



**DOCTORAL
PROGRAMS**

**MATHEMATICS & INFORMATICS
NATURAL SCIENCES
ENGINEERING**

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Vladimir Kruzhaev
UrFU Vice-rector for Research

High-quality education has always been of value, today it remains an important asset all over the globe. The level of development of the country is directly dependent on the level of scientific cognition of the nature and the society, as well as on the broad use of scientific achievements in engineering and technology. Thus the need for specialists with experience in research will only grow in the years to come.

We invite all researchers interested in the mysteries of the Universe and the organic and inorganic nature, the development of technology, economic and social spheres of life, to pursue their doctoral studies at Ural Federal University. Being one of the leading Russian universities in terms of research activities, Ural Federal University possesses all necessary facilities for doctoral students to pursue their studies in such fields as Natural Sciences, Mathematics, Engineering, Human Sciences, and Economics. Scientific advisors working with doctoral students have broad experience of working in the leading universities of the world.

A handwritten signature in blue ink, appearing to be the name of the Vice-rector for Research, Vladimir Kruzhaev.

Cover photo: UrFU doctoral students: Aftab Alam Mohammad (India), Ni Wayan Radita Novi Puspitasari (Indonesia), Fatemeh Haj Khalili (Iran) and Ebenezer Agbozo (Ghana).

We express our gratitude to all UrFU doctoral candidates and professors for the permission to use their pictures and testimonials in this brochure.

Mathematics & Informatics





A PostDoc Azeef Muhammed Parayil Ajmal (India) and a PhD candidate in Mathematics and Mechanics Hanan Magdy Darwish Shabana (Egypt) sharing ideas about their research directions

Duration of study: 4 years

Language: English or Russian

Entry requirements:

- Master's degree (or equivalent) in the related field
- B2 level of English or Russian
- Interview

Entrance exams:

- Foreign language (English/German/French)
- Mathematics and mechanics

Government scholarship is available.

See more information at:



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THE FINITE BASIS PROBLEM FOR SEMIGROUPS

Research goal:

The research focuses on one of the major open problems on the edge between the semigroup theory and the universal algebra: Tarski's problem for finite semigroups. This fundamental problem reveals surprising connections to the modern computer science, in particular, to the complexity theory.

Aspects studied:

- Computational complexity of deciding the finite basis property for finite semigroups
- The finite basis problem for "graph-generated" semigroups, like Hecke-Kiselman monoids
- Relatively inherently non-finitely based J-trivial and R-trivial semigroups

Research highlights:

Students willing to enroll in this program will work within a very international network of algebraists and computer scientists.

Career opportunities:

Specialists working on the edge between classical algebra and modern computer science are highly demanded in academia.

Supervisor's specific requirements:

Basic knowledge of semi group theory, universal algebra, and computational complexity.

Main publications:

- Auinger, K., Dolinka, I., and Volkov, M.V. (2012), "Matrix identities involving multiplication and transposition", J. Europ. Math. Soc., vol. 14, no. 3, pp. 937–969. DOI: 10.4171/JEMS/323
- Auinger, K., Dolinka, I., and Volkov, M.V. (2012), "Equational theories of semigroups with involution", J. Algebra, vol. 369, pp. 203–225. DOI: 10.1016/j.jalgebra.2012.06.021
- Auinger, K., Chen, Y., Hu, X., Luo, Y., and Volkov, M.V. (2015), "The finite basis problem for Kauffman monoids", Algebra Universalis, vol. 74, no. 3–4, pp. 333–350. DOI: 10.1007/s00012-015-0356-x



Research supervisor:
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SYNCHRONIZING AUTOMATA AND THE ČERNÝ CONJECTURE

Research goal:

The research is related to a longstanding conjecture in the theory of finite automata: the Černý conjecture. It deals with so-called synchronizing automata that are of both theoretical interest and practical value.

Aspects studied:

- Connections between synchronizing automata and the theory of nonnegative matrices
- New upper and lower bounds for the reset threshold within some important classes of synchronizing automata
- Road coloring games

Research highlights:

The automata research team at Ural Federal University is very active and maintains many international contacts.

Career opportunities:

Specialists in automata theory are in demand in both industry and academia.

