CLEO®/Europe 2019 Topic Descriptions

CA - Solid-state Lasers

The results presented in the topical area CA "Solid-State Lasers" of the CLEO-Europe conference cover different areas from novel solid-state lasers and amplifiers to large-scale laser facilities, from UV sources to mid-infrared lasers and nonlinear sources in different geometries like thin-disk and waveguide lasers operating in continuous wave and pulsed operation mode. The program for the topical area CA "Solid-State Lasers" will offer eleven high-quality technical oral sessions and one poster session with 51 contributions. This year's three pre-invited talks include a review on the history of diode-pumped Ti:sapphire lasers, the development of sesquioxide ceramic laser materials for the mid-infrared range, as well as the hot topic of waveguide lasers directly inscribed by femtosecond laser beams. Furthermore, there will be two upgraded invited talks, one presenting the recent progress at the ELI-beamlines in Czech Republic and the other one reporting on transition metal ion doped laser materials pumped by LEDs. The contributed technical program in 2019 will include state-of-the-art thin-disk laser research results, such as the first sub-100-fs laser oscillator with more than 20 W of average output power, a 4 kW single transversal mode thin-disk laser, or a dual comb thin-disk laser. The first diode-pumped visible terbium laser will also be presented. Results on high energy systems with ps and fs pulse duration at remarkable hundreds of mJ pulse energy level in the 1 µm and 2 µm wavelength range including a whole session on large-scale laser facilities are also part of the technical program. Moreover, in a session on beam control, outstanding results on high power radially polarized thin-disk lasers as well vortex lasers at different wavelengths will be presented. Following the trend of the last CLEO-Europe conferences, there will be several sessions on lasers with mid-infrared emission, in particular in the 2 µm and 3 µm spectral range. The above are few of the highlights to be discovered during the eventful week of CLEO-Europe in June 2019, now an established forum for the presentation and discussion of the newest developments and breakthroughs in solid-state laser technology.

CB: Semiconductor Lasers

Semiconductor lasers are nowadays the type of lasers with the highest share of the worldwide market, and are widely used in optical communications, spectroscopy, remote sensing, bio-medicine, industrial process monitoring and manufacturing.
This conference covers a wide range of hot topics in semiconductor laser research, spanning from fundamental physics to novel technologies aiming at the development of advanced and versatile devices that generate light of different wavelengths specifically tailored in space, time and frequency domain.
We have an impressive line-up of international speakers covering:

- Long wavelength and THz semiconductor lasers driven by applications as spectroscopy, environmental sensing, non-invasive medical diagnostics and free space communications. This demand pushes various technologies such as cascaded structures and antimonide based lasers
- Novel semiconductor laser technology concepts such as flexible and ultra-lightweight polymer lasers
- Exciting physical concepts in nano-lasers enabled by the advances in micro- and nano-fabrication techniques. These have also pushed further the integration of gain structures with different optical elements and new functionalities;
- Recent advances in generation of optical frequency combs and ultra-short pulses from a variety of very different semiconductor laser technologies
- High power lasers for LIDAR and space-borne applications

CC: Terahertz Sources and Applications

The joint symposium "Terahertz Sources and Applications" covers the latest advances in the vivid field of Terahertz fundamental physics and applications. The Terahertz frequency range remains a very exciting and unexplored part of the electromagnetic spectrum. Efficient radiation sources and imaging systems are under development and nonlinear interactions in this frequency range are being explored using recently developed sources. The joint symposium consists of eight oral sessions with the topics

1) Terahertz time-domain spectroscopy,
2) Terahertz quantum cascade laser and combs,
3) Terahertz quantum optics and spintronics
4) Terahertz quantum cascade laser and imaging
5) Terahertz applications.
6) High power THz pulse generation
7) CW Terahertz system and spectroscopy
8) High power Terahertz sources and applications

Among the highlights of the program are the invited talks of Cristina Benea Chelmus reporting on the measurement of time and spatial correlations of terahertz vacuum fields as well as the Terahertz spintronics Tobias Kampfrath. Other highlights are progresses in c.w. high resolution THz spectroscopy (invited talk of Michele De Regis), as well as progress in terahertz quantum cascade laser frequency combs and applications. Discussed in the sessions will be also Terahertz generation with record high field intensities as well as the development of near-field spectrally resolved Terahertz microscopy techniques.

