PhD day

March 20th 2020

Institut de Botanique de
l'université de Montpellier
(163 rue Auguste Broussonnet)

Dear colleagues,

Welcome to the PhD day of the Laboratoire Charles Coulomb. This day is a major annual scientific and convivial event in our laboratory where PhD students present their research topics. It is a great opportunity for everyone, from PhD students to post-doctoral students and researchers, to discover the diversity of the research lines conducted in the laboratory and to get acquainted with each other to strengthen the relationships between the different teams of the laboratory. This year we have a lot of participants so that the program is very dense.

Each student has 10 minutes for presentation and questions from the audience. However, the scientific discussions can be continued during the two coffee breaks and the lunch break in an informal atmosphere.

Thank you for your attendance and enjoy the day,

The organizers:
Laura Casas Ferrer, Benjamin Guiselin, Haitham Hrich, Vladimir Pimonov
Christelle Eve, Christian Ligoure.

LABORATOIRE CHARLES COULOMB MONTPELLIER

cnrs

UNIVERSITE MONTPELLIER

MORNING SESSION (9h – 12h40)	
8h30	ARRIVAL COFFEE (Check in)
9h00	Introduction by Pierre LEFEBVRE

Carole-Ann Charles

Christian Ligoure et Laurence Ramos

Matière Molle et Verres (MMV)

Matière Molle (MATM)

''Viscoelasticity and elastocapillarity of an inertial liquid shock''

9h10 – 9h20

Freely expanding liquid sheets formed by drops of Maxwell fluids are investigated. A sheet is produced by the impact of a drop on a quartz plate covered with a thin layer of liquid nitrogen that suppresses shear viscous dissipation thanks to an inverse Leidenfrost effect. The time evolution of the sheet is simultaneously recorded from top and side views using high-speed cameras operating at 6700 and 3000 fps, respectively.

The investigated systems are characterized by low elastic moduli and cover a wide range of relaxation times, thus giving access to a large spectrum of Deborah numbers (De<<1, De~1 and De>>1). The latter is defined as the ratio between the relaxation time of the viscoelastic fluid and the time to reach the maximal sheet expansion tmax (typically of the order of 10 ms).

We measure tmax and dmax, the maximal expansion of the sheets, as a function of the impact velocity. We observe an enhanced expansion for elastocapillary samples (De~1) as compared to elastic (De>>1) or capillary (De<<1) samples. In addition, an unexpected decrease of tmax with decreasing impact velocity is observed for the elastocapillary fluids. To account for this and rationalize the role of capillarity, elasticity and viscous dissipation in the expansion dynamics of all investigated samples, we propose to include biaxial viscous dissipation in a free harmonic damping oscillator model toward the description of the sheet expansion beyond the scaling arguments. Results from this model reproduce quite accurately the experimental values obtained for dmax and tmax.

Rosa Maria D'Ambrosio Goncalves

Éric Anglaret et Christophe Blanc

Nanostructures et Spectroscopies (NANO)

Nanomatériaux (NMAT)

''Photo-thermal properties of single wall carbon nanotubes (SWNT)-based microgels''
9h20 - 9h30

Thermal responsive microgels (TRM) are cross-linked polymers with diameters in the range 50 nm-5 µm which display a volume phase transition (VPT) between a hydrophilic water-swollen state and a hydrophobic deswollen state. The most widely used polymer to prepare TRM so far was poly (N-isopropyl acrylamide) (PNIPAM), because its VPT occurs in the range 32-33°C, close to the physiologically relevant range for biomedical applications. VPT can also be driven by light in so-called hybrid photo-thermal responsive microgels (HPTRM). Resonant light absorption by photosensitive additives embedded in the volume or at the surface of HPTRM generates heating of the polymer via non-radiative relaxations. Single-walled carbon nanotubes (SWNT) are well-known to display outstanding photo-thermal conversion efficiency. Surprisingly, the photo-thermal properties of SWNT were never exploited so far to design SWNT-based HPTRM. In this study, we addressed the challenge to design hybrid microgels (PNIPAM/SWNT) and investigate the photo-thermal properties of the system.

Rodrigo Calderon
David Polarski
Physique Théorique (PTH)
Théorie des Champs et Physique Mathématique (TCPM)
''On the linear growth of cosmic perturbations''
9h30 – 9h40

In this talk, I will briefly present how the theory Inflation naturally provides the seeds needed for Large Scale Structure Formation (such as galaxies and clusters of galaxies) we observe in the Universe today.

