Once more the Portuguese Optics and Photonics community joinned efforts and with the support of colleagues and friends from all over the world, successfully organized the 4th International Conference on Applications in Optics and Photonics, AOP2019, which will be held at the Faculty of Sciences of the University of Lisbon, May 31 to June 4, 2019.

Since 2011 the Portuguese Society for Optics and Photonics successfully organizes the AOP conferences celebrating Optics and Photonics and its remarkable contribution to the development of our societies and humankind.

On the footsteps of the AOP2011 conference in Braga (www.optica.pt/aop2011), the AOP2014 in Aveiro (www.aop2014.org), and AOP2017 at the University of Algarve in Faro (www.aop2017.org) in 2017, this year' edition will gather over 200 participants that will share a pleasant and exciting week reviewing the state-of-the art on the widest range of O&P subjects, foreseeing and discussing the future of research in Optics and Photonics. Nine plenary sessions and 25 keynote lectures in all fields of Optics and Photonics delivered by a remarkable selection of world renowed scientists, will set the quality level of excellence of an exciting scientific program with nearly 240 presentations.

In the open friendly informal environment that characterizes our conferences, the AOP2019 will be an excellent opportunity to increase the external visibility of the research in O&P in Portugal and all over the World and to establish and or strenght sound mutually beneficial cooperation relationships among us, our research institutions, the industry, higher education institutions and scientific societies committed to the promotion of Optics and Photonics and of its impact in the development of our societies.

The next edition of SPOF' conference is already in preparation to be held September 6 to 10, 2021, at the University of Tras-os-Montes e Alto Douro in Vila Real in the north of Portugal. We are looking forward to welcome you all there.

As chairperson of the conference and president of the Portuguese Society for Optics and Photonics, SPOF, it is my pleasure and honor to welcome you to Lisbon for a most successful and enjoyable AOP2019 conference!

Universidade do Minho, Braga, May 14, 2019.

Manuel Filipe Pereira da Cunha Martins Costa

Program Overview

Friday (May 31)	Saturday (June 01)	Sunday (June 02)	Monday (June 03)	Tuesday (June 04)
	8:30 - 8:55 **Registration**	8:30 - 8:55 **Registration**	8:30 - 8:55 **Registration**	8:30 - 8:55 **Registration**
	8:55 - 9:40 **Plenary session** **Pl 4**	8:55 - 9:40 **Plenary session** **Pl 6**	8:55 - 9:40 **Plenary session** **Pl 7**	8:55 - 9:40 **Plenary session** **Pl 9**
	9:45 - 10:45 **Paralell sessions** **Sa.1.a | Sa.1.b | Sa.1.c**	9:45 - 10:45 **Paralell sessions** **Su.1.a | Su.1.b | Su.1.c**	9:45 - 10:45 **Paralell sessions** **Mo.1.a | Mo.1.b | Mo.1.c**	9:45 - 10:45 **Paralell sessions** **Tu.1.a | Tu.1.b | Tu.1.c**
	10:45 - 11:15 **Coffee break**	10:45 - 11:15 **Coffee break**	10:45 - 11:15 **Coffee break**	10:45 - 11:15 **Coffee break**
11:00 - 13:45 **Registration**	11:15 - 12:30 **Paralell sessions** **Sa.2.a | Sa.2.b | Sa.2.c**	11:15 - 12:45 **Paralell sessions** **Su.2.a | Su.2.b | Su.2.c**	11:15 - 12:30 **Paralell sessions** **Mo.2.a | Mo.2.b | Mo.2.c**	11:15 - 12:00 **Special Session** **Womens in Optics**
				12:00 - 12:30 **Awards & Closing ceremony**
	12:30 - 13:55 **Lunch**	Informal interactions Free time	12:30 - 13:55 **Lunch**	**Wine tasting** **&** **Farewell**
13:45 - 14:30 **Opening ceremony**	13:55 - 14:40 **Plenary session** **Pl 5**		13:55 - 14:40 **Plenary session** **Pl 8**	
14:30 - 16:45 **Plenary sessions** **Pl1, Pl2** and **Pl3**	14:45 - 16:00 **Paralell sessions** **Sa.3.a | Sa.3.b | Sa.3.c**		14:45 - 16:00 **Paralell sessions** **Mo.3.a | Mo.3.b | Mo.3.c**	
	16:00 - 17:00 **Coffee break &** **Poster session Sa.T**	16:00 - 19:30 **Visit to the** **Lisbon's Oceanarium** **&** **Parque das Nações**	16:00 - 17:00 **Coffee break &** **Poster session Mo.T**	
17:00 - 19:30 **Welcome reception** **(with visit to the** **Museum of Lisbon)**	17:00 - 18:30 **Paralell sessions** **Sa.4.a | Fr.4.b | Fr.4.c**		17:00 - 18:30 **Paralell sessions** **Mo.4.a | Mo.4.b | Mo.4.c**	
	Informal interactions Free time	19:30 - 22:30 **Conference Dinner**	18:35 - 19:05 **Special Session ACTPHAST4R**	
			19:05- 20:00 **SPOF General Assembly**	
	21:30 - 22:30 **Astronomical Talk &** **Lisbon's Fado Performance** **at Planetarium Calouste** **Gulbenkian**			

AOP 2019 – Program

FRIDAY, May 31

13:45 - 14:30 - Opening Cerimony

Professor Luís Carriço (Director of de Faculty of Science of the University of Lisbon)
Professor Maria Luisa Calvo Padilla (ICO' Past-President)
Professor Humberto Michinel (EOS' President)
Professor Santiago Royo (Representative of PHOTONICS21)
Professor Pedro Andrés (Representative of RIAO-SOFIA)
Professor Manuel Filipe Costa (SPOF' President and Chairperson of AOP2019)
Professor João M. Pinto Coelho (Chair of the Local Organizing Committee of AOP2019)

14:30 - 16:45 - Plenary Sessions

Pl1, Pl2 & Pl3 - Room 3.2.14 - Chair(s): José Manuel Rebordão | António Lobo

AOP100-178 (Plenary)	**Polarisation-sensitive optical coherence tomography – what's changed?**	David Sampson University of Surrey (United Kingdom)
AOP100-8 (Plenary)	**Designing instrumentation: the astronomers perspective**	Nuno Santos IA & Fac. Ciências, U. Porto (Portugal)
AOP100-253 (Plenary)	**Axions: Search for Dark Matter using Ultra-Intense Lasers**	José Tito Mendonça Instituto Superior Técnico (Portugal)

17:00 - 19:30 - Welcome reception (with visit to the Museum of Lisbon)

SATURDAY, June 1

8:55 - 9:40 - Plenary Session

Pl4 - Room 3.2.14 - Chair(s): António Lobo

AOP100-239 (Plenary)	**Laser spectroscopy to meet challenges in medicine**	Katarina Svanberg Lund University (Sweden)

9:45 - 10:45 - Parallel Sessions

Sa.1.a - Room 3.2.14 - Chair(s): Gonçalo Figueira

AOP100-244 (Keynote)	**Controlling light to the limit with the dispersion-scan technique: from single-cycle pulses to biomedical imaging**	Helder Crespo Universidade do Porto (Portugal)
AOP100-26	**New ultrashort OPCPA petawatt class beamline for Vulcan laser facility**	Marco Galimberti STFC, UKRI (United Kingdom)
AOP100-151	**VEGA laser facility beamlines management for pump-probe experiments.**	Cruz Méndez Valverde Consorcio Centro Láseres Pulsados (Spain)

Sa.1.b - Room 3.2.15 - Chair(s): Manuel Abreu

AOP100-68 (Invited)	**ESPRESSO Coudé-Train: ESO's VLT working as 16-metre telescope**	Alexandre Cabral IA & FCUL (Portugal)
AOP100-121	**The PESIT-IIA Observatory for the Night Sky (PIONS): Assembly and ground calibration results**	Ambily Suresh Indian Institute of Astrophysics (India)
AOP100-154	**Solar coherence instrument based on digital micromirror devices, to measure spatial coherence of solar granules**	Tiago Magalhães IA & FCUL (Portugal)
AOP100-10	**Ray tracing in stressed lenses in dynamical-optical systems**	Luzia Hahn Inst. of Eng. and Computational Mech., University of Stuttgart (Germany)

Sa.1.c - Room 3.2.16 - Chair(s): António Lobo

AOP100-33 (Keynote)	**Stable and strong light-emitters based on colloidal quantum dots encapsulated in robust and processable matrices**	Nikolai Gaponik TU Dresden (Germany)
AOP100-250	**Nanostructured yttrium aluminum composites doped with the rare earth elements: sol gel synthesis and up-conversion luminescent behavior**	Margarita Stepikhova Institute for Physics of Microstructures (Russian Federation)
AOP100-27	**Developing tunable optical analogues using nematic liquid crystals**	Tiago Ferreira INESC TEC - CAP (Portugal)

10:45 - 11:15 - Coffee break

11:15 - 12:30 - Parallel Sessions

Sa.2.a - Room 3.2.14 - Chair(s): António Lobo

AOP100-176 (Keynote)	**Multimodal optical coherence tomography**	Wolfgang Drexler Medical University Vienna (Austria)
AOP100-80	**Fast OCT image enhancement using deep learning for smart laser surgery**	Yakub Aqib Bayhaqi University of Basel (Switzerland)
AOP100-89	**Laser speckle rheology for evaluating mechanical properties of biomaterials: a pilot study**	Javier Ruiz-López Univ. de Granada (Spain)
AOP100-28 (Invited)	**A simulation analysis for dimensioning of an amorphous silicon planar waveguide structure suitable to be used as a surface plasmon resonance biosensor**	Alessandro Fantoni ISEL & CTS-UNINOVA (Portugal)

Sa.2.b - Room 3.2.15 - Chair(s): José A. Rodrigues

AOP100-181 (Keynote)	**Lidar imagers for automated vehicles: an overview**	Santiago Royo Universitat Politècnica de Catalunya (Spain)
AOP100-217 (Invited)	**The LiDAR hop-on-hop-off route: visiting the LiDARs past, present, and future landscapes**	Eduardo Nunes-Pereira University of Minho (Portugal)
AOP100-257 (Invited)	**Optical phased arrays for enabling solid-state LiDAR systems**	Marcus Dahlem IMEC (Belgium)

Sa.2.c - Room 3.2.16 - Chair(s): Nikolai Gaponik

AOP100-115 (Keynote)	**Carbon-based nanomaterials in suspensions far beyond the nonlinear optical threshold**	Bernd Eberle Fraunhofer IOSB (Germany)
AOP100-189	**Engineering of fluorescent biomaging tools based on quantum dot-encoded polyelectrolyte microcapsules and their cancer cell targeting applications**	Galina Nifontova National Research Nuclear University MEPhI (Russian Federation)
AOP100-49 (Invited)	**We play with chemistry to design colloidal semiconductor nanocrystals**	Vladimir Lesnyak TU Dresden (Germany)
AOP100-203 (Invited)	**New collective modes in twisted bilayer graphene**	Tobias Stauber Inst. de Ciencia de Materiales de Madrid (Spain)

12:30 - 13:55 - Lunch

13:55 - 14:40 - Plenary Session

Pl5 - Room 3.2.14 - Chair(s): Gonçalo Figueira

AOP100-213 (Plenary)	**Attosecond soft X-ray spectroscopy in condensed phase**	Jens Biegert ICFO & ICREA (Spain)

14:45 - 16:00 - Parallel Sessions

Sa.3.a - Room 3.2.14 - Chair(s): Jorge Ojeda-Castaneda | Fabian Hartmann

AOP100-198 (Invited)	**Reliability of ridge waveguide distributed feedback lasers for communications applications: from device specification and failure analysis to life-time calculation**	Horacio Cantu CST Gobal Ltd. (United Kingdom)
AOP100-137	**Quantum dots/azo-dyes hybrid structures for sensing**	Kirill Annas ITMO University (Russian Federation)
AOP100-212 (Invited)	**Functionalizing glass by inducing local compositional changes with ultrafast lasers**	Javier Solis Consejo Superior de Investigaciones Cientificas (Spain)
AOP100-156	**Quantum dot particles as anisotropic emitters for luminescent solar concentrator**	Natalia Zawacka University Ghent (Belgium)

Sa.3.b - Room 3.2.15 - Chair(s): José M. Baptista | José Figueiredo

AOP100-174 (Keynote)	**"Unipolar photonics": cross-gap, self-oscillating light emmission in GaN/AlN and InGaAs/AlAs RTDs at room temperature**	Elliott Brown Wright State University (United States)
AOP100-11 (Invited)	**Nanoscale vertical-emitting nanopillars for efficient sub-wavelength LEDs**	Bruno Romeira INL - International Iberian Nanotechnology Laboratory (Portugal)
AOP100-54	**GaN-based distributed feedback laser diodes for optical communications**	Steffan Gwyn University of Glasgow (United Kingdom)
AOP100-36	**Spike-free pulse generation in semiconductor injection seeding laser**	Pawel Grześ Wojskowa Akademia Techniczna (Poland)

Sa.3.c - Room 3.2.16 - Chair(s): Tobias Stauber

AOP100-2 (Keynote)	**Nonlinear optical properties of a new inorganic-organic nanocomposite material highly dispersed with semiconductor CdSe quantum dots**	Yasuo Tomita University of Electro-Communications (Japan)
AOP100-133 (Invited)	**Nonlinear electrodynamics of two-dimensional crystals**	Sergey Mikhailov University of Augsburg (Germany)
AOP100-169	**Harmonic generation in 2D materials**	Manuel Rodrigues INESC Tec & FCUP (Portugal)
AOP100-188	**Polariton-assisted emission of strongly coupled organic dye excitons in a tunable optical microcavity**	Dmitriy Dovzhenko National Research Nuclear University MEPhI (Russian Federation)

16:00 - 17:00 - Poster Session & Coffee break

Sa.T – C3 Lobby - Chair(s): João Coelho | Alexandre Cabral

AOP100-55	**The development of an optical design tool for atmospheric dispersion correction**	Bachar Wehbe IA & University of Porto (Portugal)
AOP100-159	**A compact optical polarimeter for portable telescopes used for teaching astronomy**	Gregory Topasna Virginia Military Institute (United States)
AOP100-102	**Image encryption system based on a nonlinear joint transform correlator for the simultaneous authentication of two users**	Juan Vilardy Ortiz Universidad Popular del Cesar (Colombia)
AOP100-103	**Experimental optical encryption scheme for the double random phase encoding using a nonlinear joint transform correlator**	Juan Vilardy Ortiz Universidad Popular del Cesar (Colombia)
AOP100-104	**Image authentication using a joint transform correlator-based encryption and decryption systems and the photon counting imaging technique**	Juan Vilardy Ortiz Universidad Popular del Cesar (Colombia)
AOP100-106	**Optical image encryption using a nonlinear joint transform correlator and the Collins diffraction transform**	Alvaro Herrera Universidad de La Guajira (Colombia)
AOP100-107	**Uncertainty principle in the gyrator domain**	Ronal Perez Universidad de La Guajira (Colombia)
AOP100-108	**Image processing operators based on the Gyrator transform: generalized shift, convolution and correlation**	Ronal Perez Universidad de La Guajira (Colombia)
AOP100-109	**Optical image encryption system using several tilted planes**	Juan Vilardy Ortiz Universidad Popular del Cesar (Colombia)
AOP100-110	**Mathematical modelling of the digital holography using the fractional Fourier transform**	Carlos Jimenez Universidad de La Guajira (Colombia)
AOP100-114	**On how thick diffusers can contribute to the design of optical security systems**	Artur Carnicer Universitat de Barcelona (Spain)
AOP100-134	**Temperature dependence of the drying process in polymer solutions observed by dynamic speckle detection**	Elena Stoykova Inst. of Optical Materials & Technologies (Bulgaria)
AOP100-162	**Estimation of the germination percentage of coffee seeds by means of dynamic speckle image processing**	Eberto Benjumea Univ. Popular del Cesar (Colombia)
AOP100-163	**Image filtering using the discrete cosine transform and symmetric convolution over finite field**	Juan Vilardy Ortiz Universidad Popular del Cesar (Colombia)
AOP100-164	**Image encryption based on the discrete sine transform over finite field**	Juan Vilardy Ortiz Universidad Popular del Cesar (Colombia)
AOP100-12	**Control of population inversion and coherence generation in rubidium and cesium atoms**	Iduabo John Afa Universitat Autonoma de Barcelona (Spain)
AOP100-25	**Solid-state harmonic generation near IR driving field**	Mukhtar Hussain Instituto Superior Técnico Univ. of Lisbon (Portugal)
AOP100-42	**Development of soft X-ray Ar+8 lasers excited by low-current capillary Z-pinch discharges**	Sergei V. Kukhlevsky University of Pécs (Hungary)
AOP100-53	**Numerical modelling for a 3 µm OPCPA laser pumped at 1 µm**	Joana Alves IPFN & IST & UL (Portugal)
AOP100-77	**Experimental characterization of thermal lensing in a diode-pumped 10 Hz 100 mJ Yb:YAG amplifier**	Victor Hariton Instituto Superior Técnico (Portugal)

AOP100-85	**Ultrashort optical parametric amplifier and oscillator up to the near-infrared**	Mario Galletti Instituto Superior Técnico (Portugal)
AOP100-210	**Development of a compact and portable SHG FROG**	Ana Filipa Ribeiro Instituto Superior Técnico (Portugal)
AOP100-29	**Pump-and-probe dark plane illumination diagnostic for ultra-cold gas density imaging**	Ruggero Giampaoli Instituto Superior Técnico (Portugal)
AOP100-35	**Spectral dependence of aerosol light absorption over Camagüey, obtained from an integrating sphere spectral system**	Sandra Mogo University of Beira Interior (Portugal)
AOP100-39	**A proposal for parametrical characterization of induced electric fields in materials**	Rosario Martínez-Herrero Universidad Complutense de Madrid (Spain)
AOP100-56	**Paraxial propagation and kurtosis of fields generated by pseudo-Schell vortex sources**	Rosario Martínez-Herrero Universidad Complutense de Madrid (Spain)
AOP100-123	**Development of thin films composed of plasmonic nanoparticles (Au, Ag) dispersed in a CuO oxide matrix for optical (gas) sensing**	Maria Manuela Proença University of Minho (Portugal)
AOP100-1	**Basic holography for optometry**	Manuel Filipe Costa University of Minho (Portugal)
AOP100-16	**Assessment of the accommodative facility training with flippers between sessions**	Hugo Pena-Verdeal Univ. de Santiago de Compostela (Spain)
AOP100-81	**Simulating n-body systems under alternative theories of gravity using solvers from nonlocal optics**	Tiago Ferreira INESC TEC - CAP (Portugal)
AOP100-86	**High-performance solver of the multidimensional generalized nonlinear Schrödinger equation with coupled fields**	Tiago Ferreira INESC TEC - CAP (Portugal)
AOP100-93	**A hardware-independent solution for high-performance simulations of the Maxwell-Bloch system**	Nuno Azevedo Silva INESC TEC (Portugal)
AOP100-94	**Exploring dissipative optical solitons controlling gain and loss in atomic systems**	Nuno Azevedo Silva INESC TEC (Portugal)
AOP100-135	**Quantum fluid equations for atomic gases**	Ariel Guerreiro INESC TEC & U. Porto & Tx Adv. Comp. Center (Portugal/United States)
AOP100-136	**Hilight: a new simulation platform for advanced photonics**	Ariel Guerreiro INESC TEC & U. Porto & Tx Adv. Comp. Center (Portugal/United States)
AOP100-139	**A new approach to generating entangled light in integrated optics using ring resonators**	Ariel Guerreiro INESC TEC & U. Porto & Tx Adv. Comp. Center (Portugal/United States)
AOP100-140	**Rogue waves in nonlinear optical media**	Ariel Guerreiro INESC TEC & U. Porto & Tx Adv. Comp. Center (Portugal/United States)
AOP100-141	**Artificial intelligence assisted nonlinear Fourier transform**	Ariel Guerreiro INESC TEC & U. Porto & Tx Adv. Comp. Center (Portugal/United States)
AOP100-143	**How many neurons does it take to solve the nonlinear Schrödinger equation?**	Ariel Guerreiro INESC TEC & U. Porto & Tx Adv. Comp. Center (Portugal/United States)
AOP100-168	**FIR Tamm polaritons in a microcavity with an incorporated graphene sheet**	Jorge Silva University of Minho (Portugal)
AOP100-175	**Simulating particle influence on silicon nitride strip waveguide single-mode parameters**	Marcus Baumgart Carinthian Tech Research AG (Austria)
AOP100-208	**Synthesis and optical properties of Sc2O3 nanoparticles doped with lanthanide ions**	Magda Antoniak Wroclaw University of Science and Technology (Poland)
AOP100-218	**Monitoring of Mn ions incorporation into quantum dots by EPR and Luminescence spectroscopy**	Yuiriy Galyametdinov Kazan National Research Technological U. (Russian Federation)
AOP100-30	**Weighted average of the Gouy phase shift for paraxial surface plasmon polaritons packets in lossy media**	Rosario Martínez-Herrero Universidad Complutense de Madrid (Spain)
AOP100-75	**Analyzing the electrical parameters of photovoltaic devices based on PbS nanocrystals to optimize their architecture**	Dmitry Onishchuk ITMO University (Russian Federation)
AOP100-19	**Fabrication and characterization of edge-emitting heterojunction bipolar light-emitting transistors (HBLETs)**	Chia-Lung Tsai Chang Gung University (Taiwan)

17:00 - 18:30 - Parallel Sessions

Sa.4.a - Room 3.2.14 - Chair(s): Pedro Andrés | José A. Rodrigues

AOP100-216 (Keynote)	**Computational imaging with structured light and single-pixel detection**	Jesús Lancis Universitat Jaume I (Spain)
AOP100-177 (Keynote)	**Lidar techniques for atmospheric aerosol remote sensing**	Adolfo Comerón Universitat Politècnica de Catalunya (Spain)
AOP100-242	**Inspection of virtual images in an AR-HUD from "Innovative Car HMI" project**	Moises A.S.Duarte Universidade Do Minho (Portugal)
AOP100-37	**Up/down link data transmission for indoor navigation based on visible light communication**	Paula Louro Instituto Superior de Engenharia de Lisboa (Portugal)

Sa.4.b - Room 3.2.15 - Chair(s): Bruno Romeira | José Figueiredo

AOP100-248 (Invited)	**Mid-infrared photodetectors based on resonant tunneling diodes and interband cascade structures**	Fabian Hartmann University of Wuerzburg (Germany)
AOP100-31	**Bidirectional communication between Infrastructures and vehicles through visible light**	Manuel Augusto Vieira ISEL & IPL & CTSUNINOVA (Portugal)
AOP100-4 (Invited)	**Resonant tunneling diode photodetectors: state of the art and future prospects**	Andreas Pfenning Universität Würzburg (Germany)
AOP100-170 (Invited)	**Functional metamaterials for optical sensing of hydrogen**	Ariel Guerreiro INESC TEC & U. Porto & Tx Adv. Comp. Center (Portugal/United States)
AOP100-222	**Plasma control by pattern recognition in laser induced breakdown spectroscopy**	Miguel Ferreira INESC TEC & U. Porto (Portugal)

Sa.4.c - Room 3.2.16 - Chair(s): Paulo Tavares | Mª. del Mar Pérez Gómez

AOP100-22 (Keynote)	**Wavelength-tuning Fizeau interferometry with a laser diode**	Yukihiro Ishii Tokyo University of Science (Japan)
AOP100-41	**White-light interferometer with tunable lens**	Pavel Pavlicek Palacký Univ. (Czech Republic)
AOP100-14	**Evanescent wave amplification applied to scattering of particles on surfaces**	Dmytro Kolenov TU Delft (Netherlands)
AOP100-34	**Hyperspectral quantitative phase imaging using lens-in-lens common-path interferometer**	Alexander Machikhin Sci. and Tech. Center of Uni. Instrumentation of Russian Academy of Sciences (Russian Federation)
AOP100-101	**Determination of the optical properties in transparent conductive electrodes based on an indium-tin oxide coating using the IAD method.**	Ana Belén Rodríguez-Aguila Univ. de Granada (Spain)

21:30 - 22:30 - Astronomical Talk & Lisbon's Fado Performance at Planetarium Calouste Gulbenkian

SUNDAY, June 2

8:55 - 9:40 - Plenary Session

Pl6 - Room 3.2.14 - Chair(s): António Baptista

AOP100-245 (Plenary)	**Light diagnostics and light treatments in the eye**	Susana Marcos Instituto de Optica "Daza de Valdés" (Spain)

9:45 - 10:45 - Parallel Sessions

Su.1.a - Room 3.2.14 - Chair(s): Pedro Serra

AOP100-116 (Keynote)	**Amblyopia treatment: what we know and what we don't know!**	Brendan Barrett University of Bradford (United Kingdom)
AOP100-83	**Transcranial magnetic stimulation in adults with asymmetric visual acuity**	Ana Rita Tuna University of Beira Interior (Portugal)
AOP100-112 (Invited)	**Vision as a predictor of expertise in high demanding visual tasks**	António Baptista University of Minho (Portugal)

Su.1.b - Room 3.2.15 - Chair(s): Giulio Cerullo

AOP100-43 (Invited)	**Diode-pumped solid-state lasers at 1 μm for optical parametric pumping**	Celso João Instituto Plasmas e Fusão Nuclear (Portugal)
AOP100-46	**Few-cycle, CEP stable, high power mid-infrared laser system**	Hugo Pires Instituto Plasmas e Fusão Nuclear (Portugal)
AOP100-172	**Double trace autocorrelator for precise measurement of pulse front tilt in a high power laser system**	Gonçalo Figueira Instituto Superior Técnico (Portugal)

Su.1.c - Room 3.2.16 - Chair(s): Sergey Mikhailov

AOP100-179 (Keynote)	**THz frequency combs in graphene field-effect transistors**	Hugo Terças Instituto Superior Técnico (Portugal)
AOP100-223	**Wavepacket diffraction on a metal film with a single slit covered by graphene**	Yuliy Bludov University of Minho (Portugal)
AOP100-152	**Photoinduced increase of electron transfer efficiency of QDs based hybrid structures**	Anna Orlova ITMO University (Russian Federation)

10:45 - 11:15 - Coffee break

11:15 - 12:45 - Parallel Sessions

Su.2.a - Room 3.2.14 - Chair(s): Brendan Barret | António Baptista

AOP100-129 (Invited)	**Ocular optical quality dynamics during accommodation in subjects with accommodative dysfunctions**	Sandra Franco University of Minho (Portugal)
AOP100-160 (Invited)	**Short-review about the safety and effectiveness of implantable collamer lenses for the correction of refractive errors**	Pedro Serra ISEC & Opht. Clinic-Vista Sanchez Trancon (Portugal/Spain)
AOP100-128	**Evaluation of the optical properties of two different types of soft contact lenses: hydrogel and silicone-hydrogel**	Ana Maria Ionescu Universidad de Granada (Spain)
AOP100-130	**Variations of the optical properties of two types of contact lenses with dehydration**	Ana Maria Ionescu Universidad de Granada (Spain)
AOP100-127 (Invited)	**Epidemiology of vision problems in Europe: a Portuguese perspective**	Eduardo Teixeira University of Beira Interior (Portugal)

Su.2.b - Room 3.2.15 - Chair(s): Orlando Frazão | Susana Silva

AOP100-249 (Invited)	**Structural health monitoring with fiber Bragg grating sensors: challenges on optical interrogators**	Francisco Araújo HBM FiberSensing (Portugal)
AOP100-145	**Simultaneous measurement of refractive index and temperature using a double antiresonant hollow core fiber**	Marta Ferreira University of Aveiro (Portugal)
AOP100-117	**Enhanced temperature sensing with Vernier effect on fiber probe based on multimode Fabry-Perot interferometer**	André Gomes INESC TEC (Portugal)
AOP100-73	**Fibre-integrated phase-change devices**	Tiago J. Martins INESC TEC (Portugal)
AOP100-47	**Use and validation of fiber optic gratings for planetary exploration: new challenges**	Raquel López Heredero INTA (Spain)
AOP100-15	**Unveiling the potential of fused polymer optical fibers: emergence of magnetic field sensitivity**	Tiago Paixão University of Aveiro (Portugal)

Su.2.c - Room 3.2.16 - Chair(s): Helder M. Crespo | Alessandro Fantoni

AOP100-200 (Keynote)	**Fundamentals of neutron waveguides: a proposal for slow neutron beams confinement and applications**	Maria Luisa Calvo Padilla Universidad Complutense de Madrid (Spain)
AOP100-91	**Fluids of Light in atomic systems: from superfluidity to quantum simulations**	Nuno Azevedo Silva INESC TEC (Portugal)
AOP100-166	**Unscrambling complex sample composition, variability and multi-scale interference in optical spectroscopy**	Rui C. Martins INESC TEC (Portugal)
AOP100-144	**Analysis of Fizeau wedge with a non-air gap by plane wave expansion**	Margarita Deneva Technical University of Sofia (Bulgaria)
AOP100-40	**Simulation analysis of a thin film semiconductor MMI 3 dB splitter opersting in the visible range**	Paulo Lourenço Univ. Nova de Lisboa (Portugal)

16:00 - 19:30 - Visit to the Lisbon's Oceanarium & Parque das Nações

19:30 - 22:30 - Conference Dinner

MONDAY, June 3

8:55 - 9:40 - Plenary Session

Pl7 - Room 3.2.14 - Chair(s): Paulo Fiadeiro

AOP100-194 (Plenary)	**Optical techniques for improved vision**	Pablo Artal Lab Óptica, Universidad de Murcia (Spain)

9:45 - 10:45 - Parallel Sessions

Mo.1.a - Room 3.2.14 - Chair(s): Sandra Franco

AOP100-58 (Invited)	**Modelling effect of time on visual acuity for vanishing and conventional optotypes**	Paulo Fiadeiro University of Beira Interior (Portugal)
AOP100-79	**Limitation of tables indicating the relation between age and reading addition for presbyopia correction**	Karola Panke University of Latvia (Latvia)
AOP100-124	**Influence of pupil function in pseudophakia**	Elsa Fonseca University of Beira Interior (Portugal)
AOP100-88	**Smartphone viewing distance during active or passive tasks and relation to heterophoria**	Karola Panke University of Latvia (Latvia)

Mo.1.b - Room 3.2.15 - Chair(s): Jürgen Jahns

AOP100-17 (Keynote)	**Seeing around corners: using the light field to extract information from scattered light**	James Leger University of Minnesota (United States)
AOP100-7	**Three-dimensional surface reconstruction for evaluation of wrinkling on textile fabrics**	António de Oliveira Mendes University of Beira Interior (Portugal)
AOP100-9	**Optics-computer vision combination for object detection and marking**	Amir Handelman Holon Institute of Technology (Israel)

Mo.1.c - Room 3.2.16 - Chair(s): Igor Nabiev

AOP100-105 (Invited)	**Influence of morphology on the exciton fine structure of single colloidal nanoplatelets**	Serguei Goupalov Jackson State University (United States)
AOP100-119	**Quantitative imaging of advanced nanostructured materials with scattering-type scanning near field optical microscopy**	Stefan G. Stanciu University Politehnica of Bucharest (Romania)
AOP100-51 (Invited)	**Mueller matrix measurements of self-assembled gold nanoparticles in chiral structure**	Yann Battie Université de Lorraine (France)
AOP100-62	**Electric-field effect on the optical activity of helical semiconductor nanoribbons**	Tatiana Pereziabova ITMO University (Russian Federation)

10:45 - 11:15 - Coffee break

11:15 - 12:30 - Parallel Sessions

Mo.2.a - Room 3.2.14 - Chair(s): Paulo Tavares

AOP100-207 (Keynote)	**Scattering killed the (light) sheet... or did it?**	Jorge Ripoll UC3M (Spain)
AOP100-125 (Invited)	**Spatially variant retarders used as geometric phase diffractive elements**	Ignacio Moreno Univ. Miguel Hernández de Elche (Spain)
AOP100-52	**Meta-surface diffractive optics based on the resonance-domain diffraction phenomena**	Michael Golub Tel Aviv University (Israel)
AOP100-113	**On the behavior of vector light needles using modulation functions with topological charge**	Artur Carnicer Universitat de Barcelona (Spain)

Mo.2.b - Room 3.2.15 - Chair(s): António Lobo

AOP100-161 (Invited)	**Optical fiber tools for single cell trapping and manipulation**	Ana Rita Rodrigues Ribeiro 4DCell (France)
AOP100-132	**Development of drug-loaded magneto-sensitive liposomes investigated by fluorescence techniques**	Beatriz Cardoso University of Minho (Portugal)
AOP100-235	**Cross-validation of EEG data for Cognitive Workload Evaluation using an Eye-tracker in Imaging System Tasks**	Pedro Mendonça Universidade de Lisboa (Portugal)
AOP100-225	**Holographic optical tweezers at the tip of a multimode fibre**	Ivo Leite Leibniz Institute of Photonic Technology (Germany)
AOP100-171	**Photorealistic ray-traced visualization of the compound insect eyes**	Hocheol Lee Hanbat National University (Korea, Republic of)

Mo.2.c - Room 3.2.16 - Chair(s): Yann Battie

AOP100-186 (Invited)	**Nanophotonic tools based on the conjugates of nanoparticles with the single-domain antibodies for multi-photon micrometastases detection and ultrasensitive biochemical assays**	Igor Nabiev Université de Reims Champagne-Ardenne (URCA) (France)
AOP100-87	**Towards optically-detected high-speed magnetic resonance spectrum measurements**	Charles Mignon UMCG (Netherlands)
AOP100-187	**The crucial role of surface ligands in photostability of colloidal quantum dots**	Mariya Zvaigzne National Research Nuclear University MEPhI (Russian Federation)
AOP100-184 (Oral)	**Collective modes of self-assembled supercluster metamaterials: towards label-free sensing**	Aliaksandra Rakovich King's College (United Kingdom)
AOP100-146 (Oral)	**Studying the optical properties of carbon dots depending on the solvent type**	Evgeniia Stepanidenko ITMO University (Russian Federation)

12:30 - 13:55 - Lunch

13:55 - 14:40 - Plenary Session

Pl8 - Room 3.2.14 - Chair(s): Mikhail Vasilevskiy

AOP100-13 (Plenary)	**Nanoplasmonics for energy conversion: generation of hot electrons and of acoustic surface waves**	Stefan Maier LMU Munich (Germany)

14:45 - 16:00 - Parallel Sessions

Mo.3.a - Room 3.2.14 - Chair(s): Stefan Maier

AOP100-23 (Invited)	**2D Materials for Polaritonics**	Nuno Peres University of Minho (Portugal)
AOP100-180	**Tuning the properties of surface magnon-polaritons on a ferromagnet using a graphene sheet**	António Costa University of Minho (Portugal)
AOP100-44 (Invited)	**Manipulations of light emission through defect engineering in 2D materials**	Wei-Yen Woon National Central University (Taiwan)
AOP100-82	**Enhancing nanoplasmonic sensing with metallic nanowires: from D-type to suspended core fibres**	Diego Santos IPNF & Fac. of Exact Sciences and Eng. (Portugal)

Mo.3.b - Room 3.2.15 - Chair(s): Rogério Nogueira

AOP100-240 (Keynote)	**Laser Spectroscopy Applied to Environmental, Ecological, Agricultural and Food Safety Research**	Sune Svanberg Lund University (Sweden)
AOP100-48 (Invited)	**Effect of hepatic vein on gold-nanoparticle-mediated-hyperthermia in liver cancer**	Mandana Jalali University of Duisburg-Essen (Germany)
AOP100-59	**Core-shell magnetic-plasmonic nanoparticles enclosed in biocompatible hydrogels for multimodal cancer therapy**	Sérgio Veloso University of Minho (Portugal)
AOP100-126	**Development of magnetic/plasmonic nickel ferrite/gold nanoparticles covered with lipid bilayers for applications in combined cancer therapy**	Ana Rita O. Rodrigues University of Minho (Portugal)

Mo.3.c - Room 3.2.16 - Chair(s): Manuel Abreu

AOP100-224 (Keynote)	**Optical fibres in astronomical spectrographs**	Gerardo Ávila ESO (Germany)
AOP100-228	**Study on creating an aspheric primary mirror of a large telescope using spherical mirror segments**	Jacob Annu Indian Institute of Astrophysics (India)
AOP100-241	**Ultra-low noise optoelectronic sensor in white light source for CCD calibrations instrument**	David Alves IA & FCUL (Portugal)
AOP100-65	**Atmospheric dispersion correction: model requirements and impact on radial velocity measurements**	Bachar Wehbe IA & University of Porto (Portugal)

16:00 - 17:00 - Poster Session & Coffee break

Mo.T - C3 Lobby - Chair(s): João Coelho | Alexandre Cabral

AOP100-74	**Ultra-fast DNA sequence alignment utilizing optical 1D Fourier transform**	Hoda S. Bahnamiri Sharif Univ. of Technology (Iran, Islamic Republic of)
AOP100-76	**Optical pattern generator for efficient bio-data encoding in a photonic sequence alignment architecture**	Saeedeh Akbari Rokn-Abadi Sharif Univ. of Technology (Iran, Islamic Republic of)
AOP100-138	**Fiber optic sensor for monitoring tangential and vertical forces for wheelchair application**	Cátia Tavares I3N & University de Aveiro (Portugal)
AOP100-147	**A Hermite-based approach to bone segmentation in CT images**	Lorena Vargas-Quintero Universidad Popular del Cesar (Colombia)
AOP100-149	**An image fusion scheme based on the hermite transform for nuclear medicine and magnetic resonance analysis**	Leiner Barba Jimenez Universidad Popular del Cesar (Colombia)
AOP100-157	**Magnetic circular dichroism spectroscopy of QDs/SPIONs nanosystems**	Anna Orlova ITMO University (Russian Federation)
AOP100-165	**Raman spectroscopy and diffuse reflectance of biomass soot samples**	Mary Carmen Peña-Gomar U. Michoacana de San Nicolás de Hidalgo (Mexico)
AOP100-197	**Assessment of light's dazzling effect on the EEG signal of subjects performing tasks that require concentration**	João Santos Universidade de Lisboa (Portugal)
AOP100-230	**Designing fibre probes for holographic microendoscopy**	Beatriz Silveira Leibniz-Institute of Photonic Technology (Germany)
AOP100-236	**Electrophoretic light scattering for study mixed saliva studies**	Ekaterina Savchenko Saint-Petersburg State Polytechnical Univ (Russian Federation)
AOP100-238	**Hardware/software co-design for structural analysis of biosubstrate**	Ekaterina Savchenko Saint-Petersburg State Polytechnical Univ (Russian Federation)
AOP100-24	**Visual search in three-dimensional non-medical images: visual-motor performance of radiologists**	Tatjana Pladere University of Latvia (Latvia)
AOP100-16	**Assessment of the accommodative facility training with flippers between sessions**	Rosa Calo-Santiago Univ. de Santiago de Compostela (Spain)
AOP100-18	**Study of the ocular biometric changes and stray light on diabetic patients**	Clarisse Teixeira dos Reis University of Beira Interior (Portugal)
AOP100-57	**The impact of keratoconus apex's localization on eye aberrations**	Sanita Liduma University of Latvia (Latvia)
AOP100-66	**Jacobi-Fourier polynomials phase masks for high resolution imaging of the retina**	Miguel Olvera-Angeles Univ. de Santiago de Compostela (Spain)

AOP100-63	**Experimental performance of Jacobi-Fourier polynomials phase masks for wavefront coding**	Enrique Gonzalez-Amador Univ. de Santiago de Compostela (Spain)
AOP100-70	**Improving slit lamp managing skills with low cost spy wifi cameras**	Justo Arines-Piferrer Univ. de Santiago de Compostela (Spain)
AOP100-90	**Using FVSQ to identify functional indicators of visual problems among older people residing in nursing homes: a study in Santiago de Compostela**	Covadonga Vázquez Sánchez Univ. de Santiago de Compostela (Spain)
AOP100-95	**Analysis of the relationship of the central tear meniscus area with the tear film symptomatology and stability**	Carlos García Resúa Universidad de Santiago de Compostela (Spain)
AOP100-96	**Meibomian gland loss area and its relationship with age and ocular surface disease index**	Jacobo Garcia-Queiruga Univ. de Santiago de Compostela (Spain)
AOP100-97	**Relationship between visual therapy vectograms and accommodative parameters in young healthy subjects**	Hugo Pena-Verdeal Univ. de Santiago de Compostela (Spain)
AOP100-98	**Evaluation of the relationship between symptomatic assessment, corneal staining and tear meniscus by image analysis**	Silvia García Montero Univ. de Santiago de Compostela (Spain)
AOP100-111	**Assessment of Van Herick Technique by using ImageJ software**	Dolores Ferreiro Univ. de Santiago de Compostela (Spain)
AOP100-120	**The influence of coloured lighting on ocular accommodation**	Raquel Moreira University of Minho (Portugal)
AOP100-122	**Compensative effect between corneal and internal ocular aberrations during a near vision task**	Gomes Jéssica University of Minho (Portugal)
AOP100-131	**The influence of coloured lighting on visual acuity and visual contrast sensitivity**	Marta Gil University of Minho (Portugal)
AOP100-148	**Astigmatism correction in direct ophthalmoscopy**	Justo Arines-Piferrer Univ. de Santiago de Compostela (Spain)
AOP100-150	**Prevalence of accommodative and binocular vision dysfunctions in a Portuguese clinical population**	Sandra Franco University of Minho (Portugal)
AOP100-196	**In line Fabry-Perot cavities manufactured by electric arc fusion of NIR-laser micro-drilled optical fiber flat tips**	Marta Nespereira Universidade de Lisboa (Portugal)
AOP100-182	**3D prototyping of a fiber Bragg grating vibration sensor for power transformers**	Catarina Monteiro INESC TEC (Portugal)
AOP100-211	**In-plane wavelength multiplexing of fibre Bragg gratings in a multicore optical fibre**	Ravil Idrisov Leibniz-IPHT (Germany)
AOP100-221	**Interrogation methods for functionalized optical microbubble resonators aimed at water microcontaminants**	Paulo Santos INESC TEC (Portugal)
AOP100-227	**Measurement of the temperature using an optical fiber with nanoparticles on the surface**	Duber Avila Padilla Univ. Popular del Cesar (Colombia)
AOP100-229	**Sensitivity of TiO2-coated optical microfibers for temperature measurement**	Sindi Horta Univ. Popular del Cesar (Colombia)
AOP100-233	**Optical fiber cavity coated with polyvinylidene fluoride (PVDF) for humidity sensing**	António Vaz Rodrigues Universidade do Porto & INESC TEC (Portugal)
AOP100-234	**Luminescent materials based on anisometric lanthanide complexes**	Andrey Knyazev Kazan National Research Technological U. (Russian Federation)
AOP100-60	**Optical thermometer based on surface plasmon resonance**	Victor Coello CICESE (Mexico)
AOP100-67	**Recent developments on fiber-based ring-down technique for remote sensing**	Susana Silva INESC TEC (Portugal)
AOP100-155	**Response of optically transparent pH sensing films to environmental conditions**	Daniela Topasna Virginia Military Institute (United States)
AOP100-84	**Femtosecond laser micromachining of Fabry-Pérot interferometers in fused silica for refractive index sensing**	João Maia INESC TEC (Portugal)
AOP100-190	**Electrodynamics model of a hydrogen sensor based on a special photonic crystal fiber taper coated with a nano-scale palladium film**	Vladimir Minkovich Centro de Investigaciones en Óptica AC (Mexico)

AOP100-226	**Polycaprolactone as a biomaterial host for second-harmonic generation**	Cesar Bernardo Univ. do Minho (Portugal)
AOP100-173	**Application of a novel LIBS prototype as an analytical grade tool for Li quantification in pegmatite samples**	Miguel Ferreira INESC TEC & U. Porto (Portugal)
AOP100-202	**Efficient and stable holographic gratings stored in an environmentally friendly photopolymer**	Marta Morales-Vidal Universidad de Alicante (Spain)
AOP100-215	**Measurement of the refractive index of glass by optical metrology**	Inês Leite FCUL, University of Lisbon (Portugal)
AOP100-237	**Studies of biological liquid films for preliminary diagnostics**	Ekaterina Savchenko Saint-Petersburg State Polytechnical Univ (Russian Federation)
AOP100-195	**Compositional optical and electrical characteristics of SiOx thin films deposited by reactive pulsed DC magnetron sputtering**	Joaquim Carneiro University of Minho (Portugal)

