Introducing the *Laser Physics* and *Laser Physics Letters* highlights of 2016

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Editorial

Introducing the *Laser Physics* and *Laser Physics Letters* highlights of 2016

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There have been tremendous developments in laser technology and light sources over recent years that are pushing forward the frontiers of science. New applications across physics, biomedicine and industry are thriving due to technological progress. As two journals that are dedicated to developments in laser science, *Laser Physics* and *Laser Physics Letters* publish many notable articles in the field. In recognition of the high quality of articles over the past year, we present a selection of some of the most popular articles published by *Laser Physics* and *Laser Physics Letters* throughout 2016, all of which are believed to have the potential to make a high impact on future research directions. Those chosen are recognised for their high-interest with readers and importance in the field, providing a snapshot of the broad subject coverage and international make-up of both journals.

We hope that you find these highlights useful and look forward to publishing more cutting-edge work in the year ahead.

Summary of the highlights articles:

Physics of Lasers

- *Enhancement of random lasing assisted by Ag nanoparticle doped dye medium in solidified fiber*—a study of the random laser action from a Ag nanoparticle doped Rhodamine-B dye medium in different structures: cuvette, liquid crystal cell, fiber [1].
- *The power stability of a fiber amplifier based on a multifunction card and PID control program*—a solution is presented to precisely stabilize the light power of a fiber amplifier based on the dual-path feedback loops of both the acousto-optical modulator and fiber amplifier [2].
- *Multi-gigahertz repetition rate ultrafast waveguide lasers mode-locked with graphene saturable absorbers*—the successful realization of the multi-GHz repetition rate self-starting mode-locked operation of miniature waveguide Nd:YAG lasers operating at 1064 nm is reported [3].
- *External-cavity diamond Raman laser performance at 1240 nm and 1485 nm wavelengths with high pulse energy*—a slope efficiency of 54% and output energy as high as 1.2 mJ in single pulse at 1240 nm are achieved with the optimized cavity, while a pulse energy of 0.70 mJ is obtained in the eye-safe spectral region at 1485 nm [4].
- *Thermo-optical and spectroscopic properties of Nd:YAG fine grain ceramics: towards a better performance than the Nd:YAG laser crystals*—the thermo-optical properties of highly Nd^{3+} doped YAG ceramics are investigated giving evidence that the YAG ceramic is an excellent material for an ultra-high-power microchip laser system and for devices requiring minimum pump-induced local heating generation [5].
- *High-energy room-temperature Fe^{2+}:ZnS laser*—the characteristics of a room temperature laser on polycrystalline ZnS:Fe^{2+} subjected to diffuse doping from two sides are investigated [6].

Fibre Optics and Fibre Lasers

- *Multi-wavelength erbium/Raman gain based random distributed feedback fiber laser*—a multi-wavelength generation in a random distributed feedback fiber laser based on hybrid Raman and erbium gain and a Lyot all-fiber spectral filter is demonstrated for the first time [7].
- *All-normal dispersion passively mode-locked Yb-doped fiber laser using MoS_2–PVA saturable absorber*—the generation of a dissipative soliton in an all-normal dispersion ytterbium (Yb)-doped fiber laser using few-layer molybdenum disulfide (MoS_2) as a saturable absorber is demonstrated [8].

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- *High power burst-mode operated sub-nanosecond fiber laser based on 20/125 μm highly doped Yb fiber*—a master oscillator power amplification structured high power sub-nanosecond fiber laser with pulse bunch output is experimentally demonstrated [9].
- *Finely tunable laser based on a bulk silicon wafer for gas sensing applications*—a very simple continuously tunable laser based on an erbium ring cavity and a silicon wafer is presented [10].
- *Broadband wavelength tunable mode-locked thulium-doped fiber laser operating in the 2 μm region by using a graphene saturable absorber on microfiber*—by tuning the polarization states in the laser cavity, the laser exhibits tunable wavelength mode-locked pulses over a wide range from 1880 to 1940 nm, providing a compact, user friendly and low cost wavelength tunable ultrashort pulse source in the 2 μm region [11].
- *2 kW (2 + 1) GT-wave fiber amplifier*—a home-made 2 kW (2 + 1) GT-wave fiber is reported, and its use demonstrated in the creation of a bidirectional pump amplifier [12].