I will then move onto perturbation theory: focusing on how we can study the evolution of these perturbations in time, and infer something about the nature of Dark Energy, and/or test our current theories of Modified Gravity.

Colin Avogadri
Benoit Jouault et Frédéric Teppe
Axe : Physique Appliquée (PA)
Transport Quantique & Nouveaux Systèmes 2D (TQNS)

''Effet Hall Quantiques de spin dans les matériaux III-V''
9h40 – 9h50

Je présenterai les effets Hall quantiques de spin ainsi que les isolants topologiques, et comment les mesures de magneto-transport permettent de sonder les propriétés électroniques de ces matériaux.

Kévin Austry
Mauro Antezza et Brahim Guizal
Physique de l'Exciton, du Photon et du Spin (PEPS)
Théorie du Rayonnement Matière et Phénomènes Quantiques (RMPQ)
''Force et transfert de chaleur dans les systèmes nanostructurés''
9h50 – 10h00

Photons can transfer their momentum to bodies and thus generate forces that can be particularly high. This is the case, for example, of van der Waals forces, ubiquitous, attractive, dominant on the submicron scale and which can have destructive effects on the micro/nanoelectromechanical devices. If the bodies are at different temperatures, there will also be a radiative heat transfer between them, due to the tunnelling of energy in the near field.

The van der Waals forces and the radiative heat transfer in nanostructured devices such as diffraction nano-gratings will be studied in this talk.

Jeanne Simon
Christophe Goze-Bac (L2C) et Nadia Bertin (INRAE Avignon)
Bio Nano Imagerie (BNI)
Imagerie et spectroscopie RMN (IRMN)
''Combining MRI development, histology and modelling approach to assess the distribution of resources in plant architecture - case of the tomato plant and of the response to water deficit''
10h00 – 10h10

Water and carbon status throughout growth and development are tightly controlled by the plants and are key components of their responses to environmental stresses. Measuring and predicting resource availability and transport within intact plants is a challenge. The objective of my work is to estimate, in a non-invasive way using Magnetic Resonance Imaging (MRI), xylem

and phloem fluxes in the tomato plant architecture and to measure their diurnal variations in well-irrigated plants as well as in water and heat stressed plants. These estimations, combined with histological measurements, will allow us to improve a functional structural plant model, able to predict the plant behaviour under contrasting environments.

Carole Chevalier
Andrea Parmeggiani
Physique Théorique (PTH)
Systèmes Complexes et Phénomènes Non-linéaires (SCPN)
''Modelling Spatio-temporal Dynamic of Ribosome During Translation''
10h10 – 10h20

Translation of messenger RNA (mRNA) leads to the production of proteins and is the last step of gene expression in cells. The dysregulation of translation can lead to illnesses linked to the dysregulation of protein production, like cancer and neurodegenerative diseases. About ten years ago a ribosomal density mapping strategy (Ribo-seq) was developed, leading to an abundance of experimental data. The time is therefore ripe to apply theoretical physics methods to study translation. To do so, we model the dynamic of ribosomes on mRNA using the Totally Asymmetric Simple Exclusion Process (TASEP), which is an out-of-equilibrium one dimensional directed transport model, and the Poisson process. With Monte Carlo simulations and a mean field approach, we propose ways to infer dynamic parameters of translation.

Léna Chénais
Annelise Faivre
Physique Appliquée (PA)
Matériaux Hybrides et Nanostructures (HYBR)
''High-performance HRG''
10h20 – 10h30

The goal of my PhD is to better understand the origin of unexpected damage arising sometimes at the surface of some silica hemispherical resonator used in a gyroscope (HRG) produced by SAFRAN Electronics and Defense and to eradicate this potential degradation. Using different physicochemical techniques, I am consequently trying be better characterize the effect of the shaping process on

the residual stresses and cracks eventually remaining at the subsurface, in particular with the use of "equivalent flat silica surfaces".

Yoann Baron

Anais Dréau et Guillaume Cassabois

Physique de l'Exciton, du Photon et du Spin (PEPS)

Nanostructures Quantiques Propriétés Optiques (NQPO)

''Optically-active point defects in silicon for quantum technologies''

10h30 – 10h40

As for classical information technologies, silicon is one of the prime platforms for the emerging field of quantum technologies. My PhD work deals with investigating the quantum properties of fluorescing point defects recently isolated at single scale in this flagship material of microelectronics. I will discuss the challenge of controlling such individual quantum systems for applications in quantum photonics and quantum communication networks.

