SCIENCE NEWSLETTER

Faculty of Physics, M.V. Lomonosov Moscow State University 1/2014

HOW TO EDUCATE REAL PHYSICISTS

Interview with the Dean of the Faculty of Physics, Lomonosov Moscow State University, Prof. **N.N. Sysoev** taken by **Andrew Shmarov** and **Dan Medovnikov** for the project *Page 42* (page 42.ru) in February 2014.

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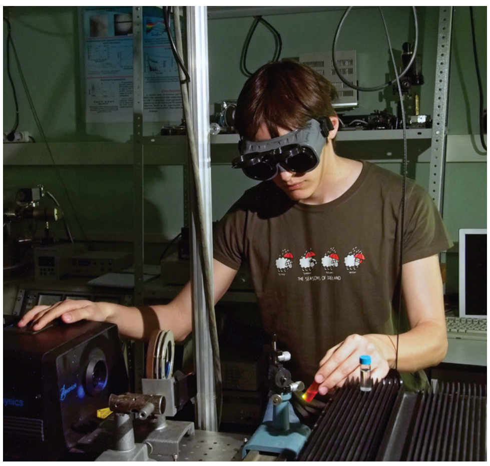


From basic science to engineering

Andrew Shmarov: What is this new trend — Engineering at the Faculty of Physics? Faculty of Physics, Lomonosov Moscow State University is seemingly an absolutely academic story. And suddenly, words such as engineering... Is that correct that you run mostly R&D, rather than engineering?

Nikolay Sysoev: We do both R&D and design & development (D&D) nowadays. The matter is that the situation has been changed both in our country and surely in the World. Previously, we were mostly engaged in basic research and then our results were implemented at applied institutions. Now, this does not work. Therefore, in order to survive, make money and teach our students not only basic research, but also applications, innovative developments, we try to give them not only the fundamental knowledge, but also engineering. At the moment we are trying to create at the Faculty of Physics a new department of Physical Engineering, where we will teach our students not only the fundamental science, but also what is the D&D and how to run it.

Dan Medovnikov: When I started to study Physics as a student at Lomonosov Moscow State University, my first thoughts were that I came to the temple of high science, will do pure theory, will write a beautiful formula on the blackboard. By contrast, first thing I was forced to work on during the first year — an introduction to experimental techniques. I started to learn how to use a soldering iron in order to create a generator, for instance. For this you must to learn how to create the box it will be assembled in and many other things. And we passed almost the entire production cycle in the workshops of the Physics Faculty. I would estimate that some 70 % of the stuff of the Faculty of Physics have always been experimentalists,people who can create almost everything by their hands.

Nikolay Sysoev: Absolutely! Without such practical skills nowadays with microchips and microprocessors,with other serious instruments,a student of physics cannot be educated. And physical engineering,which is extremely interesting, is a completely new approach for developing new technologies and apparatus. Physicist,if he does not know what's inside your phone and how the chip works,is not a physicist anymore. Surely,we do have strong theoreticians,but as Physics is largely an experimental science,engineering skills become obligatory.

Dan Medovnikov: Kapitsa or Rutherford did almost everything by their own hands. Please tell us about your academic interests.

Nikolay Sysoev: I am interested in physics of explosion. It combines gas dynamics,plasma physics,fluid dynamics,supersonic jets and plasma aerodynamics,cold plasma. Suppose,a body flies at a supersonic speed and it is covered in a supersonic flow by a so-called plasma sheet. This affects the drag coefficient,gives you the opportunity to effectively control the flight at these altitudes. This is what offers you a plasma aerodynamics...

Dan Medovnikov: Tell me,now this topic of hypersonic weapons is very fashionable. Again,I am sorry,the message of V.V. Putin addressed the American concept of lighting a strike anywhere in the world in less than an hour. A key element of such technologies is hyper-sound. And why the plasma aerodynamics is important here,as you said?.

Nikolay Sysoev: Plasma aerodynamics is important not only for for the hyper-sound,it can really affect the drag coefficient. We work experimentally on this at the Chair of Molecular Physics. There are so called gas-dynamic tables joining the body,for example,in the Earth's atmosphere,and it is necessary to consider the pressure,density, speed — everything changes. These tables were created for the space age,and they were secret. Americans calculated their own tables, we — our own. Then,Americans recognized that our tables that were calculated at the Faculty of Physics were much more accurate. Why molecular physics,although here not only molecules interact? Because these processes are occurring behind the shock front — molecules rotate,oscillate,move forward,and all this at the molecular level is taken into account in the calculations and is observed in experiments. This is the real nanotechnology,this was done for decades ago. Though, it becomes fashionable just recently to talk about nanotechnologies. You probably know that the explosion of a kilogram of TNT generates approximately 10–12 % of nanodiamonds? It's also nanotechnology! And we were doing it for decades before beginning of nano-era. We have shock tubes,in which we get supersonic flows. For example,the plasma sheet was obtained experimentally in our laboratory on the third floor of the Physics Faculty.

Dan Medovnikov: Let us talk about the hyper-sound. Which speed does it mean? Already up to 10 Mach,perhaps?

Nikolay Sysoev: The Mach number shows how many times the speed of the body exceeds the speed of the sound. At our department,we experimentally obtained a speed of Mach 40. For this,we speeded up the gas in a shock multi-diaphragm tube and then it wrapped around the pipe installed at the exit of the tube,reaching that speed. To register,we visualised shock wave using a complex system of interferometers,shadow and other methods while filming that time on the tape. Shooting speed must be a few (2–3)million frames per second. How to do this? No one film will stand it...

Dan Medovnikov: During the Atomic Project our engineers figured out how to shoot explosions!

Nikolay Sysoev: Yes,they used a rotating mirror. We initially used in our experiments at the Faculty of Physics exactly those devices,but had to utilize them shortly because of their remaining radiation. Anyway,it is interesting to see how molecules behave at these speeds, what are their translational,rotational characteristics,how they behave, how transmit energy.

Andrew Shmarov: Can some real artefacts — a missile or warhead,for instance,be speed up up to 40 Mach?

Nikolay Sysoev: Surely,not! But to hypersonic,up to 5–6 Mach that would be possible to speed them up,so that it would be impossible to "catch" them. We however are mostly engaged in basic research.

Innovations from the Faculty of Physics: In telecommunications and engine construction.

Dan Medovnikov: There are very interesting properties seem to arise. Well, apart from that of the plasma sheet, the plasma itself behaves extremely interesting.

Nikolay Sysoev: Absolutely! The plasma itself, its density and turbulence in the flow around. Explosion is not only ignited by the explosives (TNT, RDX or others). Laser blast, for example. If one focuses even an ordinary laser, not very powerful, the energy released in the focus spot would be enough to trigger explosion and the shock wave — similar to what happens in a regular explosion. Physics of explosion is a field of science, a certain direction. I lecture a novel course on Physics of Explosion for the 5th year students of Physics, which has never been delivered at the Physics Faculty. This field of Physics really absorbs all physical sciences: quantum mechanics and electrodynamics, theoretical mechanics and others. Practically, many field of Physics come into the play here.

Dan Medovnikov: It generally seems to be one of the most complex physical processes. When detonated an atomic bomb, what a beautiful physics, where both fundamental and applied science are present, and the gap between them is extremely small.

Nikolay Sysoev: This is an example of merging the fundamental and applied science. No innovation is possible without basic science.

QS TOPUNIVERSITIES
Worldwide university rankings, guides & events

Lomonosov Moscow State University was ranked among 50 best universities all over the World in Physics and Mathematics

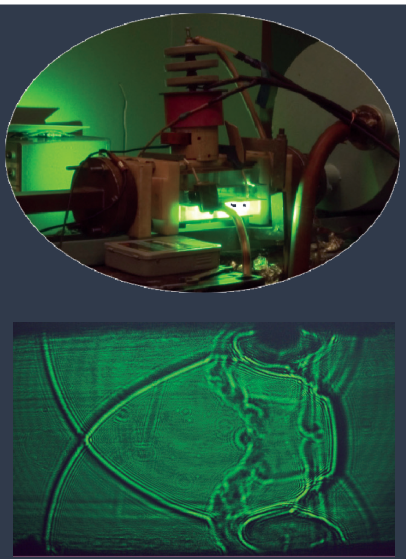
Lomonosov Moscow State University was ranked among 50 best World universities by criteria of education quality and research under Physics and Astronomy and Mathematics. According to the annual QS rating 2014 published by the British company Quacquarelli Symonds, the Moscow State holds 49 position in both fields.

By comparison with the previous year, MSU degraded a bit in Mathematics (had position 42), but raised in Physics (5–100 in 2013). Moreover, MSU is also within the first 100 universities by modern languages and philosophy.

