The Abdus Salam
International Centre
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Winter College On Optics:
Trends in Laser Development and
Multidisciplinary Applications to Science and Industry
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LAMP presentations

POSTER ABSTRACTS

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Analysis of explosive residues in human fingerprints using optical catapulting–laser induced breakdown spectroscopy

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Abstract:

In the present work, Optical Catapulting (OC) in combination with laser-induced breakdown spectroscopy (LIBS) has been effectively tested for the analysis of explosives residues in human fingerprints left on glass surfaces in the form of solid aerosols. The goal of OC-LIBS is to combine the advantages of optical catapulting with the fast analytical response and the multielemental capability of LIBS. Advantages of optical catapulting include the absence of contamination of the specimen analyzed and the freedom from spectral contribution of the substrate where the sample is placed. LIBS analysis offers the added possibility to identify the catapulted material. OC-LIBS may find applications when chemical analysis of residues and fingerprints is needed, for instance in forensic analysis. Chemical images generated by OC-LIBS provided visual information on the spatial distribution of the explosive residue in the latent fingerprints.

Drivers of biological productivity on the western Hokkaido coast, Ishikari Bay, Japan

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Abstract:

We report on a 16-month time series of the primary productivity, chlorophyll biomass and environmental variables in Ishikari Bay, the western Hokkaido coast, from September 2006 to December 2007. During the high biomass period (April, May, July, August, and September), the average phytoplankton biomass (as chlorophyll *a*) and productivity were 6.92 ± 4.5 µg Chl a L^{-1} and 209.1 ± 167.6 µg C L^{-1} d^{-1}, respectively. The water column salinity profiles suggested that nutrient upwelling from bottom waters, especially in summer and autumn, when autotrophic production was at a maximum, was the major source of nutrients fueling the productivity in near-surface waters. Size-fractionation measurements showed that the micro-size fraction (> 10 µm) accounted for > 80% of the total phytoplankton biomass and productivity. Stoichiometrical analysis of inorganic nutrients revealed a seasonal low (13) and high (25) DIN-to-PO_4 ratio and a seasonal low (30) and high (37) Si-to-PO_4 ratio, suggesting that phytoplankton growth was possibly limited by nitrate and phosphate and not by silicic acid. We conclude that bottom-upwelling of nutrients resulting from wind-driven mixing may have been a significant source of nutrient input in this oligotrophic coastal system, and reduced mean light intensity in the mixed layer (I_m) corresponding to highest SPM (7.25 ± 8.20 mg L^{-1}) may have been crucial in controlling the Chl *a* biomass, especially in spring.

High power AlGaInAs mode-locked Lasers with integrated Optical Amplifiers

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Abstract:

1. Introduction and background

High power semiconductor mode locked lasers (SMLLs) are important sources for optical fiber communication systems, optical sampling, non-linear frequency conversion and signal processing [1]. The maximum output power obtained from the SMLLs is limited due to non-linear relation between the optical field, carrier density and refractive index, and this leads to pulse phase modulation and mode locking instabilities. Various schemes for getting high output power from SMLLs are lasers array [1], bowtie gain regions [2], tapered waveguides [3], master oscillator power amplifiers (MOPAs) [4] and slab coupled optical waveguides (SCOWLs) [5].

2. The Principle

We report on the fabrication and characterization of high output power mode-locked semiconductor lasers monolithically integrated with semiconductor optical amplifiers (SOAs). These integrated devices were fabricated using 1.5 μm AlGaInAs/InP epitaxial material, which have a three quantum well active region and a far field reduction layer in the n-cladding layer. These devices were operating at repetition rate of 40 GHz. The highest average output power of 200 mW with a corresponding output peak power of > 1.2 W was achieved from a semiconductor mode locked laser integrated with a 2° tapered SOA.

3. Wider implications and Characteristics

The MOPA concept was used for achieving high output power from semiconductor lasers. We monolithically integrated SMLLs with single transverse mode ridge waveguide SOAs and tapered SOAs of different taper angles, respectively. The effect of the integration of different types of SOAs on the output power and the mode locking performance of these devices are investigated. An average output power of 130 mW and peak power > 1W was obtained from a SMLLs monolithically integrated with single mode SOAs. For further increase in the output power, we integrated 2° tapered SOAs at the output of SMLLs and obtained an average output power of 200 mW with corresponding peak power of 1.2 W. We also integrated a 6° tapered SOA at the output of a SMLL, which gives a maximum output power of 105 mW under CW current conditions. The lower output power obtained from 6° tapered SOA devices is due to the increased heating effects due to high CW current requirement . It is anticipated that these devices would exhibit better output power performance in pulsed current operation.

