№ 1/2013

SCIENCE NEWSLETTER

of the Faculty of Physics, Lomonosov Moscow State University

In This Issue:

With this current issue of the Science Newsletter of the Faculty of Physics, Lomonosov Moscow State University, we launch a new publication in a format of a regular newsletter, which, as we hope, will bring fresh, updated information on scientific news, research activities, and related events in the life of our department to our staff members, undegraduate and graduate students, postdocs, collaborators and partners.

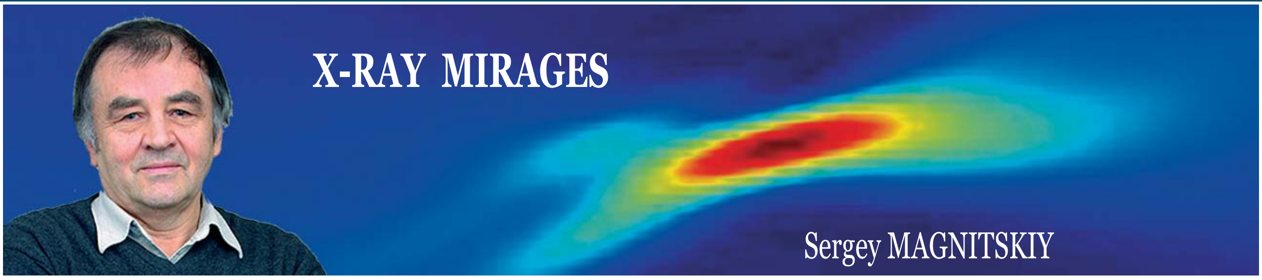
Talking of the Faculty of Physics, Lomonosov Moscow State University, first of all I should stress that we offer the best education in Physics in Russia and one of the best worldwide. All our professors are also active scientists working in various fields of Physics. Therefore, our students study Physics "from the first hands", and all of them are being involved in research from the first steps at the Faculty. We do pay lot of attention to the students work in a great variety of physical practicums that complement both courses on general Physics and specialized courses, as well as in the field and in the research labs of our Faculty and in the partner Institutes. This, in combination with enhanced training in theoretical Physics and Mathematics, Computer Physics and great variety of specialized courses in the last few years of their education, forms a strong fundamental education of high quality we do offer.

Faculty of Physics is also a key research center in Physics and related fields worldwide. Seven Nobel-prize winners in Physics and one Nobel-prize winner in Piece were either graduates or professors of our department. Every year our staff members are awarded by various prestigious international awards both in Russia and abroad. By and large, Russia gives an essential contribution to Physics worldwide, and physicists from Lomonosov Moscow State University play in this process a crucial role.

Faculty of Physics is also a "living organism", which develops and actively follows the demands of our society in education, research, and innovations. Thus, over few last years new chairs of Medical Physics, Physics of Nanosystems, Particles and Cosmology, and Physical-Mathematical methods of Control were established and such specializations as "Physics and Management of Research-Intensive Technologies" and "Engineering Physics" were launched. We do pay great attention to the innovations carrying the results of our research to the level of technologies and industrial applications.

I greatly hope that this Science Newsletter will help us to find new partners in research and shorten the way from fundamental research to applications and innovations, from our fundamental discoveries to their successful implementations in not too distant future.

Prof. Nikolay N. Sysoev
Dean, Faculty of Physics
Lomonosov Moscow State University



X-RAY MIRAGES

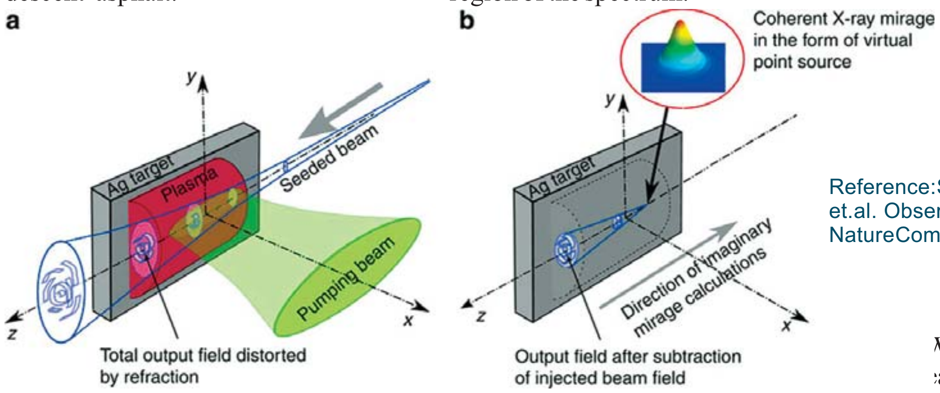
Sergey MAGNITSKIY

Mirage phenomena can be observed by your own eyes not only in a desert, but also in a laboratory in the invisible to your eyes x-ray frequencies range. In the x-ray range of spectrum, this phenomena has been experimentally observed for the first time and theory was derived, which describes mathematically not only x-ray mirages, but also mirages in any other region of the spectrum, by the researchers from the Faculty of Physics, Lomonosov Moscow State University in collaboration with their foreign colleagues.

Mirages in the optical range of the spectrum are well-known as a beautiful and misterious phenomena that is aroused in the atmosphere of the Earth. All of us know examples of the mirages in a desert when an exhausted stranger suddenly sees something reminding "water" at the Horizon. Even in a city, one can sometimes see puddles on incandescent asphalt.

Lasers, which generate laser beams in the optical range of the spectrum (i.e., laser pointers, lasers that are used for laser-shows), are well-known. However, amplification of the radiation (a laser is a kind of a quantum generator and the acronym LASER reads as "light amplification by stimulated emission of radiation") can be arranged not just in the optical region of the spectrum.

developed a general theory of the mirage phenomena, which was not existed in Optics, juts its qualitative description», claimed Sergey Magnitskiy, one of the authors of this research, Associate Professor of the Chair of General Physics and Wave Processes, Faculty of Physics, Lomonosov Moscow State University.



Reference:S.Magnitskiy,N.Nagorskiy,A.Faenov et.al. ObservationandtheoryofX-raymirages.— NatureCommun. 4.June.2013.

A key reason that causes mirages is a strong inhomogeinity of the air due to the different warming-up of its layers. A beam of light propagates in such a media not along a straight line (due to the different refractive indices of the different layers of the air) and, as a result, an observer can see instead (or along with) the remote object its virtual image, which is shifted towards the original one.

As it is turned out, the mirages can be observed not only in optical range of the spectrum, but also in its x-ray region. For the first time, this has been done by researchers from the Faculty of Physics, Lomonosov Moscow State University, in collaboration with their foreign colleagues. They observed a mirage in the x-ray spectral region while studying the spectral properties of the x-ray laser.

The idea of x-ray lasers exists for many years. It was launched for the first time in 1973 by Rem Khokhlov, Professor of the Faculty of Physics, Lomonosov Moscow State University, who also used to be a rector of this University. Later, in 1981, a possibility of developing of x-ray lasers pumped by the nuclear reaction was announced by American scientists who put this idea into the basement of the so called "Star War". Nowadays, x-ray lasers, based on the ideas developed more than 40 years ago at the Faculty of Physics, MSU, still alive being heavily employed in scientific research.

Russian physicists, when they have discovered an x-ray mirage, studied the physical basis of the phenomena and not only determined the conditions for x-ray mirages, but also developed for the first time their general theory. «We

Vorking with the x-ray laser, the :archers observed a sequence of dark and light rings—the interference picture of the x-rays from two coherent sources. This interference picture was rather unpredictable and unusual as a laser provides only a single coherent source. «The origin of these interference fringes was extremely strange and, at hand, absolutely unclear», — tells Sergey Magnitskiy. However, soon we revealed the reason for this phenomena and were able to clarify its nature, not only qualitatively, but also mathematically.

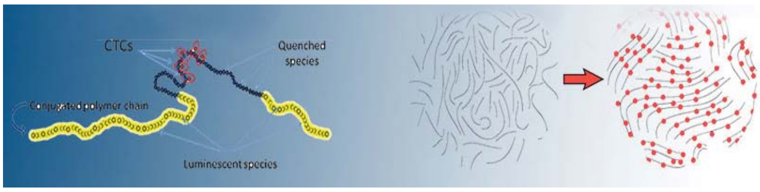
In a regular media, the refrective index for the x-rays slightly differs from a unit. For this reason, despite of more than 100 years of wide use of x-rays, noone observed x-ray mirages in this spectral region. However, a new generation of the superintense laser systems drastically changed the situation, as allows creation of a new media — a plasma with the electronic density that exceeds 10^{19} cm^{-3}, in which refraction of the x-ray radiation (the refraction of x-rays in such a media is possible due to the strong ingomogeinities of the electron density to which the x-rays are quite "sensitive") plays a crucial role. Active media of the x-rays lasers are examples of such media.