17:00 - 18:30 - Parallel Sessions

Mo.4.a - Room 3.2.14 - Chair(s): James Leger

AOP100-3 (Keynote)	**Symmetries in optical wavefields**	Jürgen Jahns FernUniversität in Hagen (Germany)
AOP100-219 (Keynote)	**Neuromorphic photonics for future ultrafast brain-inspired computing systems**	Antonio Hurtado University of Strathclyde (United Kingdom)
AOP100-45	**Optically trapped micro-paddle for measuring piconewton forces**	Weronika Lamperska Wroclaw Univ. of Science & Technology (Poland)
AOP100-71	**Graphene oxide as a tunable platform for microsphere-based optical fiber sensors**	Catarina Monteiro INESC TEC (Portugal)

Mo.4.b - Room 3.2.15 - Chair(s): Celso João | Hugo Pires

AOP100-6 (Keynote)	**Preparing to be dazzled: experiments in laser eye dazzle**	Craig Williamson Dstl Porton Down (United Kingdom)
AOP100-254	**Development and application of laser hologram production techniques for the teaching of Physics and the public awareness of science**	José Caiongo Chibaca IFIMUP-IN & University of Porto (Portugal)
AOP100-32	**Bi-directional VLC LED-assisted navigation system for large indoor environments**	Maria Manuela Carvalho Vieira ISEL & IPL (Portugal)
AOP100-258	**Crack growth testing automation in fracture mechanics**	Paulo Tavares INEGI (Portugal)
AOP100-204	**Photocatalytic and smart asphalt mixtures: an overview**	Iran Rocha Segundo University of Minho (Portugal)

Mo.4.c - Room 3.2.16 - Chair(s): Wei-Yen Woon

AOP100-61 (Keynote)	**Ultrafast carrier and spin dynamics of two-dimensional semiconductors**	Giulio Cerullo Politecnico di Milano (Italy)
AOP100-185 (Invited)	**Light-matter interaction: plasmon-exciton hybridization in strong coupling regime**	Yury Rakovich Ctr de Fisica de Materiales & NRNU MEPhI & IKERBASQUE (Spain/Russian Federation)
AOP100-191 (Invited)	**Measuring valley polarization lifetime and diffusion lengths in transition metal dichalcogenides using time resolved second-harmonic generation**	Jose Viana-Gomes Nat. U. Singapore & C. Adv. 2D Materials & U. Minho (Portugal/Singapore)
AOP100-183	**Modification of multiphoton emission properties of single quantum dot due to the long-range coupling with plasmon nanoparticles in thin-film hybrid materia**	Victor Krivenkov National Research Nuclear University MEPhI (Russian Federation)
AOP100-118	**Low-loss broadband optical waveguides fabricated in glass by femtosecond laser direct writing**	Vítor A. Amorim University of Porto & INESC TEC (Portugal)

18:35 - 19:05 - Special Session ACTPHAST4R

Mo.5.a - Room 3.2.14 - Chair(s): Manuel F. M. Costa

AOP100-247 (Keynote)	**Open access to European photonics prototyping platforms for innovation-driven researchers: "ACTPHAST4R"**	Hugo Thienpont Vrije Universiteit Brussel (Belgium)

19:05 - 20:00 - SPOF General Assembly

TUESDAY, June 3

8:55 - 9:40 - Plenary Session

P19 - Room 3.2.14 - Chair(s): Elliot Brown

AOP100-214 (Plenary)	**Multifunctional low cost metal oxides: from materials to devices**	Elvira Fortunato FCT - UNL (Portugal)

9:45 - 10:45 - Parallel Sessions

Tu.1.a - Room 3.2.14 - Chair(s): Ignacio Moreno

AOP100-205 (Keynote)	**Tunable focalizers: phase conjugate pairs**	Jorge Ojeda-Castañeda Universidad de Guanajuato (Mexico)
AOP100-69	**Fabrication of periodic structures in optical fibers by femtosecond laser micromachining for sensing applications**	Duarte Viveiros INESC Tec & University of Porto (Portugal)
AOP100-21	**Cross-correlation of distributed fiber optic strain map for structural elements diagnosis**	Monica Ciminello CIRA SCpA (Italy)

Tu.1.b - Room 3.2.15 - Chair(s): Catarina Monteiro | Beatriz Silveira

AOP100-78 (Keynote)	**Large photorefractive effect observed in non-ferroelectric smectic liquid crystal blends containing small amount of chiral compound**	Takeo Sasaki Tokyo University of Science (Japan)
AOP100-167	**Photorefractive properties of lithium niobate crystals studied by Raman spectroscopy**	Ninel Kokanyan CentraleSupélec (France)
AOP100-259	**Laser ranging in underwater medium: a study into the effect of influence factors on the system performance**	Wang Xin Monash Univ. Malaysia (Malaysia)

Tu.1.c - Room 3.2.16 - Chair(s): Serguei Goupalov

AOP100-251 (Keynote)	**Bose-Einstein Condensation of Photons in a Dye-filled Microcavity**	João Rodrigues Imperial College London (United Kingdom)
AOP100-92 (Invited)	**Enhanced fluorescence in hybrid materials composed of a dye and plasmonic nanoparticles**	Pedro Paulo Instituto Superior Técnico (Portugal)
AOP100-72	**Exploring the Coupling of 0D and 2D materials**	Cesar Bernardo Univ. do Minho (Portugal)

10:45 - 11:15 - Coffee break

11:15 - 12:00 - Special Session Womens in Optics

Tu.2.a - Room 3.2.14 - Chair(s): Katarina Svanberg

Katarina Svanberg (University of Lund)
Catarina Monteiro (SPIE Student Chapter, University of Porto)
Beatriz Silveira (Leibniz-IPHT)
Ana Rita Bastos (OSA Student Chapter, University of Aveiro)
Mariana Ferreira Ramos (OSA Student Chapter, University of Aveiro)

12:00 - 12:30 - Awards & Closing ceremony

Room 3.2.14

SPIE' Best Student Paper Awards
EOS' Best Student Poster Award
Best Student Poster on Optical Communications and Sensors, OSA Student chapter of the Univ. of Aveiro
Best PhD Thesis in Optics and Photonics in Portugal in 2016, SPOF
Best PhD Thesis in Optics and Photonics in Portugal in 2017, SPOF

Wine tasting & Farewell

Paper AOP100-1

Basic holography for optometry

Authors: M. F. Costa, Univ do Minho (Portugal)

Physical optics and holography in particular are giving a major contribution to de development of optometry, ophthalmology and ophthalmic optics and exciting developments are foreseeable. Holographic optical elements are in the core of new auto-phoropters that, using three tunable-focus fluidic lenses and thin-film holographic optical elements, are designed to perform automatic refractive error measurement and provide a diagnostic prescription without supervision in an effective way. Holographic multivergence targets are used in the subjective measurement of the astigmatic errors. Holographic contact lenses became available as well as holographic lenses that can replace the traditional meniscus ophthalmic lenses. CAD (computer-aided design) tools and new methods of engraving/printing holograms will further help the modelling, tridimensional visualization of structures of the visual system and noninvasive characterization. In this communication we will briefly present a hands-on approach to introduce holography to undergraduate optometry students. After introducing the basic concepts of coherence and understanding interference and diffraction the students explore holography beginning with Denisyuk holography by its simplicity and easier implementation. Students realize in practice how holography works, understanding the importance of light coherence and vibration isolation and realizing the difficulties and limitations when working with transparent optical elements and alive structures.

Paper AOP100-2

Nonlinear optical properties of a new inorganic-organic nanocomposite material highly dispersed with semiconductor CdSe quantum dots

Authors: Y. Tomita, Univ of Electro-Communications (Japan)

Photopolymerizable nanocomposite materials, the so-called photopolymerizable nanoparticle-polymer composites (NPCs), can record multi-dimensional photonic lattice structures by holographic assembly of nanoparticles in polymer. We have developed various types of such NPCs for versatile applications in photonics and neutron optics. When nanoparticles with large optical nonlinearities are employed, NPCs can be used for a new type of nonlinear optical nanocomposite materials. In this work we report on the fabrication and the nonlinear optical characterization of a semiconductor CdSe quantum dots (QDs) dispersed NPC film at the doping concentration of CdSe QDs as high as ~7 vol.%. The film can be both uniformly and holographically cured by green light. Open and closed Z-scan measurements, degenerate multi-wave mixing and femtosecond pump-probe and transient grating measurements are conducted. It is found that the observed fifth-order optical nonlinearity has the cascaded third-order contribution that becomes significant at high doping concentrations of CdSe QDs. We describe a generic closed Z-scan theory for nonlinear optical materials possessing both saturable absorption and high order/saturable nonlinear refraction, useful for the analysis of our nonlinear optical measurements. It is also shown that there are picosecond-scale intensity-dependent and nanosecond-scale intensity-independent decay components in the nonlinear refraction and transparency data. The former is caused by the Auger process as observed in colloidal CdSe QDs, while the latter comes from the electron-hole recombination process.

Paper AOP100-3

Symmetries in optical wavefields

Authors: J. Jahns, Fern-Univ Hagen (Germany)

Symmetries in the propagation of a wavefield occur due to constraints, imposed either by the structure of an optical element or by the propagation medium. The spatial properties of a wavefield may be influenced by translational symmetry, inversion, reflection, and rotation. The temporal properties may also be subject to certain symmetries, as, e.g., parity-time symmetry. The study of symmetries may be useful for the basic understanding of light propagation as well as for the specific design of a component or system. Symmetries have thus been investigated in various regards, e.g., from a geometrical-optics point of view [1], for describing spatial-temporal behavior of a multimode optical oscillator [2] and for introducing the concept of supersymmetry into the design of optical structures [3]. Here, we discuss various examples of light propagation under the constraints of specific symmetries. These include the design of micro-optical systems, rotational symmetries that occur in discretized diffractive optical elements as well as spatial and spatio-temporal properties of self-imaging wavefields.

[1] M Szilagyi and P. H. Mui, Symmetries in geometrical optics: theory, J. Opt. Soc. Am. A12, 2753-2759 (1995)
[2] J. Farjas, D. Hennequin, D. Dangoisse and P. Glorieux, Role of symmetries in the transition to turbulence in optics, Phys. Rev. A 57, 580-584 (1998)
[3] M.-A. Miri, M. Heinrich, R. El-Ganainy and D. N. Christodoulides, Supersymmetric optical structures, Phys. Rev. Lett. 110, 233902 (2013)

Paper AOP100-4

Resonant tunneling diode photodetectors: state of the art and future prospects

Authors: A. Pfenning, Lehrstuhl für Technische Physik, Universität Würzburg (Germany); F. Hartmann, L. Worschech, S. Höfling, Lehrstuhl für Technische Physik (Germany)

The need for ever more sensitive and faster photodetectors has resulted in a variety of novel optoelectronic devices and refined device concepts. One such device is the resonant tunneling diode (RTD) photodetector. RTDs are nanoelectronic devices that can be operated as high-gain and high-speed light sensors, with the possibility to resolve incident light down to the quantum level of single photons. We give a detailed report on resonant tunneling diode photodetectors. The underlying physical principles of RTD photodetectors are discussed, an overview of the state of the art is given, and future prospects of RTD photodetectors are highlighted.

Paper AOP100-6

Preparing to be dazzled: experiments in laser eye dazzle

Authors: C. Williamson, DSTL Porton Down (United Kingdom)

This presentation will introduce the topic of laser eye dazzle – the disruption to vision caused by visible wavelength lasers – and summarise recent experiments to understand its effects. Laser eye dazzle is commonly encountered in commercial aviation, where aircrew are being maliciously targeted by high power handheld lasers, and it is also increasingly deployed by security forces as a non-lethal option to warn and determine intent. Despite the growing importance of laser eye dazzle, there has been no safety guidance available to detail its impacts on visual performance. Over recent years, a series of experiments has taken place to fill this gap with a robust characterisation of laser eye dazzle effects: atmospheric scatter has been measured to understand how atmospheric conditions affect the severity of dazzle; human volunteer laser exposures have been used to study the laser wavelength and ambient luminance dependencies of dazzle; and laser exposures through windscreens have been used to reveal scatter and transmission impacts. These experiments will be presented, together with the resulting 'laser eye dazzle safety framework' [1] that allows dazzle effects to be quantified in simple safety calculations across a wide range of scenarios.

[1] C. A. Williamson and L. N. McLin, “Determination of a laser eye dazzle safety framework,” Journal of Laser Applications 30, 032010 (2018); https://doi.org/10.2351/1.5029384

Paper AOP100-7

Three-dimensional surface reconstruction for evaluation of wrinkling on textile fabrics

Authors: A. de Oliveira Mendes, P. Torrão Fiadeiro, R. Alberto Lopes Miguel, J. Mendes Lucas, Universidade da Beira Interior (Portugal)

In this paper an optical triangulation system is used to perform the three-dimensional surface reconstruction of different textile fabrics for an objective evaluation of wrinkling. The system works by projecting a light stripe onto the surface of a fabric sample and according to the amount of wrinkling exhibited on it, the light stripe will suffer larger or smaller deviations. During the scanning process, images of the light stripe are captured while the sample moves relatively to it registering a given number of profiles across a certain extension of the fabric sample in analysis. These profiles are then used to obtain three-dimensional images containing the topographic surface reconstruction of the analyzed fabrics. Through the obtained 3D images in the scanning process it is possible, visually, to distinguish very easily the differences exhibited on each fabric sample in terms of wrinkling. It is also possible, after processing of the topographic data, to perform the necessary calculations allowing a quantitative evaluation of wrinkling, being both analyses, as expected, completely in agreement with the reference grades of the subjective wrinkling evaluation associated to each one of the fabric samples used in the current work.

Paper AOP100-8

Designing instrumentation: the astronomers perspective

Authors: N. Santos, Instituto de Astrofísica e Ciências do Espaço and Departamento de Física e Astronomia, Fac. Ciências, Univ. Porto (Portugal)

The development of state-of-the-art astronomical instrumentation, strongly motivated by curiosity driven research, is driving the development of new technologies. In this context, one of the hottest fields of present day astronomy is the search and characterization of planets orbiting other stars. With the goal of allowing for the detection the minute signals of other Earths orbiting other Suns, several challenges have to be addressed, both scientific and technological in nature. In this talk I will present two examples of state-of-the-art astronomical instruments used in this field (ESPRESSO/ESO, and CHEOPS/ESA). I will in particular focus on the scientific requirements that were used to define the final instrument design and construction.

Paper AOP100-9

Optics-computer vision combination for object detection and marking

Authors: A. Handelman, Holon Institute of Technology (Israel)

Object recognition and delineation is an important task in many environments, such as in crime scenes and operating rooms. Marking evidence or surgical tools and attracting the attention of the surrounding staff to the marked objects can affect people's lives. In this paper, we present a novel optical system that comprises a camera, computer and small laser projector, which can detect and delineate objects in the environment. In order to proof the optical system's concept, we show that it can operate in a hypothetic crime scene, in which a pistol is present, and automatically recognize and segment it by various computer vision algorithms. Based on such segmentation, the laser projector illuminates the actual boundaries of the pistol, and thus allows the personals in the scene to comfortably locate and measure the pistol without holding any intermediator device, such as an augmented reality handheld device, glasses or screens. By using additional optical devices, like diffraction grating and a cylinder lens, pistol size can be estimated. The exact location of the pistol in space remains static, even after its removal. Our optical system can be fixed or dynamically moved, making it suitable for various applications that require marking of objects in space.

Paper AOP100-10

Ray tracing in stressed lenses in dynamical-optical systems

Authors: L. Hahn, P. Eberhard, Institute of Engineering and Computational Mechanics, University of Stuttgart (Germany)

The optical system performance of high-precision optical systems like lithography objectives can be affected by the presence of mechanical stresses in the optical glass. mechanical stresses typically occur as a result from mechanical loads acting on the dynamical-optical system or temperature changes induce thermal stresses in the affected optical components. In this work, we present a ray tracing method which considers the rays state of polarization while propagating through a mechanically stressed lens.

The framework of elastic multibody systems offers a convenient method to compute stresses in optical elements and generate the information about lens deformations, the refraction index, etc. which are required for the polarization ray tracing method employed here. The evident advantage is that it allows to consider arbitrary time-dependent loads acting on an elastically modeled lens causing its deformation and thus also its stresses. Moreover, it provides the possibility of including thermal effects, such as the lenses' expansion and the change of the refraction index due to the absorption of thermal energy emitted by the light rays.

The emerging anisotropy and the inhomogeneity of the optical material due to the resulting stresses alter the refraction of the light rays and their states of polarization. The proposed ray tracing scheme considers birefringence at the lens-front and uses gradient- index ray tracing within the lens. Simultaneously, the polarization states are traced with the aid of Jones vectors.

A numerical example demonstrates the advantages of the proposed polarization ray tracing method.

Paper AOP100-11

Nanoscale vertical-emitting nanopillars for efficient sub-wavelength LEDs

Authors: B. Romeira, J. B. Nieder, INL – International Iberian Nanotechnology Laboratory (Portugal)

Nanophotonic light sources, and specifically nanolasers and nano-light-emitting diodes (nanoLEDs), show unique potential for small footprint, ultra-fast (>10 GHz) and low energy consumption (<10 fJ/bit) in high-density interconnected optical circuits. Advances in this field will significantly boost the transmission and processing capabilities of optical chips, which are said to outperform electronic solutions in the information technology, namely in future computing approaches, e.g. neuromorphic computing for artificial intelligence.

Despite much progress, subwavelength nanolasers and nanoLEDs suitable for optical nanocircuits are lacking. Among numerous challenges, poor light extraction and large nonradiative recombination rates play a key role in the efficiency as the surface-to-volume ratio of these nanodevices increases substantially. Although there has been intense research in surface passivation techniques and surface-modified structures, so far the achieved surface recombination rates are still too large and the light extraction efficiency is too low to realize efficient nanoscale light sources.

In this work, we present our recent developments on the design, simulation and nanofabrication of subwavelength vertical-emitting nanopillars using undoped AlGaAs/GaAs compound semiconductors. Specifically, we will discuss i) passivation methods for suppression of surface recombination; ii) strategies for improving light extraction efficiency; and iii) Purcell enhancement of radiative emission using metal-cavity design.

The improved light extraction methods and radiative enhancement of the emission combined with suppression of surface carrier losses discussed here are crucial for the future development of high-performance nanoscale optoelectronic devices for low-power optical interconnects, supporting the realization of room-temperature highly-efficient nanoLEDs/nanolasers as a first milestone for optical chips and their application in future computing systems.

Paper AOP100-12

Control of population inversion and coherence generation in rubidium and cesium atoms

Authors: I. Afa, Universitat Autonoma de Barcelona (Spain); B. Anwasia, Universidade do Minho, Centro de Matemática, (Portugal)

Efficient control of population inversion and atomic coherence has formed a basis for numerous theoretical and experimental studies in the field of quantum and atomic optics. With the introduction of higher bound Rydberg states, studies have successfully incorporated selective excitation and manipulation of these states into quantum technology applications using neutral atoms and molecules.

We demonstrate a comparative study based on the density matrix formalism in the control of population transfer and coherence generation in Rubidium and Cesium atoms using pi-pulse scheme. In the present study, cascade configuration of Rb and Cs atoms are considered as 5S(1/2)-5P(3/2)-4D(3/2)-6P(1/2) and 6S(1/2)-6P(1/2)-5D(3/2)-7P(1/2) respectively. The density matrix equations are solved beyond the rotating wave approximation and a selective range of ultrashort pulses between 100fs to 10ps are considered for illumination, studying the influence of pulse chirp and laser detuning. An extension of the Cs configuration is made to 12P(1/2) and 8F (5/2) Rydberg states and a comparison between single and multiphoton processes is carried out to demonstrate its applicability in Rydberg state manipulation.

The goal of the present study is to extend the demonstrated robust mechanism to new systems for manipulation of states useful in ultrafast quantum technology and ultra-high precision spectroscopy.

Paper AOP100-13

Nanoplasmonics for energy conversion: generation of hot electrons and of acoustic surface waves

Authors: S. Maier, LMU München (Germany)

The decay of localized surface plasmons in metal nanoparticles via Landau damping leads to the generation of energetic, out-of-equilibrium electron/hole pairs, with within a few femtoseconds thermalize to the lattice, leading to localized heating. I will discuss several applications of these decay pathways.

Firstly, we have demonstrated the use of plasmonic hot electrons for guiding molecular self-assembly, via controlled bond-breaking of thiol-bonds in gold nanoparticle plasmonic systems. The same concept can also be utilized as an absorption imaging system with sub- diffraction resolution.

Secondly, we have shown that the lattice vibrations induced in nanoparticles via plasmon decay can launch surface (Rayleigh) waves in the underlying substrate. This enables the controlled launching of acoustic surface waves from nanoscale plasmonic launch sites. These results open up numerous exploitation routes for localized surface plasmons in energy conversion systems.

Paper AOP100-14

Evanescent wave amplification applied to scattering of particles on surfaces

Authors: D. Kolenov, S. F. Pereira, P. H. Urbach, TU Delft (Netherlands)

Recently, a new technique to enhance the sensitivity in low-contrast subwavelength particle detection based on far-field light scattering combined with evanescent-wave amplification has been demonstrated. The method typically uses a thin ~20nm dielectric material on top of the substrate under the inspection. Experimentally, an improvement of the signal-to-noise ratio of almost 500% has been achieved.

In this contribution, we will show an extension of this research with a more in-depth study of other enhancing materials in conjunction with various polarization states of the incoming light on the substrate. According to our findings, an even-higher gain in the scattered far field can be achieved. The usage of cylindrically polarized light over conventional laser beams has been analysed in order to have higher sensitivity. Furthermore, the studied effect is analysed using dielectric materials for the coating layer which maintains the high flatness of the sample, even when very thin layers are deposited on it. We also point out the importance of the low absorption in the enhancing material to maintain significant evanescent amplification. Finally, we study the directionality in scattering and provide modal analysis by introducing parametric sweep of refractive index and covering layer thickness.

We believe that such a scheme may have an impact on both scientific and industrial applications. These include detection of subwavelength particles, contamination control, and biological applications.

Paper AOP100-15

Unveiling the potential of fused polymer optical fibers: emergence of magnetic field sensitivity

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We propose a new magnetic field tip sensor based on a polymer optical fiber submitted to catastrophic fuse effect (POFFE). The sensor consists on the coupling of a typical silica optical fiber (SMF-28) with a small length of POFFE, which works as the sensing element. The operation principle is based on the reflected wavelength shift of the Fabry-Pérot cavity produced by the interfaces “silica optical fiber/UV cure glue” and “UV cure glue/POFFE”. Experimental tests were conducted to assess the sensor magnetic sensitivity by applying transversal uniform magnetic field in the range from 0 to 1000 mT, for different field orientations. As a term of comparison, a sensor without catastrophic fuse effect was also characterized. After the characterization to magnetic field intensity and orientation, the most promising results were obtained for an orientation of 0 degrees with different sensitivities according to the field intensity range: 39 pm/mT for 0-40 mT, 8 pm/mT for 40-180 mT and saturating for higher values until reaching 1000 mT. The combination of polymer optical fiber intrinsic advantages with the sensor magnetic sensitivity reveals that this device could be suitable for application in challenging environments, such as high safety risk environments or even in medical and biomedical areas, where conventional electronic devices have significant limitations.

Paper AOP100-16

Assessment of the accommodative facility training with flippers between sessions

Authors: R. Calo-Santiago, H. Pena-Verdeal, C. García-Resúa, E. Punin Dorrio, M. J. Giraldez, Univ de Santiago de Compostela (Spain)

Purpose: Accommodative anomalies are a group of distinct visual anomalies that reduce the efficiency of the visual system. Binocular accommodative facility (BAF) therapy is used to train the ability of the eye to repeatedly change its accommodative state when changing focus between two focal planes during a period of time. The aim of this study was to evaluate the effect of BAF training with standard flipper dioptric treatments on a group of non-symptomatic young adults.

Material and methods: 67 subjects were recruited among students attending the Optometry Clinic of the Optometry Faculty (USC, Spain). All of them had good general health and were free of any accommodative or binocular problems. Subjects were scheduled to four session one-week apart. In each session, they were requested to measure the BAF in cycles/minute (cpm) with a ±2.00D flipper while focusing a near test at 40 cm. Patients were also requested to point the difficulty for clearing with the pair of minus, plus of with no lenses.

Results: There was found a statistical difference on BAF between the first and the final session when the whole sample was analysed (paired t-test: $p < 0.001$), and when the sample was grouped by lens clearing difficulties (paired t-test: all $p \leq 0.005$). BAF showed a statistically significant difference between results obtained in each session (ANOVA: $p = 0.002$), and between the results of contiguous paired sessions (paired t-test: all $p \leq 0.047$).

Conclusion: The present study showed the positive effect of traditional dioptric training in the amplitude flexibility improvement.

Paper AOP100-17

Seeing around corners: using the light field to extract information from scattered light

Authors: J. R. Leger, D. Lin, T. Sasaki, C. Hashemi, Univ of Minnesota Twin Cities (United States)

Several methods have been proposed to solve the problem of "seeing around corners", where light scatters from a rough surface before it is observed. Although active methods (using, for example illumination with short pulses of laser light) have proven quite effective, they have the distinct disadvantage of being non-covert. In this presentation, we restrict the imaging problem to using only natural light. We examine the efficacy of plenoptic measurements, where the entire four-dimensional radiance function of the scattered light is measured. We quantify the amount of information that is contained in the scattered light and propose several approaches for extracting data from the plenoptic signal. We show that by using a synergistic relationship between the angular and spatial components of the plenoptic function, one can retrieve significant information from the scattered signal, including the three-dimensional location of specific objects and, in some cases, complete image recovery.

Paper AOP100-18

Study of the ocular biometric changes and stray light on diabetic patients

Authors: C. Teixeira dos Reis, University of Beira Interior (Portugal)

Study of the ocular biometric changes and Straylight on Diabetic Patients

Objective: To evaluate the influence of type 2 diabetes on the quality of retinal image by measuring the intraocular straylight and the evaluation of its correlation with the biometric changes on the cornea and the lens caused by this pathology.

Methods: A case-control study in which the study sample carries 54 type 2 diabetic patients (62,7± 7,2 years) and the control sample carries 27 control patients (64,6±7,1 years). Both groups performed strayligh measurements with the method comparasion- compensation (C-Quant), measurement of corneal thickness and backscattering with a Scheimpflug camera (Pentacam HR). The central thickness of the cornea and lens were also measured with a optical coherence biometer (Lenstar LS900). These measurements were only performed on the right eye.

Results: A slight increase in straylight was observed in the diabetic group (+0,043 log(s)), however with no statistical significance (p=0,430). There were no significant differences in ocular biometry of diabetic patients compared to control patients. However, a weak positive correlation between straylight and corneal thickness was observed in diabetic patients when measured with the biometer (r= 0,281; p= 0,039). Regarding backscatter, there were no significant changes between the groups ($p = 0.678$) nor a significant correlation with intraocular scattering ($r = 0.017$, $p = 0.901$).

Conclusions: In relation to the control group, diabetic patients did not present significant increase in straylight. The biometric variables are within the normal values, therefore there are no sources of increase of straylight.

Paper AOP100-19

Fabrication and characterization of edge-emitting heterojunction bipolar light-emitting transistors (HBLETs)

Authors: C. Tsai, C. Yu, Y. Lu, C. Yu, Chang Gung University (Taiwan)

In this study, two InGaAs/GaAs multiple quantum wells (MQWs) were introduced into the base region of heterojunction bipolar transistors (HBTs) to facilitate the generation of light emission. For these heterojunction bipolar light-emitting transistors (HBLETs), the lateral emission design will be useful to address the issue associated with the shielding of light by the top emitter electrode. In the experiment, the proposed HBLET with a 500 μm (length) × 24 μm (width) emitter exhibits an offset voltage of 0.46 V and can provide a 0.5-mA collector current (IC) as the bias current (IB) is set as 3 mA. As shown in the Gummel plot, at 300 K, the common-emitter current gain is calculated to be 0.39 at IB = 8.7 mA. In addition, the collector (base)-current ideality factor of the HBLETs is evaluated as 1.8 @ IC ~ 0.1 mA (4.53 @ IB ~ 0.1 mA). In comparison with conventional HBTs, the lower current gain found in HBLETs is attributed to injected carriers (electron) from the emitter is partly recombined with hole in In0.15Ga0.85As/GaAs MQWs at base region to contribute to light emission so that the resultant collector current is reduced. On the other hand, the peak emission wavelength of ~960 nm at IB = 50 mA is observed in the electroluminescence spectrum of the HBLETs. Furthermore, more intense light output can also be achieved in edge-emitting HBLETs, i.e., the respective light output power is 77.6 μW and 87.2 μW/facet at IB = 60 mA for the surface- and edge-emitting HBLET.

Paper AOP100-20

Structural monitoring of full scale composite vessels during hydro-proof and mechanical acceptance tests by surface bonded distributed sensing fiber optic

Authors: M. Ciminello, A. Concilio, C. Richiello, CIRA SCpA (Italy); G. Fabbi, A. Mataloni, P. Perugini, V. Mancini, AVIO (Italy)

This work resumes the results achieved by a monitoring system installation methodology for distributed sensing optical fiber tested by the authors on the composite vessel of VEGA launcher vehicle third stage motor (Z9 solid rocket motor) during its hydro-proof and compression acceptance tests. To monitor such vessel's behavior and finalize the sensor system to the detection of structural defects, CIRA and AVIO have conducted small scale and research activities based on high resolution distributed strain analysis. Down selected surface treatments and adhesives have been applied on a full scale application (Z9 motor case). A distributed 20m long optical fiber was surface-bonded according to a segmented layout describing axial and circumferential paths.

The deformation logged during the hydrostatic pressurization and mechanical compression tests demonstrated satisfactory congruence with the reference strain gauges. The assessment of the acquisitions showed that the circumferential sections were monitored without loss of signal, holding a deformation magnitude higher than 1% and constant as expected all along the pressure plateau. On the axial segments, however, the bonding technique was not yet highly effective due to a specific irregular profile of the filament wound structure. In the future activity a procedure will be implemented and tested for the axial path, during which a first layer of high viscosity paste will be distributed to fill the surface voids due to the structure waviness and then sandpaper will be used to smooth local ridges. At the same time, an automated surface bonding process will be studied in order to overcome all the difficulties related to the "hand" deposition of the fiber and to tackle the relevant time-consuming issue.

Paper AOP100-21

Cross-correlation of distributed fiber optic strain map for structural elements diagnosis

Authors: M. Ciminello, CIRA SCpA (Italy)

This work resumes the results achieved by a methodology developed by the authors about a no-model based approach for SHM. The variation of a current strain map respect to an offset is still considered, but the novelty of this methodology is to provide a signal to noise ratio improvement by cross-correlation function applied to a derived signal. In detail the method is based on the use of the gradient operator to enhance strong signal dispersions, which in turn, indicate a local structural discontinuity induced by a damage and then the cross-correlation function to increase the signal to noise ratio. Sensors and data processing are properly down-selected and the health monitoring system designed according to the specific goal. The selected sensor is a distributed fiber optic interrogated by Rayleigh backscattering technique. This solution can provide a spatial resolution of 5 mm for almost 850 sensors and a max sampling rate of 250 Hz for 2 m long fiber optic. In this case, the bonding line integrity of skin-stringer interface is the committed target, and the capability of debonding detection after low energy impact is estimated. The methodology is tested on aeronautical stiffened CFRP panels under different loading conditions: residual strain after impact, applied static load, applied quasi static load. The results are encouraging and further applications are going to be planned to monitor the structural haelth condition of composite panels during the manufacturing process.

Paper AOP100-22

Wavelength-tuning Fizeau interferometry with a laser diode

Authors: Y. Ishii, Tokyo Univ of Science (Japan)

Phase-shifting Fizeau interferometers have been widely used as optical shop testing instruments. Wavelength tuning in a laser diode (LD) is an effective way of performing the phase-shifting technique to test large optics [1]. The phase shifts introduced by the wavelength changes of a LD become equal in both axial and off-axial rays at the optical path differences between a test sphericity and a reference in large optics as compared with a PZT movement to be impracticable. Because the tuning wavelength determines the resolution, it cannot in general be increased without knowing exact phase-shift measurements.

We describe that a 16-sample phase-extraction algorithm is derived from Fourier analysis in a Fizeau interferometer. This wavelength- tuning algorithm gives no systematic phase errors due to the multiple-beam interference, the alignment error between a reference and a test object, and the power changes of a LD by changing its currents. The wavelengths by changing the LD currents are fast sampled to introduce 16 time-varying phase differences of $\pi/3$ between the two beams of the interferometer. A $\pi/3$ phase can be correctly measured by Fourier-transformed method by using the time-sequence interference fringes extracted from the interference fringes of a plano-convex lens. The experimental result of a steep surface topology of a plano-convex lens is shown.

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Paper AOP100-23

Plasmonics in graphene

Author: N. Peres, University of Minho (Portugal)

An introduction to the plasmonic properties of graphene will be given. Also, the optical properties of other 2D materials will be considered.

Paper AOP100-24

Visual search in three-dimensional non-medical images: visual-motor performance of radiologists

Authors: T. Pladere, V. Andriksone, University of Latvia (Latvia); R. Pitura, Riga Stradins University (Latvia); M. Velina, K. Panke, G. Krumina, University of Latvia (Latvia)

The visual search abilities of radiologists are systematically challenged and trained due to the specifics of their professional tasks. We investigate whether the differences in visual search performance and motor behavior can be tracked among individuals with varying level of radiological expertise for three-dimensional non-medical images.

9 certified radiologists (on average, 22 years of radiological experience), 9 resident radiologists (on average, 2 years of radiological experience) and 9 medical students (no radiological experience) accomplished visual search tasks on the volumetric multi-plane display. The achromatic stimuli were presented in a true depth on several display planes. The images could be manipulated by using a computer keyboard. The set size and target-distractor similarity varied in the presented tasks. Individuals searched for a target circle that had a larger line thickness comparing to all other circles. We assessed and compared the search performance and image manipulation strategy among three groups.

Despite clear differences in radiological experience, no significant differences were found in the correct response rate and visual search time among groups. The search performance varied depending on the target-distractor similarity and set size. However, the image manipulation analysis revealed significant differences among groups. The total number of clicks was considerably higher for the resident radiologists and medical students comparing to the experienced radiologists who preferred to skip manipulations for the most of the tasks. Our results suggest that the radiological experience does not interfere with the outcome in the developed visual search task, but may be reflected in motor behavior.

Paper AOP100-25

Solid-state harmonic generation near IR driving field

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High harmonic generation (HHG) in solids is a promising route towards compact and bright sources of XUV pulses, owing to the higher electron density in solids. By driving various solids with strong IR electric fields, a way to unveil the microscopic mechanism of the HHG process, and the electronic structure of the solid itself, is possible.
As a result, there has been growing interest in the mapping of the band structure of solids by solid-state HHG.
In the present study, we have generated the second harmonic in the MgO and ZnO crystal with an 800 nm driving laser wavelength of 40 fs pulse duration. Second harmonic generation (SHG) has been investigated relative to the orientation angle between the crystal and laser polarisation. Anisotropic and asymmetrical behavior of SHG in MgO is observed, while an anisotropic and more symmetrical response is observed in ZnO crystal, showing the sensitivity of SHG on the crystal structure. To observe the effect of changing the electronic structure, SHG was studied with Cr doped MgO. This showed complete mitigation of orientation effects observed in pure MgO, and an increase in SHG efficiency, highlighting the sensitivity of the HHG process to the exact electronic structure.

Paper AOP100-26

New ultrashort OPCPA petawatt class beamline for Vulcan laser facility

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After many years of operational of the Vulcan Petawatt Laser Facility, delivering high quality support for the laser plasma community, a improvement is required to keep the facility at world leading level.

To better understanding of the laser plasma interaction at petawatt level and increase the flexibility of the facility, a new laser beamline was proposed. The design specification for the new beamline are:

Pulse length: < 30fs

Energy: ~30J

Repetition rate: 1 shot every 5min.

The main aim is to allow betatron radiation probing of the plasma but also it will make possible new class of experiments, having the unique capability to two petawatt class pulses with different parameters.

There are different laser technology that can provide laser pulses within the requested parameters. Using the expertise in the Central Laser Facility, we decided to use the Optical Chirped Pulse Amplification (OPCPA) for the new beamline.

In this way, a short pulse length could be amplified, due to the large bandwidth of the process. While this is not important for betatron radiation, it will open a new set of experiments for study QED effect.

The overall project is aiming to deliver pulses by the end of 2020, with a reduced repetition rate of 1 shot every 20 min. In the second phase, a new design of gas cooled disk amplifier will increase the repetition rate to 1 shot every 5min.

In addition to the new beamline, the long pulse capability for the Petawatt target is planned to the improved, increasing the available energy to the kJ scale.

In this contribution, we present the new beamline project in the Vulcan laser system. The overall project is quickly discussed, followed by a more in depth presentation on the work on the Front End and the CPA design.

Paper AOP100-27

Developing tunable optical analogues using nematic liquid crystals

Authors: T. D. Ferreira, N. A. Silva, A. Guerreiro, INESC TEC - CAP (Portugal) and Department of Physics and Astronomy, Faculty of Sciences, University of Porto (Portugal)

This paper proposes using nematic liquid crystals as tunable setups to implement optical analogues of physical systems and phenomena that are hard or even impossible to study experimentally under controlled conditions.

Optical analogues share the same physical model with the systems that they emulate and can be understood as a form of physical simulations that basically perform optical computation. However, their success relies not only on the existence of media with optical properties capable of emulating the models associated with the original system as they interact with light but also on the possibility of being able to tune those properties in order to cover the multitude of conditions or range of parameters.

In particular, the Schrödinger-Newton model is a good candidate for this kind of studies as it can describe a plethora of different phenomena in physics that can be implemented in the laboratory using optical analogues, commonly supported by thermo-optical materials. However, such materials have limitations, and, in this work, we elaborate on nematic liquid crystals as a more advantageous alternative. We review how nematic liquid crystals can be used as a tunable support medium for optical analogues of superfluids by analyzing the dispersion relation of light under specific conditions and using numerical simulations based on GPGPU supercomputing to verify our findings. Extending on this, we explore more direct manifestations of superfluid effects in nematic liquid crystals, such as drag-force cancellation in the superfluid regime and the possibility of creating a roton-minimum in the dispersion relation.

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Paper AOP100-28

A simulation analysis for dimensioning of an amorphous silicon planar waveguide structure suitable to be used as a surface plasmon resonance biosensor

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In this work we present a simulation study about the characteristics of a semiconductor structure suitable to be used as a guided wave optical biosensor based on Surface Plasmonic Resonance effects (SPR). The proposed structure is a planar waveguide where the operation mode is based on the coupling between a dielectric waveguide and the surface plasmon mode in an adjacent, metal-coated, waveguide. Coupling between the waveguide mode and the SPR produces an intensity modulation of the transmitted light controlled by the concentration of the searched biomarkers at the metal surface. The final power coupled into the output waveguide is the sensor output. Amorphous silicon can be deposited by at temperatures lower than 300°C, an attractive characteristic which makes it back-end compatible to the CMOS process. Moreover, the amorphous silicon technology is much cheaper than the its crystalline counterpart. So, a-Si:H and other thin film semiconductors, like a-SiC:H, a-SiNx and ITO are the proposed material for the waveguide, while gold and aluminium are the metals considered for the plasmonic coating. Following the simulation results, experimental measurements of the waveguides transmission properties are presented.

Paper AOP100-29

Pump-and-probe dark plane illumination diagnostic for ultra-cold gas density imaging

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Magneto-optical traps have been used for decades to cool down atoms to very low temperatures (few μK) and to observe novel phenomena that have allowed scientist to achieve very important results in several physics related topics. Despite many outstanding results, the collective dynamics of atoms and photons in the trap are still far from being completely understood. In order to investigate the various phenomena taking place in large magneto-optical traps it is necessary to measure the density distribution of the atomic cloud and this has to be performed in a time scale short enough for the atoms to be considered immobile (about hundreds of μs). So far, all the measurements have been performed, either via absorption or scattering techniques, by collecting the line-of-sight integrated light.

We propose a pump and probe absorption diagnostic technique, integrated with a large magneto-optical trap, that allows to directly retrieve the density distribution of the cold-atom cloud without relying on column density integrated signals and on the assumption of spherical symmetry. Later on, as an important new application of this diagnostic method, we intend to use our experimental setup to study the bubble turbulent regime arising in optically thick media.

Paper AOP100-30

Weighted average of the Gouy phase shift for paraxial surface plasmon polaritons packets in lossy media

Authors: R. Martínez-Herrero, J. Polo, V. Zamora, Univ Complutense de Madrid (Spain); A. Manjavacas, University of New Mexico (United States)

The electromagnetic modes of metal surfaces, known as surface plasmons (SPP), have been a subject of extensive investigation over the past decade, since they play a key role in the field of nanophotonics. Their large degree of field confinement enables applications as diverse as photonic interconnects [1,2] and ultrasensitive biosensors [3,4]. However, in order to fully leverage the potential of these excitations, it is important to entirely understand the propagation properties of these surface waves beyond the simple plane wave approximation. Recently, we have introduced a set of Hermite–Gaussian (HG) SPP modes that form a complete basis for the solutions of Maxwell's equations for a metal-dielectric interface in the paraxial approximation [5]. Using this formalism, the goal of this work is to investigate the relationship between the spatial structure of an SPP packet and the normalized weighted average of the Gouy phase shift.

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Paper AOP100-31

Bidirectional communication between Infrastructures and vehicles through visible light

Authors: M. Vieira, ISEL/IPL/CTSUNINOVA (Portugal); M. Vieira, ISEL/IPL-CTS/UNINOVA (Portugal); P. Louro, ISEL/IPL/CTSUNINOVA (Portugal); P. Vieira, ISEL/IPL/IT (Portugal)

Cars are becoming ever more connected to other cars, to transport infrastructure, to pedestrians, and to datacenters. Vehicle to everything (V2X) communication technologies bring new possibilities to autonomous cars, since they create the opportunity for constant cooperation among different vehicles and between vehicles and intelligent road infrastructure, thus making tasks like route planning and accident avoidance much easier.

A safe smart vehicle lighting system that combines the functions of illumination, signaling, communications, and positioning is presented. The bidirectional communication between the infrastructures and the vehicles (I2V), between vehicles (V2V) and from the vehicles to the infrastructures (V2I) is performed through Visible Light Communication (VLC) using the street lamps and the traffic signaling LEDs to broadcast the information. Vehicle headlamps are used to transmit data to other vehicles or infrastructures (traffic lights) allowing digital safety and data privacy. As receivers and decoders, pin/pin SiC Wavelength Division Multiplex (WDM) photodetectors, with light filtering properties, are being used.

We propose the use of white polychromatic-LEDs to implement the WDM. This allows modulating separate data streams on four colors which together multiplex to white light. When a probe vehicle enters the infrastructure's capture range, the receivers respond to light signal and the infrastructure ID and traffic message are assigned. They perform simultaneously the V2V distance measurement and data transmission functions and, using the headlamps, resend the data to the other vehicles or to the traffic signals (V2I). A I2V2V2I traffic scenario is stablished. A vulnerable road user case that covers pedestrians, cyclists and wheelchairs is also considered. A phasing traffic flow is developed as a Proof of Concept (PoC). The experimental results confirm that the cooperative vehicular VLC architecture is a promising approach concerning communications between road infrastructures and cars, fulfilling data privacy.

