université de BORDEAUX

LAPHIA international symposium
3rd edition

July 2 - 3, 2015
Institut d'Optique d'Aquitaine - Talence
http://laphiasymposium.u-bordeaux.fr/en/

programme financé par l'ANR : ANR-10-IDEX-03-02

Welcome to the third annual symposium of the Cluster of Excellence LAPHIA (Excellence Initiative – University of Bordeaux). This year, it is collocated and will run in parallel with **ETOP 2015 from 29 June to 3 July 2015** at Institut d'Optique d'Aquitaine in Talence - France.

The objectives of this **LAPHIA** symposium are to bring together the international specialists who work in the fields of photonics/laser/imaging, to present the actual state of the art, and to exchange their meanings on the evolution of the relevant technologies.

Once a year, the Cluster organizes an international symposium in Bordeaux. This key event is the opportunity to gather the global community, including researchers and industrials, around the three LAPHIA axes: laser, photonics and innovative imaging. This event is also an opportunity to highlight women in the fields of science and engineering in with the "Women in Optics" workshop. Two talks about the physics and chemistry's Nobel Prizes of 2014 will also be held.

Students are also involved

This year, two poster sessions will be organized by the committee in order to highlight the research works of Ph.D. and post-doctoral fellows, but also to reinforce the network between the members of the community. The best poster prizes will be attributed during the closing session of the symposium.

Apart from this exciting scientific program, we welcome you to the 3rd annual Symposium to embrace and enjoy what Bordeaux has to offer – its unique blend of contemporary and traditional ways of life as well as its cultural landmarks, attractions, and entertainment.

We wish you all a most interesting, rewarding and stimulating symposium.

The Direction

Evelyne Fargin, Lionel Canioni, Philippe Balcou, Philippe Bouyer

General Index Program

Program of the week

	June 29, 2015	June 30, 2015	July 1, 2015	July 2, 2015		July 3, 2015
9:00 - 9:30 am		ETOP	ETOP		ETOP	**X.RIBEYRE** - CELIA (Bordeaux) ***How turn light into matter in laboratory***
9:30 - 10:00 am				**REGISTRATION** - Hall IOA		**R.CHAPOULIE** - IRAMAT - CRP2A (Bordeaux) ***Studying ancient materials with multi-physics for preventive purposes. The case of prehistoric wall paintings***
10:00 - 10:30 am				**H.AZIZ** - University of Waterloo - Canada ***An Overview of OLEDs: Challenges & Research Opportunities***		**S.DILHAIRE** - LOMA (Bordeaux) ***Ultrafast Energy Transport at Nanometer Scale***
10:30 - 11:00 am						*Coffee break*
11:00 - 11:30 am				**M.NOLLMANN** - Center for Structural Biochemistry-CNRS/INSERM - ***Nuclear organization and remodeling at super-resolution***		**G.DUCHATEAU** - CELIA (Bordeaux) ***Interaction of femtosecond laser pulses with dielectric materials***
11:30 - 12:00 am						**"Bordeaux Student Chapter in Optics"**
12:00 - 12:30 pm				*Lunch*		**M.HACHET** - INRIA (Bordeaux) ***HOBIT - Hybrid Optical Bench for Innovative Teaching***
12:30 - 1:00 pm						*Lunch*
1:00 - 1:30 pm						
1:30 - 2:00 pm						
2:00 - 2:30 pm	ETOP	ETOP	ETOP	**Workshop : "Women in optics"** *(common session ETOP & LAPHIA)* **K. RICHARDSON**-Central Florida University **M. BLANCHARD_DESCE**-ISM-Univ. Bordeaux **C. BOUDOUX**-École Polytechnique de Montréal **R. BELLO DOUA**-Alphanov **M. PAOLETTI**-Univ. Bordeaux **C.LAGABRIELLE**-Univ. Bordeaux		**Flash presentation - Posters** (Group B)
2:30 - 3:00 pm						**Poster session** - Group B - Hall IOA
3:00 - 3:30 pm						
3:30 - 4:00 pm						
4:00 - 4:30 pm				**Flash presentation - Posters** (Group A)	ETOP	
4:30 - 5:00 pm				**Poster session** - Group A - Hall IOA		**Poster's prizes** *Closing session of the symposium*
5:00-5:30 pm						
5:30 - 5:45 pm						
5:45 - 6:00 pm						
6:00 - 08:00 pm				**Cocktail & expo** - Hall IOA (*invitation only*) ***Milieu Amplificateur : Les lasers en Aquitaine***		

Thursday session

- 9 : 30 am – 10 : 00 am – Hall IOA
  REGISTRATION
- 10 : 00 am – 11 : 00 am – Auditorium

An Overview of OLEDs : Challenges & Research Opportunities

Hany AZIZ – University of Waterloo, Canada

Twenty five years after their invention in a lab, Organic Light Emitting Devices (OLEDs) are now used in commercial products. As the technology moves from the lab to the market place, certain fundamental and technological issues related to OLED efficiency, reliability and manufacturing become increasingly more important and create new opportunities for research. In this seminar a brief introduction to OLEDs will be given and some of those issues and opportunities will be highlighted. Some of our research activities in those areas will also be briefly presented.

- 11 : 00 am – 12 : 00 am – Auditorium

Nuclear organization and remodeling at super-resolution

Marcello NOLLMANN - CNRS/INSERM, Montpellier, France

The main limitation of current conventional optical microscopy methods relies on their limited spatial resolution due to diffraction. Different super-resolution microscopies have been developed over the past years to break the diffraction barrier. In this talk, I will present different super-resolution methodological developments (PALM/STORM/SIM) and their application to solving specific biological questions. In particular, I will report on studies in which these microscopies have been used to investigate the organization and remodeling of DNA within the cell.

- 12 : 00 am – 2 : 00 pm – Hall IOA
  Lunch

Workshop : "Women in optics"

- 2 : 00 pm – 4 : 00 pm – Auditorium

Members of the panel « Women in optics »

- **Kathleen Richardson** – Pr of optics – CREOL – Central Florida University

Dr. Kathleen Richardson is currently Professor of Optics and Materials Science and Engineering at CREOL/College of Optics and Photonics at the University of Central FL, where she runs the *Glass Processing and Characterization Laboratory (GPCL*). Dr. Richardson is currently President of the American Ceramic Society (ACerS), and a past-Chair of ACerS' Glass and Optical Materials Division (GOMD) and a past-President of the National Institute of Ceramic Engineers (NICE). She is currently a member of the Board of Directors of the Society of Photo-Optical Instrumentation Engineers (SPIE) and the Coordinating Technical Committee (CTC) of the International Commission on Glass (ICG). Most recently, Dr. Richardson has served on advisory boards of numerous organizations, including the Board of Directors of the American Ceramic Society (ACerS), Virginia Tech's Materials Science and Engineering Department, the NSF-ERC on *Mid-Infrared Technologies for Health and the Environment* (MIRTHE) at Princeton University and as part of the Australian Research Council's *Centre of Excellence for Ultrahigh-bandwidth Devices for Optical Systems* (CUDOS), in Sydney Australia. She is a recognized world leader in infrared glass research and education, and as a result of these efforts, currently holds the rank of Fellow, in the American Ceramic Society, the Society of Glass Technology (UK), SPIE and the Optical Society of America (OSA). Since 2006, she has served as a member of the Board of Trustees at Alfred University.

- **Mireille Blanchard-Desce** – Pr and team leader Photonics and Omics Enabled by Innovations in Chemical Synthesis - ISM – University of Bordeaux

Mireille Blanchard-Desce is a CNRS research director and the team leader of "Photonics and Omics Enabled by Innovations in Chemical Synthesis" (Phoenics) at ISM laboratory, she has over 220 publications in international journals, 6 book chapters, 6 patents, more than 90 invited lectures at conferences. She received several prizes and awards : the Bronze Medal of the CNRS (1990), Physical Chemistry prize of the French Chemical Society (1996), French Academy of Sciences Prix Mergier-Bourdeix (1999), Silver Medal of the CNRS (2008) and Légion d'honneur (2011). She has been the coordinator of international programs like TOPBIO (TwO Photon absorbers for BIOmedical applications) a FP7 Marie Curie Initial Training Networks (ITN) and principal investigator in numerous interdisciplinary projects.

- **Caroline Boudoux** – Pr. at École Polytechnique de Montréal, co-President/co-Founder of Castor Optics

Caroline Boudoux, PhD, obtained her PhD in 2007 from the Harvard-MIT Division of Health Sciences and Technology under the joint mentorship of Brett E. Bouma and Guillermo J. Tearney. She then studied coherent control applied to nonlinear microscopy at École Polytechnique (France) under Emmanuel Beaurepaire and Manuel Joffre before joining the Engineering Physics department of École Polytechnique Montréal in 2007 as an assistant professor. She is now an associate professor and a faculty member of the Biomedical Engineering Institute. She is currently a visiting scholar at Stanford University.Her research focuses on biomedical optics, particularly the translation of optical diagnostics technologies for clinical applications in the fields of head and neck surgery. In 2013, she co-founded Castor Optics, a spin-off company commercializing double-clad fiber optics couplers.

- **Marion Paoletti** - Policy Officer for equality between women and men at the University of Bordeaux

Marion Paoletti is associate professor of political science at the University of Bordeaux, she's member of the center Emile Durkheim. Since July 2014, she is Policy Officer for equality between women and men at the University of Bordeaux ? She recently published "France : feminist or antifeminist?" (with Christine Bard) in Travail, genre et société (32, 2014, pp. 141-163).

- **Christine Lagabrielle** – Associate Professor in psychology of labour and organizations (gender studies), Laboratory EA 4139 Psychology, Health and Quality of Life, University of Bordeaux

Several of her research are focused on gender stereotypes and difficulties faced by women in male-dominated jobs. These studies investigate how some individual factors (satisfaction, self-efficacy, organizational commitment, perception of gender identity conflict...) and some organizational factors (tactics of organizational socialization, social support...) influence the intention to leave or remain in jobs traditionally held by men.

Poster session – group A

- 4 : 00 pm – 4 : 30 pm – Auditorium
  Flash presentation
- 4 : 30 pm – 5 : 45 pm – Hall IOA
  Poster session

1	Probing the Phase Transitions of Silicon by Fourier-domain interferometry	Papagiannouli	Eirini
2	Micrometric Structuration of Second Order Nonlinear Optical Properties of Amorphous Materials	Bondu	Flavie
3	Experimental Investigation of Plasmonic Dicke Effect in Au-Fluorophore Nanohybrids	Fauché	Pierre
4	Second Harmonic Generation stability in chalcogenide glasses	Lepicard	Antoine
5	Generation and Parametric Amplification of Broadband Phase Stabilized Ultrashort Pulses at 2 µm	Archipovaite	Giedre Marija
6	Optical Manipulation of Vortex Lattice	Magrini	William
7	Laser-Induced Spectral Shift of Single Molecules Self-Coupled to a Metallic Surface	Reenu	Baby
8	2D & 3D Laser Micro-/Nano-Printing in Silver-Containing Glasses	Desmoulin	Jean-Charles
9	Analytical Formalism for the Analysis of Collective Light Scattering by Hybrid Nanostructures	Kosionis	Spyridon
10	Backwards Optical Torque	Hakobyan	Davit

Abstracts : Ref. Appendices

Cocktail & Exhibition

- 6 : 00 pm – 8 : 00 pm – Auditorium & Hall IOA

INVITATION ONLY

Opening exhibition (in french) :

Milieu amplificateur

Les lasers en Aquitaine

L'aquitaine abrite aujourd'hui le Laser Méga Joule, l'un des deux lasers les plus énergétiques du monde. Mais ce colosse n'a pas poussé sur un terrain neutre : la tradition de recherche, de formation et de transmission de compétences autour des lasers remonte aux années 1960. Dans cette exposition, vous découvrirez cet outil fascinant tant d'un point de vue technique et scientifique que parce qu'il suppose la transversalité des domaines d'activité, le travail en commun et le partage du savoir.

Bonne route !

Une exposition du **CNAM Aquitaine / LAPHIA-Université de Bordeaux / CEA**.

Avec l'aide de la Route des Lasers, la Région Aquitaine, Cap Sciences et le CNRS.

Commissaire d'exposition : Yann Deret Le Berre

Directeur Artistique : Jean-François Dareths

Comité scientifique : Emmanuel Abraham (Université de Bordeaux), Hervé Floch (Route des Lasers), Jean Lajzerowicz (CEA), Jean-Christophe Delagnes (Université de Bordeaux), Laurent Sarger (professeur émérite - Université de Bordeaux), Lionel Canioni (Université de Bordeaux), Sébastien Montant (CEA)

Remerciements : Anne-Lise Bué, Rolland Lehoucq, Sebastien Forget, Antony Mauvais, Olivier Retif, Catherine Cuenca, Christel Poujol

Friday session

- 9 : 00 am – 9 : 30 am – Auditorium
  Chairman : Jean-Christophe Delagnes – CELIA, France

How turn light into matter in laboratory

Xivier RIBEYRE – CELIA, France

X.Ribeyre[1], E. D'Humières[1], S. Jequier[1], M. Lobet[1,2], O. Jansen[1] and V.T. Tikhonchuk[1]

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Direct production of electron-position pairs in photon collisions is one of the basic processes in the Universe. The electron-positron production □+□ to $e^+ + e^-$ (linear Breit-Wheeler process) is the lowest threshold process in photon-photon interaction, controlling the energy release in Gamma Ray Bursts, Active Galactic Nuclei, black holes and other explosive phenomena [1]. It is also responsible for the TeV cutoff in the photon energy spectrum of extra-galactic sources.

The linear Breit-Wheeler process has never been clearly observed in laboratory with important probability of matter creation [2]. The laser induced synchrotron source of gamma-rays may open for the first time a possibility to observe this process in laboratory [3].

Thank with MeV photon source new experimental set-up based on numerical simulation with QED effect is proposed to achieved more than 10^4 Breit-Wheeler pairs per shot.

We acknowledge the financial support from the French National Research Agency (ANR) in the frame of "The Investments for the Future" Programme IdEx Bordeaux - LAPHIA (ANR-10-IDEX-03-02) - Project TULIMA. This work is partly supported by the Aquitaine Regional Council (project ARIEL).

[1] Ruffini, R. et al. Physics Reports **487**, 1-140 (2010).

