CLEO®/Europe 2017 Topic Descriptions

CA - Solid-state Lasers

CLEO-Europe has traditionally been the forum where the newest developments and breakthroughs in the solid state laser technologies were heavily represented, covering broad range of topics spanning from new laser materials, and laser designs ranging in spectrum between deep ultraviolet and mid-infrared to the broad range of application-driven developments. This CLEO-Europe is not an exception. The program for solid state lasers will offer eleven high-quality technical oral sessions and carefully selected poster presentations. The technical program will feature five prominent invited speakers on subjects ranging from ultra-high-stability laser systems used for gravitational wave detection to novel diode-pumped Alexandrite lasers specially developed for space-based LIDARs. The technical program for Solid State Lasers at CLEO-Europe 2017 will offer many extraordinary achievements and novel ideas. It is worth briefly mentioning here some of them. One of the most active areas of current development is in mid-infrared laser technologies, both concerning new laser materials and power scalable laser and amplifier designs. Notable in this area is the first demonstration of Kerr-lens mode-locked Ho:YAG oscillator generating more than 20 W of average power at 2.1 µm in a power-scalable thin-disk design. Another work which will be presented at CLEO Europe goes even further into mid-infrared by demonstrating femtosecond amplifier generating 0.5 GW peak powers in the wavelength range between 3.8 µm and 4.8 µm by employing Fe^{2+}:ZnSe gain medium. Raman laser technology recently has received substantial boost with development of high-quality synthetic diamonds. CLEO Europe has always had a strong representation of new developments in Raman lasers. This year’s program will present a real breakthrough in Raman diamond laser technology with demonstration of record quasi-CW power of 329 W with efficiency of 34% and excellent beam quality. The above are just few highlights which will be presented during the eventful week of CLEO-Europe in June 2017.

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 fiber communications, optical storage, spectroscopy, bio-medicine. They are also widely used for the optical pumping of other types of lasers.

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, with emission of ultrashort light pulses or continuous output power up to very high levels.

We have an impressive line-up of international speakers covering:

- New gain materials, compatible with silicon technology, pushing further towards seamless integration of semiconductor lasers with microelectronics;
- Novel semiconductor laser concepts such as a Fano laser based on photonic crystals;
- Recent advances in ultrafast high-power vertical-external-cavity lasers, towards record-short pulse durations;
- Advances in fabrication which have enabled further integration of gain structures with different optical elements and new functionalities;
- Quantum-cascade lasers for emerging applications in the mid-infrared spectral region, which are of high relevance for spectroscopy applications, such as environmental sensing and non-invasive medical diagnostics

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 five oral sessions with the topics

1) High field and nonclassical terahertz pulses,

2) Terahertz quantum cascade laser and combs,

3) Terahertz near-field microscopy and spectroscopy,

4) Non-linear terahertz sources,

5) Terahertz spectroscopy.

Among the highlights of the program are the invited talk of Denis Seletskiy reporting on the generation and detection of squeezed mid-infrared single cycle pulses. The ultrashort and broadband character of the squeezed light strongly contrast that work with previous reports in the visible that relied on non-linear optics and homodyning with narrow band lasers. Other highlights are progresses in THz imaging (invited talk of Euan Hendry), ultrafast investigation of magnetism driven by THz waves, progress in terahertz quantum cascade laser frequency combs. 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; nonlinear frequency conversion in the visible and IR; telecommunications applications and all-optical switching; all-optical delay lines and slow light; optical parametric devices such as optical parametric amplifiers and oscillators; nonlinear optics in waveguides and fibres, including photonic crystal structures and microstructured optical fibres; quasi-phasematched materials and devices; novel nonlinear materials , metamaterials and nanostructures; stimulated scattering processes and devices; applications of optical solitons and photorefractives; electro-optic and Kerr devices in crystals and semiconductors; Raman based devices including amplifiers and lasers; nonlinear probing of surfaces; multi-photon excitation and upconversion techniques in imaging and coherent Raman microscopy. An increased interest is evident in the area of quantum computing and information oriented applications. 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 keynote presentation, Jas Sanghera from the Naval Research Lab, Washington DC will review the state of the art in infrared materials and fibre optics. The fabrication, properties and applications will be described in detail during the presentation.