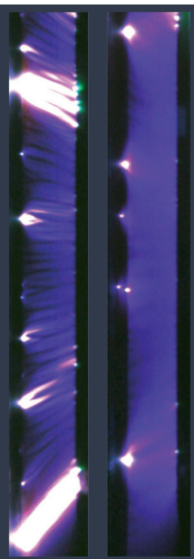
In the group of universities of 101 to 151 positions, the MSU falls in Chemistry, Information, Geology, and Hydrology. It also took position in top-200 by Material Sciences, Statistics, Operational Studies, and Machinery. Thee best universities were called Harward University (USA), MIT (USA), and Oxford University (UK).

In 2014 the ranking of the World universities was made for 30 specialities (fields). This ranking evaluates the universities by four parameters: academic reputation, employers reputation, average citation index of s specific paper, and by Hirsch-index.

A NEW TYPE OF PLASMA ACTUATOR BASED ON THE DISTRIBUTED HIGH-CURRENT SURFACE DISCHARGE WAS SUGGESTED AND STUDIED



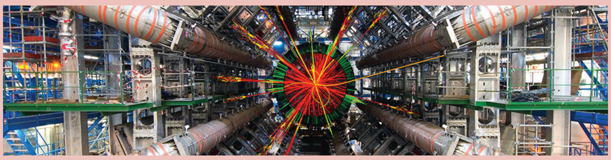
Shock wave from the controlled pulsed energy release.



Plasma sheet

Physicists from Moscow State Univ. suggested and studied a new type of plasma actuator based on the distributed high-current surface discharge.

A plasma sheet(actuator)of 0.5 mm thick consists of a set of parallel charges sliding at the dielectric surface. The energy,which is reached at the nanosecond action of a pulsed discharge on a gas flow can be up to 3 eV per molecule, when the action itself is due to the generation of shock waves from the controlled pulsed energy release. The actuator can affect the shock waves, specifically, in the boundary layer at the supersonic flow of the elements of the aircrafts. Physicists from Lomonosov Moscow State University headed by Professors Nikolay Sysoev and Irina Znamenskaya demonstrated that in the periodic pulsed regime the plasma actuator allows controlling the flows at the aircrafts at transsonic and supersonic speed.



NEW RESULTS FOR DARK MATTER SEARCH IN THE ATLAS EXPERIMENT (CERN)

Physicists of Lomonosov Moscow State University (group headed by Prof. Lidia Smirnova) in international ATLAS collaboration (CERN) received new results for the dark matter search in the ATLAS experiment.

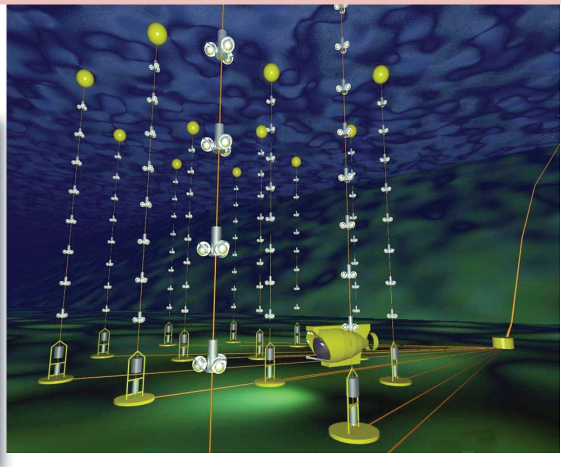
A search for weakly interacting massive particles (WIMP), denoted by χ, is fulfilled in proton-proton collisions at the center mass energy 8 TeV with all data (20 fb^{-1}) available in the ATLAS experiment. These particles are the most probable candidate for the role of dark matter in the universe. They can be produced in proton collisions by pairs via some unknown intermediate state. These searches have greatest sensitivity at low WIMP masses $m\chi$, where direct detection experiments are less powerful. Similar to neutrinos, WIMPs are invisible in the ATLAS detector, but the events can be registered due to large missing energy if initial-state radiation of a standard model particle exists. The reaction can be written as $pp \rightarrow \chi\bar{\chi} + X$, where X is associated to jet, photon and W or Z bosons. New search is fulfilled for events with associated production of hadronically decaying W or Z bosons with single massive hadron jet in final state.

Events with missing transverse momentum more than 350 and 500 GeV were selected. No excess of events over standard model expectations is observed. As a result, the stronger limits on mass scale M^* of the unknown interaction in an effective field theory expressed as a function of mass $m\chi$ are set for various operators and couplings of WIMPs with standard model particles. These results can be presented as the limits on the dark matter-nucleon scattering cross section. The essential achievement of ATLAS results is well seen in low mass region of $m\chi$ for masses up to few tens of GeV, but as distinct from experiments with direct measurements of dark matter interactions, they are model dependent.

These results have been published by the ATLAS collaboration the group of Prof. Lidia Smirnova is a part of in Phys. Rev. Lett. **112**, 041802 (2014).

DEEP-SEE NEUTRINO TELESCOPES WITH LARGE VOLUMES

Researchers, postgraduate students and students of the Faculty of Physics, Moscow State University, are deeply involved into research on the deep-see neutrino telescopes with large volumes.



"The study of astrophysical neutrinos is currently a very promising area of research for many scientific centers working in ultrahigh-energy physics," — the head of the research team in the Faculty of Physics and SINP Associate Professor Evgeny Shirokov said. His group takes part in several large international neutrino projects.

Astrophysical sources of information about distant objects in the Universe may be: primary protons, gamma rays and neutrinos. However, at energies greater than a few TeV photons interact with infrared and microwave background, forming electron-positron pairs. Protons and electrons due to their electric charge are affected by magnetic fields in space and cannot allow us to determine their trajectory from the source to the Earth.

Neutrinos have a very low cross section and provide us information about the distant sources with negligible distortions — their direction remains almost unchanged. It distinguishes neutrinos from other elementary particles as the unique messengers. This fact is one of the most significant differences between neutrino detection and registration of photons and high-energy protons.

A Cherenkov radiation began to be in common use for the detecting ultrahigh-energy neutrinos in the early 90-ies of the last century. The result was a creation of new class of systems — large volume deep-see neutrino telescopes.

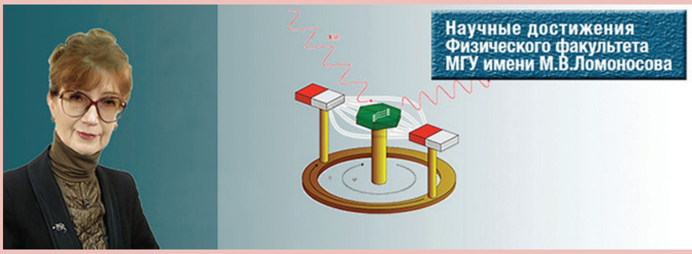
Since 2005 a scientific group from MSU consisting of collaborators, graduate students and students of the Faculty of Physics and SINP participates in the work for designing, creation and data processing on the large volume neutrino telescopes in such projects as NEMO, ANTARES and KM-3Net. In June 2011 the ANTARES collaboration meeting held in Moscow at the Faculty of Physics.

The main efforts of the scientific work conducting by the group are following questions:

- ☐ Development and creation of new types of optical modules for the photomultipliers on neutrino telescopes;
- ☐ Solution of the problem with bioluminescence in seawater detection. In this area several filters of bioluminescence were successfully created that significantly accelerated the decoding of received signals;
- ☐ A new algorithm for finding supernovae and other astrophysical objects of this type using neutrino detection was developed;
- ☐ Searching neutrinos from the recently discovered gamma-ray phenomena of so-called "Fermi bubbles", which cause the luminescence in the galactic plane;
- ☐ Modeling various configurations of optical modules for the neutrino telescope with more than 1 km^3 volume;
- ☐ Possible acoustic detection of astrophysical neutrinos.

Simultaneously the research group is working on the creation of online Internet portal for neutrino physics.

The latest contributions of the group are published in Nucl. Instrum. Meth. A **656**, 11–38 (2011); J. Instrum. **8**, P07001 (2013); Eur. Phys. J. C **74**, 2701 (2014).



SYNCHROTRON RADIATION FOR MAGNETISM

Physicists from LomonosovMSU in an international team of scientists developed a novel experimental technique based on synchrotron radiation diffraction,which allows determining the sign of Dzyaloshinskii–Moriya interaction and opens up new possibilities for a studying magnetic and magnetoelectric materials.