Supervisor's specific requirements:

- Knowledge of some basics of automata theory, formal languages, and computational complexity
- Programming skills will be an advantage

Main publications:

- Volkov, M. V. (2008), "Synchronizing Automata and the Černý Conjecture" in Martin-Vide, C., Otto, F., Fernau, H. (eds.), *Language and Automata Theory and Applications*, Springer-Verlag, Berlin-Heidelberg-N.Y., Germany, pp. 11–27.
DOI: 10.1007/978 3540 88282 4_4
- Ananichev, D. S., Gusev, V. V., and Volkov, M. V., (2013), "Primitive digraphs with large exponents and slowly synchronizing automata", *J. Math. Sci.*, vol. 192, no. 3, pp. 263–278.
DOI: 10.1007/s10958013 1392 8
- Fominykh, F. M., Martyugin, P. V., and Volkov, M. V. (2013), "P(1)aying for synchronization", *Int. J. FoundationsComp.Sci.*, vol. 24, no. 6, pp. 765–780.
DOI: 10.1142/S0129054113400170.
- Volkov, M. V. (2009), "Synchronizing automata preserving a chain of partial orders", *Theor. Comput. Sci.*, vol. 410, no. 37, pp. 3513–3519.
DOI: 10.1016/j.tcs.2009.03.021



Research supervisor:
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MATHEMATICAL MODELING IN PHYSIOLOGY AND MEDICINE

Research goal:

The study focuses on mathematical modeling in medical research.

Aspects studied:

- Mathematical modeling in physiology and medicine. Personalized models in cardiology
- Numerical methods for solving ordinary differential equations and partial differential equations in life sciences
- Software developing for complex systems, finite element methods, and parallel computing
- Image analysis in medical researches

Research highlights:

Projects dealing with heart functions (normal and pathological) using mathematical models, including personalized models.

Career opportunities:

- Research activity
- Teaching
- Biomedical technologies
- Biomedical engineering

Supervisor's specific requirements:

Basic knowledge of dynamic systems, basic skills in numerical calculations, and programming (within the scope of the successfully completed undergraduate program).

Main publications:

- Khokhlova, A., Iribe, G., Katsnelson, L., Naruse, K. and Solovyova, O. (2018), "The effects of load on transmural differences in contraction of isolated mouse ventricular cardiomyocytes", *J. Mol Cell Cardiol.*, vol. 114, pp. 276–287.
DOI: 10.1016/j.yjmcc.2017.12.001
- Di Achille, P., Harouni, A., Khamzin, S., Solovyova, O., John Rice, J. and Gurev, V. (2018), "Gaussian Process regressions for inverse problems and parameter searches in models of ventricular mechanics", *Frontiers in Physiology*, vol. 9, issue AUG, 1002.
DOI: 10.3389/fphys.2018.01002
- Chumarnaya, T. V., Kraeva, O. A., Tsyvian, P. B. and Solovyova, O. E. (2018), "Functional geometry of the left ventricle in term newborns with different birth weights", *Human Physiology*, vol. 44, no. 5, pp. 565–573.
DOI: 10.1134/S0362119718030040



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COMBINATORIAL OPTIMIZATION AND MACHINE LEARNING

Research goal:

The main object of the research is studying the problems being on the border between two closely related fields of modern theoretical computer science: 'Combinatorial Optimization' and 'Machine Learning'. The main topics are computational complexity and polynomial time approximation of combinatorial problems, design and implementation of learning algorithms of high generalization ability.

Aspects studied:

- Combinatorial optimization: complexity, polynomial time approximation algorithms with performance guarantees, approximation schemes, thresholds, etc.
- Machine learning: statistical learning theory, ensembles of classifiers, performance guarantees

Supervisor's specific requirements:

- Master degree in applied mathematics or computer science
- The experience of independent research in the sphere of computational complexity of algorithms and/or theory of algorithmic (machine) learning

Main publications:

- Khachay, M., Neznakhina, K. (2016), "Approximability of the minimum-weight k -size cycle cover problem", *J. of Global Optimization*, vol. 66, issue 1, pp. 65–82. DOI: 10.1007/s10898-015-0391-3
- Khachay, M., Dubinin, R. (2016), "PTAS for the Euclidean Capacitated Vehicle Routing Problem in R^d ", *LNCS9869*, pp. 193–205. DOI: 10.1007/978-3-319-44914-2_16
- Khachay, M., (2015) "Committee polyhedral separability: complexity and polynomial Approximation" *Machine Learning*, vol. 101, issue 1–3, pp. 231–251. DOI: 10.1007/s10994-015-5505-0
- Khachai, M., Neznakhina, K. (2015), "Approximability of the problem about a minimum weight cycle cover of graph", *Doklady Mathematics*, vol. 91, no. 2, pp. 240–245. DOI: 10.1134/S1064562415020313
- Khachai, M., Neznakhina, K. (2015), "A polynomial-time approximation scheme for the Euclidean problem on a cycle cover of a graph", *Proc. of Steklov Inst. of Math*, vol. 289, s. 1, pp. 111–125. DOI: 10.1134/S0081543815050107



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STOCHASTIC DYNAMICS

Research goal:

The research focuses on the challenging problem of the analysis of noise-induced phenomena in nonlinear dynamic systems. This problem is connected with the mathematical bifurcation theory, probabilistic analysis, computer simulation, and applications to the various domains of the nonlinear science.

Aspects studied:

- Theoretical study of the scenario of local and global bifurcations in nonlinear systems with regular and chaotic dynamics
- Computer modeling and visualization of stochastic dynamics and probabilistic phenomena
- Asymptotic and approximations of the stochastic attractors

Research highlights:

The goal is to train specialists able to solve the problems of modern stochastic analysis with applications in neurodynamics, population biology, macroeconomic dynamics, and biochemistry.

Supervisor's specific requirements:

Basic knowledge of differential equations, probability theory, and numerical methods.

Main publications:

- Bashkirtseva, I., Chen, G. and Ryashko, L. (2013), "Stabilizing stochastically-forced oscillation generators with hard excitation: a confidence-domain control approach", *Eur. Phys. J. B*, vol. 86, p. 437. DOI: 10.1140/epjb/e2013-40592-2
- Bashkirtseva, I., Neiman, A.B. and Ryashko, L. (2015), "Stochastic sensitivity analysis of noise-induced suppression of firing and giant variability of spiking in a Hodgkin-Huxley neuron model", *Phys. Rev. E*, vol. 91, p. 052920. DOI: 10.1103/PhysRevE.91.052920
- Bashkirtseva, I. and Ryashko, L. (2017), "Stochastic sensitivity analysis of noise-induced order-chaos transitions in discrete-time systems with tangent and crisis bifurcations", *Physica A*, vol. 467, pp. 573. DOI: 10.1016/j.physa.2016.09.048

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COMBINATORICS AND ALGORITHMIC PROPERTIES OF WORDS AND RELATED OBJECTS

Research goal:

The study focuses on the structural, numerical and algorithmic properties of sequences of symbols, together with the related properties of trees and graphs.

Aspects studied:

- Combinatorics of words
- Automata and formal languages
- Stringology
- Graph theory

Research highlights:

The research team you will join is young, very active, and highly involved in international collaboration.

Career opportunities:

Getting PhD degree from the Ural Federal University opens the way to postdoc positions in many universities.

Supervisor's specific requirements:

- A sufficient background in discrete mathematics and theoretical computer science: algorithms and complexity, automata and formal languages, graphs, combinatorics and discrete probability
- Programming skills are highly desirable

Main publications:

- Shur, A.M. (2012), "Growth properties of power-free languages", *Computer Science Review*, vol. 6, no. 5, pp. 187–208. DOI: 10.1016/j.cosrev.2012.09.001
- Rubinchik, M. and Shur, A.M. (2018), "EERTREE: An efficient data structure for processing palindromes in strings", *European Journal of Combinatorics*, vol. 68, pp. 249–265. DOI: 10.1016/j.ejc.2017.07.021
- Borozdin, K., Kosolobov, D., Rubinchik, M. and Shur, A.M. (2017), "Palindromic Length in Linear Time", *28th Annual Symposium on Combinatorial Pattern Matching (CPM 2017)*, Warsaw, Poland, July 4–6, vol. 78, pp. 23:1–23:12. DOI: 10.4230/LIPIcs.CPM.2017.23
- Kärkkäinen, J., Kempa, D., Nakashima, Y., Puglisi, S.J. and Shur, A.M. (2017), "On the Size of Lempel-Ziv and Lyndon Factorizations", *34th Symposium on Theoretical Aspects of Computer Science (STACS2017)*, Hannover, Germany, March 8–11, pp. 45:1–45:13. DOI: 10.4230/LIPIcs.STACS.2017.45
- Gourdel, G., Kociumaka, T., Radoszewski, J., Rytter, W., Shur, A. and Walen, T. (2018), "String Periods in the Order-Preserving Model", *35th Symposium on Theoretical Aspects of Computer Science (STACS2018)*, Caen, France, February 28 – March 3, vol. 96, pp. 38:1–38:16. DOI: 10.1016/j.ic.2019.104463

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MATHEMATICAL MODELING OF THE PROPERTIES OF FERROFLUIDS

Research goal:

The research is focused on the theoretical description of the static and dynamic properties of ferrofluids with the help of the mathematical methods of statistical mechanics, the computer simulations and the methods of the numerical solutions of the differential equations.

Aspects studied:

- Statistical mechanics of ferrofluids
- Structural, thermodynamic and magnetic properties of the ferrofluids
- Influence of the inter-particle interactions on the static and dynamic properties of the ferrofluids

Research highlights:

Students from this program will have an opportunity to be involved in international collaborations, present the results of the research work on the scientific conferences.

Career opportunities:

Graduated students will be specialists in the field of the theoretical and numerical methods of the description of the complex fluids. The acquired skills can be used to obtain a post-doctoral position in Universities and Research Centers in Russia and abroad.

Supervisor's specific requirements:

- Basic knowledge of thermodynamics and statistical physics
- Skills in numerical methods of computer simulations
- Skills in numerical methods of solutions of differential and non-linear equations

Main publications:

- Batrudinov, T.M., Nekhoroshkova, Yu.E., Paramonov, E.I., Zverev, V.S., Elfimova, E.A., Ivanov, A.O. and Camp, P.J. (2018), "Dynamic magnetic response of a ferrofluid in a static uniform magnetic field", *Physical Review E*, vol. 98, art. 052602. DOI: 10.1103/PhysRevE.98.052602
- Ivanov, A.O., Kantorovich, S.S., Elfimova, E.A., Zverev, V.S., Sindt, J.O. and Camp, P.J. (2017), "The influence of interparticle correlations and self-assembly on the dynamic initial magnetic susceptibility spectra of ferrofluids", *Journal of Magnetism and Magnetic Materials*, vol. 431, pp. 141–144. DOI: 10.1016/j.jmmm.2016.09.119
- Elfimova, E.A., Ivanov, A.O., Lakhtina, E.V., Pshenichnikov, A.F. and Camp, P.J. (2016), "Sedimentation equilibria in polydisperse ferrofluids: critical comparisons between experiment, theory, and computer simulation", *Soft Matter*, vol. 12, pp. 103–112. DOI: 10.1039/C6SM00304D



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NUMERICAL METHODS FOR THE SOLUTION OF THE FUNCTIONAL DIFFERENTIAL EQUATIONS

Research goal:

Many mathematical models in various scientific fields can be described by differential equations (ordinary or partial) and have the effect of heredity. As far as these objects are difficult for analytical research, the relevant problem is the development of effective numerical methods, the verification of their stability and convergence, the development and testing of the corresponding software.

Aspects studied:

- Numerical methods for the solution of the functional differential equations, the partial differential equations with delay and the fractional functional differential equations
- Theory of the positional control of systems with delay
- Theory, ensembles of classifiers, and performance guarantees

Research highlights:

The study is aimed at training specialists to be aware of theoretical and computer methods of a research of dynamic systems with heredity.

Supervisor's specific requirements:

Basic knowledge of numerical methods.