[2] Bamber C. et al. Phys. Rev. D, **60**, 092004 (1999).

[3] Capdessus, R. et al., PRL **110**, 215003 (2013).

Friday session

- 9 : 30 am – 10 : 00 am – Auditorium
  Chairman : Jean-Christophe Delagnes – CELIA, France

Studying ancient materials with multi-physics for preventive purposes. The case of prehistoric wall paintings

Rémy CHAPOULIE – IRAMAT – CRP2A, France

R. Chapoulie[1], B. Bousquet[2], C. Ferrier[3], D. Lacanette-Puyo[4]
[1] IRAMAT-CRP2A, LASCARBX, Université Bordeaux Montaigne, France
[2] CELIA, LAPHIA, Université de Bordeaux, France
[3] PACEA, LASCARBX, Université de Bordeaux, France
[4] I2M-TREFLE, CPU, INP, France

The preservation of prehistoric ornate caves has been an issue for more than ten years now, following the problems encountered in the caves of Lascaux (France) and Altamira (Spain), due in particular to the presence of tourists.
The interdisciplinary and international skills of Bordeaux universities' labs as well as the fact that many sites are geographically close, have allowed researchers from many disciplines to gather their efforts together. The goal of the work in progress is to offer the best methodology to the curators of ornate caves.
The phenomena which are responsible for the evolution of the aspect of the walls represent the main challenges. Those phenomena can occur indiscriminately between the different phases of the paintings or after the last representations were drawn. In the latter case, they can lead to a degradation which is more or less advanced or even to their disappearance. The apparition of a layer of calcite on the painted walls is the most notable degradation phenomenon.
The work that has been started by the geo-archaeologists specialized in karstic zones and the climatologists concern scales that are inherent to their research subject; they are vast scales that go from the centimeter to the kilometer. That study is on-going. It is completed by an observation and analysis study on scales that go from the centimeter to the nanometer.
Our research is based on a pre-study that enabled the selection of a cave which is bare of cave art. That lab-cave – as it was dubbed – has been equipped in order to gather temperature data as well as CO2 levels. On that site, we try to adopt a double approach which associates whenever possible the lab methods and the field methods which are less sedentary.
That presentation, given at the symposium of the LAPHIA Excellence Cluster, will show the observation and analysis results in SEM-EDX, Cathodoluminescence, pXRF,

Raman and LIBS. We will namely reveal the co-existence of several types of calcitic facies on the walls. A database dedicated to the lab-cave in a digital workplace allocated to researchers and integrating geo-referencing (interactive 3D model) is being elaborated. That database should accelerate the work on data analyses.
The study which is being developed in the lab cave aims at defining the best analytical protocol. The latter will be applied to other sites and more specifically to the cave art sites since there is a special attention paid to the non-invasive aspect of the techniques that are used.
Results and conclusions are evidently expected in the case of painted caves. That is exactly what the MultiMat* program makes possible; to allow us to study other caves, painted or not, to elaborate an extensive blueprint which will benefit from all that data coming from all the different sites.

* The MultiMat program is supported by the IdEx (2015-2016). It works under the supervision of a scientific committee: Bruno Bousquet, Rémy Chapoulie, Catherine Ferrier and Delphine Lacanette-Puyo.
Related to this program are two other programs (CEGO and PHYT) both supported by the Région Aquitaine, with Léna Bassel as PhD and Faten Ammari as post-doc.

Friday session

- 10 : 00 am – 10 : 30 am – Auditorium
  Chairman : Jean-Christophe Delagnes – CELIA, France

Ultrafast Energy Transport at Nanometer Scale

Stefan DILHAIRE – LOMA, France

Energy transport is fundamental to both improving our understanding of basic material properties and advancing the intelligent design of new and more optimally functional materials. Energy transport is mediated by various particles and their subsequent interactions, including electrons, photons, phonons, plasmons, spinons, and excitons. The precise nature of any material determines which of these are most important. A more complete understanding of materials currently in development is of critical importance for a wide range of applications ranging from energy harvesting photovoltaics and thermoelectrics to next generation molecular electronics and mechanisms of material failure in nanoelectronics. Currently, there are a number of unanswered questions that are impeding the advancements of many important real-world applications, including the development of green technologies. Our research goal is to answer some of these questions. For example, how does nano-structuring --- such as changes in dimensionality, layering, and nanoparticle impregnation --- change energy transport characteristics? What effects do chemical and structural modifications on the near-field scale have on far field measurements of energy transport? Is it possible to decouple electronic and thermal transport in materials? What is the source of heat generation in nano electronics systems? The goal of this work deals with the design of materials with more precise and efficient control of energy transport by managing thermal properties of those systems or make them work to our advantage.

Currently, pump-probe spectroscopy is being successfully applied to energy transport measurements using techniques such as picosecond acoustics and time domain thermal reflectance with high temporal resolution. These measurements, however, are limited by the diffraction to half the wavelength light. Quasiparticle excitations such as plasmon- [2] and phonon [1] dominate near field, sub-wavelength effects, and high spatial resolution is required to probe them.

We will present ultrafast ultrasonics and temperature measurement allowing imaging and filming phonons, electrons and plasmons at femtosecond scale. Applications to ultrasonography of single cells [3], thermal conductivity identification of nano materials [1] and hot electron production in plasmic nano objects [2].

[1] G. Pernot et al., Precise control of thermal conductivity at the nanoscale through individual phonon-scattering barriers, Nature Materials 9, 491 (2010)
[2] O. Lozan,et al, Anomalous Light Absorption around Subwavelength Apertures in Metal Films, Phys. Rev. Lett. 112, 193903 (2014)
[3] Thomas Dehoux et al., All-optical broadband ultrasonography of single cells, Nature Scientific Report **5**, Article number: 8650 (2015)

Friday session

- 10 : 30 am – 11 : 00 am – Hall IOA
  Coffee break

- 11 : 00 am – 11 : 30 am – Auditorium
  Chairman : Stefan Dilhaire – LOMA, France

Interaction of femtosecond laser pulses with dielectric materials

Guillaume DUCHATEAU – CELIA, France

E. Smetanina[1], L. Barilleau[1], O. Dematteo[1], R. Beuton[1], B. Chimier[1], S. Skupin[1], A. Bourgeade[2], H. Bachau[1], G. Geoffroy[1], N. Fedorov[1], K. Mishchik[1], J. Lopez[1], C. Javaux Léger[3], C. Hoenninger[4], R. Kling[3], Y. Petit[5,1], T. Cardinal[5], L. Canioni[1], V. Tikhonchuk[1], G. Duchateau[1,*]

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Optical materials can be structured by laser pulses to get new material functionalities in various scientific area going from photonics to medicine. For instance, wave guides, nano-gratings, emergence of nonlinear optical properties for data storage, cutting and welding of materials are applications of great interest. Structuration driven by a train of laser pulses is strongly emerging due to its advantages: table top laser facility, very well controlled structuration with energy deposition accuracy in the nJ range by adjusting the number of pulses, etc. The material structuration due to pulse-to-pulse cumulative effects should be deeply understood to design specific structures. This may be achieved by modelling the main physical processes and their possible couplings.

Our strategy to model the overall interaction including the main physical processes responsible for material modifications will be presented, including a focus on the LAPHIA project MOBILE. For the latter, a phosphate glass doped with initially uniformly distributed Ag+ ions is irradiated. The laser-induced ionization first leads to the formation of Ag^0 atoms through the reaction $Ag^+ + e^- \rightarrow Ag^0$. The latter specie may then associate with Ag^+ to form Ag^{2+}, which exhibits luminescence properties allowing to observe the spatial size of modified zone. Experimental observations and calculations show the emergence of a micrometric ring structure after an irradiation by 107 laser p ulses with parameters: 1030 nm, 470 fs, 1.2 μm of waist, 100 nJ, 10MHz. Due to the migration of charged species, a static electric field originates leading to the formation of nonlinear optical properties. A model including laser heating, heat diffusion, and thermally-activated diffusion and kinetic reactions of the various silver species, allows us to account for the observed structure. Details of the modelling, mechanisms for cumulative effects, and influence of laser parameters on the ring characteristics will be presented as well.

This study has been carried out in part with financial support from the French State, managed by the French National Research Agency (ANR) in the frame of "the Investments for the future" Programme IdEx Bordeaux (ANR-10-IDEX-03-02). The CEA and Femtoweld project are also acknowledged.

Friday session

- 11 : 30 am – 12 : 00 am – Auditorium
  Chairman : Stefan Dilhaire – LOMA, France

Presentation of "Bordeaux Student Chapter in Optics"

Aquitaine Region is a fast-growing photonics Region: progress in optics and photonics plays an important role in many industrial sectors (aerospace, energy, automotive, communications, health, medical, etc). Thanks to its competitive environment (around 80 companies in laser and photonics, Alphanov – Route des lasers, high level research labs of the University of Bordeaux, IOGS Bordeaux …), Bordeaux is certainly the second place in France after Paris. The actors of the Aquitaine Region develop a common photonics strategy for future research and innovation in Europe.

We also have a large student community and our aim is to provide students with a range of internationally – recognized training courses, to enable them to become managers in photonics. In this frame, within the "Bordeaux SPIE Student Chapter in Optics", two profiles of students will be involved: the Master and PhD students in physics working in optics and photonics but also the Master and PhD students in chemistry connected to the materials and photonics area.

This project belongs to the education priorities of the Cluster LAPHIA (IdEx Bordeaux) and will federate the student community of Bordeaux: PhD and Master students from the University of Bordeaux and IOGS Bordeaux. It will allow them to build team skills in organizing events but also to connect with the international optics & photonics community. The creation of a SPIE student chapter is therefore a key project for our student community.

Contact : info.laphia@u-bordeaux.fr

Friday session

- 12 : 00 am – 12 : 30 am – Auditorium
  Chairman : Stefan Dilhaire – LOMA, France

HOBIT – Hybrid Optical Bench for Innovative Teaching

Martin HACHET – INRIA, France

We explore innovative approaches for teaching optics and we develop new forms of pedagogical supports. To achieve this goal, we built a complementary team composed of experts in the field of optics, human-computer interaction, computer graphics, sensors and actuators, and education science. Our objective is twofold. First, we want to ensure that the students will learn with our systems the same concepts and skills that they learn with traditional methods. Second, we hypothesis that such systems open new opportunities to teach optics in a way that was not possible before, by manipulating concepts beyond the limits of observable physical phenomena.

- 12 : 30 am – 2 : 00 pm – Hall IOA
  Lunch

Poster session – group B

- 2 : 00 pm – 2 : 30 pm – Auditorium
  Flash presentation
- 2 : 30 pm – 4 : 30 pm – Hall IOA
  Poster session

11	Light-Bending Effect in the Visible Range with U-Shaped Nanoparticles	Al Sheikh	Lamis
12	Matter-Wave Laser Interferometry Gravitation Antenna (MIGA)	Riou	Isabelle
13	Hot Electron Production in Plasmonic Devices	Lozan	Olga
14	Tuneable Organic Nanodots as Biocompatible and Eco-Friendly Alternative to Quantum Dots for Biophotonics	Cueto Diaz	Eduardo
15	Reactive Sintering of Niobate Compound by Spark Plasma Sintering	Kim	Ka-Young
16	Test of the Weak Equivalence Principle Using a Dual-Species Atom Interferometer in Microgravity	Chichet	Laure
17	Monte-Carlo Simulations on the Two-Photon Breit-Wheeler Process	Jansen	Oliver
18	Synthesis of Plasmonic Nanostructures for Guiding Light	Ivaskovic	Petra
19	From Ships to Rockets	Krasnodebski	Marcin
20	The PETAPhys diagnostics	Boutoux	Guillaume
21	Modification of Space-Charge Embedded Glass Surfaces by Photoactive Molecules	Bouriga	Meriem
22	Recent Results on Shock Wave Propagation in Low-Z Materials for Shock Ignition	Maheut	Yohann
23	Study of Shock Dynamics for Shock-Driven Inertial Confinement Fusion	Sakaki	Takaya
24	Slow Light : From Anderson Localization to Devices	Faggiani	Rémi
25	Modeling of Experiments on the Trapping of Relativistic Electrons in a High Intensity Optical Lattice	Hadj-Bachir	Mokrane
26	NIR-Emitting Molecular-Based Nanoparticles as New Two-Photon Absorbing Nanotools for Single Particle Tracking	Daniel	Jonathan
27	Spatially-Controlled Light-Triggered Self-Assembly of a Polyaromatic Organogelator	de Vet	Christiaan

28	Self-Assembled Fluorescent Nano-Ribbons : Imaging of Growth and Laser-Induced Local Color-Tuning on Individual Objects	Schäfer	Philip
29	Tunable GHz Repetition Rate Laser Pulses From a Single-Frequency Laser for Picosecond Acoustic Physics	Aubourg	Adrien
30	Influence of Laser Smoothing Choices on Stimulated Brillouin Scattering in the Context of LMJ Fusion Experiment	Chatagnier	Aurore
31	Phase Locking a Clock Oscillator to a Coherent Atomic Ensemble	Cantin	Etienne

Abstracts : Ref. Appendices

Poster's Prizes

- 4 : 30 pm – 5 : 00 pm – Hall IOA
  Closing session of the symposium
  By Philippe Balcou, deputy director of LAPHIA

General Information

The organizing comittee

- **Lionel Canioni** - Director LAPHIA : lionel.canioni@u-bordeaux.fr
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Website : http://laphia.labex.u-bordeaux.fr/en/

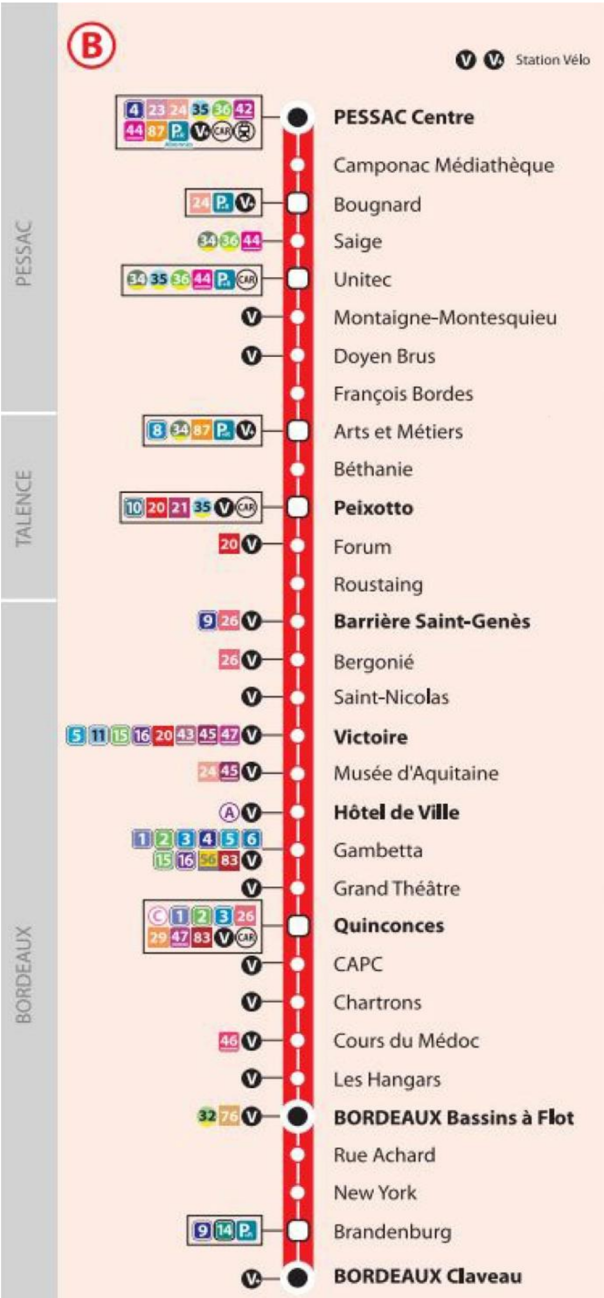
General Information

Transport – Tramway B

Institut d’Optique d’Aquitaine – Stop **“Arts et Métiers”**

Station Train Bordeaux St Jean – Stop **« La Victoire »** and then bus n° 10 or 16.

