not only how the ethnomusicologist can exploit the mass of sound documents but also, 2) how these memory objects can be returned to the communities of origin. One of the aims of this project is to strengthen the dynamism of examined archive centers, both in its own reference territory and in an international dimension, by bringing them to the attention of the scientific community and by opening up new paths for transnational collaborations.

**Keywords:** Ethnomusicology, Sound Archives, Music, Mediterranean area, Transdisciplinarity, Transculturality

## Evidence of Zika Virus Circulation in Mali

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Little is known about the circulation of Zika virus in Mali. Here, we conducted a serological survey of 793 asymptomatic volunteers aged  $\geq 15$  years (2016), and 637 blood donors (2013) to assess the seroprevalence of Zika virus infection in two eco-climatic regions of Mali (tropical savannah and warm semi-arid region), using ELISA and seroneutralization assays. The overall seroprevalence was  $\approx 12\%$  and increased with age, with no statistical difference between males and females globally. We identified in 18% (95% CI: 13% – 23%) of individuals, immunological markers of an outbreak that occurred in the late 1990s in the warm arid sites. In tropical savannah sites, we estimate a low rate of endemic transmission with 2.5 ‰ (95% CI: 2.0‰ – 3.1‰) of population infected by Zika virus each year. These data demonstrate the circulation of Zika virus in Mali and identify a previously unidentified outbreak in the late 1990s.

**Keywords:** Zika virus, seroprevalence, Mali.

# **Can migrations both respond to climatic constraints and improve the living conditions of rural households?**

## **Evidence from Niakhar (Senegal)**

Ngyemdjo Kamguen Ulrich

Although the literature points to crisis migrations as a major response of vulnerable territories to climate change, this paper shows that climatic conditions in Sahelian agricultural areas are associated with different migratory projects: migrations as a survival strategy and as a strategy for accumulating wealth. Using rainfall and number of rainy days to investigate the effects of climate variations on two types of migration, we found that climate variations have a negative effect on short-term migration and a positive effect on long-term migration. Using latent migration networks variables as instruments, we found a positive effect of both migration types on improvement in living standards. However, long-term migration effects are more important than short-term ones. Thus, short-term migration appears as a defensive response to climate change, even if it leads, in the long run, to improving living standards, whereas long-term migration seems more connected to an explicit strategy to escape poverty.

**Keywords:** Niakhar; climate variation; short-term migration; long-term migration; living standards

# **Searching for classical geometries in spin foam amplitudes: a numerical method**

Giorgio Sarno

We develop a numerical method to investigate the semiclassical limit of spin foam amplitudes with many vertices. We test it using the Ponzano-Regge model, a spin foam model for three-dimensional euclidean gravity, and a transition amplitude with three vertices. We study the summation over bulk spins, and we identify the stationary phase points that dominate it and that correspond to classical geometries. We complement with the numerical analysis of a four vertex transition amplitude and with a modification of the model that includes local curvature. We discuss the generalization of our results to the four-dimensional EPRL spin foam model, and we provide suggestions for new computations.

# Designing polymeric carriers for the vectorization of new antiplasmodial drugs.

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*Plasmodium falciparum* parasite is one of the leading causes of infant mortality in sub-Saharan Africa and causes high morbidity (WHO: 450,000/year), hence a public health emergency. The major concern is to develop new polymer carriers enabling the vectorization of new classes of antiparasitic drugs [1] while ensuring an effective, flexible and inexpensive synthetic strategy for developing countries. The innovation in this project consists in using iminium derivatives both as initiator of the polymerization and as an active principle anchored to the polymer.[2] Indeed, these molecules have proved antiplasmodial activities and no cytotoxicity. As proof of concept, the antiplasmodial activity of these drug polymers has already been evaluated and correlated to the polymer chain lengths. These results will be presented.

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# **An aerosolized antimicrobial combination for treatment of *Pseudomonas aeruginosa* infections**

Hana DOUAFER, Véronique ANDRIEU and Jean Michel BRUNEL

During the last decades, multiple approaches have been developed to combat bacterial resistance. One of them involves combination therapies of existing antibiotics with potentiating adjuvants, reempowering the activity of the antibiotic against resistant strains by improving the permeability or suppressing antibiotic efflux. Once co-administered with an antibiotic these peculiar chemosensitizers “suppress” the resistance and “improve” the antibiotic activity.