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Laser induced orientational nonlinearities in liquid crystals

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Abstract:

There are various mechanisms which can lead to the reorientation of the nematic liquid crystal (NLC) director. One of these mechanisms is thermomechanical effect. There are three types of thermomechanical effects. The first effect is the hydrodynamical flow caused by the temperature gradient, the second effect is the temperature change due to non-uniform flow and the third effect shows that the temperature gradient can reorient the director of a non-uniform NLC. In this study third type thermomechanical effect is presented in both pure and azo-dyed liquid crystal cells. Gaussian laser beam creates transversal temperature gradient in the cell which leads to reorientation of director of NLC due to the third type thermomechanical effect. It has been proved that the nonlinearitiy in this case is within the same range as that of the giant optical nonlinearitiy (GON). Unlike GON, in this case we even have reorientation of molecules when laser impinges normally on the first wall of the liquid crystal cell.

Laser cutting process modeling

E.H. Amara, K. Kheloufi, S. Aggoune, T. Tamsaout

Abstract:

We develop a numerical modeling to simulate the cutting process of metals using a high power laser beam. The range of working temperatures vary between the ambient and could be beyond the vaporization one. When the evaporation regime is reached the evaporated material can be simulated by a mass transfer from the treated material to the environing gas, whereas the material at liquid state is expelled by a gas jet. Phenomena such as humps and striations occurrence at given cutting speeds are particularly investigated.

Comparison of a new trace gas sensor with a commercial relative humidity sensor

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Abstract:

Second and third generation Quantum Cascade Laser Open – Path Systems (QCLOPS), with tunability in the ranges 1020 – 1070 cm-1and 965 – 1260 cm-1respectively has been developed and tested. Results for water vapour monitoring was in good agreement with a commercial relative humidity sensor. Results obtained for targeted smoke compounds (Benzyl alcohol and 2-methylphenol) compared very well with Fourier transform infrared spectrometer measurements and the know-it-allinfrared database.

Laser-Induced Breakdown Spectroscopy (LIBS) for analysis of Human Fingernails

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Abstract:

Laser induced breakdown spectroscopy (LIBS) is an elemental characterization technique for analysis of a samples. This method provides multi-elemental in-situ sample analysis down to trace concentrations and it is so proper for analysis of biological samples. LIBS offers many advantages compared to other elemental analysis techniques including: A sample preparation- free measurement technique; Extremely fast measurement time, usually a few seconds, for a single analysis; Broad elemental coverage, including lighter elements, such as H, C, N, O, Na etc; Versatile sampling protocols that include fast raster of the sample surface and depth profiling; Thin-sample analysis without the concern of substrate interference.

The aim of our work is to use LIBS of fingernails as a tool for diagnosis of some diseases. Q- switched Nd:YAG laser was used as a source and an Echelle spectrograph equipped by an intensified charge-coupled device (ICCD) camera used for time resolved detection. Measurements carried out on several sets of nail samples. For example, laser induced breakdown spectroscopy was used to investigate the possible effect of osteoporosis on the elemental composition of fingernails. Also, the ability to classify healthy, osteopenic, and osteoporotic subjects based on their fingernail spectra has been examined. In another experiment the aim was to identify differences in elemental fingernail composition between opium-addicted and healthy adult human subjects using laser-induced breakdown spectroscopy.

The results of our analysis show that classification of fingernails is attainable. Some evidence of association between elemental composition of fingernails and unusual feeding habits can be obtained. Also there are correlations between some diseases like osteoporosis and LIBS of fingernails.

Ultra-Novel Applications of UltraFast Photonics Systems

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Abstract:

There are a number of competitive advantages of ultrafast semiconductor lasers and detectors, in particular their high speed and ease of optical and electronic control and synchronization. Ultrafast photonic systems based on semiconductor lasers also present a significant reduction in both cost and footprint, and applications include spatially-resolved optical spectroscopy, whereby the composition of an object may be determined spatially. There is an overwhelming interest in using these non-invasive optical techniques in security, bio-sensing and manufacturing, in order to replace the existing photonic systems whose slow nature inhibit the use of these techniques in real-time characterization and imaging. Academic beneficiaries include those in Life Sciences and Medicine for the study of proteins and, as well as cancer diagnostics. Ultrafast photonics systems therefore open up excellent opportunities in various avenues of research with profound impact in many fields.

Improvement Of The Resonant Photoacoustic Signal Of Methane In Air Adding Different Collisional Partners

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Abstract:

In this work we studied the resonant photoacoustic technique applied to the detection of methane. The excitation was performed with a mechanically modulated optical parametric oscillator tuned at 3,3 μm. The acquisition was synchronous with a lock-in amplifier whose reference came from the mechanical modulator. In previous work, we have found that the photoacoustic signal of methane in air is lower than in pure nitrogen. This is because, after a strong energy exchange between resonant levels of oxygen and methane, part of the absorbed optical energy is stored in a metastable level of oxygen (1500 cm^{-1}) instead of being converted into kinetic energy. In this work we try to revert this process by adding different collisional partners of oxygen and methane: water, helium, sulphur hexafluoride and 1,2-Dichlorotetrafluoroethane. We developed a numerical model based on rate equations, which describes the time evolution of the excited populations and the heating of the sample when water or helium are added, with the aim of predicting the amplitude of the photoacoustic signal. The model showed good agreement with the experimental results.