Quantum Optics and Quantum Information Science

- *Efficient light storage with reduced energy loss via nonlinear compensation in rubidium vapor*—an experimental demonstration of efficient light storage based on a modified technique of electromagnetically induced transparency in hot rubidium vapour is reported [13].
- *Correlation, coherence and context*—it is shown, using several examples, how intimately context, correlation and coherence are interrelated [14].
- *Preparation of vibrational quantum states in nanomechanical graphene resonator*—the quantum dynamics of a nanomechanical graphene resonator are studied [15].
- *Quantum transformation limits in multiwave parametric interactions*—the properties of the quantum continuous variable fields produced in coupled nonlinear processes composed of the down- and up-conversion processes are thoroughly analyzed [16].
- *Fast generating Greenberger–Horne–Zeilinger state via iterative interaction pictures*—the construction of shortcuts to adiabatic passage for three-level systems by iterative interaction picture (multiple Schrödinger dynamics) are explored [17].
- *Detecting the Chern number of topological Weyl semimetals in 3D optical lattices*—a realistic scheme to directly probe the Chern number of topological Weyl semimetals in optical lattices is proposed [18].

Ultrafast Optics and Strong-Field Physics

- *Environmentally friendly HF (DF) lasers*—the physics of self-sustained volume discharge without preionization in working mixtures of non-chain hydrofluoride HF lasers is reviewed [19].
- *High-order harmonic emission in bowtie-shaped nanostructure with few-cycle spatially inhomogeneous laser fields when the atom is placed at different spatial positions*—the harmonic spectra in the vicinity of the center of the nanostructure gap when a helium atom is placed at different spatial positions is investigated [20].
- *The influence of a permanent dipole moment on the tunnelling ionization of a CO molecule*—it is shown that the linear Stark effect due to a molecule permanent dipole moment does not influence the rate of molecule ionization by laser radiation in the multiphoton limit [21].
- *Drift and noise of the carrier–envelope phase in a Ti:sapphire amplifier*—the drift and noise measurement of the carrier–envelope phase of ultrashort pulses in a three-pass Ti:sapphire-based amplifier is reported [22].
- *Temporal contrast improvement based on the self-diffraction process with a cylinder mirror*—a cylinder reflective mirror is used to increase the incident pulse energy to multi-millijoules in a study of temporal contrast enhancement based on a self-diffraction process [23].
- *Improvement of the temporal and spatial contrast of high-brightness laser beams*—a novel method is suggested for the temporal and spatial cleaning of high-brightness laser pulses, which seems more energy-scalable than that based on crossed polarizers and offers better contrast improvement compared to the plasma mirror technique [24].

Nonlinear Optics

- *Compact design for 2D electronic spectroscopy*—a passively phase-stabilized 2D electronic spectroscopy set-up, with compact size and easy implementation and maintenance, is presented [25].
- *Watt-level supercontinuum generation in As_2Se_3 fibers pumped by a 2-micron random fiber laser*—an As_2Se_3 fiber supercontinuum system pumped by a novel random Q-switched 2 μm Tm^{3+} fiber laser is reported [26].
- *Akhmediev breathers, Kuznetsov–Ma solitons and rogue waves in a dispersion varying optical fiber*—Akhmediev breathers, Kuznetsov–Ma solitons and optical rogue waves in a dispersion varying optical fibre based on a variable-coefficient nonlinear Schrödinger equation are investigated [27].
- *Regular 'breathing' of a near-single-cycle light bullet in mid-IR filament*—experimental and numerical studies of a temporal evolution of a light bullet formed in isotropic LiF by mid-IR femtosecond pulse (2600–3350 nm) of power, slightly exceeding the critical power for self-focusing, are presented [28].
- *High energy femtosecond pulse compression*—an original method for retrieving the Kerr nonlinear index is proposed and implemented for TF12 heavy flint glass [29].
- *Toward a sub-terawatt mid-IR (4–5 μm) femtosecond hybrid laser system based on parametric seed pulse generation and amplification in Fe^{2+}:ZnSe*—an experimentally measured seed pulse gain of about 2 cm^{-1} allows possibilities in the scaling power of such a femtosecond laser system in terawatts for the first time [30].