Currently, many drug delivery systems are used and aim for an optimal drug administration by minimizing drug degradation, decreasing its side effects and increasing its bioavailability. In this context, pulmonary route has become an attractive pathway for infections treatment.

The aim of our study is to develop and evaluate a new potent pharmaceutical form intended for pulmonary administration to defeat cystic fibrosis, based on a combination of an antibiotic (Doxycycline) with an adjuvant: a polyaminoisoprenyl derivative NV716 allowing restoration of doxycycline efficacy against *P.aeruginosa* strains naturally resistant to doxycycline. The proof of concept of such a combination has been previously verified in vitro on various *P. aeruginosa* strains. (PlosOne, 2016).

# **L'évolution des ports des Grandes Pyramides de Gizeh (Egypte)**

Sheisha Hadeer

L'Egypte ancienne est l'une des premières civilisations à avoir recours au transport fluvial. La reconstruction du complexe des Grandes Pyramides (Khufu, Khafre et Menkaure) était le plus grand projet architectural de l'Ancien Empire (4700-4150 BP, Shaw, 2000), réalisé grâce à un réseau de voies navigables, de canaux et de ports. D'après les papyrus de Wadi el-Jarf (Mer Rouge, Tallet, 2016), les roches calcaires étaient exportées de Thurah vers le port de Gizeh. Pour révéler les principales étapes de l'histoire géo-archéologique des ports des Grandes Pyramides de Gizeh, le focus sera mis sur la compréhension des facteurs de changement, plus particulièrement (i) Caractérisation des zones humides à Gizeh: Analyse de bio-indicateurs terrestres et aquatiques (pollens, spores, charbons de bois, algues...) et macrofossiles végétaux (feuille, bois et graine / fruit). ii) Caractérisation des faciès sédimentaires (granulométrie, morphométrie, MEB, Méthode de Passega...) et cartographie des dynamiques spatiales et bathymétriques, effectuée.

# **Improved in Vivo Diagnosis of Bone Quality, and Application to Osteoporosis**

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Worldwide one on three woman and one on five man aged 50 years or older will perform a fragility fracture caused by osteoporosis. Several studies are been made on the feasibility of assessing trabecular bone using MRI suggesting that bone inner structure is assessible using both 3T and 7T MR scanners.

The aim of this study was to present the resolution impact when trying to assess both standard trabecular bone features (BVF, Tb\_Th, Tb\_Sp and Tb\_N) and new features as local orientation and number of structural arches. Furthermore, we investigated two techniques found in the literature for the resolution enhancement by comparing the results between images at different scales.

The information obtained from this study could quantify the resolution impact in MRI images presenting features that are affected by the pixel size and others that instead are independent.

In this study, we present a preliminary step forward an optimized osteoporosis risk stratification and therapy delivery.



# **Microfluidic tools to image chemotaxis of swimming leukocytes**

Garcia-Seyda Nicolas<sup>1,2</sup>, Aoun Laurene<sup>1</sup>, Seveau Valentine<sup>1</sup>, Bajenoff Marc<sup>2</sup>, Theodoly

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Naïve T lymphocytes circulate between blood and lymph nodes in their search for antigen. The contribution of different chemokines to this process is inferred from loss-of-function experiments where the entry, homing within or exit from lymph nodes are impaired. However, their actual migration along defined chemokine gradients has not been imaged so far. This gap arises due to the lack of a proper in vitro substrate, since the migration of these cells is independent of integrins. Therefore, current knowledge about lymphocyte chemotaxis is derived from Transwell experiments, which circumvent the necessity of cell adhesion. Nevertheless, this technique presents several caveats as the gradient profile is unknown, the chemokines may bind to the porous membrane and function as adsorbed rather than soluble gradients, and because random migration (chemokinesis) can be mistaken with directed one (chemotaxis). Finally, real information on migration parameters such as speed, directionality and persistence, is missing. To circumvent these issues, we are developing a set of microfluidic tools to create stable gradients on cells migrating without adhesion (swimming).

# **Structural characterization of the GltJ protein and its interactions with the cytoplasmic platform during the adventurous motility of *Myxococcus xanthus***

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The motility of bacterial cells promotes a range of physiological phenomena such as nutrient detection, predation, biofilm formation and pathogenesis. *Myxococcus xanthus* uses the so-called adventurous motility (A-motility) to explore new places, change direction and leave the cell swarms.