Laser ablation of aluminum targets for nanoparticles generation

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Abstract:

Generation of nanoparticles by laser ablation of solid targets situated in liquid took advantage in the last years due to the versatility of the method and cheap production set-up. The method can be applied to a large class of materials due to the possibility to ablate under the action of laser radiation very hard but also soft materials with a proper selection of incident laser radiation parameters, the possibility to induce high temperatures and high pressure in a very localized region, the high purity of the obtained nanoparticles and the in-situ nanoparticle storage in the surrounding liquid. Also the storage of the nanoparticles in suspension has the advantage of the possibility to use a high variety of liquids, but also to ensure a safe manipulation of the nanoparticles. We have used the so called laser ablation in liquids (LAL) method to produce nanoparticles from pure aluminum targets. The interest for aluminum and aluminum oxide nanoparticles is related with their exothermal oxidation reaction and hydrogen storage application for energetics. We have used a pulsed nanosecond Nd:YAG laser working at 355 nm to ablate the pure aluminum ingots situated in water. In order to select the proper irradiation conditions, due to the strong dependence of the ablation process on the fluence/intensity of the laser radiation, a preliminary study of the ablation print was realized with optical microscopy and white light interferometry. We have obtained nanoparticles with diameters of 3-5 nm, organized in clouds of 40 - 80 nm dimension but also nanoparticles of 20-40 nm, as the TEM analyses has evidenced. The incident laser fluence was in this case about 12 J/cm^2. Higher nanoparticles dimensions, between 16 and 90 nm were obtained for higher incident fluencies and a high number of laser pulses.

Highly Sensitive Elliptical-Nanowire-Based Sensor

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Abstract:

We propose a high-sensitive single-mode elliptical Mach-Zehnder interferometer (MZI)-based sensor composed of two elliptical silica nanowire arms with diameter of 800 nm. The sensor exploits the fractional power propagating in the evanescent field outside the waveguide boundary in order to analyze the properties of the specimen surrounding the waveguide.

Development Of Wearable Transmission Pulse Oximeter

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Abstract:

Pulse Oximeter is an instrument, which *non-invasively* monitors the saturation of hemoglobin in arterial blood. Under normal physiological conditions, oxygen saturation ranges between 95%-100%. When saturation falls below the normal range, an unhealthy clinical condition is indicated and some intervention is generally required. Hence there is a need for quick and noninvasive determination of hemoglobin in arterial blood and convenient display of the reading. This need is met by pulse Oximeter which is based on the fractional change in light transmission through an artery at two different wavelengths illuminating one side of a finger which is detected on the other side, after having traversed the intervening vascular tissues. The signal, which varies with time in consonance with the heartbeats, is superimposed on a D.C. Level, which is selected out by designing matched filters. The amplitude of the signal is of the order of 1% of the D.C. Level. The Oxy-hemoglobin (SpO_2) and the pulse rate may be digitally displayed on LCD module.

CW frequency doubling of Yb-doped fiber laser inside a periodically poled silica fibre

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Abstract:

Fibre laser sources are widely used in science and technology. A new way for effective frequency doubling is to use periodically poled silica fibres (PPSF) [1]. A constant transverse electric field is created inside a fibre across the core while the fibre is hated to ~300ºC. The electric field which is stored in the fibre by cooling to room temperature, couples with the $\chi^{(3)}$ of the glass giving rise to a second-order nonlinearity. Subsequent selective erasure of the stored field by exposure to UV radiation allows one to build a periodic structure. The period of the structure has to fulfill the quasi-phase-matching condition for efficient second harmonic generation (SHG) [2].

The capability for effective SHG in PPSF was demonstrated in pulsed regime [3]. In this work the continuous wave frequency doubling of Yb-doped laser in PPSF is studied. Single frequency DFB-laser and multi-frequency ring cavity laser with are used in experiments at wavelength ~1030 nm.

Maximal second harmonic power is obtained with multi-frequency non-polarized laser, but frequency doubling nonlinear efficiency coefficient $k = P_{2\omega}/(P_{\omega})^2$ is higher for single-frequency laser. It should be noted that the transition to linear polarization of multi-frequency laser did not increase the nonlinear efficiency.