CD: Applications of Nonlinear Optics

The CD program presents novel applications of nonlinear optical phenomena and new devices. The topics cover spectral broadening, super continuum nonlinear frequency conversion and light propagation in waveguides, fibers and micro-resonators, including photonic crystal structures, nano- and two dimensional materials. Novel technologies for tunable light sources including optical parametric amplifiers and oscillators are present. Advances in nonlinear imaging, spectroscopy and upconversion Systems are discussed. Nonlinear applications at extreme wavelength from the EUV to the IR start to emerge in the field. Quantum oriented applications and information technologies are present. New developments in high power lasers and spatio temporal manipulation of light are portrait. On micro-chip scale nonlinear devices and application for telecommunication are displayed.
A number of distinguished invited speakers completes the very active area of applications of nonlinear optics.

CE: Optical Materials, Fabrication and Characterisation

The topical session CE is devoted to modern and novel aspects in the fields of fabrication and characterization of optical materials.
In his invited presentation, Marko Lončar from Harvard University, Cambridge (USA) will highlight recent exciting developments and applications of nanophotonics.
Angela Seddon from University of Nottingham, UK will present an invited talk on mid-infrared fibres and glasses for impressive medical applications.
Manfred Fiebig from ETH Zurich, Switzerland, will review the nonlinear optical techniques to gain insight into multiferroic materials, which exhibit pronounced coupling effects between magnetic and electric properties, and hold promise for novel devices.
Charles Mackin from IBM Research Almaden, USA, will take us into the remarkable inter-disciplinary world of resistive memory, neural networks and optical components and assess challenges and opportunities for optical implementations of brain-inspired computational algorithms.
Julian Gargiulo's invited talk from Ludwig-Maximilan-Universitat, Germany, will present an on-chip hollow-core waveguide – the light cage – fabricated by 3D nanoprinting, a promising platform for real-time gas sensing or nano-object tracking.
The final invited talk from Università di Roma la Sapienza, Italy, will be presented by Ludovica Falsi, addressing "giant" broadband refraction in the visible in ferroelectric perovskites which promises to overcome chromatic aberration and shrink the diffraction limit down to the nanoscale. This allows new opportunities for nanoscopic imaging and improving the performance of photovoltaic cells.

The most recent advances in the fabrication, characterization and application of novel optical materials will be presented and discussed in sub-sessions devoted to: Opportunities for advanced nanostructured and non-linear optical materials; Infrared materials, fibres, glasses and applications; Multiferroics and non-linear optics and photonics; Neuro-inspired computing and random photonics; Microresonators and diffractive optics; Metamaterials and functional photonic bandgap systems; Advances in optical fibre configurations and materials; High performance Bragg gratings and mirrors; Rare earth polymers, ceramics, fibres and beyond; Novel light confinement waveguide technologies; Advanced layered materials for photonics.

CF: Ultrafast Optical Technologies

Ultrafast Optical Technology is still a highly topical and rapidly evolving research field, which is strongly reflected in this year's contributions. Key focus areas are the development of novel technologies for ultrashort pulse generation, characterization and control, and their applications on ultrafast (femtosecond) timescales. The presented methods and applications cover an extremely broad spectral range, from the infrared to the extreme-ultraviolet domain.

The invited talks cover several frontier topics in ultrafast science: polarization control in high-harmonic generation (by M.C. Chen), fiber lasers for pushing ultrafast spectroscopy to the single-photon limit (by A. Leitenstorfer), generation of broad-band ultrashort pulses in gas-filled photonic-crystal fibers (by D. Novoa), non-linear propagation of ultrashort mid-infrared laser pulses (by V. Shumakova). Twelve oral sessions will feature presentations from leading scientists covering the hottest topics in the field, ranging from fundamental ultrafast technologies to novel applications with disruptive potential.

The topics featured are: Ultra-broadband laser sources; New technology for ultrafast oscillators; Novel methods in pulse characterization; New avenues in generation and characterization of ultraviolet pulses; Oscillators with high average power; Recent developments in few-cycle pulse generation; Advances in harnessing the carrier-envelope phase; New sources for extreme-ultraviolet light; Fiber lasers; Wavelength conversion; Solitonic pulse propagation.