Paper AOP100-32

Bi-directional VLC LED-assisted navigation system for large indoor environments

Authors: M. Vieira, M. Vieira, P. Louro, A. Fantoni, ISEL/IPL-CTS/UNINOVA (Portugal); P. Vieira, ISEL/IPL-IT (Portugal)

Airports and modern railway stations must satisfy high communication requirements. A VLC LED-assisted navigation system for large indoor environments is presented. White RGB-LEDs, whose original function was providing illumination, are used as transmitters due to the ability of each individual chip to switch quickly enough to transfer data. This functionality is used for communication where the multiplex data can be encoded in the emitting light. A VLC scenario for large crowded environments is established, the emitters and receivers are characterized and the communication protocol presented. The light signals emitted by the LEDs positioned in strategic areas are interpreted directly by the receivers of the customers. A SiC optical sensor with light filtering and demultiplexing properties receive the modulated signals containing the ID and the geographical position of the emitters and other informations, demultiplex and decode the data and locate the customer receiver in the environment. Bi-directional communication between the infrastructure and the mobile receiver is tested

Different layouts are analyzed. Two cellular networks are tested and compared: the square and the hexagonal. In the first, the proposed cluster arrangement is an orthogonal aggregate of square unit cells. In the second, an oblique system is used leading to clusters of hexagons in a 6-neighbor topology. Like the squares, the regular hexagons fit together without any gaps to tile the plane. A 2D localization design, demonstrated by a prototype implementation, is presented. The key differences between both topologies are discussed. Results show that the choice of one or both topologies depends mainly, on the layout of the environment.

For both, the transmitted information, indoor position, motion direction as well as bi-directional communication are determined. The results showed that the LED-aided VLC navigation system make possible to determine the position of a mobile target inside the network, to infer the travel direction along the time and to interact with information received.

Paper AOP100-33

Stable and strong light-emitters based on colloidal quantum dots encapsulated in robust and processable matrices

Authors: N. Gaponik, TU Dresden (Germany)

The recent advances in preparation of colloidal quantum dots (QDs) embedded into various processable host materials will be overviewed. Making the QDs compatible with the host materials and embedding technologies is a challenging task, as it demands in many cases the post-synthetic modification of the QD-surfaces while preventing their optical properties from deterioration. To assure embedding of the QDs into inorganic salt matrices, besides typically used co-crystallization, the methods based on the liquid-liquid diffusion assisted crystallization as well as “cold flow” approach were introduced. Salt matrices may also be considered as a media for the efficient solid-state anion exchange and corresponding luminescence color tuning as demonstrated on the example of perovskite QDs. The resulting QD-based composites are exceptionally stable and easily processable emitters available in form of fine powders, bulk solids of various shapes or hybrid thin films. Their potential applications as color convertors in the light-emitting diodes, display backlighting, photovoltaic windows, and optical sensors will be discussed.

Paper AOP100-34

Hyperspectral quantitative phase imaging using lens-in-lens common-path interferometer

Authors: A. S. Machikhin, O. Polshchikova, A. Vlasova, V. Pozhar, Scientific and Technological Center of Unique Instrumentation of Russian Academy of Sciences (Russian Federation)

Quantitative phase imaging is widely used in biomedical and industrial applications for morphology and dynamics characterization of various unstained samples with nanoscale sensitivity. Registration of phase images in multiple narrow wavelength bands enables analysis of spectral properties as well as extending the dynamic range and increasing the accuracy of quantitative phase measurements. In this paper, we present a new scheme for hyperspectral quantitative phase imaging, based on acousto-optic filtration of light in lens-in-lens common-path interferometer. It is implemented as a PC-controlled compact add-on module for light microscope, has a robust and vibration insensitive design, and allows a single-frame high-speed quantitative amplitude and phase imaging of various samples. Acousto-optic filtration provides fast and arbitrary wavelength tuning within the visible range 450-800 nm with adjustable spectral resolution. Choosing proper parameters of the interferometer and acousto-optical filter allows adapting the proposed scheme to many microscopy applications.

Paper AOP100-35

Spectral dependence of aerosol light absorption over Camagüey, obtained from an integrating sphere spectral system

Authors: S. Mogo, University of Beira Interior (Portugal) and Atmospheric Optics Group of Valladolid University (GOA-UVa) (Spain) and Instituto Dom Luiz (IDL), Faculdade de Ciências, Universidade de Lisboa (Portugal); B. Barja, Laboratorio de Investigaciones Atmosféricas, Universidad de Magallanes, Punta Arenas, Chile (Chile); V. Cachorro, Atmospheric Optics Group of Valladolid University (GOA-UVa) (Spain); A. Barroso, R. Monteiro, University of Beira Interior (Portugal); Á. de Frutos, Atmospheric Optics Group of Valladolid University (GOA-UVa) (Spain); R. Estevan, Instituto Geofísico del Perú, Lima, Perú (Peru); J. Antuña, Atmospheric Optics Group of Camagüey (Cuba)

Atmospheric aerosol particles were collected at Camagüey (21.42° N, 77.85° W, 122 m asl), Cuba, during 2010 and 2012, for investigating the absorption of light by particles, particulate matter (PM) concentration, and elemental composition.

Samples were collected with a low volume particulate Dekati PM10 impactor twice a week with a collection time of 24 hours. The sample flow rate was 15 l/min. Gravimetric analysis of the particulate matter fractions PM1 (PM<1 μm) was carried out for 104 samples.

An Integrating Sphere Spectral System (IS3) was developed for measuring the spectral absorption coefficient from the UV to the visible wavelengths with a spectral resolution of 10 nm. The system uses a filter-based method. The light absorption is determined by measuring and comparing the intensity of light transmitted by filters with and without particles deposited.

The IS3 is fully described in this work. It consists of a 6 inch integrating sphere with a spectral reflectance of 98 % that covers the wavelength range from 250 to 2500 nm. The light source includes a 150 W xenon lamp included in an ORIEL APEX illuminator equipped with a transmission filter, and an automated scanning monochromator. The signal is detected by a compact size Si detector (200–1100 nm) connected to a light meter. With this approach continuous spectra of the absorption coefficients in the 320–800 nm spectral range can be obtained with variable spectral resolution.

Spectral absorption coefficients measured by the IS3 are registered and analyzed during the campaign period.

Paper AOP100-36

Spike-free pulse generation in semiconductor injection seeding laser

Authors: P. Grześ, M. Michalska, J. Świderski, Wojskowa Akademia Techniczna im. Jaroslawa Dabrowskiego (Poland)

Major features of fiber lasers built in a Master Oscillator Power Amplifier (MOPA) architecture are high output power and excellent beam quality. These attributes are strongly demanded in industrial, military and scientific applications. However, fiber lasers are not limited to the role of the raw optical power generators. For example, in high-capacity communication fiber lasers have gained an attention mainly due to high efficiency, scalability and robustness. In these sophisticated applications high signal fidelity is also requested. In basic and cost-effective solution directly modulated semiconductor lasers are used as injection seeders. They allow to generate electronically controlled pulses with duration down to hundreds of picoseconds. In this high-speed regime relaxation oscillations distort the pulse shape significantly which may cause inefficiencies in the amplification process and spectral quality reduction of the output. To improve the switching process of the semiconductor laser and suppress the oscillations, a technique called light injection can be used. In this method a constant external radiation is injected into a cavity to increase the initial value of photon density. As a result, an amplitude of the initial spike is reduced and dumping ratio of relaxation oscillations is enhanced. The paper presents an injection seeding laser with spike-free nanosecond pulse generation. To suppress relaxation oscillations the continuous light injection technique is used. The experimental setup is based on off-the-shelf semiconductor lasers. Besides, all the components are fusion spliced making the system all-fiber. The experimental results show a high temporary fidelity generation without significant deformation of the exciting pulse.

Paper AOP100-37

Up/down link data transmission for indoor navigation based on visible light communication

Authors: P. Louro, M. Vieira, M. A. Vieira, Instituto Superior de Engenharia de Lisboa (Portugal)

Optical communications operating in the visible range, either indoor or outdoor, are labelled as Visible Light Communication (VLC) and use white LEDs or single-color LEDs to code and transmit the information data. This technology is nested on the ubiquitous use of LEDs for lighting solutions and to the high energy efficiency of LEDs lighting when compared to conventional lamps.

Indoor navigation based on VLC are attractive solutions for Indoor Positioning Systems (IPS), as Global Positioning Systems (GPS) signals are strongly absorbed by the buildings and other wireless solutions need to be used. In this work it is proposed an indoor navigation system based on the use of VLC technology for assisting warehouse management with autonomous vehicles. The system is designed to establish bidirectional communication between a static infrastructure and the mobile picking robot. Data transmission uses three different communication channels ensured by three different wavelength emitters of white tri-chromatic LEDs. A dedicated photodetector with selective spectral sensitivity in the visible spectrum is used. Different codification schemes are proposed to establish both uplink and downlink communication between LED lamps and mobile robots. The code schemes were designed to ensure synchronization between frames, to shield the decoding process from errors and to minimize flickering effects. The localization algorithm makes use of the Fourier transform to identify the frequencies present in the photocurrent signal and the wavelength filtering properties of the sensor under front and back optical bias to detect and identify the transmitted optical signals and make the adequate spatial position correspondence.

Paper AOP100-39

A proposal for parametrical characterization of induced electric fields in materials

Authors: R. Martínez-Herrero, G. Mejías, J. Sanchez, J. Perez, Univ Complutense de Madrid (Spain)

The study of the total electric field generated in a material in response to an external incident field is a problem of current interest in many branches of science ranging from nanophotonics to biophysics [1,2], and the exact electric field calculation is not easily computed as it involves both physical and computational considerations. In this work we summarized the induced electric field features using global parameters [3,4] enabling characterization of the volume where the magnitude of the induced electric field is mainly concentrated, as well as the predominant polarization state over the volume where the power is significant. In addition an uncertainty relationship was proven that linked the region of concentration of the induced electric field and the region where its maximum rate of change occurs.

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Paper AOP100-40

Simulation analysis of a thin film semiconductor MMI 3dB splitter operating in the visible range

Authors: P. Lourenço, Univ Nova de Lisboa (Portugal); A. Fantoni, M. Vieira, ISEL (Portugal)

In this work we present a simulation study about the characteristics of a semiconductor structure suitable to be used as a multimode interference (MMI) 3dB power splitter. The simulations are realized with the application of Beam Propagation and FDTD numerical methods. This work supports the development of a biomedical plasmonic sensor based on the coupling between a dielectric waveguide and the surface plasmon mode in an adjacent, metal-coated, waveguide, and where the output readout is performed through an a-Si:H photodiode. Using a multimode interference (MMI) 1×2 power splitter, the sensor can be easily calibrated by a reference arm. Amorphous silicon can be deposited by PECVD process at temperatures lower than 300°C, an attractive characteristic which makes it back-end compatible to the CMOS process. As the spectral sensitivity of amorphous silicon is restricted to the visible range, the waveguides should be operating with light wavelength lower than 700 nm, so a-SiC:H, a-SiNx and ITO are the materials hereby proposed for waveguide and MMI power splitter. The analysis presented in this work aims to define the optimal dimensions for the MMI structure, as a function of the material properties and the operating wavelength.

Paper AOP100-41

White-light interferometer with tunable lens

Authors: P. Pavlicek, Palacký Univ (Czech Republic)

White-light interferometry is an established and proven method for precise measurement of the shape of objects. Shape of objects with both smooth and rough surface can be measured. However, white-light interferometry suffers from some limitations. One of them is that the measured object must be mechanically moved relative to the measuring device during the measurement.

We present an optical 3D sensor based on white-light interferometry that can measure the shape of objects without the mechanical motion of the object. Instead of the object, the reference plane moves and scans the shape of the object. A part of the imaging system is an electrically tunable lens that ensures that the measured part of the object is sharply imaged during the whole measuring procedure. The motion of the reference plane is done using a modulation interferometer. The optical path difference of the modulation interferometer is changed using a fiber stretcher or a mirror with piezo actuator.

Paper AOP100-42

Development of soft X-ray Ar+8 lasers excited by low-current capillary Z-pinch discharges

Authors: S. V. Kukhlevsky, Univ of Pecs (Hungary)

The goal of present study is development of compact soft X-ray lasers excited by capillary Z-pinch discharges with low currents. One of our systems, which is based on an impulse transformer without using Marx generator, was developed to generate pumping pulses with ~10 kA amplitude and ~50 ns rise-time. Our MHD simulations show that the pulses with such parameters could be sufficient for achievement of the mirror-less lasing in soft X-ray (46.9 nm) Ar+8 lasers at the electron densities of 10^17-10^18 cm^−3 and temperatures of 60-80 eV of the capillary plasma. The results of the development and experimental investigation of the pumping scheme based on a 1:4 auto step-up impulse transformer are presented. The energy was stored by a capacitor with the stored energy E~100 J. In the case of 15-25 kV primary-winding voltage, we achieved 90-100 kV output pulses with current-amplitude

~10-15 kA and rise-time ~80ns. Another pumping system uses an elongated plasma channel and optimized electrode configuration. The laser properties of plasma channels have been analyzed by using our MHD model for different parameters of the pumping scheme.

This study was supported by the Human Resource Development Operational Program (contract EFOP-3.6.2-16-2017-00005).

Paper AOP100-43

Diode-pumped solid-state lasers at 1 µm for optical parametric pumping

Authors: C. P. João, H. Pires, N. Gomes, J. Alves, V. Hariton, S. Künzel, G. Figueira, Instituto Plasmas e Fusão Nuclear (Portugal)

The unprecedented ability to deliver few-cycle laser pulses tunable over several octaves at high peak and average powers makes optical parametric amplification (OPA) lasers the most promising sources to explore new regimes of laser-matter interaction, to drive new radiation sources and to boost attosecond science.

Currently, these systems remain limited by the CPA (chirped pulse amplification) lasers pumping the OPA stages. Scalability at high energies and repetition rates is intrinsically dependent of pump systems and their optimization remains as one of the most important challenges for laser science.

In the last two decades, direct diode-pumped laser sources, particularly those based in ytterbium gain media, have consolidated their role as the primary pump source for OPA lasers, due to unparalleled wall-plug efficiency providing high-energy picosecond pulses at average powers that reach the kilowatt range.

In this work, we will present a short review of the state-of-art of diode-pumped laser systems and of our contributions in this field, in particular as OPA pumping devices. We will discuss the opportunities that this type of technology can open when used as the front- end of large-scale, high power laser facilities, and the wide range of applications associated to these specific and unique laser sources.

Paper AOP100-44

Manipulations of light emission through defect engineering in 2D materials

Authors: W. Woon, National Central Univ (Taiwan)

We report the studies on light emission of various systems involving two dimensional (2D) materials with different characteristics, including semiconductor, insulator, and semi-metal., Defects are introduced in chemical vapor deposition (CVD) grown tungsten disulfide (WS2), hexagonal boron nitride (h-BN), and graphene through either ion implantation or scanning probe lithography. It was found that the intensity, spectral shape, and lifetime of the photoluminescence of the defective WS2 can be effectively modified. On the other hand, defective h-BN showed controllable visible light emission through defect density manipulations. As for graphene, although it does not emit light due to the gapless feature, the intensity, lifetime and spectral features of the fluorescence of a nearby polymer can be effective manipulated through quenching manipulation by defects in graphene.

Paper AOP100-45

Optically trapped micro-paddle for measuring piconewton forces

Authors: W. Lamperska, Wroclaw University of Science and Technology (Poland); K. Markiewicz, University of Warsaw (Poland); S. Drobczynski, Wroclaw University of Science and Technology (Poland); P. Wasylczyk, University of Warsaw (Poland); J. Masajada, Wroclaw University of Science and Technology (Poland)

Optical tweezers are a powerful device using optical trapping in order to precisely manipulate and examine a specimen in micro- and nanoscale. Over the years, optical tweezers have been enriched with various features, such as fluorescence microscopy, Raman spectroscopy, cells sorting. However, most of them require specialized and expensive equipment. In contrast, we report on a unique and simple microtool, which opens up a new way of measuring piconewton forces.

The proposed microtool is called a micro-paddle. It consists of two spheres, acting as handles, with a bar between them and a square 'blade' on the end. There are also two smaller spheres at both ends of a perpendicular arm which provide extra stabilization. The total length of this microtool is 45 μm whereas the blade is 10x10 μm. The micro-paddle was 3D printed with the two-photon polymerization technique and then immersed in a chamber filled with water.

We present new possibilities that arise from introducing micro-paddles to the optical tweezers system. Firstly, the microtools were tested for sensitivity to forces even below single piconewtons. This included e.g. exposing the paddle to weak hydrodynamic flow produced by oscillating microbead or pressing one paddle against the other. The response of the tool was measured as a displacement of the rear handle from the trap center. Finally, having confirmed the sufficient sensitivity, the force of microorganisms and human spermatozoa pushing onto the paddle was studied. In our work we demonstrate these experiments and discuss further applications of micro-paddles.

Paper AOP100-46

Few-cycle, CEP stable, high power mid-infrared laser system

Authors: H. Pires, C. P. João, M. Galletti, V. Hariton, J. Alves, N. Gomes, G. Figueira, Instituto de Plasmas e Fusão Nuclear (Portugal)

High power, ultrashort lasers operating in the mid-infrared (2-10 μm) domain have attracted significant attention during the last decade, due to a number of favorable properties and applications. They drive the shortest laser pulses known to man, allow the generation of coherent XUV radiation up to the water window, and can be used to create and probe the dynamics of excited molecular systems, from linear molecules to DNA strands. The mid-IR also corresponds to the spectral signature of biological samples, namely proteins (~6 μm), promising scientific and industrial applications in the medical fields.

In the context of the Portuguese National Roadmap of Research Infrastructures (2013) Laboratory for Intense Lasers (L2I) was funded for an upgrade of the installed laser capability, to provide access to external users.

In this work, we will present the main laser system: a diode-pumped, OPCPA-based few-cycle, high energy, high power mid-infrared laser system, providing few-cycle pulses at high repetition rate. Plans for its subsequent amplification to the mJ level at 10 Hz will also be shown.

These two lasers will be used as the main driver for high harmonic generation and laser-plasma acceleration experiments. Additionally, they will be open for access by external users. This will be an unprecedented experimental capability at the national level, allowing experiments in a novel physical regime.

Paper AOP100-47

Use and validation of fiber optic gratings for planetary exploration: new challenges

Authors: R. López Heredero, A. Fernández Medina Maeso, Á. Pérez García, T. Belenguer, INTA (Spain)

Planetary exploration based on in situ measurements represent one the greatest challenges of the present and future lander's science instruments. The main goal of this kind of missions is to search for extinct or extant life and study the habitability of the environment. The Space Optics Area at INTA works in the development of space instrumentation based on different optical systems to detect and characterize minerals by detecting inorganic/organic compounds. Nowadays, advanced techniques based on microfluidic systems allow to develop compact instruments for wet chemistry studies by analyzing processed samples extracted from soils or ice. The use of a multi-parameter sensor to analyze liquid samples is of great interest of the space community to study the habitability of the lander impact zone and to identify biomarker signatures. Fiber optic sensors can provide great benefits for planetary exploration including electromagnetic immunity, multiplexing and mass and power saving. The use of Fiber Bragg Grating (FBG) sensors have greatly increased the last two decades in Earth applications and INTA has successfully demonstrated their capability and reliability in space applications for strain and temperature measurements. For planetary exploration, sensors based Long Period fiber Gratings can be good candidates to provide key information in future missions thanks to their extremely sensitivity to the external refractive index. In order to demonstrate and validate this technology for space applications, it is necessary to follow an extensive test campaign simulating the harsh space environmental conditions mostly in terms of radiation and temperature. The goal of this work is to present the plan followed by INTA for the use and validation of innovative optical devices for space applications. This plan has been initiated and first preliminary results are shown. These are the first steps to increase the technology readiness level (TRL) required for the use of new technologies in space.

Paper AOP100-48

Effect of hepatic vein on gold-nanoparticle-mediated-hyperthermia in liver cancer

Authors: M. Jalali, University of Duisburg-Essen (Germany); P. Mertin, Ruhr University Bochum (Germany); A. Rennings, D. Erni, University of Duisburg-Essen (Germany)

Gold-nanoparticle–mediated–hyperthermia is a non-invasive, target-based cancer treatment with significantly reduced side effects compared to conventional treatments. In this work, a simulation platform for gold-nanoparticle-mediated-hyperthermia is set up and is used to investigated the effect of the hepatic vein in vicinity of the tumor in case of liver cancer. An array of 80×20×20 nm3 gold nanorods with 800nm periodicity is considered and illuminated with 38 Wcm-2 860nm laser, which is the plasmonic mode of the corresponding nanorods. The geometrical shape and size of the nanoparticle is designed in a way that the plasmonic mode is located within the first near infrared window (650nm-900nm) with minimum light-tissue interaction that allows light to effectively penetrate into the body. The temperature increase within the tumor is calculated for the two cases of tumor location in the middle of the liver and in vicinity of the liver hepatic vein. In order to reliably account for convective cooling through the vein, the underlying heat convection coefficient is calculated based on energy and motion equations for Navier-Stokes fluid with laminar blood flow when only a portion of the vein is heated. The mentioned arrangement of nanorods is capable of 13º temperature rise within the liver when the tumor is in the middle of liver. However, when the tumor is located near the hepatic vein only about 3º temperature raise is achievable, as the convective heat transfer through the blood flow causes accelerated cooling and consequently the cells would not be ablated.

Paper AOP100-49

We play with chemistry to design colloidal semiconductor nanocrystals

Authors: V. Lesnyak, Physical Chemistry, TU Dresden (Germany)

Colloidal semiconductor nanocrystals (or quantum dots) have evolved during last few decades from fundamental concepts to real commercial products (one of the recent examples is a line-up of Samsung QLED TVs in which quantum dots are employed as color converters) owing to intensive efforts of a range of research groups worldwide. These nanomaterials benefit on one hand from their unique size-dependent optoelectronic properties based on quantum confinement effect. On the other hand, their solution-based synthesis is a remarkably simple process, which can be implemented in nearly any chemistry lab.

In this talk, our recent work on the colloidal synthesis of different semiconductor nanocrystals will be summarized. Particular attention will be paid to ligand exchange reactions, as a versatile approach to alter their surface.[1] In the framework of the colloidal synthesis, a well-controllable method to create core/shell heterostructures based on CdSe quantum dots[1a] and CdSe nanoplatelets[2] with precisely tunable optical properties will be shown. Another aspect of nanocrystal surface chemistry to be addressed is the alteration of surface ligands to compatibilize quantum dots with polymer matrices aiming at transparent and stable nanocrystal-in-polymer composites.[3]

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Paper AOP100-51

Mueller matrix measurements of self-assembled gold nanoparticles in chiral structure

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Gold nanoparticles (GNPs) hold a great potential as structural and functional building blocks for three-dimensional (3D) nanoarchitectures with specific optical applications. When GNPs are closely assembled, their localized surface plasmon resonances (LSPR) are coupled, resulting in the enhancement of the electric field in the gap between the adjacent nanoparticles. This NPs interaction gives the opportunity to build new metamaterial which control the polarization state of light.

In this context, we have investigated the optical properties of complex nanostructures which consist of GNPs grafted on silica nanohelices with tunable handedness. This gold nanohelices are self-aligned by spray coating at grazing angle to form thin film. Mueller matrix measured in transmission, show that these films exhibit linear dichroism and birefringence, as well as circular dichroism. The sign of the circular dichroism depends on the handedness of the chiral helices. Contrary to circular dichroism, the linear birefringence and dichroism are closely related to the orientation of nanohelices. The pseudo optical axes of films are found at ±45° to the nanohelices axis. This Mueller matrix is analyzed with a coupled dipole model which takes into account the interaction between GNPs, the density and the orientation of nanohelices. We show that that the dichroism and the birefringence of the film come from the plasmonic coupling of NPs organized along an anisotropic and chiral structure. Finally, we demonstrate that GNPs grafted on nanohelices are good candidates as building block of new polarization management devices.

Paper AOP100-52

Meta-surface diffractive optics based on the resonance-domain diffraction phenomena

Authors: M. A. Golub, Tel Aviv Univ (Israel)

Modern applications of diffractive optical elements (DOEs) require large fan angle and numerical aperture (NA), high diffraction efficiency and tailored spatial distribution of light. However traditional "scalar" kinoform diffractive optics with large grating periods fails to deliver such performance, because of insufficient diffraction angles and severe trade-off between diffraction efficiencies, diffractive featuresizes and number of phase levels.

The resonance domain diffractive optical elements developed in our research feature wavelength-scale grating periods, large Bragg diffraction angles and high diffraction efficiencies. They can be treated as meta-surfaces based on binary phase diffraction structures with high aspect ratio. Our design approach combines geometrical optics and rigorous vectorial light diffraction at aperiodic diffractive zones. Fabrication on fused silica wafers with the aid of direct e-beam writing, reactive ion etching and nano-imprint is insensitive to small deviations in the shape of the diffractive grooves.

The developed and fabricated resonance-domain diffractive lenses proved, theoretically and experimentally, their capabilities as focusing spectroscopic gratings, collimating beam combiners, finite and infinite-conjugate coherent imagers in RGB lasers light with 84-92% diffraction efficiency and NA of 0.14-0.50. It was experimentally proved that the resonance-domain 8-microlens arrays with NA 0.16 successfully serve as single-mode fiber beam collimators with 100% fill factor and diffraction-limited performance. Resonance- domain tophat beam shapers of structured light with fan angle 20 degrees and 84% diffraction efficiency will be presented.

Results of the research have important applications in spectrometry, fiber optical communication, 3D display, augmented and virtual reality, head mounted displays, gesture recognition, 3D imaging and sensing.

Paper AOP100-53

Numerical modelling for a 3 μm OPCPA laser pumped at 1 μm

Authors: J. Alves, H. Pires, C. P. João, G. Figueira, IPFN/IST/UL (Portugal)

Ultrafast and broadband laser sources in the mid-infrared (mid-IR) spectral domain (3-8 μm) find important applications in many fields, such as metrology, imaging and spectroscopy. During the last two decades, a significant effort has been placed in the development and refinement of this laser technology, leading to several scientific breakthroughs. The scarcity of ultrafast solid-state lasers in this spectral range limits the generation of energetic mid-IR pulses to nonlinear techniques, such as optical parametric chirped pulse amplifiers (OPCPA) [1]. Such methods not only enable the fundamental broadband amplification capability but also exhibit wide tunability, which makes them even more attractive. On the other hand, the requirement of pump-signal synchronization with picosecond precision and the limited amount of transparent optical media in the mid-IR are considerable challenges.

In this work, we perform a numerical investigation on the performance of different nonlinear optical media for ultrabroadband OPCPA at 3 μm operating wavelength, when pumped by a high energy (>100 mJ) source at 1030 nm. We compare the energy and bandwidth gain, as well as the conversion efficiency achieved through a set of available high-damage nonlinear crystals transparent at these wavelengths. Specifically, we demonstrate the potential for scaling the mid-IR OPCPA output to the multi-mJ-level. We discuss the main challenges for the implementation of a new ultrafast, high energy mid-IR source at the L2I facility and the potential applications of such a system.

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Paper AOP100-54

GaN-based distributed feedback laser diodes for optical communications

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Over the past 20 years, research into Gallium Nitride (GaN) has evolved from LED lighting to Laser Diodes (LDs), with applications ranging from quantum to medical and into communications. Previously, off-the-shelf GaN LDs have been reported with a view on free space and underwater communications. However, there are applications where the ability to select a single emitted wavelength is highly desirable, namely in atomic clocks or in filtered free-space communications systems. To accomplish this, Distributed Feedback (DFB) geometries are utilised. Due to the complexity of overgrowth steps for buried gratings in III-Nitride material systems, GaN DFBs have a grating etched into the sidewall to ensure single mode operation, with wavelengths ranging from 405nm to 435nm achieved. The main motivation in developing these devices is for the cooling of strontium ions (Sr+) in atomic clock applications, but their feasibility for optical communications have also been investigated. Data transmission rates exceeding 1 Gbit/s have been observed in unfiltered systems, and work is currently ongoing to examine their viability for filtered communications.

Ultimately, transmission through Wavelength Division Multiplexing (WDM) or Orthogonal Frequency Division Multiplexing (OFDM) is desired, to ensure that data is communicated more coherently and efficiently. We present results on the characterisation of GaN DFBs, and demonstrate their capability for use in filtered optical communications systems.

Paper AOP100-55

The development of an optical design tool for atmospheric dispersion correction

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In ground based astronomical observations, atmospheric dispersion shifts the image of the object at different wavelengths due to the wavelength-dependent index of refraction of the atmosphere. Thus, using an Atmospheric Dispersion Corrector (ADC) is mandatory in order to avoid any wavelength dependent losses. Typical ADC configurations, for high resolution astronomical instruments, are two counter-rotating prisms, a set of, at least, four prisms paired together. With the arrival of large telescopes with higher angular magnification, and spectrographs with higher resolution, the requirements on the dispersion correction are becoming more critical due to the impact on the produced science (e.g. radial velocity precision). We developed an ADC optical design tool in order to select the best set of glasses in terms of residuals, transmission, resulting image quality, Fresnel losses, taking into account the required spectral range and typical atmospheric conditions where the ADC will be working. A demonstration of the capabilities of the tool is presented with the analysis of the impact of different melt data, the effect of different glass Sellmeier coefficients between catalog and measured ones, that can create a difference in the residuals above few tens of milli-arcseconds (mas). The tool allows the investigation of critical steps on the ADC design phase and speeds up the glass selection process critical for the harder requirements of the future instruments/telescopes.

Paper AOP100-56

Paraxial propagation and kurtosis of fields generated by pseudo-Schell vortex sources

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Coherence characteristics of a light source determine the properties of the propagated field. This fact has a significant impact in a wide range of applications such as remote sensing [1], free space optical communications [2,3], or optical trapping [4,5]. Consequently, the design of partially coherent sources with different characteristics of coherence across the source plane has been a very active field in the last decade (see for example [6,7]).

Recently, we have introduced a new type of partially coherent sources, the so called Pseudo-Schell model sources [8]. Such sources radiate fields with peculiar behaviors in paraxial propagation. The goal of this work is characterize, in the space-frequency representation, the paraxial evolution and the kurtosis parameter of fields generated by Pseudo-Schellvortex sources.

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Paper AOP100-57

The impact of keratoconus apex's localization on eye aberrations

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The optical quality of central part of eye cornea impacts the eye image quality on the retina. The central corneal optical irregularities in case of keratoconus or the aberrations demonstrate the changes in light direction when it passes through eye's optical system and it has been described by Zernike coefficients. Our study goal was to evaluate the impact of keratoconus apex's localization on eye aberration. 79 eyes with the first, second, and third keratoconus stages by Amsler-Krumich classification were analysed in our study. We had divided all eyes in two groups: if the keratoconus apex was in the area with 1.5 mm large radius around optical axis, then subjects had the central apex position; if the apex was outside this area, then – the peripheral apex position. The dominant aberrations of keratoconic eyes were the vertical coma and the spherical aberrations. The average RMS of vertical coma's aberration in case of the central apex was -0.29 μm and in case of the peripheral apex was -0.23 μm for 8 mm cornea without statistical significant difference by Mann-Whitney test ($p=0.51$). Average spherical aberration in case of the central apex was -0.01 μm and in case of the peripheral apex was 0.10 μm with statistical significant difference by Mann-Whitney test ($p=0.01$). Keratoconic eyes have increased corneal aberrations comparing to normal eyes. Aberrations reduce vision quality on retina by reducing subjects' high contrast vision acuity and contrast vision sensitivity. Aberrations are the main reason why subjects with keratoconic eyes experience reduced quality of vision.

Paper AOP100-58

Modelling effect of time on visual acuity for vanishing and conventional optotypes

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Visual acuity (VA) tests the ability of a subject to detect or identify an object. The time given to perceive an optotype is an important determinant of the VA. The purpose of this study was to investigate the variation of VA with time for conventional and vanishing optotypes.

Four participants, aged 21-52 years old, observed monocularly the optotypes presented on an LCD monitor distancing 8.0m. The studied VA's included the discrimination of conventional and vanishing optotypes and the detection of vanishing optotypes. A temporal 2-alternative forced choice with window duration controlling the optotype presentation was used. The detection task required identifying the window displaying a (5-by-5) letter E (vanishing) and the discrimination tasks required identifying the window with the E facing right (conventional and vanishing). The VA's were determined through the method-of-constant-stimuli and the 75% correct responses after a Weibull fit of three trials for a series of presentation durations (0.33, 0.50, 0.75, 1.00, 1.50, 2.00, 3.00 and 6.00) secs. The VA variation was modelled using an exponential decay function to determine the VA gain for each type of VA and the time taken to reach a stable VA.

The presentation duration and type of acuity influenced the VA level and variation of VA depended on the type of VA tested. Using an exponential decay function the gain in the detection of vanishing optotype was 0.13 (CI: 0.08; 0.17) logMAR, and in the discrimination of vanishing and conventional optotypes was 0.09 (CI: 0.05;0.14) logMAR and 0.08 (0.05; 0.11) logMAR, respectively. The time taken to reach 75% of the maximum VA for discrimination of conventional optotypes was 1.8 (CI: 1.3, 2.2) secs, followed by the detection, 2.4 (CI: 1.7, 2.8) secs, and discrimination, 3.1 (CI: 2.0, 3.9) secs of vanishing optotypes.

VA level is dependent on the presentation duration of the optotype and vanishing optotypes require longer durations to achieve the VA threshold.

Paper AOP100-59

Core-shell magnetic-plasmonic nanoparticles enclosed in a biocompatible dehydropeptide-based hydrogel containing lysine

Authors: S. Veloso, P. Ferreira, J. Martins, P. Coutinho, E. Castanheira, University of Minho (Portugal)

The introduction of magnetic or metallic nanoparticles into hydrogels enhances their properties and applications into magnetic resonance imaging, biosensing, hyperthermia and as a template material [1]. Self-assembled biocompatible peptide-based hydrogelators have shown promising results as nanocarriers for antitumor drugs [2-5]. The combination of plasmonic and magnetic nanoparticles will synergistically enhance anticancer therapeutic strategies on the desired target through photothermia, magnetic hyperthermia, drug release and photodynamic therapy [1].

In this work, superparamagnetic manganese ferrite ($MnFe_2O_4$) nanoparticles either coated with a gold shell [6] or decorated with gold nanoparticles, were successfully incorporated into a new self-assembled peptide-derived hydrogel. The new magnetogels were tested as drug nanocarriers and photothermia capabilities were evaluated following the release of a model drug (curcumin).

Fluorescence-based techniques (fluorescence emission, FRET and fluorescence anisotropy) were used to assess hydrogelator physicochemical properties and incorporation of drugs in the magnetogels, drug transport towards model membranes and tuneable release upon plasmon excitation.

The developed magnetic/plasmonic nanosystems exhibited promising results for application in multimodal cancer therapy, combining chemotherapy and photothermia.

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Paper AOP100-60

Optical thermometer based on surface plasmon resonance

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In this work, we present a new alternative of an optical thermometer based on the surface plasmon resonance (SPR) that operates at a single-wavelength and with the ability to realize real-time measurements without the need of further data analysis. The operation intervals of the temperature of water were determined and the sensitivity for each interval were examined. This method can be integrated with current biological or chemical sensors, in order to study endothermic and exothermic reactions in real time.

Paper AOP100-61

Ultrafast carrier and spin dynamics of two-dimensional semiconductors

Authors: G. N. Cerullo, Politecnico di Milano (Italy)

Transition Metal Dichalcogenides (TMDs) are emerging materials for electronic, spintronic and quantum information processing applications. When thinned to a single layer (1L), they become direct bandgap two-dimensional semiconductors, with optical response dominated by tightly bound (up to 0.5 eV binding energy) excitons, due to the strong quantum confinement and the reduced Coulomb screening. In addition, the large spin-orbit coupling lifts the spin degeneracy of the valence and the conduction bands; due to the lack of inversion symmetry, spin and valley indexes are locked and valley-polarized carriers can be excited by circularly polarized light. Finally, layers of different TMDs can be easily integrated vertically by mechanical stacking, forming van der Waals heterostructures with rich physics. In this talk we present results on the non-equilibrium optical response of 1L TMDs investigated by a variety of ultrafast optical spectroscopy techniques. We first study exciton dynamics of 1L-MoS2 by broadband femtosecond transient absorption, showing that the non-equilibrium optical response is dominated by the renormalisation of both band gap and exciton binding energies caused by photo-excited charge carriers. We then use two-colour helicity-resolved pump-probe spectroscopy in order to disentangle the intervalley and intravalley spin-flip processes of electrons in the conduction band of 1L-WS2, time resolving the formation of the dark excitons which are responsible for photoluminescence quenching in this material. Finally, we study heterostructures of WSe2 and MoSe2 and time resolve the sub-picosecond build-up time of the interlayer exciton formed upon injection of a hole from MoSe2 to WSe2, as well as its temperature-dependent lifetime.

Paper AOP100-62

Electric-field effect on the optical activity of helical semiconductor nanoribbons

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Over the last few years, the role of chiral nanocrystals has been intensively addressed in nanophotonics and biomedicine. Nanocrystals having chiral design or adsorbing chiral molecules are frequently used as photometric sensors. One of the main challenges of creating such devices is to obtain a strong circular dichroism signal. Semiconductor nanocrystals of different chiral shapes have recently been suggested as an important pathway to the enhancement of chiroptical response of complex structures.

Nanocrystals with helical morphologies have been demonstrated by several science groups, showing extremely high strength of optical activity. Control of the circular dichroism of chiral nanocrystals is achievable by changing both their shapes and geometric parameters. An alternative simpler approach is to expose chiral nanocrystals to an external electric field.

Here we suggest a theoretical model describing the chiroptical properties of semiconductor helical nanoribbons in electric field. The exposure of the nanoribbons to the electric field leads to creation of minibands in their energy structure. The chiral geometry of helical nanoribbons and the electric-field effect allow one to enhance the circular dichroism signal and optical density. Our results pave the way towards new biomedical applications, for example, helical nanoribbons can be used for visualization of electrically active human cells.

Paper AOP100-63

Experimental performance of Jacobi-Fourier polynomials phase masks for wavefront coding

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Wavefront Coding is a mature technique developed for obtaining high resolution images in presence of variable amounts of misfocus aberrations, specially defocus. Wavefron Coding is an optical-digital technique that uses a complex optical element that induces certain deformation to the wavefront in order to obtain an Optical Transfer Function inmune to defocus. The image degradation induced by the optical element is posteriorly restored by image postprocessing. The optical elements typically are designed in terms of cubic phase masks or combination of Zernike polynomials included third order terms. In the present work we explore numerically and experimentally the suitability of the Jacobi-Fourier Polynomials for coding the wavefront. The numerical evaluation was made based on Fourier Optics. For the experimental demonstration we built an optical system comprising: an s an USAF target (Thorlabs USAF test R1DS1P); collimating lens of 25.4 mm; diaphragm of 12mm diameter; an SLM spatial light modulator (LCOS PLUTO Holoeye Photonics); a wavefront sensor Thorlabs WFS30-14AR; a 50mm lens working as objective; a camera Thorlabs DCC1545M; and two 4f systems for conjugating the entrance pupil with the SLM and the SLM with the exit pupil. In the SLM we draw different wavefront coding elements based on trefoil Zernike Polynomials and Jacobi-Fourier polynomials J8,8 , J9,9. Comparison of the performance of these phase masks in presence of different amounts of defocus were made by studying the resolution of the USAF test after image deconvolution. We observed numerically and experimentally that the Jacobi – Fourier Polynomials provides better images with less artefacts

Paper AOP100-65

Atmospheric dispersion correction: model requirements and impact on radial velocity measurements

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Observations with ground-based telescopes are affected by differential atmospheric dispersion when seen at a zenital angle different from zero, a consequence of the wavelength-dependent index of refraction of the atmosphere. One of the pioneering technology in detecting exoplanets is the technique of radial velocity (RV). In fact, atmospheric dispersion can introduce changes in the detected spectrum shape that will affect the RV precision. The current and future high precision spectrographs are expected to deliver a precision of 10 cm/s (e.g. ESPRESSO). To minimize and nullify this effect, an Atmospheric Dispersion Corrector (ADC) should be employed. ADC designs are based on sky dispersion models that give different results, which in the blue region, can reach a few tens of milli-arcseconds (mas) in the sky (a difference up to 40 mas); a value close to the current requirements (20 mas in the case of ESPRESSO). In this paper we will describe tests done with ESPRESSO (that showed a difference of 20 m/s between different ADC positions) and HARPS (that showed a difference of 4 m/s by switching on and off the slope correction function) to understand the influence of atmospheric dispersion on RV precision; detail some analysis performed, using data from EFOSC (between 600 nm and 700 nm), to evaluate the different sky models, in order to minimize the requirements on the design of an ADC.

Paper AOP100-66

Jacobi-Fourier polynomials phase masks for high resolution imaging of the retina

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Wavefront Coding is a mature technique developed for obtaining high resolution images in presence of variable amounts of misfocus aberrations, specially defocus. Wavefron Coding is an optical-digital technique that uses a complex optical element that induces certain deformation to the wavefront in order to obtain an Optical Transfer Function inmune to misfocus. The image degradation induced by the optical element is posteriorly restored by image postprocessing. Recently we have demonstrated the suitability of Jacobi – Fourier Polynomials for coding the wavefront, providing images with less artefacts and more resolution than those based on Zernike polynomials. In the present study we analyse numerically and experimentally the performance of the phase masks based on Jacobi – Fourier polynomials in presence of complex aberrations like those present in the human eye. The numerical evaluation was made based on Fourier Optics. For the experimental demonstration we built an optical system comprising: an s an USAF target (Thorlabs USAF test R1DS1P); collimating lens of 25.4 mm; diaphragm of 12mm diameter; an SLM spatial light modulator (LCOS PLUTO Holoeye Photonics); a wavefront sensor Thorlabs WFS30-14AR; a 50mm lens working as objective; a camera Throlabs DCC1545M; and two 4f systems for conjugating the entrance pupil with the SLM and the SLM with the exit pupil. In the SLM we draw different wavefront coding elements based on trefoil Zernike Polynomials and Jacobi-Fourier polynomials J8,8 , J9,9. We observed numerically and experimentally that the Jacobi – Fourier Polynomials provides better images with less artefacts independently on the ocular wavefront aberrations explored.

Paper AOP100-67

Recent developments on fiber-based ring-down technique for remote sensing

Authors: S. Silva, INESC TEC (Portugal); O. Frazão, INESC TEC (Portugal) and Faculty of Sciences of University of Porto (Portugal)

A fiber cavity ring-down (CRD) technique using a linear cavity configuration was developed for remote sensing. The proposed scheme is based on a single fiber coupler of 99:1 and two thin-film mirrors located at the end of the fiber arms. Compared with the conventional CRD, this linear configuration eliminates one output coupler, which is replaced by two highly reflective mirrors. The proposed scheme features remote sensing, as it uses an optical time-domain reflectometer (OTDR) as both input and output sources, enabling interrogation of the output signal in reflection. Therefore, the oscilloscope (and photodetector) at the transmission output port is no longer needed to interrogate the sensing head as the OTDR serves that purpose. This is one of the major advantages of the proposed linear CRD design, combining the fact that the output signal acquired by the OTDR provides measurements in decibels, which allows attaining the decay time (μs) with a linear response (rather than an exponential behavior obtained by the oscilloscope). The viability of this configuration for remote sensing is also demonstrated for a maximum fiber length of 10 km. As a proof-of-concept, a fiber Bragg grating (FBG) was used inside the cavity, acting as both a mirror and a strain sensor. This linear CRD scheme allows the use of different types of mirrors, which can also be used as sensor elements, thus featuring remote sensing in a compact and simple configuration.

Paper AOP100-68

ESPRESSO Coudé-Train: ESO's VLT working as 16-metre telescope

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ESPRESSO is a fibre-fed, cross-dispersed, high-resolution, echelle spectrograph to fully exploit the European Southern Observatory VLT (Very Large Telescope), and it was open to the astronomical community in the end of2018.