In order to describe the observed phenomena, the researchers developed an universal algorithm — they derived a mathematical equation that describes the mirage phenomena in all regions of the spectrum. For calculation of the x-rays propagation in the plasma researchers from Lomonosov Moscow State University developed a special approach, which takes into account the hydrodynamical properties of the plasma. They demonstrated that in the plasma a second, imaginery source of coherent radiation is created, which is strongly synchronized by phase with the initial generator, i.e. they are coherent. The interaction of the radiation from both these coherent sources leads to the formation of the interference picture that is in fact a mirage in the x-ray region of the spectrum. The mirage, which shows a unique property — coherence.

Following Sergey Magnitskiy, their results can be extended to at least two practically-interesting applications. First of all, in developing the x-ray holograms, which can be basically formed due to the existance in the plasma of two coherent x-ray sources. In this scheme, the images of the objects can be obtained with extremely high resolution at the order of 10 nm. «We have already started to work in this direction», — tells the researcher. Second, we can talk about so called clocking—special coverings that make the object they cover invisible. «In Optics, definite progress is reached in this direction",—adds Magnitskiy.—"Just imagine, that we made an object invisible in the optical range with the help of clocking technique. If we shine it with x-days, it will nevertheless visible, again. Earlier, it seemed to us that cloacking is impossible in x-ray region because it leads to a kind of a mirage, and nobody observed mirages in the x-ray region prior to us. Our results opens a possibility to create the coverings, which would be invisible in the X-ray domain. However, it is not a nearest future», — adds Sergey Magnitskiy.

(Reprinted from www.msu.ru).

MOLECULAR ADDITIVE IMPROVES POLYMERS FOR PLASTIC ELECTRONICS



Researchers from the Faculty of Physics, MSU, in collaboration with their Russian and German colleagues, have improved the structural and electronic order of a semiconducting polymer by using a molecular additive. The results of their work have been published in The Journal of Physical Chemistry Letters. **4.** 1298 (2013).

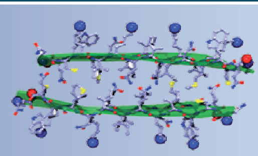
Semiconducting or conjugated polymers are the key materials of plastic (organic) electronics. They are lucky to combine the polymer mechanical properties and the semiconducting electronic properties. Conjugated polymers can be used in a plethora of organic electronic devices, such as light, flexible and semi-transparent displays, organic light emitting diodes (OLEDs), solar cells, microchips and many others. One of the key problems here is to create organic materials with good semiconducting properties. Nowadays, the electronic performance of semiconducting polymers is far below that of the crystalline silicon, which is the main semiconductor of the modern electronics. However, for the best organic semiconductors, their key electronic characteristic, free charge mobility, is already higher than that of amorphous silicon, which is used in each mobile phone or computer display. Usually, polymers are amorphous that hinders the charge transport in them. Therefore, ways to improve the order of semiconducting polymers are of high demand.

In the recent works, the researchers from the Faculty of Physics, led by Prof. Dmitry Paraschuk, have shown that crystalline (and therefore structurally ordered) domains are formed in the archetypical semiconducting polymer, MEH-PPV, with addition of specific molecules with high electron affinity (electron acceptors), TNF [The Journal of Physical Chemistry Letters. **4**. 1298 (2013)]. Observation of the crystallinity in a thin polymer film was done with the help of X-ray diffraction methods. These measurements were conducted by a German colleague on the DELTA synchrotron and colleagues from the Institute of the Crystallography of Russian Academy of Sciences, Moscow. Moreover, the additive decreases the concentration of the electronic defects, which were detected by means of several optical techniques, one of which was realized by a German colleague from Berlin.

What is the mechanism of polymer order enhancement? The researchers from the Faculty of Physics showed that polymer ordering is associated with interaction between the molecular additive and the pi-conjugated chain [The Journal of Physical Chemistry C. **117** 6972 (2013)]. The additive (TNF) forms an intermolecular charge-transfer complex with the semiconducting polymer (MEH-PPV), which makes the polymer chain more planar [J. Chem. Phys. **127.** 104905 (2007)]. Interestingly, the complexes are not randomly distributed over the chains but form clusters. The researchers suggested that the clusters of the additive: polymer complexes are inherited in the film and result in the observed domains of ordered polymer chains. Therefore, one can expect that appropriate additives can improve the semiconducting properties of polymer materials for plastic electronics.

These studies were done by using the nano-Raman-spectrometer purchased in the framework of Lomonosov Moscow State University Development Program.

A GUIDE FOR GENES



International group of scientists including researchers from Moscow State University developed unique nanostructures for curative gene delivery to cells.

(The results were published in ACSNano, 2011, 5(9):6894-6909. doi: 10.1021/nn2011943.)

Gene therapy is a relatively new area of medicine targeted on treatment of hereditary diseases. Positive results are still not numerous, but lately gene therapy has been developing fast; in particular cancer treatment ways are being tested. The principles of method are obvious: injecting some genetic material that would "correct everything." But there devil is in the detail. How one can insert alien genetic information to an already existing genome? In some cases the Mother Nature itself gives an answer despite the fact that is consists in suggesting very unpleasant creatures for a decision. Notorious HIV represents a retrovirus that is capable to build its genome into human DNA and reproduce itself thereby.

Scientists mimicated this mechanism quite a long time ago and invented so-called retroviral vectors that are genetically modified retroviruses bearing a gene which is to be built in a cell. Alas, the technique has its shortcomings. Physiologically, the transfer of genes from a vector to human DNA is a rather slow process, besides it is not always possible to create a high concentration of virus particles. Until recently, RetroNectin has been the only permitted medication, which could boost the things in a way (RetroNectin is a protein consisting of more than of 500 amino acid residues). However, it is quite possible the situation would change soon. A short peptide consisting of only 12 amino acid residues and outperforming RetroNectin has been developed by an international group of scientists including researchers from Moscow State University; their article was published in Nature Nanotechnology, a high-ranking scientific journal (Nature Nanotechnology. 2013, 8(2):130-6).

The scientists showed that a peptide named EF-C, is capable to self-assemble into the rod-like nanostructures (fibrils) with a diameter about 4 nm and 100–400 nm long. The fibrils bind to retrovirus vectors and help these to merge with a cellular membrane. As a result they vectors are able to throw a genetic material in a cell.

In pilot studies, EF-C peptide boosted infecting cells by retroviruses being at least 4 times more effective than any other known peptide medications and, what is more, it turned to be low-toxic. Besides, the new peptide is much easier and more practical to operate with, compared to its analogs. EF-C binds to retroviruses in a normal solution, whereas for RetroNectin special surfaces are required.

One of the most important issues of the whole study is as follows: what structural features help fibrils to be as efficient? The Russian participants found the answer in computer simulation of fibril self-assembly using Moscow State University "Lomonosov" supercomputer.

"When boost of retrovirus vector delivery to eukaryotic cells was discovered, the researchers from the Medical Center of University of Ulm, who found the effect, began to look for its molecular causes. To this end, a lot of measurements using various methods were needed including the method we applied — molecular modeling of peptide self-assembly," says Alexei Khokhlov, who is the leader of the MSU research team in this study and vice rector of Moscow State University. "Modeling explained the results obtained experimentally; then this explanation and predictions of computer modeling were in turn verified by additional experiments."

With the use of the "Lomonosov" supercomputer, the scientists found out that fibrils twist in a spiral with a length of period of 28 nanometers. "It is very important for their biological properties", — says Alexey Shaytan, a researcher at the Biology Department of Moscow State University.

The retrovirus particles (negatively charged) are able to interact with a cellular membrane (also negatively charged) in case repulsion between them becomes small. For example, positively charged polymeric molecules attached to virus particles result in complexes that do not repulse from membranes. Such molecules enwrap viruses, screening virus charges, but thereby losing their own charges; the resulting complex is mostly electro neutral. "They wind around viruses as a beadwork" comments Alexey Shaytan. "The charges on a virus approximately matches the number of beads the virus can bind. It becomes a neutral particle, which possibly might bind to membrane; but it is also possible that it does not as beads screen virus glycoproteins by means of which the virus interacts with external cellular receptors."

The fibril behaves differently: according to computer modeling, it is a thick twisted spiral; the positive charges as located around its axis in each direction. Therefore if one part of the spiral attaches to a virus, another one is always free and charged positively; it helps a complex to reach the membrane; this results in a more efficient capture of virus particles by the cell. "What is more interesting, the rigid fibrils do not wind around virus — glycoproteins are free and interact with receptors on the cell surface," says Shaytan. His computer experiment also showed that fibrils themselves are very stable in solution and can be such as long as needed — without breaking up to initial peptide molecules and without sticking together. "If the fibrils were unstable, we would not be able to speak about prospects for clinical practice,"— says Shaytan.