TBC Website : http://www.infotbc.com/



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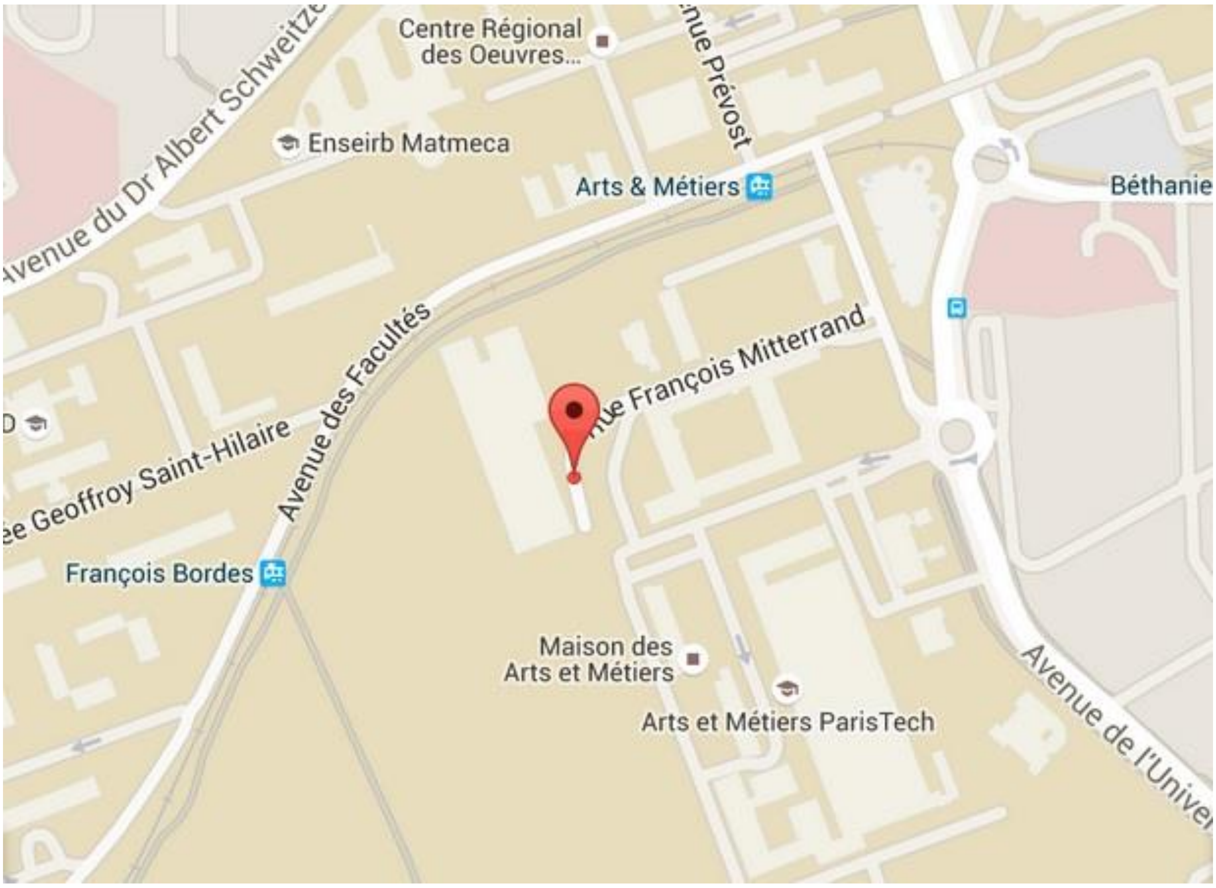

Appendices
Abstracts – Posters

1. PAPAGIANNOULI Eirini

Probing the Phase Transitions of Silicon by Fourier-domain interferometry

I. Papagiannouli, J. Gaudin, V. Blanchet, S. Petit, D. Descamps, C. Fourment

CELIA, Uni. Bordeaux, CEA, CNRS 351, Cours de la Libération, Talence cedex, France

The study of reflectivity of a solid material during its irradiation, as well as the ultrafast dynamics associated with the relaxation of the system, has been the subject of numerous theoretical and experimental works in the past. Among the many techniques that have been developed over these years, Fourier-domain interferometry (FDI) can provide both time- and space-resolved measurements with high resolution[1-3].

In the present work, polarisation resolved FDI has been performed on a silicon target in order to determine the amplitude and the phase of the complex reflection coefficients to probe phase transitions (amorphization and fusion) induced by ultra-short laser pulses[4]. A part (70 %) of the Aurore laser beam (1kHz, 25 fs, 800nm) was focused on the Si target (1 mm thick, <100> single crystal wafer) to trigger the phase transition. The remaining part of the beam (30%) was frequency converted through a non-collinear optical parametric amplifier (NOPA), finally delivering a 100 fs, 20 µJ probe pulse at 532 nm. Non-resonant pump-probe experiment has been therefore performed at different delays, up to 9 ps, and at different excitation levels, ranging from 50 to 350 mJ/cm². Post irradiation analysis using optical microscopy, AFM and micro-Raman spectroscopy reveal three different materials modification thresholds leading to amorphization or ablation. The threshold values for which the phase transitions of silicon was taking place were determined beforehand in order to perform the FDI measurements above each different threshold. The experimental results, currently under investigations, will be presented and discussed in terms of thermal and non-thermal processes with respect to recent theoretical results[5].

This first demonstration of non-resonant, polarization-resolved FDI measurements pave the way to new insight in ultra-short structural dynamics of irradiated materials.

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2. BONDU Flavie

MICROMETRIC STRUCTURATION OF SECOND ORDER NONLINEAR OPTICAL PROPERTIES OF AMORPHOUS MATERIALS

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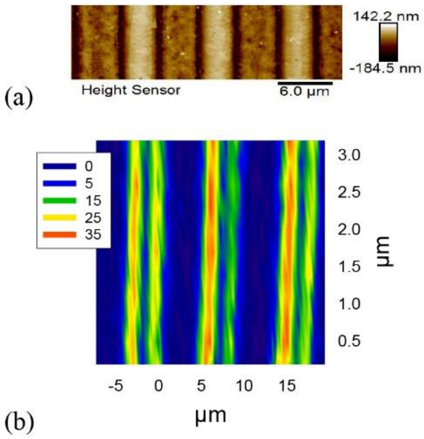
Since the 90's, the increasing need of information transport and storage leads to the elaboration of optical devices as frequency converters, amplifiers… These devices are based on the nonlinear optical (NLO) properties of the materials involved.

Amorphous materials do not exhibit second order NLO response because of their centrosymmetry. Thermal poling consists in applying a DC electric field on a heated sample which is then brought back to room temperature while maintaining the electric field. A space charge is induced within the poled material breaking its centrosymmetry which then induces second order NLO properties through an electro-optic effect.

In this work, we present a technic to design second order NLO properties in amorphous materials using structured electrodes during thermal poling [1].

In this study niobium borophosphate glass composed of Na, B, P, Nb, O is used. The anode consists of a 100 nm ITO layer deposited on a dielectric substrate. This electrode has been previously structured by locally removing the ITO layer to obtain a succession of insulated and conductive lines. This structuration was printed on the surface of the niobium borophosphate glass. Figure (a) presents the glass topology measured by atomic force microscopy (AFM) after thermal poling. It shows topological variations on the glass surface corresponding to the printed lines [2,3]. Figure (b) presents the NLO signal oriented in the plane of the surface measured by second harmonic generation microscopy (SHG) after thermal poling. The maximum of the NLO signal is localized on the border of the lines.



Figures : (a) Cartography of the glass surface measured by atomic force microscopy, (b) Cartography of the NLO signal oriented in the surface plan measured by second harmonic generation microscopy after thermal poling treatment.

SHG microscopy showed the possibility to control the localization and the geometry of the anisotropy within the poled material using structured electrodes and thus to control its second order NLO properties. The charge accumulation due to edge effect on the electrode structuration seems to be a key point of this micro-poling process.

Raman, X-ray microprobe and ellipsometry analyses allowed determining the structure, the composition and the optical indices variation of the glass.

The possibility to induce a microscopic structuration of the second order NLO signal on amorphous surfaces was demonstrated. This new second order NLO properties printing process is easy to apply and would allow the elaboration of optical devices.

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3. FAUCHÉ Pierre

Experimental Investigation of Plasmonic Dicke Effect in Au-Fluorophore Nanohybrids

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In collaboration with Spyridon Kosionis[2] and Philippe Lalanne[2].

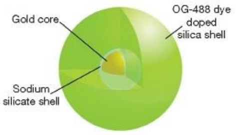
1. Abstract

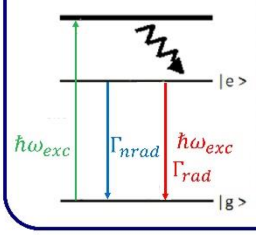
After Bergman and Stockman [1] introduced the phenomenon of surface plasmon amplification by stimulated emission of radiation (SPASER) in 2003, the realization of a SPASER-based nanolaser has been demonstrated by Noginov [2] *et al* in 2009 for a strongly doped silica shell around a gold core. To gain insight into this nanoplasmonic device, Pustovit and Shahbazyan proposed the mechanism of plasmonic superradiance to describe cooperative emission by a finite ensemble of emitters located near a metal nanoparticle [3]. We present experimental evidence of the plasmonic Dicke effect from the fluorescence characterization of different concentrations of organic emitters grafted to plasmonic nanoparticles.

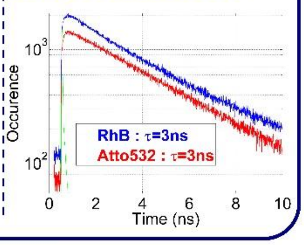
2. Introduction

Quantum nanoplasmonics : need for a nanometric, coherent and high-frequency modulable source

Diagram of the hybrid nanoparticle architecture used by Noginov *et* al. [2] to demonstrate a SPASER-based nanolaser as proposed by Bergman *et al.* [1]







3. Theoretical model

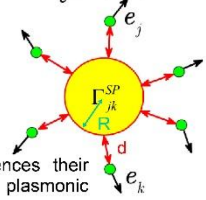
Lorentz oscillators driven by the common electric field created by all dipoles in the presence of a metal nanoparticle.

$$\frac{\epsilon(r,\omega)\omega^2}{c^2}\boldsymbol{E}(\boldsymbol{r},\omega) - \nabla\times\nabla\times\boldsymbol{E}(\boldsymbol{r},\omega) = -\frac{4\pi i\omega}{c^2}j(r,\omega)$$

Using Green formalism

$$\Gamma_{jk} = -\frac{4\pi q^2\omega_0}{mc^2} Im\{\boldsymbol{e}_j\cdot G(\boldsymbol{r}_j,\boldsymbol{r}_k,\omega)\cdot\boldsymbol{e}_k\}$$

$$\Gamma_{jk} = \Gamma_{jk}^{rad} + \Gamma_{jk}^{nrad} \qquad j,k \in [1;N]$$

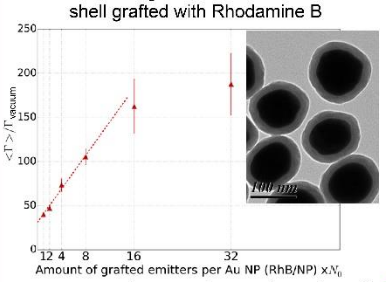


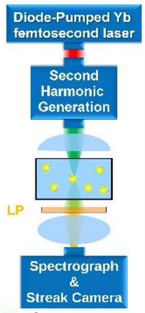
Plasmonic coupling of emitters influences their fluorescence properties to form plasmonic superradiance.

We are interested in the evolution of Γ.
This decay rate is expected to scale with the number of emitters N.

4. Ensemble Results

86nm diameter gold core with a 15nm silica shell grafted with Rhodamine B



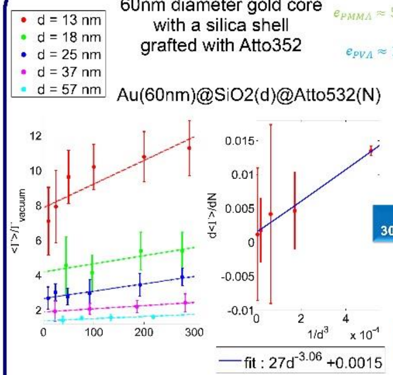


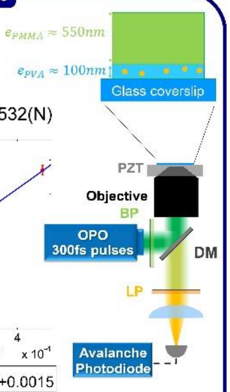
Average decay rate scales with N before saturation of the surface

5. Single particle Results

60nm diameter gold core with a silica shell grafted with Atto352

Au(60nm)@SiO2(d)@Atto532(N)





- Average decay rate scales with N
- $\Gamma_{N=1}$ is larger close to the core
- $\frac{d<\Gamma>}{dN}$ evolves as $1/d^3$

6. Conclusion

- As predicted, the average decay rate scales with the number of emitters [3].
- The average decay rate evolves as $1/\mathrm{d}^3 + \Gamma_{N=1}$.