This spectrograph was installed at the Combined Coudé Laboratory (CCL) of the VLT, fed by four Coudé Trains, which bring the light from the Nasmyth platforms of the four 8.2-metre Unit Telescopes to the CCL.

With all four Telescopes combining their light-collecting power to feed a single instrument, the ESPRESSO Coudé Train effectively transforms the VLT into the largest optical telescope in the world in terms of collecting area.

The Coudé Train is composed of a set of prisms and lenses to deliver a pupil and an image in the CCL, up to 70 m away, including an Atmospheric Dispersion Compensator. The use of only refractive optics, and Total Internal Reflection, has the advantage of the inherent higher throughput, especially in the blue region of the spectrum. With these complex optics, ESPRESSO can either collect the light from up to all four Unit Telescopes together, or alternatively receive light from any one of the telescopes independently, allowing for more flexible usage of observing time.

In this paper, we present the ESPRESSO Coudé Train concept, the design and the implementation on the VLT.

Paper AOP100-69

Fabrication of periodic structures in optical fibers by femtosecond laser micromachining for sensing applications

Authors: D. R. Viveiros, J. M. Maia, V. A. Amorim, P. A. Jorge, P. V. Marques, INESC Tec (Portugal) and FCUP, Faculty of Sciences of University of Porto (Portugal)

Fiber gratings are employed as in-fiber optical filters and reflectors in telecommunication systems, fiber lasers, and sensors. Traditionally, fiber gratings are fabricated by UV laser exposure through periodic UV light pattern created by two-beam interference (with phase masks, for example). The importance of the fiber gratings as devices for manipulating fiber guided light has led, in this work, to the development of a femtosecond laser direct writing system to explore the fabrication of periodic structures in optical fibers. The system is controlled with LabVIEW enabling high design flexibility and precise control of all relevant experimental parameters (scanning velocity and optical writing power, fiber positioning, vision and alignment features). The system has been primarily designed for the fabrication of point-by-point first order Bragg gratings; this is possible due to the high spatial resolution due to the non-linear process triggered by femtosecond laser absorption. The fabrication results as a function of the several relevant parameters will be discussed in detail. The fabrication of gratings has shown to be possible through the fiber polymer coating and in a variety of optical fibers without any special treatment for sensitivity enhancement. The femto-inscribed Bragg gratings were characterized in temperature and compared with the traditional UV-inscribed to verify their thermal stability, as femtosecond gratings offer higher thermal stability, withstanding temperatures up to 1000ºC. This opens the possibility to address high-temperature thermal monitoring in, for example, nuclear power plants, aerospace industry, and steam turbines. Long period gratings were also characterized in temperature and sensitivity to external refractive index.

Paper AOP100-70

Improving slit lamp managing skills with low cost spy wifi cameras

Authors: J. Arines, Univ de Santiago de Compostela (Spain)

In optometry or ophthalmology practice, the beginnings are crude. Teachers have to explain the managing of different instruments most of the times by showing how they do the exploration, but without showing the students what they are viewing. This is surely not a good practice. It would be better to share the teacher's viewing with the students in order to increase the efficiency of the experience. In a previous work we showed how the use of a low-cost webcam improved the learning experience of students of the faculty of Optics and Optometry of the University of Santiago de Compostela (Spain). In the present work we go further in the reduction of the cost and in the increase of the flexibility and opportunities of gain. We propose the use of low cost wifi spy cameras for sharing the teacher's viewing during Slit Lamp exploration. The use of this kind of cameras allows the student to connect with their smartphones to the camera wifi and see what the teacher is viewing. Additionally, the teacher can connect to different cameras from a different room in order to control and correct the exploration conducted by the students. These small cameras are also suited to be used with other instruments like retinoscopes, ophthalmoscopes, etc.

Paper AOP100-71

Graphene oxide as a tunable platform for microsphere-based optical fiber sensors

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Optical fiber sensors have been widely studied, presenting many advantages over electric sensors. Optical fibers are lightweight, compact, immune to electromagnetic interferences passable of be applied in harsh environments. Interferometric sensors are among the most explored configurations and have many different sensing applications. Particularly, fiber Fabry-Perot interferometers, proposed in literature over the last decades, have found several physical and chemical sensing applications. Fabry- Perot cavities in optical fibers can be achieved by creating a hollow section between a single mode fiber (SMF) and a diaphragm, by micromachining or by using fiber Bragg gratings as mirrors. Recently, microsphere-based Fabry-Perot interferometers were demonstrated in literature. The microsphere structure can be achieved with simple and fast fabrication methods, and present high sensitivity to strain and transverse load.

Unique properties of different materials can be used to improve fiber sensors. In particular, graphene has attracted much attention due to its high aspect ratio (surface to volume ratio) and mechanical and optical properties. Graphene oxide (GO) and reduced graphene oxide (rGO) offer similar properties as graphene with the advantage of an easier production, wider range of deposition methods and a lower cost. In this work, the properties of GO are explored to improve the performance of hollow microsphere FP sensors. Multilayer coating of polyethylenimine (PEI) and GO deposition in hollow microspheres was achieved using the layer-by-layer technique. The number of PEI/GO bilayers was varied to study the influence on the reflectivity and visibility of the reflected spectrum.

Paper AOP100-72

Exploring the Coupling of 0D and 2D materials.

Authors: C. R. Bernardo, M. Vasilevskiy, M. Belsley, M. Rodrigues, Univ do Minho (Portugal)

Artificial nanostructures can be engineered to obtain a variety of specific optical and electronic properties, depending on their material, size and shape. More recently researchers have begun to explore how combining different types of these structures might reinforce their respective strengths to attain promising materials for the next generation of optoelectronic devices. Towards this end, we assembled several structures that combine Quantums dots (QDs) or nanoplatelets (NSs), known for their strong interaction with electromagnetic radiation in the visible and near infrared region but possessing poor carrier transport properties, with members of the family of transition metal dichalcogenide (TMDs).

Since these materials can be coupled via exciton-exciton interactions, we have probed this coupling using Time-Correlated Single Photon Counting (TCSPC) and Ultrafast Transient Absorption Spectroscopy (TAS) in an attempt to characterize the underlying physical processes and evaluate the potential technological significance of these hybrids structures.

In these preliminary studies we have used colloidal CdSe and CdTe QDS and CdS nanoplatelets synthetized by solvo-thermal process coupled to MoS2 obtained by mechanical exfoliation from a larger crystal. The systems were fabricated by spin-casting the QDs or NSs from a dilute solution onto the substrate with the TMD.

Paper AOP100-73

Fibre-integrated phase-change devices

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Combining phase-change materials with well-established, reliable and mature light-guiding platforms such as optical fibers constitutes an important contribute to reenergizing the field of designer optical properties, bridging the gap between promising new physical properties and real world applications with potential to revolutionize data processing networks. Two non-volatile switches merging a chalcogenide glass phase-change medium with a side-polished fiber and an optical fiber tip are proposed. Both offer switching capability across a wide wavelength range in the near-infrared band with intensity switching ratios of 2.68 dB and 6.3 dB, respectively. The versatility of these light-modulating schemes is further emphasized by the possibility of engineering the optical response of both devices by adjusting their geometry. Fibre-integrated phase-change devices could find application in a number of fields such as telecommunication and data storage.

Paper AOP100-74

Ultra-fast DNA sequence alignment utilizing optical 1D Fourier transform

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Big data processing, such as DNA variant discovery, by electrical computers requires vast amount of computation causing lots of energy consumption. However, optical processing, due to its inherent nature of parallel processing, offers much faster data processing with lower power consumption. In this regard, optics has been adopted for detection of DNA sequence mutations in quite a few researches. In this manner, this paper proposes an optical correlation-based method taking advantages of optical Fourier Transform to efficiently locate the edits as a means of DNA sequence alignment. On the other hand, utilizing a novel binary coding of DNA sequences in one dimension, we propose optical 1-D Fourier Transform with the capability of parallel processing of multiple lines within a 2D image fed by a 2D SLM (Spatial Light Modulator). For this purpose, we take optical Fourier Transform of a DNA sequence through a single axis, and then, utilizing optical spatial properties of the second axis, we provide parallel comparison of multiple windows of DNA sequences. Taking advantages of window-based optical 1-D Fourier Transform, rather than a 2-D one, is a key advantage of the proposed optical processing approach. Simulation results verify that assuming SLM size of 1000 * 1000 pixels, with switching speed of 60 times per seconds, and window size of 250 base-pairs, we can obtain processing speed of 15 million base- pairs per seconds. Moreover, our simulation results show significant speedup, against well-known BLAST algorithm, with much less power consumption as the most obvious benefit of optical processing.

Paper AOP100-75

Analyzing the electrical parameters of photovoltaic devices based on PbS nanocrystals to optimize their architecture

Authors: D. Onishchuk, P. Parfenov, A. Litvin, ITMO University (Russian Federation)

Currently, the development of solar cells and light-emitting diodes based on colloidal nanocrystals is one of the fastest growing research areas. The fabrication of devices with high energy conversion efficiency requires consideration of many features of the used materials. Knowing the material electrophysical properties and how to alter them, one can create highly efficient devices with desired features. The main way to study photovoltaic devices parameters are the analysis of dark I–V and C–V characteristics using methods of Mott–Schottky (MS), Mott–Gurney (MG) and Fowler–Nordheim (FN), as well as the impedance spectroscopy.

In this paper we discuss the parameters optimization of solar cells based on colloidal PbS nanocrystals by analyzing their J–V and C–V characteristics. We evaluate the device performance change with the addition of the P3HT (Poly(3-hexylthiophene-2,5-diyl)) or PCBM (Phenyl-C61-butyric acid methyl ester). We measure the charge carriers' density, mobility, their transfer type and the built-in potential and show how such parameters correlate with device efficiency. The influence of transport layers, materials and the electrode deposition quality and the contact oxidation on the parameters are considered as well. We also discuss the photovoltaic devices parameters improvement recommendations and analyze the general applicability of the MS, MG, and FN methods to the photovoltaic cells.

Paper AOP100-76

Optical pattern generator for efficient bio-data encoding in a photonic sequence alignment architecture

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Since genetic information is encoded in DNA molecules, mutations, as changes in a DNA strand, disrupt DNA transcriptions and causes missing, malformed proteins, or healthy proteins at an undesired concentration, which results in cellular dysfunction. The accelerated expansion of genetic databases has led to a need for a more efficient method for detecting mutations that underlie genetic diseases. Genome sequence alignment compares DNA strands to identify similarity and differences in sequence. Currently available tools run various soft-wares within powerful data centers. But the abundance of collections, containing hundreds of thousands of sequences with a length of more than 50,000 symbols, makes some issues for them. Although current algorithms, such as MuSCLE and MAFFT, which often adopt dynamic algorithms, somehow overcome low speed and memory limitation, they are still not practically usable for large amount of genetic information. In this manner, we propose optical solutions to significantly increase speed of SA (up to 90%), overcome memory limitation, reduce power consumption, and considerably increase output accuracy. For this purpose, adopting Joint Fourier Transform-based correlation is introduced in this paper. As the initial step, we transform the bio- data into the properly coded optical data to be fed to the optical setup. In this paper, we will present a novel optical coding approach, utilizing the genetic algorithm to present an automated method for generating the most efficient optical code for any type of bio-data (DNA, RNA, and Protein). The simulation results verify the proposed coding efficiency in terms of optical resolution and storage space.

Paper AOP100-77

Experimental characterization of thermal lensing in a diode-pumped 10 Hz 100 mJ Yb:YAG amplifier

Authors: V. Hariton, Universidade de Lisbon, Instituto Superior Técnico (Portugal); C. Paiva João, H. Pires, G. Figueira, Universidade de Lisbon (Portugal)

Laser systems generating powerful, ultrashort pulses have experienced phenomenal growth over the last two decades. For many applications where high peak power and high average power are required, diode-pumped solid-state lasers are widely regarded as one of the most efficient options.

One main technological bottleneck is the scaling of the output power of these laser sources. Using an end-pumping scheme with a high-intensity pump is the most widespread solution. However, the generated thermal lensing effect, induced birefringence and inhomogeneities can seriously jeopardize the laser performance and modify the stability of the system. Therefore, careful study of the thermal effects is crucial for the design of next-generation high-power laser sources.

In this work, we describe the generation of a homogeneous pump beam using a periodic microlens array system and present the corresponding results. We perform an experimental study and provide a theoretical description of thermal lensing in a diode-pumped amplifier operating at low repetition rates (1-10 Hz), in the high pump power (max 4 kW) regime. This range of parameters is extremely relevant for high-intensity pulsed laser systems using diode-pumped laser either as primary or as pump sources. In these particular conditions, the heat deposited during the pumping time window leads to a dynamically changing temperature gradient and consequently a dynamically variable thermal lens in the laser rod. We characterize the dependence of thermal lensing with power and repetition rate within this range and develop a theoretical model assisted by a finite element analysis, with the capability of characterizing the pumping behaviour in two spatial and one temporal dimensions, which describes adequately the observed results for a pulsed diode-pumped Yb-doped crystal.

Paper AOP100-78

Large photorefractive effect observed in non-ferroelectric smectic liquid crystal blends containing small amount of chiral compound

Authors: T. Sasaki, Tokyo University of Science (Japan)

Chiral Compound Smectic C Liquid crystals containing photoconductive chiral dopants are known to exhibit a large photorefractive effect. Photorefractive properties of ferroelectric liquid crystal (FLC) blends composed of smectic C liquid crystal (LC) compounds and photoconductive chiral dopants have been reported. When laser beams are interfered in a photorefractive material, a refractive index grating is formed. The photorefractive effect induces a change in the refractive index by a mechanism that involves both photovoltaic and electro-optic effects. The most characteristic phenomenon of the photorefractive effect is the asymmetric energy exchange, in which the energy of one of the interfering laser beams transfer to the other. The asymmetric energy exchange can be utilized in optical signal amplification. Amplification of moving optical signals by photorefractive FLC blends has been investigated. To obtain a photorefractive FLC, a photoconductive compound is also added to the FLC mixture. However, in the most case, the photoconductive compounds are not liquid crystalline materials, addition of the photoconductive compound to the FLC mixture disturbs the alignment of FLC molecules. Thus, the light scattering in the FLC medium increases. The light scattering in the photorefractive material is not preferable, because the interference fringe is distorted by the light scattering. In order to avoid this problem, photoconductive compounds that also possess chiral structure were synthesized. A photorefractive FLC can be obtained just by mixing of the photoconductive chiral compound with a FLC mixture. We have reported that photorefractive FLC blends containing photoconductive chiral dopants exhibits a large photorefractivity and a fast response. However, when the photoconductive chiral dopant is used, as changing the concentration of the photoconductive chiral compound, both the concentrations of photoconductive moiety and the chiral moiety change. In the present study, effect of the concentration of chiral moiety on the photorefractive effect of LC blends was investigated.

Paper AOP100-79

Limitation of tables indicating the relation between age and reading addition for presbyopia correction

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This study refers to potential limitations related to specific undefined guidelines used in optometry that suggest near addition (add) values based on patient age. 216 adults (aged 35 to 80 y.) enrolled in the study. We found relationship between age and amount of near add ($r = 0.73$), age and near visual acuity without add ($r = 0.51$) and near visual acuity without add and near add amount ($r = 0.78$). Guideline based age expected near add technique provided 0.29 D higher add compared to plus build up. Based on our results, we highlight that usability of age expected near add in clinical environment is limited because of large individual differences

Paper AOP100-80

Fast OCT image enhancement using deep learning for smart laser surgery

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One of the most common image denoising technique used in Optical Coherence Tomography (OCT) is the frame averaging method. It averages multiple, registered images of the same region into a single image. Inherent to this method is that the more images are used the better the resulting image. This comes, however, at the price of increased acquisition time and introduced sensitivity to motion artefact. To overcome these limitations, we developed a Multi-Resolution Convolutional Neural Networks (CNN) able to imitate averaging method using only a single image frame. We trained a CNN to enhance OCT images based on their 300-fold averaged images. In this study, we acquired OCT images of pig femur bone from 60 different position for training and another 60 for testing. For training, we used only the first 10 frame images from each position and the correspond 300-fold averaged images as reference.

The reconstructed image has an improvement in the signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) parameters compared to the original image. The average SNR and CNR were 12.92 dB and 4.72 dB respectively for the raw images and 16.64 dB and 6.34 dB for the 300-fold averaged images; and 15.87 dB and 7.31 dB for the CNN filtered images. Additionally, we also observed an improvement in the sharpness of 0.31 for the averaged images and 0.44 for the CNN filtered images. This result shows the possibility to use this method as pre-processing step for real-time tissue classification for smart laser surgery.

Paper AOP100-81

Simulating n-body systems under alternative theories of gravity using solvers from nonlocal optics

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This paper reports the development of a numerical module for the HiLight simulation platform dedicated to the propagation of light in nonlocal nonlinear optical media and the adaptions implemented for it to be used as a numerical test-bed to evaluate the impact of new extensions of the Theory of General Relativity in the dynamics of an n-body system.

The phenomenology of light in nonlocal and nonlinear media is very rich and can be described by a multitude of effective models, with different levels of detail and approximations, which coincide with few or no differences with those found in many other fields of physics. In particular, nonlocal extensions of the Generalized Nonlinear Schrödinger equation (also known as the generalized Schrödinger-Newton system) constitute a wide class of physical models that can be found in both optics and in the studies of alternative theories for gravity. Therefore, numerical solvers developed for the former can be adapted to address the later. Indeed, this paper discusses the adaptation of a numerical solver of the generalized Schrödinger-Newton system based on GPGPU supercomputing, initially developed to investigate the properties of light in exotic nonlocal media, to tackle the dynamics of large distributions of matter whose interaction is governed by extensions of the Theory of General Relativity, namely those based on non- minimal coupling between curvature and matter. The structure of the resulting simulation module, its performance, and its testing are analyzed.

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Paper AOP100-82

Enhancing nanoplasmonic sensing with metallic nanowires: from D-type to suspended core fibres

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This paper explores and compares two different plasmonic optical fibre sensor configurations, based on D-type and suspended core fibres combined with metallic nanowires, and investigate how their different geometrical parameters can affect the coupling between localized plasmonic modes and the optical mode supported by the fibres, and how that ultimately results in improved sensor performance.

Fibre optical sensors based on plasmonic resonances with metallic nanostructures have revolutionized the field of optical sensing because they have permitted to obtain sharper and fine-tuned resonances with higher sensitivity [1-4]. The essence for exploring the properties of localized plasmonic modes and their coupling with the optical guided mode depends, not only on the choice of the materials employed in the device, but also on the geometry of the different components and their relative position, which ultimately determine the spatial distributions of optical power of the different modes and consequently their overlap and coupling [4-5].

We use numerical simulations based on finite element methods to demonstrate the importance of shaping the features of the guided optical mode to promote the coupling with the localized modes, in the two types of fibres considered. The results clarify some of the fundamental aspects behind the operation of these devices [6] and provide novel proposals for enhanced refractive index sensors.

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Paper AOP100-83

Transcranial magnetic stimulation in adults with asymmetric visual acuity

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Purpose

Transcranial Magnetic Stimulation (TMS) is able to change cortical excitability of the visual cortex, and influence binocular balance. Our main goals were to evaluate suppressive imbalance and visual acuity (VA) before and after applying TMS in a group of subjects with asymmetric visual acuity and to raise awareness about new techniques allowing balance recovery of vision.

Methods

13 young adults with ages between 19 and 24 years where split in two groups, the first one with 5 volunteers with one line VA difference (group A) and the second one with 8 volunteers with at least two lines of VA difference between their eyes (group B). They were submitted to a session of continuous theta burst stimulation (cTBS) and were evaluated before and after. VA and suppressive imbalance (SI) were used as control parameters.

Results

Improvement was observed in sensory ocular dominance of the non-dominant eye in all patients that were evaluated and VA had improved in almost all of them. For group A, the initial average of SI was 0,081 (± 0,046) and after cTBS was 0,023 (± 0,033). For group B the SI was 0,26 ±0,18 before cTBS and 0,12 ±0,12 afterwards.

Discussion

VA and SI had significant enhancements compared to baseline after cTBS in these groups of subjects. We conclude that cTBS is a technique able to improve performance in the visual system, possibly by increasing neuronal plasticity.

Paper AOP100-84

Femtosecond laser micromachining of Fabry-Pérot interferometers in fused silica for refractive index sensing

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Femtosecond laser direct writing is a high precision fabrication technique that can be used to write three-dimensional structures for specific applications, depending on the nature of light-matter interaction. In the case of fused silica, the material modification, started by a non-linear light absorption process, can manifest itself: (i) as an increase of the refractive index around the focal volume, resulting in the formation of optical circuits (optical waveguides, Bragg gratings, power splitters) or (ii) as an enhancement of the etch rate of the laser-affected zones relative to the bulk material, leading to an anisotropic HF (hydrofluoric acid) etching reaction and enabling the fabrication of three-dimensional microfluidic systems.

Here, both effects are combined to yield a Fabry-Pérot interferometer, where optical waveguides and microfluidic channels are integrated monolithically in a fused silica chip. The design of these interferometers is studied, with the influence of the waveguide propagation and coupling losses on the interferometer visibility and on the spectrum's signal-to-noise ratio being determined.

Application of this device as a refractive index sensor was also confirmed by injecting different liquid samples inside the microfluidic channel. The proposed device also allows interconnection to inlet/outlet tubes that supply the fluid to be characterized, and to optical fibers for light propagation into and out of the chip, therefore enabling the construction of a complete and integrated optofluidic sensor. The device can also be used for specific applications, such as magnetic field sensing, by using ferrofluids whose refractive index changes with the strength of the applied magnetic field.

Paper AOP100-85

Ultrashort optical parametric amplifier and oscillator up to the near-infrared

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Coherent light sources in spectral regions inaccessible to lasers have been an important issue for more than five decades. Despite tremendous progress in laser technology, substantial portions of the optical spectrum from the ultraviolet to the infrared still remain inaccessible to conventional laser sources.

This limitation arises from the limited active medium gain bandwidth, defining the operating spectral region of the laser. The application of such devices is limited, while also placing a boundary on ultrashort pulse generation requiring very broad bandwidths. In this context, coherent optical sources based on nonlinear conversion, with femtosecond pulse duration and wide tunability, are rapidly emerging. They are of considerable interest for a wide range of scientific applications.

Our goal is to investigate the generation of ultrashort laser pulses in the near-IR between 800 and 1000 nm, interesting for current large scale laser projects based on optical parametric chirped pulse amplification (OPCPA).

An innovative sub-20 fs tunable optical parametric oscillators (OPO) at 800 nm based on BiBO/PPLN in a collinear scheme was designed and developed; meanwhile, an ultra-broadband (~200nm), 30uJ, ps two-stage non-collinear OPA at 870 nm based on LBO within the 1 PW OPCPA VULCAN beamline for betatron imaging, was developed and characterized.

The OPOs will be implemented in existing laser systems: L2I (IST), for generating a seed pulse for a new ultrashort amplifier; and Vulcan system (CLF), for generating an off-harmonic femtosecond probe line. Their similar requirements ensure the same technology can be applied with tuning of the spectral parameters.

Paper AOP100-86

High-performance solver of the multidimensional generalized nonlinear Schrödinger equation with coupled fields

Authors: T. D. Ferreira, N. A. Silva, A. Guerreiro, INESC TEC - CAP (Portugal) and Department of Physics and Astronomy, Faculty of Sciences, University of Porto (Portugal)

We report on the development of a numerical module for the HiLight simulation platform based on GPGPU supercomputing to solve a system of coupled fields governed by the Generalized Nonlinear Schrödinger Equation (GNLSE) with local and/or nonlocal nonlinearities.

The GNLSE plays an important role in describing a plethora of different phenomena in various areas of physics. In optics, this model was initially used to describe the propagation of light through local and/or nonlocal systems under the paraxial approximation, but more recently it has been extensively used as a support model to develop optical analogues. However, establishing the relation between the original system and the analogue, as well as, between their model and the actual experimental setup is not an easy task. First and foremost because in most cases the governing equations are nonintegrable, preventing from obtaining analytical solutions and hindering the optimization of the experiments. Alternatively, despite numerical methods not providing exact solutions, they allow to test different experimental scenarios and provide a better insight to what to expect in an actual experiment, while giving access to all the variables of the optical system being simulated. However, the numerical solution of a system of an N-coupled GNLSE in systems with two or three spatial dimensions requires massive computation resources and must employ advanced supercomputing and parallelization techniques, such as GPGPU. This paper focuses on the numerical aspects behind this challenge, describing the structure of our simulation module, its performance and the tests performed.

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Paper AOP100-87

Towards optically-detected high-speed magnetic resonance spectrum measurements

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The measurement of magnetic resonance has found applications in spectroscopy and imaging for medicine and chemistry mostly. However, the state-of-the-art methods require bulky and expensive equipment lacking high spatial or temporal resolutions. In this project we investigate the potential of the nitrogen-vacancy (NV)-centre, an atomic defect found in diamond, to be an alternative for high speed detection of magnetic resonance spectrum.

Indeed, the separation of the NV-centre energy levels, and thus optical properties, linearly depends on the surrounding magnetic field. A spatial gradient of magnetic field thus translates to a spatial gradient of energy, over a homogeneous surface filled with NV-centres. Such a surface will then allow the detection of magnetic resonance spectrum, directly visible in the NV-centres optical signal.

In our design, a bulk diamond is implanted and annealed to create a dense distribution of NV-centres on one face (0.5x1 mm2) with a known orientation in the plane (110). Then the diamond is placed over a microfluidic chamber and at the centre of a goniometer mount on which a magnet is attached. The NV-centre fluorescence signal is exited using a modulated laser diode and collected through a home-made wide-field microscope. We demonstrate the acquisition of ESR (electron spin resonance) using microwave and T1- relaxation over the sensing surface (300x300 µm2). The alignment and positioning of the magnetic gradient is achieved by measuring the ESR over the surface.

The method shall eventually lead to the measurement of magnetic resonance spectrum of small quantity of chemical samples within seconds by fully-optical means.

Paper AOP100-88

Smartphone viewing distance during active or passive tasks and relation to heterophoria

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We analysed viewing distance for smartphone users (n = 60, aged 18-45 y.) in terms of passive or active task, relation to heterophoria, type of refractive error and smartphone font size. We found significantly shorter viewing distance for digital active task compared to digital passive task and also for digital passive task compared to hardcopy passive task. Low add improved reading speed but did not influence the viewing distance. Viewing distance was unrelated to type of refractive error and heterophoria type. Writing speed on a smartphone decreased with age (r = -0.46).

Paper AOP100-89

Laser speckle rheology for evaluating mechanical properties of biomaterials: a pilot study

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The main aim of this study is to develop a non-contact and integrated experimental device based on Laser Speckle Rheology (LSR) technology to evaluate the rheological properties of biomaterials or tissues in situ. To test the experimental device, two kind of test samples were generated with different composition and known elastic properties. The samples are acoustically excited while they are illuminated with a coherent beam, generating a speckle pattern that is picked up by a CMOS after going through a neutral density filter and a film polarizer. By measuring the variations of the laser speckle patterns, caused by the movement of the endogenous dispersive centers (scattering) within the tissue, the sequential correlation between continue frames and the contrast for each frame are calculated. The Young's module increases as the concentration of the endogenous dispersive center of the test sample. However, the results of LSR method using sequential correlation showed that the correlation value remains constant for both test samples, so it does not seem a properly method. Nevertheless when the frequency increases, the contrast value decreases, allowing to discriminate between the both types of test samples in the 140-340Hz range. The study conclude that the integrated LSR experimental device developed, together with laser speckle contrast imaging method, could be usefull to evaluate the rheological properties of new biomaterials.

Paper AOP100-90

Using FVSQ to identify functional indicators of visual problems among older people residing in nursing homes: a study in Santiago de Compostela

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Purpose: There is a lack of information in Spain respect visual dependent limitations of nursing home residents. A questionnaire would help to identify these problems. This study uses the Functional Vision Screening Questionnaire (FVSQ) to identify limitations on visual dependent daily activities of people residing in nursing homes.

Methodology: we examined 324 older residents (mini-mental test scores > 18 points). FVSQ was used to identify functional indicators of visual problems. FVSQ scores < 9 points were classified as “no visual problems” and FVSQ scores ≥ 9 points were classified as “presence of vision problems”.

High contrast presenting visual acuity (PVA) was determined as reference for the diagnosis of distance and near visual impairment (PVA < 6/18, WHO criteri). The responses to the different items were also analysed. Data analysis was developed using the SPSS 24.0 program.

Results: 36,4% of the residents have distance VI and 34,6% have near VI. 20,4% of the subjects present both distance and near VI. The percentage of older adults that reported visual problems (FVSQ scores ≥ 9 points) reaches 7,5%. 39,4 % of the residents cannot read normal newspaper and books letters and 22,9 % have difficulties to read their own handwriting. We have found an important absence of response in several items.

Conclusions: it is necessary to know the visual dependent activities of our residents in order to adapt the items of FVSQ to obtain higher response rates. The presence of incomplete questionnaires reduces the utility of FVSQ to identify vision problems.

Paper AOP100-91

Fluids of Light in atomic systems: from superfluidity to quantum simulations

Authors: N. Azevedo Silva, T. D. Ferreira, A. Guerreiro, INESC TEC (Portugal)

As quantum-driven processes and properties start to shape the future of technology, quantum simulations appear as a crucial piece of the puzzle, acting both as building blocks and catalysts for the improvement of the understanding of unique quantum features. In essence, they can be understood as a class of prototype experiments that allow a study of quantum properties in a controllable environment. In this context, quantum fluids of light are one of the strongest candidates for this role as coherent behavior is easily accessible and not hidden by detrimental thermal noise usually present in more common quantum systems. In this work, we explore the underlying theory of quantum fluids of light in propagating geometries through the hydrodynamic interpretation of light, where photons behave as interacting particles in the presence of a nonlinear medium. Exploiting the highly controllable optical properties of atomic systems and their enhanced nonlinear properties related to quantum coherence phenomena, we discuss how they can be used to set a tunable platform for quantum simulations. As examples, we demonstrate a series of quantum features of this light fluid in the form of superfluidic-like behaviors, ranging from the more common and experimentally confirmed suppressed scattering, drag-force cancellation, and Bogoliubov-like dispersion relation for the elementary excitations, to other interesting phenomena yet to be explored, such as the case of persistent currents, rotons and crystallization.

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Paper AOP100-92

Enhanced fluorescence in hybrid materials composed of a dye and plasmonic nanoparticles

Authors: P. Paulo, D. Botequim, D. M. Prazeres, S. M. Costa, Instituto Superior Técnico (Portugal)

Metal nanoparticles can act as optical antennas to couple light more efficiently in the excitation and emission from fluorescent molecules. The antenna effect of plasmonic nanoparticles has been explored to increase the sensitivity in fluorescence- based detection schemes [1], or to enable the detection of single-molecule fluorescence from weakly emitting molecules [2,3]. The largest fluorescence enhancements are obtained from surface regions of large plasmon near field, or plasmon hot-spots. In non- spherical particles, these hot-spots are typically located in regions of large curvature, e.g. at the tips of gold nanorods. This contribution reports on the functionalization of colloidal gold nanorods with fluorescently-labeled DNA's to optimize the antenna effects for fluorescence signal enhancement. Initially, a non-selective functionalization of the gold nanorods was employed to produce highly loaded dye-nanoparticles. This non-selective approach resulted in modest fluorescence enhancements, because the large enhancements at the rods' tips are most likely averaged out with low enhancement or even quenching of dye molecules located at the particle sides. Next, a tip-selective functionalization was implemented in order to specifically attach the fluorescent DNA's at the plasmonic hot-spots. This approach improved significantly the fluorescence emission from the dye-particle assemblies resulting in an emission increase of 17-fold relatively to the same dye in the absence of the nanorod antenna. Further characterization studies were performed by confocal fluorescence lifetime microscopy with single-particle sensitivity. These results highlight the importance of site- selective approaches for hot-spot functionalization, in order to maximize plasmonic effects for applications in imaging or biosensing [4].

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Paper AOP100-93

A hardware-independent solution for high-performance simulations of the Maxwell-Bloch system

Authors: N. Azevedo Silva, T. D. Ferreira, A. Guerreiro, INESC TEC (Portugal)

The interaction of light with matter in near-to-resonant conditions opens a path for the exploration of new quantum-enhanced optical response that can play an important role in future photonics-driven technology. In the last three decades this has been a hot topic of research in optical sciences, however, as the attention shifts towards many-level atomic systems, interacting with several electromagnetic fields and most of the times involving multi-dimensional experimental scenarios, the ever-increasing complexity of the physical systems makes the analytical approach to the semiclassical model of the Maxwell-Bloch equations impossible without any strongly-limiting approximations. In this context, robust and high-performance computational tools are mandatory. In this work, we describe the development and implementation of a cross-platform Maxwell-Bloch numerical solver - a module from HiLight, a Multiphysics simulation platform under development by our group - that is capable to exploit the different hardware available to tackle efficiently the problems under consideration. Moreover, it is demonstrated that this simulation tool can address a vast class of problems with considerable reduction of simulation time, featuring speedups up to 30 when running in massive parallel GPUs compared with the same codes running on a CPU, showing its potential towards addressing a large class of modern problems in nowadays photonics.

Paper AOP100-94

Exploring dissipative optical solitons controlling gain and loss in atomic systems

Authors: N. Azevedo Silva, T. D. Ferreira, A. Guerreiro, INESC TEC (Portugal)

Solitons are localized wave solutions which can appear in nonlinear systems when self-focusing effects balance the usual beam diffraction (for spatial solitons) or pulse dispersion (for temporal solitons) of common optical media. Their stability and particle-like behavior make them ideal candidates for applications that range from communication to optical computing. However, in real-world physical systems, the existence of dissipative processes makes these otherwise stable solutions unstable, and true solitons are particularly hard to observe in systems featuring non-negligible dissipation, such the case of plasmonic systems. In these cases, a special type of localized stable solutions, called dissipative solitons, is still possible to be obtained, if, in addition to a balance between diffraction and nonlinearity, an additional equilibrium between gain and loss is also present. In this work we discuss theoretically how a 4-level atomic system and an incoherent pumping process can be an ideal experimental testbed for studying this interesting class of solutions, featuring tunable optical properties and controllable gain/loss dynamics that allow to study different classes of temporal and spatial dissipative optical solitons.

Paper AOP100-95

Analysis of the relationship of the central tear meniscus area with the tear film symptomatology and stability

Authors: C. Garcia-Resua, H. Pena-Verdeal, J. Garcia-Queiruga, R. Calo-Santiago, M. Giraldez, Univ de Santiago de Compostela (Spain)

Purpose: Tear film meniscus evaluation offers a non-invasive indication of the total volume of the tear. The aim of this study was to analyse the relationship of the central tear meniscus area with symptomatology and tear film stability.

Material and methods: 120 subjects who completed an OSDI questionnaire were enrolled in the study. After fluorescein instillation, two videos were recorded by a digital camera attached to a slit-lamp. The first video recorded the lower central portion of the tear meniscus (6 o'clock) with a short light beam (3x5mm), and the second one recorded the complete ocular surface obtaining the Break- Up time (BUT) and Maximum Blink Interval (MBI). A self-design program (FWCapture) were used to acquire the videos while the subjects were requested to keep the eye open for as long as possible three times. Images were extracted from each video by a masked observer. From de first video, Central Tear Meniscus Area with fluorescein (CTMAF) was"manually" measured by using ImageJ software (command ">>freehand tool"). From the second video, BUT and MBI were determined by counting video frames then converted in seconds; both parameters were averaging using only the two most similar measurements.

Results: CTMAF showed a negative correlation with OSDI score (Spearman Rho: $p < 0.001$, $r = -0.372$). There was found a statistical difference in the CTMAF between OSDI subgroups (Kruskal-Wallis: $p = 0.001$). CTMAF showed a positive correlation with BUT/MBI (Spearman Rho: both $p \leq 0.003$, $r \geq 0.246$)

Conclusions: Tear film volume showed a relationship with the symptomatology and tear film stability.

Paper AOP100-96

Meibomian gland loss area and its relationship with age and ocular surface disease index

Authors: J. Garcia-Queiruga, H. Pena-Verdeal, D. Ferreiro, C. García-Resúa, E. Yebra-Pimentel, Univ de Santiago de Compostela (Spain)

Purpose: Meibography images bring information about the status and integrity of the meibomian glands (MG). The aim of this study was to correlate the meibomian gland loss area (MGLA) with age and dry eye symptomatology.

Material and methods: A total of 110 subjects were recruited for the study. From the Meibography images obtained with the Topcon® CA-800 topographer, MGLA was calculated as the difference between the total area of the tarsus and the MG presence area measured by using the ImageJ software. Before examination, all subjects completed an OSDI questionnaire. OSDI scores were grouped in 4 severity categories: normal (score ≤12), mild (score 12–22), moderate (score 22–32) and severe (score ≥32). Age were categorised in 3 subgroups: ≤25 years, from 25 to 45 years and ≥45 years. MGLA was also grouped in 4 categories of loss: ≤25 %, from 25 to 50%, from 50 to 75% and ≥75%.

Results: Analysis was performed by dividing the sample in the 4 MGLA subgroups; this subgroups showed differences in age ($p<0.029$; Kruskal-Wallis test) and differences in OSDI scores ($p<0.010$; Kruskal-Wallis test). Sample was divided in 3 age subgroups and differences were obtained in MGLA values among subgroups ($p<0.010$; Kruskal-Wallis test). Samples was divided in 4 OSDI subgroups and differences were obtained in MGLA values among subgroups ($p<0.010$; Kruskal-Wallis test). Positive correlation (Spearman Correlation) were obtained for both, MGLA vs. age ($r=0.329$, $p<0.010$) and MGLA vs. OSDI ($r=0.380$, $p<0.010$).

Conclusion: In the present study MGLA showed a relationship with age and OSDI.

Paper AOP100-97

Relationship between visual therapy vectograms and accommodative parameters in young healthy subjects

Authors: H. Pena-Verdeal, R. Calo-Santiago, S. García-Montero, C. Vazquez-Sanchez, M. Giraldez, Univ de Santiago de Compostela (Spain)

Purpose: Vectograms are visual therapy material based on red/green or polarized targets that used similar but slightly different images for each eye to train fusion and vergence skills. The aim of this study was to analyse the relationship of three accommodative parameters (the Negative Relative Accommodation [NRA], the Positive Relative Accommodation [PRA] and the Accommodative Amplitude [AA]) with the results of four different visual therapy vectograms.

Material and methods: 45 subjects free of any accommodative or binocular problems were recruited among students attending the Optometry Clinic of the Optometry Faculty (USC). In a first session, the accommodative tests were performed according to their standard protocols. In a second session, following manufacturer's instructions, the subjects performed in a random order four different calibrated vectograms: two red/green Variable Demand Anaglyphs (one based on circles [VDA-C] and one on draws [VDA-D]), one red/green Fixed Demand Anaglyph [FDA], and one polarized with Variable Demand [VDP]. Subjects were asked to indicate the maximum value both base-out (BO) and base-in (BI), where the image fusion was lost.

Results: NRA showed a negative correlation with the BO results of the VDP ($p = 0.040$, $r = -0.270$). PRA showed a negative correlation with the BO results of the VDA-C, the VDA-D and the VDP (all $p \leq 0.017$, $r \geq -0.323$). NRA showed a positive correlation with the BI results of the VDA-D, the FDA, and the VDP (all $p \leq 0.013$, $r \geq 0.341$).

Conclusion: Accommodative parameters seem to have some influence in the visual therapy training with vectograms.

Paper AOP100-98

Evaluation of the relationship between symptomatic assessment, corneal staining and tear meniscus by image analysis

Authors: S. Garcia-Montero, D. Ferreiro, C. Vazquez-Sanchez, H. Pena-Verdeal, E. Yebra-Pimentel, Univ de Santiago de Compostela (Spain)

Purpose: Vital staining is one of the most widely test used to evaluate the corneal damage. The aim of this study was to assess the relationship of the corneal damage with tear meniscus height (TMH) and dry eye symptomatology.

Material and methods: 530 subjects were recruited among patients of the Optometry Clinic (USC). Previously, all of them completed an OSDI questionnaire. Two videos of ocular surface were recorded from each patient by a digital camera attached to a slit-lamp.

Firstly, a video of central tear meniscus under 40x with the Tearscope device illumination was recorded. From those videos, a masked observer extracted one image and TMH was measured by using the ImageJ software. Secondly, after fluorescein instillation, the corneal surface was recorded by another experienced masked observer, who assigned a category to the corneal damaged based on the Oxford Scheme. The evaluation was stratified by corneal zones based on the CCLRU grading scales (central, superior, inferior, nasal and temporal).

Results: When the sample was grouped by the corneal staining Oxford Grade, there was found a statistical difference between groups in OSDI and TMH value (ANOVA: both $p \leq 0.006$). There was found a difference in OSDI value when corneal damage was located in nasal or inferior areas (t-test; both $p \leq 0.015$), and a difference in TMH value arises when damage was in the central, nasal or inferior areas (t-test; all $p \leq 0.013$).

Conclusions: There is a relationship between corneal damage grade and corneal zones with dry eye symptomatology and tear film volume.

Paper AOP100-101

Determination of the optical properties in transparent conductive electrodes based on an indium-tin oxide coating using the IAD method.

Authors: A. Rodríguez-Águila, A. Toral-López, J. C. Cardona, A. M. Ionescu, N. Rodríguez, F. García Ruiz, A. Godoy, M. M. Pérez Gómez, Univ de Granada (Spain)

Recently there has been a great interest in the search of appropriate materials to be employed as Transparent Conductive Electrodes (TCEs), inasmuch as they are key elements in the operation and performance of optoelectronic devices in general, and of solar cells in particular. Currently, the most used material is indium-tin oxide (ITO). The aim of this study is to evaluate the optical properties of TCEs based on an ITO coating. By means of the Inverse-Adding Doubling (IAD) method, transmittance and reflectance measurements provide the information necessary to determine the absorption coefficient and the reduced scattering coefficient. We have employed an integrating sphere setup to measure the total transmittance and reflectance. The experimental procedure was conducted under repeatability conditions of measurement in order to determine the uncertainty associated to the optical properties of the ITO electrode. The results show that the ITO electrodes present a high transmittance (75-85%) and very low reflectance (lower that 1.5%). The albedo point out that absorption predominates versus the scattering, changing for the medium-high wavelengths of the visible range where scattering tends to predominate.

These optical properties represent useful references and data for applications requiring the precise knowledge of the light transport through this type of material used in photovoltaic applications. Hence, the IAD method has been demonstrated as an appropriate method of analysis as it provides information of outstanding interest to carry out a quantitative control of any material employed as TCE.

Paper AOP100-102

Image encryption system based on a nonlinear joint transform correlator for the simultaneous authentication of two users

Authors: J. M. Vilardy Ortiz, Universidad Popular del Cesar (Colombia); M. S. Millán, E. Pérez-Cabré, Universitat Politècnica de Catalunya (Spain)

We propose a new encryption system based on a nonlinear joint transform correlator (JTC) using the information of two biometrics (one digital fingerprint for each user) as security keys of the encryption system. In order to perform the decryption and authentication in a proper way, it is necessary to have the two digital fingerprints from the respective users whose simultaneous authentication is pursued. The proposed security system is developed in the Fourier domain. The nonlinearity of the JTC along with the two security keys given by the two random phase masks and the two digital fingerprints of the two users allow an increase of the system security against brute force and plaintext attacks. The feasibility and validity of this proposal is demonstrated using digital fingerprints as biometrics in numerical experiments.

