XVII Juan José Giambiagi Winter School

Light and light-based technologies

August 3-7, 2015
Departamento de Física J.J. Giambiagi
FCEyN, Universidad de Buenos Aires

Contents

About the J.J. Giambiagi School

The Giambiagi Winter School is organized by the Physics Department of Exact and Natural Sciences School of the University of Buenos Aires, Argentina. Each year the School is devoted to a different topic and its main purpose is to offer graduate students and young researchers an up-to-date perspective given by world-recognized experts, in a relaxed working atmosphere promoting interaction and potential future collaborations.

The School will consist of a series of lectures and a related workshop on latest research results. Time will be available for discussions of posters and short seminars. The official language of the School is English.

The present edition of the School is devoted to the field Light and Light-based Technologies. The importance of this topic is the impact that has in a great variety of areas, ranging from biology, technology, semiconductor industry, microscopy, medicine and art, among others. The ongoing development of light sources, allows the continuous advancement of various technologies. As a key example we can cite the semiconductor industry, in which every year is established which technology will be used (sources, techniques, materials) to print circuits even smaller than the previous one, allowing the perpetual increase in processors speed. The semiconductor industry employees light to print the components of the circuits, using the technology known as optical lithography. In medicine, light sources are used to perform surgery, as in the curing of eye disease, and novel techniques such as optical coherence tomography to inspect breast cancer. In art, light has been used for cleaning the paintings and study its pigments.

The continuous development of these techniques and technologies, motivated the United Nations Organization to establish that year 2015 would commemorate internationally light and light-based technologies. "In proclaiming an International Year focusing on the topic of light science and its applications, the UN has recognized the importance of raising global awareness about how light-based technologies promote sustainable development and provide solutions to global challenges in energy, education, agriculture and health. Light plays a vital role in our daily lives and is an imperative cross-cutting discipline of science in the 21st century. It has revolutionized medicine, opened up international communication via the Internet, and continues to be central to linking cultural, economic and political aspects of the global society."

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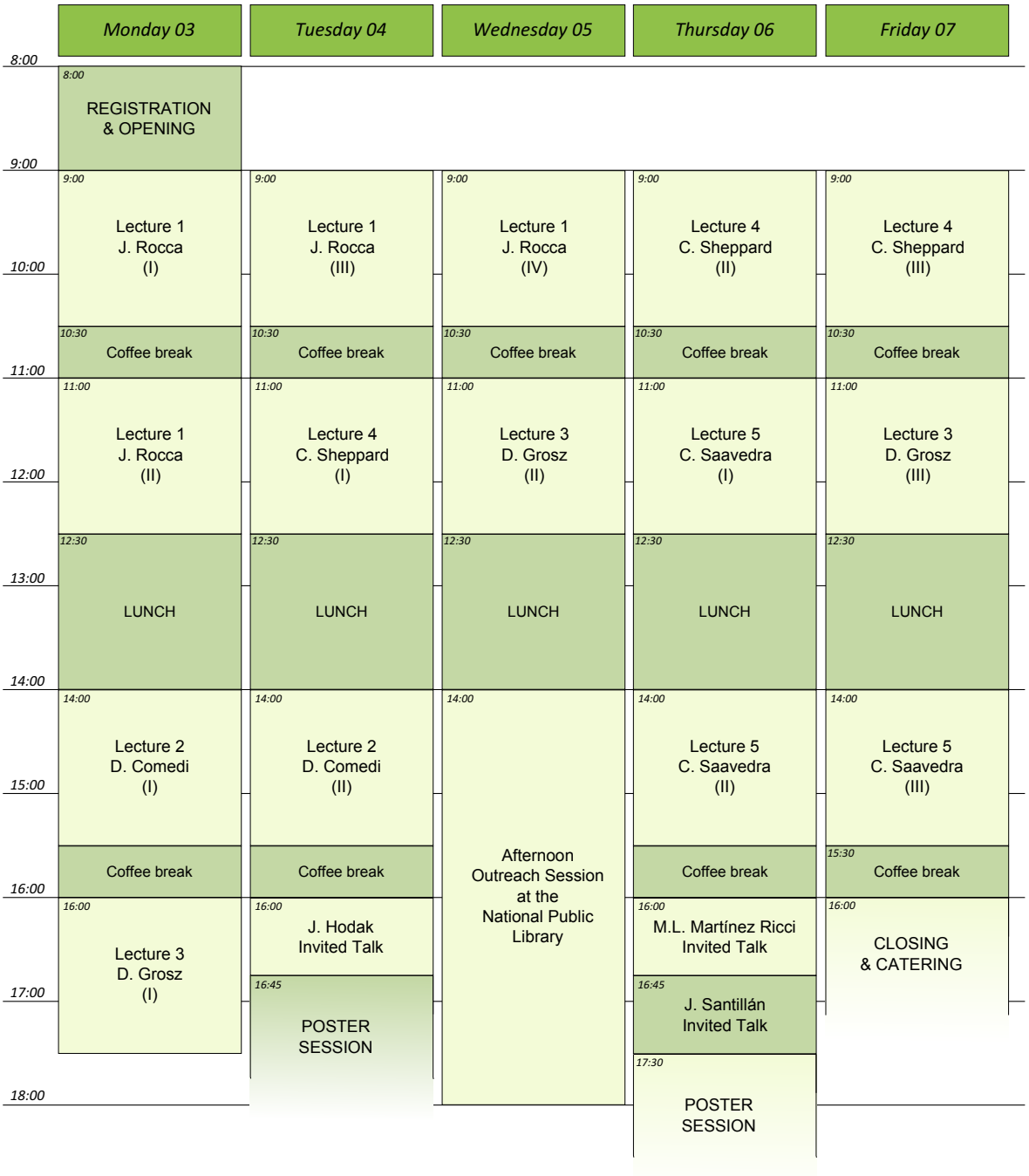
Schedule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Registration and Opening - 8:00 hs

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5 *Jorge Rocca*
X-ray Lasers: Extreme brightness at short wavelength

Coffee Break - 10:30 hs

Lecture 1 (continued) - 11:00 hs

Lunch - 12:30 hs

Lecture 2 - 14:00 hs

5 *David Comedi*
Semiconductor LED Materials

Coffee Break - 15:30 hs

Lecture 3 - 16:00 hs

6 *Diego Grosz*
Fiber-optic communication systems

Tuesday

Lecture 1 (continued) - 9:00 hs

Coffee Break - 10:30 hs

Lecture 4 - 11:00 hs

6 *Colin Sheppard*
Microscopy

Lunch - 12:30 hs

Lecture 2 (continued) - 14:00 hs

Coffee Break - 15:30 hs

Invited Talks, session 1 - 16:00

6 *José Hodak*
Probing nanomaterials with absorption and emission of light

Workshop & Poster Session 1 - 16:45 hs

Wednesday

Lecture 1 (continued) - 9:00 hs

Coffee Break - 10:30 hs

Lecture 3 (continued) - 11:00 hs

Lunch - 12:30 hs

Afternoon Outreach Session at the National Public Library - 14:00

(see brochure for schedule)

Thursday

Lecture 4 (continued) - 9:00 hs

Coffee Break - 10:30 hs

Lecture 5 - 11:00 hs

7 *Carlos Saavedra*
Quantum information with multidimensional quantum systems

Lunch - 12:30 hs

Lecture 5 (continued) - 14:00 hs

Coffee Break - 15:30 hs

Invited Talks, session 2 - 16:00

7 *María Luz Martínez Ricci*
Óptica de Nanoestructuras: de la Teoría a la Experimentación

7 *Jesica Santillán*
Light at the nanoscale

Workshop & Poster Session 2 - 17:00 hs

Friday

Lecture 4 (continued) - 9:00 hs

Coffee Break - 10:30 hs

Lecture 5 (continued)- 11:00 hs

Lunch - 12:30 hs

Lecture 5 (continued) - 14:00 hs

School Closing with Catering - 16:00 hs

List of Lectures and Talks

X-ray Lasers: Extreme brightness at short wavelength - *Lecture 1*

Jorge Rocca,
Colorado State University

These lectures will build up on fundamental concepts of how light interacts with materials to show how intense X-ray laser beams can be generated. The lectures will describe how efficient plasma heating techniques allow for the generation of bright soft x-ray lasers on a table-top. Applications of soft x-ray lasers in ultra-high resolution imaging, nano-scale materials characterization and modification, and other fields will be discussed.