Physics of Cold Trapped Atoms

- *Quantum phase diagrams and time-of-flight pictures of spin-1 Bose systems in honeycomb optical lattices*—by treating the hopping parameter as a perturbation, with the help of cumulant expansion and the re-summing technique, the one-particle Green's function of a spin-1 Bose system in a honeycomb optical lattice is calculated analytically [31].
- *Statics and dynamics of quasi 1D Bose–Einstein condensate in harmonic and dimple trap*—a quasi 1D ^{87}Rb Bose–Einstein condensate in a harmonic trap with an additional dimple trap in the center is investigated [32].
- *Theory of cold atoms: Bose–Einstein statistics*—in this tutorial the specifics of the correct theoretical description of atoms obeying Bose–Einstein statistics are explained, including trapped Bose atoms [33].
- *Direct comparison between a 2D magneto-optical trap and a Zeeman slower as sources of cold sodium atoms*—a direct comparison between a two-dimensional magneto-optical trap and a Zeeman slower as source of cold sodium atoms to load a standard 3D magneto-optical trap is reported [34].
- *2D bright and dark-in-bright dipolar Bose–Einstein condensate solitons on a one-dimensional (1D) optical lattice*—the statics and dynamics of anisotropic, stable, bright and dark-in-bright dipolar quasi-2D Bose–Einstein condensate solitons on a 1D optical-lattice potential are studied [35].

Laser Methods in Chemistry, Biology, Medicine and Ecology

- *Laser technologies in ophthalmic surgery*—the scientific and technological basis for laser systems for refractive surgery developed at the Physics Instrumentation Center at the Prokhorov General Physics Institute is described [36].
- *Low-level lasers affect uncoupling protein gene expression in skin and skeletal muscle tissues*—UCP2 and UCP3 (uncoupling protein) mRNA gene relative expression in the skin and skeletal muscle tissues of Wistar rats exposed to low-level red and infrared lasers is evaluated [37].
- *Biospeckle technique for the non-destructive differentiation of bruised and fresh regions of an Indian apple using intensity-based algorithms*—in a rigorous comparison, a number of algorithms are applied to differentiate the bruised and fresh regions of an Indian apple through biospeckle technique during its 9 day shelf life [38].
- *Multiple spatially resolved reflection spectroscopy for in vivo determination of carotenoids in human skin and blood*—a new concept of a sensor for determination of analytes (chromophores) concentrations in human skin is presented [39].

- *Simultaneous triple-modality imaging of diffuse reflectance, optoacoustic pressure and ultrasonic scattering using an acoustic-resolution photoacoustic microscope: feasibility study*—the opportunity for cost-effective use of conventional optoacoustic hardware to realize additional imaging modalities such as ultrasonic microscopy and diffuse optical reflectometry within the same laser pulse are discussed [40].
- *Diffraction microgratings as a novel optical biosensing platform*—characteristic absorption bands of *Staphylococcus aureus*, in particular, its buried carotenoid fragments, were detected in FT-IR spectra with 10-fold analytical enhancement, paving the way for the spectral express-identification of pathogenic microorganisms [41].

Laser Spectroscopy

- *Simulation and experimental research of x-ray toroidally bent crystal imaging with laser-produced plasma*—based on comparison experiments with both toroidally and spherically bent crystals using a Cr line as the backlighter, it is shown that using toroidally bent crystal, a 2D image with the same magnifications in meridional and sagittal directions can be obtained with higher spatial resolution [42].
- *Nano-mechanical and biochemical characterization of different subtypes of breast cells using atomic force microscopy and Raman spectroscopy*—combining atomic force microscopy with Raman spectroscopy, three different subtypes of breast cell lines, including metastatic cancer cells (MDA-MB-231), non-malignant cancer cells (MCF-7) and benign cells (MCF-10A), are studied to compare their differences in nano-mechanical and biochemical properties [43].
- *Raman spectroscopy combined with principal component analysis and k nearest neighbour analysis for non-invasive detection of colon cancer*—the feasibility of using Raman spectroscopy for the diagnosis of colon cancer is investigated [44].
- *Optimized frequency dependent photothermal beam deflection spectroscopy*—the optimization of the experimental setup for photothermal beam deflection spectroscopy is performed by analyzing the influence of its geometrical parameters (detector and sample position, probe beam radius and its waist position etc) on the detected signal [45].
- *Two- and three-mode dressed entanglement multichannel in cavity four-wave mixing of* Pr^{3+}*:YSO*—four-wave mixing and two cascade four-wave mixing in Pr^{3+}:YSO vapor is used to generate two- and three-mode entanglement states of the electromagnetic field with the influence of the multi-dressing parametric amplification four-wave mixing process on two- and three-mode entanglement discussed theoretically [46].
- *Spatial distribution of the optogalvanic signal in a microplasma detector for lab-on-a-chip gas analysis*—it is investigated how miniaturized optogalvanic spectroscopy can fill the gap for sensors combining selectivity and versatility for chip-level gas analysis [47].