Paper AOP100-103

Experimental optical encryption scheme for the double random phase encoding using a nonlinear joint transform correlator

Authors: J. M. Vilardy Ortiz, Universidad Popular del Cesar (Colombia); M. S. Millán, E. Pérez-Cabré, Universitat Politècnica de Catalunya (Spain)

We present a new experimental optical encryption scheme based on a nonlinear joint transform correlator (JTC) to implement the optical security technique of the double random phase encoding (DRPE). The DRPE, which is usually performed in a 4f-processor, encodes an image into a stationary white noise pattern (encrypted image) by using two random phase masks (RPMs). In our experimental setup, the input plane of the JTC is fully encoded in phase and this plane contains two non-overlapping data functions (images). In the encryption step, the phase-encoded image to be encrypted and the two RPMs are placed in the input plane of the JTC with the purpose of obtaining the needed intensity distributions at the output plane to compute the encrypted image. The optical and numerical transformations are performed in the Fourier domain. A nonlinear operation is introduced to modify the joint power spectrum (JPS) of the JTC in order to reproduce exactly the same results of the DRPE. The experimental optical encryption scheme based on a three-step JTC is implemented by using an optoelectronic setup. The input plane of the JTC is optically implemented by means of a phase-only spatial light modulator (SLM). The decryption process is performed using a virtual optical system. Experimental and numerical results of the optical encryption and simulated decryption systems are presented, in order to show the feasibility of the proposed security system.

Paper AOP100-104

Image authentication using a joint transform correlator-based encryption and decryption systems and the photon counting imaging technique

Authors: J. M. Vilardy Ortiz, Universidad de La Guajira (Colombia); M. M. Milán, E. Pérez-Cabré, Universitat Politècnica de Catalunya (Spain)

In this work, we propose the use of the photon counting imaging technique at the input plane of a joint transform correlator (JTC)-based encryption system to authenticate two images represented by a primary image and a random phase mask (RPM). All the transformations are performed in the Fourier domain. The double random phase encoding (DRPE) technique is implemented on a nonlinear zero-order JTC architecture. The decryption and authentication processes are simultaneously performed. The authentication process of the primary image and the RPM is implemented using a nonlinear correlation. The security of the encryption system is improved and the authentication process is more robust against unauthorized attacks when the photon counting is applied at the input plane of the JTC. We perform several numerical simulations of the encryption and decryption-authentication systems in order to illustrate our proposal.

Paper AOP100-105

Influence of morphology on the exciton fine structure of single colloidal nanoplatelets

Authors: S. Goupalov, Jackson State University (United States)

Atomically flat colloidal semiconductor nanoplatelets (NPLs) have been attracting much interest due to their fascinating optical properties and potential for applications. In this work we investigate how morphology affects photoluminescence (PL) properties of single elongated 5 monolayer-thick CdSe NPLs and core/shell CdSe/CdZnS NPLs with smooth and rough shells.

Single NPLs exhibit polarized emission and the shell deposition reduces the polarization degree. Moreover, room-temperature polarization-resolved PL spectra of ~66% of the rough shell NPLs and ~45% of the smooth shell NPLs reveal three energetically distinct, linearly polarized emitting states with energy splitting of ~25 meV. Out of these three states, the highest and lowest energy states have almost identical polarization orientation while the polarization of the middle state orients nearly orthogonal (60-70 degree) to that of the highest and lowest energy states. In order to explain the origin of these states we assume that the heavy-hole exciton can get localized on the island of shell roughness, and calculate the fine structure of energy levels of the localized exciton. Due to the large value of the exciton longitudinal-transverse splitting for CdSe (~1 meV) and small 2D exciton Bohr radius in NPLs (<10 Å), the fine-structure splitting of ~25 meV between the two orthogonal linearly polarized exciton states can be reached for the island as large as 70 Å x 120 Å. Meanwhile, for a delocalized exciton, the fine-structure splitting is calculated to be 63 meV which makes the high- energy delocalized exciton level not accessible at room temperature. Moreover, what appears as non-orthogonality of localized exciton states can be quantitatively explained assuming slight inclination of the island main in-plane axes with respect to the main in- plane axes of the NPL and taking into account strong depolarization field in the direction perpendicular to the axis of NPL elongation.

Paper AOP100-106

Optical image encryption using a nonlinear joint transform correlator and the Collins diffraction transform

Authors: A. R. Herrera, J. M. Vilardy Ortiz, R. A. Perez, Universidad de La Guajira (Colombia)

The Collins diffraction transform (CDT) describes the optical wave diffraction from the generic paraxial optical system. The CDT has as special cases the diffraction domains given by the Fourier, Fresnel and fractional Fourier transforms. In this paper, we propose to describe the optical double random phase encoding (DRPE) using a nonlinear joint transform correlator (JTC) and the CDT. This new description of the nonlinear JTC-based encryption system using the CDT covers several optical processing domains, such as Fourier, Fresnel, fractional Fourier, extended fractional Fourier and Gyrator domains, among others. The maximum number of independent design parameters of the proposed encryption system using the CDT increases three times in comparison with the same encryption system using the Fourier transform. The proposed encryption system using the CDT preserves the shift-invariance property of the JTC-based encryption system in the Fourier domain, with respect to the lateral displacement of both the key random mask in the decryption process and the retrieval of the primary image. The viability of this encryption system is verified and analysed by numerical simulations.

Paper AOP100-107

Uncertainty principle in the gyrator domain

Authors: R. A. Perez, J. M. Vilardy Ortiz, Universidad de La Guajira (Colombia); C. O. Torres, Universidad Popular del Cesar (Colombia)

The Gyrator transform (GT) is a new mathematical tool for analysis and processing of two-dimensional signals, which belongs to the linear canonical transform. The GT describes rotations in the phase space and it has been used in applications of light propagation, image processing and quantum physics. In this paper, we develop and present the uncertainty principle for a two- dimensional signal (image), giving us lower bound on the product of the spreads (uncertainty product) of the image representations in two specific Gyrator domains (GDs). The lower bound obtained for the uncertainty principle depends on the two rotation angles used in the two GDs of the image or two-dimensional signal. The resulting uncertainty principle can be used in optical image processing applications based on the GT.

Paper AOP100-108

Image processing operators based on the Gyrator transform: generalized shift, convolution and correlation

Authors: R. A. Perez, J. M. Vilardy Ortiz, Universidad de La Guajira (Colombia); C. O. Torres, Universidad Popular del Cesar (Colombia)

The Gyrator transform (GT) is used for images processing in applications of light propagation. We propose new image processing operators based on the GT, these operators are: generalized shift, convolution and correlation. The generalized shift is given by a simultaneously application of a traslation and a specific linear phase shift. The new operators of convolution and correlation are defined using the GT. All these image processing operators can be used in order to design and implement new optical image processing systems based on the GT. The sampling theorem for images whose resulting GT has finite support is developed and presented using the previous defined operators. Finally, we design, implement and show the results for an optical image encryption system using a nonlinear joint transform correlator and the proposed image processing operators based on the GT.

Paper AOP100-109

Optical image encryption system using several tilted planes

Authors: J. M. Vilardy Ortiz, C. J. Jimenez, Universidad de La Guajira (Colombia); C. O. Torres, Universidad Popular del Cesar (Colombia)

A well-known technique for optical image encryption is the double random phase encoding (DRPE) technique, which uses two random phase masks (RPMs), one RPM at the input plane of the encryption system and the other RPM is placed at the Fourier plane of the optical system, in order to obtain the encrypted image. In this work, we propose to use tilted planes for the input and Fourier planes of the optical DRPE system with the purpose of adding two new security keys given by the angles of the tilted planes. The tilted distributions at the input plane of the optical DRPE system are the image to encrypt and the first RPM. The second RPM is tilted at the Fourier plane of the optical DRPE system. The angles of the tilted planes allow to improve the security of the encrypted image. We perform several numerical simulations in Matlab with the purpose of demonstrating the validity and feasibility of the proposed image encryption system.

Paper AOP100-110

Mathematical modelling of the digital holography using the fractional Fourier transform

Authors: C. J. Jimenez, J. M. Vilardy Ortiz, Universidad de La Guajira (Colombia); S. Salinas, Universidad del Zulia (Venezuela)

We present the mathematical modelling of the digital in line holography in terms of the fractional Fourier transform (FrFT). The processes described are the capture, storage, transmission or reconstruction of the digital in line hologram using the propagation of a single phase in the free space. We develop the needed algorithms in order to perform the processes mentioned above. We check and analyse the validity of the proposed mathematical modelling of the digital holography by means of computing simulations.

Paper AOP100-111

Assessment of Van Herick Technique by using ImageJ software

Authors: D. Ferreiro, S. García Montero, J. García Queiruga, E. Punin Dorrio, E. Yebra-Pimentel, Universidad de Santiago de Compostela (Spain)

Purpose: Primary angle-closure glaucoma is a common cause of blindness where angle closure is a fundamental pathologic process. Van Herick technique is one of the commonest tests used in clinical settings for iridocorneal angle estimation, but training is required. With the development of imaging devices for the anterior segment of the eye, such as multi-diagnostic platform VX120 (Visionix), objective quantification of the angle can be obtained. The purpose of this study is to compare the angle estimation of Van Herick (with the aid of image processing software) with that obtained by objective VX120 platform.

Material and methods: 49 subjects were enrolled in the study among patients attending the Optometry Clinic of the Optometry Faculty (USC). All of them were assessed with multi-diagnostic platform VX120 (Visionix) in order to obtain the Anterior Chamber Depth (ACD) and temporal iridocorneal angle (TA) parameters. Then, an image of the temporal optic section of the cornea (following the requirements of Van Herick technique) was obtained from each subject by using a camera attached to a slit-lamp. Finally, Van Herick's temporal angle was determined as a ratio between the peripheral anterior chamber depth and corneal thickness (AC/C ratio) by using ImageJ software.

Results: Van Herick´s AC/C ratio showed a significant correlation with both TA ($r=0.389$, $p=0.006$) and ACD ($r=0.370$, $p=0.009$). As expected, both VX120 parameters (ACD and TA) showed a significant correlation between them ($r=0.863$, $p<0.001$).

Conclusions: Van Herick´s AC/C by using ImageJ software supposes a valuable parameter for iridocorneal angle estimation.

Paper AOP100-112

Vision as a predictor of expertise in high demanding visual tasks

Authors: A. M. Baptista, University of Minho (Portugal); P. Serra, Ophthalmologic Clinic Vista Sánchez Trancón (Spain); B. Barrett, University of Bradford (United Kingdom)

Humans conduct many tasks that are visually demanding. However, many of these tasks are difficult or impossible to study in the laboratory (e.g. vision during fire-fighting, in the military and during surgery) with the aim of determining the skills needed to achieve expertise in these tasks. One area where visual demands are high and where better, or more effective use of, vision may contribute to better performance is the area of elite sport. In this study, we used football officiating (in referees and assistant referees), an activity recognised as very demanding for vision, and we tested the hypothesis that the level of vision measured in the clinical setting contributes to the level of performance on the field. Measures of clinical vision (e.g. visual acuity) and perceptual vision (e.g. figure/ground segmentation) were collected in Portuguese elite football officials and used as independent variables in a multiregression analyses to determine which, if any, of the parameters could be used as predictors of performance on the field. Each official's performance on the field over three seasons was judged by colleagues within Portuguese football to allow a rank order to be created. The analysis revealed that visual memory, stereoacuity, number of years officiating and affiliation (the officiating centres they came from) contribute significantly to a model which explains 28% variance in of official´s performance.

Paper AOP100-113

On the behavior of vector light needles using modulation functions with topological charge

Authors: A. Carnicer, Universitat de Barcelona (Spain); R. Martínez-Herrero, Universidad Complutense de Madrid (Spain); D. Maluenda, Centro Nacional de Biotecnología (CSIC) (Spain); I. Juvells, Universitat de Barcelona (Spain)

In a previous publication [1], we introduced a set of modulation functions able to produce tunable-length vector light needles in the focal domain of a high numerical aperture lenses. These distributions display interesting mathematical properties such as radial symmetry and large derivative values. Moreover, the modulation function has a zero value jump at the entrance pupil of the focusing system. Taking into account the region of the propagation axis that encloses the 75% of the on-axis irradiance, we derived a formula that provides a fair a-priori estimation of the length of the needle. Our approach was experimentally tested and verified in the laboratory. The modulation distribution was optically implemented using spatial light modulators and digital holography techniques [2]. A variety of optical needles of different lengths were produced. In particular, we reported optical needles with lengths larger than 80 lambda [3].In the present communication, we expand our previous developments in the field by introducing spiral charge to the modulation function. We analyze the effect of this new element on the behavior of light along the optical axis.

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Paper AOP100-114

On how thick diffusers can contribute to the design of optical security systems

Authors: A. Carnicer, K. Ahmadi, I. Juvells, Universitat de Barcelona (Spain)

Recent developments in optical authentication and validation demonstrate the ability of the properties of light to distinguish among counterfeit and true samples [1]. Sometimes, metallic nanoparticles or thin films technology is used during the fabrication process in order to provide a strong polarimetric signature. In particular, the combined examination of the state of polarization of light after interacting with the sample and the statistical analysis of the speckle patterns provide enough information to train machine learning methods. In this way, these techniques would be able to predict whether the sample is true or fake. On the other hand, phase-encoding masks using cello-type diffusers provide an extra security layer. After propagation, phase encoded information becomes a Poisson-like noise distribution, and thus access to the original signal is very difficult. In a recent paper we studied the capacity of three-dimensional phase coders using thick diffusers to enrich the amount of information for training machine learning algorithms [2].

The objective of this communication is to evaluate to what extent a thick diffuser modifies and reinforces the uniqueness of the optical signature of the sample. In order to achieve this objective, we analyze the behavior of thick diffusers using a numerical model. First, surfaces are realistically modeled using Perlin noise and compared with profilometry results. Then, polarized light interacts with the sample and finally the speckle pattern is analyzed. Experimental results validate the proposed model.

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Paper AOP100-115

Carbon-based nanomaterials in suspensions far beyond the nonlinear optical threshold

Authors: B. Eberle, S. Dengler, Fraunhofer IOSB (Germany)

Nanoparticles are known to show excellent electrical, thermal and mechanical properties, which make them suitable for a wide variety of applications. Many of these materials have been found to show also a strong nonlinear optical (NLO) behavior under intense laser light illumination. These materials attenuate intense laser radiation while exhibiting high transmittance at low irradiation levels, which makes them suitable for so called optical limiting (OL) applications. It is known that the OL mechanisms are related mainly to nonlinear (NL) absorption and NL scattering.

Carbon-based nanomaterials like fullerenes, single- or multiwall carbon nanotubes (CNT), or graphene, were intensively studied during the last decades. In particular, C60 and MWCNT are known as OL benchmark materials of high efficiency and well known OL characteristics. The common understanding in literature concludes that the main OL mechanism of MWCNT suspensions is NL scattering whereas C60 suspensions show mainly NL absorption.

In this work we present our studies on the NLO response of suspended MWCNT and C60 from low up to very high laser fluences. NL transmittance and scattering phenomena were investigated using nanosecond laser pulses at 532 nm. Our measurements far beyond the OL threshold revealed results that cannot be explained by the OL mechanisms relevant around the OL threshold.

Paper AOP100-116

Amblyopia treatment: what we know and what we don't know!

Authors: B. Barrett, University of Bradford (United Kingdom)

Around 20 years ago, a major report published in the UK concluded that while the amblyopia treatment methods of the day appeared to work, there was very little hard evidence to support to their effectiveness. This conclusion spawned a huge volume of research, including many large-scale, multi-centred randomised controlled trials (RCTs). This talk will provide a summary of the key findings from the major studies. This recent research has itself led to a major change in amblyopia treatment: glasses (containing full refractive correction) alone are the first form of treatment and are now worn for a minimum of 16-20 weeks before any other form of treatment (e.g. patching) is initiated. Studies have compared different patching and optical penalisation regimens. Newer binocular approaches to amblyopia treatment have also been subjected to scientific scrutiny. We now have the evidence that amblyopia treatment works, and answers have been provided too many question such as: is full-or part time patching better? Can amblyopia be treated in older children and adults? Can mild amblyopia be treated? Are the newer, binocular methods effective? However, there are many residual questions including: are newer methods faster and/or more effective that traditional ones? As well as visual acuity, can binocularity (e.g. stereopsis) be recovered by treatment? Why do some amblyopic children not respond to treatment? Thanks to recent research, we now know much more about amblyopia treatment but there is also plenty still to be learnt!

Paper AOP100-117

Enhanced temperature sensing with Vernier effect on fiber probe based on multimode Fabry-Perot interferometer

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Sensing at small dimensions in biological and medical environments requires miniaturized sensors with high sensitivity and measurement resolution. In this work a small optical fiber probe was developed to present the Vernier effect, allowing for enhanced temperature sensing. Such effect is an effective way of magnifying the sensitivity of the structure in order to reach higher resolutions. The device is a multimode silica Fabry-Perot interferometer structured at the edge of a tapered multimode fiber by focused ion beam milling. The Vernier effect is generated from the interference between different modes in the Fabry-Perot interferometer. The sensor was characterized in temperature, achieving a sensitivity of 654 pm/ºC in a temperature range from 30 ºC to 120 ºC. The Vernier effect provided a temperature sensitivity over 60-fold higher than the sensitivity of a normal silica Fabry-Perot interferometer without the effect. The temperature resolution obtained was 0.14ºC, however this value was limited by the resolution of the OSA and can be improved to less than 0.015 ºC.

Paper AOP100-118

Low-loss broadband optical waveguides fabricated in glass by femtosecond laser direct writing

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Integrated optical waveguides are traditionally fabricated by photolithographic techniques due to its technological maturity. However, a more recent approach uses a femtosecond laser to write the waveguide core directly in the material. This technique offers prototyping flexibility, without the need for masks or multiple fabrication steps, and three-dimensional geometries, which are not possible in traditional fabrication methods. Despite the new possibilities, the spectral characteristics of such waveguides are far from ideal.

In this work the fabrication of optical waveguides with femtosecond laser direct writing in two materials, fused silica (Suprasil 1) and alkaline earth boro-aluminosilicate glass (Eagle2000), is reported; the results of the influence of typical fabrication parameters, such as pulse energy and scan velocity, on insertion loss (350 to 1750 nm) are given. Tests conducted in fused silica have evidenced the presence of a strong C/λ^4 trend in propagation loss, suggesting that losses at shorter wavelengths are primarily caused by Rayleigh scattering, hindering the production of low-loss waveguides in this region. Coupling loss at longer wavelengths is also present, indicating an insufficient refractive index contrast, as well as Mie scattering, through a wavelength independent baseline loss.

Optimization through the variation of the parameters was found to be possible, with Rayleigh scattering being the limiting factor on the fabrication of low-loss broadband optical waveguides in fused silica. Optical waveguides fabricated in Eagle2000 exhibited lower Rayleigh scattering with a two order of magnitude higher scan velocity when compared with fused silica, enabling the fabrication of low-loss broadband waveguides.

Paper AOP100-119

Quantitative imaging of advanced nanostructured materials with scattering-type scanning near field optical microscopy

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The scientific communities working in optics and photonics have placed massive efforts over the past couple of decades for developing imaging techniques capable of optical resolutions beyond the diffraction barrier. Among these, scanning- probe techniques that exploit the interaction of a laser beam and a sharp tip for optically probing an investigated sample hold huge potential for the nanoscale characterization of advanced materials, as they don't require sample labeling. For example, scattering-type Scanning Near Field Optical Microscopy (s-SNOM) has been demonstrated as a valuable tool for revealing local structural properties, plasmonic behavior, free-carrier concentration or surface charge domains, at resolutions down to 10nm, independent of the illumination wavelength. In recent proof-of-concept experiments we have shown that besides optical images with nanoscale details that can be qualitatively interpreted, s-SNOM provides as well quantitative information of the real and imaginary parts of the dielectric function, and hence of optical parameters such as refractive index, transmittance, absorption, etc. In this work we further demonstrate these capabilities in the frame of several experiments that highlight how quantitative imaging with s-SNOM brings significant added value to the in-depth understanding of advanced nanostructured materials such as microcapsules for drug delivery assembled with layer-by-layer strategies, ultra-thin optical coatings with tunable color properties, and various types of nanoparticles with important application such as conversion of sunlight into heat, upconversion of infrared light or theranostics. We discuss as well complementarities that exist between s-SNOM and other near-field and far-field imaging techniques, and showcase advantages of correlative imaging.

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Paper AOP100-120

The influence of coloured lighting on ocular accommodation

Authors: R. Moreira, J. M. Linhares, S. M. Franco, University of Minho (Portugal)

The lighting systems that is used in our daily tasks are an important factor in our vision quality. These systems must be suitable to the visual needs required by these type of tasks.

The aim of this work is to evaluate the influence of coloured lighting on ocular accommodation and its response with the lighting used. Twenty subjects, with ages ranged from 18 to 35 years old, participated in the study. All subjects had 6/6 corrected visual acuity or better, normal colour vision and no history of ocular disease or surgery.

The accommodative amplitude and the monocular and binocular accommodative facility were measured under normal conditions (assuming white LED light) and with coloured LED lighting with different peak wavelengths.

The accommodative parameters measured under different conditions of illumination are analysed, compared and presented, assuming the white LED light as the reference light source.

Improvements over the reference light source on the parameters that were analysed are identified and assumed as better lighting conditions.

Paper AOP100-121

The PESIT-IIA Observatory for the Night Sky (PIONS): Assembly and ground calibration results

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The PESIT/IIA Observatory for the Night Sky (PIONS) is a near ultraviolet astronomical instrument to be flown on a small satellite. The optical system consists of a 150 mm Ritchey–Chrétien telescope with a wide field of view of 3 degrees. The intrument images the sky in the 180–280 nm region with a 13" spatial resolution and 2 ms temporal resolution. A photon counting detector, developed in-house, acquires the images at upto 500 frames per second. The instrument acts as a survey telescope for time-domain astronomy, as it scans the sky continuously to detect transient events from supernova explosions, stellar flares, or tidal disruption events. In this paper, we give an overview of the instrument and describe the optical assembly and alignment procedure. We will also discuss the methods and results from the ground calibration.

Paper AOP100-122

Compensative effect between corneal and internal ocular aberrations during a near vision task

Authors: G. Jéssica, G. Andreia, S. M. Franco, University of Minho (Portugal)

The purpose of this study was to analyze the changes of corneal, internal and total ocular aberrations with a near vision task.

Nineteen emmetropic students of University of Minho (19 eyes) with age between 19 and 25 years old performed a near vision task (accommodative demand of 2.50 D) for 30 minutes. The Zernike coefficients up to sixth order were extracted immediately before and after the task using the Visionix VX 120 (VisionixLuneau,Chartes,France) equipment. The results were evaluated for 3 and 5 mm pupil diameter.

Several Zernike coefficients (corneal Z(2,-2) and Z(6,-2), internal Z(4,2) and Z(6,4), and both corneal and internal Z(5,-5), Z(5,-3), Z (5,3), Z(6,2)) showed significant changes after the task. All corneal and internal aberrations, except Z(3,-1), Z(3,3) and Z(4,-4), increased in opposite direction, resulting in a slight change of total ocular aberrations. The high order root mean square (RMS) of corneal and internal aberrations increased after the task, but total root mean square did not show statistical significant differences. There was an interaction between corneal and internal aberrations, not only in ocular relaxed state, but also with near vision tasks. The visual system seems to adapt and compensate the changes induced by the task, leading to a decrease of the total ocular aberrations, allowing a less intensified decrease of ocular optical quality with the task.

Paper AOP100-123

Development of thin films composed of plasmonic nanoparticles (Au, Ag) dispersed in a CuO oxide matrix for optical (gas) sensing

Authors: M. Proença, M. Rodrigues, J. Borges, F. Vaz, University of Minho (Portugal)

The selective detection of flammable and/or toxic gases (e.g. CO), using optical sensors is presently a raising trend over the well-established conductometric-based methods. The present work proposes a reliable and effective possibility of an active material suitable to be used in an optical sensor. The solution is based on nanocomposite films, containing (Au, Ag) nanoparticles embedded in an oxide matrix. The sensitivity mechanisms of the films are tailored according to the Localized Surface Plasmon Resonance (LSPR) phenomenon revealed by these materials, which is strongly dependent on the composition, distribution, size and clustering tendency of the nanoparticles, but also on the surrounding dielectric medium. Both Au and Ag nanostructures exhibit LSPR effect in the visible range of the spectrum and, due to their high values of refractive index sensitivity, they are ubiquitous in the literature for sensing applications. Furthermore, Ag-Au bimetallic nanoparticles have attracted significant attention because of their corresponding monometallic counterparts that may allow further improvements on their set of properties. In this work, different sets of Au:CuO, Ag:CuO and Au-Ag:CuO thin films were prepared, aiming to find suitable nanoplasmonic platforms, capable of detecting the presence of gaseous molecules through changes in LSPR band. Results showed that the formation of Au and Ag well-defined nanoparticles with the annealing process in a stoichiometric CuO matrix, allowing the appearance of sharp transmittance LSPR (T- LSPR) bands, which could be tailored according to the envisaged application, focused on the refractive index sensitivity (RIS).

Paper AOP100-124

Influence of pupil function in pseudophakia

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Background

In pseudophakia, the eye is unable accomodate so proximal objects can be properly focused. Achieving functional vision levels relies on individual anatomical features and pupil size is one of these. This study measured the range of pupil sizes found in a population of pseudophakes, for an object placed at different distances, and model the optical quality associated to pupil variation.

Methods

The pupil size of 59 pseudophakic eyes (age mean±SD: 70.5±11.2y/o) was measured using a binocular eye-tracker. The participants observed on a monitor a circular white patch subtending 5deg (luminance: 65.3cd.m-2) with a cross on its centre, during 15 seconds. The object was placed at 3.0, 1.0, 0.66, 0.5, 0.4, 0.33m. The pupil size variation as a function of object distance was modelled using a linear mixed model. The mean and 95% confidence interval were calculated for an infinitely distant object and the slope of the function, indicative of the proximal myosis. The effect of object distance on the image quality was modelled using a pseudophakic model eye for the pupil size data.

Results

The mean distance pupil sizes was 4.45 (95%CI: 2.75, 6.15)mm and the mean proximal myosis was -0.21 (95%CI: -0.61, -0.04)mm/D. The VA estimation for a distance object ranged from -0.1logMAR for the smallest pupil to 0.08logMAR and the near VA when mean myosis was considered ranged from 0.28logMAR to 0.65logMAR.

Conclusions

The range of estimated visual acuities obtained suggests that the distance pupil size should be assessed if the visual performance, especially at near distances, is to be estimated in a reliable way.

Paper AOP100-125

Spatially variant retarders used as geometric phase diffractive elements

Authors: I. Moreno, M. Sánchez-López, Univ Miguel Hernández de Elche (Spain)

In this presentation we introduce different geometric-phase (GP) diffractive elements, including lenses, q-plates and diffraction gratings. These are spatially-variant retarders, where the neutral axes are oriented in the plane of the waveplate according to a given phase function. When tuned as half-wave retarders, they act on input circularly polarized light by changing the helicity of the circular polarization and adding the GP pattern encoded on the axis orientation. Some of these elements are already commercially available and can be used to build optical systems with new capabilities, in what has been called fourth generation (4G) of diffractive optics. We analyze the polarization conversion properties of these elements when illuminated with arbitrary states of polarization. We also present techniques for their spectral characterization, in order to evaluate their polarization conversion efficiency at different wavelengths. Finally, an example of an optical system based on GP lenses that is useful to characterize vortex beams and vector beams is discussed.

Paper AOP100-126

Development of magnetic/plasmonic nickel ferrite/gold nanoparticles covered with lipid bilayers for applications in combined cancer therapy

Authors: R. Rodrigues, I. Rio, E. Coutinho, P. Coutinho, University of Minho (Portugal)

The potential of nanosystems with combined magnetic and plasmonic properties for biomedical applications has been recognized. Magnetic nanoparticles can enable magnetic drug targeting and hyperthermia, while plasmonic gold nanoparticles ensure effective local heating (photothermia) using relatively low energies for gold excitation. Considering cancer therapy, the combination of magnetic and plasmonic capabilities in a single multifunctional nanosystem allows magnetic guidance and production of local heat, the latter promoting triggered drug release and synergistic cytotoxic effect in cancer cells (combined chemo/phototherapy) [1].

In this work, magnetic/plasmonic nanoparticles of nickel ferrite/gold were prepared and characterized, including core/shell nanoparticles (with a nickel ferrite magnetic core and a gold plasmonic shell) and nickel ferrite nanoparticles decorated with gold nanoparticles.

In order to develop applications in combined cancer therapy, the prepared nanoparticles were covered with a lipid bilayer, these systems being able to transport drugs. The heating capabilities of the nanosystems were evaluated through the fluorescence quenching of the dye rhodamine B incorporated in the lipid bilayer upon excitation with a light source. The developed multifunctional nanosystems have shown promising results for application combined cancer therapy (chemo/phototherapy).

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Paper AOP100-127

Epidemiology of vision problems in Europe: a Portuguese perspective

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The blindness and visual impairment are conditions with high impact on the quality of life of the populations. Nevertheless, those conditions should and can be avoidable if we act efficiently at the primary eye care level.

With this work, the authors will identify, with the existing evidence-based, the predominant visual problems responsible for avoidable blindness and visual impairment (severe to moderate), that affects the adult population in Western Europe, and extrapolating them to the Portuguese reality.

Specifically, the authors will comment on a study of Age Macular Degeneration performed in Portuguese Region of Cova da Beira and Castelo Branco nursing homes, present the Prevalence of the disease found, visual acuity and the knowledge of the disease among that population. Moreover, they will also address the new Portuguese National Strategy for Vision Health (2020-2030).

Paper AOP100-128

Evaluation of the optical properties of two different types of soft contact lenses: hydrogel and silicone-hydrogel

Authors: A. Ionescu, A. Talaveron López, J. C. Cardona, S. Lopez Sierra, A. Rodriguez-Aguila, J. Ruiz-Lopez, M. M. Perez, R. Ghinea, Univ de Granada (Spain)

Objective: The aim of this study is to benchmark the optical properties of two different types of contact lenses in the visible spectra using the Inverse Adding Doubling method.

Materials and Methods: Two types of hydrophilic contact lenses were analyzed: LC1 - daily replacement hydrogel - Hioxifilcon A and monthly replacement silicone-hydrogel - Asmofilcon A. Three different dioptric powers (n=6) were analyzed for each lens type (1.00 D,

-2.00 D, -3.00 D). The measurements of reflection and total diffuse transmission for specific wavelengths of the visible spectrum were made using an integrating sphere and an argon ion laser and a He-Ne laser. Transmittance, absorption coefficient and the reduced dispersion coefficient for each sample were obtained using the Inverse Adding Doubling method.

Results: The hydrogel and hydrogel-silicone contact lenses used in this study showed differences in transmittance, absorption coefficient and dispersion for the studied wavelengths of the visible spectrum. Lower transmittance, lower absorption and higher dispersion were found for daily replacement contact lenses - Hioxifilcon A than for monthly replacement contact lenses - Asmofilcon A. It has also been found that as diopter powers increase for both type of lenses, transmittance and absorption decrease and dispersion increases, which may have implications on the visual performance of these contact lenses.

Significance: Values reported in this study provide references and useful data for applications that require knowledge of the transport of light through these types of materials, with implications on the visual performance and optical quality that these material can provide.

Paper AOP100-129

Ocular optical quality dynamics during accommodation in subjects with accommodative dysfunctions

Authors: S. M. Franco, J. Gomes, Centre of Physics, University of Minho (Portugal)

Complaints of blurred distance vision after performing a near-vision task are common in the optometric practice. Several of these subjects showed no alterations in the optometric tests that are normally performed.

In this work a new technique to study the accommodative response to different stimulus is presented. Ocular accommodation is evaluated from ocular wavefront aberrations that are continuously measured during the response to different accommodative demands.

Several accommodative parameters can be computed from the collected data: accommodative response, lag of accommodation, latency, response time.

These parameters are computed for both accommodation and disaccommodation process and results are present for subjects with accommodative disorders before and after a visual therapy program was applied.

The results could help us perform an early diagnose, better understand the accommodative dysfunctions and objectively evaluate the results of vision therapy in the treatment of these conditions.

Paper AOP100-130

Variations of the optical properties of two types of contact lenses with dehydration

Authors: A. Ionescu, S. Lopez Sierra, R. Ghinea, J. C. Cardona, A. Talaveron López, J. Ruiz-Lopez, A. Rodriguez-Aguila, M. M. Perez, Univ de Granada (Spain)

Objective: The aim of this study is to analyse the effect of dehydration of contact lenses on their optical properties. Materials and Methods: Two types of hydrophilic contact lenses with different water content (57% and 40%, respectively) have been analyzed: LC1 - daily replacement hydrogel - Hioxifilcon A and monthly replacement silicone-hydrogel - Asmofilcon A. The measurements of reflection and total diffuse transmission for specific wavelengths of the visible spectrum were made using an integrating sphere and an argon ion laser and a He-Ne laser. Transmittance, absorption coefficient and the reduced dispersion coefficient for each sample were obtained using the Inverse Adding Doubling method. The level of dehydration (% of water content) of each contact lens with time was controlled by its weight.

Results: Statistically significant differences were found between the dehydration levels of Hioxifilcon A and Asmofilcon A contact lenses. The conventional hydrogel lenses dehydrate more quickly which leads to a greater and faster alteration of their optical properties. For both materials, reflectance increases due to scattering within the material and transmittance decreases due to increased absorption of the material as the material is dehydrated. These changes are most evident for daily LCs of conventional hydrogel.

Significance: The evaluation of the optical properties of the contact lens materials leads to a better understanding of how the material behaves, as well as offering quality control to ensure biosanitary well-being in the society. The knowledge of these properties has the potential to improve the comfort, functionality and biocompatibility of contact lenses

Paper AOP100-131

The influence of coloured lighting on visual acuity and visual contrast sensitivity

Authors: M. Gil, University of Minho (Portugal); J. M. Linhares, Centre of Physics (Portugal); S. M. Franco, Centre of Physics, University of Minho (Portugal)

The aim of this study is to assess how the exposure to different color LED illumination can affect the visual acuity (AV) and the visual contrast sensitivity (SVC). In addition, the discomfort glare induced by each illumination condition was also assessed through the subjective scale of De Boer.

Two groups of 10 subjects each were used. Group 1 - subjects with ages between 18 and 25 years and Group 2 - subjects over 50 years of age. Subjects with colour vision disabilities, internal opacities, ocular or systemic pathologies or previous ocular surgeries were excluded.

Observers only had as light sources the CSV-1000 lamps (mesopic conditions) and LED lamps at different colours. Subjects had the best possible correction placed. They were dark adapted for 5 minutes and the AV and SVC measured under glare conditions.

The analysed conditions were compared with the data obtained for the lamps of the CSV-1000, considered as the reference model. Improvements in the results obtained over the reference condition will be identified and proposed as preferential lighting conditions.

Paper AOP100-132

Development of drug-loaded magneto-sensitive liposomes investigated by fluorescence techniques

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Magneto-sensitive liposomes can be obtained by encapsulation of magnetic nanoparticles into liposomes or by the coverage of magnetic nanoparticles with a lipid bilayer. The so-called magnetoliposomes make possible to explore the synergistic effect between chemotherapy and magnetic hyperthermia in cancer therapeutics. Both aqueous magnetoliposomes (magnetic nanoparticles entrapped in liposomes) and solid magnetoliposomes (clusters of nanoparticles covered by a lipid bilayer), containing biocompatible magnetic nanoparticles, have been developed [1-3], exhibiting a superparamagnetic behavior and diameters below 150 nm. These nanosystems were successfully tested as nanocarriers for fluorescent potential antitumor drugs. Drug-loaded magnetoliposomes have shown the ability to interact by fusion with models of biomembranes [1-3] and to release the antitumor drugs in in vitro assays using human tumour cell lines [2]. Fluorescence-based methodologies, including Förster Resonance Energy Transfer (FRET), emission quenching and fluorescence anisotropy, have been used as valuable tools for this investigation.

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Paper AOP100-133

Nonlinear electrodynamics of two-dimensional crystals

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The discovery of graphene and other one-atom-thin crystals in 2000ies opened up a new era in material science – the age of two-dimensional (2D) materials. A variety of metallic, dielectric and semiconducting 2D crystals have been obtained which paved the way to build artificial, made layer by layer, devices with desired electrical and optical properties.

In graphene, the first discovered 2D crystal, electrons and holes have gapless energy dispersion and behave like relativistic quasi- particles with the vanishing effective mass. This leads to a strongly nonlinear electrodynamic and optical response of this material in the very broad frequency range from microwave and terahertz up to infrared and visible light frequencies. Moreover, the infrared nonlinear response of graphene resonantly depends on the charge carrier density, which can be electrically tuned by applying a gate voltage in the graphene field-effect transistor. The opportunity to electrically control the nonlinear crystal response is the unique property of graphene; it is not available in conventional (three-dimensional) nonlinear optical materials.

In this work we will give an overview of our recent results in the theory of the nonlinear electrodynamic effects in graphene, among which are the harmonics generation, four wave mixing, Kerr effect and other. A theoretical analysis of methods of measuring nonlinear properties of 2D materials, as well as results of first experimental demonstrations of the gate voltage tunable nonlinear graphene response will be discussed.

Paper AOP100-134

Temperature dependence of the drying process in polymer solutions observed by dynamic speckle detection

Authors: E. Stoykova, B. Blagoeva, L. Nedelchev, D. Nazarova, Institute of Optical Materials and Technologies (Bulgaria)

Dynamic speckle metrology can be applied to determine the speed of various processes in samples of industrial or biological nature. The method allows to identify regions of lower or higher activity on the sample surface through statistical processing of the speckle patterns formed on this surface under laser illumination.

In this paper, we study the influence of the substrate temperature on the drying process in polymer solutions leading to formation of thin photo birefringent polymer films. This would allow us to find the optimal temperature conditions in order to obtain smooth and uniform thin films for the shortest possible time. For this purpose, we record several sets of correlated in time speckle patterns of a transparent drop of azopolymer solution on a glass plate illuminated by laser light. The temperature of the glass substrate and respectively of the polymer solution is controlled by high-precision thermal stage. Using dynamic speckle metrology, we acquire two- dimensional maps of the structure function at different time lags.Thus, we obtain information about the speed of drying of the polymer solution depending of the substrate temperature. This data are further correlated with the optical quality of the dry polymer thin films.

Paper AOP100-135

Quantum fluid equations for atomic gases

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Although the quantum theory of the optical response of individual atoms to coherent light with frequencies close to electronic transitions and the fluid equations for a gas are well known and understood from first principles, they are developed independently of each other and therefore cannot be applied directly to describe many of the quantum collective and transport phenomena that occur in cold atomic gases, especially in what regards their interaction with optical pulses and beams. Few attempts have been made to derive a consistent formalism and theory that are capable to model this type of systems, and those which exist rely on the adaptation of several ad-hoc hypothesis and simplifications, such as space and time dependent density operators. This formalisms paves the way for the development of new simulation tools[1-3] and to explore new problems in nonlinear optics out of equilibrium[4-5].

This work sketches a novel formalism, which not only is more general and starts from basic principles of statistical quantum mechanics, but also recovers existing formalism and results for some limits.

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Hilight: a new simulation platform for advanced photonics

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We report on the development of HiLight, a new multiphysics simulation platform for advanced photonics with interactive modules[1-5] for the propagation of light in multitude of spatially structured optical media, including nonlocal and nonlinear media, optical lattices with atomic gases and plasmas, among others.

Conventionally the interaction between light and optical media is described in terms of the refractive index but the optical response of matter to coherent electromagnetic fields encloses an intricated combination of phenomena and feedback processes that become more evident in optical devices that combine nanoscale sizes, optical frequencies near atomic transitions of the media, short pulse durations and transport effects. Understanding, controlling and harnessing these phenomena is of paramount importance as building blocks for new technologies, such as nanophotonic and plasmonic devices for optical sensing and fully-optical information processing and transmission. The conventional simulation tools and supporting physical models based of electromagnetic wave and beam propagation fall short to address the completeness and specificity of the next generation of photonic engineering and applications and must integrate aspects such as the localized electromagnetic character of light in confined structures and the quantum and collective character of matter, and eventually of light itself[7-10]. Furthermore, to satisfy these requirements, the next generation of simulation tools must make use of massive computation resources, and employ advanced supercomputing and parallelization techniques, such as GPGPUs.

This paper focus on the current development of HiLight, the current simulation modules, their performance and the tests performed.

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Paper AOP100-137

Quantum dots/azo-dyes hybrid structures for sensing

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Quantum dots (QDs) are spherical semiconductor nanocrystals, whose optical properties can be tailored by changing their chemical composition and size. QDs based hybrid structures are widely used now as highly sensitive sensors owing to their perfect tunable optical properties.

1-2-pyridylazo-2-naphthol (PAN) can form chelate complex with zinc atom on the surface of CdSe/ZnS QDs. Luminescecnce of CdSe/ZnS QDs can be completely quenched by Förster Resonance Energy Transfer in QD/PAN complexes. We have demonstrated that PAN molecule can desorb from the QD surface leading to QD PL recovery in the presence of an analyte, which has high affinity to PAN. Recently it was shown that using porous polyethylene terephthalate track membranes for analyte pre-concentration is a potential way of detection of extremely low ion concentration.

Our five-year intensive study of the complexes has shown that they have serious shortcoming, namely new trap-states born because of PAN desorption from the QD surface. We believe these trap-states are the reason of new nonradiative channels in QDs, which efficiently compete with their excitonic luminescence. It makes complexes based on CdSe/ZnS QDs and PAN molecules useless in real sensor application.

Here we suggest a way of overcoming the limitation associated with trap-states. We demonstrate that replacing of CdSe/ZnS by ZnS QDs doped by Mn^{2+} makes QD luminescence insensitive to new nonradiative channels in the QD/PAN complexes due to fast energy transfer from ZnS matrix to Mn^{2+} in QDs. It opens the way to full potential of QD/PAN complexes in detection of extremely low ion concentration.

Paper AOP100-138

Fiber optic sensor for monitoring tangential and vertical forces for wheelchair application

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The presented work reports the architecture design, implementation and performance analyses of a fiber optic sensor for monitoring tangential and vertical forces in wheelchairs/patient interface. This sensor is composed by a biaxial in-line optical fiber sensor with two fiber Bragg gratings (FBGs), for the simultaneous measurement of these two forces. The solution presented stands out by the simplicity of its design and the outreach of its applications.

For the construction of this sensor, only one optical fiber with two FBGs was used, the two FBGs were placed in adjacent cavities composed by different materials, cork (FBG1) and hard polymer (PLA) (FBG2). Each of these cavities was posteriorly filled with epoxy resin. After its production, the sensor was calibrated for tangential and vertical forces. Following, it was possible to determine the sensitivity constants for each of the FBGs in the presence of each type of force. Using a system of two equations it is possible to differentiate the magnitude of each type of force, even when they are applied simultaneously. The results obtained in the new sensor were later compared with the results obtained by an electronic sensor, where a RMSE <0.1 was obtained, proving its efficiency and accuracy. Some sensors were applied in orthopedic wheelchairs cushions and these two types of forces were measured simultaneously.

Devices of this type are very important for the monitoring of abnormal tangential and vertical forces suffered in areas of greater contact for wheelchair users, to aid in the prevention and treatment of pressure ulcers.

Paper AOP100-139

A new approach to generating entangled light in integrated optics using ring resonators

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We present a proposal to generate entangled light in a ring resonator at high temperatures using parametric modulation instability produced by the control of the nonlinear optical properties of the ring material that supports a Hilbert subspace with reduced decoherence.

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Paper AOP100-140

Rogue waves in nonlinear optical media

Authors: A. Guerreiro, N. A. Silva, A. L. Almeida, I. S. Madureira, T. D. Ferreira, A. Pereira, Universidade do Porto (Portugal) and CAP/INESC TEC - Technology and Science and FCUP - Faculty of Sciences (Portugal)

This paper presents puzzling results obtained from simulation of the generation of Rogue Waves in nonlinear optical media governed by the Generalized Nonlinear Schrödinger equation (GNLSE) from an optical noise.

