

**The Department of General and Experimental Physics** continues joint research with the **University. Adam Mickiewicz (Poland, Poznan), the University of Exeter (UK, Exeter) and the University of the Basque Country (Spain).**

Lecturer of the Department of General and Experimental Physics Prof., Ph.D. Reshetnyak SO in the framework of international cooperation, 2 reports were made at open seminars at the **Adam Mickiewicz State University in Poznan (Poland) within the framework of the International Research Staff Exchange Scheme (IRSES)**

, funded by the European Community under a grant for joint research on the subject of the department.

At the invitation of the **Vice President of the International Center of Future Science (Jilin University, Changchun, China) Prof. HanWei prof. Yu.I. Jejer** was from **January 12 to February 11, 2019 and from July 7, 2019 to August 19, 2019 at Jilin University as part of a research group led by prof. G.G. Levchenko.**

He has been engaged in scientific and research activities on modeling and research of the effects of shape memory in magnetoactive elastomers.

The Department of General Physics and Solid State Physics cooperates with foreign educational and research organizations:

**1. Ckarkson University, NY. Center of Advance Material Processing - Nanoparticle physics, mathematical modeling of biological systems in accordance with the cooperation agreement between NTUU "KPI" and Clarkson University.** Professor of the department Gorshkov VM enrolled as a Research Professor at Clarkson University since May 2009.

**2. Los Alamos National Laboratory USA, NM - Quantum Chemistry.** Cooperation agreement.

**3. England, London Imperial College - Development of devices based on acoustic metamaterials.** Cooperation agreement April 30, 2016 - May 31, 2019.

Professor of the **Department of Mathematical Physics, Doctor of Technical Sciences, Beiko I.V.** is the coordinator of cooperation with the Computing Center of the Russian Academy of Sciences in the development of methods for optimizing large-scale problems.

**Professor of the Department of Mathematical Physics, Ph.D., Shvets O.Yu.** is a member of the editorial board of the Chaotic Modeling and Simulation Journal (USA).

Associate professors of the **Department of Mathematical Physics Zhuravska GV and Stepanenko NV** passed internships on March 3-9, 2019 under the IMANS project "Internship for educators + English language school" at the Western Finnish College, Guittinen, Finland (Order №845-n of March 6, 19).

**Associate Professor of Mathematical Physics Karpalyuk TO** passed an internship on June 21-26, 2019 under the project "Modern University in the European education system: teaching methods, scientific and pedagogical development, distance education and internationalization of the educational process" in Przeworsk, Poland (Order № 3085-n from 23.09.2019) .

### **Los Alamos National Laboratory (LANL).**

<http://www.lanl.gov/>

In recent years, Physics and Mathematics implements collaborations with Los Alamos National Laboratory (LANL). This lab was established in 1943 for the Manhattan Project to create nuclear weapons.

Now LANL conducted basic research in many areas of physics involving scientists from different countries.

A series of works made for direct participation by representatives of "KPI" by professor V. Gorshkov, ended publication of the book "Magnetic resonance and microscope and a single spin measurement", World Scientific, 2006. It is dedicated registration technique in solid individual electron spins, which gives a unique tool for research in physics, chemistry, biology and medicine.

Distribution initially coherent laser beam in turbulent atmosphere. Sample numerical simulation that demonstrates and fragmentation, and the wandering of the beam (wandering).

Productive cooperation is "KPI" and LANL in the field of optical communications made using a laser beam (Prof. V. Gorshkov, S. Torous graduate student). How will this kind of inherent high sociability, privacy and high density of information transferred. A significant factor that hinders the implementation of key technical solutions, is the atmosphere, which in almost any weather conditions are turbulent. Even small spatial variations of refractive index lead to distortion of the laser beam. In the process of spreading a bunch fragmentation (divided into separate beams) and deviates from the original direction. The level of received signal is random, which increases the likelihood of errors while decoding information. A study conducted at the Physics Department of Mathematics, devoted to the development of methods of suppression of fluctuations of the signal detector.

Widespread use of mathematical modeling in the study of propagation in turbulent atmosphere, the so-called partially coherent beams (including optical vortices), allowed to achieve a reduction of fluctuations in the signal 20 times. This figure is a record in the world today. The results of joint work published in the JOURNAL OF PHYSICS B: ATOMIC, MOLECULAR AND OPTICAL PHYSICS (2009), highly appreciated at the annual conference Photonics West-San Francisco-2009 and included in the list of the highest achievements of LANL in 2009.

At the stage of consolidation is an agreement on cooperation for the next three years -

Memorandum of Understanding Between Los Alamos National Laboratory and National Technical University of Ukraine "KPI".

Assume joint work in the field

Theory and modeling of propagation of light through the turbulent atmosphere;

Theory and modeling of sensors and imagers;

Modeling the dynamics of quantum systems interacting with the environment;

Modeling of electromagnetic radiation scattering and absorption by NSS;

Study of surface-enhanced Raman scattering (SERS) and fluorescence of molecules adsorbed on the NSS interfaces and on micro-resonators;

Modeling of controlled growth of nano-particles.

House (Los Alamos, USA), inhabited opener neutrino D. Chadwick and father of plutonium chemistry Richard Baker.

**Center of the leading technologies in material science (Clarkson University, NY)**

<http://www.clarkson.edu/camp/>

Over the past three years is active cooperation, secured relevant agreements with the Center for Advanced Technologies in Materials (Clarkson University, NY).

Works devoted to nano-physics. It is known that the properties of the same substance contained in the particle size of 100-200nm, significantly different from the physical and chemical properties of micron particles (and higher) dimensions. Nanoparticles find the widest application in medicine, microelectronics, and even in agriculture Improvement. Methods of obtaining nanoparticles should provide their monodispersity (uniformity of size) and accountability form on which depend heavily on physical and chemical properties of particles. Often, depending on the mode of formation, the shape of particles varies with the same initial substances.

Form nanochastys iron, obtained at work - Wang, CM, DR Baer, JE Amonette, MH Engelhard, Y Qiang, and J Antony. 2007. "Morphology and oxide shell structure of iron nanoparticles grown by sputter-gas-aggregation." Nanotechnology 18:255603

That is the theory of shape of nanoparticles during the growth of physicists dedicated to "KPI" and Clarkson University. It was shown that the correct form of nanoparticles in the form of polyhedrons is often the result of substantial non-equilibrium diffusion of growth modes, which can be controlled by changing the temperature and the concentration of free atoms (molecules) in it.

Theoretical recommendations confirmed by real experiments. One of the last publications (2009): <http://pubs.acs.org/action/doSearch?action=search&searchText=Shape+Selection+in+diffusive>. Numerical simulations by using a unique algorithm (V. Gorshkov, A. Zavalov), which allows quite accurately describe the dynamics of systems with several millions of free atoms (molecules) and the dynamics of surface atoms (molecules) nanoparticles that grow.

Regularities in the formation mechanisms of nanoparticles attracted considerable interest in the circle of specialists, and the article was the subject of attention at many sites, from site space agency NASA and ending with medical sites.

**Center for Quantum Device Technology (Clarkson University, NY)**

<http://www.clarkson.edu/cqdt/>