Main publications:

- Pimenov, V. and Lekomtsev, A. (2015), "Convergence of the scheme with weights for the numerical solution of a heat conduction equation with delay for the case of variable coefficient of heat conductivity", *Applied Mathematics and Computation*, vol. 256, pp. 83–93.
DOI: 10.1016/j.amc.2014.12.149
- Pimenov, V. G. and Hendy, A. S. (2015), "Numerical studies for fractional functional differential equations with delay based on BDF-type shifted Chebyshev approximations", *Abstract and Applied Analysis*, 510875, pp.1–12.
DOI: 10.1155/2015/510875
- Pimenov, V.G. and Tashirova, E.E. (2013), "Numerical methods for solving a hereditary equation of hyperbolic type", *Proceedings of the Steklov Institute of Mathematics*, vol. 281, s. 1, pp. 126–136.
DOI: 10.1134/S008154381305012X



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PARALLEL NUMERICAL METHODS FOR DIFFERENTIAL EQUATIONS

Research goal:

The research is related to elaboration of parallel numerical methods for differential equations in partial derivatives, differential equations with time delay, and fractional differential equations.

Aspects studied:

- Parallel numerical methods for differential equations in partial derivatives with time delay
- Parallel in time numerical methods for differential equations fractional differential equations
- Domain decomposition and parallel multigrid methods

Research highlights:

Skills and qualifications in parallel numerical methods are of high demand in industry. Designing aircraft fuselages, aerodynamics, and modeling of the heart muscle. This is far from a complete list of tasks where it is required to use parallel numerical methods.

Career opportunities:

Academic institutes, The Boeing Company, Intel Corporation, NASA, and many others.

Supervisor's specific requirements:

Basic knowledge of numerical methods and parallel programming.

Main publications:

- Solodushkin, S. I., Yumanova, I. F. and De Staelen, R. H. (2015), "First order partial differential equations with time delay and retardation of a state variable", *Journal of Computational and Applied Mathematics*, vol. 289, pp. 322–330.
DOI: 10.1016/j.cam.2014.12.032
- Solodushkin, S. I., Sagoyan, A. A. and Yumanova, I. F. (2017), "One Parallel Method for Solving the Multidimensional Transfer Equation with Aftereffect", *Lecture Notes in Computer Science book series*, vol. 10187, pp. 617–624.
DOI: 10.1007/978 3319 57099 0_70
- Solodushkin, S. I., Yumanova, I. F. and De Staelen, R. H. (2017), "A difference scheme for multidimensional transfer equations with time delay", *Journal of Computational and Applied Mathematics*, vol. 318, pp. 580–590.
DOI: 10.1016/j.cam.2015.12.011



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THEORETICAL STUDIES AND MATHEMATICAL MODELING OF SOFT MAGNETIC MATERIALS

Research goal:

The research is focused on studying the properties and the behavior of the new type of materials for advanced industrial and bio-medical technologies - compositions of nano- and micro-sized magnetic particles in the polymeric environment. The goal of the theoretical studies is the development of theoretical models that allow predicting the properties of these systems basing on the information about the characteristics, the form and the concentration of the particles, as well as the characteristics of the matrix containing them.

Aspects studied:

Theoretical study of phase transitions and non equilibrium phenomena in complex fluids and soft matters – polymers, colloids, magnetic colloids and compositions of these materials.

Research highlights:

The study is aimed at training specialists to be aware of theoretical and computer methods of the description of the complex composite media and materials. The research work is performed in close collaborations with scientific groups of the Dresden Technical University (Germany), Granada University (Spain), and University of Nice-Sophia Antipolice (France).

Career opportunities:

Work in the field of theoretical study and computer modeling of soft and heterogeneous materials, their industrial and biomedical applications.

Supervisor's specific requirements:

- Basic knowledge of thermodynamics and statistical physics
- Skills in numerical methods of solutions of differential and non-linear equations

Main publications:

- Lopez-Lopez, M. T., Rodriguez-Arco, L., Zubarev, A., Kuzhir, P. and Iskakova, L., "Fernando Gonzalez-Caballero, N-like rheograms of concentrated suspensions of magnetic particles", J. Rheology, vol. 60, no. 2, pp. 267–274.
DOI: <http://dx.doi.org/10.1122/1.4942232>
- Orlandi, G., Kuzhir, P., Izmaylov, Y., Alves Marins, J., Ezzaier, H., Robert, L., Doutre, F., Noblin, X., Lomenech, C., Bossis, G., Meunier, A., Sandoz, G. and Zubarev, A. (2016), "Microfluidic separation of magnetic nanoparticles on an ordered array of magnetized micropillars", Physical Review E, vol. 93, 062604.
DOI: [10.1103/PhysRevE.93.062604](https://doi.org/10.1103/PhysRevE.93.062604)