Akio Ikesue from World Lab Co, Japan will present an invited talk on new trends for optical ceramics which show the potential for new functionality for lasers and related markets.

Rolindes Balda describes in his invited talk the design of new rare-earth (RE)-based optical materials for their use in optical telecommunications, solid state lasers, three-dimensional full-color displays, solar cells, and others. Oxyfluoride glass-ceramics are promising RE hosting candidates since they combine the good chemical and mechanical stability of oxide glass matrixes with the good optical properties of low phonon energy fluoride nano-crystals.

Harald Giessen will present miniaturized micro- and nano-optics in his invited talk. Advanced approaches using femtosecond 3D direct laser writing for miniaturized micro and nano-optical components, solving the problem of axis coma in metasurfaces.

Patrik Hoffmann's invited talk describes mask projection for the ablation of substrates resulting in surface microstructures such as diffractive optical elements and smart passive windows. Sapphire, diamond and other very hard and brittle materials can be machined with lasers.

The final invited talk from IBM Research Zurich, will be presented by Benedikt Mayer, will address the monolithic integration of III-V gain materials directly on silicon using a novel template assisted selective epitaxy enabling high Q integrated optical structures.

The most recent advances in the fabrication, characterization and application of novel optical materials will be presented and discussed in sub-sessions devoted to Laser Materials; Integrated Photonics Devices; Thin film and Multilayer Structures; Metasurfaces and Metamaterials; Semiconductor Photonics; Laser Structuring and Material Processing; Novel Optical Materials and Devices; Nonlinear Optics; Infrared Materials; Optical fiber materials and structures.

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, femto- and attosecond timescales. The presented methods and applications cover an extremely broad spectral range, from the terahertz to the extreme-ultraviolet domain. The tutorial talk, to be given by Uwe Morgner from Universität Hannover, will give an overview on optical parametric amplification in the few-cycle regime.

The invited talks cover several frontier topics in ultrafast science: high-power ultrafast thin-disk oscillatory (by C. Saraceno), high-power fiber lasers (by A. Tünnermann), the precise spatio-temporal characterization of optical waveforms (by T. Witting) and upscaling of OPCPA technology to extreme peak powers (by R. Budriūnas). Thirteen 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: Optical parametric amplification at low- and high-power levels; High-power ultrafast lasers, fiber systems and novel techniques; New concepts for high-power and short-pulse oscillators; XUV generation and strong-field processes; Ultrafast spectroscopy, broadband nonlinear optical technologies.

CG – High-field Laser Physics and Attosecond Technologies

The discovery of high-harmonic generation in solids has opened a new and rich research field in attosecond and high-field physics. This progress is nurtured by significant advances in ultrafast laser sources beyond the traditional Ti:sapphire system – in particular, towards longer wavelengths and higher repetition rates. The rapid growth of high-field science in the condensed phase is prominently reflected in two full sessions featuring two invited speakers. One session is devoted to the generation of high-harmonics in solids. Shambhu Ghimire from the Stanford PULSE institute, a pioneer in this field, will report on experiments performed with bulk solids and two-dimensional crystals as the generation media. A second session revolves around a wide and rich array of strong-field phenomena in solids and liquids. New routes to steer coherent electron dynamics in solids at petahertz frequencies are presented by Eleftherios Goulielmakis, Max Planck Institute of Quantum Optics in Garching, in his invited talk.

Substantial progress has also been made in the application of advanced momentum imaging techniques and the extension of attosecond and high-field spectroscopy to molecular targets. A particular highlight is presented in an invited talk by Yoann Pertot on time-resolved x-ray absorption spectroscopy using water-window harmonics (located at photon energies between 280 eV and 530 eV – or 2.3 nm to 4.5 nm wavelength). Pertot and co-workers gained new insights in complex electron dynamics during the dissociation process in CF_4 and SF_6 using their new spectroscopic tool.

Additional opportunities for the application of attosecond spectroscopic techniques are enabled by the recently gained control over the polarization state of high-harmonic radiation, including circularly polarized pulses or beams carrying orbital angular momentum. Circular polarization, for example, is attractive for studying ultrafast magnetic properties.