Jorge Rocca is a Distinguished Professor at the Department of Electrical and Computer Engineering and Physics Department, Colorado State University, USA. He served as Director of the NSF Center for Extreme Ultraviolet Science and Technology. He received a diploma in Physics from the University of Rosario in Argentina in 1978 conducting research at CITEFA, and a Ph.D in ECE from Colorado State University in 1983. His research group demonstrated the first gain-saturated table-top soft X-ray laser using a discharge plasma as gain medium, and later extended bright high repetition rate table-top EUV lasers to wavelengths down to 8 nm using laser-created plasmas, achieving full phase coherence. He and his collaborators have demonstrated the use of these lasers in nano-scale imaging, dense plasma diagnostics, nano-scale material studies, and photochemistry. He has published more than 200 peer review journal article on these topics. Prof. Rocca received the Arthur. L. Schawlow Prize in Laser Science from the American Physical Society in 2011, and the Willis E. Lamb Award in Laser Science and Quantum Optics in 2012. He is a Fellow of the American Physical Society, the Optical Society of America, and the Institute of Electrical and Electronic Engineers. He was an IEEE LEOS Distinguished Lecturer for 2006-07, and early in his career he was an NSF Presidential Young Investigator.

Mon 9:00, 11:00; Tue & Wed 9:00

Semiconductor LED Materials - *Lecture 2*

David Comedi,
Universidad Nacional de Tucumán

This course comprises two talks of about 90 minutes each and is planned for advanced undergraduate or novice graduate students in Natural Science or Engineering. Basic concepts on Semiconductor Physics will be presented, with special emphasis on p-n homo and heterojunctions and luminescence induced by electrical current (electroluminescence) phenomena, with the purpose of providing a general view on properties and technology of active LED materials. Within this context, the history of LED devices will be critically and briefly discussed, starting from their origins as indicators to current LED applications in photonics and lightening.

David Comedi is the Director of the NanoProject Group and Professor of Physics at the National University of Tucumán, and Independent Researcher at Argentina's National Research Council (CONICET). He received his BA (1983), MSc (1986) and PhD (1990) degrees in Physics from the Israel Institute of Technology, Technion. Between 1990 and 1993, he carried out postdoctoral work at the Centre for Electrophotonic Materials and Devices, McMaster University, Canada. In 1993, Dr. Comedi was invited by the Physics Institute at the State University of Campinas (Unicamp), Brazil, where he became later Associate Professor. In 2001, he was awarded the "Livre-Docencia" title on the Electronic Structure and Electronic, Optical and Magnetic properties of Condensed Matter by Unicamp. Dr. Comedi's contributions to the fields of semiconductor nanotechnology, ion-solid interactions, ion-beam assisted thin film deposition, doping, defect spectroscopy, electronic structure of non-crystalline and nanostructured semiconductors, luminescence and the structure of semiconductor alloys have been published in 91 papers in leading peer reviewed Journals. He has graduated 3 Master, 2 PhD and several undergraduate students in Physics, and has acted as a reviewer for important scientific journals and as adviser and member of Physics and Scientific committees of national research councils and agencies of Brazil and Argentina.

Mon & Tue 14:00

Fiber-optic communication systems - *Lecture 3*

Diego Grosz,
Instituto Balseiro, Universidad Nacional de Cuyo - CONICET

In this short course we will discuss the basics of linear and nonlinear propagation in optical fibers, transmission and reception of data, and components and subsystems of high-capacity fiber-optic communication systems. Finally, we will also present some applications of nonlinear fiber optics outside the area of communication systems.First class:Basic concepts of fiber optics. Milestones. Transmission windows. Linear and nonlinear propagation impairments.Second class:Transmitters and receivers. Optical components. Discrete and distributed optical amplification. Wavelength Division Multiplexing (WDM). Design issues of high-capacity optical systems.Third class:Some applications of nonlinear fiber optics outside the realm of communication systems.

Diego Grosz is an Associate Professor at Instituto Balseiro (IB), Cuyo University, Independent Researcher at the National Council for Science and Technology (CONICET), and head of the Optical Communication Group (IB). He received a Licenciado degree in physics from University of Buenos Aires (1993) and a Doutor em Ciências degree from State University of Campinas (UNICAMP), Brazil (1998). He was a Member of the Technical Staff at Lucent Technologies (1999-2003) where he worked on the design and development of LambdaXtreme, the highest-capacity optical communication system in the world at that time. He has published extensively in the area of fiber-optic communication systems and holds eight patents. He received the Central Bell Labs Teamwork Award (Lucent Technologies, USA, 2002), the "Ernesto E. Galloni" Award from the National Academy of Exact and Natural Sciences (Argentina, 2003), and the Konex Diploma in Science and Technology (Konex Foundation, Argentina, 2013).

Mon 16:00; Wed & Fri 11:00

Microscopy - *Lecture 4*

Colin Sheppard,
Italian Institute of Technology

First Class:Tight focusing of light.
Second Class:Confocal microscopy and superresolution.
Third Class:Phase contrast imaging

Colin Sheppard obtained his PhD degree from University of Cambridge. He recently moved to Italian Institute of Technology, Genoa, where he is Senior Scientist in the Nanophysics Department. Previously he has been Professor in the Departments of Bioengineering, Biological Sciences and Diagnostic Radiology at the National University of Singapore, Professor of Physics at the University of Sydney, University Lecturer in Engineering Science at the University of Oxford, and Lecturer in Electrical Engineering at UCL. He has held many visiting positions at different institutions, including EPFL, MIT, Stanford University, Tokyo University and TU-Delft. His research interests include microscopy, including confocal and multiphoton microscopy, phase imaging, image reconstruction, diffraction, scattering, and beam & pulse propagation.

Tue 11:00; Thu & Fri 9:00

Probing nanomaterials with absorption and emission of light - *Invited Talk*

José Hodak,
INQUIMAE, DQIAQF, Facultad de Ciencias Exactas y Naturales, UBA.

Absorption and fluorescence emission allow simple means of accessing nanoscopic processes at nanoscopic scales. I will discuss the use of fluorescencemeasurements to study the permeation process of a fluorogenic probe across the walls of silica nano-shells, and the use of spatially resolved abrotption-emision experiments to study graphene oxide.A nanoparticle located in the interior of a nano-shell permits to activate a fluorescent probe to reveal kinetics parameters of diffusion across the nanoshell wall. Graphene oxide (GO) is a two dimensional material that can act as an insulator or a semiconductor depending on the degree of oxidation and it may be converted to graphene by chemical or photochemical means. I will present spatially resolved studies of the photo-reduction of GO single layers.Several processes are found to occur sequentially during the GO photo-reduction with optical properties as well as kinetic parameters showing heterogeneityacross individual GO fragments.

José Hodak obtained his Licenciatura en Cs. Químicas degree in 1995, at the DQIAQF. Later in 2001 he obtained his PhD degree from the Department of Chemistry, Notre Dame University (Indiana, USA). He worked as a Research Associate at the Joint Institute for Laboratory Astrophysics, University of Colorado at Boulder, between 2001 and 2004, with the Prof. David Nesbitt group. He was a Foreign Researcher - Lecturer at the Department of Physics, Faculty of Science, Mahidol University, Bangkok, Thailand from 2005 to 2010. He now works as an Investigador Independiente CONICET in INQUIMAE, and he is also Profesor Adjunto at the DQIAQF. His current line of research is the study of physical chemistry of materials, using spatially resolved optical fluorescence and absorption techniques, and ultrafast transient spectroscopy.

Tue 16:00

Quantum information with multidimensional quantum systems - *Lecture 5*

Carlos Saavedra,
CEFOP - Universidad de Concepción

These three lectures are devoted to show how multidimensional quantum systems can be used in a more efficient manner for quantum information processing. In the first lecture, we will show the basic elements of quantum information with D-dimensional quantum systems (qudits). We shall also show how qudits can be used for general characterization of quantum channels. The physical implementations of qudits, in particular those based on single and two-photons states, will be also addressed. During the second lecture, we will show the use of qudits for implementing more secure quantum key distribution protocols and quantum states reconstruction. Finally, the last lecture will show the use of qudits for fundamental tests of quantum theory and the state of the art of feasible applications for long distance quantum communication.

Carlos Saavedra is the Scientific Director of the Center for Optics and Photonics and Professor of Physics Department at Universidad de Concepción, Chile. He receded a PhD in Physics form Catholic University of Chile (1992). Between 1997 and 1998, he was an invited researcher at the Institute for Theoretical Physics, University of Innsbruck, Austria. His first research was oriented to the study of radiation-matter interactions in the context of cavity quantum electrodynamics. Later, he has been mainly interested in quantum information, where he has studied problems such as: controlled generation and detection of photons for quantum communication; physical implementation of quantum information protocols. At present, the study of quantum information from quantum optics is his main research area. Besides, he is working in developing super-resolution techniques for microscopy applications. He has published 72 research articles in leading peer reviewed Journals and several preprints. Between 2012 and 2015, he was a member of the Science Council, National Commission for Scientific and Technological Research, Chile.