- Ezzaier, H., Alves Marins, J., Razvin, I., Abbas, M., Ben Haj Amara, A., Zubarev, A. and Kuzhir, P. (2017), "Two-stage kinetics of field-induced aggregation of medium-sized magnetic nanoparticles", The Journal of Chemical Physics, vol. 146, 114902.
DOI: <http://dx.doi.org/10.1063/1.4977993>
- Bonhome-Espinosa, B., Campos, F., Rodriguez, I. A., Carriel, V., Marins, J. A., Zubarev, A., Duran, J. D. G. and Lopez-Lopez, M. T. (2017), "Effect of particle concentration on the microstructural and macromechanical properties of biocompatible magnetic hydrogels", Soft Matter 13, 2928.
DOI: [10.1039/c7sm00388a](https://doi.org/10.1039/c7sm00388a)



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MODELING AND STUDY OF STOCHASTIC PROBLEMS

Research goal:

The research is devoted to study of stochastic problems, that is initial and boundary problems for equations that are modeled with allowance for random perturbations. Such equations are called stochastic. The huge interest to the problems is related to the important role of random factors in the processes surrounding us, especially, in physics, biology, and financial mathematics. Models that give an accurate description of these processes lead to stochastic equations in finite and infinite dimensional spaces.

Aspects studied:

- Modeling and investigations of the Cauchy problem for stochastic equations
- Application of semigroup, regularization, and distribution methods for solving well-posed and ill-posed stochastic problems
- Application of interrelations between stochastic problems and PDEs for probabilistic characteristic of random processes that are described by stochastic equations

Research highlights:

The research is focused on training specialists in mathematical methods for modeling and solving stochastic problems that take in consideration different random perturbations in physics, biology, and financial mathematics.

Supervisor's specific requirements:

Basic knowledge of functional analysis and probability theory (within the scope of the successfully completed undergraduate program).

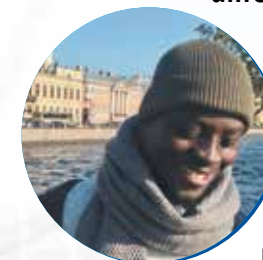
Main publications:

- Melnikova, I.V. and Filinkov, A. I. (2001), The Cauchy problem. Three approaches Monographs and Surveys in Pure and Applied Mathematics, 120, Washington: Chapman & Hall/CRC, London, New York, UK, 260 p. ISBN 9780367397470
- Melnikova, I.V. (2015), "Generalized Solutions to Stochastic problems as Regularized in a Broad Sense", 10th ISAAC Congress, 3–8 August 2015, Macau, China, pp. 51–57. DOI: 10.1007/978-3-319-48812-7_7
- Melnikova, I.V. (2016), Stochastic Cauchy Problems in Infinite Dimensions. Regularized and Generalized Solutions, CRC Press: London–New York, UK. ISBN 9781482210507
- Melnikova, I. V. and Alekseeva, U. A. (2018), "Semigroup Classification and Gelfand–Shilov Classification of Systems of Partial Differential Equation", Mathematical Notes, vol. 104, no. 6, pp. 98–111. DOI: 10.1134/S0001434618110329

James Okrah (Ghana)

It has been a **tremendous experience** for me so far doing my Phd in Ural Federal University. The **Department of Regional and international Economics** with its plans and policies has made research very interesting for me as a phd student and a **Junior research Fellow**.

My supervisor has been a **great source of inspiration** and he has exposed me to a greater height of good research. Because of my Supervisor, I have the **opportunity to learn from different professors from different countries** who share my passion for innovation and education. To me it is a **blessing to be working with such a man who has passion and love for research and has a great desire for knowledge**.