COFFEE BREAK (10h40 – 11h10)

Vladimir Pimonov

Vincent Jourdain

Nanostructures et Spectroscopies (NANO)

Nanomatériaux (NMAT)

''Optical studies of the growth kinetics of individual carbon nanotubes''

11h10-11h20

Carbon nanotubes (CNTs) due to their unique properties are promising materials for electronic and optical applications. However, several unsolved problems stand on the way toward their practical usage, especially the direct synthesis of CNTs with desired chirality and structure. To address this question, our team developed optical methods to image individual CNTs in real growth conditions (at ambient pressure, on a substrate) and relate their growth kinetics with their chirality.

Florentin Fabre

Vincent Jacques

Physique de l'Exciton, du Photon et du Spin (PEPS)

Nanostructures Quantiques Propriétés Optiques (NQPO)

''Magnetic imaging of CrTe2 flakes with a single spin microscope''

11h20 – 11h30

Experimental methods allowing for the detection of single spins in the solid-state, which were initially developed for quantum information science, open new avenues for the design of highly sensitive quantum sensors. In that context, it was shown that the electronic spin of a single nitrogen-vacancy (NV) defect in diamond can be used as an atomic-sized magnetometer, providing an unprecedented combination of spatial resolution and magnetic sensitivity under ambient conditions [1]. Here static magnetic fields are measured within an atomic-sized detection volume by recording the Zeeman-shift of the NV defect electronic spin sublevels though optical detection of the magnetic resonance (ODMR) [1]. In the last years, this technique has emerged as a versatile tool that offers valuable information on technologically relevant magnetic materials [2]. Scanning-NV magnetometry was recently exploited to study the magnetic properties of CrI3 flakes down to the monolayer limit at cryogenic temperature [3].

Here we present our preliminary results on magnetic imaging of 2D ferromagnets under ambient conditions. We focus on exfoliated flakes of CrTe2, which is a van der Waals crystal with an in-plane magnetization orientation at room temperature [4]. Magnetic field distributions recorded above 10-nm thick layers of CrTe2 reveal ferromagnetic monodomain, since magnetic fields are only produced at the edges of the flakes. These preliminary experiments illustrate the benefit of NV magnetometry to study the magnetism of two-dimensional (2D) van der Waals magnets.

[1] L. Rondin, et al., Rep. Prog. Phys. 77, 056503 (2014).
[2] F. Casola, et al., Nat. Rev. Mater. 3, 17088 (2018).
[3] L. Thiel, et al., Science 364, 973 (2019).
[4] D. C. Freitas et al., J. Phys.: Condens. Matter. 27, 176002 (2015).

Alessandro Carbonaro
Domenico Truzzolillo et Luca Cipelletti
Matière Molle et Verres (MMV)
Matière Molle (MATM)
''Effective interfacial tension in miscible molecular fluids''
11h30 – 11h40

Interfacial tension between immiscible fluids is a well-defined, well-known quantity occurring in a wide range of phenomena. By contrast, this quantity is neither easily defined nor fully understood for miscible fluids, for which it does not exist at equilibrium. However, an "effective interfacial tension" (EIT) is supposed to transiently exist between miscible fluids, stemming from spatial gradients of concentration or density in a multifluid system [1]. Nevertheless, the existence of these so-called "Korteweg stresses" is still debated [2-3], since they are hardly detectable in simple miscible liquids, where diffusion rapidly smears out interfaces.

One possibility for studying EIT is observing the evolution of the shape of drops when they are subject to an external forcing, as in spinning drop tensiometry (SDT). In an SDT experiment a drop is injected in a denser background fluid contained in a cylindrical capillary, which is then spun, resulting in the elongation of the drop. The drop shape, which depends among other parameters on the EIT, is then followed by video imaging.

We modify a commercial SDT apparatus and use fluorescent drops in order to retrieve the full three-dimensional concentration profile of the drop, allowing us to follow the dynamics of the interface with unprecedented detail. We exploit this technique to study the elongation dynamics of drops suspended in both immiscible and miscible backgrounds where surface tension is negligible [4].