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. Waveform synthesis, on the other hand, scales field-controlled laser-matter interaction to ever-increasing intensities, reaching the relativistic domain.

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, large-scale switching and storage. The tutorial given by Andrew Weiner (Purdue University, US) over ultrafast time-to-frequency signal processing illustrates the variety of subjects covered by this sub-committee. Two invited papers also highlight these issues: the first one by Hartmut Hafermann (Huawei Technologies, France) is related to Nonlinear Fourier Transform to overcome the current capacity limit. The second one by Yojiro Mori (Nagoya University, Japan) brings to light a very large-scale optical switch for intra-data-centre networking. In addition to these invited papers, 28 oral presentations organized in 6 sessions and 16 posters illustrate the most recent advances in optical technologies for communications and data storage: non-linear propagation, techniques for noise reduction, photonic processing, short-reach and high-capacity systems, and optical sources.

CJ - Fibre and Guided Wave Lasers and Amplifiers

This topic convers different aspects of waveguide and fibre laser oscillators and amplifiers including novel waveguide and fibre geometries; power scaling of waveguide and fibre lasers - including beam combination techniques; mid-infrared lasers and nonlinear coherent sources; pulse generation, amplification and compression; advances in fibre waveguide materials - including 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, lithium niobate, quantum dots, nanowires, germanium etc. Especially, silicon nitride as material for integrated photonics and nonlinear waveguides was investigated in several contributions. Compared with silicon this material enables integrated optics in visible wavelength range. Its supprisingly high nonlinearity has also induced research towards integrated optical combs and second harmonic generation. Also versatile properties of metamaterials and –surfaces on lightwaves at the interfaces is an 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 factro the 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. CLEO Europe will excite interest from researchers, students and industrialists. Several topics from this are illuminate the on going and future directions of Horizon 2020 research.

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). Large international research efforts, such as mapping the human brain, or investigating, which parts of the brain control behavior, emotions and decisions, could not be accomplished without novel intravital optical imaging methods or the optical control of gene expression by optogenetics. 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 2017, an entire session is devoted to the latest research in coherent biomedical imaging. In a separate session, labelfree optical spectroscopy and microscopy devoted to imaging the distribution and accumulation of drugs in vivo , as well as its effects on the body are discussed. In addition, other emerging concepts in biophotonics, such as low-cost labelfree imaging and diagnostic devices will be presented. The integration and miniaturization of optical technologies enables ever smaller devices for medical and environmental sensing, which, when combined with smart phone technology helps to improve human health by monitoring vital parameters even in rural areas. Other emerging trends that will be presented during biophotonics sessions include the spatio-temporal manipulation of light fields to shape and control how light propagates through dense biological materials. In a joint symposium, the use of photonics in cancer detection and therapy, in particular its use in noninvasive and nondestructive imaging is highlighted, while a separate joint session focuses on the novel application of short-pulsed lasers for prototyping and manufacturing microscopic devices, such as microfluidic delivery systems and sensors. Also, in a joint session between CLEO Europe and the European Conferences on Biomedical Optics (ECBO), the application of photoacoustic imaging, which increases the penetration depth for in-vivo imaging and covers a wide range of size scales is highlighted.

These methods and inventions are driven by the continuous development of lower cost, more compact advanced light sources for microscopy, phototherapy, and surgery which will be presented and demonstrated at the 2017 World of Photonics conference.

CM - Materials Processing with lasers

This session reports on the advancement of material processing with lasers. Recent progress in micro/nano processing; generation of nano-particles and nano-features; 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 special emphasis will be given to ultrafast laser processing of materials. This field is very rapidly growing due to remarkable progress of ultrashort laser systems and laser beam engineering. Novel optical and biomedical applications of different laser processing technologies continue to emerge, especially laser generation of nanoparticles and fabrication of nano and microstructures by laser surface structuring and two-photon polymerization. In particular, a joint session with CL - Photonic Applications in Biology and Medicine will be organized this year. Topics will also include temporal and spatial beam shaping, polarization effects in laser material processing, novel laser material interactions, and advanced applications.

This session should be interesting for both academic and industrial communities.