Thu 11:00, 14:00; Fri 14:00

Óptica de Nanoestructuras: de la Teoría a la Experimentación - *Invited Talk*

María Luz Martínez Ricci,
INQUIMAE, DQIAQF, Facultad de Ciencias Exactas y Naturales, UBA

Los materiales nanoestructurados han sido ampliamente estudiados y caracterizados a lo largo de las últimas décadas. En esta charla se mostrará cómo sistemas estudiados previamente en forma teórica y simulada han sido llevados a cabo experimentalmente, creando sistemas nano-compuestos complejos diseñados para obtener una respuesta óptica definida. Los ladrillos de construcción de estos sistemas compuestos pueden ser diversos y entre ellos nos centraremos en las películas delgadas porosas y las nanopartículas metálicas y/o semiconductoras.Se mostrará además que no sólo es posible diseñar sistemas para la investigación básica, sino también sistemas aplicados a la industria, llevando los experimentos de laboratorio a pruebas realizadas en piezas de gran escala.

María Luz Martínez Ricci egresó como Lic. en Física de la UBA. Se doctoró en el mismo centro de estudios en el área de electromagnetismo aplicado bajo la dirección de Dr. Depine. Luego, realizó su post-doctorado en el grupo de NanoQuímica del Dr. Galo Soler-Illia, en donde complementó sus estudios teóricos y de simulación con la síntesis de sistemas nanoestructurados por vías de química suave, Actualmente, es Investigadora Asistente del CONICET en el Laboratorio de Superficies y Materiales Funcionales liderado por la Dra. Aldabe Bilmes en el INQUIMAE. Sus áreas de trabajo refieren a la óptica de sistemas nanoestructurados complejos, entre ellos nanopartículas, sistemas porosos, cristales fotónicos, etc.

Thu 16:00

Light at the nanoscale - *Invited Talk*

Jesica Santillán,
Centro de Investigaciones Ópticas (CIOp) - Universidad Nacional de Catamarca (UNCa)

The interaction between electromagnetic radiation and free electrons in small metallic nanostructures or metal-dielectric interfaces of the order or less than the wavelength of light is governed by the type of metal, geometry, structure, size, wavelength and the surrounding medium.The behavior can be interpreted based on the existence of "plasmons" whose unique features make a "fingerprint" for each metal and can be appropriately used for metal nanoparticles sizing. It can also be used to determine the type of structures that nanoparticle presents: simple (bare core) and more complex spherical core-shell structures (metal-metal oxide or metal-dielectric).Applied results to the characterization of nickel, copper and silver colloidal suspensions generated by femtosecond laser ablation using the technique of optical extinction spectroscopy are presented, together with the theoretical design of a isolated silver particle sensor.

Jesica Santillán is Assistant Researcher at the National Council for Science and Technology (CONICET) and Professor of Chemical Department at the National University of Catamarca (UNCa). She obtained her degree in Physics from National University of Catamarca (2006) and her PhD in Physics from National University of La Plata (2013). Currently, she belongs to the Plasmonics research group at the Optics Research Centre (CIOp) of La Plata city, Buenos Aires, Argentina. Her research is devoted principally to the study of the optical properties of metal nanoparticles synthesized by femtosecond pulse laser ablation of solid targets in liquids. Also, she has worked on sensing properties of plasmonic devices based on Kretschmann configuration.

Thu 16:45

Poster Contributions

All posters will be exhibited simultaneously at the hall next to the main auditory. Two poster sessions will be held on Tuesday 16:45 and Thursday 17:00 hs

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2. *Generalized phase-shifting algorithms: error analysis,* **Gaston A. Ayubi**, Instituto de Física, Facultad de Ingeniería, Universidad de la República. 12

3. *Development of a photon counting module using avalanche photodiodes (SPAD),* **Sebastian A. Bordakevich, Augusto A. Kielbowicz, Miguel A. Larotonda**, División Óptica Cuántica, DEILAP, CITEDEF. 13

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5. *Study of the relative ratio of the intensities between the reference and the object waves in digital holography,* **Raúl Castañeda, Diego Hincapié, Sebastián Bedoya, Jorge Herrera-Ramírez and Jorge Garcia-Sucerquia.**, Universidad Nacional de Colombia. 15

6. *Automated real-time SPR immunosensor for specific detection of lowmolecular-mass analytes in natural water samples,* **Mauro D. Cocco, Nicolás G. Tognalli, Baptiste Auguie, María A. Daza Millone, María E. Vela, Roberto Salvarezza, Martín Rumbo, Guillermo Docena, Jorgelina Montoya, Alejandro Fainstein**, Centro Atómico Bariloche, Instituto Balseiro, CNEA. 16

7. *Open Source Fast Filter Wheel,* **Agustín Corbat, Marina Cuenca, Catalina von Bilderling, Lía Pietrasanta, Hernán Grecco**, Laboratorio de Electrónica Cuántica, Departamento de Física, FCEN, UBA. 17

8. *Below-bandgap excitation of bulk semiconductors by light carrying linear momentum,* **Fabián Correa, Guillermo Quinteiro**, Physics Department, University of Buenos Aires. 18

9. *Producción y detección de fotones gemelos a partir del fenómeno de conversión paramétrica descendente (SPDC),* **Rodrigo Cortiñas, Lorena Rebón, Claudio Iemmi**, LPI, Departamento de Física, FCEyN, Universidad de Buenos Aires. 19

10. *One-shot three-dimensional scene analysis,* **J.M. Di Martino, A. Fernández, J.A. Ferrari**, Facultad de Ingeniería, Universidad Nacional de la República. 20

11. *Transporte de masa en azo-polímeros y sus mezclas físicas con nanotubos de carbono,* **J. F. Döppler, M. G. Capeluto, S. Goyanes, and S. Ledesma**, LPI, Departamento de Física, FCEyN, Universidad de Buenos Aires. 21

12. *Infrared optical characterization of doped ZnO nanorods,* **D.L. Gau, M. Berruet, S. Botasini, E.A. Dalchiele, R.E. Marotti**, Instituto de Física and CINQUIFIMA, Facultad de Ingeniería, Universidad Nacional de la República 22

13. *Caracterización Eléctrica y Electrónica de Películas Porosas de Titania para aplicaciones en Celdas Solares Híbridas,* **Fernando González, María Dolores Perez**, Departamento Energía solar Comisión Nacional de Energía Atómica (CNEA). 23

14. *Classical modeling of the second-order spatial coherence for optical fields,* **Juan González**, Department of Natural Sciences, Univ. Autónoma de Colombia. 24

Contributed Poster Abstracts

Nonlinear Imaging Microscopy: Setup and Applications for Epithelial Cancers Diagnosis

Javier Adur[1,2,3], Carlos L. Cesar[3], Víctor H. Casco[1,2]

(1) Microscopy Laboratory Applied to Molecular and Cellular Studies. Engineering School. National University of Entre Ríos, Oro Verde, Entre Ríos, Argentina.
(2) CITER - Research and Transfer Center of Entre Ríos. Argentina. CONICET-UNER (3101) Oro Verde, Entre Ríos, Argentina
(3) INFABiC - National Institute of Science and Technology on Photonics Applied to Cell Biology. Campinas, São Paulo, Brazil

Nowadays, two-photon excitation and other nonlinear optical approaches have been successfully used within the microscopy framework which evolved as an alternative to conventional single-photon confocal microscopy. Usually, they are collectively known as nonlinear microscopy, which includes two-photon excited fluorescence (TPEF) microscopy, second, and third harmonic generation (SHG, THG) microscopy, and coherent anti-Stokes Raman scattering (CARS) microscopy. TPEF approach provides high-resolution images of molecular autofluorescence signals in living tissues; SHG microscopy has been successfully used to study structural protein arrays, such as collagen; while CARS and THG signal can be used both to reveal the presence of lipid bodies and to highlight the cell nuclei inside the thickness of a tissue.

Here will be briefly described and discussed the nonlinear contrast physical principles of each technique, and how to combine and build these setup, on a single commercial multimodal confocal system platform. The usefulness of these techniques to detect early changes associated with the progression of epithelial cancer shall be displayed. Thereby, this multi-contrast nonlinear optical microscopy setup, emerge as a valuable tool to differentiate between cancerous, benign, and healthy tissue.

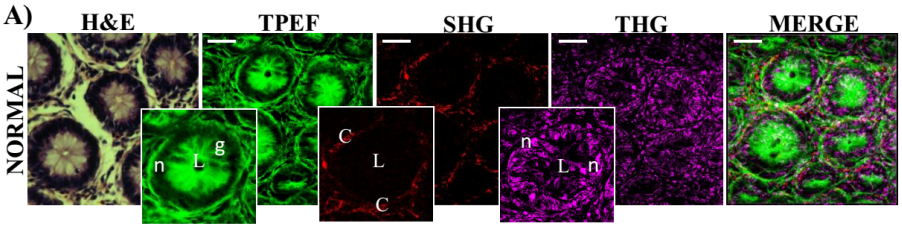


Figure: Representative H&E-stained and TPEF, SHG, THG, and MERGE cross-sectional images of colon tissues. Scale bars = 20 μm. Abbreviations: L: luminal crypt orifice, g: goblet cells, n: nucleus, c: collagen.