It is remarkable that the methods of computer modeling applied to the solution of the task with fibrils, first intended for other purposes.

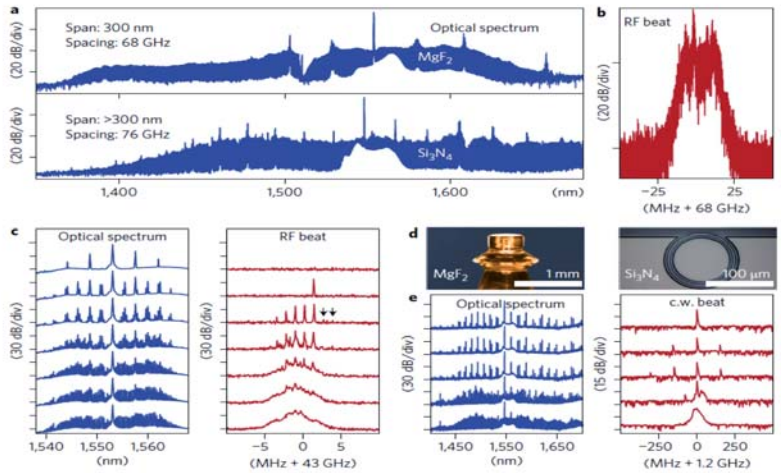
"It is a successful coincidence that we have recently gained experience in studying polypeptides that self-assembly in fibers: this was a project to model strong electro conductive fibers based on polypeptide-polythiophene block copolymers. We were able to immediately use our experience for the new study,"— says Khokhlov.

(Reprinted from www.msu.ru).

UNIVERSAL DYNAMICS AND NOISE OF KERR OPTICAL FREQUENCY COMBS IN MICRORESONATORS

[Nature Photonics. 6. 480–487 (2012)].

Optical microresonators with whispering gallery modes, uniquely combining small size (of the order of millimeter and smaller) and giant quality-factor (up to 10^{12}), were proposed in 1989 at the Faculty of Physics, MSU in the group of Prof. V.B. Braginsky. It was found in 2007 that in microresonators of this type, due to cascaded hyperparametric generation and four-wave mixing processes, the so-called Kerr optical combs may be formed (radiation with wide and dense equidistant line spectrum) with just continuous wave pump. Analogous combs have revolutionized precision measurements and were awarded by the Nobel Prize in 2005 (T.Haensch, J.Hall) but require bulky equipment. Using of comb generator based on microresonators opens a possibility to create compact stable and low-noise microwave oscillators detecting on a photodiode beat frequency. This frequency corresponds to the distance between nearest fundamental modes of the resonator (FSR) and equals to the inverse of the round-trip time of light in the cavity. Numerous studies of optical combs in microresonators of different geometry in many laboratories, however, showed that the generation of broad frequency combs with increasing pump power is accompanied by appearance of multiple peaks and broadening in the beat spectrum. In collaboration with the group of T. Kippenberg (EPFL, Switzerland), we have theoretically and experimentally shown that this additional broadening and spectral peaks are not associated with any thermodynamic noise processes. These features are the consequence of the nonlinear dynamics of the formation of the comb caused by the balance of quality factor with material and geometric dispersion of the modes. Furthermore, it was shown theoretically that the generation process may begin not with the nearest to pump neighboring modes but with the modes that are separated by a whole number of FSR. Precision measurements of the optical and RF spectra of the combs in the initial stages of its formation in the two types of microcavities — two manufactured out of crystalline MgF_2 and two integrated Si_3N_4 confirmed the universal character of the revealed dependences.measurements of the optical and RF spectra of the combs in the initial stages of its formation in the two types of microcavities — two manufactured out of crystalline MgF_2 and two integrated Si_3N_4 confirmed the universal character of the revealed dependences.



Wide optical spectra of optical combs in MgF_2 and Si_3N_4 microresonators (a). Broadened RF beatnote signal for MgF_2 cavity (b). The evolution of optical and RF beat spectra in MgF_2 and Si_3N_4 (c,e) resonators shown (d).

THE ACOUSTIC RADIATION FORCE

Sapozhnikov, O.A., and Bailey M.R. "Radiation force of an arbitrary acoustic beam on an elastic sphere in a fluid." — J. Acoust. Soc. Am. **133**, No. 2. 661–676 (2013).

Collaborative research of physicists from Moscow State University and the University of Washington open new prospects for the use of the ultrasonic radiation force.

Waves of any nature carry not only energy, but also momentum. Radiation force is a result of a change in wave momentum due to the scattering at an obstacle. The rate of momentum change, averaged over the wave period, equals the radiation force. This force is well known to physicists, particularly in relation to optical waves. Its magnitude is easy to estimate using quantum language, presenting light as a flux of photons with energy and momentum. These simple expressions show that the radiation force is proportional to the power of the wave. The speed of light is fairly large, so that the corresponding radiation force is relatively small. The first who experimentally measured the optical radiation force (in the late 19th century) was famous

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Russian scientist P.N.Lebedev, whose monument is located at the entrance to the Physics Faculty of MSU. With the advent of lasers it has become possible to obtain sufficiently intense light beams, and thus it has become relatively easy to create noticeable radiation force on the obstacles. In particular, modern optical tweezers are based on this principle.

And what can be said about radiation force of acoustic waves? It is noteworthy that the aforementioned factor for sound is approximately 5 orders of magnitude greater than the corresponding factor for light, i.e., generating a noticeable radiation force is much easier. One of the most vivid demonstrations of manifestation of the effect of the radiation force is the "acoustic fountain" — the emergence of a hydrodynamic jet on the surface of a fluid when an ultrasonic beam is focused on that surface (see photo). Another example is the method of measuring the total power of ultrasonic sources by "weighting" of the emitted beam: ultrasound is directed to an absorber that lies on an electronic balance; the radiation force results in a noticeable change of the absorber weight, which thus allows to measure the total power of the incident wave. The radiation force makes it possible to realize the levitation of small particles and microbubbles. Another illustration of the effect is excitation of the hydrodynamic flow (the so-called acoustic streaming) by an ultrasonic beam that is absorbed in liquid. Similarly, shear waves can be excited in a gel-like material. The possibility of remote excitation of shear waves has already found application in medicine for ultrasound diagnostics of tumor formation in soft biological tissues.

As is often the case, a simplified description helps to understand the cause of the phenomenon, but it is not always possible to describe the effect quantitatively. Such is the situation with the calculation of the acoustic radiation force for real beams and real scattering objects. Until recently, the solution to the problems was possible only under simplifying assumption of one-dimensional nature of the waves or small scatterer size as compared to the wavelength. A rigorous calculation of the radiation force requires the ability to solve the three-dimensional scattering problem, and then use this solution to calculate the radiation force by integrating the radiation stress tensor on any fixed surface enclosing the scatterer. In early 2013, Dr. Oleg Sapozhnikov (Department of Acoustics, Physics Faculty, MSU) and Dr. Michael Bailey (Applied Physics Laboratory, University of Washington, USA) have published a paper in the Journal of the Acoustical Society of America, where they developed an analytical method for the calculation of the radiation force of an arbitrary acoustic beam on an elastic sphere of arbitrary size in a fluid. The authors have not only developed an efficient method of calculating the radiation force, but also used it to describe the forces that can be applied to kidney stones in the human body when using ultrasonic sources in the form of multi-element diagnostic arrays. It was found that the ultrasonic beam can be used not only to push the stone along the ultrasound beam, but also in other directions. This shows that it is possible to remotely manipulate kidney stones. In particular, it is possible to push the small stones to the exit of the patient kidney, and the large stones, on the contrary, can be pushed back in the kidney in order to avoid blockage of the ureter. This approach has already caused enormous interest among urologists, and work is currently being performed to create a medical device based on the effect of the radiation force.

MAGNETOPLASMONIC CRYSTALS FOR EFFECTIVE CONTROL OF LIGHT

Scientists of Faculty of Physics, Lomonosov Moscow State University, in an international team of scientists have fabricated a novel nanostructured plasmonic material, which tremendously enhances the already known magneto-optical Faraday and Kerr effects and gives rise to a new magneto-optical effect. Light intensity modulation by 24% is demostrated. This is a unique opportunity for the control of light at frequencies above 1 GHz in modern integrated optics devices. The results were published in June and July 2013 in two papers in the journal Nature Communications.

Magnetic field control of light is among the most intriguing methods for modulation of light intensity and polarization on sub-nanosecond time scales. The implementation in nanostructured hybrid materials provides a remarkable increase of the magneto-optical effects.