All the studies available revealed that this motility is controlled by cytoplasmic proteins<sup>1–3</sup>, MglA and AglZ, coupled to the bacterial cytoskeleton MreB and a molecular motor Agl, as well as a multiprotein complex<sup>4</sup> (Glt) crossing the entire bacterial membrane. This assembly forms focal adhesion complexes (FACs) which propel the cell in a certain direction beforehand defined by the cytoplasmic protein, MglA. Within the Glt multiprotein complex, GltJ is a protein who plays a critical role in FACs assembly and regulation. GltJ is located in the inner membrane with a cytoplasmic N-terminus composed of a "Zinc Ribbon" (ZnR) domain and a "Glycine-Tyrosine-Phenylalanine" (GYF) domain.

# **A novel technique and devices for the high Energy X-Ray Dosimetry in the Radiotherapy and Oncology at High Spatial resolution**

Sree Bash Chandra DEBNATH- sree.debnath@univ-amu.fr

The use of high energy X-ray beams in radiotherapy is part of the therapeutic strategy in oncology treatment. The last ten years have seen increasing stereotactic treatment in radiotherapy, using high dose delivered and very small fields [1]. The industrial development of X-ray detectors to measure precisely the delivered dose is mostly based on ionization chambers and photodiodes whose advancements are still hindered by the size of the detectors and the difficulty of ensuring the conversion efficiency of high energy to low energy X-ray photon or electron [2-4]. To overcome this problem, we developed a simple and small-scale fibred X-ray dosimeter of 200  $\mu\text{m}$  diameter. Small field ranging from 3 x 3  $\text{cm}^2$  to 0.5 x 0.5  $\text{cm}^2$  were sequentially measured using the fibred detector and commercial ones. Good agreement was obtained among all measurements in compare to the reference detector and reliability of the measurements was shown for the smallest field sizes.

## **Patrx2: a cytoplasmic thiol-oxydase chaperon implicated in the export of a type-six secreted toxin**

Marie M. Grandjean, Edwige B. Garcin, Laetitia Houot, Latifa Elantak, Christophe Bordi and  
Corinne Sebban-Kreuzer

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The cytoplasm of most organisms is a highly reducing environment in which cysteines of proteins are maintained in thiol/thiolate form thus settling the dogma that there is no disulphide bond in the cytoplasm. In that sense, thioredoxin proteins are known to reduce disulphide bonds of abnormally oxidized proteins in the cytoplasm. Remarkably, we found an unusual cytoplasmic thioredoxin (Patrx2) from the bacterium *Pseudomonas aeruginosa*. The active site of Patrx2 does not contain the consensus thioredoxin sequence, instead it presents the active site sequence of the eukaryotic protein disulfide isomerase (PDI) whose role is to oxidize proteins. We have characterized the Patrx2 thioredoxin. Using NMR spectroscopy, we solved the structure of Patrx2, we investigated its catalytic oxidase and reductase activities, and we analysed its redox properties. We observed important differences between Patrx2 and the canonical bacterial thioredoxin and our results are likely indicative of the involvement of Patrx2 in disulfide isomerisation of distinct substrates within the cytoplasm of the bacteria.

# **Co-Invention Networks Structure and The Role of Human Resources Management: The Case of Artificial Intelligence Industry**

Lina Masood

In the era of advanced technology, technological innovation is a critical resource for achieving a competitive advantage for many companies. The success of companies is derived from their outstanding technological capabilities. Indicators of technological innovation typically relate to Research and Development (R&D) activities where the number patents are one of the most commonly innovation indicators. However, it is not possible to understand technological innovation and patenting processes without understanding the relationships between inventors where learning is a key factor. In addition, there is a need to understand the role of human resource management (HRM) strategies and network governance of key inventors, in creating and maintaining efficient co-invention networks that can enhance corporate competitiveness and promote open innovations. This thesis seeks to assess the importance of network structure formation and governance of human capital in companies' innovations and to explore the role of alternative HRM strategies in enhancing the formation of efficient networks and social capital.