Generalized phase-shifting algorithms: error analysis

Gaston A. Ayubi

Instituto de Física, Facultad de Ingeniería, UdelaR, Montevideo, Uruguay

Phase-shifting is a well-known technique for phase retrieval that requires a series of intensity measurements with certain phase-steps. Harmonics and linear phase-shift errors are the main source of errors in interferometry. In this work we present a systematic algebraic approach for the generation of phase-shifting algorithms(for interferograms with arbitrarily phase-steps) insensitive to harmonics and linear phase-shift errors

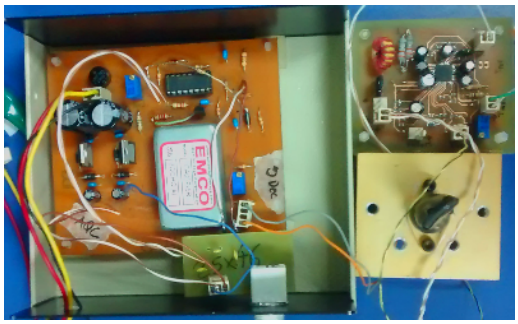
Development of a photon counting module using avalanche photodiodes (SPAD)

Sebastian A. Bordakevich, Augusto A. Kielbowicz, Miguel A. Larotonda

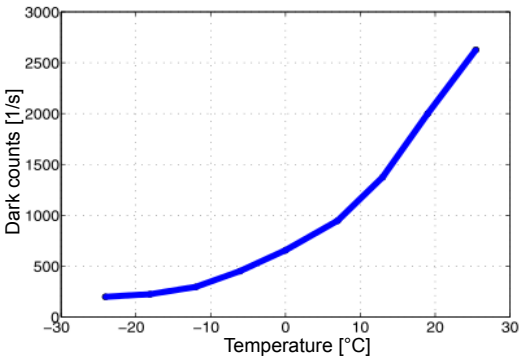
Departamento de Física "J.J. Giambiagi", FCEyN, UBA
División óptica cuántica, DEILAP, CITEDEF

Working with low levels of light often requires the use of instruments such as photon counting modules. These detectors, however, usually are between the most expensive laboratory supplies. The goal of this work is to locally develop a low cost photon counting module using an avalanche photodiode (SPAD). The module comprises an active quenching circuit that stops the avalanche, temperature stablization by means of a closed loop control system, and single mode or multimode fiber coupling through a standard FC connector.

We present preliminary results, that include the characterization of the dependence of dark counts of the detector and its breakdown voltage with the temperature. We obtain a minimum of 200 cps at -20°C. We also investigate different options for the active quenching circuit, studying the dead time between counts that each circuit can provide. This dead time is around 400 ns for the first implemented circuit. Finally we include perspectives and near future work.



Counting module prototype. Left: active quenching circuit. Right, top: Temperature control circuit. Right, bottom: APD (covered), heatsinked



Measured dark count rate vs temperature

CW Fluorescence imaging of tissue-like media in reflectance geometry

Carbone, Nicolás Abel

CIFICEN (UNCPBA - CONICET). Pinto 399, Tandil, Buenos Aires, Argentina.

The present work, part of my ongoing PhD thesis, aims to study the use of CW diffusely remitted NIR light as a diagnostic technique of neoplasms in soft tissue. The main approach is through the use of reflectance geometry where a CCD camera images a wide area of the free face of a turbid medium illuminated by a point-like source.

In order to overcome the exponential decay of light intensity as we move away from the source, a novel normalization procedure was developed. In it, multiple exposures of the medium are taken moving the relative position between the bundled CCD and source, and the imaged medium. These images are then blended together creating a background image where inhomogeneities are blurred out.

As a way of increasing the contrast between the inhomogeneity and the medium the use of fluorophores was also studied. Indocyanine Green (ICG) was chosen because previous independent research showed that its pharmacokinetics is different in healthy tissue than in malignant lesions.

Due to the low signal-to-noise ratio that this approach usually produces, image analysis and noise reduction play a key role. Noise sources were characterized and modeled and several noise reduction techniques were tested.

The resulting technique was tested using artificial phantoms designed to mimic realistic situations and the results compared to proven theoretical models. The construction and characterization of these phantoms was a process in itself and different approaches were considered. Clinically realistic fluorophore and absorber concentrations were used and proved that the technique is viable.

Study of the relative ratio of the intensities between the reference and the object waves in digital holography

Raúl Castañeda[a], Diego Hincapié[a,b], Sebastián Bedoya*[a], Jorge Herrera-Ramírez[b] y Jorge Garcia-Sucerquia[a].

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In this work, we present a study on the effect of the relative ratio of the intensities of the reference and object waves in digital holography with respect to the quality of the numerical reconstructions of the digitally recorded holograms. To perform the study, we have recorded several holograms of the same sample varying the ratio of intensities between the reference and object waves. In addition to the numerical reconstructions of these holograms, we have carried out an analysis of the intensity profiles of the digitally recorded holograms before and after performing the needed process of spatial filtering. The results of the numerical reconstructions and the analysis of the intensity profiles allow us to conclude that on contrary to the analogous process of optical holography, in digital holography is not necessary to keep a high control in the intensity ratio between the reference and object waves. In general, it can be stated that this relation of intensities is of low importance, while it is assured the correct sampling of the hologram and the no saturation of pixels are guaranteed.

Automated real-time SPR immunosensor for specific detection of low-molecular-mass analytes in natural water samples

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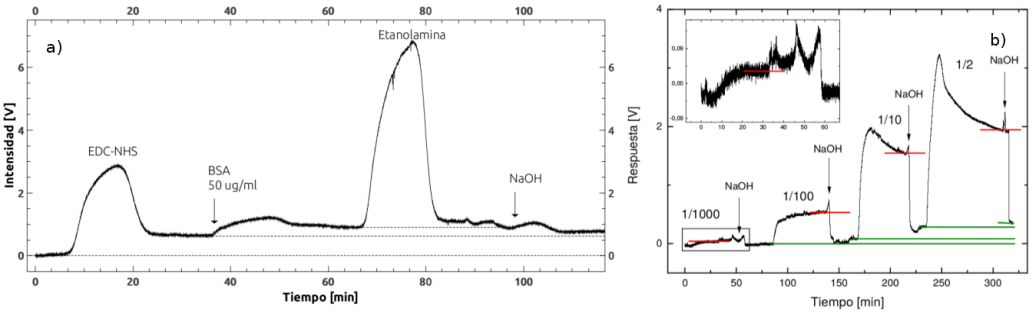
Though the toxicity of pesticide and herbicide compounds in many cases has still to be determined, their extended use has raised public awareness for the potential consequences upon the environment and human health. This is a concern that has motivated the development of cost-effective real-time monitoring techniques applicable to glyphosate in phreatic waters.

We describe a fully self-contained and automated portable surface plasmon resonance (SPR) immunosensor designed for real-time analysis of low-molecular-mass analytes in natural water samples. The system integrates pumps and valves for solution injection, and the automation of the optical alignment neccesary for its operation. The device is tested with the model system dinitrophenol(DNP)-anti-dinitrophenol in an inhibition scheme, and the sensitivity is assessed.

The surface modification of the SPR gold substrate (Fig. a) starts with the ex-situ formation of a self-assembled monolayer (SAM) of mercaptoundecanoic acid (MUA) during 24 hs. A mixed solution of the coupling agents EDC and NHS are then put in contact during 15 min with the MUA functionalized sensor chip to activate the carboxylate groups, followed by the covalent attachment of a BSA-DNP conjugate. Finally, ethanolamine is used as blocking agent for the non-bonded carboxylate functional MUA groups. A NaOH solution was used for substrate regeneration. The sensor chip was introduced in the fluid cell and the experiments were carried out using serial dilutions of a 0.54 mg/ml anti-DNP solution (Fig. b). These experiments have shown a limit of detection (LOD) of 540ppb of anti-DNP, which corresponds approximately to a DNP LOD of 4ppb.



Open Source Fast Filter Wheel

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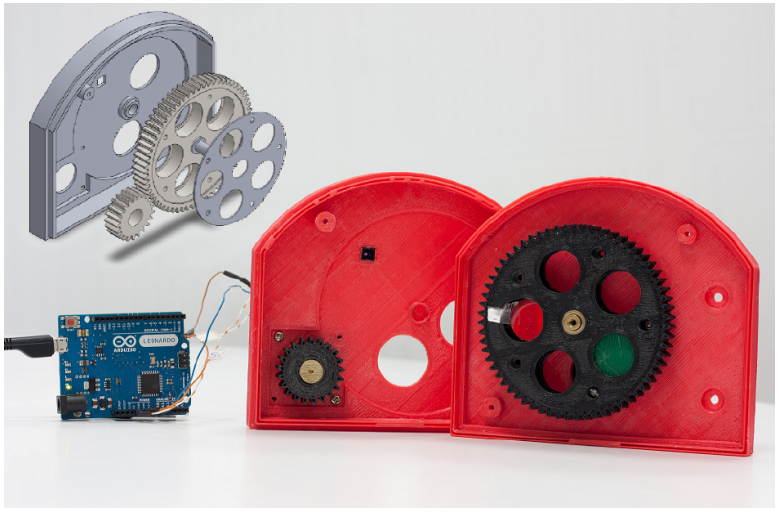
† Both authors collaborated equally in this work.