Also an external fibre ring cavity scheme is assembled for SHG efficiency enhancement. The length of the ring was varied via piezoelectric and output signal is detected via photo detector and oscilloscope. We can estimate how losses influence fundamental power enhancement and compare them with experimental data. At the moment PPSF samples have large losses and power in cavity can be increased only twice. If one can decrease excess losses in cavity down to 0.5 dB tenfold second harmonic power enhancement can be obtained and milliwatt second harmonic power under the watt pumping with quadratic scaling under the pump gain.

Thereby in this work possibilities of continuous wave SHG in all fibre scheme were studied in single- and multi-frequency regimes. It was demonstrated that efficiency is limited by excess loss level in PPSF for fundamental radiation.

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Quantum Cascade Lasers for spectroscopic applications: feasibility and asset for muonic-hydrogen experiment.

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Abstract:

Quantum cascade lasers (QCL) represent nowadays a mature technology to obtain MIR and FIR laser sources. We report about characterization of a laser source capable of achieving a high pulsed power density on a target cavity with tunability around 7 μm. This source will be used in an experiment of muonic atoms spectroscopy. Our work is based on a QCL with characteristics exploitable for the mentioned experiment. The range of emission wavelengths can be chosen by means of tailoring the growth structure. The emission wavelength is tunable with a very good precision and a high optical power can be emitted in a spot of small size. These QCLs are suitable for several applications, including gas spectroscopy in the IR range. We give a summary of the measurements performed on a quantum cascade laser. In this work we provide some characteristics of QCLs, showing that they are suitable candidates for biosensing applications. We perform the tunability of the QCLs as function of the temperature and the applied voltage. For that, the measurements have been performed at different temperatures and voltages, to look for the moving of the emission wavelength.

Keywords: quantum cascade lasers, gas sensing, infrared spectroscopy, muonic hydrogen.

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Measurement of Caffeine in Coffee Beans by UV-Vis spectrophotometer

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Abstract:

In this research the optical transition probabilities of caffeine and methods of measuring caffeine contents in coffee beans were investigated by experimental and computational methods. The implemented methods for determination of the contents of this compound in coffee beans are the liquid-liquid extraction or extraction of caffeine from coffee by dichloromethane and fitting Gaussian function to the spectrum by non-linear curve fitting based on the Lavenberg Marquardt algorithm to eliminate the possible interferences. The contents of caffeine determined by these methods for green coffee beans are in the ranges of 0.90-1.27 %. The optical transition probabilities of caffeine were determined in different solvents by integrating the absorption coefficients in the wave number regions. The calculated value of transition dipole moment of caffeine in water in their wave number regions are 10.40×10^{-30} C m. The corresponding oscillator strength in water is 0.19. In addition the time dependent Schrodinger equations have been solved to compare the theoretical expression with experimentally measured physical quantities.

Principles and development of FLIM and FRET

Stephanie Haggett

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Abstract:

This poster describes the physical principles of FLIM (fluorescence lifetime imaging microscopy) and FRET (Förster resonance energy transfer). FLIM and FRET techniques have particular characteristics that mean they can be used to great effect in bio-molecular imaging applications. Also described here is development of the various techniques up to date and plans for my research and why this will be relevant to current interest.

Design and Simulation of Nano-Antennas (Nantennas) for Energy Harvesting

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Abstract:

Worldwide energy demands have increased by 40% over the last 20 years. To meet the increased requirements for solar-conversion technologies; dramatic improvements are required in the state-of-the-art of photovoltaics (PV) technologies. Efficiency improvements and cost/complexity reduction are the main issues that need to be addressed to meet these goals. Several approaches have been pursued to harvest energy from the sun. Photovoltaics are the most common technique for the conversion of solar energy to electricity. However, PV solar cell devices are designed to absorb solar energy in the visible region (400 nm-700 nm) which constitutes (46 %) of the solar spectrum. In this regard, there is need to harvest more solar energy by extending the absorbed range to the IR region, through developing solar cell antennas covering this region.

An alternative to photovoltaics is the "nano-rectennas", which is a combination of a receiving nano-antenna and a rectifier. The nano-rectenna uses nano antenna to efficiently absorb the incident solar radiation. In addition, a high frequency metal-insulator-metal (MIM) tunneling diode is used to rectify the AC field across the antenna, providing DC power to an external load.

In this research proposal, novel designs of nano-antenna with different geometric parameters over different frequency ranges are introduced and analyzed. The suggested designs can increase the efficiency of collecting the solar energy. In this regard, numerical simulations are investigated for improving the harvesting efficiency and directivity of one element and multi element (array) of the nano antennas.

Single molecule force/fluorescence detection: An overview

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Abstract:

Fluorescent probes provide new opportunities to explore models which explain the physical and chemical properties of biomolecules. We have combined dual beam optical tweezers (fixed, λ = 830nm) with single molecule fluorescence detection (SMF) (λ = 350-700 nm), the details related to the setup are given. The high detection efficiency is achieved by choosing the emission wavelengths of the fluorescence reporter molecules in a band pass window different from the trapping and excitation wavelengths. Our results shows (a) manipulation and attachment of functional mitochondria to aldehyde activated polystyrene spheres, (b) Detection of single quantum dots, alexa dyes covalently coupled to λ DNA and fluorescent images of λ DNA.