"Recently, we have demonstrated the unique properties of magnetoplasmonic crystals — specially designed metal-dielectric heterostructures containing a magnetic dielectric layer, on which a thin gold layer with slit grating is deposited. When light passes through a magnetoplasmonic crystal magneto-optical Faraday and Kerr effects get significantly enhanced, says Vladimir Belotelov, one of the authors of the papers, Faculty of Physics of Lomonosov Moscow State University. In such materials surface plasmon polaritons and the hybrid plasmonic waveguide modes can be excited. Near the frequencies of their excitation interaction time of light with a magnetic film magnetized in the direction of light propagation is greatly increased. It leads to an enhancement of the Faraday effect, i.e. to the increase of the rotation angle of the incident light polarization.

At the same time, if the structure is magnetized in the plane and along the slits of the gold grating, a giant transverse Kerr effect is observed, which is manifested in the transmitted light intensity variation with the reversal of the structure magnetization. In this case, the main role is played by a shift of the plasmonic resonance caused by the magnetization reversal."

Vladimir Belotelov claims that "an important feature of the developed magnetoplasmonic crystals is that they not only amplify the already known effects, but also give rise to new magneto-optical effects not present in homogeneous films."

When a magnetoplasmonic crystal is illuminated by a light polarized perpendicular to the grating slits a hybrid plasmonic waveguide mode can be excited. If the structure is magnetized in its plane and perpendicular to the gold grating slits, an additional waveguide mode of orthogonal polarization can be excited, which modifies the optical spectra of the sample and increases its transmittance at the resonant frequencies.

Vladimir Belotelov says: "In this work we have achieved a relative increase in transmittance of 24%, that is a record value for the magneto-optics not using crossed polarizers." The calculations predict that the new magneto-optical effect can be greatly increased with the use of magnetic films of an optimum thickness and with large magneto-optical parameter. This makes it very promising for the application of nanophotonics. Further, the effect allows manipulating and exciting waveguide modes by a magnetic field and light of proper polarization.

This concept was developed by an international team of researchers, including a group of Magneto-Optics and Photonics, Chair of Photonics and Microwave Physics of the Faculty of Physics, Lomonosov Moscow State University, where research on plasmonic structures has been conducted for the past seven years.

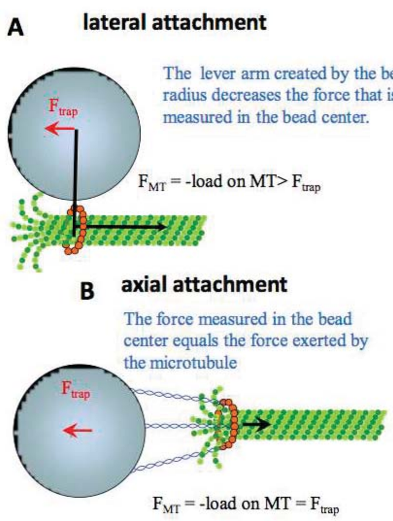
MICROTUBULE EXERTS A FORCE OF UP TO 30 PN

Researchers of the Faculty of Physics in collaboration with American scientists revealed a role of the microtubules in dividing chromosomes. (PNAS. **110**. 7708–13 (2013)).

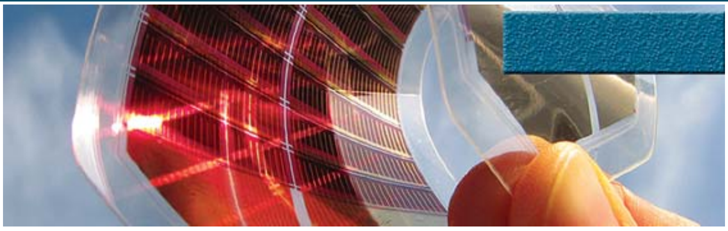
One of the key functions of a living cell is to segregate genetic material (chromosomes) between daughter cells with precision and accuracy. Today it is well established that at least in some organisms the microtubules are the main drive for chromosome movement. These cellular polymers, which are hollow tubes of 25 nm in diameter, exist in the states of growth (assembly) and shrinking (disassembly). In the disassembling state the shortening end of a microtubule is formed by the filaments bending outwards. These bending filaments can utilize the energy of GTP hydrolysis to push attached cargo and perform mechanical work (Nature **438**. 384–388 (2005)).

It is thought that during cell division the microtubule ends attach to the chromosomes and move them, but exact mechanism of this attachment is unclear. Moreover, the energy of GTP hydrolysis during microtubule disassembly is enough to exert up to 70 pN, however experimental observations previously yielded no more than 5 pN.

In the latest paper by the researchers from Facylty of Physics, MSU, together with their colleagues from Universities of Colorado and Pennsylvania the authors set out to answer these two questions. They measured the force, which a disassembling microtubule exerts to displace a glass microbead from the center of a laser trap. The researchers found out that the amplitude of this force is directly influenced by the mechanism of the bead attachment to the microtubules. If the bead is attached to a microtubule laterally using short linkers (<5 nM), then the force acting on the bead center is on average 3 pN. If the bead is attached by artificial protein fibrils 100 nm in length, then during movement after the end of a microtubule it repositions at the microtubule axis and the force amplitude measured in the bead center rises up to 30 pN. These values are in excellent agreement with our theoretical predictions (PNAS **104**. 19017–22 (2007)). The observed difference in the force amplitude can be explained by the lever arm effect created by a microtubule acting on a bead surface and a laser trap acting on a bead center, which leads to the laser trap's huge advantage over the microtubule (see Figure). When the bead is oriented on the microtubule axis, the lever arm is not present, which allows us to measure the real force developed by a single microtubule.

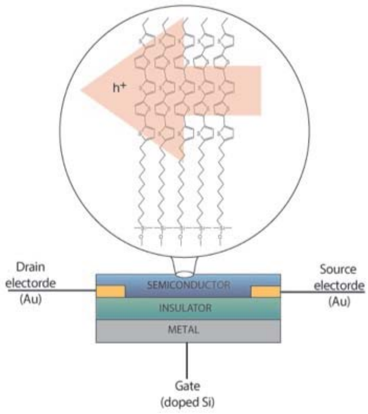


MOLECULAR MONOLAYER FIELD-EFFECT TRANSISTORS



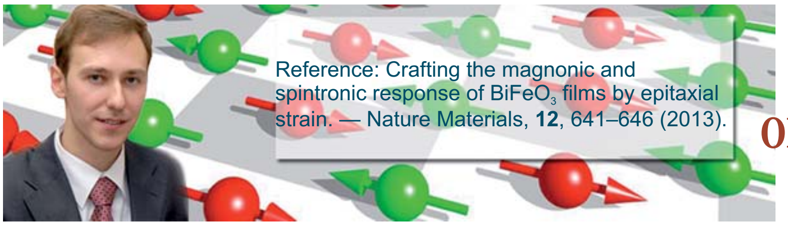
In collaboration with their Russian and German colleagues one-molecule-thick organic transistors and integrated circuits have been developed [Appl. Phys. Lett. **103**, 043310 (2013)].

Organic electronics enables a wide range of ultrathin, light, flexible, transparent and cheap devices, such as displays, chips, sensors, which allow new applications impossible for traditional silicon electronics. Organic electronics can be fabricated using so called “wet” technologies, i.e. the material is being transferred onto a substrate using inkjet printing, aerosol spraying and other techniques. Organic field-effect transistor (OFET) is one of the basic blocks of organic electronics. As in a conventional transistor, it has three electrodes — source, drain and gate. The current flows from the source to the drain, and its magnitude is controlled by the gate, applying the corresponding voltage. The current in OFET flows mainly in an ultrathin near-surface layer with a thickness of several nanometers. This allows creating ultrathin and effective OFETs with a one-molecule-thick active layer. Earlier, efficient monolayer OFETs were developed using self-assembled monolayers (SAM). The SAM process requires the substrate to be dipped into solution of semiconducting molecules and waiting for many hours until molecules “stick” to the substrate and form a well-organized layer.



In their recent work researchers from Faculty of Physics led by Dr. Dmitry Paraschuk in collaboration with colleagues from Institute of Synthetic Polymer Materials (ISPM RAS) have developed ultrathin OFETs with the molecular monolayer deposited by Langmuir–Blodgett technique. This technique allows fabricating thin films in several minutes. First, a monomolecular crystalline layer forms on water surface, then, keeping its intrinsic high-organized structure, it is transferred onto a substrate with electrodes. The OFETs fabricated by the Langmuir–Blodgett technique show the electric performance similar to those prepared by the more time-consuming SAM technique. Importantly, unlike to SAM, the Langmuir–Blodgett film is weakly bounded to the substrate, and this does not spoil the device perfor-mance. Integrated electronics with large amount of transistors (inverter and oscillator) were developed with the help of the colleagues from Max Plank institute (Mainz). This work reveals alluring prospects of ultrathin organic electronics based on Langmuir– Blodgett process.