Rogue Waves were first described as high intensity and short-lived oceanic waves that appear to be formed randomly at high sea without warning to disappear without a trace afterwards. This type of waves can also be formed in other systems, such as nonlinear optical media, and despite having gained much interest in the scientific community in recent years, their exact nature and full understanding is still illusive. Several theories have been proposed, some based on the constructive interference of random waves, while others point to a nonlinear exchange of energy between waves similar to the notorious Fermi-Pasta-Ulam problem associated with recurrence. Given the difficulty in obtaining high quality experimental and observational data, many of the studies into Rogue Waves have been done computationally, but many of these still fail to have enough accuracy and resolution to clarify important aspects of the formation of these waves.

In our study we have implemented a solver of the GNLSE using GPGPU supercomputing capable of simulating extensive systems that support large populations of Rogue Waves with fine resolution and used it to investigate the statistical properties of these waves. The results surprisingly appear to contradict much of the intuition behind the models for Rogue Waves.

Paper AOP100-141

Artificial intelligence assisted nonlinear Fourier transform

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We present the development of a signal analysis module for the HiLight simulation platform that performs a Nonlinear Fourier Transform (NFT) assisted by Artificial Intelligence (AI).

The NFT was initially developed in combination with the Inverse Scattering method to analyze the propagation and spectral content of nonlinear signals and for fibre optics telecommunications using solitons. These techniques could only be applied to situations modeled by integrable nonlinear propagation equations, which combined with limited computational power available then and the appearance of other telecommunication technologies, resulted in a dying out of their importance. The recent resurrection of interest in nonlinear signals, either motivated by the identification of nonlinear dynamical processes in a multitude of systems (physical, biological, optical, etc.) or by the potential to exploit them in technological applications, renewed the importance of developing tools capable of identifying the nonlinear excitations in a signal, much alike the spectral decomposition of linear waves into harmonic components provided by the common Fourier transform.

This paper presents an optimized version of the NFT for systems governed by the Nonlinear Schrödinger equation (NSE) assisted by an AI that not only extends the applicability of this method to some non-integrable generalizations of the NSE but also allows retrieve the superparameters of this equation, making it applicable to analyze real world data, where the NSE is only valid approximately.

Paper AOP100-143

How many neurons does it take to solve the nonlinear Schrödinger equation?

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This paper reports on the development of an Artificial Intelligence (AI) module for the HiLight simulation platform consisting of a numerical solver of the time-independent generalized nonlinear Schrödinger equation (GNLSE) for bi-dimensional problems using Deep Learning. Once optimised, this module is able to provide solutions with increased expediency and reduced numerical noise, which amply surpasses the performance of standard numerical techniques. This type of solvers is of paramount importance to design and develop solid-state and nano-optical devices, to implement solvers based on Density Functional Theory (DFT) [1] for modelling quantum atomic systems, and to study the complex dynamics of out-of-equilibrium systems and/or many body systems [2] (e.g. Bose-Einstein condensates [3]), which remain hard to address even with the aid of supercomputing techniques and advanced massive computing platforms.

The recent revolution in AI brought about the development of extremely efficient methods to recognise patterns in large amounts of data, and lead to its widespread application in real-world problems and to an accelerated improvement in the performance of the supporting software and hardware, an example of which is GPGPU supercomputing. Solving partial differential equations (PDE) is a less known application of AI that is quickly gaining critical importance in scientific and engineering problems [4]. Exploiting these developments, our module is comprised of several deep neural networks (DNN) capable of learning from known solutions of the time-independent bi- dimensional GNLSE. This article also expands on the methods used to augment their training datasets, and the tests used to validate the results obtained by the DNNs.

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Paper AOP100-144

Analysis of Fizeau wedge with a non-air gap by plane wave expansion

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The optical interferential wedge or Fizeau wedge (FW) finds application in optical metrology, spectroscopy and laser technology. A conventional FW consists of two flat mirrors divided by a gap with linearly increasing thickness. A plane monochromatic wave falling on the FW generates an infinite number of plane waves both in transmission and reflection. The angular separation between these waves is given by twice the angle at the wedge apex while the amplitudes form a geometric progression with a common ratio given by two reflections inside the FW. As a result, the apex angle, reflection coefficients of the wedge coatings and the refractive index of the gap determine a unique interference pattern on both FW's sides.

Various FW applications require knowledge of its response to illumination by a laser beam with an arbitrary wavefront. Recently, we applied the plane wave expansion method to study transmission and reflection of an air-gap FW under illumination with a Gaussian beam. The essence of this approach is usage of the angular spectrum of the beam and the known FW response to illumination with a plane wave. In this study we propose FW description for the more general and frequently encountered case of a FW with a non-air gap. The developed algorithm is applicable to wedges with refractive indices different from 1 and illuminating beams with arbitrary amplitude and phase distributions. Comparison to the experiment is also provided.

Paper AOP100-145

Simultaneous measurement of refractive index and temperature using a double antiresonant hollow core fiber

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In this work, an inline sensor based on a double anti-resonant hollow core fiber is proposed for the simultaneous measurement of refractive index and temperature. The fiber, consisting of four silica capillaries with wall thickness of ~1.5 um and a cladding with a thickness of ~36.5 um, is spliced between two sections of single mode fiber. The spectral behavior, measured in transmission, results from the combination of different frequencies which enable the discrimination between the two parameters. The sensing head is subjected to refractive index measurements using aqueous solutions with different concentrations of ethanol. For a sensor with a length of ~10 mm, and considering the lower frequency signal, the sensitivity to refractive index is 384 nm/RIU, whereas for the higher frequency, the sensitivity attained is 5.6 nm/RIU. On the other hand, the sensing head presented a sensitivity to temperature of 25.5 pm/K and 27.9 pm/K for the higher and lower frequencies, respectively.

Paper AOP100-146

Studying the optical properties of carbon dots depending on the solvent type

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Carbon dots (CDs) are new luminescent nanomaterials, possess such advantages as simple and non-expensive synthesis and low citotoxity. Due to their exelent oplical properties, CDs are perspective in bioimaging, sensorics, photocatalysis, and photonic devices. Despite the large amount of literature devoted to CDs, the photophysical processes and electronic structure of CDs are still under discussion.

Here we investigate the optical properties of CDs prepared by hydrothermal method and then dispersed into 12 solvents with different polarity (ε): water, methanol, ethanol, butanol, isopropanol, dimethylformamide, acetonitrile, chloroform, carbon tetrachloride, xylene, toluene, hexane. With the decreasing of the polarity the bathochromic shift of the CDs' absorption band was observed. It was shown that CDs are poorly dispersed in solvents with low polarity. Furthermore the dissolving CDs in carbon tetrachloride lead to the appearance of the completely different optical responses of the sample, that may be attributed to a molecular fluorophore. The investigation of the photoluminescence decay showed that the longest lifetimes and highest intensity of photoluminescence is observed in polar solvents: alcohols, water, and dimethylformamide.

The obtained data revealed a strong dependence of the CDs' emission states of on chemical environment. Therefore, we assumed that the luminescence centers in the CDs are located near or on their surface. The CDs surface design with specific functional molecular groups opens up a possibility of tuning optical transitions and interaction of CDs with the surrounding medium, which may be applied in sensorics and biotechnology.

Paper AOP100-147

A Hermite-based approach to bone segmentation in CT images

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Computed tomography (CT) images of the human bone system are essential for evaluation of abnormalities and disease detection of the patients. Structural and anatomical information can be assessed with CT with the aim of performing diagnosis, planning and treatment evolution. Automatic segmentation can provide a fast, objective evaluation and quantification of the bone conditions. In this work, we propose a segmentation technique based on a multiresolution scheme consisting of a region growing method and the Hermite transform (HT). The HT provides a powerful mathematical tool which is useful for extraction of the image features. These are obtained through a set of Hermite coefficients. A seed or a presegmentation is used to initialize the region growing approach and coefficients of the HT are posteriorly employed to grow the initial shape. We have used Hermite coefficients up to second order. Edge, gray level and zero crossing information obtained with the HT are configured for the growing criterion. Several CT images were used for evaluation demonstrating the feasibility of the proposed method. Different metrics were employed for performance assessment and we have compared results of the proposed method against the manual segmentation.

Paper AOP100-148

Astigmatism correction in direct ophthalmoscopy

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Retinal imaging obtained with simple direct or indirect ophthalmoscopes, or fundus cameras are one of the most used techniques to check the healthy of human eyes. The eye presents different optical aberrations that introduce misfocus to the observed image. This misfocus is mainly caused by defocus and astigmatism, with contributions mainly of trefoil, coma and spherical aberration. Most of the systems for retinal imaging incorporate a knot for correcting defocus, and it is rare to see equipment able to correct also astigmatism, despite those involving Adaptive Optics. In the present work we present experimental data using an artificial eye in order to show how much astigmatism significantly reduces the quality of the retinal images obtained with a panoptic direct ophthalmoscope with two different magnifications (no magnification and a 6x magnifier). The setup consists of an USAF test (Thorlabs USAF test R1DS1P) acting as a retina of an artificial eye built with a plano-convex lens of 25.4mm and a pupil of 6 mm. Cylinder trial lenses (0.75D - 4D) placed between the panoptic ophthalmoscope and the artificial eye. We used an astigmatism correcting device built by our own to see the improvement in the images in case we correct the astigmatism with this device. The images were registered with an Ipad pro. The results show that small amounts of astigmatism do not distort significantly the images with low magnification but once we introduce magnification to the system or increase the astigmatism, it is important its correction for obtaining good quality images.

Paper AOP100-149

An image fusion scheme based on the hermite transform for nuclear medicine and magnetic resonance analysis

Authors: L. Barba Jimenez, L. Vargas Quintero , Universidad Popular del Cesar (Colombia); J. Calderon , Medicina Nuclear S.A. (Colombia); C. Torres Moreno, Universidad Popular del Cesar (Colombia)

Medical image modalities are fundamental for evaluation of the human body. The use of different image modalities has become necessary for evaluation of different conditions and diseases of patients. The analysis of anatomical and metabolic information, which is useful in a variety of anomalies detection, can be reached by combining image techniques such as nuclear medicine (NM) and magnetic resonance (MR). We propose a novel image fusion scheme based on the Hermite transform which allows to project an input image onto a set of base functions composed by the Hermite polynomials. The resulting coefficients provides information regarding the features of the input images. Our method is able to combine NM and MR at the level of the coefficients. Different fusion rules are used for the low and high order coefficients. Our method considers that both input images have been previously registered.
We evaluate the proposed approach using a set of brain MR and NM images. Several metrics were employed for quantitative performance. By comparing with other approaches of the state of art, we demonstrate the proposed method is highly competitive.

Paper AOP100-150

Prevalence of accommodative and binocular vision dysfunctions in a Portuguese clinical population

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Several studies have suggested that accommodative and non-strabismic binocular dysfunctions are commonly encountered in optometric practice. As the prevalence of these dysfunctions among the Portuguese population was not well known, this study evaluated its prevalence in a clinical population in the north of Portugal.

This study included 156 consecutive nonpresbyopic subjects that came to 2 Portuguese optometric clinics over a period of 3 months. The subjects agreed to participate in it and fulfilled the inclusion criteria. A complete visual exam including the measurement of visual acuity, refraction, near point of convergence (NPC), distance and near phoria, near and distance fusional vergences, amplitude of accommodation, monocular accommodative facility (MAF), relative accommodation and lag of accommodation was conducted.

One hundred fifty-six subjects with mean age of 24.9 ±5.3 years (from 18 to 35years old) participated in the study. Several clinical findings were significantly different from the expected values. Of the 156 subjects examined, 32 % presented a binocular vision and/or accommodative disorders accompanied or not by refractive errors. Of all the subjects, 21.1 % had accommodative disorders and 10.9% had a binocular vision dysfunction (table 5). Accommodative insufficiency (11.5 %) was the most prevalent disorder followed by convergence insufficiency (7.1 %) and accommodative infacility (5.8 %). The normal group represents the subjects who presented just a refractive error or no visual/ocular problems.

Our findings indicate that accommodative and non-strabismic binocular disorders are common among a clinical population of Portugal. Accommodative insufficiency was the most prevalent dysfunction presented in the studied population, followed by accommodative infacility and convergence insufficiency. The population studied showed values for amplitude of accommodation, PRA and MAF lower than the expected, while the results for the binocular vision exams presented values similar to the expected ones.

Paper AOP100-151

VEGA laser facility beamlines management for pump-probe experiments.

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VEGA system is a petawatt laser facility belonging to the Spanish Pulsed Lasers Center. This system allows the possibility to develop experiments for exploring the physics of linear and non-linear interactions of intense lasers with matter.

The Ti:Sapphire Chirped Pulse Amplification-based laser chain has three common frontend outputs at 1 PW, 200 TW and 20 TW. These beamlines have a central 800 nm wavelength, 30 fs temporal width and work at 1 Hz, 10 Hz and 10 Hz respectively.

This configuration, as well as the near future installation of an additional 1kHz, 600 μJ, 6 fs carrier envelope phase system synchronized with VEGA laser chain, opens the possibility of multiple pump-probe experiments that are not routinely found in other facilities.

Key components of such a research infrastructure are specific laboratory conditions management as well as reliable laser sources with proper pulse characterization.

The final goal is the achievement of enough beam quality and spatio-temporal synchronization precision for experimental users, together with high precision and shot to shot and day to day reproducibility.

In this work we present a fast description of the layout of the laser system and lab conditions. We also include a summary of improvement plans for different outputs synchronization and beam quality checking as well as first delay-management prototype calculations and preliminary experimental results.

Further highlights of operational experience obtained from the first user access call developed during 2018 and laser improvement plans are also presented.

Paper AOP100-152

Photoinduced increase of electron transfer efficiency of QDs based hybrid structures

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QDs are widely used in hybrid nanostructures as energy or charge donors. Formation of hybrid structures allows creating objects with unique properties. TiO2/QDs structures have a huge potential in bacterial infections theranostics; such interest is caused by antibacterial activity in wide spectral range due to effective electron transfer from QD to TiO2 nanoparticle. QDs based hybrid structures belong to the class of photoactivable systems, whose efficiency directly depends on the relaxation processes of electronic excitation in QDs. It is well known that light irradiation of QDs can lead to a decrease in the efficiency of nonradiative processes associated with trap states on the QDs surface, and could significantly affect the luminescence properties of QDs and the functionality of QDs based structures.

Here we have examined the effect of the photoinduced processes on the QDs surface on the ROS generation efficiency by TiO2/QDs multilayered structures. The optimal conditions of external radiation were matched with photoinduced increase of Quantum Yield of QDs luminescence by 85%. The effect of photoinduced processes in QDs on structures functionality has been estimated by their ROS generation using visible radiation. The analysis of photophysical properties of the pre-irradiated structures has shown the 150% growth of ROS generation efficiency because of up to 2.5 times increase in the electron transfer efficiency.

The results of our work confirm that preliminary photoinduced changes in the efficiency of nonradiative relaxation in QDs allows for significant increase of QDs based structures functionality.

Paper AOP100-153

Evaluation of photometer stability for illuminance interlaboratory comparison

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The recent revision of standard ISO 17025:2017 which is dedicated to promote confidence in operation of testing and calibration laboratories included the risk management approach in its new version. One relevant aspect of this inclusion is the validity of laboratory measurement results which is monitored by proficiency testing or interlaboratory comparison, so that the comparison result gives an evaluation of laboratory final product: the measurement result. The aim of this work is to present the evaluation of a photometer concerning its use as travel standard in an illuminance interlaboratory comparison.

The photometer stability was evaluated performing an illuminance calibration prior and after a road transportation among 3 different locations in Brazil which performed a travel distance of approximately 2250 km. The photometer illuminance calibration was realized using The Inverse Square Law with 6 measurement points ranging from 50 lux to 2000 lux. The calibration setup was prismatic optical branch with 1000 W FEL type luminous intensity standard lamp and a laser system for alignment. The luminous intensity standard lamp was operated at its reference current according the German National Metrology Institute (PTB) calibration report with a current uncertainty of ± 1 mA and the distance from the lamp to the photometer reference plane was measured with a 0.5 mm resolution measurement tape. The maximum illuminance calibration uncertainty obtained was 1.6%.

The photometer stability obtained after the road transportation was better than 0.6% which shall be considered as an uncertainty component in the illuminance interlaboratory comparison.

Paper AOP100-154

Solar coherence instrument based on digital micromirror devices, to measure spatial coherence of solar granules

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Since the first successful measurement of the diameter of a star by Michelson and Pease in 1921, optical interferometry has been used in a variety of contexts in astrophysics. Light collected by different telescopes is used to determine the interferometric visibility (modulation) of a given star which is then used, for example, to reconstruct its image or to determine its diameter.

The Sun is not a homogeneous light source. Besides the effects of limb darkening, it shows other surface phenomena, such as solar granules (due to surface convection). When measuring the interferometric visibility, these effects will add a contribution to the signal, even though most of the interferometry signal comes from the overall solar disk. Separating the contributions of solar granules and solar disk would enable a better measurement of the visibility and the observation other smaller contributions from within the granules. Moreover, in addition of measuring the interferometric visibility, other coherence functions could also be measured, namely, the complex degree of coherence.

We present the conceptual design of, we hope, a space-based optical instrument capable of measuring the degree of coherence from individual solar granular cells, the SCI or Solar Coherence Instrument. For design purposes, we use Hinode Solar Optical Telescope as a baseline and SCI as a focal plane instrument. SCI is based on Digital Micromirror Devices which enable robust dynamical selective imaging of individual granules and to implement a sequence of different base Young experiments to measure coherence.

Paper AOP100-155

Response of optically transparent pH sensing films to environmental conditions

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There are numerous applications for thin films based chemical pH sensors, such as biomedical, military, environmental, food, and consumer products. pH sensitive films fabricated through the ionic self-assembled monolayer technique are of high interest due to easy and environmentally friendly preparation technique. They can also be incorporated in multifunctional, conformal, flexible, and optically transparent lightweight and inexpensive sensors. The pH active films that we characterized were made of polyelectrolyte polyallylamine hydrochloride and water-soluble organic dye molecule Direct Yellow 4. The films were monitored in situ in various environmental conditions and for selected periods. Our results indicate that for optimized thickness and composition, the pH sensing films have extended lifetime response.

Paper AOP100-156

Quantum dot particles as anisotropic emitters for luminescent solar concentrator

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Semiconductor quantum dots (QDs) are highly efficient luminescent particles and can be used as light emitters for various applications, including luminescent solar concentrator (LSC). Among different types of colloidal nanocrystals, rod-like shaped nanocrystals (NRs) exhibit anisotropic light absorption and emission properties. The ability to control the position and orientation of these NRs and their collective alignment within the device is of a crucial importance. In fact, one of the approaches for increasing the efficiency of LSC involves enhancing the emission in the concentrator plate by using aligned anisotropic emitters. The study included synthesis of core-shell rod particles and the evaluation of their alignment grade in a functioning device. The degree of alignment was monitored by measuring the transmission as a function of time during the application of a time-dependent voltage. The transition from randomly oriented particles to their full alignment as a function of the electric field can be attributed to the permanent dipole of the NRs. The measurements of the operational devices were performed, revealing the dependency of different particle length and the minimum voltage necessary for an optimal alignment. Additionally, specific optical studies have been undertaken, with the aim of proving the actual increase in the directional emission. A custom-made setup was assembled, allowing a detailed analysis and comparison between varying QRs materials, as well as, the evaluation of the relative emission intensities in the operational devices, confirming a significant enhancement in directional luminescence efficiencies.

Paper AOP100-157

Magnetic circular dichroism spectroscopy of QDs/SPIONs nanosystems

Authors: A. O. Orlova, A. S. Bazhenova, Y. A. Gromova, A. Dubavik, V. G. Maslov, ITMO University (Russian Federation)

Development of cheap, stable, biocompatible and nontoxic multimodal agents for cancer theranostics is the mainstream in modern nanomedicine. Coupling bright luminescent species, for example A2B6 quantum dots (QDs), with magnetic material, like superparamagnetic iron oxide nanoparticles (SPIONs), is a direct way to realize a smart agent for early detection of diseases, drug delivery and magneto hyperthermia. In fact, today a huge number of different examples of QDs/SPIONs systems are known and examined. Despite successful tests of such systems in vitro or in vivo experiments in living cells and in animals, the challenge remains because of their tendency to aggregate in biological media. This challenge will be overcome by thorough examination of nanoparticle aggregation at each stage of formation of QDs/SPIONs systems.

Here we demonstrate that applying Magnetic Circular Dichroism (MCD) spectroscopy to biocompatible QDs/SPIONs systems not only allows studying their magnetic properties but can be successfully used for real-time monitoring of QDs/SPIONs systems aggregation during their formation. It opens a way to precise control over the colloidal stability of such complex systems based on magnetic materials and helps reach the stability of QDs/SPIONs systems in biological media.

Paper AOP100-159

A compact optical polarimeter for portable telescopes used for teaching astronomy

Authors: G. Topasna, D. M. Topasna, Virginia Military Institute (United States)

Using off-the-shelf optical components a simple, compact optical polarimeter is designed for use with portable telescopes. The polarimeter is optimized for telescopes with an aperture of 10 inches and an f/10 focal ratio, which are typically used in introductory observational astronomy courses. The polarimeter can be used to measure bright standard stars that have published polarization values for the degree of polarization and position angle in the V band. Aperture photometry is used to measure the stellar fluxes on CCD images, which in turn is used to determine the Stokes parameters that are used to calculate the polarization state of a star. By using the polarimeter, students gain insight into how stellar polarization is accurately measured and they become familiar with how Stokes parameters are used in practice.

Paper AOP100-160

Short-review about the safety and effectiveness of implantable collamer lenses for the correction of refractive errors

Authors: P. M. Serra, A. Sanchez Trancon, S. Cerpa Manito, Ophthalmologic Clinic - Vista Sanchez Trancon (Spain)

Implantable collamer lenses (ICL) for the correction of refractive errors is an expanding refractive surgery technique consisting of the implantation of a collamer lens in the posterior chamber of the eye. Although the safety and effectiveness have been demonstrated, other issues, for instance, related to lens sizing are still under debate.

This literature review analysed published articles for the newer version of the STAAR Visian ICL EVO4b. The available evidence is discussed regarding the techniques and methodologies used for determining the size of the ICL; the safety of the technique; and the effectiveness of the technique in correcting the refractive error and protecting against secondary effects observed in refractive surgery.

The data published showed there are various methodologies and techniques used for predicting the lens position, which has a direct influence on the size of the lens chosen, but all have limited prediction ability. With respect to the ICL safety, there is a trend towards a decreasing number of complications, but evidence for long term complications is still poor. Regarding the effectiveness of the treatment, the ICLs are predictable in the correction of moderate to high ametropias, but the presence of photic phenomena is reported.

Given the data published, ICL is an effective refractive technique for the correction of ametropias. The short term safety is good, especially if the lens is correctly sized for the eye, however, long-term safety still requires investigation. The methodology used for sizing still requires improvement, especially regarding the techniques and parameters used for calculation.

Paper AOP100-161

Optical fiber tools for single cell trapping and manipulation

Authors: A. d. Rodrigues Ribeiro, 4DCell (France); A. Guerreiro, INESC TEC (Portugal); J. Viegas, MASDAR (United Arab Emirates); P. Jorge, INESC TEC (Portugal)

Through over 47 years of existence, the field of optical trapping has found no restrictions in extending across natural sciences, while fomenting innovative research. Currently, optical trapping setups rely on spacious and expensive microscopes, adapted to accommodate extra optical components to produce the desired optical trapping fields.

Nevertheless, optical fibers are an attractive replacement o□ering compact and low cost solutions. Scaling down optical manipulation implicates transforming the optical fiber tips into special micro structures enabling the desired trapping by suitable intensity patterns (TIP). This presentation will describe the development of optical fibers as platforms to produce adequate TIPs for manipulation of cells and micro particles. Along the presentation, the design, fabrication and test of the TIPs will presented and discussed. In particular, the presentation will focus on the two fabrication methods used, namely photo-polymerization and focused ion beam milling and the outcomes achieved.

Paper AOP100-162

Estimation of the germination percentage of coffee seeds by means of dynamic speckle image processing

Authors: E. Benjumea, F. Vega, C. Torres, Univ Popular del Cesar (Colombia)

The determination of the germination capacity of coffee seeds is a great concern for coffee growers. The slow germination of the seeds and the use of traditional methods of estimation (sowing of samples of a population) lead to the investment of long intervals of time in it, generally of one to two months. Additionally, the conditions of transport and storage, and the high sensitivity of the seeds to humidity and temperature affect their germination capacity. In the present work, the analysis of the temporal evolution of the speckle diagram of coffee beans was carried out to establish the presence of live embryos in seeds in short time intervals (minutes). The implemented system consists of a CMOS camera of a cell phone for the acquisition and transmission of the images of size 720x480 pixels, a computer for the management, reception and processing of the same, a wireless local area network, a He-Ne 633 laser nm with 10 mW of power as a coherent light source, an optical diffuser and an aluminum surface for the placement of the seeds. The study showed satisfactory results to determine how many and which seeds germinate from a given total. The use of the proposed system reduces the time of estimation of the germination percentage from months to minutes. In addition, this research opens the doors to future projects for classification of coffee seeds by mechanical systems, and to crop productivity prediction projects.

Paper AOP100-163

Image filtering using the discrete cosine transform and symmetric convolution over finite field

Authors: J. M. Vilardy Ortiz, L. Barba, C. O. Torres , Universidad Popular del Cesar (Colombia)

In this work, the discrete cosine transform (DCT) and the symmetric convolution are implemented over a specific finite field with the purpose of filtering images. The finite field is a finite set of integer numbers where the basic math operations are performed using modular arithmetic. The image filtering process is described and synthetized in VHDL code over the finite field with an order given by the Mersenne prime number 8191, a large enough finite field to avoid overflow. The development of the VHDL code for the image filtering over the mentioned finite field are performed using the HDL Coder in Simulink. The quality of the resulting filtered image using the DCT and symmetric convolution over finite field is much better in comparison with the resulting filtered image using the linear convolution over real numbers. The proposed image filtering do not require any rounding and do not introduce computational noise.

Paper AOP100-164

Image encryption based on the discrete sine transform over finite field

Authors: J. M. Vilardy Ortiz, Universidad Popular del Cesar (Colombia)

We propose to use iterative discrete sine transform (DST) over finite field in order to encrypt and decrypt images. The finite field is a finite set of integer numbers where the basic math operations are performed using modular arithmetic. The finite field used in the encryption process has an order given by the Mersenne prime number 8191 and the description and synthesis in VHDL code of the encryption and decryption processes over the previous finite field are performed using the HDL Coder in Simulink. The encrypted image presents an uniformly distributed histogram. The security keys is composed by 64 integers with thirteen bits for each integer. The key space of the proposed encryption process is larger. The previous features of the security system allow a better protection of the encrypted image against brute force and statistical analysis attacks.

Paper AOP100-165

Raman spectroscopy and diffuse reflectance of biomass soot samples

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In this work, soot obtained through the combustion of three types of biomass is analyzed as low cost coatings for solar energy applications. These materials are obtained by incomplete combustion of pine resin, firewood in a hearth and sugarcane.

Raman spectra present the characteristic D and G bands related to disordered graphite at 1350 cm-1 and homogeneous graphite at 1580 cm-1 for the three investigated samples. Band intensity peaks and its widht can be employed to determine the amount of carbon present in soot samples. On the other hand, curves of diffuse reflectance have low spectral values of about 0.025, indicating that these materials are highly absorbent. Besides, it was found that pine resin soot and wood soot show a similar spectral behavior; in UV-VIS, the reflectance increases exponentially while in the IR zone it nearly constant. On the contrary, sugarcane soot samples shows a linear increase throughout the analyzed spectral range. Differences between the reflectance curves are related to the elemental composition of each type of investigated sample.

Paper AOP100-166

Unscrambling complex sample composition, variability and multi-scale interference in optical spectroscopy

Authors: R. Costa Martins, INESCTEC (Portugal)

This work relates to big data self-learning artificial intelligence methodology for the accurate quantification of constituents and classification of samples from spectral information, where complex composition, variability and multi-scale spectral interference is present. Multi-scale interference and convolution, which is highly severe in complex samples, leads to the observation of fragmented and diffused information along the spectra. This drawback has prevented the application of optical spectroscopy to areas where very low analytical error is paramount, such as health care.

This work presents the breakdown of highly complex biological spectral signals into high dimensional feature spaces, where each sub- space is correlated with both a specific constituent concentration or categorical condition. The developed unsupervised artificial intelligence is able to establish its own knowledge base when new data is fed by performing feature space transformations, searching directions of co-variance and optimizing local composition-spectral correlations. This method allow the artificial intelligence to establish knowledge maps of both quantifications and classifications, finding across the feature space data, dimensions that allow a correspondence between constituents composition and spectral bands variance. Moreover, a similar approach is derived for defining the convex hull regions of different classes. Such results in the creation of knowledge maps for both quantification and classification, providing high accuracy quantifications and classifications. A benchmark against state-of-the-art chemometrics and artificial intelligence is provided.

Paper AOP100-167

Photorefractive properties of lithium niobate crystals studied by Raman spectroscopy

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Lithium Niobate (LiNbO3) crystals are one of the most highly investigated crystals among photorefractive materials, due to the versatility of this material for a large number of applications such as; phase-conjugation, holographic storage, frequency doubling, SAW sensors or else electro-optic modulation.

Series of Raman measurements were carried out on iron-doped lithium niobate crystals with different compositions in order to characterize structural, optical and electric properties. Spectra gave possibility to release information about site occupation of iron ions in the crystal lattice. Thus, we have focused on the behaviour of the linewidth of the A1[TO1] Raman mode that allows to evaluate compositions of samples. Finally, we performed time dependent Raman measurements that leaded to the determination of saturation values of the photo-induced space charge field depending on crystal composition.

Paper AOP100-168

FIR Tamm polaritons in a microcavity with an incorporated graphene sheet

Authors: J. Silva, University of Minho (Portugal)

Tamm polaritons (TPs) are formed at the interface between a semi-infinite periodic dielectric structure (Bragg mirror) and another reflector. They result from the coupling between optical Tamm states (OTSs) and elementary excitations in the materials that form the interface, such as metal plasmons or semiconductor excitons.

Here, we discuss the formation of TPs in the far-infrared spectral range, in the optical-phonon reststrahlen band of a polar semiconductor such as GaAs, attached to a Bragg reflector (BR). Their dispersion relation and the frequency window for the TP existence are calculated for a GaAs-BR interface. Microcavity structures containing a gap between the two reflectors are also considered, including those containing an inserted graphene layer. The possibility of tuning the TP states by changing graphene's Fermi energy is demonstrated. The tuning efficiency is discussed in connection with the location of the inserted graphene sheet.

Paper AOP100-169

Harmonic generation in 2D materials

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Photonic devices still greatly rely on electronics for operation and integration, this fact constrains the levels of performance and applicability of these technological applications. One key objective of photonics research at the present time is the development of all-optical devices and for this type of structures Nonlinear Optical Effects (NLO) are fundamental. As photons do not interact with themselves (at least in the optical region), the only way to make a photon-controlling-photon device is somehow changing the propagating media. Light is used to induce controlled changes in the dielectric properties of the media where it propagates; consequently, the propagation of this same light field, or other with different characteristics, is also altered in a very controllable way. However, this is only possible if the media possesses (sufficient) NLO process efficiency. The use of 2D materials for light modulation provides an increase in performance while compared with silicon-based structures [1, 2].

In this communication, we show some results for harmonic generation in 2D materials. We also explore the layer dependence of the NLO properties of these crystals which, in tandem with controllable fabrication techniques, enables the tailoring of these materials for specific applications and their integration in photonic devices [3, 4, 5].

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Paper AOP100-170

Functional metamaterials for optical sensing of hydrogen

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We present the design, fabrication and optical characterization of functional metamaterials for optical sensing of Hydrogen based on inexpensive self-assembly processes of metallic nanowires integrated in nanoporous alumina templates[1-5]. The optical properties of these materials strongly depend on the environmental concentration or partial pressure of hydrogen and can be used to develop fully optical sensors that reduce the danger of explosion.

Optical metamaterials are artificial media, usually combining metallic and dielectric sub-wavelength structures, that exhibit optical properties that cannot be found in naturally occurring materials. Among these, functional metamaterials offer the added possibility of altering or controlling these properties externally after fabrication, in our case by contact with a hydrogen rich atmosphere[9-11]. This dependency can be used to design[6-8] and develop[1-5] optical sensors that respond to this gas or to chemical compounds that contain or release hydrogen.

In this paper we present some designs for hydrogen functional metamaterials and discuss the main parameters relevant in the optimization of their response.

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Paper AOP100-171

Photorealistic ray-traced visualization of the compound insect eyes

Authors: H. Lee, W. Lee, Hanbat National Univ (Korea, Republic of)

The compound eye mechanism of the insect has been known to its characteristics of wide field of view and fast response. And a few previous researches showed the massive and large scale sensor integration or its working principle such as a simplified prototype. However, the real biomimetic and optical device is not realized yet because of the applicable design to the industry and manufacturing difficulty. In this study, our approach is to make a virtual compound eye mechanism on the computer using visualization technique based on the photorealistic ray-tracing as the optical design tool. All eyeball of the dragonfly is modelled with a sphere of the diameter 0.1mm. In the entire elliptic eye, the length and height is about 3mm and 2mm, respectively. All micro eyeballs have the redundant refraction images, which are transferred to the photoreceptors through the total reflection function of the following crystalline cones, which are exactly different with the single lens camera imaging such as human eye. For the computational ray-tracing by several thousands of microstructures in micro optics, the configuration is oversized automatically only during rendering and later the image is fit to the real size of computer model. Finally this virtual compound eye can show the converted image of the reference image captured by high quality of single lens camera, which is combined by the thousands of micro eyeball, crystalline cone, and photoreceptor together. And more it can reflect interactively the design change of optical configuration considering the manufacturing process.

Paper AOP100-172

Double trace autocorrelator for precise measurement of pulse front tilt in a high power laser system

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The 3D characterization of ultrashort, ultraintense laser pulses is a topic of great interest. Spatio-temporal distortions are very frequent in ultrafast optics and can assume a wide range of configurations, creating the need for dedicated diagnostics capable of a full measurement in both domains. One of the most commonly found distortions is pulse front tilt (PFT), that is, the pulse front is not parallel to the wavefronts, such that the time of arrival of the pulse peak varies across the pulse aperture. In particular, in high power lasers based in chirped pulse amplification PFT may lead to a dramatic decrease in the focused intensity.

In this work, we describe the design and demonstrate the operation of a single shot autocorrelator capable of measuring independently and simultaneously the duration and the PFT of ultrashort laser pulses. This device is highly versatile, self-calibrating, exhibits a high resolution and is able to detect the presence of PFT in unknown pulses, providing instantaneous feedback about their magnitude and signal [1].

We demonstrate the use of this autocorrelator for the measurement and characterization of the PFT induced by beam defocusing at the input of a large aperture, single pass grating compressor of a high power laser.

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Paper AOP100-173

Application of a novel LIBS prototype as an analytical grade tool for Li quantification in pegmatite samples

Authors: D. Guimarães, INESC TEC (Portugal); M. Ferreira, INESC TEC (Portugal) and Faculty of Sciences of the University of Porto (Portugal); R. Ribeiro, C. Dias, A. Lima, Faculty of Sciences of the University of Porto (Portugal) and ICT - Institute of Earth Sciences (Portugal); R. Martins, INESC TEC (Portugal); P. Jorge, INESC TEC (Portugal) and Faculty of Sciences of the University of Porto (Portugal)

In the past 10 years, hard rock lithium (Li) production has been increasing significantly of total Li supply due to green energy storage. In order to meet the world-wide demand, particularly for batteries in the Electric Vehicle Industry, there is a need to develop new instrumentation that minimize the footprint of laboratorial analyses. It is crucial to be able to perform a high throughput, accurate, at-line, chemical analysis to support the localization of new resources. Currently employed analytical methods can't detect light elements such as Li (X-ray fluorescence), or require complex expensive techniques (e.g. Inductively Coupled Plasma Mass Spectrometry).

Motivated by this, our team developed a high-resolution advanced spectroscopy Laser Induced Breakdown Spectrometry (LIBS) prototype that enables real time identification and analytical grade Li quantification in lithiniferous rocks.

Samples were collected from Mina do Barroso (Portugal), claimed as Western Europe's largest spodumene Li discovery. Over 50 samples from a reverse circulation drill were collected, one for each meter interval. All samples were dried, milled and pressed into pellets which were analysed by LIBS.

For quantification, 2 models were used: linear models obtained with the intensity of selected Li spectral lines and advanced chemometrics methods. These results were compared and checked against the results by a certified laboratory.

The LIBS prototype was able to successfully quantify and detect Li even in low quantities (~200 μg/g), enabling to build a fast profile of Li distribution. This is of enormous geological importance and makes this instrument a competitive alternative to traditional methods.

Paper AOP100-174

"Unipolar photonics": cross-gap, self-oscillating light emission in GaN/AlN and InGaAs/AlAs RTDs at room temperature

Authors: E. R. Brown, Wright State Univ (United States)

InP-based resonant-tunneling-diode (RTD) oscillators have advanced beyond the 1.0 THz barrier and are currently enabling new THz systems applications, especially in wireless communications and radar. In this presentation, we will address our recent discovery of a new RTD-type optical emitter from the hexagonal GaN/AlN materials system. Because of the huge intrinsic polarization fields at the GaN-AlN interfaces, these RTDs are more challenging than their cubic GaAs and InP counterparts. This required a complete redesign through rigorous modeling to overcome asymmetries, as well as process and growth challenges. Over the past 3 years, we have realized the first reported stable, room-temperature NDR in GaN/AlN RTDs, with very high peak current densities (>> 2×105 A/cm^2), enabling up to >>100 GHz oscillation and ps switching in the wide bandgap material system for the first time. The GaN/AlN RTDs emit strong near-UV radiation at the GaN bandgap, which has been explained by resonant-, interband- "co- tunneling", and offers a semiconductor-based photonic technology which requires no p-type doping. The universal nature of this new mechanism has also been established through near-IR light measurements made on more traditional In0.53Ga0.47As/AlAs-on-InP RTDs. The potential for high-efficiency LEDs and high-speed laser diodes will also be addressed, as will the reality of a self-oscillating light source utilizing the inherent NDR region of the RTD-LED structures.

Paper AOP100-175

Simulating particle influence on silicon nitride strip waveguide single-mode parameters

Authors: M. Baumgart, J. Pribosek, A. Tortschanoff, Carinthian Tech Research AG (Austria)

Air quality monitoring is an important tool to identify dangerous pollutants, to support personal health and to achieve an eco-friendly environment. Detecting and classifying particles over a wide range of types and sizes is essential for precise air quality determination. Especially the detection of nano-particles is challenging due to their small sizes. Optical waveguide-based detection principles look promising for nano-particle detection. The feasibility of a strip waveguide for this task is examined using finite element method (FEM) based simulations in this study. The simulation model is built up in 3D using the COMSOL Multiphysics® platform and according simulations were performed using the capabilities of COMSOL's Wave Optics module. First, the waveguide geometry parameters were varied to identify suitable geometries for single-mode wave guidance of the TE00 and TM00 modes. The geometries with their according effective wave index as well as the evanescence field ratio (EFR) are reported. In a second step, the particle influence on suitable waveguide geometries is investigated for spherical particles of radii from 50 to 500 nm. The particle position and its material are varied as well. Mainly the intensity and phase changes of the single-mode wave introduced by the presence of a particle are analyzed. Additional, the underlying physical effects are discussed using electromagnetic wave theory. The results show non-linear and non-monotonic behavior and give substantial input to understand basic particle interaction with waveguide structures. Furthermore, they provide helpful knowledge for designing waveguide-based particle detectors.

Paper AOP100-176

Multimodal optical coherence tomography

Authors: W. Drexler, Center of Medical Physics and Biomedical Engineering, Medical University Vienna (Austria)

In the last 25+ years optical coherence tomography (OCT) has established itself as a unique non-invasive, optical medical diagnostic imaging modality, enabling unprecedented in vivo cross-sectional tomographic visualization of internal microstructure in a variety of biological systems. Ophthalmology has been the most successful and commercially most active medical field for OCT so far, but several other OCT applications, e.g. in cardiology, dentistry, gastroenterology or dermatology, are on the verge of expanding their market comparable to or larger than that of ophthalmology.

Especially in the last decade ultrabroad bandwidth light sources as well as spectral/frequency domain OCT detection technology enabled three-dimensional ultrahigh resolu¬tion OCT with unprecedented axial resolution, approaching resolution levels of con¬ventional histopathology, enabling optical biopsy of biological tissue. Furthermore emerging swept source laser technologies and parallel or full-field OCT techniques enabled multiple millions of A-scan rates per second, allowing large area OCT scans with high definition sampling, investigation of dynamic processes or four-dimensional (3D over time) imaging.

In addition, extensions of OCT are under development that should provide enhanced contrast or non-invasive depth resolved functional imaging of the investigated tissue, including extraction of birefringent, spectroscopic, blood flow or physiologic tissue information. These extensions of OCT should not only improve image contrast, but should also enable the differentiation and early detection of pathologies via localized functional state.

Recently OCT has also been combined with different complementary imaging technologies (photoacoustics, CARS, multi-photon microscopy, fluorescent imaging) to hybrid/multi-modal approaches to compensate fundamental limits of OCT in order to significantly enhance its performance towards metabolic and molecular imaging.

Paper AOP100-177

Lidar techniques for atmospheric aerosol remote sensing

Authors: A. Comerón, C. Muñoz-Porcar, F. Rocadenbosch, A. Rodríguez-Gómez, M. Sicard, Universitat Politècnica de Catalunya (Spain)

Although they have been around since shortly after the first lasers were developed, the use of radar lasers or lidars (lidar is an acronym for “light detection and ranging” turned word) has been fostered in the last 30 years by the conjunction of technological advances in laser sources and photodetectors on the photonic side, and of increased data storage availability and the ability to run software for controlling complex systems on the computer technology side. Lidars extend the basic principles of radar to the optical range of wavelengths and, because the relatively strong interaction between radiation in this spectral range and molecules and particulate matter in the atmosphere, they are a choice instrument for range-resolved atmospheric sounding. Lidars are an important tool for research on atmospheric aerosols (suspended particulate matter). This research is important for several reasons, among which the impact of aerosols on the Earth radiative budget through both their direct effect in scattering and absorbing radiation and their indirect effect because of their influence in cloud formation and precipitation. Lidar measurements of vertical profiles of atmospheric aerosol properties in coordinated networks is playing a crucial role in quantifying and constraining these effects, which, because the high temporal and spatial variability of the aerosols, are difficult to model. Aerosol vertical profile measurements can also be used as a proxy for important meteorological variables, like the mixing layer height, which has also influence on the dilution of pollutants in the atmosphere and eventually on health issues. This talk will present the basics of the use of photonic technologies and techniques to build and operate advanced lidar systems for aerosol profiling and the range-resolved retrieval of its optical properties.

Paper AOP100-178

Polarisation-sensitive optical coherence tomography: what's changed?

Authors: D. D. Sampson, Univ of Surrey (United Kingdom)

Polarisation-sensitive versions of optical coherence tomography, PS-OCT for short, date back to the inception of the field in the early 1990s. Alteration of the polarisation state of light by biological tissue is intrinsically appealing as a source of contrast, and polarised-light microscopy is an established field. Features such as the extent of fibres, such as collagen or muscle cells, and their sub-resolution alignment, and the shape of scatterers such as cells, are readily probed by such methods with resolution and on length scales that lend themselves to translational applications such as tumour and burns assessment and wound monitoring. Why has PS-OCT, then, not made much of a mark to date? This state of play has started to change. Our first foray into PS-OCT was to propose depolarisation as a surrogate for multiple scattering in 2007, but since then we have focused on en face imaging of birefringence magnitude and optic-axis orientation. Our exploration began in muscle tissue, with images of birefringence averaged over 500 μm-thick sections in normal and muscular dystrophy mouse models, showing great contrast enhancement over OCT alone. We have latterly refined our methods dramatically to enable high-axial-resolution (<15- μm) parametric imaging in catheters and needles, focusing on airway smooth muscle in asthma and human breast cancer. We expect polarisation-based contrast to demonstrate great advances over the coming years and in this talk we will explain why.