CG: High-Field Laser and Attosecond Science

The field of attosecond and high-field physics rapidly expands from its gas phase origins towards applications in solid systems. At the same time spin and orbital angular momentum of the interacting light as well as the studied system add new observables. Anne L'Huillier, from Lund University and a pioneer of this field, presents a tutorial about the origins, the fundamentals and the trends in attosecond science. Progress in this area is further nurtured by rapid advances in ultrafast laser sources – in particular, towards high repetition rates and average powers.

The rapid growth of high-field science in the condensed phase is prominently reflected in three sessions at this conference. In a session devoted to attosecond dynamics in bulk solids, Julia Gessner from the Max-Planck-Institute of Quantum Optics in Garching reports in an invited talk on a recent experiment accessing ultrafast magnetization dynamics with attosecond tools. Several speakers demonstrate how the generation of high-harmonics in solids can provide insights into high-field phenomena in these systems.

The aspect of spin and angular momentum in strong-field ionization is discussed in the invited talk of Reinhard Dörner from the University of Frankfurt. He and his team utilize the m-state selectivity of strong-field ionization to produce spin-polarized electrons and ionic ring currents.

At the same time an entire session is devoted to the optical aspects of spin and orbital momentum. In the invited talk of Thierry Ruchon, from CEA Saclay, the transfer of orbital angular momentum in noncollinear high-harmonic generation is discussed. As he and other speakers in that session show, these sources open the door to control and spectroscopy of chiral systems. Circular polarization is also attractive for studying ultrafast magnetic properties.

Substantial progress has also been made in the application of advanced attosecond spectroscopy techniques to samples of reduced dimensionality, ranging from zero-dimensional quantum dots to two-dimensional materials.

The parameter range of high-field laser sources is continuously being expanded. The two major trends are the scaling of high-harmonic driving lasers to higher repetition rates, leading to ever-increasing photon flux

of the harmonic extreme ultraviolet emission. This opens new opportunities for imaging, field emission spectroscopy and coincidence techniques.

CH: Optical Sensing and Microscopy

Since the invention of the microscope, increasing the resolution of optical images has enabled us to improve our understanding of very small objects and living systems and to detect a wide range of details relevant for material science, diagnostics and environmental monitoring. With the latest advances in lasers, fiber optics and integrated photonics, sensor systems with ever increasing sensitivity and speed are emerging, while footprints are becoming smaller and costs are decreasing.
The papers that are going to be presented in this topic offer a glimpse at the breadth of this dynamic and growing research area. The 13 sessions of selected oral presentations include Spectroscopy and Microscopy, Integrated Sensors, Lidar Systems, as well as sensors based on photoacoustics, optical fibers and nanostructures, which are used to study gases, biomolecules, cells and environmental conditions. Further applications and techniques are covered in a rich session with 48 posters.
We are privileged to explore the frontiers of this field with five invited presentations on highly sensitive fiber sensors, on-chip diagnostics, photonic crystal protein sensors, hyperspectral imaging and optomechanical tissue analysis, delivered by Hans-Peter Loock from Queen's University (Canada), Boris Mizaikoff from Ulm University (Germany), Jian-Jang Huang from the National Taiwan University, Cristian Manzoni from Politecnico de Milano (Italy), and Andre Armani from University of Southern California (USA).

CI: Optical Technologies for Communications and Data Storage

Increasing capacity of optical networks and making faster optical signal processing drives technological breakthroughs in the field of optical communications, storage and computing. This topic area covers theoretical and experimental aspects ranging from devices and systems to various types of applications, such as nonlinear propagation, spatial division multiplexing, photonic processing, signal regeneration, lasers and large-scale switching.

Two invited papers clearly highlight these trends: Georg Böcherer (Huawei Technologies, France) will talk about probabilistic shaping as a new paradigm for optical communications to reach the Shannon capacity limit. The invited talk by Antonio Napoli (Infinera, Germany) on multi-band optical systems highlights how trade-offs among complexity in implementation and performance should be considered for ultra-high speed transmission systems. In addition to these invited papers, 26 oral presentations organized in 5 sessions and 17 posters illustrate the most recent advances in neural network assisted receivers, in computational efficiency and noise robustness in Nonlinear Fourier Transform based transmissions, and in optimization of transmission systems and components for metro and short-range links. Other interesting perspectives discussed along the papers are high-speed, energy efficient integrated photonics, and phase and spectrum control for pulse shaping and wave manipulation.

