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Forum de la communauté ultrarapide du plateau de Saclay

February, 13th, 2023
Pascal Institute

Foreword

The Plateau de Saclay is a major international player in time-resolved studies, from the optical developments that gave rise to them to the experimental and theoretical studies that they allow. The field of research extends from atto-physics, atto- and femto-chemistry, and femto-biology to multi-scale studies in all phases of matter. The range of developments and studies carried out is extremely wide and includes many laboratories and stakeholders in the territory. The dynamism of theme 3 of the LABEX PALM is proof of this, as well as the two Equipex (ATTOLab and Apollon) which were built in the 2010s.This richness, resulting from the diversity of studies and sites, offers exceptional opportunities for transdisciplinary collaborations, provided that the members of the community know each other and exchange. In spite of the electronic means of communication that have been put in place, the end of the labex and equipex programs is altering the quality of these exchanges.

The objective of FOCUS is to federate the community of the Plateau de Saclay (IP-Paris and University of Paris-Saclay) working on scientific topics dealing with ultrafast dynamics (or almost).FOCUS proposes local and friendly events, encouraging discussions and scientific meetings.

Welcome to the first edition of FOCUS!

Pascale Changenet & Lionel Poisson
Co-chairs of the forum

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- Lionel Poisson (ISMO, Université Paris Saclay)
- Pascale Changenet (LOB, Institut Polytechnique de Paris)
- Federica Agostini (ICP, Université Paris Saclay)
- Bruno Albertazzi (LULI, Institut Polytechnique de Paris)
- Elsa Cassette (LuMIn, Université Paris Saclay)
- Fabien Gatti (ISMO, Université Paris Saclay
- Romain Géneaux (LIDYL, Université Paris Saclay)
- Stefan Haessler (LOA, Institut Polytechnique de Paris)
- Adrien Leblanc (LOA, Institut Polytechnique de Paris)
- Manuel Llansola (I2BC, Université Paris Saclay)
- Eirini Papagiannouli (LCF, Université Paris Saclay)
- Thierry Ruchon (LIDYL, Université Paris Saclay)

Practical information

The meeting will start at 9:15 am, and will end from 5 to 7 pm with a cocktail and poster session.

It will be held in Institut Pascal, Bât 530, Rue André Rivière, 91400 Orsay. In practice, it is just behind ISMO, in the « Belvédère area » of Paris Saclay University.

GPS: 48.706600247493576, 2.1774608149888213

Speakers

Speaker

Tatiana Giraud

Lab. Écologie, Systématique et Évolution

Comprendre l'évolution en étudiant la domestication des champignons du fromage.

La théorie de l'évolution par sélection naturelle offre un paradigme extrêmement puissant pour comprendre pourquoi le monde vivant est tel qu'il est, pour comprendre comment la biodiversité se forme et quelle est sa dynamique au cours du temps, et pour comprendre comment les populations arrivent à s'adapter ou non à un environnement changeant. La domestication est un excellent modèle pour étudier l'évolution et l'adaptation et cette conférence se focalisera sur le cas des champignons utilisés pour l'affinage des fromages, notamment des fromages bleus, des Bries et des Camemberts. Des études génomiques et expérimentales révèlent les adaptations des champignons pour la maturation des fromages et les mécanismes génomiques impliqués.

Sophie Kazamias

IJCLab

Speaker

Activités sources ultra-rapides sur la plateforme LASERIX: lumière structurée XUV, accélération d'électrons et premiers tests de la nature électromagnétique du vide

Présentation au nom de la plateforme LASERIX, projets PALLAS et DELLIGHT
La plateforme LASERIX est une plateforme universitaire installée à l'IJClab. Le laser pilote est une chaîne Ti :Sa de niveau 50 TW fonctionnant à 10 Hz. La spécificité de l'installation est que plusieurs thématiques de recherche sont menées en parallèle, en forte interaction avec le contexte local, national et européen. Il y a aussi une vocation affirmée d'ouverture à la formation niveau master avec l'accueil d'étudiants en TP et stages de tous niveaux. Je présenterai les travaux récents sur la génération de faisceaux de lumière XUV portant un moment orbital par génération d'harmoniques d'ordres élevés et amplification dans un laser X. J'exposerai la contribution de LASERIX à la thématique de l'accélération laser plasma dans le cadre de la contribution française à EUPRAXIA. Je conclurai sur un projet beaucoup plus prospectif de démonstration d'effet de réfraction de la lumière induit dans le vide par la présence d'un champ électromagnétique ultra-intense.