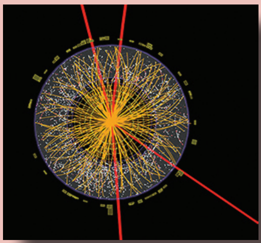
Magnetism — the spontaneous alignment of atomic moments in a material – is driven by quantum-mechanical 'exchange' interactions. The interactions between atomic magnetic moments may be not direct, but mediated by the intervening matter. For instance, the oxygen-mediated antisymmetric superexchange — Dzyaloshinskii–Moriya (DM) interaction [Dzyaloshinsky, Sov. Phys. JETP **5**, 1259 (1957); J. Phys. Chem. Solids **4**, 241 (1958); T. Moriya, Phys. Rev. Lett. **4**, 228 (1960); Phys. Rev. 120, **91** (1960)] results in weak ferromagnetism in oxides. It can be expressed in terms of a DM vector D and the vector product of spins IDM~D[SixSj]. Moriya realized that the vector's direction and magnitude are closely related to the local symmetry of the system. Currently the DM interaction is the key element in the physics of multiferroics, hence a great deal of effort is devoted to its theoretical and experimental studies.

In the paper published in Nature Physics **10**, 202-206 (2014) an international team of scientists proposes a novel experimental technique based on interference between two x-ray scattering processes (one acts as a reference wave),which is combined with a second unusual approach of turning the atomic antiferromagnetic motif with a external magnetic field. Novel technique is applied to determine the phase of the magnetic x-ray scattering signal,and the sign of the DM interaction in FeBO3. $FeBO_3$ is essentially antiferromagnetic, with sublattices almost anti parallel and a small local twist leading to weak ferromagnetism. Symmetry alone cannot say whether this local twist will be left-handed or right-handed. The absolute sign of the local twist can be found both experimentally and theoretically using techniques described in the paper.

In order to observe interference between the two scattering processes, XMaS (ESRF,Grenoble,France)measurements were carried out at the 003 reflection that is 'forbidden' for the vastly stronger charge scattering processes, and has comparable amplitudes of resonant and magnetic scattering signals near the Fe absorption edge maximizing the effects of interference. The sign and amplitude of the magnetic scattering signal depends on the spin direction, which can be rotated with a magnetic field. We thus can control the amplitude and phase of both the magnetic scattering and resonant reference wave.

Three types of measurements are presented. The first shows a remarkable effect – an apparent jump in the energy of the resonant scattering peak as the magnetic motif is rotated by 180 degrees,as a result of constructive (destructive)interference to the low (high)energy side of the resonance. The opposite jump was observed when the phase of the resonant scattering was reversed by changing the sample rotation angle. The direction of the jump gives the phase of the magnetic scattering. The second measurement shows the intensity,measured as a continuous rotation of the field angle,for the low and high energy side of the resonance. For the final measurement,the sample azimuthal angle was varied continuously, with a fixed photon energy and field applied in two opposite directions. In all cases, the phase of the magnetic scattering is in agreement with the calculations. We find that the magnetic structure twist in the is in the same direction as that of the oxygen atoms. So, a new interference technique in which measurements are carried out with precise control of the amplitude and phase of a reference wave gives an unambiguous result for the sign of the DM interaction. Our experimental results are validated by state-of the-art ab initio calculations. Together,our experimental and theoretical approaches are expected to open up new possibilities for exploring, modeling and exploiting novel magnetic and magnetoelectric materials.

These results are published in the paper: V.E. Dmitrienko, E.N. Ovchinnikova, S.P. Collins, G.Nisbet, G.Beutier, Y.O.Kvashnin, V.V.Mazurenko, A.I. Lichtenstein,M.I. Katsnelson,"Measuring the Dzyaloshinskii–Moriya interaction in a weak ferromagnet", Nature Physics **10**(3),202–206 (2014).



NEW RESULTS OF HIGGS BOSON STUDY IN THE ATLAS EXPERIMENT (CERN)

Physicists from LomonosovMoscow State University (group headed by Prof. Lidia Smirnova) in ATLAS collaboration (CERN) received new research results on Higgs boson in ATLAS experiment.

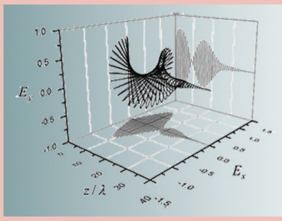
The Nobel Prize in Physics 2013 was awarded jointly to Francois Englert and Peter W. Higgs following the discovery in summer 2012 of new scalar particle in ATLAS and CMS experiments at the Large Hadron Collider in CERN. During 2012, the effective operation with the registration of proton-proton collisions at the centre mass energy 8 TeV, the largest world achievement, was carried on by these experiments. At the end of collider run the amount of detected proton collisions was in approximately 2.5 times larger than at a moment of the new particle discovery announcing. Results of the full data set analysis for the first run of Large Hadron Collider operation, completed at the beginning of 2013, confirm that the properties of discovered particle with mass 125 GeV corresponds to Standard Model Higgs boson [Phys. Lett. B **716**, 1–29 (2012); **726**, 120–144 (2013); **726**, 88–119 (2013)]. The main arguments for this statement are the determination of spin and parity of the particle ($JP = 0+$), the correspondence of measured production cross sections and branching ratios for different decay channel to Standard Model predictions. The elaborate analysis allowed even to define the roles of different production mechanisms of new particle. It is shown, that in addition to gluon fusion as the main production mechanism of Higgs boson, the mechanism of vector boson (W, Z) fusion contributes also. The last contribution is at the level of 7 % of the total Higgs boson production cross section at 8 TeV, which is equal to 22 pb. The observation of the new particle in different decay channels gives the possibility to extract the estimations of Higgs boson couplings with gauged bosons and fermions. It is shown that the ratio of couplings with W and Z bosons is equal to unity, as expected in Standard Model. Non-zero coupling with fermions is observed mainly from measurements of Higgs boson decays to tau-leptons.

The study, established the correspondence of a discovered particle with mass 125 GeV to Higgs boson, responsible for breaking of electroweak symmetry in the Standard Model, is actively continuing with existing experimental data. A question is whether this state is in fact the Higgs boson of the Standard Model (SM), or part of an extended Higgs sector (such as that of the minimal super-symmetric Standard Model, MSSM), a composite Higgs boson, or a completely different particle with the Higgs-like couplings. New results of such study are published by ATLAS experiment in February this year [Phys. Rev. D **89**, 032002 (2014)]. This paper reports the first search at the Large Hadron Collider data for the new heavier states of Higgs boson, decaying by the cascade with observed particle with mass of 125 GeV as a final state. Many beyond-the-SM models introduce a heavy neutral Higgs partner H0 and additional Higgs doublet with non-zero electric charge, H±. From the experimental data one can conclude that there are no events in addition to SM predictions. But, the obtained limits do not exclude completely existing of heavy partners of h0 particle.

New result is obtained in ATLAS experiment in search of resonance in $Z\gamma$ system, $H \to Z\gamma$ [Phys. Lett. B **732**, 8–27 (2014)]. Diagrams of such decay are similar to diagrams for decay $H \to \gamma\gamma$, which is reliably registered in an experiment, and the expected event number in SM for such decay is well known. The resonance excess of events is possible to observe if H particle is a new neutral scalar of a different origin or a composite state. The observed limits for resonance signals in mass region mH from 120 to 150 GeV are at the level from 3.5 to 18 times larger than SM predictions. The expected limit for resonance signals assuming the existence of a SM Higgs with mH = 125.5 GeV is 10 times SM prediction. The results are dominated by statistical uncertainties, so increase of data is necessary.

The research group of Prof. Lidia Smirnova (Faculty of Physics, MSU) that participates in the ATLAS collaboration (CERN), includes also diploma and graduate students from the Faculty of Physics who develop methods for reconstruction and identification of the electrons and muons. The results of the above studies have been published in Phys. Rev. D **89**, 032002 (2014) and in Phys. Lett. B **732**, 8–27 (2014).

NONLINEAR POLARIZATION OPTICS OF ULTRASHORT OPTICAL PULSES



Physicists from LomonosovMoscow State Univ. (group of Prof. Vladimir Makarov, which includes also G.A. Gryaznov, I.A. Perezhogin, and N.N. Potravkin) theoretically studied nonlinear optical activity in a gyrotropic media during the propagation of ultrashort optical pulses.

The effect of nonlinear optical activity, i.e., the intensity-dependent polarization plane rotation of linearly polarized light in a medium with cubic nonlinearity was theoretically predicted almost fifty years ago at the Faculty of Physics, Lomonosov Moscow State University, by S.A. Akhmanovand V.I. Zharikovand in 1979 it was experimentally observed by S.A. Akhmanov, B.V. Zhdanov, N.I. Zheludev and A.I. Kovrighin. Initially this rotation was explained solely by the spatial dispersion of the nonlinear optical response of the medium. Later it was discovered that the intensity-dependent polarization ellipse rotation takes place in crystals of cubic, hexagonal and tetragonal crystal systems owing to nonzero real and imaginary parts of the components of local and nonlocal cubic optical susceptibility tensors.