Remarkably, we find that for sufficiently low interfacial tensions spinning drops can develop a dumbbell shape, consisting in two large heads connected by a thinner central body, as reported many years ago, albeit with no explanation, in [5]. We show that, for miscible fluids, not only is this "dog-bone" shape determined by the density and the viscosity contrast with respect to the background fluid, but it also depends on the molecular structure of both fluids. Furthermore, for drops of water-glycerol mixtures under the same centripetal forcing, we observe that drops richer in water –hence with a lower viscosity- deform more slowly than more viscous drops, richer in glycerol.

Neither of these observations can be explained by hydrodynamic arguments alone. Therefore, these results point at the existence of an interfacial stress dependent on the molecular characteristics of the fluids. Building on these observations, we investigate the origin and dynamics of such a dumbbell shape by systematically varying the composition of the drops.

We rationalize the dynamics of the drop shape using a simple model where we balance the normal pressure on the drop, the shear stress that opposes the deformation and the effect of the EIT. By modelling the deformation dynamics, we measure the value of the EIT, which turns out to be on the order of 100 nN/m for the fluids considered here (drops of water-glycerol mixtures in a pure glycerol background). The experimental results, shown in Fig. 2 as a function of the water concentration in the drops, are in good agreement with a quantitative prediction based on a phase field model [3] and solve a long-standing controversy stemming from the conflicting literature values of the EIT for water-glycerol systems [6-7].

Our experiments confirm the presence of an off-equilibrium effective interfacial tension at the interface between miscible molecular fluids and propose a novel method to measure EIT and extremely low interfacial tensions in general, paving the way for an in-depth understanding of Korteweg stresses in molecular fluids.

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[2] D. Truzzolillo and L. Cipelletti, Soft Matter, 13, 13-21 (2017).
[3] D. Truzzolillo, L. Cipelletti et al., Phys. Rev. X, 6, 041057 (2016).
[4] A. Carbonaro, L. Cipelletti and D. Truzzolillo, Langmuir, 35, 11330-11339 (2019).
[5] C. D. Manning and L. E. Scriven, Rev. Sci. Instrum., 48, 12, 1699–1705 (1977).
[6] P. Petitjeans, C. R. Acad. Sc. Paris, 322, 673-680 (1996).
[7] M. Legendre, P. Petitjeans and P. Kurowski, C. R. Acad. Sc. Paris, 329 (2001).

Zhen Zhang
Simona Ispas et Walter Kob
Physique Théorique (PTH)
Physique Statistique (STAT)

''Chemical bonding in oxide glasses: Insights from first-principles calculations''

11h40 – 11h50

A good knowledge of chemical bonding and bond strength in oxide glasses (e.g. window panels, tableware) is of fundamental importance to understand their mechanical behavior on the microscopic scales. To this aim, we perform first-principles simulations to investigate the electronic properties, in particular the nature of bonding, in silica-based glasses.

Castillo Ivanovitch

Sebastien Nanot

Physique Appliquée (PA)

Transport Quantique & Nouveaux Systèmes 2D (TQNS)

''Josephson Junctions by Electrostatic tuning of Dichalcogenides''

11h50 – 12h00

The objective of this project is to develop gate tuneable Josephson Junctions (JJ) based on Transition Metal Dichalcogenides (TMDs.) Single crystals of either multilayers and monolayers will be used as the unique material forming the junction where the electronic phase will be tuned by local gates. As a consequence, the proposed junction will be fully controlled in-situ.

Alrik Durand

Anaïs Dréau et Vincent Jacques

Physique de l'Exciton, du Photon et du Spin (PEPS)

Nanostructures Quantiques Propriétés Optiques (NQPO)

''Single artificial atoms in silicon emitting at telecom wavelengths''

12h00 – 12h10

As for classical information technologies, silicon is one of the prime platforms for the emerging field of quantum technologies. In the context of quantum communications, my PhD objective is to isolate in this material new individual quantum systems that feature a telecom emission adapted to long-distance exchange of information in optical fibers. By combining optical microscopy and tools from quantum optics, I will explain how I detected single artificial atoms in silicon that exhibit a fluorescence at telecom wavelengths.