EQEC 2017 Topic Descriptions

EA - Quantum Optics

Quantum Optics uses the fundamental interaction between quantum light and quantum matter for precision measurements, information processing, and miniaturized devices. This year's keynote lecture will be given by Ian Walmsley who will present the revolutionary development how quantum optics experiments can be integrated on chips. A tutorial lecture on chiral quantum optics by Arno Rauschenbeutel will introduce this emerging topic. Other invited topics cover optomechanics (Martin Frimmer), quantum simulations using Rydberg atoms (Thierry Lahaye), quantum-enhanced measurements (Mark Kasevich), and a loop-hole-free Bell test (Kai Redeker).

The unexpected behavior of quantum mechanics is nowadays used to design and implement groundbreaking new methods to employ light and matter in emerging quantum technologies. For instance, researchers use atomic vapor, sometimes cooled almost to the absolute zero of temperature, to make new kinds of sensors and information processors. Detection schemes based on fundamental quantum interference have been designed to measure the quantum properties of light at the single-photon level, while other devices exploit single atoms, molecules or single particles of light (photons) trapped between tiny mirrors, or even artificially made quantum objects such as quantum dots, nonlinear crystals, or microscopic mechanical oscillators. 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 computation. 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 & 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 level of control and coherence that has been achieved in a large variety of systems allows implementing more and more complex quantum operations and algorithms. In quantum communication we are concerned with secure communications and the networking of quantum computers. In quantum computing the few qubit applications and small-scale quantum simulations dominate the current research. 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 is the use of quantum coherence to enhance measurement. For example one can use entanglement to beat the standard quantum limit, i.e. shot noise, for a collection of independent particles through entangled states, which can instead achieve the Heisenberg limit, where the relative precisions scales linearly with the number of particles or measurements. The basic technologies for these are trapped ions, photons in integrated waveguide circuits, superconducting qubits, single quantum dots and other individual solid state quantum systems.

EC - Ultracold Quantum Matter and Quantum Simulation

Ultracold quantum matter offers unprecedented opportunities for exploring fundamental quantum few-body and many-body phenomena. The interaction between light and matter is thereby the key tool to control quantum matter in the laboratory, using the most advanced laser sources. These technological developments allow pushing further the frontiers of current quantum research. The study of ultracold quantum matter is not only providing insight into the microscopic world, but also has a strong technological potential as demonstrated, e.g., quantum simulators.

The topical session will present some of the recent remarkable achievements in the context of manipulating and controlling quantum systems of various kinds with light.

The control of particles and light has reached a level, where ensembles of ultracold particles can be manipulated and monitored to reveal the manifestation of strongly-correlated many-body physics. For instance, non-linear modes and solitonic patterns in non-equilibrium quantum gases and strong interacting regimes in fermionic systems are experimentally observable, sometimes through the use of ultra-narrow optical resonances. Quantum simulators are now foreseen to be achieved with a variety of systems such as strings of atomic ions, dilute samples of ultracold neutral atoms, or superexcited Rydberg atoms.

All these achievements and prospects illustrate the strong interplay between the developments of laser technologies, and the emerging field of quantum technologies including quantum simulation, sensors, quantum information.

ED – Precision Metrology and Frequency Combs

From the very beginning the laser was used as a valuable tool for research and an important breakthrough for 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 1990ies has permitted to complete this task in a simple way. Improved 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 over larger distances. Optical clocks require stable reference local oscillators which are realized by optical cavities. Significant progress has been achieved in their construction. Extension of the optical frequency comb techniques to other frequency domains, such as the microwave, mid-infrared, millimetre waves or ultra-violet domain is now extending the measurement possibilities even further. This gave rise to a strong interest in technological applications for industries in domains as different as environment, security, telecommunication or defence.

The Precision Metrology & Frequency Comb sessions will document the recent developments in this field including subjects such as quantum metrology, optical clocks and novel frequency comb sources at new wavelength regions as well as stabilization techniques.