Studying dynamic processes at the cellular level, requires a fast exchange of filters and/or polarizers for quantitative imaging. In this work we present an automatic filter wheel which is part of the SOMA project (Open Opto-Mechanics System). This low cost automatic filter wheel allows the exchange of filters in less than 200 milliseconds. Most of the pieces are manufactured by a 3D printer, which offers high versatility when it comes to replacing or modifying them. The electronics is controlled by an Arduino board from the computer and any programming language can be used to send the instructions. In this open project all the drawings and codes for producing and controlling the devices are available online*, thereby any of the components can be manufactured and modified according to the application requirements.

***www.lec.df.uba.ar/soma/**



Below-bandgap excitation of bulk semiconductors by light carrying linear momentum

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We theoretically investigate the response of bulk semiconductors to excitation by plane waves light below the energy bandgap. To do its we modify the generalized assumption, known as “vertical transitions”(VT), that neglects the photon’s momentum in direct absorption/emission processes. Exceptions are found in early and recent works, reporting theoretical and experimental results strongly dependending on the conservation of the linear momentum of the photon that results in new selection rules not accounted for by VT.

The dynamics of electrons in a semiconductor having a valence and a conduction bands is described by Heisenberg equations of motion for populations in each band plus the quantum coherence between them; these equations form a coupled system. Under the condition of low field excitation, the equations can be treated perturbatively and can be decoupled. The first order term in the light field is the quantum interband coherence whereas, populations are second order in the light field. Then, the linear response of the unexcited system (zero conduction band population) can be obtained.

We show that the excited states can be thought of as a superposition of slightly perturbed exciton states undergoing center-of-mass motion. The susceptibility shows the expected features, i.e. no spatial dependence but “spatial dispersion”(dependence). The COM-motion correction introduces a tiny shift in the absorption line. Used in conjunction with Maxwell’sequations, the susceptibility yields information about the effect that electrons has on the EM field, eg. attenuation of the beam.

Producción y detección de fotones gemelos a partir del fenómeno de conversión paramétrica descendente (SPDC)

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En este trabajo se implementó y caracterizó un sistema generador y detector de fotones gemelos. En particular se optimizó el dispositivo para la obtención de pares entrelazados en polarización a partir del proceso de conversión paramétrica descendente llevada a cabo en un cristal no lineal BBO tipo II. Se estudiaron por separado los estados de un solo fotón y los sistemas de dos fotones realizando las correspondientes tomografías para reconstruir el estado preparado y así analizar las características del proceso, sus fuentes de error y reproductibilidad. Se generaron estados entrelazados y fueron utilizados para medir la violación de la desigualdad de Bell CHSH por más de 40 desviaciones estándar.

One-shot three-dimensional scene analysis

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In this work we will show that it is possible to perform three-dimensional (3D) analysis and extract features without performing a 3D surface reconstruction. We propose a novel approach that consists in acquiring the scene under the projection of structured light (plus the natural ambient illumination), which allows us to obtain the depth gradient map using a simple processing step with very low hardware requirements.

Transporte de masa en azo-polímeros y sus mezclas físicas con nanotubos de carbono

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El interés en el estudio y generación de nuevos materiales fotosensibles se fundamenta en sus diversas aplicaciones, tan diversas como la biomimética, almacenamiento de información, litografía, etc. Recientemente se ha mostrado que es posible inducir birrefringencia ópticamente en materiales poliméricos que contienen colorantes derivados del azobenceno. El azobenceno consiste en un grupo funcional azo unido a dos anillos fenilos. La sustitución de los anillos por distintos terminales permite obtener una gran variedad de compuestos. Algunos compuestos, además, presentan transporte de masa al ser iluminados por una fuente de longitud de onda adecuada. Estos amplían sus prestaciones a aplicaciones donde la variación en superficie sea de interés, como en litografía.

En este trabajo se estudió el material fotosensible poly[1-[4-(3-carboxy-4-hydroxyphenylazo)benzenesulfonamido]-1,2-ethanediyl, sodium salt], un polímero funcionalizado comercial, compuesto por una molécula fotosensible derivada del azobenceno unida covalentemente a una matriz polimérica. Se estudió la inducción de birrefringencia y la formación de redes en films delgados. Se observó que además de la formación de una red de birrefringencia, se produce transporte de masa, dando lugar a la formación de una red en relieve. Se consiguieron modulaciones de 160 nm y 240 nm al utilizar figuras de interferencia de polarización e intensidad, respectivamente.

Se estudió el efecto de la adición de nanotubos de carbono en la formación de la red. Debido a las propiedades mecánicas y de transporte de los nanotubos, es de interés estudiar la posibilidad de crear materiales con sus características y las propiedades ópticas de la molécula fotosensible. Usando el colorante DO3 para disolverlos, se fabricaron muestras PAZO con nanotubos. En estas se lograron modulaciones en superficie de 530 nm, y se observaron eficiencias de difracción del 40%.

Infrared optical characterization of doped ZnO nanorods.

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ZnO is a transparent n-type semiconductor with a bandgap of approximately 3.3 eV and a refraction index of about 2. It is usually doped using group-III elements Al, In or Ga as substitutional elements for Zn and group-VII elements Cl and I as substitutional elements for O. Using appropriate methods it is possible to obtain ZnO nanorods (aspect ratio from 3-5). These structures are currently studied due to their applications in energy harvesting and light emitting devices. In the present work ZnO nanorods were grown electrochemically on a FTO substrate and doped using NH_4Cl as Cl precursor. Such chloride impurities may act as electrical donors, producing an increase of free electrons. This behavior has been optically analyzed using infrared radiation. To perform the characterization the optical reflectance $R(\lambda)$ was measured in the band from 1.3 μm to 25 μm using a Shimadzu IR Prestige-21 Fourier Transform Infrared Spectrometer equipped with an SRM-8000A accessory. In the region from 1000 to 3600 nm the transmittance was measured using monochromated light (Oriel 77250 monochromator) and a Sciencetech IA-020-TE2-H InAs thermoelectrically cooled detector. From the results a metallic like behavior is observed: the reflectance increase to the IR and diminish into the visible region. In this region (transparency region) the behavior is complicated by oscillations associated with interference phenomena. The onset of reflectance shifts to the visible region when the concentration of Cl is increased, which implies that Cl is effectively generating free carriers in the semiconductor.

Caracterización Eléctrica y Electrónica de Películas Porosas de Titania para aplicaciones en Celdas Solares Híbridas

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Departamento Energía solar Comisión nacional de energía atómica (CNEA)

Recientemente se han demostrado importantes esfuerzos en el área de las celdas solares híbridas de estado sólido (CSH). Estas celdas combinan el uso de materiales fotoactivos inorgánicos y orgánicos, aprovechando las ventajas de ambos materiales. Por un lado, los semiconductores inorgánicos otorgan robustez y estabilidad al mismo tiempo que ofrecen novedosas estructuras tridimensionales que permiten interfaces del tipo “bulk” altamente controladas. Por otro lado, los materiales orgánicos consisten en una opción de bajo costo para el mejor aprovechamiento de la luz solar en toda su extensión espectral.

En este proyecto se estudian propiedades eléctricas y electrónicas de materiales aplicados a este tipo de celdas. Empezando por los materiales inorgánicos (titania policristalina mesoporosa) con vista a repetir estas técnicas en los materiales orgánicos.

Se prepararon las muestras mediante dip coating con distintas estructuras tridiminecionales y a distintos tratamientos térmicos. Las muestras consisten en una membrana densa o mesoporosa (estructura tipo bulk) de titania. Así como también se realizaron membranas de bicapa (una mesoporosa sobre una densa).

Se realizaron mediciones de impedancia y modelado de circuito equivalente y se extrajeron parámetros eléctricos del mismo, así como también se midieron curvas IV en altas tensiones para la obtención de movilidades típicas.

Classical modeling of the second-order spatial coherence for optical fields

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A classical modeling of optical field is proposed to describe the second-order spatial coherence on chaotic sources, as the stars. This description is based on the theory of spatial coherence wavelets. Its fundamental concept is the correlation between these wavelets which also involves the correlation of the cross-spectral densities of the fields. The concepts of radiant and virtual point sources are introduced and Young's experiments with virtual sources are analyzed. This theory suggests that the second-order spatial coherence state of light can be described in terms of three layers of point sources; a strategy that can increase the performance of numerical algorithms. The modulation in coherence found is similar to that measured in Hanbury-Brown and Twiss effect for the case of binary stars.