Paper AOP100-179

THz frequency combs in graphene field-effect transistors

Authors: H. Terças, Instituto de Plasmas e Fusão Nuclear (Portugal)

A suspended graphene sheet is subjected to a gate potential, which controls the local electronic density. Additionally, a bias potential between the source and the drain is applied, making the Dirac cone to tilt and therefore allowing a current. In the presence of a gate potential, the local plasmon dispersion relation is that of shallow waters. If proper (asymmetric) boundary conditions are applied, then a dynamical instability can develop in the system (Dyakonov-Shur instability). It turns out that such instability is responsible for the collective "shaking" of the electron gas, leading to density fluctuations of the order of 100%. This means that the graphene electrons act as a half-plate antenna, radiating in the THz range. A spectral analysis of the emitted signal shows that a series of equally separated peaks appear in the range of 1-10 THz, showing that we are in the presence of a THz frequency comb. Moreover, by determining the far-field properties of the radiation, we can observe that it exhibits appreciably large values of both spatial and temporal coherence, paving the venue for a novel method to produce low-power THz laser in integrated-circuit technologies. The advantage in respect with previous schemes advanced in the literature is the fact that no external laser sources are needed, making a all-electronic solution much more compact and physically robust.

Paper AOP100-180

Tuning the properties of surface magnon-polaritons on a ferromagnet using a graphene sheet

Authors: A. T. Costa, Y. V. Bludov, M. I. Vasilevskiy, N. Peres, University of Minho (Portugal)

We study the electromagnetic response of a ferromagnetic slab covered by a graphene sheet. At optical frequencies the response is dominated by magnon-polaritons propagating along the surface of the ferromagnet. We show that the dispersion relation of the surface magnon-polaritons (SMP) can be changed dramatically by modest changes in the conductivity of the graphene sheet, which can be easily controlled electrostatically. For a wide range of parameters the SMP have negative group velocity. This indicates that the direction of energy flow can be tuned electrostatically. The effects of changing the equilibrium direction of the magnetization on the properties of the SMP are also investigated.

Paper AOP100-181

Lidar imagers for automated vehicles: an overview

Authors: S. Royo, Univ Politecnica de Catalunya (Spain); J. Riu, Beamagine (Spain)

Lidar imagers have been placed in the spotlight by the advent of automated driving. If cars are going to sense its complex environment in the coming years, a number of sensors covering different needs are expected to be implemented. It is becoming evident that the performance and measurement principles contributed by lidar sensors are in general complementary to those of radars and conventional 3D imagers, both in short range and in long range applications. This talk will introduce the different types of lidar imagers currently competing in the field, their main limitations, the overview of the key components, and the different strategies which may be pursued to deliver a full lidar image. We'll review the state of the art of the available key components, and outline its main limitations. Finally, we'll present our efforts towards the development of a high speed, high resolution lidar imager. We'll also briefly touch some of the key steps which took us from a research-oriented PhD Thesis to a profitable spin-off company.

Paper AOP100-182

3D prototyping of a fiber Bragg grating vibration sensor for power transformers

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Vibration sensing is an important subject in industrial and electrical engineering. Conventional electric sensors present major drawbacks in harsh environments applications due to the sensitivity to electromagnetic interference. Optical fiber sensors are being explored as an alternative due to their electromagnetic interference immunity, compactness, capability of multiplexing and high temperature and corrosion resistance. Fiber Bragg gratings (FBG) are one of the most explored sensing structures in literature with applications in strain, curvature, temperature, and vibration sensing. The sensitivity of the sensor can be tuned using embedding structures such as cantilevers, a very studied structure, especially important in electrical engineering for power transformers. Fast design and prototyping pushed the integration of 3D printing technology and of finite element method (FEM) analysis with fiber sensors, allowing a fast optimization and prototyping of the structure.

In this work, several sensing structures with an attached FBG are designed and tested for vibration detection in power transformers. An FEM analysis was performed to evaluate the response of the structures to vibrations up to 500 Hz, optimizing the FBG positioning. A 3D printer with a resolution of 0.2 mm was used for prototyping two different cantilever-based structures and the FBGs were attached at the maximum strain points. Both structures were tested to vibrations from 10 to 500 Hz.

Paper AOP100-183

Modification of multiphoton emission properties of single quantum dot due to the long-range coupling with plasmon nanoparticles in thin-film hybrid material

Authors: V. Krivenkov, S. Goncharov, P. Samokhvalov, National Research Nuclear University MEPhI (Russian Federation); A. Sanchez-Iglesias, CIC biomaGUNE (Spain); M. Grzelczak, Donostia International Physics Center (Spain); I. Nabiev, Laboratoire de Recherche en Nanosciences, LRN-EA4682, Université de Reims Champagne-Ardenne (France); Y. Rakovich, Centro de Física de Materiales (MPC, CSIC-UPV/EHU) and Donostia International Physics Center (Spain)

Semiconductor quantum dots (QDs) are known for their unique photophysical properties and, in particular, their ability to multiphoton emission caused by recombination of biexcitons. However, the luminescence quantum yield (QY) of biexciton states is relatively low due to the fast Auger non-radiative process. Plasmonic nanoparticles can significantly modify the optical properties of nearby QDs and, thus, present an attractive opportunity to accelerate the radiative rate of QDs. In this study we demonstrate the distance-controlled enhancement of the biexciton emission of single CdSe/ZnS/CdS/ZnS QDs due to their coupling with gold nanorods (GNRs). Specifically, using photon correlation spectroscopy, accompanied by time-resolved luminescence studies of the same single QD before and after coupling with GNRs, we obtained an confirmation of the plasmon-mediated increase in the QY of biexciton states. By changing the separation between the QD and GNRs, we have demonstrated that the enhancement of the biexciton emission decreases monotonically with increasing distance, but remains detectable even at distances of 170 nm. We explain this enhancement by the efficient coupling between the biexcitons in QDs and the GNRs plasmons, which leads to a transition from the prevailing contribution of resonance energy transfer at small separations between QD and GNRs and the predominant influence of the Purcell effect at longer distances. Our findings constitute a reliable approach to managing the efficiency of multiphoton emission over a wide span of distances and can be used for the development of new materials, structures and devices with applications the fields of optoelectronics, optical computing and quantum technologies.

Paper AOP100-184

Collective modes of self-assembled supercluster metamaterials: towards label-free sensing

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Plasmonics offers exceptional control of light on nanoscale dimensions through strongly enhanced light-matter interactions. And yet, the use of plasmonic structures in sensing schemes has been limited by the extremely small modal volumes, ohmic losses and the cost of their fabrication.

Recently, self-assembled superclusters of chemically-synthesised metallic nanoparticles have been proposed as means of overcoming some of these limitations [1,2]. In this work, the existence of collective modes in such supercluster metamaterials is successfully verified. This is achieved by using 3-dimensional Raman tomography to map the collective modes of the superclusters and by comparing them to electric and magnetic field enhancement maps, obtained from finite-difference time-domain calculations. Good agreement is obtained for different supercluster sizes and excitation wavelengths.

The high density of hot-spots inside the superclusters and their porosity, combined with the internalisation and tunability of their collective modes, hold great promise for their use in label-free sensing. To demonstrate the potential of this material system for sensing applications, proof-of-principle experiments were performed involving the use of a single supercluster to follow the de- protonation of a reporter label attached to the constituent nanoparticles' surfaces.

[1] V.A. Turek et al. ACS Photonics,3, 35 (2015)
[2] A. Lauri et al. ACS Photonics, 4, 2070 (2017)

Paper AOP100-185

Light-matter interaction: plasmon-exciton hybridization in strong coupling regime

Authors: Y. P. Rakovich, Ctr de Fisica de Materiales (Spain) and National Research Nuclear University MEPhI (Russian Federation) and IKERBASQUE, Basque Foundation for Science (Spain)

A brief review on studies of plasmon-exciton interactions in various nanostructures of different shapes and sizes is presented. In particular, the interactions between localized plasmons in various plasmonic nanocavities and excitons in organic semiconductors will be considered. In these hybrid structures, the anticrossing behavior of hybridized modes can be tracked using a number of spectroscopic techniques, such as absorption and photoluminescence. The recent advances in the study of plasmon-exciton interaction using magnetic circular dichroism spectroscopy will also be discussed. In these experiments, it has recently been shown that nonmagnetic organic molecules exhibit magneto-optical response due to binding to plasmonic nanoparticles.

Paper AOP100-186

Nanophotonic tools based on the conjugates of nanoparticles with the single-domain antibodies for multi-photon micrometastases detection and ultrasensitive biochemical assays

Authors: I. R. Nabiev, Univ de Reims Champagne-Ardenne (France)

Early cancer diagnostics on the molecular level using the biochemical assays and also detection of the micrometastases and disseminated tumour cells is still a challenge. The existing photonic techniques of in vitro and in vivo diagnostics and imaging are mainly limited by the difficulties related to dye photobleaching, their detection in the optically noisy cell and tissue environment.

Semiconductor quantum dots (QDs) have emerged as alternative tools for cellular labelling, biochemical sensing, probing biocatalysed reactions, and drug delivery. QDs are characterized by orders of magnitude higher multiphoton absorption cross-sections compared with organic dyes. Concerning the best recognition molecules to be used for nanophotonics probes development, single- domain antibodies (sdAbs) derived from lamas are the smallest high-affinity recognition molecules. Combined with the QD photoluminescence quantum yield approaching 100% and unique photostability, such nanophotonic probes open the prospects for the two-photon functional imaging and ultrasensitive biochemical assays development.

We have shown that QDs conjugated in a highly oriented manner with the sdAbs are powerful tools for detecting human micrometastases and disseminated tumour cells even in thick tissue sections. The two-photon (2P) microscopy approach is shown to have considerable advantages over the single-photon confocal microscopy to visualize the nanoprobes on metastatic tumours, since the emitted fluorescence generated by 2P-excitation is higher, resulting in a much better signal-to-background ratio. Additionally, the diffusibility of sdAb-QD nanoprobes through tissue facilitates their access to small metastases and complex structures, making them powerful tools for cancer immunohistochemical diagnostic in situ and in biochemical assays.

Paper AOP100-187

The crucial role of surface ligands in photostability of colloidal quantum dots

Authors: M. A. Zvaigzne, V. Krivenkov, P. Samokhvalov, National Research Nuclear University MEPhI (Russian Federation); I. Nabiev, Université de Reims Champagne-Ardenne (France)

Colloidal quantum dots (QDs) arise as photoluminescent nanomaterials for wide use in light-emission applications and biomedicine. However, it is widely known that prolonged exposure to intense light may irreversibly change their optical properties.

Two steady-state processes can be considered when dealing with this effect, namely photodarkening (PD), which results in reduced photoluminescence (PL), and photobrightening (PB), when the QD PL increases. Understanding of the mechanisms of these processes is important in the case of QD-based devices operating under continuous illumination. Here, we study the PD and PB processes in QDs with different core diameters and different shell thicknesses under laser irradiation of different wavelengths. We have found that variation of the core size has a minor effect on the stability of QD optical properties under irradiation, while the wavelength of laser radiation and shell thickness of QDs have a strong influence on their photostability. Surprisingly, PD and PB observed in colloidal solutions of QDs are almost completely suppressed when the QDs are embedded in a poly(methyl methacrylate) (PMMA) matrix. We suggest that this effect is related to the blocking of ligand-mediated charge transport between QDs in a solid sample. Therefore, it can be presumed that the photoinduced charge transfer from QD cores to the ligand molecules and desorption of the latter are responsible for the PD and PB of the nanoparticle PL. The results of our study can pave the way to improvement of QD optical stability and expand the use of QD-based applications.

Paper AOP100-188

Polariton-assisted emission of strongly coupled organic dye excitons in a tunable optical microcavity

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Light-matter coupling between the molecular dipole transitions and a confined electromagnetic field provides the ability to control the fundamental properties of coupled matter. It can be obtained by placing an ensemble of emitters into an optical or plasmonic cavity. The ratio between the reversible coherent energy exchange and damping rates of the emitter and electromagnetic modes governs the properties of the coupled system. Strong light-matter coupling for emitters with broad emission and absorption bands have been previously mostly demonstrated using plasmonic modes. The use of tunable microcavities allows one to affect the coupled state properties in a controllable manner, whereas the coupling strength in this system strongly depends on the transition dipole moment. In this study we have demonstrated controllable emission of Rhodamine 6G organic molecules with relatively low and unoriented dipole moments in a strong coupling regime by placing them into a tunable Fabry-Perot microcavity. Although in most previous studies photoluminescence emission from the lower polariton branch was dominated, in our study two distinct photoluminescence peaks where observed and attributed to the emission from both the upper and the lower polariton branches.

Moreover, their dependence on the detuning of the microcavity mode from the excitonic resonance was measured and demonstrated clear anti-crossing behavior and large Rabi splitting energy of up to 225 meV. The realized strong coupling of the electronic transition of an organic molecule with a low dipole moment can be used to design novel sources of exciton-polariton coherent spontaneous emission with a tunable emission wavelength.

Paper AOP100-189

Engineering of fluorescent biomaging tools based on quantum dot-encoded polyelectrolyte microcapsules and their cancer cell targeting applications

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Fluorescent imaging is widely used for the monitoring of distribution, interaction, and transformation of medications and drug delivery systems at the molecular, cellular, and tissue levels. Quantum dots (QDs) are fluorescent semiconductor nanocrystals with a high photostability, wide absorption spectra, and narrow, size-tunable emission spectra, which make them promising fluorescent imaging nanolabels to be encapsulated in microcarriers used as bioimaging and theranostic tools in targeted delivery, diagnostics, and imaging. Microencapsulation of QDs into a polymer microcapsule membrane using the layer-by-layer approach allows obtaining bright fluorescent polyelectrolyte microparticles with controlled size and surface charge. Functionalization of the polyelectrolyte microcapsule surface with biomarker recognition molecules, such as antibodies (Abs), ensures their specific and selective interaction with specific receptors on the membrane of cancer cells followed by internalization. This results in targeted delivery and imaging, which could be used for cancer diagnosis, treatment, and treatment monitoring. Here, we report on the key stages of the preparation of stable water-soluble QDs coated with polyethylene glycol derivatives, their optical characterization, and evaluation of their colloidal properties. We will also describe an approach to the optical encoding of polyelectrolyte microcapsules with the prepared water-soluble QDs and demonstrate their in vitro biocompatibility, their surface functionalization with Abs, and specific targeting of cancer cells. The obtained results pave the way to further research and development of cancer cell targeting theranostic and bioimaging agents based on QD-encoded polyelectrolyte microcapsules.

Paper AOP100-190

Electrodynamics model of a hydrogen sensor based on a special photonic crystal fiber taper coated with a nano-scale palladium film

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An electrodynamics model accounting for diffraction transformation of local modes in a special photonic-crystal fiber taper coated with a nano-scale palladium film is proposed. The model is used to interpret experimental data for transmittance spectra of a modal interferometric hydrogen sensor based on a special photonic crystal fiber taper with 8 nm palladium film, which was placed in a nitrogen atmosphere with a hydrogen concentration between 1.2 and 5.6 volume %. It is established that an increase of the hydrogen concentration in such environment changes the complex refractive index of the palladium film that leads to a growth of integral transmittance of the sensor and practically does not affect wavelength positions of transmittance extrema. Some possibilities for optimizing the sensor by choosing a length of the taper waist (i.e. the thinnest part of the taper) are determined.

Paper AOP100-191

Measuring valley polarization lifetime and diffusion lengths in transition metal dichalcogenides using time resolved second- harmonic generation

Authors: J. Viana-Gomes, National University Singapore (Singapore) and Center for Advanced 2D Materials (Singapore) and Univeridade do Minho (Portugal)

Polarization-resolved (PR) photoluminescence (PL) [1] and Kerr rotation (KR) [2] are commonly used to probe the degree of valley polarization (VP) of transition metal dichalcogenides (TMDs). Recently, second-harmonic (SH) generation was proposed to also probe VP [3], with the advantage over PL and KR of not requiring the material to have a bandgap or strong spin- orbital coupling, and thus extending VP measurements to other materials such as graphene. In this work, we introduce a technique that uses a single ultrafast laser pulse to simultaneously create VP and probe it by measuring SHG. This is done by engineering the polarization of the laser beam. By increasing its ellipticity, which translates into a larger VP in the sample, we observed an additional SH signal due to the VP, in good agreement with our theoretical model. Based on a transient analysis within the duration of the laser pulse, our model confirms SH susceptibility induced by VP to be directly proportional to the degree of VP, with the effect an order of magnitude higher for a quasi-resonant VP pump when compared to the off-resonant case.

[1] Nat. Nanotechnol. 7, 490 (2012), Nat. Nanotechnol. 7, 494 (2012).
[2] Phys. Rev. B 90, 161302(R) (2014), Nat. Commun. 6, 8963 (2015).
[3] 2D Mater. 4, 21027 (2017).

Paper AOP100-194

Optical techniques for improved vision

Authors: P. Artal, Lab de Óptica Univ de Murcia (Spain)

The human eye is a simple optical system, but very well adapted to the special requirements of our visual system. A better understanding of the optical properties of the eye allowed to develop new technologies to improve vision in many people. In this talk, I will revise the main optical properties of the eye and different experiments we developed during the last decades in my laboratory. In particular, based in the use of adaptive optics to manipulate light wavefronts in the eye. I will also present several recent results ranging from the nature of the lens movements, to the development of new opto-electronic instruments for the correction of cataracts and presbyopia.

Paper AOP100-195

Compositional optical and electrical characteristics of SiOx thin films deposited by reactive pulsed DC magnetron sputtering

Authors: M. P. Martins Costa, J. Carneiro, A. Samantilleke, M. Vasilevskiy, V. Teixeira, Univ do Minho (Portugal)

The influence of O2 flow rate on the compositional, optical and electrical characteristics of silicon oxide (SiOx) thin films (x < 2) were studied in this work. The SiOx thin films were obtained by pulsed DC magnetron sputtering (PMS) onto n-type Si wafers (and also on glass substrates) at a vacuum of 3×10–3 Pa. Rutherford Backscattering Spectrometry (RBS) was used to check the compositional elements of deposited films and its oxidized states were analysed via Fourier-Transform Infrared Spectroscopy (FTIR). The optical properties of as-deposited SiOx thin films were investigated from transmittance T(□□) measurements at room temperature in the wavelength range of 250 – 800 nm. The obtained data reveal that, the Urbach energy (band tail width, Eu) decreased from about 523 to 172 meV as the rate of oxygen gas flow increased. On the contrary, the optical energy band-gap (Eg) was increased from 3.9 to 4.2 eV. Conduction band and valance band positions were also evaluated. This behaviour is believed to be associated with the degree of disorder and defects presented in the as-deposited SiOx thin films, probably due to the presence of newly inserted oxidized OnSiHy species resulting from some contamination with water vapour desorbed from the walls of the deposition vacuum chamber. The electrical characteristics of the fabricated SiOx/n-Si system were studied via I - V curves and its dependence with different with O2 flow rates are reported. It was observed that the SiOx/n-Si structure exhibits a very good diode rectifying behaviour with a rectification ratio of 300 and up to 104, which refers to the samples produced with the lower and higher O2 flow rates, respectively. It was also found that the level of O2 flow rate has influence on the rectifying performance of the SiOx/n- structures since, both diode ideality factor, n and diode series-resistance, RS decreases with the increase of O2 content, therefore, possibly reflecting a closer approximation to a full stoichiometric condition.

Paper AOP100-196

In line Fabry-Perot cavities manufactured by electric arc fusion of NIR-laser micro-drilled optical fiber flat tips

Authors: M. Nespereira, J. M. Pinto Coelho, J. Rebordão, Univ of Lisboa (Portugal)

In this paper, the manufacturing of inline Fabry-Perot cavities in standard single mode telecommunication optical fiber is presented. The procedure consists in splicing two optical fiber pigtails, one of them with a micro-drilled hole in its tip, creating an air bubble in the structure of the spliced fiber. The initial hole is obtained by using near infrared radiation from a Q-switch Nd:YAG laser at 1064nm to open 5-10 micrometers deep cavities. The fiber's glass is removed by laser ablation and plasma formation processes.

Then, a standard splicing machine is used with its parameters modified to fuse the two fibers without collapsing the hole. The length of the obtained cavities lies around 80-110 micrometers, and the resulting reflected signal corresponds to an interference pattern of two parallel reflective surfaces. Furthermore, preliminary tests for various measurands such as refraction index and strain, suggest their potential as fiber-based sensors.

Paper AOP100-197

Assessment of light's dazzling effect on the EEG signal of subjects performing tasks that require concentration

Authors: J. Santos, J. M. Pinto Coelho, P. Mendonça, H. A. Ferreira, Univ of Lisboa (Portugal)

The objective of this work is to assess the ability of a brain-computer interface to acquire electroencephalographic (EEG) data in situations of luminous glare. The increasing access to high-power directional light sources (such as laser pointers, but also some flashlights) has led to a growing concern with the potential effects of its use. More than the direct damaging of the retina (however, less likely), the focus has been directed at the effects related to the change in states of concentration on individuals performing tasks whose concentration is critical (such as helicopter pilots or heavy vehicles drivers). This effect is known as "dazzling" and is typically a temporary deleterious effect on the ability to see or concentrate. However, while damage to the retina can be quantified, glare effects, being indirect (based on the effect on the execution of a given task), are typically qualitative (or at least of more subjective quantification). In this context, the use of brain-computer interfaces capable of analyzing the brain response to external stimuli, opens a door towards the creation of a new tool to evaluate the effects of dazzle. Its potential was evaluated by defining a set of strategies involving the illumination process, EEG signal recording and analysis.
A continuous performance task commonly used as an assessment in cognitive neuroscience (N-back) was used to test attention under the effect of dazzling, in parallel with EEG signals acquisition. Statistical data analysis using R programming language allowed to conclude that preliminary results show the potential of this technique.

Paper AOP100-198

Reliability of ridge waveguide distributed feedback lasers for communications applications: from device specification and failure analysis to life-time calculation

Authors: H. Cantu, A. Mckee, Compound Semiconductor Technolgies Global Ltd (United Kingdom)

Power efficient communication links based on optical fibre networks require of reliable optical sources capable of deployment for several years without failure. Assuring that the optical device will comply with operation specification within a given life-time is one of the fundamental tasks for every major provider of high quality opto-electronics products. Several analysis steps are implemented in practice in order to statistically predict the reliability and life-time expectancy of a given device. These methods include accelerated stress tests, analysis of the thermal behaviour of the devices, as well as the study of degradation of populations within a given statistical distribution. Ridge Waveguide Distributed Feedback (DFB) Lasers are complex devices which require a number of difficult and precise fabrication steps that can greatly affect its long term reliability. In this work, we describe how, from the early stages of device characterisation, it is possible to evaluate the suitability of a given device design for the long life-time demand of a challenging deployment environment (uncooled, non-hermetic operation). Understanding the reasons for non-compliance and device failure, as well as their clear association with the device fabrication procedure steps, greatly helps to systematically improve the device quality yield for volume production. At the later stages of reliability analysis, statistical data from large sample populations under accelerated stress tests will provide robust information regarding degradation mechanisms (wear out, sudden failure), which are essential to calculate parameters such as activation energies and acceleration factors. These parameters, together with existing mathematical tools, will help to assure that the device can comply with the life-time deployment specification, within a required level of accuracy.

Paper AOP100-200

Fundamentals of neutron waveguides: a proposal for slow neutron beams confinement and applications

Authors: M. Calvo Padilla, I. Molina de la Peña, R. Alvarez-Estrada, Univ. Complutense de Madrid (Spain)

Neutron optics is the branch of physics dealing with the wave behavior of neutrons. Since earlier 1936 it is well known that slow neutrons suffered diffraction by crystalline materials. Since then, many other optical phenomena have been identified as neutron interferences, neutron reflection and refraction as well as neutron confinement, in particular guide structures. For example, hollow neutron guides (with transverse dimension the order of l cm.) are routinely used to conduct slow (cold, thermal, epithermal) neutron beams along several tens of m. At later stages, actual guides could be employed to focus the beams onto smaller transverse scales (say, down to mm) for various applications: for instance, the so-named Boron-Neutron-Capture-Therapy (BNCT) with interesting applications in biomedicine. Due to the growing research and technologically relevant areas in which slow neutrons are employed, one may suppose that, besides supermirrors, there will be further increasing improvements on neutron focusing in the future (for instance, for non-destructive analysis of materials and in the framework of accelerator-based and spallation sources).

Motivated by such scientific trends, and concentrating on beam focalization onto shorter scales, we remind experiments on confined propagation of slow neutrons along the following systems. a) Guided-neutron waves in thin films, previously proposed, were established experimentally in a thin Titanium (Ti) planar waveguide with thickness 120 nm along about 20 mm (Y. P. Feng et al., Phys. Rev. B49 (1994), 10814). b) Thin polycapillary glass fibers (PGF). A typical PGF has a diameter in the mm range and a length about a few tens of cm and contains about a few thousand individual hollow capillary channels (HCC), a single HCC with an internal diameter about a few μm being a hollow waveguide for confined propagation and focusing of neutrons. Leaving aside previous independent proposals based upon thin circular waveguides (say, Ti fibres), PGFs have been shown experimentally to guide slow neutrons (H. Chen et al., Nature, 357 (1992), 390). One important limitation of both a) and b) is that , typically, the transmitted confined thermal neutron flux is smaller than the incoming (unconfined) one by about 10-3 to 10-4.

In our current study we afford proposals for confined thermal neutron propagation with transverse sizes down to about 0.1 μm along longer distances, about tens of cm, by modifying adequately a) (upon coupling the Ti layer to a suitable thin planar film). We also entertain proposals by combining a) and b). Possible relationships (consistent with the above flux limitation) to accelerator-based BNCT for small tumors, below the mm scale, are discussed.

By starting with the standard stationary Schrödinger equation we have studied possible solutions for confined modes and the capability of focusing slow neutron beams through neutron waveguide. Numerical simulations are carried out indicating that, indeed, neutrons can be confined and shows particular modal structure as expected. We have extended the treatment to addition mathematical models in order to improve the numerical simulations and to interpret the obtained results.

The final aim of our current study is to design particular planar neutron waveguides, acting as couplers and to allow confinement of neutrons beams for the purpose of more effective BNCT.

Paper AOP100-202

Efficient and stable holographic gratings stored in an environmentally friendly photopolymer

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Holographic gratings stored in one of the greenest photopolymers, called Biophotopol and patented by Holography and Optical Processing group at the University of Alicante, have been analyzed to achieve stable over time and efficient holograms. A curing process usually produces a diffraction efficiency (DE) decrement. However, when a curing process is not performed, the holographic gratings are not stable and DE will decrease over time due to the diffusion of molecular components inside the photopolymer.

In this work, a DE increment has been demonstrated after a curing stage (performed with an incoherent and low-cost LED lamp). A detailed curing protocol to stabilize the holograms while maintaining high DE, has been carried out in unslanted transmission gratings of 1205 l/mm. The holographic transmission reflection setup allows the possibility to evaluate the transmitted and diffracted intensity beam relation, in real time, by using a He-Ne laser (633 nm), while the gratings were recording with an Argon laser (488 nm).

It has been demonstrated more than a 30% DE increment after a curing process when a maximum DE in the recording stage had not been still achieved. However, in the singular case that a maximum DE in the recording stage has been already obtained, a curing stage process could produce overmodulation effects, and therefore, a DE decrement. In conclusion, a maximum DE is obtained in curing and stable hologram gratings (recording them with proper radiant exposures) over an environmentally compatible photopolymer.

Paper AOP100-203

New collective modes in twisted bilayer graphene

Authors: T. Stauber, Instituto de Ciencia de Materiales de Madrid (Spain); G. Gómez-Santos, Universidad Autónoma de Madrid (Spain)

I will discuss new collective modes hosted by twisted bilayer graphene. First, I will outline that there are quasi-localized modes that entirely consist of inter-band transistion [1] that might be responsible for the observed linear-T resistivity. Second, I will show that longitudinal plasmons in twisted bilayer graphene are necessarily "chiral", i.e., a magnetic dipole is associated to the usual electrical dipole [2]. Last, I will argue that twisted bilayer graphene might act as photonic crystals for plasmonic excitations [3].

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[3] S. S. Sunku, G. X. Ni, B. Y. Jiang, H. Yoo, A. Sternbach, A. S. McLeod, T. Stauber, L. Xiong, T. Taniguchi, K. Watanabe, P. Kim, M. M. Fogler, and D. N. Basov. Quantum Photonic Crystal for Nano-Light. Science 362, 1153 (2018).

Paper AOP100-204

Photocatalytic and smart asphalt mixtures: an overview

Authors: I. Rocha Segundo, E. F. Freitas, University of Minho (Portugal); S. Landi Jr., University of Minho (Portugal) and Instituto Federal Goiano (Brazil); M. F. Costa, J. O. Carneiro, University of Minho (Portugal)

Road pavements must be able to withstand the effects promoted by vehicle traffic and also by climate, ensuring driving conditions to meet requisites related to safety, comfort, economy and with low environmental impact. A smart asphalt mixture is a material with properties that differ from the conventional ones, which can react to external stimulus complying with those requirements. Nowadays, there is an increasing concern about the use of less harmful techniques to the environment, and about the road safety in Transportation Engineering. In this sense, heterogeneous photocatalysis based on the semiconductors application onto asphalt mixtures is a promising technology because it can mitigate air pollution and road accidents. The functionalized asphalt mixtures can degrade pollutants, such as damaging gases and oil/greases over their surface from the reactions triggered by sunlight photons, providing major environmental and social benefits. Semiconductor materials can be applied by using different techniques such as spraying coating, bulk incorporation, bitumen modification, and spreading. The photocatalyst performance can be evaluated by optical spectrophotometry. The analysis from the UV/visible diffuse reflectance spectra is often used to determine the bandgap energy of the semiconductor materials, that is, the minimum photon energy that enables their activation. The optical absorbance spectroscopy is used to analyze the photocatalytic ability of the multifunctional asphalt mixture by monitoring over time the concentration variation of an organic dye (related to its chemical degradation), which is often used as a pollutant model. In this communication, a brief review of photocatalysis applied in asphalt mixtures will be presented.

Paper AOP100-205

Tunable focalizers: phase conjugate pairs

Authors: J. Ojeda-Castañeda, Univ de Guanajuato (Mexico)

For setting optical focalizers, we discuss the use of pairs of phase-only optical masks. One element of a given pair has a complex amplitude transmittance that is equal to the complex conjugate of the other element. We show that by either an in-plane rotation or by lateral displacement of one element of the pair with respect to the other, one can control the optical path difference. This method is useful for generating varifocal lenses, governable prisms, tunable axicons, controllable axilenses, confocal systems, switchable vortices and for tuning field depth.

Paper AOP100-207

Scattering killed the (light) sheet... or did it?

Authors: J. Ripoll, Univ Carlos III de Madrid (Spain) and Instituto de Investigación Sanitaria del Hospital Gregorio Marañón (Spain)

Light Sheet Microscopy has received increasing attention in the past years due to its speed, flexibility and unique features for fast live imaging of developing organisms and large cleared samples. Even though light sheet does indeed offer great advantages over other more conventional imaging modalities when applied to imaging large volumes, it has one major foe: scattering. Scattering affects all imaging modalities, but more so those that specifically rely on generating a known pattern inside the medium in order to obtain volumetric information. This means that the excitation light sheets degrade fast when scattering is present, which adds additional spatial degradation to the scattering contribution already present in the detection arm.

In this talk I will present some alternatives that we have develped with the main goal of improving image quality in the presence of variying amounts of scattering. In particular, I will talk on the advantage of using methods such as optical projection tomography which allows implementing more complex light propagation models, and how fast dynamic light sheet imaging may be used to conform optical projection tomography datasets, thus improving image resolution when background scattering is present. This approach, which we have termed Statistical Projection Optical Tomography (SPOT), is useful when dealing with turbid samples and when isotropic resolution is an important feature.

Finally, applications dynamic light sheet imaging showcasing how these approaches may be applied to SPOT will be presented on large tissue samples.

Paper AOP100-208

Synthesis and optical properties of Sc2O3 nanoparticles doped with lanthanide ions

Authors: M. Antoniak, D. Wawrzyńczyk, M. Nyk, Advanced Materials Engineering and Modelling Group, Wroclaw University of Science and Technology (Poland)

Nanoparticles (NPs) doped with lanthanide ions have been applied as efficient optical materials due to the their long decay times, narrow emission lines and large Stokes shift. In order to enhanced optical properties of those nanomaterials, we adapted and modified the synthesis process reported by Pan et al. [1], and successfully obtained Sc2O3:RE (RE=Eu2+,Eu3+,Tb3+) NPs.

Lanthanides doped Sc2O3 NPs were synthesized via a simple one-step chemical route using oleylamine as growth controlling and surface protecting agent. The transmission electron microscope images were used to confirm the morphology and size distribution of obtained NPs. Also, we have investigated the change in optical properties of lanthanides doped Sc2O3 NPs upon changes introduced to the synthesis conditions. Furthermore, we showed that due to intense visible emission, this new nanomaterial could be potentially useful as non-contact temperature sensor.

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Paper AOP100-210

Development of a compact and portable SHG FROG

Authors: A. Ribeiro, M. Fajardo, IPFN - GoLP (Portugal); P. André, Universidade de Aveiro (Portugal); C. João, S. Künzel, J. Koliyadu, IPFN - GoLP (Portugal)

Starting from a few microseconds to the more recent attosecond bursts, the measurement of ultrashort laser pulses has been a problem of study throughout the years.

In 1993, a new technique based on Frequency-Resolved Optical Gating (FROG) was presented which had a great impact on the pulse measurement field, due to a high simplicity and reliability. Multiple variations of this same setup were proposed since then, based on the main idea of measuring the duration of a pulse by spectrally resolving the nonlinear interaction between the pulse and a delayed replica. SHG FROG, involving the nonlinearity of second harmonic generation, is the most commonly used setup with the ability for high dynamic range measurements and high robustness.

In this article, a new idea for a compact and portable 3D printed SHG FROG setup will be studied with the goal of measuring 20 fs light pulses from the 800 nanometer laser in the VOXEL laboratory, at IPFN.

With fewer optical resources, proving to be a more economical option, this 3D printed compact solution will allow for a ”plug and play” cased setup, by the use of an optical fiber connecting the second harmonic beam with an outside spectrometer, with a lower weight and a higher mobility than a conventional SHG FROG, to allow users to retrieve the intensity and phase of ultrashort laser pulses at different experimental points as a way of diagnostics and results validation.

Paper AOP100-211

In-plane wavelength multiplexing of fibre Bragg gratings in a multicore optical fibre

Authors: R. Idrisov, M. Rothhardt, H. Bartelt, Leibniz-IPHT (Germany)

Multicore fibres have attracted recently major interest for use in various fields such as telecommunications, optical sensors, robotics, etc. In combination with the concept of fibre Bragg gratings (FBG) new options of multiplexed sensing become possible. However, with conventional inscription techniques for a multicore fibre with uniform core structures, the reflection wavelength for gratings in a single cross-section plane will show the same central position and bandwidth. Therefore wavelength multiplexing for such in-plane gratings would be not feasible and additional optical fan-out techniques would be required to make sensor signals from the different cores distinguishable. We report here on a simple method to realize different FBG wavelength peaks for different in-plane cores by pre-bending the multicore fibre during the grating inscription process. This bent must be performed in a specific direction and orientation in order to introduce different tensions to different cores during inscription, resulting in FBGs with different wavelength shifts when used as a straight sensor fibre. The different signals can be then interrogated separately by analyzing the spectral properties without the need of using additional fan-out schemes. Alternative options to use multicore fibres where the cores are different in the effective refractive index will be also mentioned.

Paper AOP100-212

Functionalizing glass by inducing local compositional changes with ultrafast lasers

Authors: J. Solis, Consejo Superior de Investigaciones Cientificas (Spain)

The properties of a glass can be potentially tuned through small modifications of the composition and/or the structural arrangements of both modifiers and glass forming elements. Indeed, local modifications of the composition of glass upon irradiation with ultrashort laser pulses have been observed many times since Hirao and co-workers reported local changes in the composition of glasses irradiated to induce the precipitation of non-linear crystals in glass matrices. Since then, fs-laser induced element redistribution (FLIER) processes have been investigated by several research groups with the aim of modifying in a controlled manner the local composition of glasses to promote different functionalities.

Likely, the most successful application of FLIER for glass functionalizing up to date has been the production by our research group of high refractive index contrast, low loss optical waveguides, and very efficient waveguide optical amplifiers, and lasers in phosphate glass. In this case, a heavier glass modifier element, acting as a refractive index carrier (e.g. La3+) migrates in the opposite direction to a fast diffusing alkaline modifier (e.g. K+) during the laser-writing process, forming the positive index region contrast where light guiding occurs. We have used this principle to successfully produce glass samples with a composition specifically pre-designed for generating efficient optical waveguides by fs-laser writing.

The presentation will provide an overview of fs-laser induced ion migration phenomena in glasses, with emphasis on recent results of our research group regarding its use for the production of photonic devices and other prospective applications.

Paper AOP100-213

Attosecond soft X-ray spectroscopy in condensed phase

Authors: J. Biegert, ICFO - Institut de Ciències Fotòniques (Spain) and ICREA (Spain)

Phase transitions of solids and structural transformations of molecules are canonical examples of important photo-induced processes, whose underlying mechanisms largely elude our comprehension due to our inability to correlate electronic excitation with atomic position in real time. Here, we present a decisive step towards such new methodology based on water-window- covering (284 eV to 543 eV) attosecond soft X-ray pulses that can simultaneously access electronic and lattice parameters via dispersive X-Ray absorption fine-structure (XAFS) spectroscopy. We validate attoXAFS with an identification of the σ^* and π^* orbital contributions to the density of states in graphite. Moreover, we will show that this method can provide a real-time view on the light- field-driven carrier dynamics. This work demonstrates the concept of attoXAFS as a powerful real-time investigative tool which is equally applicable to gas-, liquid- and condensed phase.

Paper AOP100-214

Multifunctional low cost metal oxides: from materials to devices

Authors: E. M. Fortunato, Univ Nova de Lisboa (Portugal)

After the huge success and revolution of transparent electronics and with the worldwide interest in displays where metal oxide thin films (MOTF) have proved to be truly semiconductors, display backplanes have already gone commercial due to the huge investment of several high profile companies: SHARP, SAMSUNG, LG, BOE. Recently IDTechEx estimated that8 km sqr of MOTF backplanes will be used in the OLED and LCD industry by 2024, enabling a 16 billion USD market at the display module level alone.

Currently, semiconductor technology combines two very different and often incompatible materials leading to sub-optimal properties, namely simple semiconductors and oxides. The former (Si, Ge) are essential for efficient carrier transport, while the latter enable various functionalities. The challenge of the proposed work is to develop MOTF and TFTs with properties comparable to those of the simple semiconductors. In addition, the properties of many MO have never been explored. It is notable that MO provide a unique possibility to tune optical and electronic properties, from insulation to metallic conduction; besides that MO are chemically stable, mostly non-toxic and abundant materials, often manufactured by low cost methods, under ambient conditions. Consequently, devices made of MO are inexpensive, very stable and environmentally safe, the 3 most important requirements for electronics.

In this talk we will present results on recent new technologies developed at CENIMAT|i3N like transparent electronics and paper electronics where it is possible to have the use of sustainable materials used in disruptive applications.

Paper AOP100-215

Measurement of the refractive index of glass by optical metrology

Authors: I. Leite, A. Cabral, Faculdade de Ciências Universidade Lisboa (Portugal)

New luminescent materials have a wide range of applications in either chemistry, biology or electronics. The study of non-toxic and inexpensive luminescent materials is the key to a sustainable future. Luminescent Solar Concentrators (LSC) are the example of a very promising application of luminescent materials and the optimization of the optical conversion efficiency of the glasses produced is essential for the development of the LSC - for this it is fundamental to determine the refractive index of the different glasses with an accuracy below 1%.

Several techniques to determine the refractive index exist. The current situation regarding systems that perform this type of measurements in glass, is that there are simple systems for low accuracy and complex systems for high accuracy, the middle ground is left unexplored. Therefore, for the development of LSC glasses, it is clear that there is the need for a simple refractive index measurement system with an uncertainty below 1%, with low complexity, cost-effective and automated to allow a typical user to obtain the desired information on optically simple samples.

An analysis of the state of the art lead us to identify two independent techniques that can be optimized to improve the accuracy to the required levels, maintaining a low level of complexity. One technique uses the lateral displacement of a laser beam in a rotating parallel glass plate and the other is based on a Michelson interferometer measuring the change in optical path length of the same rotating plate.

In this paper we present the two selected techniques and how they were optimized to achieve the requirements for the characterization of LSC glasses.

Paper AOP100-216

Computational imaging with structured light and single-pixel detection

Authors: E. Tajahuerce, V. Climent, J. Lancis, Universitat Jaume I (Spain)

Computational imaging techniques based on structured light permit to avoid light sensors with pixelated structure. The method is based on sampling the scene with a set of microstructured light patterns while a simple bucket detector, for instance a photodiode, records the light intensity transmitted, reflected or diffused by the object. Images are then computed numerically from the photocurrent signal by using different mathematical algorithms. A common approach is to use light patterns codifying functions of a basis, such as Hadamard or Fourier components. Images are retrieved by a simple basis transformation.

The simplicity of the sensing device in single-pixel imaging allows working efficiently in conditions where light is scarce. It also makes easier to measure the spatial distribution of multiple optical properties of the light, such as the polarization state or the spectral content, in a simple way. Single-pixel detectors permit to use a broader spectral range compared to conventional cameras, helping to extend imaging techniques to exotic spectral regions. Furthermore, single pixel cameras have proved the ability to perform non- invasive imaging through scattering media in biological tissues.

In this contribution, firstly we review the fundamentals of computational imaging techniques using structured light and single-pixel detection. We focus on optical systems using Hadamard patterns as sampling functions. Second, we describe recent applications of the technique in multidimensional imaging, providing information about the spatial distribution of polarization, wavelength, or phase. Finally, we show the potential of single-pixel imaging techniques to obtain images through turbid media.

Paper AOP100-217

The LiDAR hop-on-hop-off route: visiting the LiDARs past, present, and future landscapes

Authors: E. J. Nunes-Pereira, University of Minho (Portugal)

LiDAR technology is bounded with great expectations. This is a result of the high market prospects from several industries (notably the automotive) as well as LiDAR being a key enabling technology for automation. We will drive along the current two main avenues of LiDAR, targeted to autonomous driving. We will stop at minute technicalities of LiDAR implementations. But occasionally we will also rise high, to get an eagle-eye view of the bigger picture. We will discuss why there will not happen a one- single-expensive-LiDAR-fits-all-scenarios and why a several-cheap-complementary-LiDARs alternative is more rational. We will discuss several aspects in which LiDAR changed our understanding of the landscape as well as the high impact it will have in society (economic and quality of life). Automotive LiDAR comes in an age where the societal focus is changing from private ownership to pay- as-you-use-services, and where personal responsibility will be gradually replaced by corporate liability. We will introduce some minor contributions from the Physics Centre of Minho and Porto Universities, Portugal, Europe. And by the end of the route, we will drop off the partaker to explore uncharted territory on his/her own.

Paper AOP100-218

Monitoring of Mn ions incorporation into quantum dots by EPR and Luminescence spectroscopy

Authors: Y. Galyametdinov, R. Shamilov, D. Sagdeev, Kazan National Research technological University (Russian Federation); A. Sukhanov, V. Voronkova, Kazan E. K. Zavoisky Physical -Technical Institute (Russian Federation)

Paramagnetic Quantum Dots (PQD) are semiconductor nanoparticles doped by transition metal ions like Mn2+, Cu2+ etc. They are perspective materials for nanoelectronics, photonics, biomedicine and photocatalysis.

We investigated dependence of manganese (Mn) ions incorporation into the most used CdS and ZnS nanoparticles on temperature and the time of the synthesis using the EPR technique and luminescent spectroscopy.