7. Perspectives

- Reproduce and better understand experimental results using simulation
- Observe the evolution of the response during the acquisition.
- Directly correlate optical response with structure using Quantum Dots

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Acknowledgements

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This study is part of the cooperative project TAINEPEC.

4. LEPICARD Antoine

Second Harmonic Generation stability in Chalcogenide glasses

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Abstract

Glass substrates with controlled linear and non-linear optical properties are necessary for micro-photonic applications. Such platforms can be used for the design of novel devices suitable for active optical elements and detectors. Chalcogenide glasses offer a large window of transparency in the infrared region, where most organic compounds have their signatures, making them ideal for spectroscopic applications. They also exhibit a high third order optical susceptibility: $\chi^{(3)}$. Second order optical properties are forbidden in a centrosymmetric medium. Thermal poling can break this centrosymmetry and result in a strong second order optical response. Chalcogenide glasses with their high $\chi^{(3)}$ give potentially the highest second harmonic generation among glasses. However, it has been shown that the second order optical response of poled chalcogenide glasses is not stable in time. To avoid fast relaxation of the process and to enhance longer term stability, the effect of silver injection in sulfide glasses was investigated. Second harmonic generation has been studied as a function of thermal poling parameters such as atmosphere, type of electrodes, applied voltage and temperature. Resulting signals were evaluated for their magnitude and post-poling stability. We show that the origin of the resulting signal is due to several contributions: one from the electric field and another from induced structural rearrangements.

5. ARCHIPOVAITE Giedre Marija

Generation and parametric amplification of broadband phase stabilized ultrashort pulses at 2 μm

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Ultrashort pulse light sources in the short wave infrared are interesting for different applications such as shorter attosecond pulse generation, ultrafast spectroscopy and explosive or gas detection. Unfortunately, there is no laser gain medium suitable for intense femtosecond pulse generation in this region. Therefore, the broadband signal should be generated using nonlinear frequency conversion. Usually, three methods of frequency conversion are applied: 1) difference frequency generation (DFG) between a pump and a signal pulse in a optical non-linear crystal; 2) DFG between different spectral regions of the same broadband pulse; 3) generation of an idler pulse in an OPA [1]. The generated broadband signal can later be amplified in an optical parametric chirped pulse amplifier or OPCPA [2].

In this experiment (Fig. 1) parametric amplification and generation of broadband pulses at 2 μm were investigated using DFG and OPA methods.

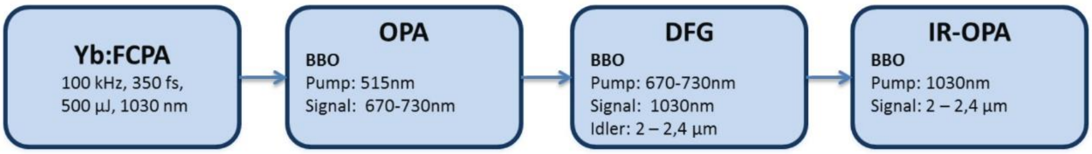

Fig. 1. Generation and parametric amplification of broadband CEP stable pulses at 2 μm.

The pump source for our 3-stage-OPA system is a home made Ytterbium doped fiber chirped pulse amplifier (Yb:FCPA) [3]. This pump system delivers 350 fs, 320 μJ pulses at 1030 nm with a repetition rate of 100 kHz. The OPA set up consists of 3 stages as depicted on figure 1: OPA, DFG and IR-OPA. In the first stage, broadband pulses of white light continuum (WLC) are amplified by the second harmonic of the Yb:FCPA pump beam. Here, a 40 nm wide spectrum around 700 nm is amplified in order to generate laser pulses at 2-2,5 μm in the next stages. In the second stage, difference frequency generation between the amplified broadband signal and fundamental pump produces carrier envelope phase (CEP) stable idler pulses in the 2 μm region. In the final stage, idler pulses, generated in the previous stage, are amplified by the fundamental Yb:FCPA pump beam. BBO crystals of different length are used in all three stages.

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6. MAGRINI William

Optical manipulation of vortex lattice

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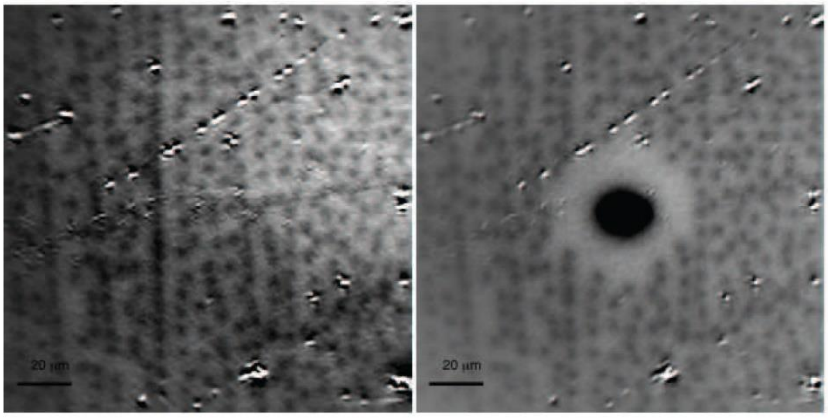
Here, we combine a magneto-optical imaging (MOI) system capable to resolve single vortices with movable focused laser beam beam to reorganize vortex matter in dense vortex clusters. The local heating of the superconductor with the laser produces a temperature profile which induces an attraction of the vortices towards the center of the laser spot. We analyze the collective vortex dynamics under high-power laser irradiation. The formation of vortex clusters is described with a model very similar to the one describing the first vortex entry into a type-II superconductor.



(a) Arranging of randomly distributed vortices. (b) Arrangement of vortices in a cluster after laser heating.

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7. REENU Baby

Abstract

The spectral properties of fluorescent molecules change when they are placed near a conducting surface. In 2007, Labeau [1] observed a spectral shift on the resonance frequency of zero phonon line (first purely electronic transition) of single molecules close to metallic surface with excitation intensity. The shift which is completely absent with dielectric substrates, is found for various metal layers of different thicknesses and for different host-guest systems. The observed shift has a linear dependence with the excitation intensity and inversely on the dephasing rate (phonons). The shift was first explained by the dipole-dipole interaction due to molecule self-coupled by a metallic mirror. But, in that case, the shift in the resonance frequency should saturate with excitation intensity, which was not observed. In my thesis, I would like to give a more accurate explanation for this spectral shift. One possibility is due to the roughness on the gold surface which can excite surface plasmons and result in the coupling between molecules. In order to investigate this, I find molecules showing the spectral shift on atomically flat gold flakes where the roughness is negligible. We observed 5 % of molecules showing the laser-induced spectral shift on gold flakes which exclude the role of roughness. The work of Perreault [3] gives an insight about the modification of the van der Waals (vdW) interaction between molecule and surface with optical field. In the non-retarded regime, the vdW interaction depends on I/Δ^2 (I is the excitation intensity, Δ is the detuning). Future work will be to study the dependence of the spectral shift of the molecule with the laser detuning.

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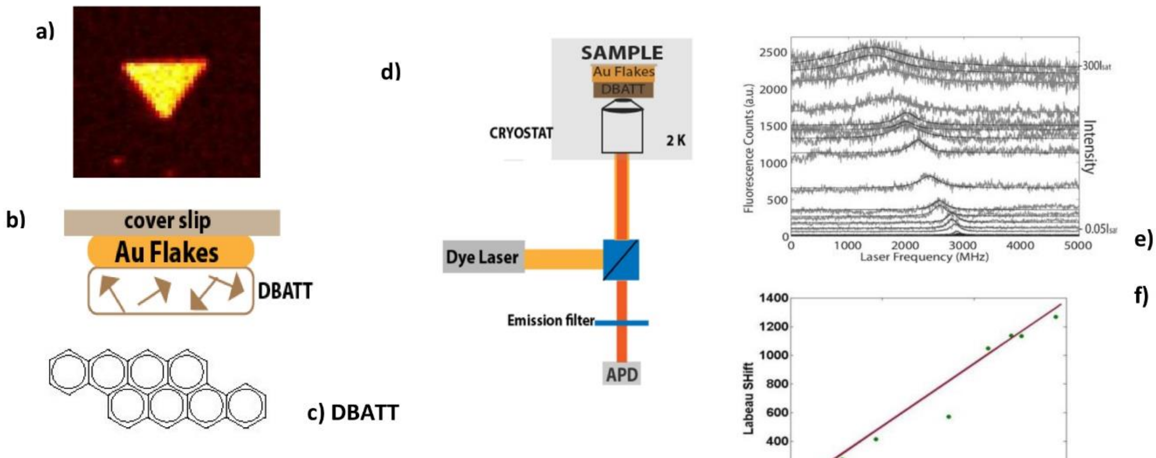

Fig 1: a) Image of gold flake. b) Sample: DBATT molecules in hexadecane matrix over gold flakes. c) Chemical structure of the aromatic DBATT molecule. d) Experimental setup. e) Laser induced spectral shift. f) linear shift dependence on linewidth

8. DESMOULIN Jean-Charles

The development of integrated optical components requires miniaturizing the optical functions. Nowadays, **3D Direct Laser Writing (DLW)** using **femtosecond Lasers** is emerging for **designing new functionalities in glasses**.

Phosphate glasses containing **silver ions** allow the **Laser writing of patterns** with **original luminescence or nonlinear optical properties**.

Thermal assisted photochemistry can be achieved thanks to **high-repetition rate** femtosecond Lasers and **heat control** via cumulative effects. Tailoring the **glass composition** and the Laser parameters enable taking profit of **photochemical** and **ionic migration** mechanisms. Strong **embedded electric field** can be implemented. Redox phenomena combined with the migration of mobile species lead to localized highly **light-emitting structures** in the voxel region.

Luminescence, nonlinear optical correlative spectroscopies and local chemical analysis allow identifying the silver species and following the physicochemical photo-produced modifications.

9. KOSIONIS Spyridon

Analytical Formalism for the Analysis of Collective Light Scattering by Hybrid Nanostructures

Spyridon Kosionis[1] & Philippe Lalanne[1]

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In collaboration with Pierre Fauché and Brahim Louis

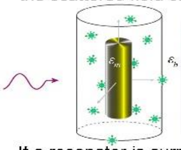
Abstract

Hybrid systems composed of discrete ensemble of point scatterers and a single resonator possess interesting optical properties, owing to the reinforcement of cooperative electromagnetic effects between the dipoles due to the interaction with the nanoresonator. In the work of Pustovit et al. [1], it was shown that the plasmon-assisted interactions between the emitters lead to cooperative emission of light. The coherent radiation of the emitters is known as plasmonic Dicke effect, since Dicke was the first to predict the collective spontaneous emission of an ensemble of emitters [2]. In the present work, we provide a theoretical description of the collective scattering response of a hybrid system comprising a molecular ensemble that surrounds a nanoresonator. Both the direct and the plasmon-assisted interactions between the emitters are included in the description. The implementation of the quasi-normal modes' (QNM) formalism is of crucial importance for the description of the electromagnetic field radiated by dissipative systems, especially for arbitrarily shaped nanoresonators, where Mie theory is not applicable. The decomposition of the radiated field by a plasmonic system is very useful, since once the QNMs are identified and normalized, the computational time for its electromagnetic response is dramatically reduced [3]. Our numerical calculations show that the profile of the average scattering cross section of the hybrid system, strongly depends on the distance between the resonator and the emitters.

1. QNMs` formalism: Total field in a hybrid nanostructure

Definition: The QNMs of a resonant structure are electromagnetic field distributions $(\tilde{\mathbf{E}}_m, \tilde{\mathbf{H}}_m)$ that are solutions to the source-free Maxwell`s equations.

Modal expansion: when a resonator is excited by a source, the scattered field can be expanded into a set of QNMs.