CJ: Fibre and Guided Wave Lasers and Amplifiers

This topic covers different aspects of waveguide and fibre laser oscillators and amplifiers including novel waveguide and fibre laser architectures; power scaling of waveguide and fibre lasers - including beam combination techniques; mid-infrared lasers and nonlinear coherent sources; ultrashort-pulse generation and amplification; advances in spatiotemporal effects in multimode fiber lasers; nonlinear frequency conversion in different waveguide geometries including solid and hollow core fibres; fabrication techniques for doped waveguide and fibre devices; active microstructured fibre and waveguide laser devices; as well as novel waveguide and fibre sources for industrial applications.

CK: Micro- and Nano-Photonics

Micro- and Nano-photonics presents topical research in nanofabrication, exploitation of new materials, novel devices and applications. The research encompasses a wide range of materials including semiconductors, silicon photonics, liquid crystals, graphene, quantum dots, nanowires, germanium etc. A

strong trend in exploiting and harnessing light coupling into, from photonic integrated circuits and optical free space systems for applications as various as sensing, imaging, controlling the emission properties has appeared this year. We also oversee the progress of metamaterials and –surfaces on lightwaves at the interfaces which are active research field. Nanostructured metasurfaces allow unprecedent control of the phase of the optical field interacting with the metasurface. Notable interest was also expressed towards optical resonators in a form of nanocavities and whispering-gallery mode devices. These devices enable sensitive detection platforms due to extremelly high quality factor of their resonance. On the other hand, nanocavities enable nanovolume localization of light fields. Nanoscale localization serves as a tool to probe the properties of, for example, single molecules or quantum properties of matter. CLEO Europe will excite interest from researchers, students and industrialists. The covered subjects illuminate the on going and future directions of Horizon Europe research.

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CL: Photonic Applications in Biology and Medicine

Biophotonics is a rapidly growing area within photonics that is focused on the applications of light to basic biological and biomedical research. In Biophotonics, optical and photonic systems are used for high-throughput diagnostics, imaging, sensing, manipulation, and therapy. This exciting area of photonics experiences ever growing interest and expanding applications - covering length scales from the centimeter scale (whole organs) to the nanoscale (single molecules) and time scales from minutes (medical diagnostics) to femtoseconds (molecular vibrations). Biomedical imaging using ultrashort lasers has rapidly expanded in recent years and now enables label-free molecular imaging and sensing in-vivo.

At CLEO Europe 2019, an entire session is devoted to the latest research on nano-optics and light manipulation. In a separate session, the focus is on label-free imaging techniques which do not rely on artifical markers. In many cases this may replace invasive biospsies and time consuming sample preparation with non-invasive optical in vivo diagnosis.

In addition, other emerging concepts in biophotonics, such as chip-based compact diagnostic devices will be presented. The integration and miniaturization of optical technologies enables ever smaller devices for medical and environmental sensing. Indeed, in the meeting, several clinically relevant applications are being presented, as a proof of success in transferring novel technologies to the clinic. The integration and miniaturization of optical technologies enables even smaller and cost-effective devices for medical and environmental sensing, available to everybody.

Other exciting topics presented during biophotonics sessions include developments in laser technology, covering ultra-rapidly wavelength swept light sources, novel high-intensity lasers and their integration into systems for biomedical applications. Also we see a rising number of optical systems incorporating enhanced data processing strategies using artificial intelligence, deep learning and big data analysis. More

information can be extracted from the optical measurements for more precise and faster diagnosis and for monitoring disease. This extends the capabilities of personalised medicine.

These methods and inventions are supported by the continuous development of lower cost, more compact and advanced light sources for microscopy, phototherapy, and surgery which will be presented and demonstrated at the 2019 World of Photonics exhibition.