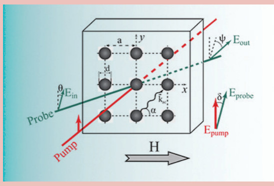
The subsequent theoretical and experimental investigations assure that the polarization self-action and interaction of waves are valid and wide spread phenomena in nonlinear optics. Waves in quantum electronic devices are practically always elliptically polarized, and the assumption of non-changing polarization during their propagation is unjustified, and can serve only to provide survey knowledge on the nonlinear optical phenomena.

The majority of theoretical results in modern nonlinear polarization optics is obtained within the framework of slowly varying envelope approximation. However, this method cannot be used efficiently for ultrashort pulses (with the duration of less than ten oscillations of the electric field). In this case, the Stokes parameters as well, as polarization ellipse ellipticity degree and orientation angle widely used in nonlinear polarization optics lose their physical meaning. Instead, the specific changes of the electric field vector in the propagating laser pulse can be seen in the hodograph of the electric field strength vector, which is the curve traced by the end of this vector.

In our studies, a modification of the finite-difference time-domain (FDTD) method with auxiliary differential equation was used for the first time for the description of the propagation of an elliptically polarized ultrashort pulse in a medium with frequency dispersion and spatial dispersion of cubic nonlinearity. We have proposed a model of such a medium, which allows for the general description of nonlinearity and formulation of material equations irrelative of the smallness of spatial dispersion parameter, which is commonly used.

Depending on the relations between the parameters determining the polarization of the ultrashort pulse and the nonlinear optical susceptibilities of the medium, various propagation modes can be realized. Complex evolution of the electric field vector in the pulse travelling through the nonlinear gyrotropic medium is essentially different from the intensity-dependent polarization ellipse rotation and deformation predicted by slowly varying envelopes method. For example, in certain cases during the propagation of the ultrashort pulse the hodograph of the electric field vector changes its helicity from right-handed to left-handed or vice versa.

The results of these studies have been published in G.A.Gryaznov, V.A. Makarov, I.A. Perezhogin, N.N. Potravkin, Phys. Rev. E **89**, 013306 (2014).



FEMTOSECOND LASER-INDUCED OPTICAL ANISOTROPY IN A 2D LATTICE OF MAGNETIC DOTS

Scientists of the Faculty of Physics (research group of Assoc. Prof. Tatiana Murzina)in collaboration with the group of Prof. Alexey Kimel (Radboud Univ.,the Netherlands) studied the dynamics of the laser-induced anisotropy in a 2D lattice of metal nanoparticles on a dielectric substrate.

Temporal characteristics of optical response of magnetic nanostructures are of high interest due to wide perspectives of applications as well as because of a large variety of new interesting effects that exist in such structures. From practical point of view, the tendency of an increase of the recording and reading speed of magnetic memories requires study the dynamics of their magnetic response with high temporal resolution. Optical pump-probe technique is used as a powerful diagnostics tool on femto- and picosecond timescales. This method is based on the usage of two laser beams, the first high-power one (pump)gets a system out of the equilibrium,while the second low-power (probe) pulse probes the state of a magnetic system after a short strictly-controlled time interval.

Recently a group of scientists from the Faculty of Physics, Lomonosov Moscow State University, and Radboud University (Nijmehen, the Netherlands) studied the dynamics of optical response of a 2D square array of cobalt nanodots on a fused quartz substrate. The dynamics of polarization plane rotation of the radiation after its interaction with such a structure was investigated. The period of a 2D lattice was 1.4 microns,the lateral size of single dot being 600 nm and its height of 30 nm. The pump-probe polarization-resolved studies were performed using an output of a high-power femtosecond laser set-up. As a result, we discovered that several mechanisms determine the polarization state of the structure, each of them being characterized by a definite relaxation time. Namely,on subpicosecond delay time the key role is played by the laser-induced birefringence induced by the fast Kerr-type nonlinearity and by ultrafast demagnetization of metal nanodots. At the timescales of about hundreds of picoseconds the optical response is determined by the magnetization recovery and acoustic excitations within the metal nanoparticles. For the delay time longer than 500 ps the polarization plane rotation is determined by the excitation of acoustic waves in the quartz substrate, the period of these waves being induced by the periodic 2D structure. Performed studies of the dynamics of these effects helps for a better understanding of physics of metal nanostructures.

The results of this work have been published in the paper I. Razdolski, V.L. Krutyanskiy, T.V. Murzina, Th. Rasing, A.V. Kimel, Femtosecond laser-induced optical anisotropy in a 2D lattice of magnetic dots. Phys. Rev. B **89**, 064306 (2014).

The team of MSU physics students took III place at the 2014 National Students Olympiad in Physics

2014 National Students Olympiad in Physics (hereinafter, the Olympiad) was organized on May 16-18 at the National Research Nuclear University (MEPhI). Traditionally, the team of physics students from LomonosovMoscow State University took part in the Olympiad. This year, our team was composed of 43 students, including the winners of the students competition in Physics at the Physics Faculty. The coach of the team was Dr. Oleg Swedes, an Assistant Professor, Chair of the Quantum Statistics and Quantum Field Theory. The largest team at the Olympiad was presented by MEPhI (63 participants).

In the team standings the MIPT and MEPHI teams took the first and second place, respectively, and the team of the Physics Faculty of Lomonosov Moscow State University won the third place, which was formed by the first three best participants:

SHIPILO Daniil Evgen'evich,

BYCHKOV Anton Sergeevich,

IVANOV Alexander Sergeevich

This year, the results of our team were better than of the most participants, but the MEPhI and MIPT. Moreover, if the Olympiad results would be counted as a sum of not just three, but at least four team members, we would beat the the MEPhI team, and if starting with seven, would beat even the MIPT team, despite it was formed exclusively from the former winners of the International Physics Olympiads.

Plus to the team achievements the organisers of this Olympiad also awarded personal achievements in solving individual problems. Most of such Letters of Honours were awarded to our students of the Physics Faculty, Lomonosov Moscow State University:

SHIPILO Daniil Evgen'evich,

SHUSTOV Pavel Igorevich,

VINOGRADOV Dmitry Sergeevich,

KONSTANTINOV Vladislav Georgievich,

PETROV Nikolay Leonidovich,

CHUKHNOVA Alexandra Vladimirovna,

SHIROKOV Il'ya Evgen'evich.

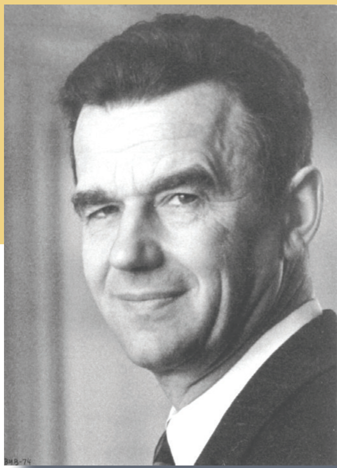
Congratulations!

Academician, head of the chair,
professor of the Faculty of Physics

Victor MASLOV

was awarded 2013 State award in Science and Technologies
for his outstanding contribution
to the developing of mathematics and mathematical basis
of modern thermodynamics.

2014 COMPETITION NAMED AFTER REM KHOKHLOV FOR THE BEST STUDENT RESEARCH WORK



Annually the Faculty of Physics, Lomonosov Moscow State University, holds best student research work competition named after Rem Khokhlov, the former rector of the Lomonosov Moscow State University and a professor of the Faculty of Physics. Terms and conditions of this competition allow the following items to be presented as a research of a student: research papers, dissertations, diploma and term papers, as well as other finished research works, which represent novel scientific results obtained by the applicant personally.

In 2014, the chairs of the Faculty of Physics nominated 28 diploma theses defended in January this year for the Rem Khokhlov competition. It was charged by a competitive juri settled by the order of the Dean of Physics from a number of actively-working scientists from our Faculty. The members of the jury noted a high scientific level of the majority of the submitted works, all of which were examined in detail and discussed not only by their formal science indicators (number of published and accepted for publication articles and a number of presentations at the conferences), but also in essence — to decide, whether the research led to the discovery of a new physical phenomenon or effect, a new theory, whether the work has a practical importance or an original methodological work.

As a result of the competition, the 1st prize of 25000 Rbl was awarded to Vera Andreeva (graduate of the Chair of General Physics and Wave Processes) for her work "Infrared and Terahertz radiation during filamentation of the two-color femtosecond laser pulse" and to A;exander Galstyan (graduate of the Chair of Nuclear Physics and Quantum Theory of Collisions) for his work "Excitation and ionization of the Helium ion in the charge-exchange reaction of a fast proton helium target".