Bruno Robert

I2BC

Speaker

Ultrafast spectroscopy meets Structural Biology : fucoxanthin-chlorophyll proteins

Robert, B[1], Gelzinis, A[2], Augulis, R[2], Buechel, C[3], Valkunas, L[2]

[1] Inst Integrat Biol Cell I2BC Univ Paris Saclay, CEA, CNRS, , F-91198 Gif Sur Yvette, France

[2] Vilnius Univ, Inst Chem Phys, Fac Phys, LT-10222 Vilnius, Lithuania

[3] Goethe Univ Frankfurt, Inst Mol Biosci, D-60438 Frankfurt, Germany

Diatoms are a major group of algae, responsible for a quarter of the global primary production on our planet. Their adaptation to marine environments is ensured by their light-harvesting antenna - the fucoxanthin-chlorophyll protein (FCP) complex, which absorbs strongly in the blue-green spectral region. The structure of an FCP dimer from Phaeodactylum tricornutum was resolved by crystallography, and the structure of the PSII supercomplex from Chaetoceros gracilis, containing several FCPs, was obtained by electron microscopy. We have measured by ultrafast spectroscopy, the excitation energy transfer in the FCP from another diatom Cyclotella meneghiniana. The published FCP structures cannot explain several observations we obtained. By combining the available structures and our ultrafast spectroscopy results we propos a trimer-based FCP model for Cyclotella meneghiniana. Our observations suggest that the structures from the proteins belonging to the FCP family display larger variations than the equivalent LHC proteins in plants, which may reflect species-specific adaptations or original strategies for adapting to rapidly changing marine environments.

Marie Froidevaux

LOA

Speaker

High Harmonic Generation in solids and strong-field photoemission. Is there a connection?

Opposite to gases, in solids, we do not need much energy to achieve strong-field effects and it could be done with tabletop IR fs-lasers operating at high frequencies.
When one talks about high harmonic generation with NIR fs-pulse it means photons, however the connection with electrons participating in the generation process is not observed experimentally. Surprisingly, while observing mostly odd order harmonics of IR photons from solids with linearly polarised IR fs-pulses, we obtained even and odd orders of hot electrons emission.
In this speech, I will present a path to connect both processes of photoelectron emission and high harmonic generation under strong-field conditions.

Luca Perfetti

LSI

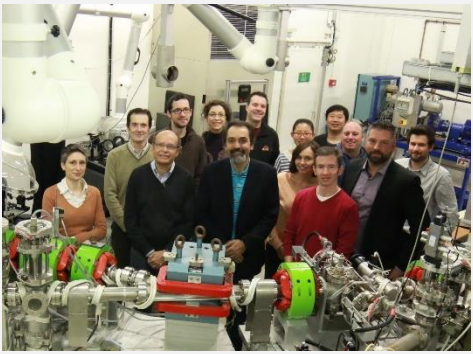
Speaker

Snapshots of electronic states and charge motion in hybrid perovskites

Time resolved ARPES is employed to characterize the transition across the tetragonal to orthorhombic phase of the hybrid perovskite CH3NH3PbI3. At the phase transition, we observe a type II band offset and drift of the charge carriers, highlighting the important role that organic cations have on the screening of local electrostatic fields. Indeed, when the orientation of organic cations is frozen in the orthorhombic phase, the positively charged termination induces a massive accumulation of excited electrons at the surface of the sample. Conversely, no electron accumulation is observed in the tetragonal phase. Next, the dispersion of electronic states in two dimensional Hybrid perovskites question the presence of large Rasbha splitting in the conduction band and provide a direct measurement the electronic effective mass. After estimating the evolution of electronic wavepacket, it is possible to exclude self-trapping phenomena that have been suggested in the literature