CM: Materials Processing with Lasers

This session reports on progress in material processing with lasers. Recent trends in micro/nano processing; generation of nanoscale features in transparent materials; refractive index modifications; laser interactions with dielectrics, semi-conductors, metals and polymers will be discussed as well as new physical phenomena behind advanced material processing. A strong emphasis will be given to ultrafast laser processing of materials, as this field is very rapidly growing due to remarkable progress in laser systems and beam engineering. This year highlights include in-volume laser processing of silicon, advanced beam shaping for material processing, femtosecond laser waveguide writing and laser additive manufacturing at the micro/nano-scale. Novel applications will also be introduced such as in-volume diamond processing and laser-written optical components for phase control.
This session will address a broad audience, from attendees interested in the fundamentals of light-matter interaction to participants willing to learn about emerging applications.

EA: Quantum Optics and Ultracold Quantum Matter

Quantum Optics uses the fundamental interaction between quantum light and quantum matter for applications like the generation of complex entanglement, fundamental precision measurements, and novel photonic devices. The interaction between light and matter is also the key tool for generating and controlling ultracold quantum matter offering unprecedented opportunities for exploring fundamental quantum few-body and many-body phenomena.
The study of quantum optics and ultracold quantum matter not only provides insight into the quantum and microscopic worlds, but also have a strong technological potential in emerging quantum technologies. For instance, researchers use atomic vapor, sometimes cooled almost to the absolute zero of temperature, to make new kinds of quantum sensors and quantum simulators, or for storage and retrieval of quantum light. Ultracold quantum matter can be manipulated and monitored to reveal effects like non-linear modes and solitonic patterns in non-equilibrium quantum gases. Detection schemes based on fundamental quantum interference have been designed to measure the quantum properties of light at the single-photon level. A whole new research field is being developed, as we understand how to use the interactions of these quantum objects with each other to address problems of measurement, sensing and simulation. These building blocks form the basis of emerging quantum technologies. Scientists are bringing these ingredients together with the aim of inventing practical devices that are robust, simple to use and offer new capabilities. Important recent developments are the construction of a plethora of different quantum light sources, and integrated photonic devices. Impressive steps towards scaling these to large arrays have been taken, which will eventually pave the way to complex quantum machines.

EB: Quantum Information, Communication, and Sensing

Quantum information is a large and very active field of physics and engineering with strong connections to atomic physics, condensed matter physics, and photonics. The basic technologies for these are trapped ions and atoms, photons in integrated waveguide circuits, superconducting qubits, single quantum dots and other individual solid state quantum systems. In quantum communication we are concerned with secure communications and the networking of quantum computers, where important components like quantum memories and interfaces are under development. In quantum computing the few qubit applications and small-scale quantum simulations dominate the current research. The level of control and coherence and the development of integrated components that has been achieved in a large variety of systems allows implementing more and more complex quantum operations and algorithms. In the few qubit applications a significant amount of research goes into developing better, sources or state preparation, higher fidelity quantum gates and improved readout and detection. Quantum sensing finally uses quantum coherence to enhance measurements in terms of precission and sensitivity.

EC: Topological States of Light

The study of topological effects of light has recently emerged as a promising research avenue for the manipulation of photons at the micron-scale. Topology describes properties of a physical system that remain unaffected by distortion. For instance, the transport properties of electrons in topological insulators are unaffected by disorder or deformations of the material. The implementation of these concepts in the world of photonics is opening new opportunities in the fabrication of micrometric scale photonic chips and lasers with photonic transport properties intrinsically robust to noise and disorder. This line of research anticipates the design of photonic devices whose functionalities are immune to the fabrication imperfections inherent to photonics technology. From a fundamental point of view, the fabrication of lattices of photonic resonators offers the opportunity to study a number of topological Hamiltonians whose properties can be directly accessed using standard optical techniques.
Beyond the physics directly inspired by solid state systems, photonic platforms allow one to study novel concepts with no counterpart in any other physical system, at the crossroads of topological physics and optics. Genuine topological photonics phenomena include the implementation of Floquet Hamiltonians, the extension of the concept of topological invariants to non-Hermitian systems (with gain and loss), exceptional points, lattices with synthetic dimensions, topological lasers, and the development of experimental protocols to measure topological invariants. A very promising avenue is the study of entangled states of light and single photon nonlinearities in a topological landscape, which provides a rich playground in the development of photonic quantum simulators. The newest trends and latest results in this area are the subject of the CLEO/EQEC EC Session "Topological states of light".