2nd prize of 15000 Rbl was awarded to Mikhail Ivanov (graduate of the Chair of Astrophysics and Stellar Astronomy), Gul'naz Nurislamova Naurovna (graduate of the Chair of Physics of Sea and Inland Water) and Dmitry Saburin (graduate of the Chair of Mathematics).

3rd prize of 11000 Rbl was awarded to Alexey Sizov (graduate of the Chair of Polymer and Crystal Physics), Arina Sinyakova (graduate of the Chair of General Nuclear Physics), Galina Pal'vanova (graduate of the Chair of Magnetism), Artem Roenko (graduate of the Chair of Quantum Theory and High-Energy Physics), and Igor Rodionov (graduate of the Chair of Magnetism).

Alexander Galstyan (Chair of Nuclear Physics and Quantum Theory of Collisions)

Vera Andreeva (Chair of General Physics and Wave Processes)

In April 2014, Associate Prof. Alexei Oreshko (Chair of Solid State Physics) defended his Dr. Sciences thesis on "Anisotropic and Interference Effects in Resonance Diffraction on Synchrotron Radiation."

In his Dr. Sci. thesis A. Oreshko develops new method for studying the properties of condensed matter, based on the diffraction of X-rays with energies close to the absorption edges of the atoms of the substance.

In terms of diffraction resonance scattering anisotropy and polarization dependence leads to the appearance of "forbidden" reflections missing in the diffraction away from the absorption edges of the atoms of the substance because of the system symmetry, but near the absorption edges occur when the incident radiation energy is close to the required for electron transition from inner-shell electrons in the outer shells of the unoccupied state or to the continuum. Of particular interest are "forbidden" reflections caused by the presence of several contributions of different nature in the scattering anisotropy. Spectral intensity of the reflection has a complex structure and interference carries unique information about the splitting of the electronic states in the substance.

However, currently existing theory of resonant X-ray scattering allows only a qualitative description of effects that occur when there is only one anisotropic factor influencing the resonant scattering. Therefore, the purpose of studies which form the basis of the Dr. Sci. thesis was to develop theoretical methods for the study of X-ray synchrotron radiation resonant diffraction in locally anisotropic media in the presence of several anisotropic factors.

Studies conducted in the thesis suggest that the method developed resonance spectroscopy of "forbidden" reflections to solve the problem of distorted studies of electron and phonon states in locally anisotropic media and opens prospects for the study of structural, magnetic and electronic properties of locally anisotropic media inaccessible to other methods.

Associate Prof. **Alexei Oreshko** (chair of solid state physics) defended his Dr. Sciences thesis on **"Anisotropic and Interference Effects in Resonance Diffraction on Synchrotron Radiation"**

Assoc. Prof. **Pavel Forsh** (chair of general physics and molecular electronics) defended his Dr. Sciences thesis on **"Optical and Electrical Properties of the Systems with Ensembles of Silicon Nanocrystals"**

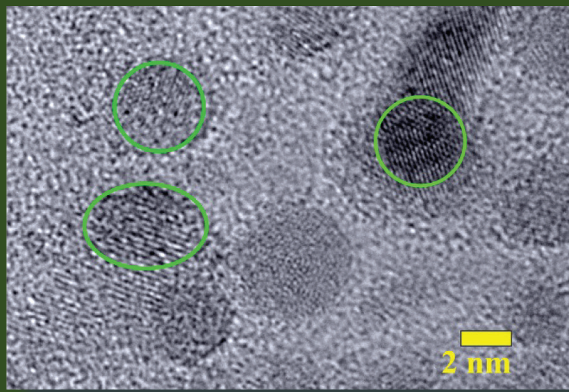
In May 2014, Associate Prof. Pavel Forsh (chair of general physics and molecular electronics) defended his Dr. Sciences thesis on "Optical and Electrical Properties of the Systems with Ensembles of Silicon Nanocrystals".

Silicon is a basic element of solid-state electronics today. Broad prospects for miniaturization of electronic devices based on silicon as well as to create new principles of operation of such devices are opened by using low-dimensional silicon structures, in particular silicon nanocrystals. Silicon nanocrystals are of great interest when they are used to create a light-emitting devices, solar cells, gas sensors, biomedical products, and etc. However fundamental processes of charge carriers generation, transfer and recombination in such systems as well as correlation these processes with structural properties of silicon nanocrystals (size, shape) and features of local environment have not been studied.

In his Dr. Sci thesis, Pavel Forsh conducted systematic studies of the optical, electrical and photoelectrical properties of the systems containing ensembles of the silicon nanocrystals were carried out in this dissertation work. Hydrogeneted amorphous silicon with silicon nanocrystals (see fig.), silicon nanocrystals embedded in silicon dioxide and porous silicon were chosen as studied materials. General patterns on influence of silicon crystalline volume fraction, their size, shape and surface coatings on the electron processes in these systems were determined. It allowed to modify the optical and electrical properties of the silicon nanocrystals systems in semiconductor and dielectric matrices by varying structure of these systems.

Obtained results are of great interest from a practical point of view. For instance the observed stability of optical and photoelectrical properties to prolonged illumination of the hydrogenated amorphous silicon containing low silicon crystalline volume fraction combined with high photosensitivity of these films create conditions for improving the efficiency of solar cells based on amorphous silicon and to increasing their lifetime. The ability to create thin-film luminescence solar concentrator based on amorphous silicon by femtosecond laser crystallization of amorphous silicon surface layer was also shown.

The inset picture shows a part of the HRTEM image of the hydrogenated amorphous silicon with silicon nanocrystals.



In April 2014,Associate Prof. Victor Ivanov(chair of polymers and crystals) defended his Dr. Sciences thesis on Computer Modeling of Phase Equilibrium in the Systems of Semiflexible Polymers and Crystals."

In his Dr.Sci. thesis V.A.Ivanovhas performed a comprehensive study of the phase behavior of various systems of semiflexible macromolecules by means of computer simulations and analytical theory. Solutions of semiflexible macromolecules of different concentrations (from extremely dilute, where the properties of single macromolecules we studied, up to concentrated solution) in bulk and under spatial constraints (near flat surfaces and inside thin films) have been studied. Phase diagrams (or diagrams of state for small systems) have been calculated. Main method of research was mesoscopic computer simulation with emphasis on lattice models of polymer systems and different Monte Carlo (MC) algorithms, including extended ensemble techniques, combined with algorithms for constructing the density of states function.

The intramolecular orientation and spatial ordering of segments in a single chain in bulk and in a single chain grafted at one end to a flat adsorbing surface have been studied in detail, and the corresponding diagram of states for a single chain of finite length has been constructed. In semidilute and concentrated solutions of semiflexible chains the phenomenon of nematic liquid crystalline (LC) ordering has been investigated, and the methods of calculation of the phase diagram of these solution in computer simulations have been developed. The effects of the finite size of the system and the phase behavior in the presence of spatial constraints (for example,a thin flat film)have been discussed. The phase diagrams of the solutions of semiflexible polymers in bulk and in a thin film have been calculated.

The important role of intra-chain stiffness has been confirmed,which leads to a complex phase behavior. It has been shown,that the stiffness of polymer chains which is measured in experiments is due to not only pure intrachain rigidity, but also strongly depends on the environment (concentration of the solution,presence of spacial constraints,etc.).

Associate Prof. **Victor Ivanov** (chair of polymers and crystals) defended his Dr. Sciences thesis on **"Computer Modeling of Phase Equilibrium in the Systems of Semiflexible Polymers and Crystals"**

Within the framwork of approach of conformation-dependent sequence design of AB-copolymers it was shown,that the conformational behavior of protein-like AB-copolymers differs significantly from the behavior of random and regular multiblock AB-copolymers. It was also shown, that the conformational behavior of flexible-semiflexible copolymer can be strongly changed by changing the ratio of the lengths of semiflexible and flexible blocks. A primary sequence of AB-copolymer was proposed,which reduces the aggregation number of micelles in a solvent which is selective to blocks A and B and accelerates adsorption of macromolecules on the surfaces in comparison with the diblock copolymer of the same composition.

International conference for students, PhD students and young scientists on fundamental sciences "Lomonosov-2014"





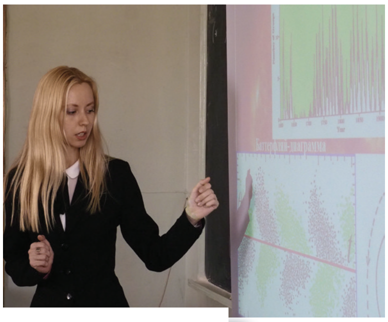
Conference "Lomonosov" is an important annual event for students and young scientists. The conference organized this April was the 21st in the series. Section "Physics", which was organized at the Faculty of Physics, Lomonosov Moscow State University on 8 April 2014 hosted 328 reports distributed within 17 sections. 362 participants took part in the Physics section, of which 199 were from Moscow and 163 participants — from other cities of Russia (Stavropol, Voronezh, Tver, Kazan, St. Petersburg, Ulyanovsk, and many others), CIS and abroad (Kazakh-stan, Ukraine, Tajikistan, China, Uzbekistan and Moldova). Among them, 108 attendees were the students, PhD students and young scientists from LomonosovMoscow State University.