Serguey Denisov

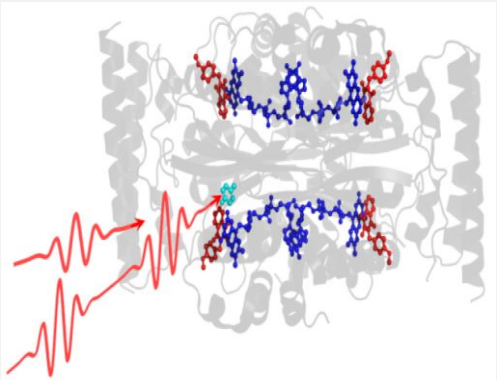
ICP



In this presentation, we will discuss modern time-resolved radiolysis and its applications in investigating electron attachment in both organic and inorganic systems, as well as charge transfer processes in radical systems. We will also delve into the development of three-pulse spectroscopy for investigating photophysical processes in anions. The presentation will include examples of our recent works in the field, and aim to provide insights into the latest advancements in this area

Modern time-resolved radiolysis: from femto- to microseconds...

Speaker



Manuel Joffre

LOB

Speaker

Femtosecond mid-infrared spectroscopy using high-repetition rate Ytterbium-doped fiber amplifiers

Mindaugas Jonusas[1], Quentin Bournet[2,3], Adeline Bonvalet[1], Michele Natile[3], Florent Guichard[3], Yoann Zaouter[3], Patrick Georges[2], Frédéric Druon[2], Marc Hanna[2], Manuel Joffre[1]

[1] Laboratoire d'Optique et Biosciences, Ecole Polytechnique, CNRS, INSERM, Institut Polytechnique de Paris, 91128 Palaiseau, France

[2] Université Paris Saclay, Institut d'Optique Graduate School, CNRS, Laboratoire Charles Fabry, 91127 Palaiseau, France

[3] Amplitude, 11 Ave Canteranne, Cité Photon, 33600 Pessac, France

The advent of high-repetition rate diode-pumped femtosecond lasers has greatly impacted the field of time-resolved femtosecond mid-infrared spectroscopy [1]. We will present the MIRThyX project, which eventually aims at applying these methods to two-dimensional infrared spectroscopy in the flavoenzyme ThyX. In particular, we will discuss how the combination of chirped-pulse up-conversion [2] with a compact mid-infrared source based on intrapulse difference-frequency mixing [3] can result in the rapid acquisition of time-resolved vibrational spectra.

[1] P.M. Donaldson,et al., J. Phys. Chem. A 122, 780 (2018).

[2] M. J. Nee et al., Opt. Lett. 32, 713 (2007).

[3] Q. Bournet et al., Opt. Lett. 47, 4885 (2022).

Dimitris Papadopoulos

LULI / Apollon

Speaker

The Apollon PW laser facility : current status and perspectives.

The Apollon laser, currently under construction at Orme des Merisiers, Saclay, France, aims to be among the first multi-PW user facilities in the world devoted to the study of high intensity laser matter interaction at intensities above $2x10^{22}$ W/cm^2. The Apollon facility offers two experimental areas: 1) The Long Focus Area where mostly electron acceleration experiments are realized and 2) the Short Focus Area where tight focusing (F#2.5) on solid targets and ion acceleration is the principal objective.

In this presentation I provide an overview of the construction progress of the facility emphasizing on the recent commissioning of the 1 PW beam-line of the laser system. In a second part I present a summary of the first experimental campaigns in both experimental areas on the PW level. In the last part an outlook on the scheduled commissioning of the 10 PW beam line in 2023 is finally discussed.