Loïc Fernandez

Jean-Loïc Kneur

Physique Théorique (PTH)

Interactions Fondamentales, Astroparticules et Cosmologie (IFAC)

Quantum Chromodynamics at finite temperature and density

12h10 – 12h20

Nous utilisons une nouvelle méthode de resommation des graphes de Feynman, invariantes d'échelles, pour recalculer la pression de QCD à température

et/ou densité finies. Cette nouvelle approche permet de potentiellement explorer le diagramme de phase de la QCD encore inconnu à ce jour.

Harry Dawson

Pascal Etienne

Physique Appliquée (PA)

Matériaux Hybrides et Nanostructures (HYBR)

''Towards a flexible Microfluidics: Modular microfluidic bio systems to achieve rapid prototyping''

12h20 – 12h30

Micro-scale fluid manipulation offers multiple advantages for biological modelling and chemical analysis in terms of reaction time and resource management. However, fluid and light interaction is required to provide quantification at the micro-scale. Attempts to date, such as the ARROW (Anti-Resonance Reflective Optical Waveguides), using di-electric cladding layers to encapsulate light remain non-transversal approaches to Lab-on-Chip technology. Using novel fabrication techniques, we aim to make real time chemical analysis on the microfluidic scale increasingly feasible.

Christine Elias

Guillaume Cassabois and Bernard Gil

Physique de l'Exciton, du Photon et du Spin (PEPS)

Nanostructures Quantiques Propriétés Optiques (NQPO)

Optical spectroscopy of hexagonal boron nitride

12h30 – 12h40

The goal of my thesis is to study the optical properties of hexagonal boron nitride (hBN). hBN is a 2D material, isostructural to graphite. I am interested in looking on the variation of the optical properties of this material depending on the number of layers.

LUNCH BREAK (12h40 – 14h10)

AFTERNOON SESSION (14h10 – 17h40)

Haitham Hrich

Sylvie Contreras

Physique Appliquée (PA)

Transport Quantique & Nouveaux Systèmes 2D (TQNS)

''De la monocouche individuelle aux hétérostructures : croissance, propriétés optiques et électriques de matériaux 2D''

14h10 – 14h20

Graphene is widely considered as a good candidate for the new generation of nanoelectronics due to its extraordinary properties. For example, Graphene has a record thermal conductivity 10 times as high as copper. It goes without saying that an entire world of physics and engineering will open up to a new era of advancements once good quality graphene can be produced at a large scale. Our group has recently optimized a reproducible and controlled growth process of a monolayer graphene on SiC (0001) at low Ar pressure (10mbar). The goal of my thesis is to develop this process in order to control (modulate) the optical and electrical properties of the obtained graphene.

Angela Haykal

Vincent Jacques

Physique de l'Exciton, du Photon et du Spin (PEPS)

Nanostructures Quantiques Propriétés Optiques (NQPO)

''A journey into the tuneable antiferromagnetic spin textures of BiFeO3''

14h20 – 14h30

Antiferromagnetic (AF) thin films are currently attracting considerable excitement for low dissipative spintronic devices. However, most of conventional real-space magnetic microscopy techniques cannot probe the AF order at the nanoscale because magnetic moments are mostly compensated, resulting in very low magnetic signals. This is a major obstacle to the fundamental understanding of nanoscale AF order and its response to external stimuli, such as spin polarized currents or electric fields. To release the full potential of AFs for next-generation spintronics, the nanoscale control and imaging capabilities that are now routine for ferromagnets must be extended to AF materials.

Here we show that scanning magnetometry based on a single nitrogen–vacancy (NV) defect in diamond is ideally suited for imaging complex AF orders at the nanoscale, even under ambient conditions. As a proof of principle, we report on the first real-space visualization of a non-collinear AF order in a thin film of bismuth ferrite BiFeO3 (BFO), a room-temperature multiferroic material in which the AF order is intimately linked to the ferroelectric one via magnetoelectric coupling. We first image the cycloidal AF order in a BFO thin film and demonstrate that magnetoelectric coupling can be exploited to manipulate the cycloid propagation direction by an electric field. We then investigate the effect of epitaxial constraint on the behavior of the AF order in strained BFO thin-films. Different substrates were used for the growth in order to tune the strain. Using scanning NV- magnetometry, we proved that tuning strain can stabilize different propagation directions of the cycloid, can change the plane in which the cycloid rotates or can collapse the cycloid into G-type antiferromagnetic domains in highly strained films. These results demonstrate how BFO can be used to design reconfigurable AF spin textures on demand.