The conference was opened with opening words by the dean of the Faculty of Physics, Professor Nikolai Sysoev, followed by a plenary lecture "Magnetoelectric materials and multiferroics" by an Assoc. Prof. Alexander Pyatakov.

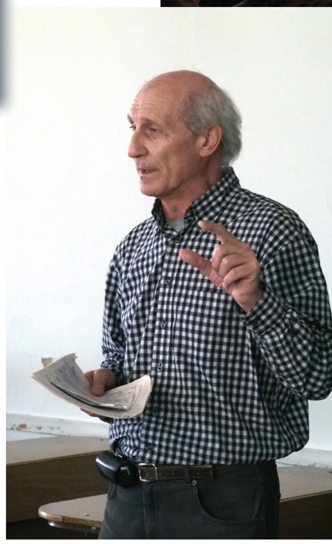
Conference sessions were led by leading scientists of the Physics Faculty who selected best reports pre-sented at the conference, which are listed below:

Astrophysics	Daria Evdokimova	MSU Faculty of Physics, 5th year student
Atom & Nuclear Physics	Maria Bogdanova	MSU Faculty of Physics, PhD student
Biophysics	Tatiana Kovalenko	MSU Faculty of Physics, 5th year student
	Svetlana Shevchenko	MSU Faculty of Physics, 5th year student
Geophysics	Alexey Tselebrovski	MSU Faculty of Physics, PhD student
Mathematics & Informatics	Roman Dabydov	St. Petersburg State Polytechnic Univ., student
Mathematical Modeling	Dmitry Senin	MSU Faculty of Physics, PhD student
Molecular Physics	Farida Shagieva	MSU Faculty of Physics, 5th year student
Nonlinear Optics	Eugene Mareev	MSU Faculty of Physics, 5th year student
Optics	Anna Tsibulnikova	Kaliningrad State Technical Univ., PhD student
Medical Physics	Kisun Li	MSU Faculty of Physics, PhD student
Radiophysics	Georgy Likhachev	MSU Faculty of Physics, PhD student
Radiophysics and Electronic Solid-State Properties	Ekaterina Morozova	UlyanovState Univ., PhD student
Solid-State Nanoelectronics	Ilya Sitnikov	MSU Faculty of Physics, 5th year student
Theoretical Physics	Anastiosiya Voronina	Voronezh State Univ., 5th year student
Physics of Magnetic Phenomena	Anna Kharlamova	MSU Faculty of Physics, stuff member
	Anton Karseev	St. Petersburg State Polytechnic Univ., 4th year student
Solid State Physics	Nikita Lednev	Donetsk National Univ., 5th year student
	Anna Zaitseva	MSU Faculty of Physics, 5th year student
Poster presentations	Mikhail Ivonin	South-Ural Federal Univ., 4th year student
	Il'kham Galliulin	Kazan Federal Eniv., student

2014 Lomonosov Readings on Physics



Section on Physics of the 2014 Lomonosov Readings on Physics was arranged at the Faculty of Physics, Lomonosov Moscow State University, on 14–18 April 2014.



This is a multidisciplinary conference, which is held annually in April. All conference papers are published in the Conference Digest in both printed and electronics versions (the latter is available at the www.phys.msu.ru). In 2014, the conference section on Physics hosted 58 presentations, which were split into eight sessions attended by the teaching and research staff of the the Faculty, as well as by diploma and PhD students. It is worth to note that besides various research topics session on "Methodology of teaching Physics" led by professors A.M.Saletsky, B.S.Ishhanov, and B.A.Strukov attracted quite a bit of attention. Traditionally, the "Lomonosov Readings" offer a platform for presenting novel research results (including those of prepared for the defence of the Dr. Sci. dissertations) by the faculty members, which have been nominated for the Lomonosov Award for the best research work.

Plenum of the Educational-Methodical Council on Physics

On May 20–21, 2014, Pskov State University hosted the Plenum of the educational-methodical council (EMC) on Physics of the Association of Classical Universities of the Russian Federation. The Plenum was attended by 33 representatives of 28 classical universities from Russia.

For more information about the plenum and the presented reports look at http://foroff.phys.msu.ru/phys

DMITRI IVANENKO

Dmitri Ivanenko (29.07.1904-30.12.1994), Professor of Physics, Lomonosov Moscow State University, was one of the greatest theoreticians of the XX century, an author of the proton-neutron model of atomic nucleus.

D. Ivanenko was born on July 29, 1904, in Poltava (Russian Empire), where he began his creative path as a school teacher of Physics. In 1923 Ivanenko entered Petrograd University. In 1926, while still a student, he wrote his first scientific works together with his friends, George Gamov and Lev Landau (Nobel Laureate in 1962). After graduating the university, from 1927 to 1930 D. Ivanenko was a scholarship student and a researcher at the Physical Mathematical Institute of the USSR Academy of Sciences. That time he collaborated with Vladimir Fok and Viktor Ambartsumian, who later become world-known scientists.

In 1929–31, Dmitri Ivanenko worked at the Kharkiv Institute of Physics and Technology, being the first director of its theoretical division; Lev Landau followed him in 1932–37. Paskual Jordan, Victor Wieskopf, Felix Bloch and Paul Dirac visited D. Ivanenko in Kharkiv. In 1929, Ivanenko organized the 1st Soviet theoretical conference and then in 1932 he launched the first Soviet journal **"Physikalische Zeitschrift der Sowjetunion"** in foreign language.

After returning to Leningrad at the Ioffe Physical-Technical Institute, D. Ivanenko concentrated on nuclear physics. In May 1932, Ivanenko published the proton-neutron model of the atomic nucleus in "Nature", and two months later Werner Heisenberg referred to his work. In August 1932, D. Ivanenko and E. Gapon proposed the pioneering nuclear shell model describing the energy level arrangement of protons and neutrons in the nucleus in terms of energy levels. Later this model was developed by Eugene Paul Wigner, Maria Goeppert-Mayer and J. Hans D. Jensen who shared the 1963 Nobel Prize for their contributions.

Ivanenko's success pushed forward the nuclear physics in the USSR. In 1933 on the initiative of Dmitri Ivanenko and Igor Kurchatov, the 1st Soviet nuclear conference was organized. Paul Dirac, Frйdйric Joliot-Curie (Nobel laureate in 1935), Fransis Perrin, Ftanko Rasetti, Victor Wieskopf and many others participated in this conference.

The realization of Ivanenko's far-reaching plans and hopes was interrupted in 1935, when he was arrested in connection with the Sergey Kirov affair, and exile to Tomsk followed. D. Ivanenko was a professor at Tomsk and Sverdlovsk Universities till the beginning of the World War II. Then, from 1943 till the last days of his life, he was closely associated with the Faculty of Physics Faculty, Lomonosov Moscow State University.

D. Ivanenko

Dmitri Ivanenko made the fundamental contribution to many areas of nuclear physics, field theory and gravitation theory.

In 1928, Ivanenko and Landau developed the theory of fermions as skew-symmetric tensors in contrast with the Dirac spinor model. Their theory, widely known as the Ivanenko-Landau- Kahler theory, is not equivalent to Dirac's one in the presence of a gravitational field, and only it describes fermions in contemporary lattice field theory.

In 1929, Ivanenko and Fock generalized the Dirac equation and described parallel displacement of spinors in a curved space-time (the famous Fock–Ivanenko coefficients). Nobel laureate Abdus Salam called it the first gauge field theory.

In 1930, Ambartsumian and Ivanenko suggested the hypothesis of creation and annihilation of massive particles which became the corner stone of contemporary quantum field theory.

In 1934 Dmitri Ivanenko and Igor Tamm (Nobel Laureate in 1958) suggested the first non-phenomenological theory of paired electron-neutrino nuclear forces. They made the significant assumption that interaction can be undergone by

D. Ivanenko, P.A.M. Dirac and W. Heisenberg (Berlin, 1958)

Dmitri Ivaneko (29.07.1904 -30.12.1994), Professor of Lomonosov Moscow State University, was one of the great theoreticians of the XX century, an author of the proton-neutron model of atomic nucleus.

an exchange of massive particles. Based on their model, Nobel laureate Hideki Yukawa developed his meson theory.