Novel Laser Materials and Lasers

- *Efficient laser operation of* $Nd^{3+}:Lu_2O_3$ *at various wavelengths between 917 nm and 1463 nm*—the favourable spectroscopic properties of the sesquioxide $Nd^{3+}:Lu_2O_3$ in terms of ground state absorption, stimulated emission, and excited state absorption cross sections, as well as the upper level lifetime, are reviewed [48].
- *Compact 0.7 mJ/11 ns eye-safe erbium laser*—the development of a compact diode-end-pumped eye-safe (~1.54 μm) passively-cooled Er,Yb:glass laser is reported [49].
- *Crystal growth, polarized spectra, and laser performance of* $Yb:CaGdAlO_4$ *crystal*—the crystal growth, segregation coefficient of Yb^{3+} ions, x-ray powder diffraction pattern, optical spectra, lifetime, and laser experiment are discussed [50].
- *SESAM-modelocked* $Yb:CaF_2$ *thin-disk-laser generating 285 fs pulses with 1.78* μ*J of pulse energy*—the potential of $Yb:CaF_2$ in a thin-disk laser architecture for high power at pulse durations shorter than 300 fs as compared to other Yb-doped crystals exhibiting broad gain bandwidth is explored [51].
- *59 fs mode-locked Yb:KGW oscillator pumped by a single-mode laser diode*—191 fs pulses with 160 mW of average power is achieved for SESAM operation, while the same oscillator can be mode-locked in a SESAM-assisted Kerr-lens regime emitting almost transform-limited 59 fs pulses with an output power of 62 mW [52].

- *Black phosphorus as broadband saturable absorber for pulsed lasers from 1 μm to 2.7 μm wavelength*—the broadband saturable absorption of multilayer black phosphorus from 1 μm to 2.7 μm wavelengths is experimentally demonstrated [53].

Optics of Nanomaterials

- *Silver nanoparticle-film based saturable absorber for passively Q-switched erbium-doped fiber laser (EDFL) in ring cavity configuration*—a passively *Q*-switched fiber laser based on a silver nanoparticle thin-film saturable absorber is demonstrated, with the saturable absorber sandwiched between two fiber ferrules, which offers simplicity, flexibility and easy integration into the laser cavity [54].
- *Polarized control of probe absorption in a single-layer graphene nanostructure system*—the behaviours of the absorptive-dispersive properties of weak probe light based on quantum coherence and interference in a Landau-quantized graphene nanostructure driven by coherent pumping fields are investigated [55].
- *Random lasing from Rhodamine 6G doped ethanediol solution based on the cicada wing nanocones*—random lasing from Rh6G doped ethanediol solution based on a cicada wing nanocones array as the scattering face and an Al-coated reflector as the fully reflecting face is demonstrated [56].
- *Femtosecond laser-induced stress-free ultra-densification inside porous glass*—fs-laser irradiation regimes, resulting in stress-free ultra-densification, decompaction and void formation inside porous glass as a function of laser pulse energy and scanning rate is reported, and these regimes are discussed in terms of thermal and hydrodynamic processes [57].
- *Light polarizer in visible and THz range based on single-wall carbon nanotubes embedded into poly(methyl methacrylate) film*—anisotropic single-wall carbon nanotube/poly (methyl metacrylate) composites were produced by stretching the polymer films with dispersed filler at elevated temperature, and the alignment of the single-wall carbon nanotubes was estimated from Raman scattering and THz absorption polarized measurements [58].
- *Nanostructuring an erbium local environment inside sol–gel silica glasses: toward efficient erbium optical fiber lasers*—a new approach for fiber laser fabrication based on the nanoporous texture of a SiO_2 xerogel and its simultaneous doping with Er/Al salts is presented [59].