This work was performed using the equipment supplied by the MSU Development Program.



NEW PERSPECTIVES FOR THE DESIGN OF THE SPINTRONICS DEVICES

Alexander PYATAKOV

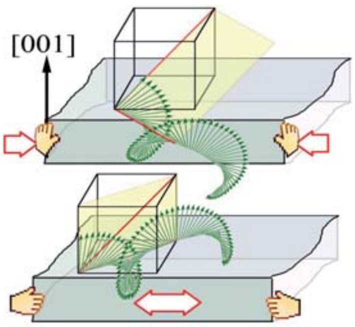
Researchers from the Faculty of Physics, Lomonosov Moscow State University, in collaboration with the international research group discovered new perspectives for the spintronic devices architecture by developing novel design for spins structure in the thin films, which allows tuning to the response of spintronic devices.

Newsletter

Spatially modulated spin structures (spin cycloids) observed in the most popular multiferroic compound bismuth ferrite $BiFeO_3$, have hindered its potential as room temperature magnetoelectric material for years.

"As it was shown in our recent paper in Nature Materials, these magnetic textures can be used to tune the spectra of magnon modes and spin valve magnetoresistance of the bismuth ferrite-based devices that offers new exiting possibilities in spinronics and magnonics", — said Alexander Pyatakov, Associate Professor with the Faculty of Physics, Lomonosov Moscow State University, who is one of the coauthors of the Nature's publication. "The shape and orientation of the spin cycloids depends on the epitaxial strain in thin films of bismuth ferrite that enables the strain engineering of spin structures and multifunctional media design", he added.

This concept was developed by international team of scientists including the Photonics and Spintronics Lab in Oscillation Physics Chair of the Faculty of Physics, Lomonosov Moscow State University, which conducts fundamental and applied research in the field of spintronics.



VICE-PRIME-MINISTER DMITRY ROGOZIN VISIT TO MOSCOW STATE

On 17th of May, 2013, Vice-Prime-Minister Dmitry Rogozin visited Lomonosov Moscow State University where he was informed of the research and innovation achievements of the University and met with the professors and students of the Faculty of Physics and of other departments of the University.

During his visit, Dmitry Rogozin suggested to launch at Moscow state a brand-new technological center, which is aimed at attraction of fresh brains into the double purpose research and technological projects. "We discussed a possibility of launching a brand-new center for the development of novel technologies and for education at the Moscow State," — he claimed at the meeting with our students and professors. He also stressed that such a new structure will allow to strongly link not only the researchers at Moscow State, but also from the whole Russian Science with the need of our government in the double-purpose projects.

"All your new ideas, impertinence in your research are greatly welcome! We are extremely interested in your brains." — said Rogozin addressing the students of Moscow State.

Day of Information Technologies at the Faculty of Physics

For the second time the "Day of Information Technologies" was organized on May 14, 2013, at the Faculty of Physics, Lomonosov Moscow State University, in co-operation with the Asus company. It was started by an introductory lecture by Prof. Victor Zadkov, Vice-Dean of Physics, under the title "How Physics Affects the Information Technologies Progress". The program also included an exhibit of the most modern computer equipment offered on the market by the Asus company, playground for most powerful computer games equipped with the top-class Asus notebooks, lectures from various leaders of the IT-market, attractive competitions, quizzes, and lost of various prizes. The major prize in the lottery was the latest Asus notebook model with touch-screen in a stylish metal case, Asus VivoBook S300CA! In the end of the Day, a tasteful surprise awaited for the participants of various events.

Important is to mention that plus to the undegraduate and graduate students of the Faculty and staff members, lots of schoolboys from our partner Moscow Schools took very active participation in all the events of the Day.

2012 Impact Factor of Moscow University Physics Bulletin

Impact-factor of the Moscow University Physics Bulletin raised up to 0.225 in 2012 J. Citation Report (c) (Thomson Reuters).

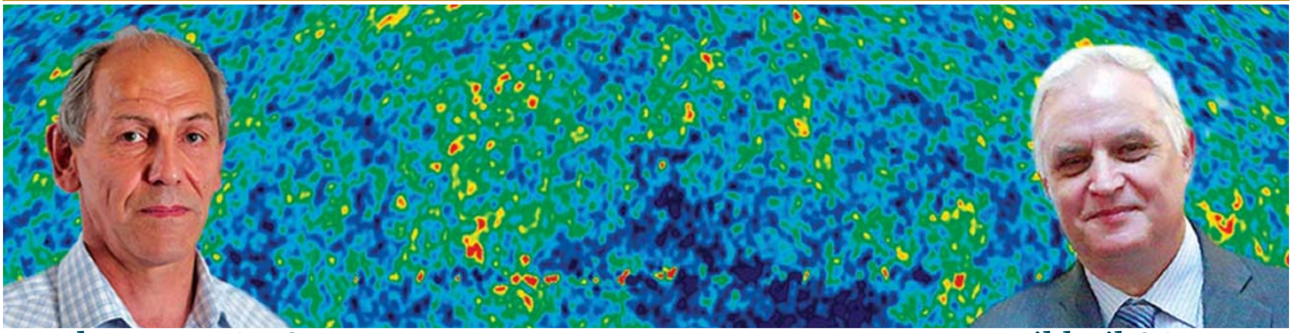
For the first time, our journal received its impact factor in 2010 and since that time it shows positive dynamics: IF-2010=0.143, IF-2011= 0.199, and IF-2012=0.225.

Moscow University Physics Bulletin publishes original papers (reviews, articles, and brief communications) in the following fields of Experimental and Theoretical Physics:

- Theoretical and Mathematical Physics
- Physic of Atom Nuclei and Elementary Particles
- Radiophysics, Electronics, and Acoustics
- Optics and Spectroscopy. Laser Physics
- Condensed Matter Physics
- Chemical Physics, Physical Kinetics, and Plasma Physics
- Biophysics and Medical Physics
- Astronomy, Astrophysics, and Cosmology
- Physics of Earth, Atmosphere, and Gydrosphere

The journal is distributed by Springer since 2007 online at http://www.springerlink.com/content/0027-1349. Subscription is required.

AWARDS



Valery RUBAKOV   Mikhail SAZHIN

Lomonosov Prize of the first category for scientific research was awarded in 2012 to chair of the Department of Particle Physics and Cosmology of the Physics Faculty of the Moscow State University, professor, academician of the Russian Academy of Sciences V.A. Rubakov and chief scientist of P.K. Sternberg State Astronomical Institute of the Moscow State University, professor M.V. Sazhin for the series of works.

Cosmic Microwave Background and Modern Cosmology

Cosmic microwave background (CMB) is one of the major sources of information on the properties of our Universe at various stages of its evolution. These are electromagnetic waves-photons-with Planckian black-body energy spectrum of temperature 2.276 K. It was emitted at rather early cosmological epoch when the temperature of cosmic medium was 3000 K and the age of the Universe was 380 thousand years (the present age is 13.8 billion years). At that time, matter transformed from plasma state, opaque to photons, to gas, transparent to photons instead. Since then, CMB photons traveled almost freely through the Universe. Their wavelengths grew because of the expansion of space and hence the temperature decreased. Thus, by studying CMB coming from different directions on the celestial sphere one obtains the photographic picture (literally!) of the Universe at the age of 380 thousand years.

CMB is not isotropic: photons coming from different directions in the sky have slightly different temperatures, see fig 1. This is predominantly due to the fact that the Universe is not homogeneous: there are galaxies, galaxy clusters, super-clusters and also giant voids containing very few galaxies. All these objects developed from primordial inhomogeneities which existed already at the time when the CMB photons were emitted. At that time, however, the relative amplitudes of inhomogeneities were very small, of order of 10^{-4}–10^{-5}. Variation of the CMB temperature over the sky is thus of this order. This is shown in fig. 1: the deviations of the temperature from the average are in the range K = ($-2\cdot10^{-4}$ K, $2\cdot10^{-4}$ K), while the average temperature is 2.7 K.

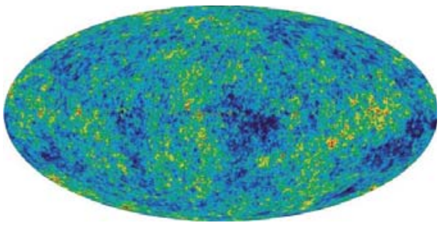


Fig. 1. CMB temperature distribution over the sky. Color shows the deviation of the temperature from the average.