Nowadays, the study in the spatial framework of Hanbury-Brown and Twiss effect is crucial for the construction of modern intensity interferometers based on Cherenkov Telescope Arrays. The aim of these devices is the measurement of the angular separation of binary stars by appealing to the second-order spatial coherence state of light recorded by their detectors.

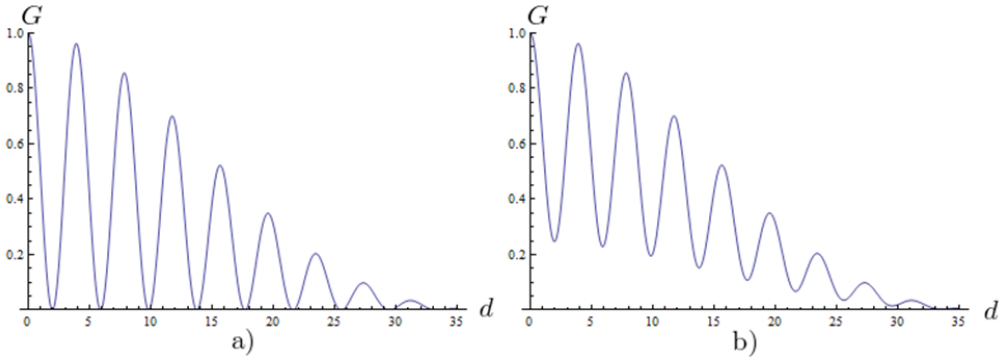

Figure: Normalized correlation G vs. distance between detectors d when the pairs of radiant point sources (stars) are: a) system of identical elements (same size and bright), b) system with one element three times brighter than the other.

Production and characterization of sensors photovoltaic (PV) of radiation UV

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The photovoltaic sensors can be use in general in any situation where the excitation of entry is a luminous radiation, in the range of wave lengths where they are sensitive, delivering an electric signal on the output. Especially its in terrestrial utilization, the photovoltaic radiómetros are very spread for the measurement of solar radiation due to the low cost compared with thermoelectric sensors as the piranómetros.

These sensors have a semiconductor as a sensing element on that on having received a radiant flow generates a current proportional to the irradiance received which, as it flows through a load resistor, generates a potential difference; this response is not flat but selective depending on the wavelength of the radiation.

PV sensors that are made in the laboratory of Solar Energy Department of CNEA possess a structure n^+pp^+ on commercial wafers of If monocrystalline type *p*. The issuers n^+ and p^+ they are formed from a codifusión of P and Al.

In order to improve the response of the sensors in the UV region it is necessary to modify the process parameters such as temperature, gas flow and time. In this way is possible to have the technology to manufacture sensors that measure a specific portion of the solar spectrum which would allow the instrument to adapt to the need of the user and in particular to obtain photovoltaic sensors suitable for use as indicators of radiation UV.

Extreme events in the dynamical behaviour of a Nd:YVO_4 laser with modulated losses: experimental approach

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Since optical rogue waves (ORWs) were first reported in 2007, the study of extreme events in optical systems has been a very active research field. In such systems, extreme events appear as high intensity pulses in the chaotic behaviour, giving a long tail in the probability distribution of the intensity of the pulses. Understanding the dynamics in which extreme events arise comprises the first step onward the prediction and control of these pulses. In this work, we study the dynamics of an all-solid-state Nd:YVO_4 laser (class B) with electro-optically modulated losses. Taking the amplitude modulation as the adjustable control parameter V, we analyze the temporal series for the maxima of intensity pulses.

At low values of V the intensity traces obtained were periodic, showing a monotonically increasing period, hysteresis and bistability. After reaching a threshold the system goes into a low-dimensional chaotic behaviour, in which the probability distribution of the temporal series presents a non-Gaussian shape. Extreme events arise as events in the long tail of the distribution at high amplitude values, we find a nonlinear dependence of their occurrence with the control parameter. These results are in good qualitative agreement with the existence of an “external crisis”, as recent theoretical model predicts. Furthermore, we observe that the predictability horizon of the dynamics associated when extreme events occur is larger than the associated to a regular pulse. Therefore, we hypothesize the existence of structures within the chaotic behaviour in which the systems becomes more predictable.

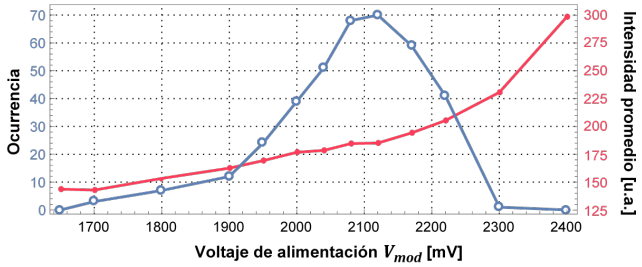

Figure 1: Occurrence of extreme events as function of control parameter V.

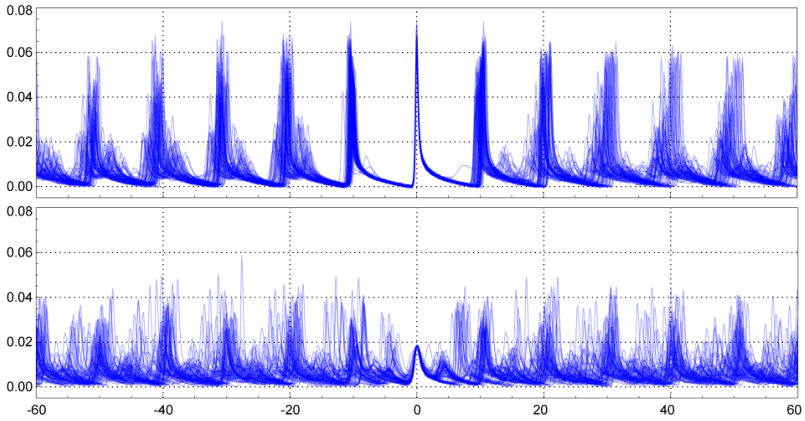

Figure 2: Overlapping of intensity traces centered on extreme events (top) and regular pulses (bottom).

Measurement of mechanical displacements by Digital Speckle Pattern Interferometry

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Digital Speckle Pattern Interferometry is a set of techniques based on overlapping speckle distributions, registering by video cameras and processing by computer systems. It's most important characteristics are: its high sensitivity, the ability to measure mechanical displacements fields generated by objects with diffusing surfaces. They require no contact with the surface of study and provide quantitative results almost automatically. For these reasons, it can be used in industrial environments to detect and evaluate defects.

This research work analyzes the performance of the DSPI technique and the algorithms used to measure displacements, both in plane of the sample and out of plane. Various aluminum plates were used, which were moved with a micrometer transversely and perpendicularly to the plane of the plate surface. A rectangular plate was displaced like a rigid body in plane and out of plane. A square plate and a circular plate, both supported in steel holders, were displaced out of plane from the center, deforming them elastically. Then different numerical methods were used to evaluate the phase distribution in the correlation fringes obtained from experimental interferograms, particularly those based on the Fourier transform and the Carré method. Next the unwrapping of these phase distribution was analyzed. The reconstruction algorithms known as norm L^0 min were discussed, which were unwrapping methods applied. Finally, the values for the displacements made with the micrometer screw were compared with the values obtained by algorithms.

The experimental work was developed in the Laboratory of Metrology and Fiber Optics of IFIR (CONICET, UNR).

Nanoscopía de fluorescencia por localización estocástica

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La microscopía óptica de fluorescencia es ampliamente usada para el análisis de muestras biológicas. Los métodos tradicionales están limitados en su resolución por la difracción de la luz, razón por la cual no permiten discernir detalles de dimensiones menores a 200 nm aproximadamente. En la última década se han desarrollado distintas técnicas [1-5], denominadas nanoscopías de fluorescencia o microscopías de super-resolución, que permiten sobrepasar este límite y obtener resoluciones un orden de magnitud mayor sin perder las ventajas de la microscopía óptica, en particular, la de seccionado 3D y la posibilidad de estudiar procesos celulares in vivo.

Las mediciones de nanoscopía por localización estocástica consisten en tomar imágenes secuencialmente donde en cada una, solo unos pocos fluoróforos son visualizados, distanciados suficientemente de modo que sus posiciones pueden determinarse con precisión mas allá del límite de difracción. El proceso se repite bajo condiciones en las que en cada imagen se visualizan distintos fluoróforos, en distintas posiciones. A medida que se obtienen y analizan imágenes de este tipo, se reconstruye una imagen artificial donde se acumulan todas las posiciones detectadas de fluoróforos, reportando estructuras marcadas con resolución limitada únicamente por el numero de fotones usados en cada localización. Típicamente se obtienen alrededor de 500-4000 fotones/fluoróforo dando lugar a imagenes con resolución de 20-40 nm. El número de imágenes individuales necesarias para reconstruir una imagen con super-resolución depende del nivel de detalle deseado pero ronda las decenas de miles.