Vibrational Quantum Defect Coupled To Improved Leroy-Bernstein Formula For A Precise Analysis Of Photoassociation Spectroscopy

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Abstract:

Laser photoassociation (PA) of cold atoms creates excited, weakly-bound molecules, which are key intermediates in the most of schemes that allow the formation of cold molecules in the ground state.
For that reason the spectroscopy of these weakly bound molecules is one of the tools to know, not only the energy position of the levels but also if it exists their mixings with neighboring levels. Indeed, the mixings determine the wavefunction shapes, especially at short internuclear distance, and thus the Franck-Condon factors required for molecule formation. We show that, for an accurate analysis of the PA spectroscopy data, the LeRoy-Bernstein formula has to be improved [1]. Furthermore we show that the use of vibrational quantum defects and of Lu-Fano graphs provide efficient tools to determine and measure the couplings [2, 3, 4].

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Exact Analytical Formalism for EDFLs & EDFAs

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Abstract:

In this talk, an exact analytical formalism for erbium doped fiber lasers and amplifiers will be presented based on my recent research work.

Title:

Quantum Gates with Trapped Ions using
Magnetic Gradient Induced Coupling

Name/Surname of all authors:

Anastasiya Khromova

Affiliation:
Department Quantenoptik, Naturwissenschaftlich-Technische Fakultaet, University of Siegen, Siegen, Germany

Abstract:

Since the original proposal from Cirac and Zoller in 1995 to use trapped ions as a quantum computer most of the experimental efforts to couple trapped ions have been performed with the use of laser light. In 2001 a method was proposed to use microwaves to implement the quantum gates. In practice, an additional inhomogeneous magnetic field is applied to the cooled chain of trapped ions and in this way the ions can be individually addressed in frequency space. Furthermore, the gradient induces a coupling between the ions' internal and motional states and the Ising-type spin-spin coupling (J-coupling) between the ions' internal states.

We call this method Magnetic Gradient Induced Coupling, MAGIC and in this talk a new experimental setup to implement it is described. Spin-spin coupling can be used to implement controlled-NOT (CNOT) gates. The CNOT gate has been implemented also between non-neighboring ions in a three-ion chain. This has been done here for the first time using the MAGIC method.

Modulation laser spectroscopy for dissolved methane detection

Sergii Kukhtin

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Abstract:

This work accesses the method for remote methane detection that is dissolved in water using modulation laser spectroscopy (MLS).

Detection of dissolved methane in water and its concentration measurements are utterly important to natural gas deposits estimation, environmental monitoring and researches related to methane hydrate compounds. Majority of optical methods cannot be utilized in water media due to harsh environmental conditions and high attenuation of IR radiation. Techniques that are commonly used for dissolved methane sensing, such as Raman spectroscopy and ATR absorption spectroscopy have major disadvantages that heavily restrain their effective marine utilization.

MLS is very promising for this purpose. It is based on frequency modulation of narrow single mode laser radiation at centre frequency of investigated substance's absorption line. Subsequent registration of signal components (harmonics) provides information on line strength and its shape. Unlike mentioned above techniques, MLS benefit from simplicity, high SNR, ability of remote operation.

Due to high attenuation in the NIR region (ranging from 0.05 to 10^4 cm^{-1}) and absence of commercially available sources for 3,31 and 7,79 μm it was decided to use single mode DFB-LD operating at $2v_3$ band of methane at 1,65 μm. This spectral region is very attractive due to following aspects. Firstly, it lies in the 3rd transmission window of an optical fibre. Therefore, single mode optical fibre can be used for long distance signal delivery allowing remote operation on a great depth. Secondly, absorption lines of $2v_3$ band of methane are by an order of magnitude more intense compared to $v2+2v_3$ band at 1,31 μm.

Apart from general concept description this work accesses theoretical investigation of the MLS method for marine applications including detection limitations, methane solubility levels, possible absorption line broadening and other related factors.

Another major part of this work is devoted to experimental equipment, measurements and results discussion.

Key words: *laser diode, spectroscopy, methane, water, sensing, optical fibre, modulation*.

Intensity fluctuations of light scattered by supramolecular inhomogeneities in H-bonded liquids

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Abstract:

$1/f$ fluctuations are widely observed in various physical, chemical and biomedical systems. One manifestation of this phenomenon has been explained as an energy partition fluctuations among phonon modes in homogeneous (quartz) and inhomogeneous (water, electrolyte solutions) media by means of light scattering experiments. The experimental result for liquids shows that the scatterers are not propagating ones such as phonons, but localized ones. Light scattering in the liquid systems occurs on phonons localized at inhomogeneities (clusters). Thus, intensity fluctuations might reflect fluctuations of the cross section scattering centers and/or fluctuations in the number of such centers in the volume of scattering.