Where do these primordial inhomogeneities, so important for galaxy formation and ultimately for our existence, come from? What is the mechanism of their creation in the early Universe? The most accepted theory capable to answer this question is the theory of cosmic inflation — the very rapid, exponential expansion of the Universe preceeding the hot cosmological stage. According to this theory, the primordial inhomogeneities are enhanced vacuum quantum fluctuations of inflaton, the field that drives inflation. This picture is consistent with everything we know of about the Universe, and, in particular, it describes in detail the observed properies of CMB.

Besides the hypothetical inflaton field, there is the gravitational field in Nature. Its vacuum fluctuations must also get enhanced at inflation and become gravity waves. Their present wavelengths must cover very large range extending up to the size of the visible Universe, while their amplitudes are determined by the energy density at inflation. The existence of these gravity waves is probably the most remarkable prediction of the inflationary theory, which distinguishes inflation from other scenarios for the start of the cosmological evolution.

In 1982, V.A. Rubakov and M.V. Sazhin, young scientists at that time, together with their young colleague A.V. Veryaskin who now lives in Australia, showed that the gravity waves created at inflation would lead to a specific contribution to the directional dependence of the CMB temperature on the sky, i.e., CMB angular anisotropy. CMB temperature anisotropy was not yet discovered at that time, there existed only upper bounds on its amplitude. Yet, by making use of these bounds, the authors found that the energy density in the Universe at inflation was at least by six orders of magnitude smaller than the so-called Planck density. This result was quite important, since at the Planck density, the usual notions of space and time, as well as the Einstein equations governing gravity are no longer valid: at this density, an almost completely unknown quantum gravity regime sets in. The result by Rubakov, Sazhin and Veryaskin means that inflation occured in the tractable regime instead, in which quantum gravity effects were negligible.

Another important aspect of that paper was that it set the direction for the search for gravity waves born at inflation: this is the study of CMB. Observational cosmology in the world follows precisely this direction. The first indication for the CMB temperature anisotropy was obtained by the Russian space experiment Relikt. One of the most difficult aspects of that experiment, as well as the CMB experiments that followed, were the data analysis. The crucial contribution into this analysis was made by M.V. Sazhin. It is due to that work that the weak signal of the anisotropy at large angular scales was extracted. Presently, the CMB anisotropy is measured in the wide range of angular scales, from very large scales (tens of angular degrees) to arc minutes, see fig. 2.

CMB encodes the information not only on the early cosmology but also on the late time and present Universe. Here, particularly interesting is the study of dark energy which drives the accelerated expansion of the Universe at the present epoch. Among the hypotheses of the nature of dark energy, quite amazing is the possibility that the dark energy density increases (!) as the Unverse expands. This type of dark energy is called phantom. Until recently, common wisdom said that such a possibility is theoretically inconsistent.

However, V.A. Rubakov and collaborators designed in 2006–2007 a concrete field theoretical model in which phantom behavior of dark energy occurs in a consistent way. A specific property of this model, as well as many other phantom models suggested later on, is the large wavelength instability leading to the growth of inhomogeneities in dark energy. It was then shown by V.A. Rubakov, M.V. Sazhin and collaborators that these growing inhomogeneities yield very particular pattern of the CMB anisotropy at large angular scales. Their analysis produced strong bounds on the phantom parameters and ruled out a class of the phantom dark energy models.

Thus, the works of V.A. Rubakov and M.V. Sazhin nicely illustrate the fact that the study of CMB is a key to understanding our Universe. No wonder, this field of science is rapidly developing in the world. Scientists from the Physics Faculty and Sternberg Institute of the Moscow State University contribute to this field strongly.

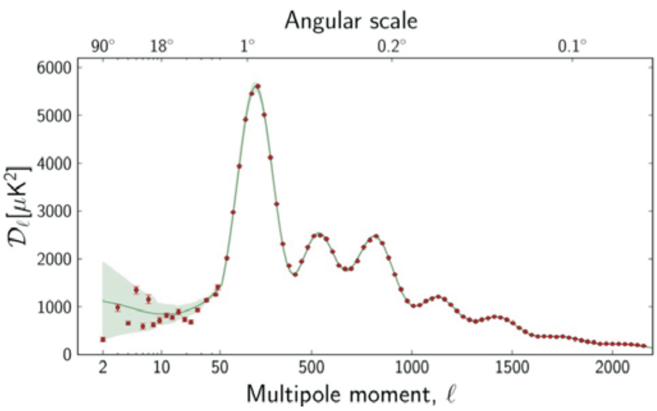
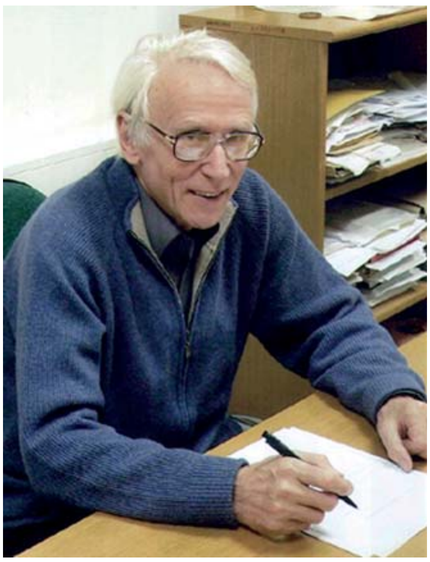


Fig. 2. Angular spectrum of the CMB temperature. Upper horizontal scale shows the angular scale, vertical scale shows the magnitude of the anisotropy. As an example, the peak at the scale of order 1 angular degree corresponds to hot and cold "spots" of angular size of about 1 degree.

Prof. Andrey SLAVNOV Received 2013 Pomeranchuk Award



The International Pomeranchuk award committee decided that 2013 award goes to academician of the Russian Academy of Sciences, professor Andrey Slavnov.

This prestigious International award named after famous Russian theoretician Isaak Ya. Pomeranchuk, is awarded annually for the best achievements in Theoretical Physics by the International Committee. E.L.Fanberg, L.D.Fadeev, L.B.Okun, J. Maldacena, and others became the awardees of this International award during15 years since its establishing.

Prof. Andrey Slavnov is a talented Russian physicist working in the field of Theoretical Physics. He is a full member of the Russian Academy of Sciences, member of the International Association of Mathematical Physics, recipient of the State award of the Russian Federation and many other Int'l awards. His research interests lie in the filed of Quantum Field Theory. He is a head of the Theoretical Physics Department of the Steklov Mathematical Institute of the Russian Academy of Sciences, head of the chair of Theoretical Physics, Faculty of Physics, Lomonosov Moscow State University.

Quantum Cooperative Phenomena in Solid State Physics

Dr. Olga Volkova, senior researcher with the Low Temperature Physics and Superconductivity chair of the Physics Faculty, won 1st prize at the 2013 Lomonosov Moscow State competition of young scientists for her series of published papers, which cover wide range of physical phenomena in spin liquids and low dimensional magnets in the broad temperature and magnetic field ranges.

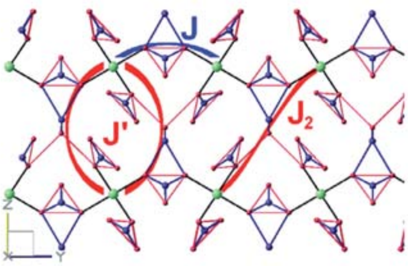
A few key results are outlined below.

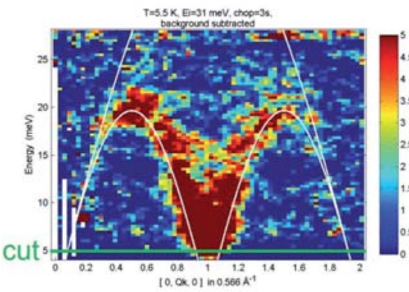
The establishment of quantum ground state of $Ba_3Cu_3In_4O_{12}$ with unique topology of magnetic subsystem composed of "paper chains" of copper S = 1/2 with three dimensional Shastry–Sutherland network. At high temperatures, magnetic susceptibility of the systemspin-flop and two spin-flip transitions occur under low magnetic fields. This leads to additional phase boundaries in magnetic phase diagram and electron spin paramagnetic resonance spectra.

Results of experimental studies of thermodynamic properties indicate for the possibility of $Ba_3Cu_3In_4O_{12}$ ground state formation of three weakly coupled mutually orthogonal antiferromagnetic structures based on Cu_{2+} (S=1/2) ions. This assumption is based on anisotropic exchange interactions between three mutually orthogonal magnetic subsystems. Quantum fluctuations provide interaction between these three subsystems supporting the appearance of order from disorder.

