Optical Materials EXPRESS

Nonlinear Optics: feature issue introduction

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Abstract: This joint issue of *Optics Express* and *Optical Materials Express* features 18 state-of-the art articles that witness actual developments in nonlinear optics, including those by authors who participated in the international conference Nonlinear Optics held in Waikoloa, Hawaii from July 15 to 19, 2019. As an introduction, the editors provide a summary of these articles that cover all aspects of nonlinear optics, from basic nonlinear effects and novel frequency windows to innovative nonlinear materials and devices, thereby paving the way for new nonlinear optical concepts and forthcoming applications.

Nonlinear Optics (NLO) has a long tradition as an international conference within the OSA conference series since 1990, typically held biannually at a location in Hawaii. The 2019 OSA NLO conference was held in Waikoloa on the Big Island from July 15 to 19th, is the 15th conference in this successful series.

Since nonlinear optical phenomena play a key role in many actual applications of photonics, the conference covers basic nonlinear optical phenomena as well as many applications, ranging over a wide range of energies and powers, from single-photons to zettawatts, and over broad spectral ranges, from THz to Gamma-ray frequencies. New advances arising in disruptive fields ranging from quantum nonlinear optics, over plasmonics and metamaterials up to high-field lasers and ultrafast optics applications, while new emerging applications are showing cross-fertilization with fields like machine learning, medical cell and brain science, or quantum and nanoscience.

Such, the purpose of the NLO conference is to provide continuously an international forum for discussion of all these aspects of nonlinear optics, including new physics, advanced materials, novel device concepts, as well as their applications in various news fields of science and technology.

This typically results in meetings with around 150 active participations. In 2019, it included a total of 175 oral and poster presentations from over 20 countries worldwide, including inspiring plenary talks, visionary invited talks, and a large number of contributed talks and poster presentations that gave ample opportunities for scientific interactions and discussions.

Though being only a small fraction of the many highest-level contributions, in nevertheless gives an excellent flavor of the cutting-edge topics covered by the meeting. Unlike typical conference proceedings, this feature issue has only accepted papers that report new, previously

#390115 https://doi.org/10.1364/OME.390115
Journal © 2020 Received 7 Feb 2020; published 14 Feb 2020

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unpublished work, and we follow the regular review process for the journals with its clear criteria of scientific value and impact being independent of the conference review.

We hope readers will enjoy this issue with the resulting 19 top-level articles that highlight the state of the art in the field. We are thankful to all of the authors and reviewers for their contribution and commitment to the field. We also would like to thank Carmelita Washington from the OSA staff for their outstanding support for making this feature issue in all its steps a success.

The topical issue follows the categories that are typically falling into three categories:

1. Fundamental Studies and New Concepts including topics from nonlinear light propagation and quantum nonlinear optics to ultrafast phenomena,
2. Nonlinear Materials including fields as cold atoms, dielectric, semiconductor, metallic and polymer material as well as nanostructured and integrated systems, and
3. Applications, covering such diverse path breaking fields as data storage, quantum information processing, artificial intelligence, or biomedical nonlinear optical devices.

Following a trend in the last NLO conferences as well as in the optics, photonics and laser community, a number of papers address complex basic effects in applied information processing devices. Such, solitons [1,2] or supercontinuum generation [3,4] have been investigated in fiber laser and amplifier systems as well as at telecommunication wavelengths. Also, quantum encryption and communication takes advantage from higher order nonlinear effects [5].

A related central theme of NLO is ultrafast nonlinear optical phenomena that are also heading for applications as ultrafast nonlinear refraction measurements [6,7], few cycle pulses in integrated nonlinear photonic circuits [8], or ultrashort pulses in epsilon-near-zero metamaterials at the telecom wavelength [9].

The advent of nanoscaled and structured materials paves the way to tomorrows' applications of nonlinear optics, as thin film semiconductor nonlinear platforms [10], integrated parametric oscillators included into two-dimensional materials [11], or nonlinear optical circuits based on complex light two-photon absorption for inspection in microelectronics [12]. In turn, nonlinear optical effects itself as e.g. z-scan can be developed into tools that allow characterizing optically relevant parameters of solutions and dyes [13].

With increasing application relevance, questions of bandwidth, phase-sensitivity, and fluctuations gain more importance. Thus, control of bistable signals [14] in resonators, bandwidth in optical networks [15], phase modulation in interconnection and network transmission [16], fluctuations in fiber lasers [17], or self-phase modulation in two-dimensional materials [18] are all based on nonlinear optical light matter interaction, especially third order wave mixing effects.

With the upcoming 60th birthday of the laser in 2020, the field of Nonlinear Optics is entering its 7th decade of innovations in optics and photonics. Nonlinear optics is not only as vibrant and stimulating as ever before, but is becoming more and more groundbreaking, being a trendsetter that fosters applications of disruptive technologies as quantum technologies, machine learning, or brain science within optics and photonics.

Thus, we can be curiously looking forward to the next OSA Nonlinear Optics conference that surely will continue this exiting trend, to be held in 2021 again in Waikoloa, Hawaii, USA.

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