Transition wavelength $\lambda_t = 920\ nm$

Natural linewidth $\gamma_0 = 75MHz$

Index of refraction of the host medium $n_b = 1.5$

Index of refraction for Au is given by the Drude model

$n_m^2 = 1 - \omega_p^2 / (\omega^2 - i\omega\Gamma)$ $\omega_p = 1.26 \cdot 10^{16} s^{-1}$ $\Gamma = 1.41 \cdot 10^{14} s^{-1}$

If a resonator is surrouded by *N* molecules, the **total field at the position of dipole** ***i*:**

$$\mathbf{E}_i(\mathbf{r}_i,\omega) = \mathbf{E}_i^I(\mathbf{r}_i,\omega) + \mu_0\omega^2 \sum_{j\neq i} \mathbf{E}_b^j(\mathbf{r}_i,\omega) - \mu_0\omega^2 \sum_{\substack{j\neq i \\ m}} \mathrm{a}_m^j \tilde{\mathbf{E}}_m(\mathbf{r}_i,\omega) + \mu_0\omega^2 \sum_m \mathrm{a}_m^i \tilde{\mathbf{E}}_m(\mathbf{r}_i,\omega)$$

First term: the incident field plus the scattered field by the resonator

$$\mathbf{E}_i^I(\mathbf{r}_i,\omega) = \mathbf{E}_b^I(\mathbf{r}_i,\omega) + \sum_m \beta_m \tilde{\mathbf{E}}_m(\mathbf{r}_i,\omega) \quad \text{with} \quad \Delta\varepsilon = \varepsilon_m - \varepsilon_b$$

$$\beta_m(\mathbf{E}_b^I,\omega) = -\frac{\omega}{\omega - \tilde{\omega}_m} \iiint \Delta\varepsilon(\mathbf{r},\omega)\mathbf{E}_b^I(\mathbf{r},\omega)\tilde{\mathbf{E}}_m(\mathbf{r})d^3\mathbf{r}$$

Second term: direct interaction of the dipole i with all the other dipoles *j* in space

Third term: resonator-mediated interaction of the dipole i with all the other dipoles *j* in space

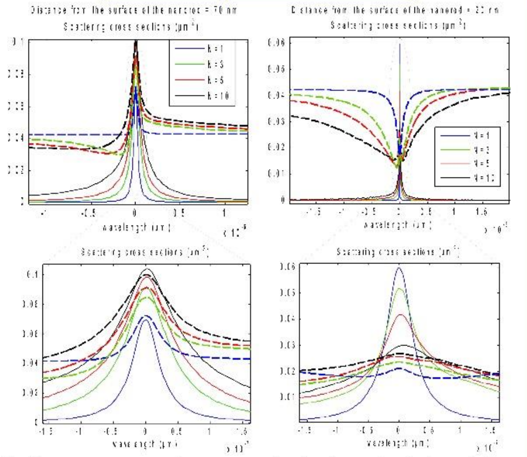
Fourth term: self-interaction of the dipole i (coupling of dipole i to the field scattered back to its position by the nanorod, after initially being emitted by the same dipole)

2. Induced Dipole Moments

$$\mathbf{p} = \alpha(\mathbf{I} - \alpha\mathbf{A} - \alpha\mathbf{I}\mathbf{b}^{(2)})^{-1}\mathbf{b}^{(1)}$$

- $\mathbf{b}^{(1)}$: *N*-dimensional vector. Its elements are the projections, on the dipoles' orientation, of the total field at the position of every single dipole, in the absence of all the dipoles
- $\mathbf{p}$: *N*-dimensional vector. Its elements are the amplitudes of the dipole moments induced
- $\mathbf{A}$: *NxN* matrix. Its elements describe the metal nanoparticle-mediated interactions (Diagonal terms: self-interactions of the molecules, Non-diagonal terms: interactions between different molecules)
- $\mathbf{b}^{(2)}$: *NxN* matrix. Its elements are the projections of the direct-interaction field components between the dipoles

3. Collective Average Scattering Cross Section



Position-average scattering cross-section (scs) spectra, for large (70 nm, first column) and small (20 nm, second column) molecular ensemble - resonator surface distances. Dashed curves: nanoparticle present, Solid curves: nanoparticle absent.

Large molecular ensemble - resonator surface distance:

- the scs is nearly a superposition of the scs of the ensemble and of the nano-resonator, due to the indirect negligible interaction
- suppression of the scs, on resonance [4]

Small molecular ensemble - resonator surface distance:

- reduction of the scs, on resonance, due to destructive interference [5] of the dipoles induced in the metal resonator by the incident field and the field sent to it by the molecular ensemble
- the suppression of the scs, on resonance, becomes even more intensive
- the increase of the number of the molecules leads to a broadening of the scs, mainly due to the increase of the indirect interaction

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Acknowledgements

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10. HAKOBYAN Davit

Backwards optical torque

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Abstract. We report on the angular analog of counter-intuitive negative optical forces by demonstrating experimentally that circularly polarized light can exert a torque on matter with opposite direction to that of the incident optical angular momentum.
Keywords : Optomechanics; Spin-orbit interaction of light; Optical angular momentum; Rotational Doppler effect.

In the recent years, unconventional optomechanical effects attracted a growing interest that was triggered by the concept of so-called negative optical forces, which refers to optical forces that push objects upstream of an incident photon flux [1] and whose experimental demonstrations of negative optical forces emerged only recently [2,3]. The extension of such counter-intuitive effects to optical torques, namely the angular analog of negative optical forces, is the purpose of our work. This corresponds to a light field exerting a radiation torque on matter, where the direction of the torque is opposite to that of the incident angular momentum [4].

Such a generalization led us to describe the reported optomechanical effects as being 'left-handed' rather than 'negative'. Indeed physicists usually refer to a phenomenon as being 'left-handed' to emphasize its counter-intuitive ("unconventional") nature and this terminology avoids potential confusion with the sign of the incident angular momentum, which can be positive or negative, irrespective of whether it induces expected or counter-intuitive mechanical effects. The concept is summarized in Fig.1 where both right-handed and left-handed manifestations of the optical torque are illustrated in the case of an arbitrary polarized incident Gaussian beam propagating along the z axis.

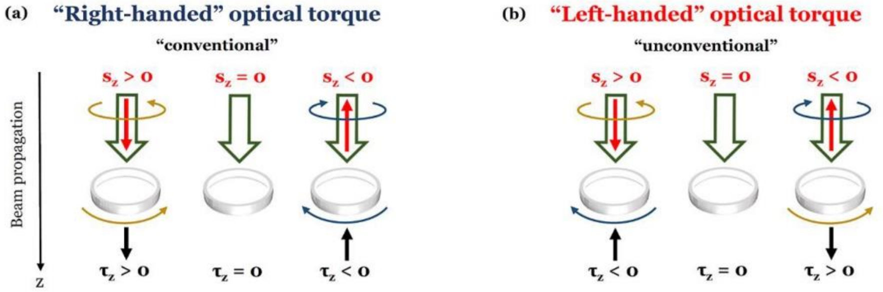

Figure 1. Illustration of intuitive and counter-intuitive mechanical manifestations of an optical torque τ_z exerted on matter by an arbitrary polarized Gaussian beam that carries an incident optical angular momentum s_z per photon along its propagation direction. (a) Right-handed situation. (b) Left-handed situation.

Acknowledgements. This study received financial support from the French State in the frame of the 'Investments for the future' Programme IdEx Bordeaux (reference ANR-10-IDEX-03-02).

11. AL SHEIKH Lamis

Lecture privée

12. RIOU Isabelle

Matter-wave laser Interferometry Gravitation Antenna (MIGA)

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LP2N, Univ. Bordeaux - CNRS - Institut d'Optique Graduate School, F-33400 Talence, France

1. Motivation

→ New type of hybrid optical-atomic gravitational detector which allows to perform high precision gravitational measurements at very low frequencies.
→ Sub10-Hz regions not accessible with pure optical (earth-based) interferometers due to seismic noise limitations.
→ Space and time correlated measurements.
→ Detection of gravitational changes on large time scales extremely interesting for geophysical analysis (geology, hydrogeology) as well as the detection of low frequency gravitational waves (sub-Hz).
→ Gravity sensitivity of 10^{-10} g/√Hz at 2 Hz.
→ Gradient sensitivity of 10^{-13} s^{-2}/√Hz at 2 Hz.

2. Operation principle

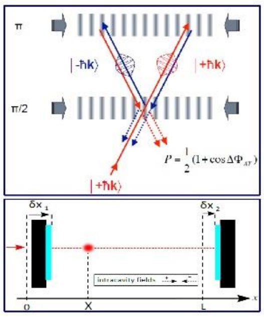
→ Pulsed-light atom interferometry with ^{87}Rb inside optical cavities.

→ 2 cavities at 780nm provide π/2–π–π/2 pulse sequence in Bragg regime.

→ Total atomic phase shift at the output: $\Delta\Phi_{AT} = (\Delta\phi_1 - 2\Delta\phi_2 + \Delta\phi_3)$

→ Probability to find atoms in state $|F=2, m_F=0, -n\hbar k\rangle$ after interrogation:

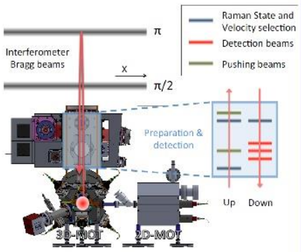
$$P = \frac{1+\cos\Delta\Phi_{AT}}{2}$$



Phase shift for a single atomic head (Injection from the left port)

$$S_\varphi(X) = \frac{4\pi v_0}{c} s_{x2} + \frac{4\pi}{c}\left[-s_{\delta v} + \frac{v_0}{2} s_h\right](X-L) + s_I(X) + \tilde{s}$$

Origin of the phase shift: Position fluctuation of the right mirror; Injection laser frequency noise; Strain of the gravitational waves; Local acceleration of the atoms; Measurement noise

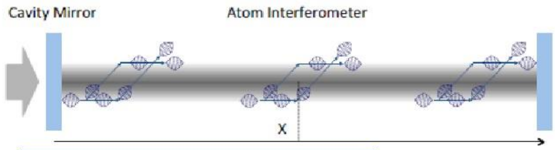


Preparation

→ First Raman beam to apply long π-pulse for velocity selection of atoms in $|F=1, m_F=0\rangle$ state.
→ Atoms remaining in state $|F=2, m_F=0\rangle$ are expulsed using a blast beam.
→ Secon Raman π-pulse to transfer atoms from $|F=1, m_F=0\rangle$ to $|F=2, m_F=0\rangle$ state.
→ Remaining atoms in state $|F=1, m_F=0\rangle$ are pushed out by another blasting beam.

Detection

→ As the angle between the two output ports is very small, a detection system based on internal state is preferred.
→ Second pass through upper Raman beam after Bragg interrogation transfers atoms from $|F=2, m_F=0, n\hbar k\rangle$ to $|F=1, m_F=0, (n-2)\hbar k\rangle$.
→ A fluorescent detection scheme measures the number of atoms on the two internal states.

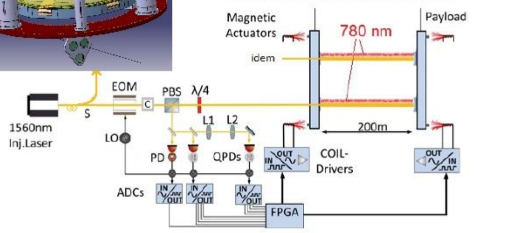


3. Suspension and injection

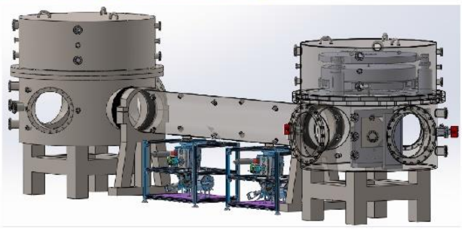
→ The mirror position noise on the atomic interferometer should be smaller than 1mrad. A good seismic isolation is required.

→ Pendulum-like suspension of payload with cavity mirrors.

→ Payload position controlled by magnetic actuation.



4. Prototype at LP2N



→ 7m long cavity under vacuum with 2 atoms interferometers and two complete suspension systems.

→ Facility to test components for the final underground installation in Rustrel (France).

→ The atom interferometers have to be under ultra high vacuum (10^{-9} mbar) in order to obtain a good fringe visibility.

5. Conclusion & perspectives

→ New type of hybrid optical-atomic gravitational detector for high precision gravitational measurements at low frequencies, commonly not accesible with pure optical earth-based interferometers because of seismic disturbances.
→ 7m long MIGA prototype is a test bench for the final MIGA experiment and will be used to push the atoms-cavity interaction to its limit.
→ Underground setup will provide an excellent environment in terms of gravity noise.
→ One meter prototype cavity-aided atomic interferometer planned for 2015 / Seven meters interferometer with two heads for end of 2016.

Acknowledgements

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13. LOZAN Olga

Hot-electron production in plasmonic devices

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The initial decay of surface plasmons occurs mainly via the creation of an electron-hole pair. This rapid process is detrimental for most plasmonic applications and devices, since it destroys the coherence of the collective electron oscillations, limits the lifetime and propagation length of surface plasmons and prevents the realization of drastic local field enhancements and limits plasmonic lifetimes to a few tens of femtoseconds. Conversely and positively, one may rather consider how to make use of the generated hot electrons to study new physical effects and to design new devices.

At the conference, we will present our recent efforts in the new area of plasmons and hot electrons:
Absorption-loss measurement in nanostructured films with hot electrons. The knowledge of the absorption losses (the local heat source term in the thermal diffusion equation) in devices using metal films is crucial for most components. The local heat generated by plasmon decays cannot be directly measured with classical low-temporal resolution techniques because these techniques provide temporally- and spatially-broadened versions of the local heat source (after heat diffusion in the metal). We have used the permittivity changes induced by hot electrons to measure the absorption losses in metal films incorporating subwavelength apertures. The measurements performed in a temporal scale of 500 fs, much smaller than the characteristic diffusion times of electrons and phonons, shows quantitative agreement with theoretical results [2].

Generation of hot electrons in plasmonic tapers. Devices capable of generating hot-electrons with good efficiencies in nanoscale spots are likely to be highly desirable [1] for future prospects in the emerging field of plasmon-induced hot carrier generation. At the conference, we will show measurements of the permittivity variations induced by the hot-electron energy relaxation in the electron gas of adiabatic nano-focusing plasmon tapers. The variations that are collected ~100-fs after the plasmon absorption are expected to provide faithful images of the local heat source or equivalently of the density of hot-carrier generation

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14. CUETO DIAZ Eduardo

Tuneable Organic Nanodots as Biocompatible and Eco-Friendly Alternative to Quantum Dots for Biophotonics

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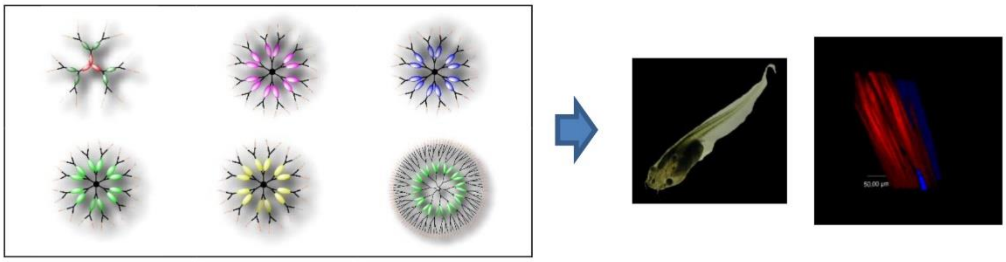
Molecular two-photon absorption (TPA) has attracted a lot of interest over the last decade owing to its applications in various fields including spectroscopy, three-dimensional optical data storage, microfabrication, high-resolution three-dimensional imaging of biological systems, and photodynamic therapy. Among these, two-photon-excited fluorescence (TPEF) has gained widespread popularity in the biology community due to the advantages it provides in microscopic imaging. Among inorganic nanomaterials, semiconductors quantum dots (QDs) have earned overwhelming popularity as photonic nano-objects due to their unique photonic and electronic properties. These include record excitation cross-sections, luminescence tunability, photostability …. However, bright QDs suffer from several drawbacks such as toxicity, blinking … and raise a number of questions with respect to environmental and safety issues (clearance, biodegradability…). In order to address these issues, we have implemented a molecular approach towards biocompatible and eco-friendly soft organic nanodots. These purely organic nanoemitters are obtained from a rational and bottom-up route and differ in both their design and electronic origin of luminescent properties from QDs. Our route is based on the control, at the single nano-object level, of the optical responses via the covalent confinement of optimized chromophores within dendrimeric architectures in which interactions are controlled. This led to tuneable nano-objects which show record one- and two-photon brightness[1] and have been shown to be a major interest for in vivo imaging[2].