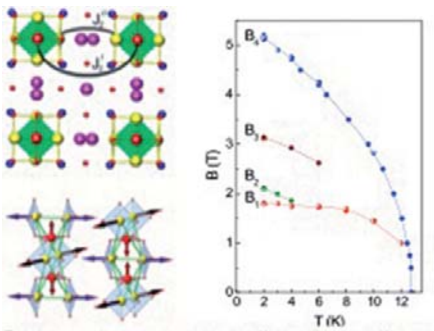
Estimation of basic parameters in $(NO)[Cu(NO_3)_3]$ near quantum critical point of Nersesyan–Tsvelik. The topology of magnetic exchange interactions in $(NO)[Cu(NO_3)_3]$ is close to the realization of Nersesyan – Tscelik "confederate flag" model. Crystal structure of this compound possesses weakly coupled layers.

The strongest intralayer interaction J passes between copper ions via nitrate groups which form infinite chains. The chains are connected to each other through the nitrate NO_3 and nitrosonium NO groups in such a way that exchange interaction along the rung J_1 is twice more than diagonal exchange interaction J_2. The ground state obeys Curie–Weiss law with large and positive Weiss temperature indicating the dominating ferromagnetic exchange interactions in the system. However, at low temperatures this compound demonstrates long range antiferromagnetic order. Besides, magnetization curve measured in magneto ordered state possesses non-trivial sequence of two such system is usually discussed in the frames of resonant valence bond (RVB) and valence bond crystal (VBC) models.





The fragments of the crystal and magnetic structures and magnetic phase diagram of $Ba_3Cu_3In_4O_{12}$.

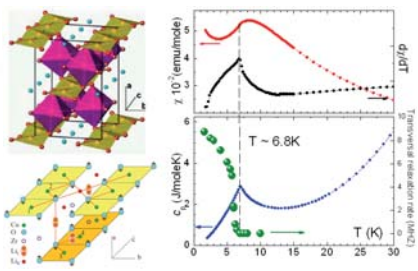


The fragments of crystal structure and topology of magnetic subsystem and inelastic neutron scattering spectrum of $(NO)[Cu(NO_3)_3]$.

The first evidences for the formation of magneto ordered state here below 0.6 K were obtained in the studies of specific heat and muon spectroscopy at ultra low temperatures. The data of Raman spectroscopy and inelastic neutron scattering of $(NO)[Cu(NO_3)_3]$ indicate for strong one dimensionality of the exchange interactions in chains.

The observation of low – dimensional antiferromagnets Li_2CuZrO_4, $AgFeO_2$, $Cr_3(PO_4)$, $Cu_2As_2O_7$ with potential of multiferroelectricity. The Li_2CuZrO_4 possesses the isolated chains of edge – shared CuO_4 squares. Theoretical calculations define the ratio of exchange integrals in chain to be equal to $–J_2/J_1$~0.3 making Li_2CuZrO_4 closest to the quantum critical point 0.25. This point separates helical antiferromagnets and ferromagnets.

In the studies of nuclear magnetic resonance, electron paramagnetic resonance and dielectric permittivity constant of Li_2CuZrO_4 it was found that lithium ions Li^+ occupy two positions: static Li_1 and half–filled flexible Li_2. The Li_2 ions form frustrated sublattice of tunneling pseudo spin – 1/2 of quantum electric dipoles.



The fragments of crystal structure and topology of magnetic subsystem, magnetic and thermal properties of Li_2CuZrO_4.

This work has been done with the help of the equipment that what bought under the Lomonosov Moscow State University Development Program.

AWARDS

Liubov OSMINKINA is a 2012 year winner of L'Oreal Russia-UNESCO For Women in Science Grants

Ph.D. L.A. Osminkina is an Assistant Professor, Chair of General Physics and Molecular Electronics, Faculty of Physics, Lomonosov Moscow State University. She is a specialist in the field of physics of low-dimensional structures, solid-state optoelectronics, sensor technologies, as well as in the biomedical applications of solid-state nanoobjects. She has made a significant contribution to the development of scientific bases of the methods of obtaining new and unique types of non-toxic and biodegradable nano-composite materials based on silicon nanostructures, which are intended to be used in sensor applications and biomedicine, including the diagnosis and treatment of socially significant diseases. She made comprehensive fundamental studies of physical and chemical properties and biocompatibility of silicon nanoparticles, which have been proposed and implemented in physical methods of activation of nanoparticles for using in medicine. First usage of biocompatible silicon nanoparticles as an amplifier of an ultrasound (sonosensitizers) to destroy cancer cells was proposed and its effectiveness was proved in a series of physical and biological experiments. Also it was first demonstrated the antiviral activity of silicon nanoparticles with respect to the human immunodeficiency virus (HIV), respiratory diseases (virus RSV), and it was proposed to use silicon nanoparticles as antiviral agents that prevent transmission of HIV and RSV.

Liubov Osminkina is the author of 37 articles in refereed journals, 62 published abstracts at the National and International conferences, one Russian patent and 3 patents applications.

Prof. Anatoly SUKHORUKOV was decorated with the Order of Friendship

Head of the Chair of Photonics and Physics of Microwaves, Prof. Anatoly Sukhorukov was decorated with the Order of Friendship of People by the decree of the Russian Presidnet MR. Vladimir Putin on 18th of May, 2013. Congratulations!

The Order of Friendship is awarded for special merit in strengthening peace, friendship, cooperation and understanding between nations, for fruitful work on the convergence and mutual enrichment of cultures of nations and peoples; for the active conservation, development and promotion of the cultural and historical heritage of Russia; for great contribution to the implementation of joint ventures with the Russian Federation, major economic projects and attracting investments into the economy of the Russian Federation; for broad charitable activities.

AWARDS

DISSERTATIONS

In June 2012, Vera Khokhlova, an Associate Professor of the Chair of Acoustics, defended her Dr.Sc. thesis entitled "Interaction of weak shock waves in dissipative and randomly inhomo-geneous media: applications in medical and atmospheric acoustics".

This thesis is devoted to studying nonlinear and diffraction wave phenomena in acoustic media with frequency-dependent absorption and random inhomogeneities. In terms of applications the topics considered in the dissertation are related to medical ultrasound and atmospheric acoustics. These specific applications are currently the most active fields in nonlinear acoustics where the results of fundamental research find most successful practical implementation. In medical acoustics, high intensity focused ultrasound (HIFU) therapy is emerging as a noninvasive technology for thermal or mechanical ablation of diseased tissue, e.g. benign and malignant tumors (Fig. 1).

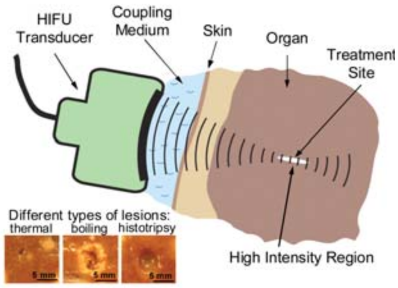


Fig. 1. Focusing nonlinear ultrasound waves in biological tissue. Application: High Intensity Focused Ultrasound (HIFU) surgery. The transducer radiates a focused ultrasound beam through the overlying tissue layers to create a high intensity region within the organ and induce thermal and/or mechanical damage of tissue.

Novel nonlinear methods of ultrasound imaging have been introduced in clinical machines based on the generation of higher harmonics of diagnostic pulses while propagating in a tissue. Nonlinear wave propagation in a turbulent atmosphere and development of theoretical and experimental models of randomly inhomogeneous media have attracted increased attention due to the development of supersonic civil aviation and the problem of sonic boom (Fig. 2). Despite the differences in terms of practical applications, these problems of medical and atmospheric acoustics can be described theoretically using nonlinear evolution equations of nonlinear wave physics in a weakly dispersive media.

An important feature of the dissertation work is that the interactions of strongly distorted acoustic signals are considered, which are significantly different from the well-studied interactions of quasi-harmonic nonlinear waves. In addition, numerical simulations combined with measurements were used here as a powerful tool to investigate nonlinear wave fields and their impact on the propagation media. This combined approach along with numerical algorithms developed for specific experimental arrangements have not only significantly extended the range of problems that can be solved, but also provide a new, higher level of investigation in medical and atmospheric acoustics.

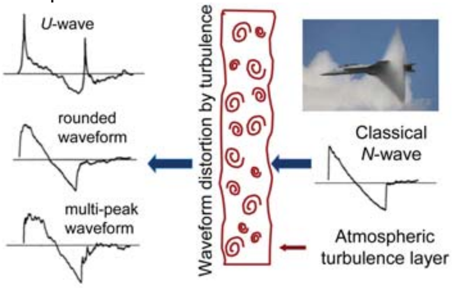


Fig. 2. Propagation of nonlinear waves in randomly inhomogeneous media. Application: sonic boom problem. Aircraft, while moving supersonically, generates an acoustic shock wave, which is called sonic boom. Propagating further to the ground the acoustic waveform is distorted by the atmospheric turbulence.