H-bonded liquids can be considered as mediums that have supramolecular heterogeneities, the existence of which is proved by static and dynamic laser scattering (M.Sedlak, 2006). Percolation model and concept of supramolecular inhomogeneities were successfully applied to describe inelastic light scattering spectra of amorphous media (S.Alexander, 1989).

In this work fluctuations of light scattering in H-bonded liquids (distilled water and water-glycerol solutions) have been investigated. The calculation of the power spectrum corresponds to time series in the range on 0.1 – 50 Hz for the expression $S(f) \sim 1/f^{\alpha}$, where the value $\alpha \propto [1.1 \div 1.3]$. We found that the index α depends on the type of liquid and solution concentration.

We consider two mechanisms of $1/f$ - process forming: fluctuations of phonon energy and fluctuations caused by dynamical inhomogeneities, predicted by percolation model. Thus, they represent Brillouin-Mandelstam scattering and Rayleigh one correspondingly. The α variability can be explained by different contributions of the both scattering mechanisms, which form an overall picture of low-frequency intensity fluctuations of scattered light in complex liquids.

Our work provides new experimental evidences for existence of supramolecular inhomogeneities in H-bonded liquids.

Title:
Chaotic and Stochastic Dynamics in a Electro-Optical System

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Abstract:

We present a scheme whereby a static non-linear, non-invertible transmission function performed by the electro-optic Mach-Zehnder modulator produces highly complex optical chaos. The scheme allows the deterministic transformation of low-dimensional band-limited chaotic signals into much higher-dimensional structures with broadband spectra and without using any delay elements or feedback. Standard benchmark tests show that all the considered complexity indices are highly increased due to this transformation in a controlled fashion. This mechanism allows the design of simple optoelectronic delayed oscillators with extremely complex chaotic output.

Electromagnetic analysis of the lasing thresholds of a plasmon-assisted nanowire laser in the visible range

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Abstract:

Using the first-principle electromagnetic modeling of lasers as open resonators equipped with active regions, we investigate a nanowire laser made of a plasmon-assisted circular silver wire concentrically covered with an active coating. Such a coating is characterized with a complex-valued refractive index, which includes refractive index and material gain. We consider a lasing eigenvalue problem and look for the discrete pairs of real parameters (λ, γ), where λ is mode emission wavelength and γ is threshold value of material gain necessary to bring the mode to lasing.

Profiling Atmosphere in Hanoi, Vietnam by Lidar Techique

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Abstract:

Study atmosphere in Hanoi, Vietnam by lidar technique is begun by our lidar group in Institute of Physics from 2010. We have developed some multi-wavelength lidar system to study atmospheric characteristics such as: aerosol, temperature, cloud. Some early results have provided important information for prediction of weather and climate in Hanoi, Vietnam. We also report some developing lidar system in our lidar group in future.

Design and construction of optical tweezers system and their applications

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Abstract:

We have built a versatile optical tweezers with mechanically controlled specimen stage movement to trap and manipulate micron-sized polystyrene particles and biological objects. The system is based on an inverted microscope using a 100x N.A. 1.25 oil immersion objective. The sample plane can be observed with a CCD camera through a dichroic mirror to generate a video image of the trapped particle. We captured and moved a particle by a strongly focused laser beam. In order to obtain the variance of the position of a 4 and 1.5 ?m polystyrene particles we have recorded the entire capture process through the CCD imaging system and then the stiffness of the trap was determined.

Laser Induced Fluorescence Technique for Early Detection of Malignancy in Buccal Mucosa of Oral Cavity

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Abstract:

Cancer is a major threat to the public health [1]. Oral cancer is one of the major cancers in developing countries. It is the most common cancer in India accounting for 50-70% of total cancer mortality [2]. The survival rates are poor and not improved in the last decade. Histopathology is the gold standard for the cancer diagnosis. It is very well recognized that early detection is essential for successful therapy in all types of malignancy. Since, taking biopsies in the early stages of cancer may not be reliable [3] there is a need of some objective screening which will fill this gap to improve the survival rates.

Laser Spectroscopy techniques are extremely sensitive for the analysis of biochemical changes in the cellular systems. Among them, tissue auto-fluorescence is an emerging optical technique for cancer detection. It has been recognized that Laser Induced Fluorescence (LIF) is a highly sensitive spectroscopy tool for biomedical applications [4, 5].