Joris Paret
Daniele Coslovich
Physique Théorique (PTH)
Physique Statistique (STAT)
Structural communities in super cooled liquids
14h30 – 14h40

When approaching the so-called "glass transition" temperature, the viscosity of super cooled liquids inexplicably increases by several orders of magnitude up to the point where they solidify. Remarkably, such a drastic slowing down occurs without a marked change of the local structure. One possible explanation for this disconnect is that the structural features relevant to the glassy slowing down are hard to detect using conventional approaches such as two-body correlations. In this work, we pursue the quest of a transparent, order-agnostic method to assess the structural heterogeneity of super cooled liquids and provide evidence of a possible hidden local order in such systems.

Jinane Elias
Pascal Etienne et Sylvie Calas-Etienne
Physique Appliquée (PA)

Matériaux Hybrides et Nanostructures (HYBR)

''Hybrid Organic-Inorganic photoresists, a promising class of materials for Optofluidic integration''

14h40 – 14h50

Through the efforts to fuse planar optics and microfluidics in order to produce dye lasers, biosensors, trapping and cell sorting device, we can notice the rising interest in optofluidics since early and mid-2000's. However, mass production of these devices heavily relies on fast and easy patterning of the constituent material. PDMS, being one of these materials, gained an added value because of its elasticity, hydrophobicity and permeability to gaz. Nonetheless, these specifications are not convenient for all types of applications. The growing capability to use Hybrid Organic-Inorganic materials for the fabrication of integrated optics components and microfluidic channels is what makes this class of materials an ideal candidate for this integration. This work aims to implement, on the same chip, an optical and a microfluidic layer using Sol-Gel processing of Organic-Inorganic materials. The interest in this vertical integration arises from the need to manipulate the fluid in the microchannels using evanescent field optical forces.

Chouaieb Saddem

Vincent Jacques

Physique de l'Exciton, du Photon et du Spin (PEPS)

''NV imaging of ferromagnetic skyrmions''

14h50 – 15h00

The goal of my PhD is to find host materials for "skyrmions" with the smallest diameters and the highest movement speeds. Using NV magnetometry allows us to characterize non-colinear spin-structures in various materials. Playing on the material magnetic damping parameter / applying short current pulses allows us to move these skyrmions under the NV-imager. I will introduce the main properties of these non-colinear textures, and present some of the results we obtained during my thesis on various materials

Paul Soudon

Andrea Parmeggiani

Physique Théorique (PTH)

Systèmes Complexes et Phénomènes Non linéaires (SCPN)

''Mechanisms of spatio-temporal regulation of translation and transcription: biophysical modelling of Ribo-seq experiments''

15h00 – 15h10

The goal of my PhD is to have a better understanding of transcription and translation processes in the cell by using tools of statistical physics. To do so, I investigate, both numerically and analytically, the link between diffusion processes, directed transport and polymer physics. Knowing transcription and translation processes are of primary importance to a better understanding of certain diseases such as cancer or genetic disease.

Clara Manesco

Csilla Gergely

Bio Nano Imagerie (BNI)

Biophotonique (BIOP)

''Broadband Coherent Anti-stokes Raman micro-Spectroscopy for optical label-free readout of Spinal Cord Injury''

15h10 – 15h20

Spinal cord injuries (SCI) affect between 2.5 and 4 million patients worldwide (40 000 in France). Handicaps induced by SCI range from minimal sensory motor deficits to complete tetraplegia. Currently, there is no curative treatment on any symptoms associated with SCI.

A scar, called glial and composed mainly of astrocytes and microglia, inhibits axonal regeneration. Amongst other, SCI consists in a neuroinflammation and demyelination processes. These mechanisms are poorly understood. Better monitoring of animal models of SCI in particular through the development of bioimaging translational tools are therefore mandatory.

Our main objectives are to pursue and extend a multimodal imaging approach combining Broadband coherent anti-Stokes Raman Spectroscopy (BCARS), a novel technique [1] based on Raman spectroscopy with faster image acquisitions [2], and multiphoton microscopy (MPM) to better understand mechanisms that underlie absence of spontaneous axonal regeneration following SCI, as well as to evaluate outcomes of therapeutic strategies that favor axonal regeneration in mice and non-human primates.