En el Centro de Investigaciones en Bionanociencias (CIBION) se desarollan técnicas de nanoscopíaa y se aplican a proyectos interdisciplinarios con distintas instituciones. En particular, el Centro cuenta con un nanoscopio de localización estocástica. En este trabajo se exponen distintos desarrollos realizados en los ultimos seis meses que incluyen:
1) La construccion y caracterización de un control de foco por sensado óptico y realimentación a través de un lazo PID.
2) La implementación de la capacidad de realizar imágenes 3D por localización estocástica con astigmatismo de la PSF
3) La implementación de un sistema para realizar imágenes a dos colores.

Además se presentaran los primeros resultados de imagenes de super-resolución obtenidas en el laboratorio.

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Two-coupled donors in a semiconductor quantum ring: effect of the external probes and magnetic field on the turning point

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The turning point of two donor system (D_2^+) confined in GaAs quantum rings under the presence of magnetic field and external probes was analyzed. Based on structural data for the quantum ring, a rigorous adiabatic procedure was implemented to separate the electron's rapid in-plane motions form the slow rotational ones. A one-dimensional equation with an effective angular-dependent potential. It was show that the turning point characteristic features are strongly dependent on the quantum ring geometrical parameters and the magnetic field.

These studies are important for the advancement of quantum computing for the construction of various components such as diodes, transistors etc.

Characterization by Optical Extinction Spectroscopy of Ag NPs synthesized by fs laser ablation using different stabilizers

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Strong research efforts have been devoted in the last decay to develop synthesis of noble metal nanoparticles (NPs) due to their applications in many areas of science and technologies. Silver NPs show unique chemical, physical and optoelectronic properties [1, 2] with good potential for use in medical therapeutics, high density optical recording. However, the synthesis of stable colloids still remains as a big challenge.

In this presentation, we study the characteristics of size stabilization of Ag colloids NPs fabricated by fs laser ablation in water and aqueous solutions using trisodium citrate ($Na_3C_6H_5O_7$) and starch as stabilizing agents at different concentrations.

Colloidal suspensions were obtained using a 100 fs amplified Ti:Sa laser system, working at λ = 800 nm and a repetition frequency of 1 kHz. The laser was focused on a solid silver target immersed in the liquid media at different pulse energies (100 µJ y 500 µJ).

The colloids were experimentally characterized through Transmission Electron Microscopy (TEM) and Optical Extinction Spectroscopy (OES). Experimental extinction spectra were fitted using Mie theory [3] considering a suitable size modification of the bulk experimental complex dielectric function and leaving size as the fitting parameter [4, 5]. The stabilizers modify Ag NPs surface through functional group in their chemical structure. This fitting procedure yielded broader size distribution for water, intermediate for starch and narrower for citrate.

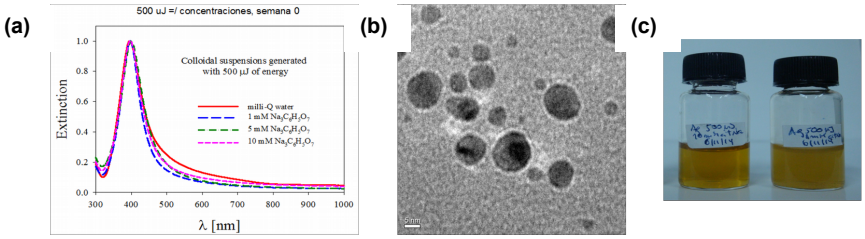

Figure 1. Ag NPs in aqueous solution with different concentrations of citrate: (a) Experimental extinction spectra, (b) TEM image (1 mM of citrate) and (c) colloidal suspensions (10 mM and 1 mM of citrate).

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Huygens Metasurfaces: Modulating the wavefront using coupled dielectric nanoparticles with backscattering suppression

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Electromagnetic metasurfaces are broadly defined as planar arrangements of resonators with characteristic spacing smaller than the operating wavelength. Traditionally, when phase modulation of the transmitted light is required, this systems have been implemented using V-shaped metallic antennas with cross-polarized emission. Recently, metasurfaces were proposed as a novel tool for the implementation of integrated optical elements, as lenses and polarizers, in integrated circuits and MEMS.

In this work we introduce an alternative concept for the implementation of visible range metasurfaces, based in high refractive index dielectric disks. We use dielectrics to avoid ohmic losses inherent to metals operating at high frequencies, while the simpler circular geometry allows us to keep the precision high at much smaller scales than the traditional design. The overlapping of the two first Mie modes, electric dipole (ED) and magnetic dipole (MD), enables us to control the phase shift of the transmitted light over all the [0-2π) range, while suppressing the backscattering by destructive interference.

We present the numeric and experimental results of a parametric study of the proposed structures, showing transmittance intensity up to 70% over all the phase shift range. We also explore the role of the coupling between resonators, suggesting the use of the distance between disks as design parameter for the tunning of the resonances. Based in this findings, we designed and fabricated a focusing metasurface , and present the results of the testing of its performance as an indirect experimental proof of the control by design over the transmitted light phase shift.

Light Scattering Measurements by Diffuse Transmittance and Reflectance spectra of electrodeposited ZnO Nanorods Arrays.

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ZnO Nanostructures are being widely studied for photovoltaic solar cells applications. As ZnO wide bandgap energy is ca. 3.3 eV it should be sensitized for photovoltaic applications. Moreover, ZnO Nanorods Arrays (NRAs) sensitized with other semiconductors (e.g. CdS, CdTe) are proposed for pure Solid State core-shell sensitized solar cells. These core-shell nanostructures could present higher efficiency due to the light scattering enhancement in the ZnO NRAs.

Although ZnO is a transparent semiconductor the ZnO samples seem white to the naked eye. However, the same samples show a red appearance when light passes directly through the samples. The Visible Total and Diffuse Transmittance and Reflectance of different electrodeposited ZnO NRAs were measured. These measurements were performed with an integrating sphere (Gigahertz-Optik UPB-150-ART).

Total (TR) and Diffuse (DR) Reflectance spectra are equal suggesting that light reflection is dominated by light scattering in the Nanostructure of the samples. The spectra show a broad peak located ca. of 450 nm. This peak shows a red-shift with the increment of the NR radius. The Diffuse Transmittance (DT) spectra also show peaks located between 500 and 650 nm that red-shift with the radius. For longer wavelengths the spectra shows a decrease between 20 and 50 % of the peak value. Moreover, the peak shows a broadening achieving almost constant spectrum for the bigger radius samples. The Total Transmittance (TT) shows a thin film like spectra that taking in consideration the diminution on the DT suggest an increase in the direct transmission for longer wavelengths.

Numerical Wave Propagation plugin for ImageJ

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Within the robust environment for image processing provided by ImageJ, an open source software, we developed a plugin for numerical wave propagation. The plugin powers ImageJ with the capability of computing numerical wave propagation by the means of three different algorithms, angular spectrum, Fresnel and Fresnel-Bluestein. Also, the plugin offers the option to work with complex fields and has the option to reproduce different representations of the output field, real and imaginary parts, phase, amplitude and intensity. The plugin, for being developed in the complete structure of ImageJ enables the users to preprocess and post-process the images using the complete set of built-in tools bundled with ImageJ. The plugin can be used for teaching and research purposes.

Fig. 1. *ImageJ main window.*

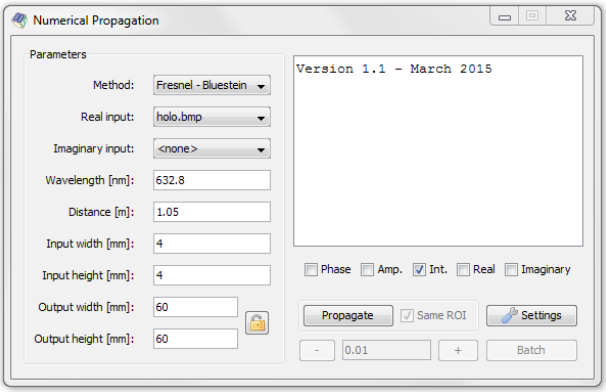

Fig. 2. *Numerical wave propagation plugin main window.*

Transferencia de energía en nanopartículas de polímeros conjugados: modelado y contraste con datos experimentales

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Los polímeros conjugados son macromoléculas compuestas por monómeros que presentan enlaces simples y múltiples alternados. Dentro de la cadena existen segmentos (cromóforos) de longitud variable en donde los electrones π se encuentran deslocalizados. Debido a la heterogeneidad estructural de estos materiales los procesos de transferencia de energía (TE) entre cromóforos y dopantes son altamente complejos. El mejor entendimiento de estos procesos es de importancia para el desarrollo de dispositivos orgánicos-electrónicos.