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15. KIM Ka-Young

Reactive sintering of niobate compound by spark plasma sintering

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Résumé

The subject aims to explore the use of new active media for the conception of new energy converter emitting in the visible spectral domain and featuring a good optical beam quality.
For a wide range of applications, red diode lasers are needed and do not offer the necessary beam quality. Frequency doubling, as used for green light generation, remains a challenge because of the difficulty of the elaboration of laser emitting around 1.2 – 1.3 µm. Moreover, this additional step does not appear very efficient in terms of compactness and performance due to the relative small efficiency of the SHG process. However, solid-state lasers emitting in the visible are still very rare.

We propose in this poster to investigate the preparation of optical ceramics to generate visible laser emission.
Transparent ceramics present a good alternative to single crystals for the processing of massive refractive materials. Many studies have been reported on yttrium sesquioxide, yttrium aluminum garnet (YAG) or magnesium aluminate spinel ($MgAl_2O_4$) materials that present interesting optical properties in the field of laser materials [1,2].
We propose here to describe the synthesis of Eu-doped Y_3NbO_7 ceramics using a reactive SPS sintering process. This material crystallizes in a cubic symmetry which is the first criteria to avoid anisotropy of optical properties. As previous investigations showed the possibility to reach a good transparency for the corresponding lutetium niobate [3], this matrix seems to be a good candidate for doping with rare earth elements.
Diffraction patterns showing the evolution of the formation of the desired phase will be discussed as a function of the powder preparation and SPS sintering conditions as well as the microstructural features of the final ceramics. The luminescence of the corresponding pellets will be also described.

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16. CHICHET Laure

Test of the weak equivalence principle using a dual-species atom interferometer in microgravity

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1. Abstract

During the last two decades, new techniques to cool and manipulate atoms have enabled the development of inertial sensors based on atom interferometry [1]. One of the goals of the ICE project is to test the weak equivalence principle (WEP) using a compact and transportable dual species atom interferometer with ^{87}Rb and ^{39}K. These two atoms have similar transition wavelengths (780 nm and 767 nm) and very different masses. To make precise tests of the WEP, this experiment is performed in a micro-gravity environment during parabolic flights onboard the Novespace zero-g aircraft using a hybrid method to account for high vibrations on the plane [2]. Recently, we successfully operated the **first dual-species atom interferometer in microgravity**.

2. Weak Equivalence Principle

- Is a postulate: "The trajectory of a body in free fall with a gravitational field is independent of its mass or of its internal composition"
- Want to test with quantum bodies (atoms)

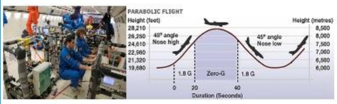
Eötvös parameter:

$$\eta = 2 \cdot \left\| \frac{\overrightarrow{a_{Rb}} - \overrightarrow{a_K}}{\overrightarrow{a_{Rb}} + \overrightarrow{a_K}} \right\| < 10^{-13}$$

3. The ICE experiment

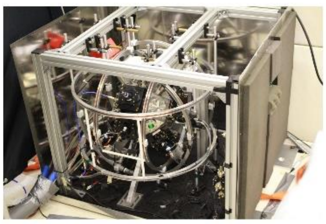
Parabolic flights

~2 campaigns per year (ESA or CNES) in the Airbus A310 Zero-G of Novespace
⇒ 30 min of 0g per flight campaign



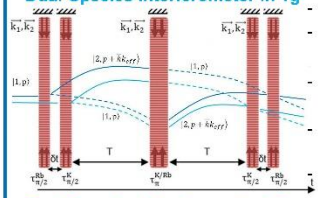
Setup

- Fiber-based Telecom lasers frequency-doubled from C-band (1560 nm & 1534 nm) to 780 nm & 767 nm for Rb and K respectively[3]
- Master-slave laser architecture
- Master lasers are locked on saturated absorption
- Titanium vacuum system
- Magnetic field compensation coils
- Ion pump (10^{-10}Torr)

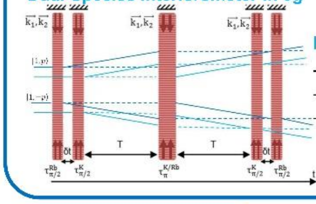


4. Atom interferometry

Dual-Species Interferometer in 1g

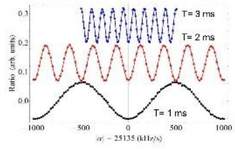


Dual-Species Interferometer in 0g



Principle

- Mach-Zehnder configuration
- Probability after detection
$$P_{|2\rangle} = 1/2 \cdot (1 - C\cos(\Delta\Phi_a + \Delta\Phi_{laser}))$$
- Phase shift sensitive to the atom's acceleration:
$$\Delta\Phi_a = (k_{eff} \cdot a)T^2$$
- In 1g, the Doppler effect of falling atoms requires us to chirp the laser frequency: $\Delta\Phi_{laser} = -\alpha T^2$
- Exact compensation of Doppler effect gives measure of g



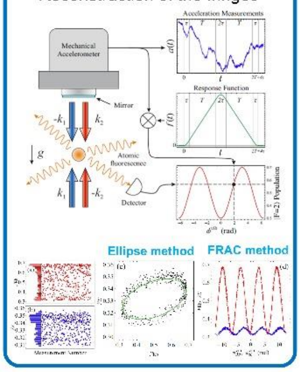
In 0g

- No Doppler effect
- Split interferometer into two
- Probability after detection
$$P_{|2\rangle} \propto \frac{1}{2}(1 - C\cos\Delta\Phi_a \cos\Delta\Phi_{laser})$$

6. Analysis techniques

Correlation with a mechanical accelerometer: the FRAC method

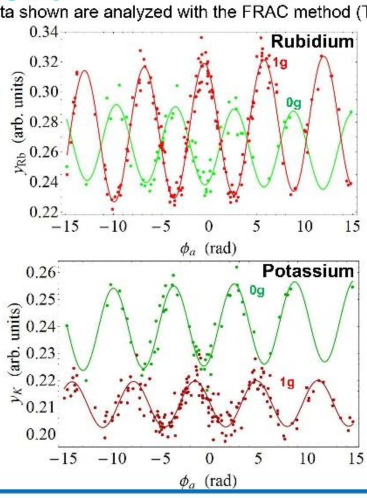
- Phase scanned randomly by the vibrations
- Vibrations recorded by a mechanical accelerometer
- Reconstruction of the fringes



7. Preliminary results

First simultaneous dual-species interferometer in microgravity

- Data shown are analyzed with the FRAC method (T = 1 ms)



8. Conclusion & perspectives

Conclusion

- Dual-species (^{87}Rb + ^{39}K) interferometer on ground and in microgravity
- First test of the weak equivalence principle in microgravity

Perspectives

- Decrease K temperature by using grey molasses cooling
- Reach ultracold temperatures with a dipole trap (BEC)

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17. JANSEN Oliver

Monte-Carlo simulations on the two-photon Breit-Wheeler process

O.jansen, X.Ribeyre, E. d'Hummières, S. Jequier, V.Tikhonchuk, M. Lobet

Current developments in laser technology open up the possibility to directly investigate a fundamental process of astrophysics[1]. The direct production of electron-positron pairs from two-photon collisions is a common phenomenon in the vicinity of dense stellar objects, but has not been observed in experiments so far. In the light of projects like ELI or Apollon we investigate the linear Breit-Wheeler process using a Monte-Carlo code. This code is developed in order to become a module for the PIC-code CALDER. With this extension to CALDER[2] in the context of the LAPHIA we aim to investigate the optimal experimental settings for investigating the linear, two-photon Breit-Wheeler process.

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Acknowledgement:
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18. IVASKOVIC Petra

Synthesis of plasmonic nanostructures for guiding light

Petra Ivaskovic[1,2], Jean-Baptiste Verlhac[2], Renaud Vallée[1], Mireille Blanchard-Desce[2], Serge Ravaine[1]

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Metal nanostructures have received a great attention in recent years due to their unique optoelectronic properties which are geometry-dependent and can thus be easily tuned.
We are fabricating new types of plasmonic architectures that can be used to investigate the possibility of transport control and routing of the light, establishing an approach to nanoscale plasmonic switching and finally aiming at nanoscale light manipulation. This would lead to many possible applications ranging from nanoelectronics, information processing and communication.
In that context, we are designing different types of nanostructures i) Y-shaped plasmonic nanostructure that consists of three gold nanorods assembled via an organic tripodal molecule and ii) V-shaped gold nanoframes. In such systems, after the excitation of one tip of the structure, the resulting plasmon is expected to propagate through a desired direction and meant to be detected via the emission of a fluorescent dye attached to their tips (Fig. 1).

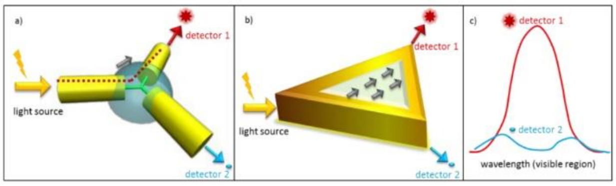


Fig. 1: Hybrid plasmonic nanostructures a) Y- shaped architecture b) V-shaped architecture c) complete emission in one branch of the nanostructure

Gold nanorods are used as building blocks for Y-shaped nanostructure and linked in a controlled Y-shape geometry via the use of a dedicated organic assembler.
Organic 3-branched molecules are being synthetized in order to serve as assembling modules between three gold nanorods to yield nanopolaritonic structures. The goal is i) to design and prepare tripodal concave molecules having rigid arms and peripheral moieties showing good affinity for gold, ii) to graft the gold nanorods onto the organic assembler as well to iii) graft fluorescent dyes on the nanorods tips. This multistep assembly strategy would lead to the target Y-shaped architecture meant for nanopolaritonics.
Second type of plasmonic architecture, hollow gold V-shaped nanostructure, is obtained by a galvanic replacement reaction between silver nanoprisms and gold, which was deposited on the edges of the silver templates.

In conclusion, we are designing and fabricating nanostructures aiming to direct the polariton flow toward the desired direction, forming an optical switch and providing access to nanoscale light manipulation.

ACKNOWLEDGMENTS
We acknowledge financial support from Cluster LAPHIA, IDEX Bordeaux project (InPhotArch).

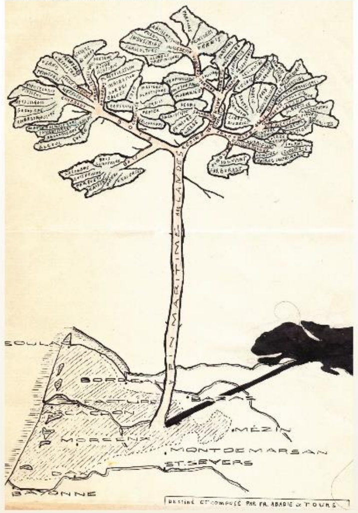
19. KRASNODEBSKI Marcin

From Ships to Rockets: Pine Institute and resin chemistry in Aquitaine (1900-1970)

By: Marcin Krasnodębski
Directors : Pascal Duris and Jérôme Pierrel
Sciences, Philosophie, Humanités (EA 4574)

LAPHIA

Source: Correspondance de Georges Brus, 1938

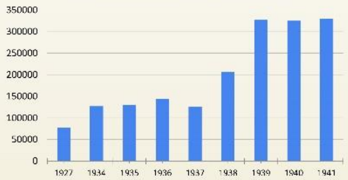


Pine of Landes: a promotional poster of the regional industry from 1938. The tree grows from the heart of Landes and each of its branches represents a different branch of industry using resins: varnishes, paints, fuels, insecticides, road coatings, lubricants, etc.

Research background:

The goal of my thesis is to explore the mutual relations of resin chemistry and resin industry in Aquitaine. For hundreds of years pine resin was one of the driving forces of the local economy, being widely used in the famous shipyards of Bordeaux for ship caulking and varnish production. But its privileged position was put in question by petrochemistry in the end of the 19th century, threatening the economic stability of the whole region. To prevent a seemingly inevitable crisis, a new actor got involved: the University of Bordeaux. In 1900, under the direction of chemistry professor Maurice Vèzes, the Laboratory of Chemistry Applied to Resin Industry was born. Its goal was to reinvent resin applications and save the forest-based economy of Aquitaine by developing new resinous products.

Pine Institute's budget in francs (inflation included, prices 1927)



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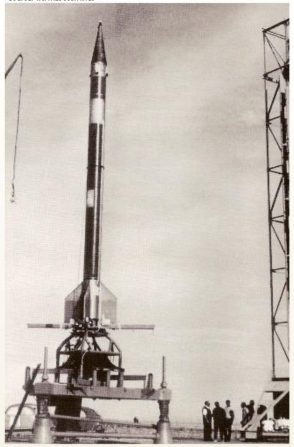

Véronique 61 Rocket: One of the first French rockets using pine turpentine fuel.

- **1900** — Creation of the Laboratory of Chemistry Applied to Resin Industry
- **1924** — Birth of the Association Pine Institute financing resin chemistry research in Aquitaine
- **1937** — Pine Institute, under the direction of the future dean Georges Brus, becomes an integral part of the University of Bordeaux
- **1939** — Creation of the Corporative Union of Resin Producers, a main funding agency of the Pine Institute.
- **Around 1950** — Involvement of the Institute in multiple industrial projects aiming for the manufacture of polymerized rosins and high end resinous products
- **1961** — Pine Institute collaborates with the Laboratory of Ballistic and Aerodynamic Research on rocket fuels from resinous products.*
- **1969** — Retirement of Brus. Jaques Valade, future minister of research, becomes the director of the Pine Institute reorienting it to research on polymers.

http://www.cartes-postales-anciennes.com

On the left:
Local turpentine farmer, "gemmeur", at work. The pine has to be "tapped" regularly in order to produce resin, which is then purified and distilled.