By analyzing the shape of the spectral lines and the g-factor ratio in the EPR spectra, the features of the distribution of Mn ions in PQD were determined. The process of self-purification of Mn:CdS PQDs from Mn ions during prolonged high temperature synthesis was observed. This leads to a change in the emission spectra of nanoparticles. It was shown that the emission from the surface defects during prolonged synthesis descreases. This occurs at the Ostwald ripening stage, when MnS clusters decompose and Mn ions are eliminated from nanoparticles.

The features of the inclusion of impurity ions of Mn in ZnS, which significantly depend on the synthesis temperature, are investigated. Mn ions predominantly form MnS clusters during synthesis at 180 ºC and individual inclusions in ZnS lattice at 260 ºC. Nanoparticles that have only MnS clusters do not show characteristic Mn ions luminescence at 590 nm and show only ZnS bandgap emission.

The work is financially supported by Russian Scientific Foundation, project 18-13-00112.

Paper AOP100-219

Neuromorphic photonics for future ultrafast brain-inspired computing systems

Authors: A. Hurtado, J. Robertson, J. Bueno, E. Wade, Univ of Strathclyde (United Kingdom)

Photonic approaches emulating the powerful computational capabilities of the brain are receiving increasing research interest as these can provide ultrafast operation speeds. In this presentation we review our work on ultrafast artificial photonic neuronal models based upon Semiconductor Lasers, the same devices used to communicate internet data traffic over optical fiber networks. We will show that a rich variety of neuronal computational features, such as spiking activation/inhibition, bursting, etc., can be reproduced optically using Vertical-Cavity Surface Emitting Lasers (VCSELs). Moreover, these optically reproduced neuronal responses are achieved in a fully controllable and reproducible way at sub-nanosecond speeds (up to 9 orders of magnitude faster than the millisecond timescales in cortical neurons). Furthermore, our results are obtained using commercially-available, inexpensive and compact VCSELs operating at the important telecom wavelengths of 1310 and 1550 nm; hence making our approach fully compatible with existing optical communication technologies. Additionally, we will also present our recent results demonstrating the successful communication of spiking signals at sub-nanosecond rates between interconnected VCSEL-based artificial photonic neurons and the use of such systems to emulate basic neuronal circuits at ultrafast speeds. These results offer great promise for new neuromorphic photonic networks for future brain-inspired computing platforms going beyond traditional digital processing technologies.

Paper AOP100-220

Performance analysis of image motion compensation system for one meter class telescope

Authors: S. Vallapureddy, Indian Institute of Astrophysics (India)

An image motion compensation system has been developed for 1.3 m telescope, Kavalur. It is designed for visible band (480-700 nm) of the electromagnetic spectrum and has spatial resolution of 0.08" with field-of-view (FOV) of 72". To evaluate the performance of the instrument, it is tested on multiple pairs of stars with angular separation of few arc-seconds (~2" to several arc- seconds (≤ 60") and of magnitude (mv) brighter than 6. The tilt corrected images have shown an ~56% improvement in image resolution and ≥ 120% improvement in the peak intensity over an integration time of 10 minutes. A closed loop correction bandwidth of ~10-15 Hz has been achieved. The root mean square (rms) image motion has been reduced, approximately, by a factor of two and half times. In this conference we present the performance analysis of the instrument on telescope.

Paper AOP100-221

Interrogation methods for functionalized optical microbubble resonators aimed at water microcontaminants

Authors: P. Santos, INESCTEC (Portugal)

Microcontaminants in the context of water pollutants can be sensed through functionalized optical microbubble resonators (OMBR). Measurements can be made through finding the wavelength positions of resonance peaks and recording their spectra characteristics, since any change in the inner medium (i.e. refractive index) or on the inner resonator surface (due to some chemical and/or biochemical bonding) induces a shift of the resonance peaks carrying information on the analyte concentration.

The sensing mechanism supporting Whispering Gallery Modes (WGM) is able to propagate themself glancing to the surface all around an equatorial plane by total internal reflections, presenting Q factors of 10^7, translating into resonance peaks with $\Delta\lambda \sim 0.1$ pm. These specifications imply the need for a laser with high wavelength stability.

Light from a tunable source, with a linewidth smaller than 200 kHz (1 fm), is passed through a stable C_2H_2 Gas cell, ensuring no wavelength shifting occurs. Its transmission is recorded using a photodetector connected to an oscilloscope and a software routine with a feedback loop to lock into each individual resonance peak and perform scans around their central positions. Measurements start by performing a full range coarse scan to identify resonance peaks in the available spectrum, followed by one finer tuning method. In this work, three methods were studied and compared: simple scans with smaller steps, modulation of the internal laser piezo tuning mirror and dithering using an external periodic waveform, from which was obtained standard deviations of 18.06, 4.35 and 0.80 pm, respectively.

Paper AOP100-222

Plasma control by pattern recognition in laser induced breakdown spectroscopy

Authors: M. Ferreira, INESC TEC (Portugal) and Faculty of Sciences of the University of Porto (Portugal); D. Guimarães, INESC TEC (Portugal); P. Jorge, INESC TEC (Portugal) and Faculty of Sciences of the University of Porto (Portugal); R. Martins, INESC TEC (Portugal)

Laser induced breakdown spectroscopy is a powerful analytical technology for raw materials and geological samples, allowing both quantification and identification of compositional elements. When facing complex samples, active control of Laser parameters is critical for providing the best ablation and plasma breakdown conditions enabling optimal spectral detection. In this research, we propose a low-computational intensive laser control approach for embedded systems using compression by principal component regression. The method is implemented with a Q-Switch Nd:YAG laser (CFR 200 from Quantel) and it relates the laser energy, number of shots and trigger-spectrometer delay to the resulting spectral patterns, in a relevant principal component space. Control model was optimized for Lithium ore samples. A dataset of samples was used to train the pattern recognition model by cross-validation, and tests comprising of random samples were done to determine the accuracy of the predictive laser control system.

Results showed that simple pattern recognition algorithms can provide optimal laser control for a particular context of samples, such as lithium ore. We further show that once an unknown sample is measured a significant reduction in iterations is necessary to determine the optimized energy, number of shots and delay when compared to a feedback control system that takes only into consideration signal/noise ratios and detector saturation limits.

Paper AOP100-223

Wavepacket diffraction on a metal film with a single slit covered by graphene

Authors: Y. V. Bludov, N. M. Peres, M. I. Vasilevskiy, Univ do Minho (Portugal)

The diffraction of localized wavepacket on the perfect metal film with the single slit, filled with the dielectric medium and covered by the graphene monolayer is considered theoretically. It is demonstrated that diffraction of the wavepacket on the slit leads to the excitation of surface graphene plasmon-polariton (SGPP) standing wave (with nodes at the slit edges). The excitation of the SGPPs is revealed by the series of the peaks in the absorbance spectrum. At these resonance frequencies the slit width contains an integer numbers of SGPP half-wavelengths. It is shown that the position of the SGPP resonances can be effectively tuned by changing the graphene's doping. From the other side the absorption spectrum (position of peaks) is shown to be extremely sensitive to the refractive index of the dielectric, which fills the slit. This phenomenon can be used in the plasmonic sensors. The advantage of the graphene-based plasmonic sensor is an additional degree of dynamical tunability. Thus, if source of electromagnetic radiation with fixed wavelength is used, then the position of plasmonic peaks can be tuned to the desired wavelength by variation of the graphene's Fermi energy. After that the value of this Fermi energy can give an information about the dielectric constant of the medium, which fills the slit.

Paper AOP100-224

Optical fibres in astronomical spectrographs

Authors: G. Ávila, European Southern Observatory (Germany)

Optical fibres are currently used in astronomy to link telescopes to instruments. Their advantages and drawbacks are analysed in the particular case for linking spectrographs. Examples of instruments using this technology are also described in this paper.

Paper AOP100-225

Holographic optical tweezers at the tip of a multimode fibre

Authors: I. T. Leite, S. Turtaev, Leibniz Institute of Photonic Technology (Germany); X. Jiang, Max Planck Institute for the Science of Light (Germany); M. Siler, Institute of Scientific Instruments of the Czech Academy of Sciences (Czech Republic); P. S. Russell, Max Planck Institute for the Science of Light (Germany); T. Cizmar, Leibniz Institute of Photonic Technology (Germany) and Institute of Scientific Instruments of the Czech Academy of Sciences (Czech Republic)

Fibre-based optical tweezers typically rely on engineered fibre terminations yielding limited flexibility in number and positioning of trap sites. Here, we demonstrate holographic optical tweezers delivered by a lensless, high-NA multimode fibre with full positioning control of multiple tweezers independently and in all directions.

We have developed an all-solid, step-index multimode fibre based on compound "soft-glasses" yielding a very-high NA reaching 0.96 at 1064nm. By further extending the methods of holographic control of light propagation in multimode fibres, we were able to mitigate the adverse effect of mode-dependent loss affecting the new fibre type. This enabled harnessing the full available NA almost completely, and demonstrating high-resolution focussing with output NAs up to 0.91 through lensless fibres. Further, we show that the NA and pureness of such foci allow stable three-dimensional optical confinement of micrometre-sized dielectric objects. Being inherently holographic, this technique is capable of generating an arbitrary number of optical tweezers, as well as precisely repositioning them independently in all directions. The versatility of the new instrument is demonstrated by simultaneous and dynamic 3D manipulation of large assemblies of dielectric microparticles, as well as manipulation of micro-objects inside optically inaccessible environments such a turbid cavity through an opening as small as 0.1mm.

Moreover, the possibility of generating aberration-free foci with NA approaching 0.9 across the fibre core opens new perspectives for high-resolution holographic micro-endoscopy, paving the way for the delivery of advanced microscopy techniques through hair-thin fibre-optic probes.

Paper AOP100-226

Polycaprolactone as a biomaterial host for second-harmonic generation

Authors: C. R. Bernardo, M. Belsley, E. Gomes, R. Batista, Univ do Minho (Portugal)

Intensive efforts have been recently focused on the nanoscale engineering and design of materials with enhanced optical properties. Organic based compounds with strong optical responses with easy conjugation with biomaterials are an attractive choice, since they can offer a broad range of potential applications ranging from fluorescence probes, light waveguides and also frequency doubled sources for local probes that can interact with biological systems.

In this work we present the production and characterization of nanofibers exhibiting a strong quadratic optical non linearity response.Sub-micron fibers consisting of the optically nonlinear organic molecule 3-Nitro Analine (3NA) embedded in Polycaprolactone (PCL) as a polymer host were produced by the electrospinning technique.

We have characterized the effective second order nonlinear susceptibilities by measuring the fiberssecond harmonic response as a function of polarization using a femtosecond mode-locked Ti:Sapphire laser system with a fundamental wavelength centered at 800nm. Preliminary results show that these polymer nanofibers embedded with optically nonlinear 3NA can produce a strong, highly polarized second harmonic response with an effective nonlinear coefficient on the order of a few pm/V roughly equivalent to that of the well-known inorganic nonlinear crystal BBO.

Paper AOP100-227

Measurement of the temperature using an optical fiber with nanoparticles on the surface

Authors: D. A. Avila Padilla D.D.S., Univ Popular del Cesar (Colombia)

In this research, the effect on the sensitivity of an optical fiber with metallic silver nanoparticles on the surface of the fiber for temperature measurement is studied. The developed system consists of silver nanoparticles deposited on the surface of an optical fiber through the technique of immersion in chemical solutions. In the experiment, the nanoparticles were deposited on a small region of a tapered optical fiber using the stretching-and-heating technique. For the measurement of temperature, the device has been characterized using a tunable laser source (TLS) by coupling the light inside the optical fiber. The sensitivity of the system is measured through the detection of changes in intensity levels using an optical spectrum analyzer (OSA).

Paper AOP100-228

Study on creating an aspheric primary mirror of a large telescope using spherical mirror segments

Authors: A. Jacob, P. Parihar, Indian Institute of Astrophysics (India); M. K. James, St. Joseph's College (India)

In the new era of astronomy, we are going towards building larger and larger telescopes. Making and maintaining a monolithic mirror of size more than 8-10m is very difficult. The future of large telescope astronomy is possible though segmented mirror telescopes. But segmentation introduces its own complications in manufacturing. Most of the good optical design solutions require an aspheric primary or secondary or both in most of the telescopes under construction or planned. Keeping this in mind we conducted a study into the segmentation methods for the large telescopes. We developed a segmentation code which can be applied for any size telescope. The code can produce segmentation with user-defined size and gap between the segments. After this, we developed a platform to study various segmentation related errors. One of the interesting studies we have conducted is mimicking an aspheric profile with appropriate spherical mirror segments. In this paper, we will present the results of our study on designing an RC type telescope optics for a 12m size class optical telescope.

Paper AOP100-229

Sensitivity of TiO2-coated optical microfibers for temperature measurement

Authors: S. Horta, Univ Popular del Cesar (Colombia)

In this research, the measurement of the temperature is reported using a tapered optical fiber coated with a titanium dioxide TiO_2 thin film, this coating has been made through chemical synthesis, while the optical fiber has been previously thinned using the technique of stretching by heating. The sensitivity of the device is analyzed by the study of intensity modulations as a function of temperature obtained through the coupling of light in the optical fiber from a tuneable laser system (TLS) and the spectral response is measured using an optical spectrum analyzer (OSA). During the experiment it was possible to identify the measurement characteristics of TiO_2 on the surface of an optical fiber and highlight its importance in measurement systems using optical sensors.

Paper AOP100-230

Designing fibre probes for holographic microendoscopy

Authors: B. Silveira, S. Turtaev, I. T. Leite, Y. Du, T. Elsmann, M. Rothhardt, T. Čižmár, Leibniz-Institute of Photonic Technology (IPHT) (Germany)

Multimode fibres (MMFs) have recently emerged as perspective minimally invasive microendoscopes for in vivo imaging. Advances in holographic wavefront shaping now allow to reconstruct an image transmitted through a multimode fibre, which can be achieved with the knowledge of the so-called transmission matrix (TM). When compared to conventional fibre-based endoscopes, MMFs offer reduced footprint and improved resolution. However, most fibres used in imaging are still the commercially available fibres originally developed for optical communications.

In practical setups, bending of the MMF can significantly modify its waveguiding properties, resulting in image distortion. Imaging can still be performed by correcting the TM, but a precise knowledge of the fibre bending is required. We then propose a new fibre design combining both the principles of holographic endoscopy and capabilities of distributed sensing, to provide feedback on fibre contortion in real time and allowing active bending compensation. Such fully flexible microendoscope could provide new insights in the study of motile and freely-behaving animal models, with minimal perturbation of their motor and functional activities.

While the damage induced by the insertion of an MMF in biological tissue is vestigial (<50um), the flat tip of the fibre can be engineered to reduce the damage even more. We propose a less invasive fibre termination, which could also offer a 360° view inside the tissue, instead of the usual imaging in front of the fibre tip. This new kind of fibre termination could allow the study of structures even less affected by the fibre probe.

Paper AOP100-233

Optical fiber cavity coated with polyvinylidene fluoride (PVDF) for humidity sensing

Authors: A. Vaz Rodrigues, Faculdade de Ciências da Universidade do Porto (Portugal) and Instituto de Engenharia de Sistemas e Computadores, Tecnologia e Ciência - INESC TEC (Portugal); N. Barroca, Catalan Institute of Nanoscience and Nanotechnology (ICN2), CSIC (Spain); M. Ribeiro, CeNTI – Centre for Nanotechnology and Smart Materials (Portugal); A. Pereira, Faculdade de Ciências da Universidade do Porto (Portugal) and IFIMUP and IN - Institute of Nanoscience and Nanotechnology (Portugal); O. Frazão, Faculdade de Ciências da Universidade do Porto (Portugal) and Instituto de Engenharia de Sistemas e Computadores (Portugal)

An optical fiber tip, ending with a portion of hollow silica tube is coated with polyvinylidene fluoride (PVDF). The small layer of PVDF works as a mirror, forming an optical Fabry-Perot cavity suitable for relative humidity (RH) sensing. The dip coating process of the optical fiber in a PVDF/Dimethyl Formamide (DMF) solution is presented in the fabrication of the optical fiber tip in order to create the optical cavity. The wavelength of the interference pattern shifts due to the refractive index (RI) variation in PVDF which is induced by RH variation. The formation of the cavity is monitored using an Optical Spectrum Analyzer (OSA) to evaluate the desired optical interference pattern and is compared to the theoretical counterpart. The optical cavity is taken to a climatic chamber to be tested in controlled parameters of temperature and humidity and is tested for RH variation, presenting a sensitivity of 32.54 pm/%RH at constant temperature.

Paper AOP100-234

Luminescent materials based on anisometric lanthanide complexes

Authors: A. Knyazev, Kazan national research technological university (Russian Federation); D. Lapaev, V. Lobkov, Kazan Physical-Technical Institute RAS (Russian Federation); Y. Galyametdinov, Kazan national research technological university (Russian Federation)

Lanthanide-containing materials have a number of unique properties. First of all, it is monochromatic luminescence and the ability to get almost any color of radiation from blue to near IR by varying the lanthanide ion. Due to this, lanthanide compounds have found wide application in various fields of science and technology, especially in such innovative areas as molecular electronics and photonics [1]. However, their main disadvantages that impede wider use are low photo and thermal stability and crystallizability, making it difficult to obtain film materials.

Anisometric analogues of the known lanthanide coordination compounds were obtained (fig. 1) [2]. The advantage of these complexes is the photo-and thermal stability, the absence of crystallization, good solubility in organic solvents and low melting point. Such compounds, due to the peculiarities of the structure, are capable to form optically transparent films by spin-coating from solutions and a melt-processing technique (light transmission is 99%), which allows them to be used as photo-stable optical media.

The vitrified films of the Eu (III) and Tb (III) complexes were tested as reusable wide-range fluorescent thermal sensors (fig. 2). Such sensors are widely demanded in the areas of space, aviation, automotive technology, to control the distribution of temperature relief over the surface of various objects. The findings demonstrated that the material is promising as a sensing element for luminescent thermometers suitable for long-term temperature monitoring in the range of 143-333 K.

Paper AOP100-235

Cross-validation of EEG data for Cognitive Workload Evaluation using an Eye-tracker in Imaging System Tasks

Authors: P. Mendonca, Faculdade de Ciencias, Universidade de Lisboa (Portugal); M. Abreu, Faculdade de Ciencias (Portugal)

Cognitive workload and fatigue are important indicators of an operator performance in some image supported tasks. High values of these indicators can reveal the need for a work shift as the human operator becomes the weakest link in the decision loop of a critical task. To assess such indicators, a portable and lightweight system was developed using Electroencephalography (EEG) to read brainwaves and an eye-tracker to detect pupil size.

The system is composed of two hardware parts for biometric data acquisition: an EEG brain-computer interface with dry sensors and an eye-tracker with three cameras. Two of the cameras, one assigned for each eye, have included an infrared LED and images are acquired using an IR band-pass filter in order to improve pupil detection. The visual stimuli presentation is synchronized with EEG by means of a Light Dependent Resistor (LDR or Photoresistor) located on a corner of the computer screen, allowing it to detect light changes in between stimulus. The output signal from the LDR is connected to the EEG acquisition board whose data is synchronized with eye-tracker data via an open-source software, Lab Streaming Layer.

The paper here presented shows some of the work produced towards the implementation of the integrated system focusing on the optical devices. As pupil dilation was found to be related to task difficulty and workload, where generally a dilation of the pupils indicate greater mental workload, these optical components can act not only as complement to the EEG system but also as a cross- validation tool.

Paper AOP100-236

Electrophoretic light scattering for study mixed saliva studies

Authors: E. A. Savchenko, E. Velichko, Saint-Petersburg State Polytechnical Univ (Russian Federation)

Mixed saliva of a human is a unique biological liquid that has a great opportunity for use in fundamental research and in the early diagnosis, prognostication, and monitoring of post therapy status. The study of biochemical composition of mixed saliva and its properties in normal samples and samples from donors with various diseases may reveal some important characteristics for noninvasive diagnostics. In biomedical practice mixed saliva is investigated by various biochemical, chromatographic and optical methods. Optical methods are mostly used due to their high sensitivity, speed, noninvasiveness, low cost, etc. In our study samples of mixed saliva from a healthy patient and patients with different diseases were studied by electrophoretic light scattering technique.

During the measurements particles in saliva migrate to the opposite charge electrode and start to separate into its constituent components due to differences in their electrophoretic mobility. This mobility is converted into zeta potential to enable comparison of molecular solution under different conditions. Experimental results and its interpretation are considered in the report.

Paper AOP100-237

Studies of biological liquid films for preliminary diagnostics

Authors: E. A. Savchenko, M. Baranov, E. Velichko, Saint-Petersburg State Polytechnical Univ (Russian Federation)

A method of functional morphology of biological liquids for medical diagnostics is considered. Studies are based on analysis of structures of self-organized films formed from biological liquids during dehydration. It was demonstrated that a number of diseases has correlations with different structures of dehydrated films. In presented studies blood serum albumin and saliva dehydrated films are analyzed. Some peculiarities of the structure of biological liquids films and possibilities of preliminary diagnostics based on their analysis are discussed in the report.

Paper AOP100-238

Hardware/software co-design for structural analysis of biosubstrate

Authors: E. A. Savchenko, E. Nepomnyashchaya, E. Velichko, Saint-Petersburg State Polytechnical Univ (Russian Federation)

In modern medicine, most clinicist still use blood analysis as the main diagnostic tool. However, existing methods for blood and other biosubstrates review do not allow mass screening studies. In this case, medicine can use a number of optical methods, which usually are able to perform express and simpler types of measurements. Our previous studies have shown that methods based on light scattering, such as dynamic light scattering, are useful for structural analysis of biological fluids, in particular blood serum and saliva. In this work, we discuss an original hardware/software complex based on dynamic light scattering technique. We present an original setup and algorithm of data analysis to analyze compounds of blood serum and other biosubstrates. Some testing of the hardware/software complex have shown high sensitivity and accuracy in structural studies of blood serum. The further applications in medicine are also discussed in the work.

Paper AOP100-239

Laser spectroscopy to meet challenges in medicine

Authors: K. Svanberg, Department of Oncology, Lund University Hospital, Lund University, Sweden and Center for Optical and Electromagnetic Research, South China Normal University, Guangzhou, China (Sweden)

Laser spectroscopy has been shown to be a valuable tool both in the detection and the therapy of human malignancies. The most important prognostic factor for cancer patients is early tumor discovery. If malignant tumors are detected during the non-invasive stage, most tumors show a high cure rate of more than 90 %. Even though there are many conventional diagnostic modalities, very early tumors may be difficult to discover. Laser-induced fluorescence (LIF) for tissue characterization is a technique that can be used for early monitoring the biomolecular changes. Photodynamic therapy is a selective treatment technique for human malignancies. To overcome the limited light penetration in superficial illumination, interstitial delivery (IPDT) with the light transmitted to the tumor via optical fibers has been developed. Interactive feed-back dosimetry is of importance for optimizing this modality and such a concept will be described. The technique has special interest for tumors, where there are no other options, such as for recurrent prostate cancer after ionizing radiation. Another technique which has been developed for medical application, is based on gas in scattering media absorption spectroscopy (GASMAS). The technique is used to detect free gas (e.g., oxygen and water vapor) in hollow organs in the human body and has been applied to the detection of inflammation in the human sinus cavities and in the middle ear in small kids. A certain proportion of these infections are viral induced and in these cases no antibiotics should be prescribed. GASMAS has a potential to discriminate the origin of the disease and thus guide in the decision of appropriate therapy, trying to fight the global problem of antibiotic resistance. The GASMAS technique can also be used for lung surveillance of prematurely born infants, and in that way help them to survive.

Paper AOP100-240

Laser Spectroscopy Applied to Environmental, Ecological, Agricultural and Food Safety Research

Authors: S. Svanberg, Department of Physics, Atomic Physics Division Lund University (Sweden)

The presentation gives a broad account of interdisciplinary laser spectroscopy with examples from the environmental, ecological, agricultural and food safety areas, as studied primarily at Lund University and South China Normal University.

Optical probing of the atmosphere using active remote sensing techniques of the laser-radar type will be discussed, but also some passive techniques employing ambient radiation. Atmospheric objects of quite varying sizes can be studied. Mercury is the only pollutant in atomic form in the atmosphere, while other pollutants are either molecular or in particle form. Light detection and ranging (Lidar) techniques provides three-dimensional mapping of such constituents. Recently, the techniques have been extended to the ecological field. Monitoring of flying insects and birds is of considerable interest, and several projects have been pursued in collaboration with biologists. Fluorescence lidar also allows remote monitoring of vegetation and historical building facades. In agricultural applications, e.g. the fertilization levels of crops can be assessed. Drone-based techniques are now being developed at SCNU. Laser spectroscopy also allows for non-intrusive quality control of pharmaceutical preparations and foods, now mostly employing the gas in scattering media absorption spectroscopy (GASMAS) technique. The talk emphasizes the value of cross- disciplinary work to help solving important societal issues.

Paper AOP100-241

Ultra-low noise optoelectronic sensor in white light source for CCD calibrations instrument

Authors: D. Castro Alves, M. Abreu, A. Cabral, J. Rebordão, Universidade de Lisboa (Portugal)

The astronomical telescopes that in most of the cases work in low light levels calibration of his CCD (charge coupled device) detector is very important. The instrument for the calibration requires three types of measurements – bias, dark current and flat field. In the first two (used for electrical device characterization) there aren't any specific requirements in terms of illumination, since they are taken in the dark. However, in flat field calibration which is used to correct the pixel-to-pixel variations in the CCD response as well as any non-uniform illumination of the detector, the illuminations requirements are more demanding. A good flat field illumination should remain constant.

In this work, it will be presented the design and results of white light source with an ultra-low noise optoelectronic sensor feedback for CCD calibrations. The ultra-low noise optoelectronic sensor is based in a high responsivity PIN detector with low dark current and it has a double oven design that minimizes the noise. The detector presents a thermal stability of ≈10^(-2) K.Hz^(-½) over 24 hours. The voltage noise floor is below 1mμV.Hz^(-½) for frequencies higher than 100 Hz.

Paper AOP100-242

Inspection of virtual images in an AR-HUD from "Innovative Car HMI" project

Authors: M. Duarte, Bosch Car Multimedia (Portugal)

The entry of Augmented Reality Head-Up Display (AR-HUD) in the Automotive Industry requires testing procedures to classify this one. The procedure built along the "Automotive Car HMI" project determines objectively if the Projection Distance, Astigmatism, Field Curvature, and Geometric Distortions of a Virtual Image from the AR-HUD behaves within the requirements, in a single shot evaluation. This designing aligns with the technology of recent Plenoptic Cameras (such as Raytrix R42). A curve of calibration converts Virtual Distance (VD) to meter. Ending-up in an algorithm that computes all the AR-HUD industrial metrics in a single run code.

Paper AOP100-244

Controlling light to the limit with the dispersion-scan technique: from single-cycle pulses to biomedical imaging

Authors: H. M. Crespo, Universidade do Porto (Portugal)

Ultrashort laser pulses lasting for only a few femtoseconds (1 femtosecond = 10^-15 seconds) and containing only a few oscillations of the electric field are among the shortest optical phenomena ever generated and measured, and are finding a growing number of applications in science and technology. In the few-cycle regime, light-matter interactions exhibit a strong dependence not only on the intensity profile of the pulses but also on their electric field. Knowing and controlling the electric field of light is paramount for attosecond science (1 attosecond = 10^-18 seconds), which is providing direct access to the ultrafast dynamics of fundamental processes in matter, allowing for the ultimate control of physical systems and devices. Despite the huge potential and demonstrated impact of few-cycle pulses in cutting-edge research, their widespread use has been hampered by limitations and difficulties in pulse measurement technology.

The dispersion-scan (d-scan) technique presents a new paradigm in ultrashort pulse measurement and control that effectively came to solve many of the problems associated with traditional pulse characterization methods, enabling the measurement and compression of extreme femtosecond pulses comprising only a single oscillation of the electric field. These sources are now behind a variety of high-impact results and applications.

In this talk we will review key aspects of the technique and present recent d-scan-enabled applications and results, ranging from ultrafast spectroscopy to improved biomedical imaging, and the first all-optical measurement of the electric field of light itself.

Paper AOP100-245

Light diagnostics and Light treatments in the eye

Authors: S. Celestino Marcos, Instituto de Optica "Daza de Valdés" (Spain)

The talk will present an overview of optical techniques that are serving to better understand basic mechanisms of vision, and that have evolve into light, portable and user-friendly diagnostics tools in the ophthalmology clinic. Besides, better knowledge of the optical, morphological and biomechanical properties of the eye, and novel use of photo-activated techniques, is leading to new paradigms for treatment.

The talk will give some examples of light-based treatments that hold promise in the correction of prevalent ocular conditions

Paper AOP100-247

Open access to European photonics prototyping platforms for innovation-driven researchers: “ACTPHAST4R”

Authors: H. Thienpont, P. Doyle, D. Martindill, J. Vlekken, N. Debaes, Vrije Universiteit Brussel (Belgium)

In this presentation we introduce the unique opportunities created with the “ACTPHAST for Researchers” EC-supported project to provide researchers with open access to the best photonics prototyping platforms in Europe. “ACTPHAST4R” is a one-stop-shop photonics technology access and support centre which is perfectly aligned with the needs of innovation-driven researchers in bridging the gap between their fundamental proof-of-concept (TRL1-2) and a research prototype (TRL4-5). “ACTPHAST4R” will provide a critical mass of European top-class researchers -in particular non-photonics researchers for whom advanced photonics is a key enabling technology to the realisation of new applications and products- with action-oriented solutions on two complementary levels. In the first instance, ACTPHAST4R will provide researchers with one-stop-shop access to the photonics expert know-how and mature technologies of 24 of Europe’s leading competence centres. The photonics technology platform capabilities of ACTPHAST4R cover the entire integrated supply chain from design to packaging, and embrace technologies ranging from free-form optics, over optical fiber technologies, to photonic integrated circuits, and MOEMS. Through intensive technology coaching, leading to focused innovation projects involving transnational internships and hands-on working with the advanced photonics technologies at the access centers, the goal is to turn the researchers’ scientific conceptual breakthroughs into industrially- relevant demonstrators. In parallel, ACTPHAST4R will provide researchers with expert business coaching to help foster their entrepreneurial mindset and deployment capabilities, with guidance to pathways for further scaling of their demonstrators and financing of innovation in the industrial domain. Ambitious targets are set for commercial valorisation successes by “star performing” researchers in the form of patents, licensing deals and spin-outs. ACTPHAST 4R will be a game-changer for the European researchers in strengthening the European innovation ecosystem and improving the cross-fertilisation of photonics with other technology areas.

Paper AOP100-248

Mid-infrared photodetectors based on resonant tunneling diodes and interband cascade structures

Authors: F. Hartmann, University of Wuerzburg (Germany)

The increasing demand for mid-infrared (MIR) light sources suitable for, e.g. molecule or gas sensing applications, has driven the development and optimization of novel MIR laser concepts such as quantum cascade lasers (QCL) or interband cascade lasers (ICL) within the recent years. Despite the excellent progress on MIR light sources, there is still a lack in appropriate MIR photodetectors. Here, we present and discuss two promising and novel GaSb/InAs-based detector concepts covering the wavelength range between 3-6 μm, i.e. the MIR wavelength range that includes the "fingerprints" of many chemical compounds of gases. First, resonant tunneling diode (RTD) photodetectors as an alternative to avalanche photodetectors. In RTDs, amplification of photogenerated minority charge carriers is based on modulation of a majority charge carrier resonant tunneling current. We present RTD based photodetectors consisting of a GaAsSb/AlAsSb double barrier structure and a quaternary Ga0.64In0.36As0.33Sb0.67 absorption layer, which are sensitive to light illumination up to a wavelength of 3.5 μm. Second, we discuss interband cascade photodetectors (ICD), in which a cascading scheme allows for fast carrier extraction and a compensation of the diffusion length limitation. ICDs combine the advantages of optical interband transitions of type II superlattice photodetectors with the excellent transport properties and the cascading principle of ICL structures.

Paper AOP100-249

Structural health monitoring with fiber Bragg grating sensors: challenges on optical interrogators

Authors: F. Araújo, HBM FiberSensing (Portugal)

Fiber Bragg grating technology is currently an established solution for structural health monitoring in a broad range of applications such as bridges, wind energy plants, pipelines, tunnels and oil rigs. The main objective is to monitor a structure over time by using measurements from Bragg grating sensors and analyzing data to determine the current state of structural health. The implementation of such monitoring systems sets specific requirements on the optoelectronic interrogators. The impact on the interrogators design will be discussed from the signal conditioning to the strategies for smart peak detection algorithms.

Paper AOP100-250

Nanostructured yttrium aluminum composites doped with the rare earth elements: sol gel synthesis and up-conversion luminescent behavior

Authors: M. V. Stepikhova, Institute for Physics of Microstructures (Russian Federation)

In this work, we report on the sol-gel synthesis and luminescence properties of yttrium aluminum nanocomposites doped with Er3+ and Yb3+ rare earth ions. These materials are of interest for photovoltaic, sensoric, bio-imaging and other applications due their up-conversion properties enabling to convert the near infrared radiation in the visible and even UV ranges [1-3]. The yttrium aluminum nanocomposites doped with Er and Yb were synthesized by the sol gel method. The corresponding sols were prepared by the stage-by-stage dissolution of the nitrate salts in alcohol and distilled water, with the citric acid used as a complexing agent. To obtain the composite powders, the finished sols were subjected to the multistage heat treatment in the temperature range of 200-1000°C.

According to the X-ray diffraction data, the powders synthesized by this technique have the (Y,Er,Yb)3Al5O12 stoichiometry and crystallize in the yttrium aluminum garnet phase with the crystallite size of ~ 40 nm and the average lattice parameter of 12 Å. We show that these powders demonstrate efficient up-conversion luminescence in the wavelength range extending from 400 to 1050 nm. Several luminescence bands were observed in the up-conversion spectra of these powders under near-IR (1535nm) excitation. These correspond to the optical transitions of Er ions: 2H9/2→4I15/2, 4S3/2→4I15/2, 4F9/2→4I15/2, 4I9/2→4I15/2 and 4I11/2→4I15/2. The mechanisms of up-conversion processes as well as the processes of inter-ion (Er-Yb) interactions were analyzed by means of the photoluminescence excitation spectroscopy and the time resolved spectroscopy methods with nanosecond time resolution.

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Paper AOP100-251

Bose-Einstein Condensation of Photons in a Dye-filled Microcavity

Authors: J. Rodrigues, Imperial College London (United Kingdom)

Bose-Einstein condensation, the accumulation of particles in the lowest energy mode due to the quantum statistical nature of bosons, has been realized in a number of different systems. Here we discuss the case of photons trapped and thermalized in a dye-filled microcavity. In contrast to polaritons in microcavities, the high molecular dephasing rate due to collisions with solvent phonons means that the condensed particles are wholly light-like. The driven-dissipative BEC formation process depends on the balance between cavity pump and loss, and thermalization imposed by multiple scattering events with dye molecules.

We present recent results on Bose-Einstein condensation of a very small number of photons, typically less than ten. The small particle number combined with the ability to spectrally resolve different cavity modes enables a full characterization of the bosonic field. By tuning the degree of thermalization, we observe a transition into multimode condensation, thus elucidating on the long-standing discussion on the differences between Bose-Einstein condensation and lasing.

Finally, we discuss recent developments on the temporal characterization of the formation of a pulsed photon BEC. Complex dynamical features are revealed due to the time-dependent nature of the cavity pump. In particular, we measure the (non-equilibrium) degree of second order coherence, which carries information about the time uncertainty associated with the statistical nature of spontaneous emission at the very beginning of condensation or lasing.

Paper AOP100-253

Axions: Search for Dark Matter using Ultra-Intense Lasers

Authors: J. Mendonça, IPFN-Instituto Superior Tecnico (Portugal)

Dark matter is a key ingredient to physical cosmology and one of the mysteries of modern science. Among a variety of possible candidates (generically referred as WIMPs and WISPs), axions are the most promising constituents of dark matter. These hypothetical particles have been proposed to solve fundamental problems of chargeparity (CP) invariance. The proof of their existence has been actively searched for more than one decade, without success, using both laboratory experiments and astrophysical observations.

In recent years, it became clear that, if they exist, the axions could be actively produced by intense laser pulses in vacuum [1,2]. Alternatively, the signature of axions could be found in the dispersion relation of electrostatic waves in strongly magnetized plasmas, due to the formation of polariton states [3]. This leads to a local distortion of the dispersion properties of electron plasma waves, in a spectral region where the phase velocity approaches the speed of light c.

In our presentation, we consider the excitation of axions by intense laser pulses, propagating in both vacuum and plasmas. A discussion of possible new experimental configurations, based on intense laser pulses, and using the available technology is also included.

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Paper AOP100-254

Development and application of laser hologram production techniques for the teaching of Physics and the public awareness of science

Authors: J. Chibaca, H. Crespo Sr., IFIMUP-IN and Department of Physics and Astronomy, Faculty of Sciences, University of Porto (Portugal)

Holography is a part of Optical Physics that deals with the capability of producing three-dimensional images using coherent light sources, namely lasers. Key phenomena in Optical Physics, such as interference and diffraction, are directly behind its remarkable characteristics. The main objectives of this work follow along two major lines: i) the development of experimental approaches enabling the production of holograms using simple and inexpensive setups, and ii) the production of holograms effectively capable of illustrating important physical principles and effects, with the purpose of engaging students in the study of Physics, and to reinforce the yet modest presence of Optical Physics (including interferometry) and Modern Physics in undergraduate physics courses in Angola. Through this approach, we will show how interference and diffraction phenomena are vital to many fields of applied physics, and how holography can be applied in differents areas of science, technology and industry. To achieve this goal, existing laser holography techniques will be studied and optimized, not only through a careful choice of materials (from light sources to optical components and recording/development procedures) aimed at simplifying experimental setups and reducing costs, but also by taking into account the object or theme to be holographed, so as to provide effective and appealing illustrations of relevant physical phenomena and applications.

Paper AOP100-256

Organometallic Non-Linear Optical Materials

Authors: G. P. Joseph, B. John, P. Thomas, St Thomas College (India)

Nonlinear optics (NLO) has emerged as one of the most attractive fields of current research in view of its vital applications in areas like optical modulation, optical switching, optical logic, frequency shifting and optical data storage for developing technologies in telecommunications and signal processing. Materials with large SONLO properties, short transparency cut off wavelengths and stable physicochemical performance are needed to realize many of the above applications. Bimetallic thiocyanates of type AB(SCN)4 with A=Zn, Co, Ni, Mn, Cd and B=Cd, Hg are one among those which satisfy the above mentioned features. Their crystal structure consists of two kinds of slightly flattened tetrahedral: AN4 and BS4. The most striking features are the –N=C=S– bridges, which connect the center atoms of the infinite three dimensional –A–N=C=S–B– networks. The metal ligand bonding in organometallics gives rise to the large macroscopic nonlinearities and excellent physicochemical stabilities due to the transfer of electron density between the metal atoms and the conjugated ligand systems. Organometallic and coordination compounds offer a variety of molecular structures by changing the metals, ligands, coordination numbers and so on. This diversity of molecular structure gives an opportunity to tune the electronic properties of the molecules, and hence to exploit the linear and nonlinear optical properties. The metal center can also behave as either an electron donor or acceptor due to the rich oxidation-reduction properties of the transition metals. Therefore, it can be expected that some novel NLO materials may be found from organometallic or coordination compounds that may combine the features and advantages of both inorganic and organic compounds, and possibly replace the existing inorganic and organic NLO materials. The present paper deals with the electrical, optical and thermal properties of organometallic crystals. Bimetallic thiocyanates of type AB(SCN)4 is synthesized using low temperature solution growth technique.

The grown samples have been confirmed using LIBS and single crystal XRD. The linear optical properties have been analyzed by measuring the cut off wavelength, band gap, Urbach energy and the refractive index of the grown crystals. The nonlinearity of the samples has been studied through open aperture Z-scan technique. The dielectric studies revealed that dielectric constant, dielectric loss decreases with increasing frequency. The electronic polarizability and thermal properties of the samples have also been investigated.

Paper AOP100-257

Optical phased arrays for enabling solid-state LiDAR systems

Authors: M. S. Dahlem, IMEC (Belgium)

The increasing development of autonomous vehicles and robotics is pushing the envelope of research in low-cost compact solid-state Light Detection and Ranging (LiDAR) systems. The technology is also used in land surveying, and has potential applications in space, security and defense. A LiDAR provides 3D machine vision by mapping out the surrounding environment, providing information on location, direction and velocity of objects within its range. In combination with other traditional sensing technologies (imagers, RADAR, ultrasound), LiDARs will be key enablers for future smart mobility platforms. The principle of operation of a LiDAR (which operates in the visible or near-infrared domain) is similar to its more mature counterpart RADAR (which uses radio frequencies). One important building block in most current LiDAR systems is the optical beam scanner, which is used to illuminate the scene or target being monitored and/or collect the reflected light signal for detection and further processing. Most existing LiDAR solutions involve mechanical beam steering devices, making them bulky and expensive. For a wide implementation of such technology in autonomous vehicles, future LiDAR systems will have to rely on more compact, cheaper and non-mechanical beamformers. In this talk, we present IMEC's recent work on chip-level beamformers (Si/SiN platform) based on optical phased arrays (OPAs). OPAs with several thousand emitters (here, leaky wave antennas), typically spaced by a few microns, result in large apertures that form narrow far-field beams. 2D beam steering is achieved by thermal phase shifting and/or wavelength tuning, with grating-free steering angles of several 10s of degrees.

Paper AOP100-258

Crack growth testing automation in fracture mechanics

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Measurement and monitoring crack growth is a fundamental activity in experimental Fracture Mechanics, tantamount to the determination of material Toughness expressed through the Stress Intensity Factor. The appraisal of a crack tip position is very dependent on operator's experience and sensitivity, which determines both reading time intervals and measurement variability. This experience is particularly significant near the end of the experiment, as missing measurements due to increase in crack growth rate can jeopardize the meaningfulness of the entire test. Furthermore, variability in the evaluation of the crack length can contribute to inconsistency in the experimental results.

In order to address these problems, an automated Vision system was developed at INEGI, which includes a patented darkfield illumination device with grazing light incidence, to assist in the detection of the smallest hairline crack in a metal specimen. The Vision system applies morphological image processing to extract crack features, such as preferred crack direction and size, from images obtained through the use of the illumination device. Using this system, continuous calculation of a fatigue crack growth rate, da/dN without test machine interruption is provided to the experimentalist in an optimized image acquisition procedure that saves as much as 7/8 of the traditional operation length.

The software tool was developed using MATLAB and is being provided to the Experimental Mechanics Community as a free and open-source solution, available both in Github and in Mathworks' MATLAB Central, with the main goal to provide means for accurate, contactless, and automated measurement of fatigue crack length in fracture experiments to all experimentalists.

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Laser ranging in underwater medium: a study into the effect of influence factors on the system performance

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Underwater detection has always been a challenge due to the limitations caused by scattering and absorption in underwater environment. Because of the great penetration ability, laser has become the most suitable technology for underwater detection. In laser ranging application, the reflected laser which contains the key information for most of the system is highly degraded along the laser propagation and reflection in water medium. Due to the complications in underwater environment, it is necessary to study the influence factors and their impact on underwater laser ranging system. In this study, we investigate the influence of incident angle, target distance, and medium attenuation. A systematic investigation of the influence factors on the reflectance and ranging accuracy is performed theoretically and experimentally. Theoretical analysis is demonstrated based on the Bidirectional Reflection Distribution Function (BRDF) and Laser Detection and Ranging (LADAR) model. An underwater peak detection pulse laser ranging system is set up for experimental investigation. The experimental results agree well with the theoretical results which show the system dependency on the reflection intensity caused by the incident angle, target distance, and medium attenuation. According to the simulation and experimental research, it can be concluded that influence factors have a direct impact on the system performance. The findings can be a reference to extend the future works to improve the performance of an underwater laser ranging system.

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