En este trabajo se presenta una combinación de estrategias experimentales y modelado teórico para estudiar los procesos de TE en nanopartículas (NPs) de polímeros conjugados dopadas con colorantes. El modelado se basa en Simulaciones Montecarlo y tiene en cuenta los siguientes parámetros: probabilidad de decaimiento de cromóforos fotoexcitados (excitones), TE cromóforo-cromóforo (difusión del excitón) y cromóforo-dopante, probabilidad de decaimiento del excitón y distribución espacial de dopantes en NPs. A partir del ajuste de los datos experimentales utilizando el modelo desarrollado se obtuvieron parámetros tales como la *distancia media recorrida por el excitón* (L_D) y la *longitud de un paso de la caminata aleatoria* (ε) los cuales son difíciles de obtener a partir de otras técnicas. Se compararon los resultados de la simulación con experimentos de espectroscopia de fluorescencia en los que se midió el grado de desactivación de fluorescencia en función de la concentración de dopantes en NPs de PDHF (polímero comercial) de 30 nm de diámetro medio dopadas con Perileno. Valores de L_D=8nm y ε=0,1nm producen un buen ajuste de los datos experimentales (Fig 1). Se realizarán nuevas iteraciones para mejorar dicho ajuste.

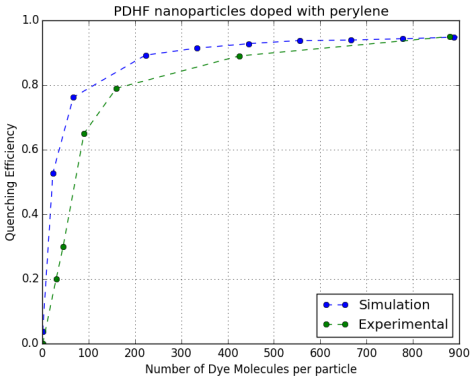

Figura 1. Eficiencia de desactivación de fluorescencia en función de la cantidad de moléculas de colorante (Perileno) por NP de PDHF.

Entropía condicional y medidas de correlaciones cuánticas en estados mixtos de dos fotones

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En este trabajo hemos comprobado experimentalmente la dependencia de la entropía condicional, asociada a un sistema mixto de dos qubits A+B, con las distintas medidas proyectivas realizadas sobre uno de los subsistemas. Esta entropía condicional se hace relevante en el presente contexto, ya que su valor mínimo permite obtener medidas de interés como la ya mencionada discordia cuántica, o el *déficit de información*. Para cierto conjunto de estados, una expresión analítica de la misma en términos de la medida proyectiva, como así también de la medida minimizante, ha sido recientemente presentada en [1]. La verificación experimental se realizó codificando el estado de los dos qubits en el grado de libertad de polarización de dos fotones. La mixtura del estado se establece a partir de la combinación de distintas polarizaciones durante el tiempo de medida. Posteriormente, se proyecta el estado de polarización de uno de los fotones (B) sobre una dirección arbitraria, y condicionada a esta medida proyectiva, se determina la matriz densidad del fotón gemelo (A) a partir de la tomografía completa de un qubit. Hemos calculado y analizado la pureza del estado del subsistema A luego de la medida proyectiva sobre el sistema complementario (medida que se relaciona directamente con la entropía condicional) y a partir de la misma, los valores de la discordia cuántica y el déficit de información para distintos estados mixtos del sistema bipartito A+B. Para todas estas cantidades, se observa un perfecto acuerdo experimental con las predicciones teóricas.

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Polarization control in single-mode optical fibers

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We present an experimental study of the procedure of birefringence compensation in single-mode optical fibers. Our final goal is to achieve the distribution, over long distances, of pairs of photons entangled in polarization. The polarization state changes when photons pass through a fiber, due to birefringence, in an uncontrollable way. In the applications involving propagation through long section of fibers, it is thus necessary to recover the initial photon's polarization state. Even though the change produced in the fiber is unknown, it can be always reduced to a rotation in the Poincare's sphere. In order to generate arbitrary rotations in Poincare's sphere, manual fiber polarization controller systems, or "bat-ears", are customarily used in the experiments. These systems use stress-induced birefringence to change the polarization of light in single-mode fibers in a controlled way. We test the performance and operation of these systems by using two optical sources: a diode laser (635 nm) and a LED at the wavelength of the intended entangled pairs (710 nm). The light was coupled into a 50 m coil of 3.5 μm core single-mode fiber. The refractive index of the fiber, and hence, the induced birefringence, can vary with changes in temperature. Therefore, we also study the temporal stability of the achieved birefringence compensation over a narrow range of temperature around room temperature.

Simplified variant of an optical chip to evaluate aggregation of red blood cells

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Traditional techniques to evaluate the aggregation of red blood cells (RBC) by optical methods require large sample volume and provide parameters that vary significantly from one method to another. A simplified variant of a chip system previously developed by Shin et al. (2009) [1] based on light transmission for measuring erythrocyte aggregation is presented. Through a detailed analysis of intensity versus time curves, relevant information about erythrocyte aggregation and its variables is obtained. Two main features of blood where altered in order to analyze them with the developed equipment: the electric surface charge of RBC, and the plasmatic protein content of the suspension medium. Parameters that provide more accuracy for the diagnosis of patients in order to have an immediate application in Clinical Medicine are proposed.

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Characterization of a phase-only spatial light modulator and generation of beams carrying orbital angular momentum

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Spatial Light Modulators (SLMs) are pixelated liquid crystal devices that can be programmed to act as holograms, and have a widespread range of applications in different areas like diffractive optics, optical storage, or optical metrology. Here we analyze the phase modulation of a liquid crystal on silicon (LCoS) display. The LCoS we use is a PLUTO parallel aligned SLM with HDTV resolution and 8 μm pixel size, that is especially suited for phase only modulation. In this type of SLM the phase level is created by a pulse width modulation (PWM) technique, which has the drawback, compared to an analog addressing, of superimposing a slight phase flicker. To characterize this flicker we measure the instantaneous phase modulation with millisecond resolution for the different schemes of PWM provided by the manufacturer. For this purpose we register the light diffracted by a binary phase grating on order 0 and 1 as a function of time. We also implement another method for obtaining the time averaged phase modulation as a function of the addressed gray level, by measuring the shift of the fringes in a two beam interference experiment. We finally use this SLM for generating beams carrying orbital angular momentum (OAM). Using the SLM, programmed with the OAM holograms, as one of Michelson interferometer's mirror, results in an interference pattern representing the phase structure of the generated beam.

Point-FCS experiments in *Xenopus laevis* oocytes to estimate calcium diffusion coefficient in cells.

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The versatility of calcium as a signaling agent is based on the great diversity of spatio-temporal behaviors that its concentration can display inside cells. Its full comprehension requires the combination of observation and modeling.
Optical techniques and fluorescent calcium dyes have provided a relatively non-invasive means to study the dynamics of intracellular calcium signals. *Xenopus laevis* oocytes are a model system in which an enormous variety of calcium signals have been observed, from localized signals to cellular waves.
For the combination of modeling and experiments to be useful it is necessary to have estimates of certain biophysical parameters in situ. One relevant parameter is the calcium diffusion coefficient which is key in shaping the spatio-temporal dynamics of intracellular calcium. Fluorescence Correlation Spectroscopy (FCS) is an optical technique that is commonly used to estimate diffusion coefficients. In this work we show the results of applying such technique in solution and in *Xenopus laevis* oocytes using Fluo-8 as the Ca^{2+} dye.

NIR Diffuse Optical Imaging of Tissue-Like Phantoms With Immerse Inhomogeneities

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In the latest years, interest has increase towards tissue imaging using NIR (Near Infrarred) light. Light interacts with biological tissues by absorption and scattering. For these tissues, in the NIR region, scattering is highly dominating over absorption, thus, light interacts multiple times before exiting the medium.

It is known that lesions can be distinguished from healthy tissue by their different optical parameters. Besides, the NIR radiation is completely harmless, allowing its frequent utilization without the effects of ionizing radiation. This imaging technique may be complemented with the use of fluorescent markers, like ICG (Indocyanine green), whose pharmacokinetics is different in healthy tissues than in malignant lesions.

I present here an overview of the work in progress, related to my PhD thesis, that focus on the localizaton in 3D and characterization of tumor-like inclusions embedded in turbid media. For this, purpose, I analyze the light emerging from the medium at different wavelengths, in the so called diffuse transmittance geometry using both, absorption and fluorescence images. The study is performed over phantoms, that are constructions emulating biological tissues (in this case, breast tissue), fabricated with distilled water, milk, ink and ICG. Furthermore I also made a research about the absorbent components . The inclusions employed are built with a higher absorption coefficient and higher ICG concentration, to represent breast tumors. A theoretical model is discussed and experimental result are presented.

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