On the right:
Maurice Vèzes (1864 – 1935): the first director of the resin chemistry laboratory in Bordeaux.

Source: Archives de l'Institut du Pin

Preliminary research results:

The resin laboratory became the Pine Institute, a world-class scientific-industrial research centre in the field of resin applications. The most remarkable thing about the Institute was its unusual administrative status. Hosted by the University of Bordeaux, it was a collective initiative financed from the contributions of thousands of forest workers, more than a hundred local companies and tens of regional institutions. By the late 1940s it was one of the richest French chemistry laboratories and it quickly became involved in such astonishing endeavors as producing rocket fuels from pine resins. The lesson we can learn from its history is that science is not bound by the traditional public or private funding logics, but more sustainable collaborative schemes are not only possible, but may be extraordinarily prolific in terms of research production.

On the right:
The Pine Institute archives. Tens of square meters of documents stored at the Faculty of Chemistry of the University of Bordeaux.

*Bois et Résineux, 20-30 december 1962

20. BOUTOUX Guillaume

The PETAPhys diagnostics

G. Boutoux[1], D. Batani[1], D. Bretheau[2], E. d'Humières[1], F. Granet[2], Ch. Meyer[2], D. Raffestin[2], V. Tikhonchuk[1] , et al.

[1]CELIA – Université Bordeaux, [2]CEA/DAM/Cesta

In addition to the Equipex PETAL+, the PETAPhys project is dedicated to the qualification phase of the PETAL laser, i.e. during the increase in power. In order to both characterize the focal spot of PETAL and get additional informations on the laser interaction with its target, we are developing two simple and robust diagnostics. The first one is an optical diagnostic based on the 2ω radiation produced in the target. The second one is a hard X-ray diagnostic that would measure Bremsstrahlung spectra and achieve pinhole-imaging of the X emission. The characteristics of these diagnostics will be presented. In a second part, we performed PIC and Monte-Carlo simulations to infer the PETAL photon source escaping from a 2 mm thick tungsten target and we simulated our whole set-up to predict the physical signal inferred by the X-ray diagnostic. These simulations will be extensively detailed.

21. BOURIGA Meriem

Modification of space-charge embedded glass surfaces by photoactive molecules

M. Bouriga, V. Rodriguez, N. McClenaghan, M. Dussauze, L. Vellutini, F. Adamietz and T. Buffeteau

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The aim of this project is to modify glass surfaces to give them the potential to host photoactive molecules and to study the optical properties of the resulting novel materials. In this context the glasses were subjected to a thermal polarization technique which embeds charge in the material. The optimization of the poling atmosphere and the electrode type permits the control of the physicochemical properties of the interface by two combined actions: a) chemical activation of the surface to enable the functionalization, and b) introduction of an enhanced internal electric field.

In parallel, a grafting protocol harnessing an efficient click reaction, has been established to covalently bind photoactive molecules to a grafted precursor on the glass surface. The chosen fluorescent molecules can have several functions; such as photoswitches, molecular probes and push-pull type molecules.

Finally, to characterize the electronic properties and the arrangement of the molecular photoactive assemblies in contact with the space charge embedded substrate, a range of complementary techniques: UV-Visible Reflection Absorption Spectroscopy (UV-Vis RAS), Polarisation Modulation-InfraRed Reflection Absorption Spectroscopy (PM-IRRAS) and second harmonic generation microscopy are employed.

This Ph.D. thesis is part of the project "Integrated Photonic Architecture" which is in the framework of the LabEx "Laser and Photonics in Aquitaine" LAPHIA.

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22. MAHEUT Yohann

Recent results on shock wave propagation in low-Z materials for shock ignition.

Y. Maheut[1], D. Batani[1], S. Baton[2], K. Jakubowska[1], M. Koenig[2], E. Le Bel[1], H. Nishimura[3], X.Ribeyre[1], C. Rousseaux[4], T.Sakaki[1], K. Shigemori[3].

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[4] Commissariat à l'Energie Atomique, 91680 Bruyères-le-Châtel, France

We performed two experiments at LULI (Paris, France) and GEKKO facility (Osaka, Japan) in the framework of the shock ignition approach to inertial confinement fusion. The goal of these experiments was the study of shock hydrodynamic in low-Z material by using radiography and traditional shock diagnostics. In the first case, we study the influence of the target geometry on the shock hydrodynamic by using SOP, VISAR and point projection radiography whereas in the second one we try followed the evolution of the shock trajectory inside the material using VISAR and time-resolved radiography.

At LULI, we used hemispherical and cylindrical plastic targets that we irradiated with a nanosecond beam (526nm, 2ns, 1.10^{14}W/cm²). We also used a picosecond beam to create an X-ray source at 4.9 keV for radiography. At GEKKO, we shot on beryllium targets with 5+2 beams (351nm, 2ns, 185+81J) and another 3 beams for radiography.

23. SAKAKI Takaya

Abstract de poster

Takaya SAKAKI
Centre Lasers Intenses et Applications
Université Bordeaux
351, Cours de la Libération
33405 Talence cedex, France

Title : Study of shock dynamics for shock-driven inertial confinement fusion

An experiment for the shock dynamics study was conducted in October 2014 in ILE (Institute of Laser Engineering, Osaka University, Japan) as part of the collaboration between ILE and CELIA laboratory. The purpose of this experiment was to study the shock created by laser GEKKO XII having an intensity on target of ~ 1013 W / cm2 (200J / beam, wavelength:0.35µm, pulse width:2ns, FWHM:500 µm). This study was to observe the shock with two diagnostics. The speed of the shock was observed by reflectometry VISARs. In addition, time-resolved imaging was performed with the X-ray radiography to observe the shock propagation in the target. And then, the experimental result was confronted with the hydrodynamic simulation CHIC code.

24. FAGGIANI Rémi

Title : Slow light : from Anderson localization to devices

Abstract : The quest for increasing speed of information processing in optical communication system is a basic desire that has been with us since the advent of Internet. Counter-intuitively, slowing light down can benefit information processing. The large spatial and temporal compression in slow light opens the prospect of strong light confinement and large light-matter interaction. In this poster, we introduce several practical applications arising from slow light effect, from strong localization at ultra-small disorder levels, large atom-photon with slow light in air and new resonance schemes in integrated optics with huge slowdowns.

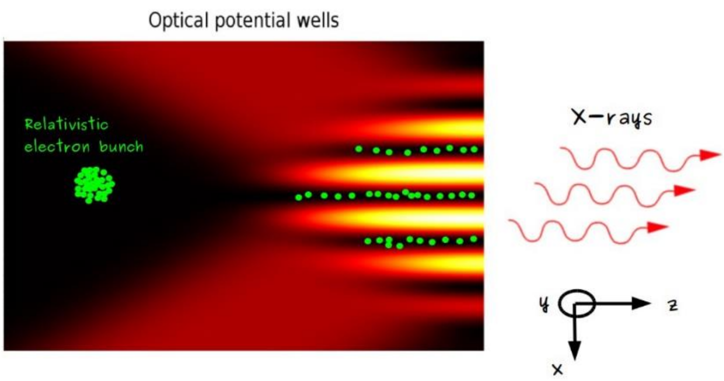
25. HADJ-BACHIR Mokrane

Modeling of experiments on the trapping of relativistic electrons in a high intensity optical lattice

M. Hadj-Bachir , B. Barbrel, E. d'Humières, V.T. Tikhonchuk and Ph. Balcou

Centre LASERs Intenses et Applications CELIA, CEA, CNRS, Université de Bordeaux 33405 Talence France.

An experiment to study the trapping of relativistic electrons into a high intensity optical lattice will be performed next fall in Salle Jaune at Laboratoire d'Optique Appliquée LOA Paris. The aim of this experiment is to study a coherent X-ray emission based on Raman XFEL process already predicted with analytical and numerical studies **[1] [2]**. The aim of this experiment which is the first step of the amplification setup is the injection of electrons in the standing wave created by the interference of two short (fs) and high intensity (<10^{18} W/cm²) laser pulses and explore the electron dynamics in high intensity optical lattice . A 3D Particle-In-Cell (PIC) code named RELIC **[3]** was developed to study the electron dynamics and to design the experiment in different geometries. In this work we show specific RELIC calculations about the trapping rate of electrons in the ponderomotive potential wells for different physical parameters. We will focus on the modification of the distribution function structures induced by the optical lattice and show some numerical modeling of LANEX diagnostics



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26. DANIEL Jonathan

NIR-emitting molecular-based nanoparticles as new two-photon absorbing nanotools for single particle tracking

J. Daniel[a], A. G. Godin[b,c], G. Clermont[a], B. Lounis[b,c], L. Cognet*[b,c], M. Blanchard-Desce*[a]

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ABSTRACT

In order to provide a green alternative to QDs for bioimaging purposes and aiming at designing bright nanoparticles combining both large one- and two-photon brightness, a bottom-up route based on the molecular engineering of dedicated red to NIR emitting dyes that spontaneously form fluorescent organic nanoparticles (FONs)[1] has been implemented. These fully organic nanoparticles built from original quadrupolar dyes are prepared using a simple, expeditious and green protocol that yield very small molecular-based nanoparticles (radius ~ 7 nm) suspension in water showing a nice NIR emission (λ_{em}=710 nm). These FONs typically have absorption coefficient more than two orders larger than popular NIR-emitting dyes (such as Alexa Fluor 700[2], Cy5.5 ….) and much larger Stokes shift values (i.e. up to over 5500 cm^{-1}). They also show very large two-photon absorption response in the 800-1050 nm region (up to about 10^6 GM) of major promise for two-photon excited fluorescence microscopy.[3] Thanks to their brightness and enhanced photostability, these FONs could be imaged as isolated nanoparticles and tracked using wide-field imaging. As such, thanks to their size and composition (absence of heavy metals), they represent highly promising alternatives to NIR-emitting QDs for use in bioimaging and single particle tracking applications. Moreover, efficient FONs coating was achieved by using a polymeric additive built from a long hydrophobic (PPO) and a short hydrophilic (PEO) segment and having a cationic head group able to interact with the highly negative surface of FONs. This electrostatically-driven interaction promotes both photoluminescence and two-photon absorption enhancement leading to an increase of two-photon brightness of about one order of magnitude. This opens the way to wide-field single particle tracking under two-photon excitation

Keywords: Nanoparticles, fluorescence, microscopy, two-photon absorption, single particle tracking.

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27. DE VET Christiaan

Spatially-Controlled Light-Triggered Self-Assembly of a Polyaromatic Organogelator

Christiaan de Vet[1], Guillaume Raffy[1] and André Del Guerzo[1]

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Abstract

In order to apply low molecular weight supramolecular gels in advanced applications, such as tissue engineering and optoelectronics, a better control over the spatial distribution of the gel scaffold is a necessity. An approach to generate and control the self-assembly of the gelator into nanostructures is the use of external stimuli.[1] Light and focused laser irradiation presents many advantages, such as contactless, spatial, temporal and energetic control of the stimulus.[2]

In this study, we present a new method to spatially trigger the nanofiber formation of 2,3-didecyloxyanthracene (DDOA)[3]. The combination of a laser induced photocleavage reaction of the precursor and scanning of a surface enables to write nano-objects down to the sub-micron scale. The real-time imaging of the self-assembly process by fluorescence microscopy can be performed by simultaneously exciting the formed anthracene with UV-light during the writing with a blue laser. Successful photogelation with a concentration as low as 1 mM in DMSO was achieved due to the high conversion yield of the photoreaction and the negligible photobleaching achieved using blue light irradiation. The mechanism of photo-induced self-assembly have been studied in more details by fluorescence lifetime, spectroscopy and video-imaging microscopy techniques.

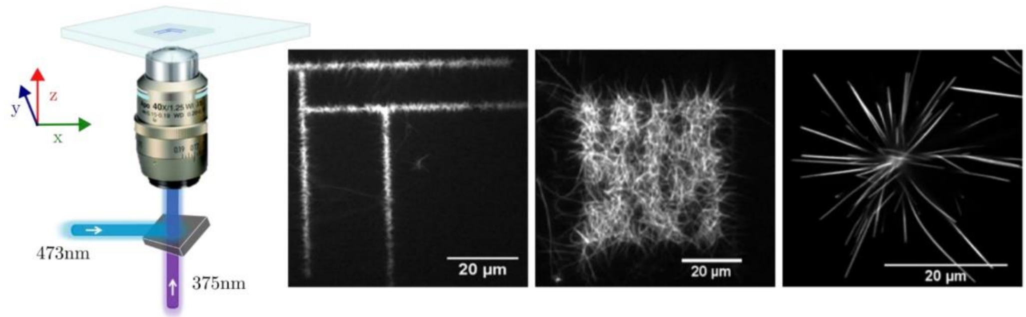

Fig 1: Left: Schematic representation of the miscroscope setup with dual laser. Right: Confocal microscopy images of different obtained patterns.

Acknowledgements
The authors acknowledge the financial support of the European Research Council (FP7/2007-2013) Marie Curie Actions.

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28. SCHÄFER Philip

Self-assembled fluorescent nano-ribbons: Imaging of growth and laser-induced local color-tuning on individual objects

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The self-assembly of π-conjugated systems can lead to various fluorescent nano-objects with exceptional optical properties. Self-assembly pathways can be controlled by molecular design, concentration, additives, solvent conditions, and temperature[1]. Their optical properties result from molecular design, molecular packing, shape and size, incorporation of suitable dopant-molecules and excitation dynamics[2]. Microscopy studies have revealed a deeper insight on the growth and ripening of 2,3-dihexadecyloxy-9,10-diphenylanthracene (DPA-C16) nano-ribbons. The optical properties of individual ripened nano-ribbons can be tuned locally. To achieve this, nano-ribbons of the blue-emitting DPA-C16 are first doped with 1% 2,3-dihexadecyloxy-5,12-diphenyltetracene (DPT-C16) or 5% 2,3-dihexadecyloxy-rubrene (Rubrene-C16) to convert into green- or orange-emitting ribbons, respectively. Under UV-excitation, the blue emission of the DPA-C16 is nearly completely quenched by Förster Resonance Energy Transfer (ET) to the dopant-molecules. These green-/orange-emitting nano-ribbons can now serve as matrix for local color-tuning. Due to the amplified excitation of the dopant by the highly efficient energy transfer to the low populated acceptor-molecules the latter photo-degrade quickly in the presence of ambient oxygen and adequate laser-irradiation. The robustness of the energy-donor under laser excitation guarantees the activation of fluorescence in the blue, rather than a more common laser-induced photo-bleaching of both donor and acceptor. The green/orange emission lapses and the blue emission awakens due to the disappearance of the energy transfer, thus enabling simultaneous negative and positive writing. Thus, by focused UV-irradiation it is possible to write into individual ribbons by changing the emission color on a sub-micrometer scale. The molecular packing maintains intact during the writing process. This study presents a first example of local tuning of optical properties to form 1D-heterostructures of *n*-acene-based nano-ribbons.