Minh-Huong Ha-Thi

ISMO

Speaker

Elucidating photodriven charge accumulation in molecular compounds using pump-pump-probe spectroscopy

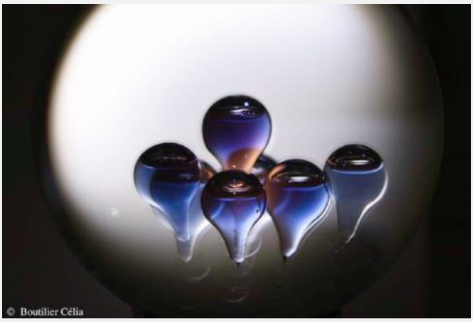
Daniel Cruz, Thu-Trang Tran, Nishith Maity, Philipp Gotico, Karine Steenkeste, Thomas Pino and Minh-Huong Ha-Thi

[1] S. Mendes Marinho, et al., Angew. Chem. Int. Ed. 2017, 56, 15936-15940.
[2] Tran, T.-T.; Pino, T.; Ha-Thi, M.-H., J.Phys.Chem. C 2019, 123 (47), 28651-28658.

Artificial photosynthesis requires several cycles of photoinduced charge separation to accumulate enough redox equivalents at the catalytic sites for the target chemistry to occur. The photoinduced charge separation on a single electron level has been intensively studied in the past decades and is now well understood. However, photoinduced charge accumulation is still challenging, and only very few number of molecular systems capable of photoaccumulating temporarily more than one redox equivalent have been investigated. Therefore, it is highly desirable to obtain more fundamental knowledge into the elementary steps of the photodriven charge accumulation process which is essential for artificial photosynthesis. Nanosecond pump-pump-probe transient absorption and resonant Raman experiments were recently developed in ISMO to probe UV-VIS absorption and vibrational signature of the charge accumulated states using sequential photoexcitation. By employing a reversible model system composed of a photosensitizer, an electron donor and a two-electron acceptor, the formation of charge accumulated state on the acceptor was demonstrated by probing either absorption or vibration mode corresponding to the doubly reduced species. Rate constants of all elementary steps in the formation and the relaxation of the doubly reduced state were determined. Our novel experimental approach to interrogate mechanisms of charge separation and accumulation should stimulate further studies to investigate more sophisticated multielectronic photocatalytic processes towards the design of more efficient photocatalysts.

Bruno Palpant

LuMIn



Rôle des électrons chauds en plasmonique ultrarapide

Speaker

The localized plasmon resonance enables effective input of energy into metal nanoparticles by light irradiation. Using ultrashort laser pulses leads to the generation of a hot electron gas, the dynamics of which results in diverse interesting phenomena: transient ultrafast modulation of the optical response, multiphoton emission of both electrons and broadband light, strong localized heat burst. We will present the basic principles of these phenomena and illustrate them through selected examples.

Luca Fedeli

LIDYL

Speaker

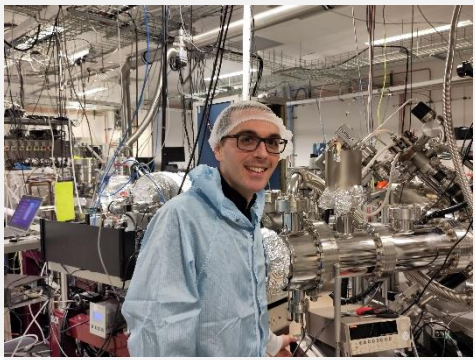
Modélisation d'un nouveau schéma d'accélération d'électrons par laser: Simulations Particle-In-Cell à l'exascale.

[1] E.Esarey al. Rev.Mod.Phys. 81, 1229, 2[1] A.A.Friedl et al. Med Phys. 49(3):1993-2013.2022
[2] E.Esarey al. Rev.Mod.Phys. 81, 1229, 2009
[3] W.P.Leemans et al. Phys.Rev.Lett. 113(24), 245002, 2014
[4] L.Fedeli et al. 2022 SC22: International Conference for High Performance Computing, Networking, Storage and Analysis (SC). IEEE Computer Society, 2022
[5] A.Myers et al. Parallel Computing 108:102833, 2021
[6] https://ecp-warpx.github.io/ (WarpX github repository)