In 1938, Ivanenko proposed a non-linear generalization of Dirac's equation. Based on this generalization, W. Heisenberg and he developed the unified nonlinear field theory in 1950th.

In 1944, Dmitri Ivanenko and Isaak Pomeranchuk predicted the phenomenon of synchrotron radiation given off by relativistic electrons in a betatron. This radiation was soon discovered by American experimenters D. Bluitt (1946) and H. Pollock (1947). Synchrotron radiation possesses a number of very particular properties which provide its wide applications. In particular, neutron stars also are sources of this type radiation. Classical theory of synchrotron radiation was developed by Dmitri Ivanenko in collaboration with Arseny Sokolov in 1948, and independently by Julian Schwinger (Nobel Laureate in 1965). For their work on synchrotron radiation, D. Ivanenko, A. Sokolov and I. Pomeranchuk were awarded the Stalin Prize in 1950. In 1956, D. Ivanenko developed the theory of hypernuclei discovered by Marian Danysz and Jerzy Pniewski in 1952.

Two of D. Ivanenko's and A. Sokolov's monographs **"Classical Field Theory"** and **"Quantum Field Theory"** were published at the beginning of the 50th. **"Classical field theory"** was the first contemporary book on field theory where, for instance, the technique of generalized functions was applied. Nobel laureate Ilya Prigogine referred to it as his text-book.

In the beginning of the 1960's, D. Ivanenko did intensive scientific and organizational work on the development and coordination of gravitation research in the USSR. In 1961, on his initiative the 1st Soviet gravitation conference was organized. D. Ivanenko was the organizer of Soviet Gravitation Commission, which lasted until the 1980's. He was a member of the International gravitation Committee since its founding in 1959. In the 70–80th, D. Ivanenko was concentrated on gravitation theory. He developed different generalizations of Einstein's General Relativity, including gravity with torsion and gauge gravitation theory. In 1985, D. Ivanenko and his collaborators published two monographs **"Gravitation"** and **"Gauge Gravitation Theory"**.

Theoretical physics in the USSR has been enormously influenced by the seminar on theoretical physics organized by D.D. Ivanenko in 1944 that has continued to meet for 50 years under his guidance at the Physics Faculty of Moscow State University. The distinguishing characteristic of Ivanenko's seminar was the breadth of its grasp of the problems of theoretical physics and its discussion of the links between its various divisions, for example, gravitation theory and elementary particle physics. The most prominent physicists in the world participated in the seminar: Niels and Aage Bohr, Paul Dirac, Hideki Yukawa, Julian Schwinger, Abdus Salam, Ilya Prigogine, Samuel Ting, Paskual Jordan, Tullio Regge, John Wheeler, Roger Penrose et al.

The scientific style of Dmitri Ivanenko was characterized by great interest in ideas of frontiers in science where these ideas were based on strong mathematical methods or experiment.

It should be noted that seven Nobel Laureates: P.A.M. Dirac, H. Yukawa, N. Bohr, I. Prigogine, S. Ting, M. Gell-Mann, G. 't Hooft wrote their famous inscriptions with a chalk on the walls of Ivanenko's office at Lomonosov Moscow State University.

Gennadi Sardanashvily
Faculty of Physics
Lomonosov Moscow State Univ.

Arsenii SOKOLOV

In 2010,100 years had passed since the birthday of **Arsenii Aleksandrovich Sokolov,** an outstanding scientist, Professor of the Faculty of Physics of Moscow State University.

A.A. Sokolovwas born in Novonikolaevsk (now Novosibirsk)in the family of teachers of the primary railway school. In 1931,he graduated from the Faculty of Physics and Mathematics of Tomsk University and in 1934, under supervision of Professor P.S. Tartakovsky, he defended the PhD thesis entitled "Motion of Electrons in a Crystal Lattice". In 1939,A.A. Sokolovmoved to Sverdlovsk (now Ekaterinburg)where he worked at Sverdlovsk Pedagogical Institute and Sverdlovsk University as Assistant Professor at first and then as Professor and Head of the Department of Theoretical Physics. In 1942,he defended the Doctoral Thesis entitled "Quantum Theory of Radiation Damping under Particle Scattering" at Leningrad Institute of Physics and Technology situated at that time in evacuation in Kazan.

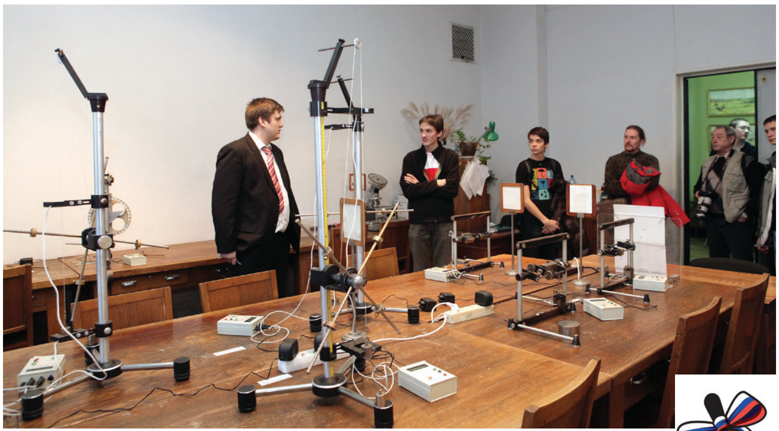
In 1945, A.A. Sokolov was A.A. Sokolov's moved (on D.D. Ivanenko's initiative and with the assistance of I.V. Kurchatov)to Moscow at the Faculty of Physics of MSU,and all his subsequent life turned out to be related with the Faculty. At first he was Professor of the Department of Theoretical Physics, after that,in 1948–1954,he was Dean of the Faculty of Physics. Under A.A. Sokolov's leadershi p,a new building of the Faculty at Leninskie Gory was constructed and equi pped; departments and laboratories were moved there from Mokhovaya street. In 1954–1986, he was Professor of the Department of Theoretical Physics, and, during 16 years (1966–1982), he was Head of this Department.

A.A. Sokolov's scope of scientific interests was very wide: classical and quantum field theory, mathematical physics,elementary particle physics,theory of electron accelerators,synchrotron radiation theory. Already in 1930s, he performed a number of fundamental works on quantum mechanics,quantum theory of solids, quantum field theory. His works of those years on neutrino theory of light and exchange theory of nuclear forces had been extended in a modern gauge theory of elementary particle interactions. A.A. Sokolov's paper (in collaboration with D.D. Ivanenko, 1937)on charge-symmetric quantization of Dirac (electron-positron) field had been included in the collection of reprints of 15 underlying works on quantum field theory published by the Physical Society of Japan. Futhermore,P. Dirac,W. Heisenberg,and other outstanding physicists were among the authors of these papers. In 1941, A.A. Sokolov developed (independently of W. Heitler) quantum theory of damping that is a fundamental method of investigation of elementary particle interactions in the strong coupling region. He created theory of Dirac particles with oriented spin (1945) and applied it to calculation of the positronium spectrum (1953) and to development of the 4-component neutrino theory that allowed him to give a new interpretation of parity violation in weak interactions (1958). At the end of 1940s – the beginning of 1950s he performed (in collaboration with D.D. Ivanenko) the pioneer works on quantum theory of gravitation. Since 1948, A.A. Sokolov with his collaborators and pupils had been developing classical and quantum theory of synchrotron radiation (SR) that is powerful electromagnetic radiation of relativistic electrons moving in a magnetic field in a circular orbit in accelerators-synchrotrons and storage rings. He derived (in collaboration with D.D. Ivanenko, 1948) a closed asymptotic formula uniformly describing the SR spectrum in the entire sufficient frequency range. In 1949, this formula was obtained independently by an American theoretical physicist J. Schwinger who afterwards cited repeatedly the paper of Soviet authors. A.A. Sokolov's research results of those years were included in a monograph "Classical Field Theory" (1949) written jointly with D.D. Ivanenko, and the authors were awarded the Stalin Prize in 1950. It was the first modern book on field theory where the technique of the theory of generalized functions (distributions)was systematically developed. The book was in high demand: a number of eminent foreign physicists, including the Nobel Prize winner I.R. Prigogine, remembered it as their reference book.