EE – Ultrafast Optical Science

There have been major developments in ultrafast optics and spectroscopy in the past few years. Four sessions will highlight a wide range of topics ranging from ultrafast dynamics at the nanoscale to remote nonlinear spectroscopy in atmosphere and novel nonlinear phenomena. One session will review the recent progress in the emerging field of ultrafast spintronics, and strongly-coupled quantum dynamics in solid-state materials. Another session is dedicated to laser beam filamentation dynamics in gases, along with progress in THz emission from filaments. Significant results in this topic will be reported on the fast-developing research field on filamentation in mid-IR spectral range. A closely related theme of ultrafast nonlinear spectroscopy and phase control is the topic of a third session. Highlights include insights into the quantum dynamics of Nitrogen molecules and molecular ions in intense laser fields, and phase-control of laser-induced ultrafast currents in dielectics at the nanoscale. The development of waveguides and laser systems has triggered renewed interest in soliton dynamics and extreme events. Important new results in this area will be discussed in the fourth session such as the first experimental demonstration of the universality of the Peregrine soliton in nonlinear ultrafast dynamics. The first experimental measurement of modulation instability in real-time in relation to the formation of optical rogue waves will also be reported.

The session EF - “Nonlinear Phenomena, Dynamics and Self-Organization” is aimed at bringing together researchers to interchange recent advances in the fields nonlinear laser dynamics, optical solitons, nonlinear microresonators, dynamics of optical pulses, structured light generation, nonlinear waveguides, and extreme events in optics. The session contains 8 oral subsections and a poster session. 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. A generation of exotic spatio-temporal molecules of light induced by nonlocality in laser systems will be demonstrated in the Semiconductor Laser session. The first experimental observation of super-cavity solitons in a driven optical cavity will be presented in the Kerr Solitons section. The existence of such unusual type of solitons was earlier predicted only theoretically. The Rogue Waves session will be devoted to the investigation of the extreme events in nonlinear optical devices. They are associated with the appearance of high amplitude rogue waves exhibiting unusual statistical properties. It will be shown that the superfluid character of the photon fluid allows to build 2D space-time geometries. By controlling the intensity and the topology of the spatial phase of the beam, an analogy with 2D black hole will be demonstrated for the first time. In the Nonlinear Fibers section the classical dam-breaking problem will be revisited.

EG – Light-matter interactions at the nano-scale

As many as 70 papers have been submitted to subtopic EG of EQEC 2017, shaping a final program that features 3 invited talks, 30 contributed talks and 21 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 have decided to focus on 6 areas to highlight recent advances and new trends in the field. One session is devoted on emission control and strong coupling regime. The invited talk will address emission control using hybrid photonic-plasmonic resonances. The control of light-matter interaction on the nanoscale towards strong coupling has been thriving in recent years. Several contributions show strong coupling expoiting coupling to either plasmonic or microcavities. Single photon sources are under continuous development in brightness, stability and photon purity. The invited talk will present a new type of stable non-bleaching photon sources based on defects in 2D-materials, which can be addressed truly on the sub-nm scale. Contribution will show intensity-squeezed light will be shown produced using an effective metallo-dielectric antenna, the control of single photon emitter dynamics, biexciton enhancement, spin coherence control, etc. Quantum nano-optics, a theme that takes another session, finds its roots in single-molecule spectroscopy. Yet again, the elegant combination of quantum optics and single-molecule spectroscopy brings in noteworthy developments. In particular, first experiments are reported, in which entanglement is processed on the nanoscale, in which light is scattered from chiral waveguides. Plasmonic circuits and photonic wires are used to control the single quantum emitter. Graphene opto-mechanics is shown to control the optical response. Another rapidly developing area of research in nano-optics concerns the strong interaction of electrons with optical near fields. Specifically, that is a topic of great interest for the advancement of free-electron physics and applications. In our session we find the control of quantum states, spatio-temporal response and sub-optical cycles of free electrons by optical near fields. We will see strongly enhanced molecular ionization and higher harmonics by metallic nanoparticles. Enhancement of non-linear optics is a steady topic in nanoscale photonics. In this session. Still there are surprises; the invited talk will show how 3rd order response can be used to shape complex fields around a single particle alone and switch emission from a single point to two spatially separated coherent sources. We will see non-linear response mediated by plasmonic oligomers, split hole resonators and other nanoantennas. Lastly, we have gathered a session devoted to complex e.m. fields, focusing on chirality, angular momentum of light and nanoscale e.m. field sensing.

