IOSA (IO-CSIC OSA student chapter) invites you to

7th IOSA scientific seminars

1st online format

Invited speakers

Alejandro Manjavacas

Aitor Villafranca

Alberto De Castro

Marcelo Bertalmío

Thursday, 17th December, 4:00 pm - 6:30 pm CET

https://bit.ly/2KwhUvm

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7th edition of the IOSA Scientific Seminars

IOSA (IO-CSIC OSA student chapter) carries out several outreach activities to spread optical science among the general population since the inception of the student chapter in 2007. Supervised by Prof. Susana Marcos and Dr. Juan Diego Ania, IOSA is composed by early-career researchers and pre-doctoral students at the Institute of Optics (CSIC) working on different fields related to optics such as visual optics, biophotonics, lasers, digital processing of images, optical fibers or theoretical and experimental studies on the optical properties of matter. Moreover, IOSA wants to contribute to the professional and scientific development of the students at the Institute of Optics, individually and as a group.

For that reason, IOSA, in collaboration with the Institute of Optics (CSIC), has organized in the last years a series of Scientific Seminars open to all the staff of the Institute of Optics: technicians, pre- and post-doctoral researchers, as well as senior researchers, including all the IOSA members willing to participate. **These seminars aim to create a friendly environment for scientific discussions in the topics of the different lines of research developed in the IO-CSIC**. IO-students will professionally and scientifically benefit from these seminars, thus they will have the chance to work in a conference-like atmosphere, to prepare a good talk, to answer tough questions from partners and senior researchers and to be questioned by their peers.

Moreover, this year we will count on special keynote invited speakers, the new official scientific staff of the Institute of Optics: **Alejandro Manjavacas**, **Aitor Villafranca**, **Alberto de Castro** and **Marcelo Bertalmío.**

IOSA Scientific Seminars 2020 Schedule

16:00 h – Opening speech by the current IOSA's president

16:05 h – *Traceable measure of BSSRDF* **P. Santafé Gabarda**

16:15 h – Invited talk: *Effect of fixational eye movements in topography measurement with OCT* **A. de Castro**

16:40 h – *Comparison of scleral biomechanics in rabbit and porcine models using OCT air-puff deformation imaging* **L. Villegas**

16:50 h – Invited talk: *Modelling the Receptive Field in a nonlinear manner* **M. Bertalmío**

17:15 h – *The geometry of the human crystalline* lens **E. Martinez-Enriquez**

17:25 h – Invited talk: *Subwavelength metamaterials for high performance integrated photonics* **A. Villafranca**

17:50 h – *Y-junction power splitter engineered through subwavelength metamaterials* **R. Fernández del Cabo**

18:00 h – Invited talk: *Using Metallic Nanostructures to Control Light at the Nanoscale* **A. Manjavacas**

18:25 h – Closing remarks.

(Central European Time Zone (CET))

IOSA Scientific Seminars 2020 Abstracts

Traceable measure of BSSRDF

Pablo Santafé Gabarda

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The Bidirectional Surface-Scattering Reflectance Distribution Function (BSSRDF) is a distribution function that describes the relation between a radiant flux that strikes an object and its radiance at any position on its surface. Due to its complexity, there is still no measurement system capable of characterizing it with metrological precision, and transferring its unit to other instruments. The key of the BSSRDF lies in its relationship with the translucency of objects and in that it allows describing those optical properties that affect volume scattering. In the Optics Institute of CSIC, a system capable of measuring BSSRDF has been developed, the Spanish Gonio-Spectrophotometer (GEFE). In this work, the BSSRDF of 12 homogeneous cataloged samples has been measured, with uncertainties lower than 3%. The obtained results can become a standard for other measuring instruments, thus transferring the unit of BSSRDF.

Effect of fixational eye movements in topography measurement with OCT

Alberto de Castro

Tenured Scientist at Instituto de Optica

The elevation of the optical surfaces of the eye can be measured with anterior segment Optical Coherence Tomography (OCT). However, the lateral resolution obtained by a dense raster scan can be limited by the fact that the data acquisition is not instantaneous. A study of the differences between repeated measurements and simulations of the process can help to understand the effect of eye movements in the topography measurements.

Data from two OCT imaging systems with different repetition rates (20 and 200 KHz), number of lines per volume (300x50 and 300x150) and acquisition times (0.6 and 0.41 s) were studied. The acquisition with the two systems was simulated computationally assuming a model for the fixational eye movements based on a random-walk in a potential pit (Engbert 2017). On each scanner position, the eye movement was applied and the sag calculated. The central 3 mm were fitted by a sphere and the residuals were fitted by Zernike polynomials up to 6th order. The corneal elevation obtained from the two OCT systems was fitted with the same algorithms. The standard deviation of the fitting parameters in the simulation was compared to the experimental.