This work deal with *in vivo* fluorescence measurement of cancerous Buccal Mucosa of the oral cavity using our LIF system. About 1582 fluorescence spectra from buccal mucosa have been recorded from 380 subjects under normal (133), premalignant (155) and malignant (92) condition, by excitation with 325 nm CW He-Cd laser. Under clinically normal, pre-malignant and malignant conditions the fluorescence spectra are found to be noticeably different. The analyses results (Principal Component Analysis) of the recorded data have shown that more than 90% sensitivity and specificity to diagnose malignancy. The LIF system developed and assembled in our laboratory is proven as a reliable device for the *in vivo* screening of susceptible population, monitoring of results of therapy, and early detection of recurrence.

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The use of gamma ray computed tomography to study the representative elementary area in measurements of soil bulk density

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Abstract:

The concept of representative elementary size (RES) deals with the definition of a minimum size or physical point of a sample which is needed to represent its characteristics of interest, that is, the size in which the measured parameter becomes independent from the sample size. Techniques that generate images such as computed tomography (CT) can be a useful tool to study RES. CT has been proved as an efficient method to study soil structure, and it has become more important as the new generations of tomographs exclusively dedicated to the study of materials. The technique has become so successful due to the fact that it is a non invasive method, that is, it does not damage the structure of the sample under analysis. In this study, the representative elementary area (REA) was determined for density (d_s) measurements of a Brazilian soil of clay texture, from data obtained via gamma ray first generation CT. Tomography images with millimetric resolution were used for both qualitative and quantitative analyses. Soil samples were collected at soil surface and their volumes varied from 50 to 100 cm^3. The tomograph is equipped with a gamma ray source ^{241}Am (59.54 keV), approximate activity 3.7 GBq, and a 7.62 cm x 7.62 cm NaI(Tl) detector. Consecutive concentric quadrangular areas (18) were selected in the CT images in order to evaluate the REA. The initial area was obtained from a square matrix of 1 x 1 (1.1 mm x 1.1 mm). For each area the d_s average value was obtained. The following criteria were used to determine the REA: i) relative deviation of d_s average value between the last and each of the other areas not superior to 5%, 4%, 3%, 2% and 1% and ii) that at least three consecutive areas cannot present different d_s values, using the variation criterion in item i. Using 2D images of soil clod samples, it was possible to determine the REA for d_s measurements with 4% reliability, based on the d_s CV measurements obtained through the paraffin sealed clod method, adopted as a standard method. For the clayey soil studied, cross section areas of 640.1 mm^2 are enough to provide representative values of this soil physical property.

Electrons scattering in Helium assisted by Laser

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Abstract:

The dynamics of laser-assisted elastic collisions electron-helium is studied using the second-order Born approximation. Detailed calculations of the scattering amplitudes are performed by using the Sturmian basis expansion. Differential cross sections for elastic scattering with the net absorption/emission of up to two photons are calculated for collision energies of 5 eV, 10 eV and 20 eV. We discuss the influence of the low-energy incident electrons on the differential cross section as a function of the scattering angle for selected choices of the laser frequency and the number of photons exchanged between the external field and electron-helium system. We also investigate the effect of laser polarization in the case of linear and circular polarization.

Determination of atmospheric parameters by moire deflectometry

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Abstract:

Turbulence in the earth atmosphere is a major obstacle to the image detection. Optical turbulence is an atmospheric effect that acts on the light propagation. It is brought about by fluctuations in the refractive index in air, i.e., air density, which affects the speed at which light wave fronts propagate. In turn, these effects can significantly degrade (blur, shimmer, and distort) images in imaging systems through the atmosphere. Parameters that show the strength of atmospheric turbulence are the refractive index structure constant, Cn2 and atmospheric optical coherence length(Fried parameter) r0. In the study of propagation of laser beams through a turbulent atmosphere, information about behavior of atmospheric turbulence during day, is essential for manufacturing optical instrument for contrast achievable with high-resolution imaging and the precision atmospheric measurement. we have determined time behavior of optical turbulence, Cn2, during 24 hours using a moire deflectometery. We discussed case studies with regard to variations in daytime and night time turbulence intensity, wind speed, and temperature. Also we determined r0 during 24 hours using a moire deflectometery.

Wideband multiwavelength source using spectral slicing

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Abstract:

A simple technique to generate multiwavelength source is demonstrated. This technique uses spectral slicing to slice a broadband light source.

Theoritical and analog simulations of bifurcation in modulated VCSELs, in optomechanics and lasers cooling

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Abstract:

We firstly investigate on the dynamics of VCSELs under self-sustained electronic oscillator and the construction of electronic metaphor of VCSELs. Secondly, we study the dynamics instability of optomechanical systems in the absence of both optical and mechanical nonlinearities. We show that the hysteresis in the system is limited by the mechanical threshold. However, in the presence of both nonlinearities, the instability is reduced in the system whereas the cooling of the mirror is limited.