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 phenomenon and properties of these novel nanophotonic devices. The nine sessions will cover the following subjects:

- Van der Waals layered materials for plasmonics: two dimensional thin materials like graphene and black phosphorus open novel possibilities to control light at the nanoscale.

- New materials for plasmonics and metamaterials: The field of plasmonics is seeking for alternative to noble metals like gold and silver used conventionally. Novel strategies include metal oxides, superconducting niobium, copper and organics materials.

- Tailoring light with metasurfaces: planar metamaterial devices realize new optical components into thin structures.

- Epsilon near zero and hyperbolic structures: materials with navishing dielectric permittivity and hyperbolic metamaterials enable diverging optical density of states, large decay rates and enhanced optical nonlinearities.

- Active and tunable nanophotonics: a new frontiers arises as it comes to the active control of the optical properties of plasmonics and metamaterials. This session will explore novel approaches to dynamically tune the plasmonic properties of nanodevices with electrical or mechanical control.

- Plasmonic light-matter interactions: strong coupling, lasing and fano resonances denote the intense interaction between light and matter in nanophotonic structures.

- Quantum nanophotonics: this new topic will bring together the EQEC communities of plasmonics and metamaterials with quantum optics to explore the near-field manipulation of light at the energy level of a single quantum.

- Ultrafast and nonlinear plasmonics: nonlinear effects including stimulated emission and second harmonic generation are receiving a growing attention, driven by both the fundamental understanding and the numerous applications.

- Nonlinear II and infrared plasmonics: this session will continue exploring the nonlinear interactions of light with plasmonic nanostructures and will finally extend the investigation range to near and mid-infrared as well as terahertz radiation.

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

EI - Two-dimensional Materials

Two-dimensional materials, such as graphene and 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. For example, the absence of a band gap in graphene enables devices operating over an ultra-wide wavelength range and at ultra-high speeds, and the electrical tunability of the Dirac fermions allows for a new class of plasmonic devices. 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 already been made in this exciting new field.
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: Quantum phenomena in 2D materials, such as single photon emitters and 2D polaritons; graphene devices and spectroscopy, including plasmonics and optoelectronics; valley dynamics in 2D materials, considering excitons and trions; and the integration of 2D materials into optoelectronic circuits with emphasis on ultrafast dynamics.

EJ- Theoretical and Computational Photonics

Now an explicit topic at this conference since 2015, the demand for predictive theoretical and computational tools continues to grow. The ability to perform optical experiments on your computer is needed in all fields of optics and photonics, from basic research to applications. New concepts get a platform for exploration and evaluation, while maturing concepts gain yet another means by which they can be developed and enhanced. The basic ingredients are efficient models that properly describe light and matter, and their interactions, in specific situations of interest. Because completely analytical solutions are often not available, modeling becomes an important technique in this field. The aim is to reduce models to lessen the computational load, but at the same time also include additional features to support the modeling of new phenomena. Both aspects are necessary to expand the boundaries and capabilities of the field.

Applied mathematics together with theoretical physics can help to properly reduce comprehensive models to more efficient ones. In turn, that can allow for fast, qualitative insight into the solution’s behaviour. Sometimes semi-analytical techniques can be used, or, in few cases, fully analytical solutions can be found for nonlinear equations (e.g. solitons). Our session on "Photonics on the Computer" contains invited and contributed talks that tackle this issue with a focus on combining intuitive models, with authentic physics, and high computational performance, covering applications in non-linear optical resonators, and ultrafast lasers. We also touch on the historically under-represented area of intuitive and interactive computational tools for use in the classroom.

From a basic point of view, the governing partial differential equations that describe the evolution of light in dispersive optical media generically include non-locality together with nonlinearity, which makes their treatment especially difficult. Nonetheless, many new and exciting concepts can arise from exploiting the richness inherent to these phenomena. Our session on "Novel concepts for the manipulation of light" covers shock wave squeezing, waveguiding from geometric phase, the conversion of light modes using multiple phase masks, and oscillating localized structures made of random waves. We also have contributions relating to the manipulation of light as it is generated, including transformation optics for manipulating Cerenkov cones, and a new form of terahertz generation using resonances in multiphoton isonisation.