Interaction of Laser Radiation with Matter

- *Plasmonics—the interaction of light with metal surface electrons*—some of the consequences of surface plasmons for a broad range of phenomena from 'lasing' to electron pairing is illustrated [60].
- *Diamond device architectures for UV laser monitoring*—the status of diamond detectors for UV laser monitoring and imaging is reviewed, with single pixel detectors, position sensitive architectures, optically activated switches and sensor arrays for beam positioning and imaging analyzed [61].
- *Spatial diagnostics of the laser-produced tin plasma in air*—new experimental studies on the laser-produced tin plasma generated by focusing the beam of a Q-switched Nd:YAG laser (532 nm) on the sample in air at atmospheric pressure are presented [62].
- *Effects of thermo-plasmonics on laser-induced backside wet etching of silicate glass*—the thermo-plasmonic effect (heat deposition via absorption of laser light by metal nanoparticles) is applied to substantially enhance the effectiveness and controllability of the microstructure formation by laser-induced backside wet etching [63].
- *Fusion of regularized femtosecond filaments in air: far field on-axis emission*—the fusion of several coherent 800 nm femtosecond filaments is induced experimentally and numerically by transmitting a beam through a mask with circular apertures followed by the focusing lens [64].
- *Hydrogen atom in a laser-plasma*—the behaviour of the eigenvalues of a hydrogen atom in a quantum plasma, as it interacts with an electric field directed along $\theta = \pi$ and is exposed to linearly polarized intense laser field radiation, is scrutinized [65].

Laser Interaction with Solids

- *Laser photoacoustic technique for ultrasonic surface acoustic wave velocity evaluation on porcelain*—a laser photoacoustic technique has been developed to evaluate the surface acoustic wave velocity of porcelain [66].
- *Excimer laser ablation of aluminum: influence of spot size on ablation rate*—the dependence of ablation rate of an Al alloy on laser beam spot size (10–150 μm) is investigated using an ArF excimer laser operating at a wavelength of 193 nm and pulse width less than 4 ns [67].
- *Laser wavelength effect on nanosecond laser light reflection in ablation of metals*—reflection of nanosecond laser pulses with different wavelengths (1.06 and 0.69 μm) in ablation of titanium in air is studied experimentally [68].
- *Effect of inter-pulse delay time on production and size properties of colloidal nanoparticles prepared by collinear double-pulse laser ablation in liquid*—the influence of inter-pulse delay times (0–20 ns) between two collinear sequential nanosecond pulses on the production and size properties (mean size and size distribution) of colloidal nanoparticles prepared by pulsed laser ablation of a silver target in a distilled water medium is studied [69].
- *Pulse-width-dependent surface ablation of copper and silver by ultrashort laser pulses*—single-shot surface laser ablation studies for important plasmonic materials—copper and silver—performed in the IR (1030 nm) and visible (515 nm) spectral ranges for variable laser pulsewidths are reported [70].

Photonics

- *Pulsed periodic laser excitation of upconversion luminescence for deep biotissue visualization*—Emission spectral properties and quantum efficiency of upconversion particles, $NaYF_4$, SrF_2, LaF_3, BaF_2 and CaF_2, doped with rare earth ions pair Yb^{3+}–Er^{3+} are studied using continuous wave and pulsed periodic excitation modes in the near infrared spectral range [71].
- *A perturbative quantized twist embedded in Minkowski spacetime*—spatially-structured gravitational waves within the paraxial approximation are investigated [72].
- *Optical redox ratio differentiates early tissue transformations in DMBA-induced hamster oral carcinogenesis based on autofluorescence spectroscopy coupled with multivariate analysis*—the autofluorescence technique demonstrates its ability to discriminate between the control from hyperplasia, dysplasia and well-differentiated squamous cell carcinoma tissue groups based on endogenous fluorophores [73].
- *A hybrid lightwave transmission system based on light injection/optoelectronic feedback techniques and fiber-VLLC integration*—a hybrid lightwave transmission system based on light injection/optoelectronic feedback techniques and fiber-visible laser light communication integration is proposed and experimentally demonstrated [74].
- *Passively Q-switched thulium-doped fiber laser with silver-nanoparticle film as the saturable absorber for operation at 2.0 μm*—a compact thulium-doped fiber laser with a Q-switched output is proposed and demonstrated [75].
- *Hierarchical multiple binary image encryption based on a chaos and phase retrieval algorithm in the Fresnel domain*—based on the chaos and phase retrieval algorithm, a hierarchical multiple binary image encryption is proposed [76].

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