# **Ex-vivo electrophysiological analysis of a mouse model carrying a KCNQ2 variant associated with early epileptic encephalopathy**

Najoua Biba, H el ene Becq, Laurent Villard , Laurent Aniksztejn

Early Onset Epileptic Encephalopathies (EOEE) represent a group of rare and intractable devastating epileptic syndromes of infancy that are characterized by epileptic activity beginning during the three first month of life and accompanied by rapid deterioration of brain function. There is a genetic basis for EOEE. Notably de novo mutations of KCNQ2 encoding the Kv7.2 subunit of the potassium Kv7/M channel have been identified in EOEE and are even the major cause of the Othahara syndrome (OS) but the underlying pathophysiological mechanism remains poorly known. Thanks to collaboration with the Marseille Medical Genetics center (INSERM UMR-S1251) we currently study a mouse model carrying a heterozygous p.T274M KCNQ2 mutation previously identified in patients with EOEE. This mutation reduces M current in heterologous cells by 60% in a configuration mimicking the patient situation. Here, we wondered if in mice, the heterozygous p.T274M mutation affected the intrinsic properties of cortical neurons.

# Managing intermittency in the electricity market

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We analyze the integration of intermittent renewable energy technologies such as solar or wind into an electricity mix comprising of conventional energy technologies. We consider the intermittent nature of renewable energy resources as an important parameter for capacity investment and propose that wholesale electricity prices be contingent on the availability of the resource and passed to consumers through state-contingent retail contracts. The novelty of the paper lies in the redefinition of the role of retailers who are able to propose diversified electricity supply and price lists that allow consumers to choose an optimal electricity consumption based on their flexibility. By considering a competitive environment whereby consumers are utility maximizers and producers and retailers maximize profits, we find efficient partial equilibrium in a contingent electricity market.

**Keywords:** electricity, renewable energy resources, intermittency, state-contingent pricing, retail contracts

# **Palaeohydrological changes recorded from a small Moroccan Middle Atlas pond during the last 6,000 cal. yr BP: a multi-proxy study**

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The perennial and seasonal wetlands diversity of the Moroccan Middle Atlas region provides a valuable “test-bed” for understanding the response of different hydrosystems to climatic variations. A multi proxy approach based on sedimentological descriptions, mineralogy, carbonate content, XRF core scanning and biological proxies, supported by AMS <sup>14</sup>C dates was applied to the 3 m core extracted from “Flowers Marsh” a small Middle Atlas pond. The aquatic system evolved from dry or very shallow waterbody (since 6,000 cal. yr BP) towards a system with progressively rising water level (after 2,000 cal. yr BP) with a high water-level around 1,400 cal. yr BP. Since then, fluctuating but generally shallow levels prevailed followed by a relatively fast level rise at 650 cal. yr BP. These data are, generally, in phase with most of the regional records. It demonstrates the ability of Flowers Marsh to record valuable palaeohydrological changes and confirms the high sensitivity of Middle Atlas hydrosystems to climatic changes.

**Keywords:** Middle Atlas, Palaeohydrology, Climatic changes, Hydrosystems, Multi-proxy.



# **A study of aerial righting reflex in hoverflies *Episyrphus balteatus***

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Hoverflies feature stunning aerial capabilities allowing them to orient themselves in various positions and orientations. For example, when taking off from the ceiling, flies must reorient dorsoventrally and stabilize body rotations via active control of their flapping wings. Righting reflex has been shown to exist in mammalian and wingless insects but have never been studied so far in winged insects [1]. After being released upside-down and dropped in free fall, hoverflies systematically rotate their body in roll once the wingbeat triggered. For the first time, we show that body rotates first at maximum roll speed as fast as  $8000^\circ/\text{s}$  and then that head rotates after a time lag of 17ms (median value) at similar angular speed.

A dynamic model of the righting reflex accounts for that head-body response by implementing a closed-loop control of both head and body combined with a feedforward control of the head body angle.



# **Managing intermittency in the electricity market**

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**Abstract** We analyse the integration of intermittent renewable energy technologies such as solar or wind into an electricity mix comprising of conventional energy technologies. We consider the intermittent nature of renewable energy resources as an important parameter for capacity investment and propose that wholesale electricity prices be contingent on the availability of the resource and passed to consumers through state-contingent retail contracts. The novelty of the paper lies in the redefinition of the role of retailers who are able to propose diversified electricity supply and price lists that allow consumers to choose an optimal electricity consumption based on their flexibility. By considering a competitive environment whereby consumers are utility maximizers and producers and retailers maximize profits, we find efficient partial equilibrium in a contingent electricity market. **Keywords:** electricity, renewable energy resources, intermittency, state contingent pricing, retail contracts.