ED: Precision Metrology and Frequency Combs

From the very beginning the laser has been an important breakthrough for both research and technological applications. In particular, laser-assisted spectroscopy and atom manipulation has tremendously improved the precision of atomic frequency measurements. For the utmost precision, frequency stabilization and counting techniques have been key ingredients. The introduction of the frequency comb in the late 1990s, acting as a 'frequency ruler' for optical frequencies, has permitted to complete this task in a simple way. Improved comb-based laser spectroscopic techniques have led to some of the best tests of quantum electrodynamics and the possibility to reliably operate atomic clocks that are based on very well defined transition frequencies in the optical domain. Whereas the current definition of the second stems from microwave optical clocks, optical clocks are now surpassing their microwave counterparts, which may lead to a future redefinition of the second in terms of an optical frequency. Indeed, optical clocks are now taking over the lead as the most precise instruments ever realized. One of the current challenges is to transfer this kind of accuracy and phase purity over large distances, which is tackled by many groups around the globe. On the other hand, the advent of broadband spectroscopic techniques based on combs and the extension of the combs' operating range to other frequency domains is now extending the measurement possibilities even further. This is giving rise to a strong interest in technological applications for industries in domains as different as environment, security, telecommunication or defence.
The *Precision Metrology and Frequency Comb* sessions will document the recent developments in this field with a focus on subjects such as optical clocks (with a keynote talk by prof. H. Katori from University of Tokyo), frequency transfer over long distances, precision spectrosopy and novel frequency comb sources in new wavelength regions (with an invited talk by Scott Diddams from the National Institute for Standards and Technology, USA).

EE: Ultrafast Optical Science

There have been major developments in ultrafast optics and spectroscopy in the past few years. Five sessions will highlight a wide range of topics ranging from ultrafast dynamics in 2D materials and fibers, control, nonlinear spectroscopy, to novel nonlinear phenomena. Among the topics will feature filamentation, femtosecond covariance spectroscopy, investigation of water splitting, lightwave valleytronics, fiber sources, and interaction with biological samples.

EF: Nonlinear Phenomena, Solitons and Self-organization

The session EF - “Nonlinear Phenomena, Solitons and Self-Organization” aims to bring together researchers to share recent advances in the fields of nonlinear laser dynamics, optical solitons and molecules, nonlinear microresonators, modulational instabilities, photon fluids, frequency combs induced by second order nonlinearities, quantum and random optical systems, and nano-optics.
The different EF fields will be presented in 10 oral and one poster sessions. In the integrated photonics session, the recent advances in Brillouin optics will be the topic of a keynote talk, followed by discussions of recent advances in III-V nanostructures. In the mode-locking session, theoretical and experimental studies on spatio-temporal localization of light in mode-locked lasers leading to generation of the so-called light bullets will be presented. Among the highlights of the nano-optics session, the nonlinear dynamics of metasurfaces will be shown. Recent advances in the research of solitons in microcavities will include the discussion of Cherenkov radiation, dark solitons, and third order dispersion. The existence of plasmon-soliton waves or self-written Y-junction will also be demonstrated as potential applications of solitons. The physics of quantum and random optical systems as well as the link with cold atoms and spin glasses will be disclosed. Finally, some analogies with fluid dynamics will be displayed leading to the so-called photon fluids dynamics.