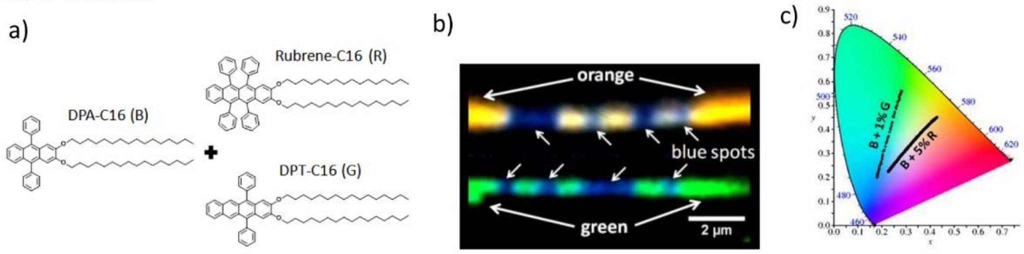

Figure: a) Molecular structures of the donor-molecule DPA-C16 and the acceptor-molecules DPT-C16 and Rubrene-C16. b) True-color confocal fluorescence images of patterned ribbons. c) Traces in the CIE-color-space during the writing processes.

Acknowledgements

The authors acknowledge the financial support of the European Research Council (FP7/2007-2013) Marie Curie Actions.

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29. AUBOURG Adrien

Tunable GHz repetition rate laser pulses from a single-frequency laser for picosecond acoustic physics

Adrien Aubourg[1], Giorgio Santarelli[1], Jerome Lhermitte[2], Eric Cormier[2], Yannick Guillet[3], Bertrand Audoin[3]
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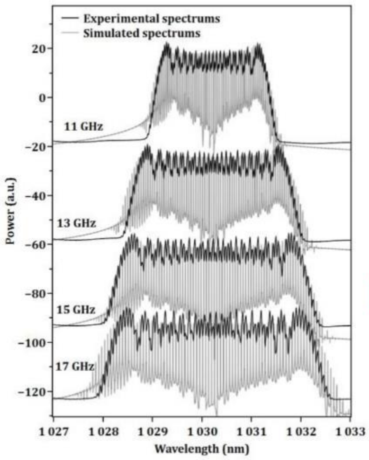
2. Celia – Univ. Bordeaux/CNRS
3. I2M – Univ. Bordeaux/CNRS

We present a novel laser architecture to generate optical picosecond pulses at 1030 nm. The novelty resides in the system's ability to continuously tune the pulse repetition rate in the very high range of 11-18 Ghz. Such a system would be useful for picosecond physics, optical frequency metrology, atomic clocks, biology, and for speeding up industrial material processes.

The repetition rate tunability is obtained by creating a frequency comb (fig. 1) from a single-frequency laser diode at 1030 nm with phase and amplitude modulators (fig. 2). The output pulses have a quadratic spectral phase which can be compensated thanks to a compressor setup, hence compressing the pulse duration around 1 ps (fig. 3).



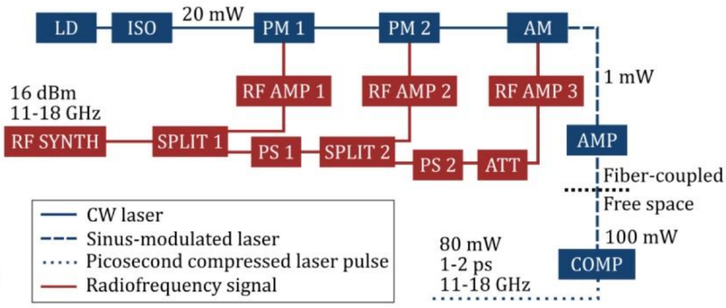


Fig 1. Optical spectrums at the output of modulators for different modulation frequencies

Fig 2. General architecture of the laser source

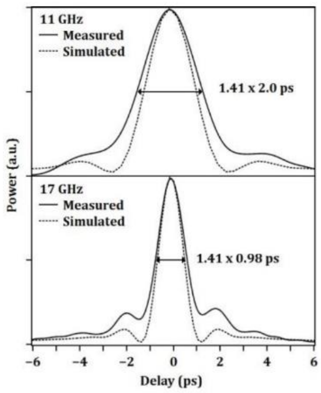


Fig 3. Autocorrelation traces of the pulse at the output of the compressor (experiments: plain. simulations: dashed).

30. CHATAGNIER Aurore

Influence of laser smoothing choices on Stimulated Brillouin Scattering in the context of LMJ fusion experiment

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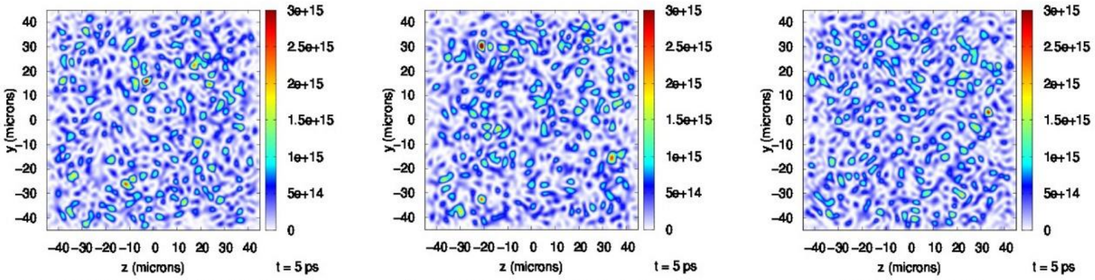
One of the biggest difficulties standing in the way of achieving Inertial Confinement Fusion is the presence of parametric instabilities, growing during the laser propagation in the plasma. In order to limit these effects, it is essential to tune the spacial distribution of the driving laser beams intensity. Various optical smoothing methods have then been developed. These methods consist in generating speckles patterns featuring many hot and cold spots, and adding them up incoherently. This addition can be instantaneous using polarization (polarization smoothing) or be done over time, by expanding the pulse spectrum and using a dispersing element in order to spatially separate frequencies (smoothing by spectral dispersion).

Smoothing by spectral dispersion has been selected on LMJ, and there is a reservation for polarization smoothing. The disperser used is a focusing grating, which allows to obtain either a purely longitudinal or longitudinal and transverse smoothing. On NIF, polarization smoothing and transverse smoothing by spectral dispersion are used simultaneously. Each method presents advantages and constraints, both regarding laser performance and instabilities limitation efficiency. Due to the spatial and temporal scales of the problem, we are especially concerned with an instability involving ion acoustic waves, namely Stimulated Brillouin Scattering.

Our first approach is to consider a set of idealized cases to simulate the Brillouin backscattering rate: transverse smoothing applied to a square beam and longitudinal smoothing applied to a circular beam with the same surface area. In order to achieve this we use sequentially two simulation codes: the first one describes the laser beam propagation in vacuum, while the second models the laser-plasma interaction. Due to limited computational resources, it is impossible to consider the entire focal spot (about 1 millimeter for LMJ case) in this second aspect of the modeling. Therefore we have considered a reduced area. We will show compromises that need to be made when choosing the simulated area, and first simulation results (cf. Figure below).



Longitudinal smoothing by spectral dispersion | transverse smoothing by spectral dispersion | without smoothing

Intensity (W/cm²) in the transverse plane at the entrance of the simulation box (300 µm before focal plan), for different smoothing parameters.

31. CANTIN Etienne

Phase Locking a Clock Oscillator to a Coherent Atomic Ensemble

E. Cantin[1,3], G. Kuyumjyan[1], D. Pandey[1], W. Cherifi[1], A. Bertoldi[1], R. Kohlhaas[2], A. Landragin[2] and P. Bouyer[1]

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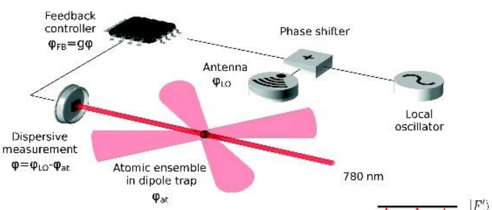
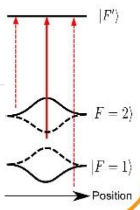
[3] Quantel,4 rue Louis de Broglie, F-22300 Lannion, France

Goal

- **Probe the phase evolution of an atomic ensemble using coherence-preserving measurements and phase corrections [1].**

Experimental setup

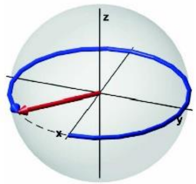




- Ensemble of 5 x10^5 ^{87}**Rb** atoms at 10 µK trapped in a **cavity** enhanced dipole trap [2]
- Measurement the atomic state by **frequency modulation spectroscopy**
- Microcontroller sends **feedback** via **coherent** microwave manipulations

Limitation

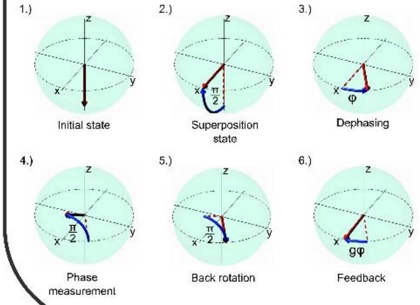
- Currently, ion and optical lattice clocks and atom-based sensors in general are limited by **the measurement process**.



- The frequency of a LO is repeatedly referenced to an atomic transition frequency by comparing their respective phase evolutions in an **interrogation time T** and applying a feedback correction.
- During the interrogation, the projection of the relative phase between the LO and the atomic ensemble is measured as a **population imbalance** of the two clock levels.
- This leads to a sinusoidal signal, and the phase drift can therefore only be **unambiguously determined** if it stays within the interval $[-\frac{\pi}{2};+\frac{\pi}{2}]$. Hence, for a given LO noise, the interrogation time of the atomic transition must be kept **short** enough such that phase drifts beyond the inversion region are avoided.

Bloch-sphere representation of the phase lock

- By implementing a **phase lock** between the local oscillator and the atomic ensemble, the phase cannot be ambiguous anymore and the interrogation time can be extended.



- **The relative phase φ** between the two oscillators drifts on the equatorial plane of the Bloch sphere.
- The phase is read out by a **coherence preserving measurement** and the state is re-inserted in the interferometer.
- After the measurement, **feedback** on the phase of the local oscillator (LO) is applied

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[3] J.Lodewyck et al., Nondestructive measurement of transition probability in a Sr optical lattice clock, Phys. Rev. A 79, 061401 (2009)

Results

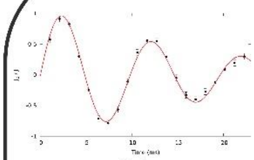


Fig.1

We first show that we can **track the relative phase in real time** (fig.1). The LO is **frequency shifted** by 100Hz so as to induce a precession on the equator of the Bloch sphere. We measure a **population difference** on the two clock states that is proportional to the **sinus of the phase.**
Each measurement causes a 2 % reduction of the atomic ensemble coherence.

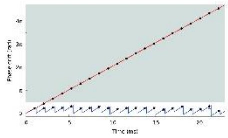


Fig.2,a

For the same frequency offset of 100 Hz on the LO, the evolution of the LO-atom relative phase is reconstructed from the J_z signal of Fig.1 and is shown in red in Fig.2.a. After each measurement, a feedback is applied **to correct the phase drift** (in blue Fig.2.a). In that case, the relative phase **stays in the inversion region** $[-\frac{\pi}{2};+\frac{\pi}{2}]$.

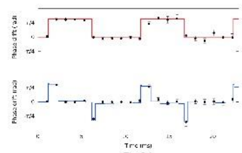
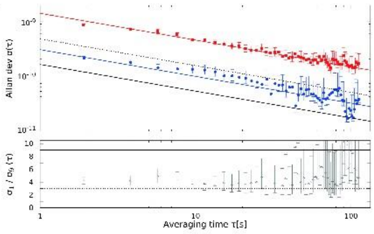


Fig.2,b

We apply now **periodic phase jumps** of π/3 back and forth on the LO. The signal in open loop is shown in red Fig.2.b. In closed loop, the phase jumps are **corrected to zero** (in blue Fig2.b).

- **Red line :** Normal Ramsey clock with interrogation time T=1 ms (without feedback).
- **Blue line :** Atomic clock making use of a PLL sequence with N=9 with T=1 ms, has a better stability by a factor 4,8.
- **Grey points :** ratio of the two instabilities. The enhancement is better than with uncorrelated measurements as in [3] (dashed line), and should be ideally at 9 (black line).

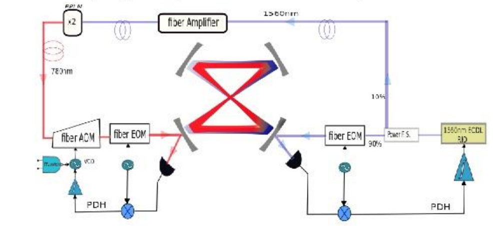


SNR=20, TD=1,9 s

The phase lock has a direct application to atomic clocks : it permits to overcome the limit of stability set by the LO noise by maintaining the relative phase in the inversion region.

Preliminary setup for QND measurement and squeezing

Exploiting a cavity–coupled probe beam will have a main advantage: **the sensitivity will be enhanced** by the square root of the finesse of the cavity (**F ~ 40,000**), thanks to the effective multi–passage of the photons on the atomic ensemble, for the same destructivity.



- The source at 1560 nm is **phase modulated** to create two sidebands around the carrier with a modulation frequency f_{mod}, one sideband will be locked to the cavity via a **Pound Drever Hall technique** with a feedback on the temperature and current of the diode (right side of the picture).
- One part of the source is amplified and **frequency doubled** to obtain the 780 nm beam, used in our experiment as a **probe beam** (left side of the picture). By knowing the free spectral range of the cavity at both wavelengths, one can properly choose the modulation frequency f_{mod} in order to **inject both radiations in the cavity.**