Some Statistical Approach to Two-Level Atom-Cavity Field System in Nonlinear Optics

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Abstract:

The work is devoted to the investigation of dynamics of system, consisting of interacting two-level atoms and field (cavity field). To such system covers also Jaynes-Cummings model. In this work, evolution of two-level many bosons system interacting with a field is investigated by means of generalized kinetic equation. On base of the Bogolyubov's method (method of elimination of bosons), solution of the generalized kinetic equation is determined and explicit expression of average value of physical quantities, characterizing present system is defined. Moreover, solution of the generalized kinetic equation is defined for the system, consisting of a single twolevel atom, interacting with a single cavity field mode. Thereby, offered in the work, statistical approach to the problem allows to generalize well-known theoretical and applied results of Jaynes-Cummings model for the systems, consisting of many two-level atoms and cavity field.

Silicon and gallium arsenide structuring by far and near-field enhanced laser irradiation in different liquid precursors.

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Abstract:

The aim of this study is to investigate the micro and submicrometer scale structuring of the silicon and gallium arsenide by liquid precursors with a 200 fs laser pulses working both at fundamental (775 nm) and frequency doubled (387 nm) wavelengths. The silicon and gallium arsenide substrates were irradiated at normal incidence, by immersing the substrates in a glass container filled with liquid chlorine (CCl_4), fluorine ($C_2Cl_3F_3$) and acetone (C_3H_6O) precursors. When irradiating the surfaces in far field, regular areas of spikes are formed. Atomic force microscopy and scanning electron microscopy of the surface show that the formation of the micro and sub-micro spikes involves a combination of capillary waves on the molten silicon surface and laser-induced etching of silicon, both at the 775 nm and 387 nm wavelength irradiation**.** The energy-dispersive x-rays measurements indicate the presence of chlorine and fluorine precursors on the structured surface. The fluorine precursors create more ordered area of Si spikes at both micro and sub-micro scale. The potential use of patterned Si substrates with gradient topography as model scaffolds for the systematic exploration of the role of 3D micro/nano morphology on stem cell adhesion and growth will be presented.
In the process involving near fields interactions, a mono or double layer of 700 nm diameter silica were self-assembled on the substrates and a single pulse from a 200 fs laser at 387 nm wavelength was applied. The influence of the medium on the near-field interactions for both substrates is investigated. Periodic arrays of ring bumps, disk and convex bumps or holes on silicon and gallium arsenide substrates will be presented.

A high dynamic Micro Strips Ionization Chamber featuring Embedded Multi DSP Processing

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Abstract:

An X-ray detector will be presented that is the combination of a segmented ionization chamber featuring one- dimensional spatial resolution integrated with an intelligent ADC front-end, multi DSP processing and embedded PC platform. This detector is optimized to fan beam geometry with an active area of 192 mm (horizontal) and a vertical acceptance of 6 mm. Spatial resolution is obtained by subdividing the anode into readout strips, having pitch of 150 micrometers, which are connected to 20 custom made integrating VLSI chips (each capable of 64-channel read-out and multiplexing) and read out by 14 bits 10 MHz ADCs and fast adaptive PGAs into DSP boards. A bandwidth reaching 3.2Gbit/s of raw data, generated from the real time sampling of the 1280 micro strips, is cascaded processed with FPGA and DSP to allow data compression resulting in several days of uninterrupted acquisition capability. Fast acquisition rates reaching 10 kHz are allowed due to the MicroCAT structure utilized not only as a shielding grid in ionization chamber mode but also to provide active electron amplification in the gas.

Tunable continuous wave all-fiber optical parametric oscillator operating below 1 μm

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Abstract:

Fiber optical parametric oscillators (FOPOs) based on a parametric four wave mixing (FWM) process offer an opportunity to generate tunable laser radiation in new spectral ranges, where conventional fiber lasers are not effective or absent. However, in spite of a great demand for continuous wave (CW) tunable fiber sources in various applications, rather low CW pump power and dispersion fluctuations in long fibers limit the parametric frequency shifts and conversation efficiency of such FOPOs. Moreover, a CW FOPO at short wavelength region, <1 μm, has not been demonstrated yet, to our knowledge.

The present work is devoted to development of CW all-fiber optical parametric oscillator, operating below 1 μm. The tuning range from 950 to 1010 nm is demonstrated using birefringent photonic crystal fiber pumped by an ytterbium doped fiber laser (YDFL) near 1 μm. CW parametric generation at 972 nm has been obtained with slope efficiency as high as 9.4% and output power of up to 460 mW. It is also shown that the FOPO slope efficiency reaches 25% and the generated power exceeds 1 W after narrowing of the pump spectrum down to 40 pm. But in this case the generated radiation is modulated with 48 ns period and 50% duty factor due to pump laser power modulation which is probably caused by stimulated Brillouin back scattering.