BCARS and MPM are conceived to reveal valuable information on structural changes in damaged tissue and monitor the effect of therapeutic strategies on regeneration, by co-localizing drugs within healthy/diseased tissues [3] and by imaging collagen fibers and axons with second harmonic generation, respectively.

1. C. H. Camp Jr, Y. J. Lee, J. M. Heddleston, C. M. Hartshorn, A. R. Hight Walker, J. N. Rich,
J. D. Lathia, M. T. Cicerone, Nat. Photonics 2014, 8, 627.
2. C. M. Hartshorn, Y. J. Lee, C. H. Camp Jr, Z. Liu, J. M. Heddleston, N. Canfield, T. A. Rhodes, A. R. Hight Walker, P. J. Marsac, M. T. Cicerone, Anal. Chem. 2013, 85, 8102
3. C. Zhang, D. Zhang, J.-X. Cheng, Annu. Rev. Biomed. Eng. 2015, 17, 415.

Laura Casas Ferrer
Gladys Massiera
Matière Molle et Verres (MMV)
Matière Molle (MATM)
''Microfluidic flow of biomimetic tissues''
15h20 - 15h30

The aim of the project is to design a biomimetic tissue with a tunable degree of internal adhesion and determine its mechanical properties (elasticity, plasticity, viscosity) by using controlled microfluidic settings. The artificial tissue is obtained by the assembly of Giant Unilamellar Vesicles, (GUVs). In order to induce the vesicle-vesicle adhesion we use the Biotin-Streptavidin pair or DNA ligands. By tuning different parameters such as the concentration of ligands, incubation mode, and volume fraction of vesicles, we manage to control the occurrence (or not) of cell-cell assembly, the strength of the adhesion, and the typical size and geometry of the vesicle aggregates. Soft matter models like vesicles are useful tools for understanding the physical properties of biological matter, and can help to understand basic biological phenomena like cell migration, embryogenesis, and metastasis. Studying this type of models is also relevant in the field of applied biomedicine, since we can obtain new and powerful tools to design and synthesize soft biomaterials and organoids that mimic the physical properties of living matter with a high degree of accuracy.

Said Pashayev
Francois Henn

Nanostructures et Spectroscopies (NANO)
Nanomatériaux (NMAT)
''Water confinement in single walled carbon nanotubes: phase states and molecular dynamics''
15h30 – 15h40

Being the primordial solvent of life, water is essential to living organisms and to human societies. Because it is abundant on earth, it is at the core of important technological developments, including green chemistry, blue energy harvesting and so on. The primordial role of water can be related to its structural properties that are unique in nature (hydrogen bond network and dipolar moment). Any modification of the water structure has a huge impact on its properties. In extreme confinement situation, water can still fit into narrow channels but at the cost of a modification of its structure. The confinement of water in carbon nanotubes has been shown to produce some remarkable structural and dynamical features as compared to bulk water, which include a lower number of hydrogen bonds, increased lifetimes of hydrogen bonds, the layered structure of water under confinement, its reduced density and viscosity, and an increased proton mobility in 1-D water chains. Water has unique properties and an understanding of the interactions between water and carbon nanotubes is key to the development of many new applications. In this context, we will take benefit of the achieved performances to probe the structure of water under confinement, the phase diagram (transition temperatures and mechanism) and the flow properties, with a particular interest toward the specific regime of non-continuum flow.

COFFEE BREAK (15h40 – 16h10)

Benjamin Guiselin
Ludovic Berthier
Physique Théorique (PTH)
Physique Statistique (STAT)
''Random Field Ising Model criticality in super cooled liquids''
16h10 – 16h20

To account for the critical slowing down of super cooled liquids decreasing the temperature and approaching the glass transition, a mean field theory has been derived recently. This theory predicts that below the experimental glass

transition, a genuine thermodynamic phase transition takes place, the order parameter being the degree of similarity (overlap) between two copies (replicas) of the same liquid. In this project, we use extensive computer simulations to investigate the outcomes of this putative phase transition in a 3D model glass former. In particular, we show the existence of a hidden critical point when switching on attraction between the two replicas.