Cette contribution présente un nouveau schéma d'accélération d'électrons piloté par laser qui pourrait trouver application pour des expériences nécessitant des charges accélérées élevées, par exemple des expériences de radiobiologie en régime FLASH[1]. Malheureusement, les schémas classiques d'accélération d'électrons par laser[2,3] ne fournissent pas simultanément une charge et une qualité suffisantes pour la plupart des applications envisagées. Pour résoudre ce problème, nous avons conçu une nouvelle source d'électrons pilotée par laser, constituée d'un jet de gaz couplé à un miroir plasma[4], afin d'accélérer une charge nettement plus importante que dans les schémas conventionnels, tout en conservant la qualité (en particulier le spectre mono-énergetique). En 2022, nous avons validé ce concept par des expériences "proof-of-principle" au laboratoire LOA (France), et par une campagne de simulations réalisée sur les superordinateurs les plus puissants du monde, en utilisant le code Particle-In-Cell WarpX[5,6] (prix Gordon Bell 2022),

Charles Bourassin-Bouchet

LCF



Speaker

Quantifying decoherence of attosecond electron wavepackets

Laser-dressed photoionisation spectroscopy has been the cornerstone of attosecond metrology for the past twenty years. We have recently revisited this historical approach to show that it strictly corresponds to a quantum state tomography of the photoionized attosecond electron wavepacket. This allows one to measure quantitatively decoherence processes occurring during ionization. Such decoherence can arise from classical ensemble averaging (pulse instabilities, spectrometer's response…) or from purely quantum-mechanical reasons (electron-ion entanglement). This work is carried out in the frame of the ANR project DECAP (IOGS-LCF / LIDYL-Attolab / LCPMR-Sorbonne Univ).

Posters

Marc Hanna	High repetition rate ultrafast MIR sources for 2D spectroscopy
David Gauthier	Polarization spectroscopy of high-order harmonic generation in gallium arsenide.
Catherine LE BLANC	Projet FemtoLED: Amplificateurs femtosecondes pompés par LED
Lucie Maëder	Measuring two-photon transition delays using 'self-probing' of a resonance
Annamaria Quaranta	
Robert Pansu	NP Laser Induced Nucleation in a µfluidic flow
Adrien Kraych	The DeLLight Experiment: Modifying the speed of light in a vacuum with intense laser pulses
Jelena Sjakste	Electron-phonon coupling and ultrafast dynamics of hot carriers in semiconductors: from interpretation of photoemission experiments to transport simulations in devices.
Chloe Magne	Generation of Long Lived Triplets By Singlet Fission

Posters

Pierrick Lample	Femtosecond dynamics in excited wide band gap dielectrics
Vasyl Veremeienko	Singlet exciton fission mechanisms in carotenoids
Xu LIU	Development of high repetition rate EUV light source for short wavelength metrologies
Anam Fatima	Phtoinduced processes in a novel donor-acceptor triad for energy applications
Lionel Poisson	Photoionization dynamics of isolated tryptophane nanoparticles
Thierry Ruchon	Photons pathways and the non perturbative scaling law of High Harmonic Generation

FOCUS

13 février 2023
Institut Pascal bât 530

09:00	 **Registration, coffee and bites** 	
09:30	Welcome – Lionel Poisson and Marino Marsi (PALM)	
09:45	Session I: Lasers ultrabrefs (Stefan Haessler)	Sophie Kazamias (IJCLab) Luca Fedeli (LIDYL) Charles Bourassin-Bouchet (LCF)
10:45	**Coffee break**	
11:15	Session II: Matériaux (Elsa Cassette)	Luca Perfetti (LSI) Bruno Palpant (LuMIn)
11:55	PEPR LUMA (Rémi Métivier)	
12:15	**Lunch break**	
14:00	Conférence d'ouverture : Comprendre l'évolution en étudiant la domestication des champignons du fromage (Tatiana Giraud)	
14:30	Session III: Transferts d'énergie et/ou de charge (Federica Agostini)	Bruno Robert (I2BC) Sergey Denisov (ICP) Minh Ha Thi (ISMO)
15:30	**Coffee break**	
16:00	Session IV: Lasers et optique ultrarapide (Romain Géneaux)	Manuel Joffre (LOB) Dimitris Papadopoulos (LULI) Marie Froidevaux (LOA)
17:00	Closing remarks: Pascale Changenet	
17:10	 **Cocktail & Posters**