The model can explain a large fraction of the variance in the topographical measurements and predicts the increment in standard deviation in asymmetric Zernike terms found experimentally. Other sources of variance such as eye rotations, axial movements or instrument and image processing precision could be considered. These simulations can serve to understand the sources of variability in topography measurements, to find the optimal acquisition protocol and to evaluate motion correction algorithms.

Comparison of scleral biomechanics in rabbit and porcine models using OCT air-puff deformation imaging

Lupe Villegas

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Myopia results from axial elongation of the ocular globe, related to the extensibility of the sclera, reduction of collagen fiber diameter, and stiffness loss. Axial elongation is related to scleral biomechanical properties, hence, quantification of these properties would help to identify target zones for a potential treatment for myopia control. We have used swept source optical coherence tomography air-puff imaging to compare scleral deformation behavior of *ex-vivo* porcine and rabbit eyes, kept at constant intraocular pressure of 15mmHg. We performed air-puff deformation imaging on superior, inferior, nasal and temporal regions on the sclera, and found larger deformation displacement in rabbit than porcine eyes, and deformation dependencies within different regions of the sclera.

Modelling the receptive field in a nonlinear manner

Marcelo Bertalmío

Research Scientist at Instituto de optica

The responses of visual neurons, as well as visual perception phenomena in general, are highly nonlinear functions of the visual input, while most vision models are grounded on the notion of a linear receptive field (RF). The linear RF has a number of inherent problems: it changes with the input, it presupposes a set of basis functions for the visual system, and it conflicts with recent studies on dendritic computations. Here we propose to model the RF in a nonlinear manner, introducing the intrinsically nonlinear receptive field (INRF). Apart from being more physiologically plausible and embodying the efficient representation principle, the INRF has a key property of wide-ranging implications: for several vision science phenomena where a linear RF must vary with the input in order to predict responses, the INRF can remain constant under different stimuli. We also prove that Artificial Neural Networks with INRF modules instead of linear filters have a remarkably improved performance and better emulate basic human perception. Our results suggest a change of paradigm for vision science as well as for artificial intelligence.

The geometry of the human crystalline lens

Eduardo Martínez Enríquez

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In this talk I will give a brief overview of my research on the crystalline lens of the human eye, mainly focused on the study of its geometry from Optical Coherence Tomography images. The crystalline lens is an important optical element in the eye, responsible for focusing, and which experiences significant changes throughout life. Knowledge of the full shape of the crystalline lens is critical in many applications, such as the improvement of the outcomes of a cataract surgery, the success of methods to restore accommodation, or for proper sizing of accommodative intraocular lenses.

Subwavelength metamaterials for high performance integrated photonics

Aitor Villafranca

Tenured Scientist at Instituto de Optica

Silicon photonics provide an untapped miniaturization potential for numerous applications including transceivers, integrated microspectrometers, lab-on-a-chip sensors, or chips for microsatellites and microdrones. However, in order to fulfill this potential we need to overcome inherent limitations of the material platform such as dispersion and birefringence. Sub-wavelength gratings (SWG) are waveguide structures comprising periodic dispositions of core and cladding material, with a period much smaller than the wavelength of the guided light, that result in a homogenous meta-material combining the optical properties of both constituents. This enables to engineer custom effective refractive indexes, dispersion profiles and anisotropic properties through geometrical design; radically opening up the possibilities of designing ultra-broadband, low-loss, and polarization-selective devices.

Y-junction power splitter engineered through subwavelength metamaterials

Raquel Fernández de Cabo

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Efficient power splitting is an essential function in silicon based photonic integrated circuits. Symmetric Y-junctions, consisting of a stem waveguide that branches into two divergent arms, are frequently used for this purpose. Unfortunately, the finite resolution of current photonics fabrication technologies results in a limited minimum feature size of the tip between the splitter arms, which penalizes fundamental mode losses since its maximum intensity coincides with the central region of the device. In this work, we propose a novel high-performance beamsplitter based on a symmetric Y-junction incorporating subwavelength metamaterials to effectively mitigate losses associated with fabrication.

Using Metallic Nanostructures to Control Light at the Nanoscale

Alejandro Manjavacas

Tenured Scientist at Instituto de Optica

The control and manipulation of light is a long-standing scientific ambition with profound implications for the development of technology. One of the most promising routes to achieve this goal involves the use of nanostructures with dimensions comparable to the wavelength of light. Metallic systems are especially interesting due to their ability to support collective oscillations of the conduction electrons, commonly known as surface plasmons. These excitations couple strongly with light, generating very large near-fields, and therefore can be used to manipulate light below the diffraction limit. In this talk, we will review the fundamental concepts of plasmonics and discuss some recent results of our research group.