For applications one is often interested in quantitative solutions obtained by numerical simulations. Corresponding tools range from direct solutions of Maxwell's Equations for optical fields in various resonators and waveguides, or with inhomogeneous, active, disordered and/or structured materials. In this context, high-performance computing becomes important. The methods are often based on massively parallel codes, including the utilization of hardware accelerators. Together, the papers in this topical section represent key points of interest in a field that uses computers to bridge between theory and experiments.

JSI - Joint Symposium on Free-Electron Lasers and Applications

Free-electron laser sources are novel, accelerator-based lasers that can generate intense radiation from Terahertz wavelength to hard x-rays. The first short wavelength free-electron laser facility, FLASH in Hamburg, started operation about a decade ago, followed by the first x-ray laser, LCLS in Stanford, and the first seeded machine, FERMI at Elettra, delivering fully coherent pulses in the extreme ultraviolet regime. Currently, the European XFEL is coming online, a new generation of x-ray free-electron lasers based on superconducting technology and with orders of magnitude higher repetition rate. More facilities are already in operation or under construction in Japan, Switzerland, Korea, and China.

The Joint Symposium on Free-Electron Lasers and Applications focuses on the latest machine developments and scientific opportunities in the ultraviolet and x-ray spectral regime. The intense, femtosecond ultraviolet and x-ray light pulses from free-electron lasers have led to many new discoveries in a wide spectrum of applications, ranging from atomic and condensed matter physics to chemistry, and to materials, biological, and high-energy density sciences. Novel two-color two-pulse modes enable x-ray/x-ray pump/probe experiments with femtosecond resolution. Fully coherent pulses open the door for quantum control approaches involving inner-shell levels. High-repetition rate operations from superconducting accelerators allow pursuing photon-hungry experiments such as ultrafast inelastic scattering.

The symposium will start out with a tutorial on free-electron lasers, explaining the underlying physics, principles of operation, and latest development for multi-pulse and ultra-short pulse operations. Two invited talks describe the new opportunities for probing molecular dynamics with femtosecond x-ray pulses as well as new approaches for 4-wave mixing in the extreme ultraviolet. A wide spectrum of contributed talks and posters ranging from single-shot, ultrafast imaging of nanostructures to theoretical approaches for coherent control of inner-shell electrons to time-resolved spectroscopy and to new ideas for free-electron laser design and operations guarantee and exciting and stimulating symposium.

JSII - Advanced Microscopy and Nanoscopy

Microscopy, and more generally imaging, is becoming a ubiquitous tool that is useful in any branch of science and technology, spanning from the field of life sciences to materials and nanotechnologies. The recording and processing of optical signals are two main issues to consider for developing and exploiting novel advanced methodologies. Actual sensors and detectors can record a large amount of data, extremely rich in information. This information is convoluted in different ways, depending on the optical configurations adopted. New strategies for extracting useful information are currently under investigation in all labs around the world. Consequently computational aspects are becoming the essence of novel emerging and future advanced microscopy and imaging approaches. Novel computational policies and processing embrace all the most advanced approaches in microscopy for extracting and analysing information from complex optical signals and advanced photonics probes. Hence, new efforts are directed towards modelling and fabricating advanced photonic tools, devices and imaging modalities and by combining nanolenses, scanning probe microscopy with computational aspects for infringing the barriers of resolution of classical microscopy, thus opening the route for a reliable inspection of world at nanoscale.

The conference will be organised in two sessions, named “Tomography and computational imaging” and “Superresolution nanoscopy”, respectively.

The first session will be devoted to cutting-edge strategies for retrieving tomographic data for full-characterization, especially those applied to biological samples. This topic is of great importance for real-world needs in future biomedical applications. The presentations will cover 3D full characterization of cells in static conditions, as well as in-flow along microfluidic channels, and this will pave the way for identification of blood disease or the identification and sorting of tumour cells. Accurate analysis of flowing blood will be also reported by accessing to a new modality in 4 dimensions.