A.A. Sokolov predicted (in collaboration with I.M. Ternov) fundamental effects of quantum fluctuations of the electron orbit in a magnetic field (1953) and radiative polarization of electrons and positrons in storage rings due to synchrotron radiation (Sokolov–Ternov effect,it was registered in the State Registry of Inventions of the USSR, the certificate No. 131,in 1973 with priority of 1963). These effects were found experimentally and investigated in detail at the first-rate world research centers; the first effect ensures normal operation of accelerations and storage rings,and the second one is used to obtain polarized beams of high-energy electrons and positrons. The term "Sokolov–Ternov effect" and corresponding references are ubiquitous in the modern world scientific literature. The fundamental monographs on the SR theory by A.A. Sokolov and I.M. Ternov are also cited very frequently: "Synchrotron Radiation" (Berlin, Akademie-Verlag; New York,Pergamon Press, 1968) and "Radiation from Relativistic Electrons" (New York, AIP, 1986) [the original Russian editions: "The Relativistic Electron" (Moscow, Nauka, 1974, 1983)]. For prediction and development of the theory of the foregoing effect, A.A. Sokolov(jointly with I.M. Ternov)was awarded the State Prize of the USSR (1976). In 1970s,he initiated application of the SR theory to investigation of the generation mechanisms of gravitational radiation under laboratorial and astrophysical conditions.

At Moscow University, A.A. Sokolov taught basic courses on many areas of theoretical physics. He was the first at the University who began teaching a course on relativistic quantum mechanics. A.A. Sokolov was a founder of a great school of theoretical physics, and he trained about 50 candidates (PhD) and 20 doctors of sciences (DSc).

A.V. Borisov, Professor



FACE–TO–SCHOOL

In the spring semester of 2014 at the Faculty of Physics, as in the previous years, we continued to work with the potential entrants to the Faculty of Physics and with the school teachers. Specifically, training was provided for the potential entrants and school teachers. Professor of the faculty held classes with students and school teachers to participate in the Physics Olympiads organized by Lomonosov Moscow State University (not only in Moscow but also at on-site Schools in Kislovodsk and Cheboksary), there were arranged series of lectures at the Moscow schools, guided tours to educational and research laboratories of the Faculty of Physics, were the qualifying and final stages of the Physics Olympiads are organized. For instance, the Olympiad "Conquer the Sparrow Hills" attracted more than 6000 participants, the Olympiad "Lomonosov" — over 4500 participants. Plus to that, the Faculty of Physics run the Moscow Olympiad in Physics in cooperation with the Department of Education of the Moscow Government. This year the Faculty of Physics was also an organizer and co-organizer of the Olympiads "Tournament named after M.V. Lomonosov" and "All-Russian tournament of the young physicists". The evening School on Physics for the 7 to 9 year schoolboys also opened its doors.

In addition, following numerous requests of potential entrants and school teachers we continued the "Physics Lectures" in the framework of the program "University Saturdays" of the Department of Education of Moscow Government, which included this semester:

- Lectures by Assoc. Prof. Sergey Ryzhkovaccompanied by physical demonstrations by the Physical Demonstrations Group in which the attendees were able to see not only familiar from the School Physics demonstrations, as well as new, unexpected and interesting experiments on Physics and Music (oscillations, waves, acoustics), Mysterious transformations (melting, boiling, etc.).
- Lectures on current trends and developments in modern physics, in which the audience could hear the news from the "leading edge" of science from the leading scientists of the Faculty of Physics:
  - «Nonlinear polarization optics», Head of the Chair of General Physics and Wave Processes, Prof. Vladimir Makarov;
  - «T-rays: Physics and Applications», Head of the Chair of General Physics and Condensed Matter Physics, Corresponding member of the Russian Academy of Sciences, Prof. Dmitry Khokhlov;

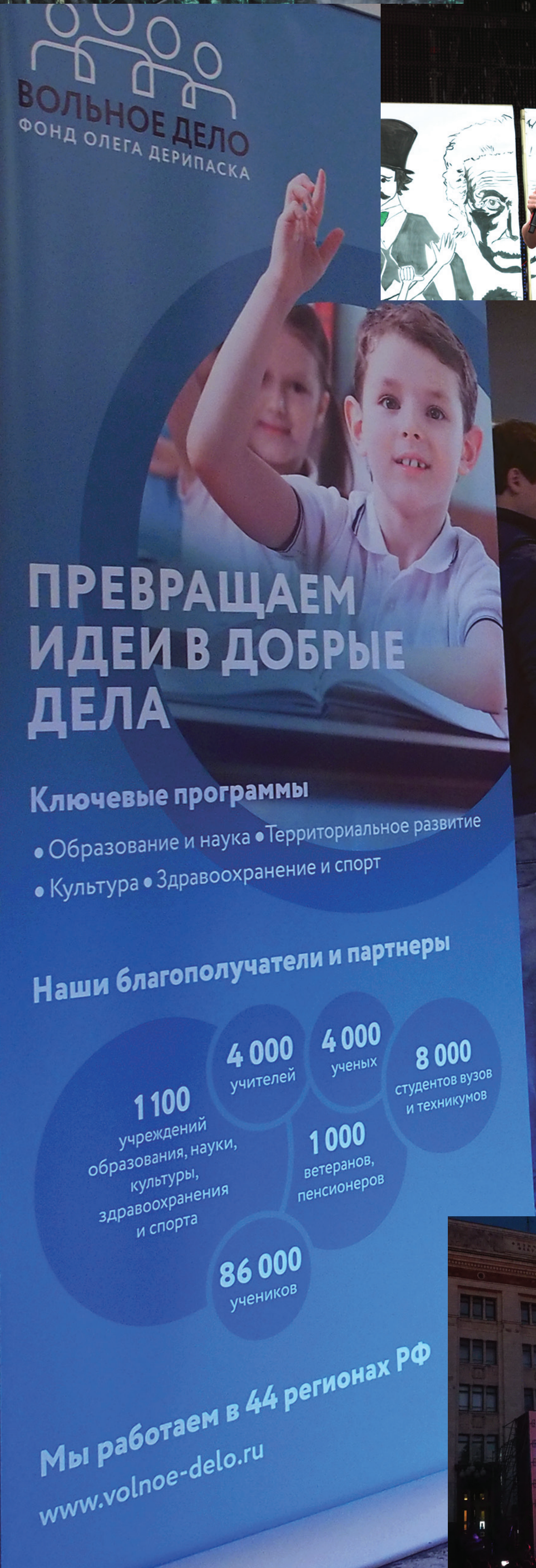
  - «Nature's steps from nonliving to living», Head of the Chair of Biophysics, Prof. Vsevolod Tverdislov;
  - «Nanotechnologies in modern Physics and Biology», Prof. Andrey Fedyanin;
  - «Superpower microwave electronics», Prof. Alexander Slepkov;
  - «Quantum phenomena in Nature: superconductivity and magnetism in the new minerals», Head of the Chair of Low-Temperature Physics and Superconductivity, Prof. Alexander Vasil'ev.

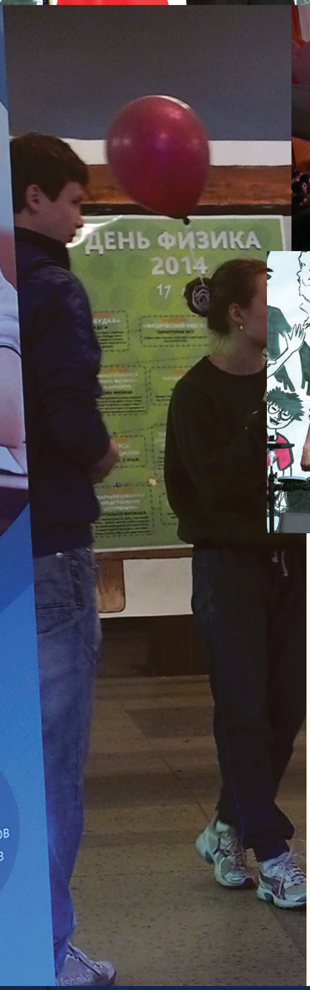
A new program "Enjoyable lessons in physics" for the future entrants to the Faculty of Physics started this semester. Within this program the potential entrants visited research labs of the Faculty of Physics (5 classes, which were attended by 99 students and 12 teachers from Moscow and Arkhangelsk region) and performed labora-tory projects in the praktikums of the chairs of General Physics (4 lessons for 31 students and four teachers) and of the General Physics and Condensed Matter Physics (3 classes for 11 students and one teacher).

Prior to the Unified State Examination (USE) on Physics, a free consultation for the entrants was arranged at the Faculty of Physics, which was conducted by a member of the Federal Commission on the the Assoc. Prof. Vitaly Gribov, a member of the USE Federal Commission on Physics and an author of the published book in "USE on Physics 2014: The most complete edition of the typical problems and questions", and by Assoc. Prof. Alexander Grachev, an author of a number of innovative Physics textbooks. This event caused great interest from lots of potential entrants from Moscow. Plus to that, for the potential attendees fro outside Moscow an internet webcasting was arranged at the site www.distant.msu.ru.

Konstantin Parfenov

Day of Physicists, 17 May 2014





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