Marouane Mébarki

Benoit Rufflé et Coralie Weigel

Matière Molle et Verres (MMV)

Physique des Verres (VERR)

''New insights into pressure-induced polyamorphism in oxide glasses''

16h20 – 16h30

The aim of the project is to use vibrationnal Brillouin spectroscopy and structural experiments at high pressure to achieve an accurate description of the microscopic mechanism of pressure-induced polyamorphism in a set of representative oxide glasses (SiO_2, GeO_2, and B_2O_3). To do this, it is necessary to understand the impact of several parameters such as the topology of the glasses or the pressurizing fluid in which the glass is immersed during compression.

Aurélien Flatres

Pascal Etienne

Physique Appliquée (PA)

Matériaux Hybrides et Nanostructures (HYBR)

''Skeletal muscle injury in intensive care unit (ICU): Tissue engineering model for diagnosis and therapeutics''

16h30 – 16h40

L'objectif de ce travail est de construire un modèle de muscle in vitro, ce qui nécessite la construction d'un support micro structuré biocompatible.

Rana Tanos

Isabelle Robert-Philip et Csilla Gergely

Physique de l'Exciton, du Photon et du Spin (PEPS)

Nanostructures Quantiques Propriétés Optiques (NQPO)

''Quantum sensing with NV center in diamond: NOVEL IMAGING MODALITIES''

16h40 – 16h50

The electron spin of the NV center shows a strong dependence on various external perturbations, allowing the measurement of several physical quantities such as the temperature, the magnetic field, the electric field and pressure. In consequence this spin perturbation dependence allows us to exploit the NV defect as a highly sensitive quantum sensor offering a resolution down to the nanoscale. During my thesis, I was interested in developing new imaging modalities for thermal and magnetic sensors.

Yoann Meriguet

Dominique Coquillat

Physique Appliquée (PA)

Spectroscopie THz (THZ)

''Terahertz spectroscopy of proteins''

16h50 – 17h00

Brownian diffusion of freely moving biomolecules is usually considered to drive the dynamics of the molecular machinery maintaining cellular functions and thus life. However, the high speed and efficiency of the encounters between cognate partners of biochemical reactions inside living cells calls for a more convincing explanation with respect to purely thermal-fluctuations-driven random walks.

In order to observe these fast biochemical interactions that we suspect to be in the Terahertz (THz) range, we need to develop new bio-sensors for the THz range. The main difficulty of these electronic bio-sensors is that they will be in contact with water, a major element of life. During this presentation we will see the approach to make these electronic sensors biocompatible as well as the results obtained on a protein.

Alban Desoutter

Didier Felbacq et Emmanuel Rousseau

Physique Théorique (PTH)

Théorie des Champs et Physique Mathématique (TCPM)

''Microscopie Brillouin sur membrane biologique''

17h00 – 17h10

La thèse consiste dans le montage d'un microscope Brillouin, dans le but d'étudier les propriétés mécaniques de cellules et tissus dentaires. Des éléments de simulation permettront de mieux comprendre le phénomène ainsi que le fonctionnement du montage optique.

Maxime Rollo

Isabelle Robert-Philip

Physique de l'Exciton, du Photon et du Spin (PEPS)

Nanostructures Quantiques Propriétés Optiques (NQPO)

''Senseurs quantiques de température aux échelles nanométriques''

17h10 – 17h20

D'abord, la présentation sera basée sur une explication du défaut unique dans le diamant appelé centre NV ainsi que ses principales caractéristiques permettant de faire de ce centre un excellent senseur quantique de champ magnétique.

Ensuite, l'objectif sera de voir comment il est possible d'utiliser cette incroyable sensibilité de champ magnétique pour en faire un senseur quantique très précis de température grâce aux propriétés des particules ferrimagnétiques ou ferromagnétiques autour de leur température de Curie.

Enfin, il sera intéressant de voir comment, en couplant des centres NV dans le diamant avec des particles magnétiques, on peut espérer fabriquer un nanothermomètre très précis.

Bruno Robert

Csilla Gergely

Bio Nano Imagerie (BNI)

Biophotonique (BIOP)

''Peptides as chalcogenide-organic linkers for biosensing''

17h20 – 17h30

We report on functionalization of chalcogenide thin film with biotinylated 12-mer peptides peptides SVSVGMKPSPRP and LLADTTHHRPWT exhibiting high binding affinity towards our inorganic surface. The specific biotin moieties were used to bind streptavidin proteins and demonstrate efficacy of the biofunctionalizated chalcogenide substrate to capture biomolecules.

FREE TIME FOR DISCUSSION (17h40-18h30)