# **Self-Assembly and Electrochemical Characterization of Ferrocene-based Molecular Diodes for Solar Rectenna Device**

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Bailey proposed in 1972 that a nanoscale antenna coupled with a rectifier can harvest broad range electromagnetic radiation from visible to infrared range but to incorporate this theory practically there are two main technological limitations: antenna miniaturization and rectification in terahertz frequency. With current technology and equipment, we are proposing a third-generation rectenna based solar cell composed of Ag nanocubes to harvest ambient visible and infrared electromagnetic waves coupled with a ferrocene based molecular diode capable of switching at terahertz frequency to convert this received energy into DC power placed on top of gold thin film. The function of these molecular diodes is two-fold: to rectify and to provide uniform nano-cavity between silver and gold. These nano-cavities are capable to support gap plasmons for absorption of light in both narrow and broad range, depending on the nanocube size dispersion. Self-assembled monolayer (SAM) of ferrocene alkane-dithiol is deposited in this nano-cavity to go below the usual 3 nm limit making the structure robust and reproduceable.

## **No Title**

Faiza Hammaz

Fruits and vegetables play an important role in the fight against vitamin A deficiency, some provitamin A carotenoids can contribute to meeting vitamin A needs, especially in developing countries where vitamin A deficiency is a real public health problem despite the many measures implemented to combat this scourge.

The objective of this work is to evaluate the potential of pulsed light treatment on nutritional quality, the increase in carotenoid  $\alpha$  and  $\beta$  carotene content in "Dailiance" variety carrots.

The lamps used are phoxene-type (20-1100 nm). Doses of pulsed light (2, 5, 10, 20 kJ/m<sup>2</sup>) were applied to both sides of the cores and stored at different temperatures (4°C, 20°C, 30°C) for 3 storage periods, 3 days/ 6 days/ 10 days.

The results obtained show us that pulsed light can be used to improve the nutritional aspect of carrots since an increase in carotenoids  $\alpha$  and  $\beta$  has been observed after treatment with 20 kJ/m<sup>2</sup> and storage at 20°C for 3 days.

# Complex Astrophysics

Gréoire Auffer

We are interested in statistical inference for complex astrophysical models in the case a very large number of galaxies must be studied. We propose a Machine learning based statistical method for reliably estimating physical properties of galaxies (such as its mass, age or star formation activity), while quantifying the uncertainties surrounding those estimates. We show that the use of a Deep Neural Network currently leads to speeding up the physical computation by a factor 1000, allowing the use of complex Monte Carlo schemes for the statistical analysis even when tens of thousands of galaxies must be analysed in a reasonable time.

# **Nanosecond laser treatment of thin gold films on ITO electrodes for bioelectrocatalysis**

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Redox enzymes such as bilirubin oxidase (BOD) have been widely used in biotechnological devices for O<sub>2</sub> reduction into water. By modulation of the pH of adsorption of BOD on SAMfunctionalized gold electrodes, we previously demonstrated that electrostatic interactions were the main processes controlling the orientation of the enzyme for fast interfacial electron transfer. It was concluded that adsorbed amount of enzyme does not directly translate to enzyme activity. In fact, bioelectrodes prepared with least amount of adsorbed enzymes show maximum specific catalytic activity indicating that enzymeenzyme interaction in a densely populated enzyme adlayer could degrade the catalytic performance. To investigate further this relationship between activity and enzyme density on electrodes, we moved toward gold nanoparticles prepared by laser ablation (LA-AuNps). Laser can provide the ability to accurately deliver a large amount of energy to a material, which can be used to rapidly introduce significant amount of heat into a solid. The unique interactions of laser radiation with metal surfaces lead to permanent changes on the material properties in a specific region such as local chemistry, crystal structure and morphology of the material.

## **No Title**

Phong NGUYEN

Retroelements replicate by reverse transcription of their RNA genome into a cDNA that is stably integrated into the host-cell genome by their own integrase (IN). Integration does not occur randomly *in vivo*, revealing a retroelement-specific pattern of preferred sites, which depends mostly of INs interaction with cellular factors that tether integration to specific sites. However, the mechanisms by which these factors interact with IN and contribute to the integration process are still poorly understood.

Important understandings on retroviral biology have been gained by studying yeast Ty LTR-retrotransposons. Ty1 target its integration to RNA Polymerase III (Pol III)-transcribed genes, which are gene-poor regions of the yeast genome. This remarkable integration site selectivity has been well studied *in vivo* and *in vitro*. However, there is no structural information on the integration process or interaction with Pol III.

In this project, we will investigate how the interactions between Ty1 IN and different components of the Pol III machinery contribute to their specific integration profile.