EG: Light-matter Interactions at the Nanoscale

As many as 50 papers have been submitted to subtopic EG of EQEC 2019, shaping a final program that features 3 invited talks, 30 contributed talks and 22 poster presentations. These cover a broad range of topics that explore how nanoscale optical fields interact with matter from a fundamental point of view. The program committee has decided to focus on 6 areas to highlight recent advances and new trends in the field.
The first session is devoted to the engineering of complex electromagnetic fields, focusing on chirality, magneto-optics, and polarization control. The invited talk will introduce examples of natural photonic structures and review recent advances in bio-inspired photonics. Another rapidly developing area of research in nano-optics concerns the strong and ultrafast interaction between optical near fields and matter. This is a topic of great interest for both the advancement of free-electron physics and the study of the excitation dynamics in modern materials. In this session, we find nanoscale control of photon-electron interactions, ultrafast spectroscopies on nanoscale matter, and the generation of ultraintense magnetic optical fields. Strictly related to strong field interactions is the field of nonlinear nano-optics. A dedicated session features contributions dealing with harmonic generation in resonant nanostructures. One session is devoted to nanoscale imaging and spectroscopy, ranging from near-field mapping to single-molecule spectroscopy. The invited talk exploits plasmonic metasurfaces to develop novel dynamic displays and holograms. A further session will focus on emission control at the nanoscale. The invited talk will address the development of novel quantum emitters as local sources of photons or plasmons for nanophotonic devices. The control of light-matter interaction via nanoantennas is the common topic of the oral contributions. The interaction between photonic excited systems and a nanostructured environment or cavity is the leading topic in a session devoted to coupling at the nanoscale. The oral contributions will span from polaritonic systems to the controlled coupling of molecules with dielectric resonators and graphene.

EH: Plasmonics and Metamaterials

Plasmonics and metamaterials are receiving a tremendous interest thanks to their unique properties to control light at the nanoscale. In the “Plasmonics and Metamaterials” topic, we will explore novel phenomena and optical properties of designer photonic nanostructures. The six sessions will cover the following subjects:

- **Engineering nontrivial lightfields:** Tailored nanostructures enable the engineering of unusual electromagnetic excitations including toroidal and anapole modes, bound states in the continuum and enhanced optical magnetic fields.

- **Metasurfaces - polarimetry, chirality and photon spin:** At the nanoscale, polarization, chirality and spin are strongly interlinked. This session explores these concepts in metamaterials and nanoantennas.
- **Plasmonics and metamaterials with 2D-materials:** Two dimensional thin materials like graphene and two-dimensional semiconductors open novel possibilities to control light at the nanoscale.
- **Metasurfaces and metadevices:** Planar metamaterial devices realize new optical components into thin structures, such as wavefront shaping, optical signal processing and spatial coherence sensing.
- **Nonlinear metasurfaces and plasmonics:** Nonlinear effects including harmonic generation, frequency mixing, and nano-optomechanical coupling are receiving a growing attention, driven by both the fundamental understanding and the numerous applications.
- **Plasmonic enhancement of light matter interactions:** Strong coupling, single emitter control, cathodoluminescence and photoelectron emission are enabled by the intense interaction between light and matter in nanophotonic structures.

These sessions will provide an outstanding overview of current topics and future trends in nanophotonics from fundamentals towards applications and including all spectral regimes: plasmonic nanostructures, antennas, cavities and waveguides; metamaterials and metasurfaces; hybrid materials; nonlinear structures and effects; active systems, systems with gain.

EI: Two-dimensional and Novel Materials

Graphene and related two-dimensional materials, such layered transition metal dichalcogenides (TMDs), have already led to many breakthroughs in diverse areas of science and engineering. Due to their unique combination of electronic and optical properties, they have also been recognized as promising materials in optoelectronics and optics in general. TMDs complement graphene by overcoming its lack of a band gap, which has led to efficient light emitters and photovoltaic devices. In addition, the large exciton binding energies, valley circular dichroism and coherence in TMD monolayers offer exciting opportunities for novel information processing devices. Significant progress has also been made in stacking 2D materials into heterostructures to enable cavity and hot electron optoelectronics on an atomic scale. This symposium will focus on fundamental aspects and applications of two-dimensional materials in optics and optoelectronics. It aims at bringing together scientists and engineers from academia and industry to exchange ideas and discuss recent results, potential applications and challenges. Topics include: Exciton and polariton physics, hot electrons and nonlinear dynamics, as well as contemporary optical spectroscopy of two-dimensional materials.

EJ: Theoretical and Computational Photonics Modelling

Computational and theoretical approaches continue to underpin leading-edge developments in lasers and optics by providing predictions of new effects, the refinement of designs and confirmation of experimental results. Our first of three sessions focuses on the development of mathematical and computational methods in support of non-linear optics and structured light. In the second session we explore the ways in which computational modelling drives emerging applications in the area of light-matter interactions such as new radiation sources and enhanced waveguides. Our third session covers quantum optics, plasmonics and meta-surfaces, with a preponderance of papers addressing surface waves. Taken together, these three sessions provide an overview of the state of the art across a range of challenging theoretical problems that are tackled using not just the power of computers but also innovative algorithms and the insight and intuitive understanding of the underlying physics.