Associate Professor of the Chair of General Physics and Wave Processes Olga Kosareva defended her PhD in May 2012. The thesis title is "Filamentation of femto-second laser radiation in transparent media".

The dissertation is devoted to the phenomenon of energy localization in the long strings or filaments due to the dynamic balance of the Kerr-induced self-focusing and nonlinear ionization in a strong light field. Theoretical studies of the author are performed in close collaboration with experimental groups from Russia, Canada, France, and USA.

The author built a fundamental physical picture of a single filament formation as well as a bunch of multiple filaments (Fig.1). These fundamentals of filamentation phenomenon are accepted and implemented worldwide. Olga Kosareva studied self-compression in the filament, which results in the formation of a few cycle pulses with 5–10 fs duration. Such high-intense (100 TW/cm^2) femtosecond pulses consisting of several light field oscillations are the efficient pump for the production of high harmonics in the UV and X-ray spectral ranges. The author was the first one to theoretically explain the light-field-induced biferfingence in the filament. The fundamental principles behind the birefringence and cross-focusing are of great importance for producing THz radiation due-to the pump pulse and its second harmonic mixing in the filament.

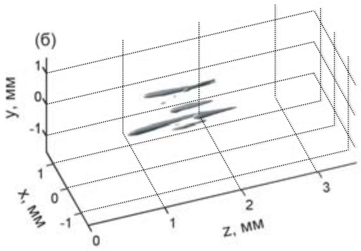


Fig. 1. Bunch of multiple filaments formed dring femtosecond laser pulse propagation in air. [Quantum Electronics 37, 1153–1158 (2007)].

Applications of the research performed within the frameworks of this doctoral dissertation are mainly associated with remote sensing of the atmosphere. Supercontinuum radiation accompanying filaments extending high into the sky bears the spectroscopic information of the atmospheric content, including volatile organic compounds and other pollution. Another tool for studying the chemical content remotely is laser-induced breakdown spectroscopy, which is based on the high intensity radiation burning the solid target. The author of the dissertation suggested several methods of increasing the fluorescence signal from the breakdown at the remote target.

At present Olga Kosareva carries out the research in the field of nonlinear optics of femtosecond laser filaments, namely, her study is concentrated on the phenomena, which takes place in the nonlinear medium existing in the high-intense filament core. Together with her group of students and young scientists Nikolay Panov, Vera Andreeva, Denis Shipilo, O.G. Kosareva has obtained important results on conversion efficiency of the pump pulse energy into the energy of THz radiation.

CONFERENCES

CONFERENCE "LOMONOSOV READINGS 2013": PHYSICS SECTION

On 15–19 April, 2013, Faculty of Physics, Lomonosov Moscow State University hosted Physics section of the conference "Lomonosov Readings 2013". Traditionally, this conference is arranged at the Lomonosov Moscow State University annually and is linked to the start of the first semester at the time of launching the Moscow State. All reports presented at this meeting are published in the Conference Abstracts, and its electronic version is also available online from the faculty's web-site.

In 2013, Physics section spanned 5 days and featured about 60 presentations that were split into 8 scientific sections chaired by the leading professors of the Faculty of Physics. Over 120 professors, researchers, graduate and under-graduate students took part in the Physics section of the conference this year. Among others, reports featuring results of the Dr. Sci. dissertations and those proposed for the Lomonosov award were reported.

XX INTERNATIONAL CONFERENCE "LOMONOSOV" FOR STUDENTS AND YOUNG SCIENTISTS

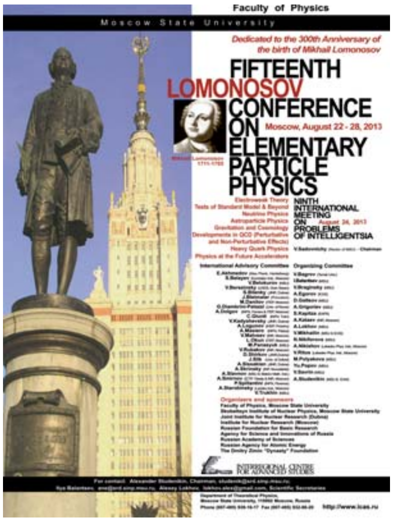
On 10th of April 2013, Faculty of Physics, Lomonosov Moscow State University hosted section of Physics of the XX Int'l Conference "Lomonosov" for students and young scientists. This conference was arranged under the umbrella of the Youth Scientific Forum "Lomonosov 2013". Section on Physics contained 16 subsections of oral papers and some sections for poster presentations. Altogether, over 300 oral presentations and some 40 posters were presented in Physics section.

Among participants of the Physics section were not only authors of the reports, but also many attendees without any paper. 227 participants came from Moscow and Moscow region, 149 — from the rest of Russia, 32 — from CIS and other foreign countries; 162 participants were students of Lomonosov Moscow State University.

The 9-th National Conference "Nitrides of Gallium, Indium and Aluminium: Structures and devices"

On 13–15 June 2013, , Faculty of Physics, Lomonosov Moscow State University hosted jointly with the Ioffe Physical -Technical Institute of the Russian Academy of Sciences IX All-Union conference on "Gallium, Indium and Aluminium Nitrides: Structures and Devices", which continues the traditions of the 1997–2000 working groups and National Conferences in 2001–2011 that held in turn in Moscow and St. Petersburg.

Three-day conference featured 55 oral and 75 poster reports. Plus to that, it was arranged a round table on "Industrial applications of nitride semiconductors technologies". Over 200 representatives from various research institutes, universities, factories, etc., from Russian and abroad took part in the meeting.



The 16th International Lomonosov Conference on Elementary Particle Physics was held at the Moscow state University on August 22–28

This series of international meeting has been organisd at the Moscow state University since 1992 under the patronage of the Rector of the MSU academician Viktor Sadovnichy. The conference was dedicated to the eightieth anniversary of the Faculty of Physics of the Moscow State University and its preparation has been strongly supported by the Dean of the faculty professor Nikolay Sysoev. The 16th Lomonosov Conference on Elementary Particle Physics is one of the most important world particle physics conference of the year 2013.

The conference programme contains more than 150 talks presented by the well-known scientists from 23 countries. The programme covered a wide site of important issues of particle physics, gravitation and cosmology. The recent discovery of the Higgs boson at the LHC in CERN was one of the hot topics of the conference programme.

The conference has been opened on August 22 that is exactly the day of the centennial since Bruno Pontecorvo birth. Academician Bruno Pontecorvo (1913–1993) is the world famous expert in particle physics who gave the distinguished contribution to neutrino physics and astrophysics. For more than 40 years Bruno Pontecorvo lived in Dubna and was the staff member at the Joint Institute for Nuclear Research, he was also the Chair of the Department of Particle Physics at the Faculty of Physics of the MSU for about 20 years. A reasonable part of the conference programme was devoted to the neutrino physic. The jubilee since birth of Bruno Pontecorvo was also celebrated at the conference during the Round Table discussion on "Exiting neutrinos: from Pauli, Fermi and Pontecorvo to nowadays prospects" that was held at closing day of the conference.

The new movie dedicated to Bruno Pontecorvo "Maksimovich. The life of Bruno Pontecorvo" produced by Geuseppe Mussardi (Italy) was shown for the first time to public at the end of the conference opening day, on August 22.

One of the most remarkable events of the conference happened during the presentation of Professor Mitsuaki Nozaki (KEK, High Energy Research Organization, Japan). On behalf of the International Linear Collider project Professor Nozaki announced the final decision on the location site of this future accelerator facility: the ILC will be constructed at Kitakami (Tohoku, Japan).

It was also very important that at the final talk of the conference programme Mr. sergey Salikhov, the Director of Department of Science and Technologies of the Russian Ministry of Education and Science, presented 5 international projects in high energy physics that are supported by the Russian Ministry of Education and Science.

Professor Alexander Studenikin,
Chairman of the Organizing Committee of the 16th Lomonosov Conference, Director of Bruno Laboratory on Neutrino and Astroparticle Physics,
Faculty of Physics Moscow state University.

CONFERENCES

SCIENCE NEWSLETTER
Faculty of Physics, Lomonosov Moscow State University

Edited by N.N. Sysoev, V.N. Zadkov, A.A. Fedyanin, N.B. Baranova
Design of typesetting by I.A. Silantyeva

Signed for printing on 31.01.2014. Circulation 200 pcs.

Faculty of Physics, Lomonosov Moscow State University
119991 Moscow, GSP-1, Leninskie Gory 1

Printed from a computer layout by Moscow University Printing House