The second session will address the fundamental issues of superresolution and nanoscopy with the aim of debating the most recent advancements and achievements in microscopy and imaging at the nanoscale. In fact, “superresolution” and “nanoscopy” are the two most important pillars of imaging at the nanoscale in the future. Results on imaging whole cells in 3D with sub-20nm resolution in live-modality will be presented. Further contributions will address the imaging of protein structures by advanced fluorescent microscopy and the modelling and application of superlenses inspired by Mother Nature.

JSIII – Joint Symposium on Laser-driven Acceleration

Particle accelerators play an essential role as tools for enabling scientific exploration. Laser-based accelerator technology has evolved dramatically in the last decade, demonstrating orders of magnitude increase in the accelerating gradient, compared to conventional accelerators, and making the dream of compact accelerators feasible. Laser-plasma-driven wakefield accelerators deliver today high-quality electron beams in the few GeV range, with excellent stability, accelerated with gradients that exceed a few hundred GV/m using PW (10^{15} W !) class laser systems at a repetition rate of 1 Hz. In this session, three breakthrough results, from Korean and from America, are reported that show, for the first time, how few GeV electron beams can be produced within a few centimeter accelerating distance. A fourth contribution from LBNL group will report on new idea that indicates how the electron beam quality can be improved by using multiple laser pulses with different colors.

The demonstration of multi-GeV electron beams with PW laser systems will be presented by Hyung Taek Kim from Center for Relativistic Laser Science, GIST, by Mike Downer from Department of Physics University of Texas at Austin, and by A. J. Gonsalves from Lawrence Berkeley National Laboratory, Berkeley, California.

JSIV - Topological Insulators in Optics

The discovery of topological insulators relying on spin-orbit coupling in condensed matter systems has created much interest in various fields in physics, including in photonics. In two-dimensional electronic systems, topological insulators are insulating materials in the bulk, but conduct electric current on their edges such that the current is completely immune to scattering. Demonstrating such effects in optics poses a major challenge because photons are bosons, rendering them fundamentally different from electrons, which are fermions. Hence, photons experience an unconventional spin-orbit coupling such that the common mechanism for the formation of topological insulators, as it is found in solid-state systems, does not apply. The field of topological photonics has emerged calling for original strategies to overcome this problem. Photonic topological insulators would have enormous potentialities in the lossless transport of photons. For example, topological protected devices could act as compact optical isolators and solve insertion loss problems in wave guiding structures, overcome the key limitation from disorder and localization in slow light and coupled resonator waveguides, and could decrease the power requirements of classical signals and improve coherence in quantum links. In parallel to these features, the flexibility of photonic platforms provides an excellent playground to investigate topological properties from a fundamental point of view.

Much like the field of topological insulators in electronics, topological photonics promises an enormous variety of breakthroughs in both fundamental physics and technological outcomes. In this vein, this symposium provides an overview of novel achievements in the field of topological photonics, discusses new conceptual ideas, and suggests applications.

JSV - Perovskite Optoelectronics

Recently, a new, potentially disruptive low cost optoelectronic technology based on hybrid perovskites has been proposed. A key feature of these materials is represented by the possibility of being self-assembled by a simple chemical deposition of the constituent units, integrating the useful properties of organic and inorganic compounds at the molecular scale within a single crystalline material. This enables a fine tuning of the optoelectronic properties. Since the first two reports on high efficiency, solution processed, solid-state hybrid perovskite based solar cells in 2012 there has been a world-wide explosion of activities on these materials. Researchers whose interests span the full range of conventional inorganic to emerging organic and hybrid optoelectronic technologies have been contributing to the prolific research output This has first lead to lab scale solar cell power conversion efficiencies now exceeding 20%. Then it has soon expanded the scope with proofs of concept of electroluminescent and lasing devices, thus potentially impacting optoelectronics under many aspects. Here we collect contributions aiming to 1) the development of materials synthesis and processing; 2) elucidate the fundamental properties such materials, which would lead to a predictive design of the device, pivotal in the development of a reliable technology; 3) explore novel optoelectronic and photonic devices concepts and production methods for assessing their potential of representing the merging point between the efficient inorganic electronics and the flexible and chameleonic organic electronics. "