JSI: Neuromorphic Photonics

This joint symposium covers the state of the art in neuromorphic photonics systems, components and wide array of applications. In particular the photonics platforms and hardware for reservoir computing, neural networks, with applications in deep-learning based solutions in optical communications receive special attention. The symposium features four invited talks from leading experts in the field of neuromorphic photonics.

JSII : Label-Free Techniques for Molecular Identification

The main focus of this symposium is to discuss novel methodologies for label-free molecular spectroscopy and imaging. The workshop includes three invited talks on i) employing coherent Raman spectroscopy for medical diagnostics and ii) application of nonlinear imaging in neuronal biology.
In addition, various label-free techniques with single molecule sensitivity are discussed.

JSIII: Photonics for Renewable Energy and Sustainability

Advances in optics and photonics can reshape the landscape of next-generation energy-harvesting, -conversion and -saving technologies. Nanostructured devices and materials offer a way to overcome the conventional light absorption limits. Novel optical spectrum splitting and photon-recycling schemes boost the efficiency of optical energy-conversion platforms. Furthermore, optical design concepts are rapidly expanding into the infrared energy band, offering new approaches to harvest waste heat and to reduce the thermal emission losses in solar-thermal applications. Broadband engineering of the emission properties of optical materials and devices also paves the way to achieving noncontact radiative cooling of solar cells, electronic circuitries, buildings, and vehicles.

This symposium will put in the spotlight these recent advances in photonics and their applications to traditional and emerging applications in energy generation and sustainability. It presents transformative ideas on light management for photovoltaics, aimed at reducing thermalisation, sub-bandgap and weak absorption losses that plaque current photovoltaic technologies in the face of the challenging broadband and wide angular range solar radiation. A good knowledge of the solar resource, tailored disorder, photonic crystal reflectors, hot electron generation and harvesting, upconversion and luminescent quantum separation are some of the innovative solutions presented. Tailoring absorption and emission properties is also a key element in new applications beyond conventional solar cell technologies. Control of radiative emission properties by nanophotonics and plasmonics, and graphene based material with enhanced absorption properties can significantly enhance thermal energy harvesting in various settings, while slow light for low-loss silicon photonics, and light recycling displays help to reduce the growing energy demands and environmental heating effects.

JSIV: Nanoscale Heat Processes

The purpose of the Symposium is to discuss the state of the art in the Nanoscale Heat Transfer and management, as well as the recent advances in the study of self-heating via electron-phonon interaction in nano devices, and of near field radiation, allowing for the exchange of relevant information among scientists, and providing the scientific basis to the newcomers.

The Symposium is subdivided into three sessions where the theoretical background, the heat transfer in plasmonic nanostructures, and the new devices controlled by heat manipulation are deeply discussed.

JSV: Quantum Sensing and Applications

Based on the development in controlling and manipulating systems at the quantum level in the recent past, a whole new technology – quantum technology- has emerged. Its specific implementations span a large variety of systems ranging from single electronic spins over atomic systems to solid state structures at the nano- and micrometer scale, and it covers notably novel schemes for computation, communication and sensing.

The focus of the joint symposium is the latter aspect in its broadest sense including the application of quantum technology tools and protocols for high-resolution scientific investigations. The sessions will cover the recent progresses in gravitometry, the developments of magnetometry, biological imaging and chemical sensing, the implementation of non-classical states of mechanical resonators and spin systems to reach sensitivity below the SQL, as well as the applications of quantum optics in imaging and time measurement.

JSVI : 50 Years of Integrated Optics

This joint symposium celebrates 50 years since Miller first coined the phrase ‘integrated optics.’ John Bowers will present a tutorial on quantum dot lasers epitaxially grown on silicon. This is supported by four invited talks covering glass integrated optics, numerical modelling techniques for integrated optical circuits, micro-resonator frequency combs, and challenges in the miniaturization of mid-infrared sensors fully integrated on silicon.