*Adven Masih (Pakistan) and
Haula Kitonsa (Uganda)
PhD candidates in Computer Science
and Facilities brainstorming*

Duration of study: 4 years

Language: English or Russian

Entry requirements:

- Master's degree (or equivalent) in the related field
- B2 level of English or Russian
- Interview

Entrance exams:

- Foreign language (English/German/French)
- Computer science and computer facilities

Government scholarship is available.

See more information at:

urfu.ru



Research



Doctoral Programs in English



Research supervisor:

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MACHINE LEARNING AND BIG DATA PROCESSING

Research goal:

The research is related to applications of machine learning and big data analysis algorithms to various field including computer vision, medical imaging, natural language processing, digital humanities and so on.

Aspects studied:

- Social networks data analysis
- Classification and segmentation of medical images
- Machine learning in Finance and FinTech
- Data driven decision making

Research highlights:

- Research in natural language processing is conducted in cooperation with Max Planck Institute for Mathematics, Germany
- The partner for research in FinTech is Sberbank, the biggest Russian bank.

Career opportunities:

- International Internet companies
- Banks and Finance Industry
- Telecom Companies
- Machine Learning and Artificial Intelligence Startups

Supervisor's specific requirements:

Basic knowledge of machine learning and deep learning, experience in computer vision, natural language processing or time series analysis. Fluency in Python (preferred), C++ or Java.

Main publications:

- Sozykin, A. and Epanchintsev, T. (2015), "MIPr – a framework for distributed image processing using Hadoop", 9th IEEE International Conference on Application of Information and Communication Technologies, AICT 2015, 14–16 October, Rostov-on-Don, Russia, pp. 35–39.
- Sozykin, A., Epanchintsev, T., Zverev, V., Khamzin, S. and Bersenev, A. (2016), "Automated Parallel Simulation of Heart Electrical Activity Using Finite Element Method", Lecture Notes in Computer Science, vol. 10049, pp. 365–372.
- Krasnobaev, A. and Sozykin, A. (2016), "An Overview of Techniques for Cardiac Left Ventricle Segmentation on Short-Axis MRI", ITM Web of Conferences, vol. 8.



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MATHEMATICAL MODELING, NUMERICAL METHODS AND PROGRAM COMPLEXES MANAGEMENT IN SOCIAL AND ECONOMIC SYSTEMS

Research goal:

The research focuses on quantitative approach to problems of decision-making and control under uncertainty and risk.

Aspects studied:

The research area covers problems of mathematical modeling in decision making and of cooperative dynamics in organizational systems by means of theory of guaranteed control-estimation under uncertainty.

Research highlights:

- Information structure appropriate for route planning of team (formation) consisting of objects with constrained dynamics. Research is inspired by problems of guidance and navigation for autonomous surface vehicles aimed at development of algorithms and software for navigation in complicated circumstances
- Explicit description of Modernization Management procedures for industrial enterprises in high-tech engineering branch. Chaotic effects of market behaviour determine relevance of research in terms of uncertainty. Long cycles of design and manufacturing as a feature of engineering industry allow to formulate an optimization problem in terms of guaranteed approach

Career opportunities:

- Innovative enterprises in high-tech industry and engineering
- Governmental and financial analysis institutions

Supervisor's specific requirements:

Sufficient level of Math.

Main publications:

- Kruglikov, S. V. (2011), "Structural Properties of Guaranteed Control-Estimation Problems for Hierarchical Systems", The 5th International Conference on Physics and Control (PhysCon 2011), September 5–8, León, Spain.
<http://lib.physcon.ru/doc?id=0838a557d81f>
- Kruglikov, S. V. and Kruglikov, A. S. (2014), "An A Priori Planning of Joint Motions for USV as a Problem of Guaranteed Control/Estimation", Applied Mechanics and Materials, vol. 494–495, pp. 1110–1113.
DOI: 10.4028/www.scientific.net/AMM.494–495.111
- Podluzhnyy, S. and Kruglikov, S. (2015), "Searching for the Credit Portfolio Structure and Building Portrait of Prospective Borrower", 16th IFAC Workshop on Control Applications of Optimization (CAO 2015), 6–9 October, Garmisch-Partenkirchen, Germany, vol. 48, Issue 25, pp. 231–235.
DOI: 10.1016/j.ifacol.2015.11.092



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SYSTEMS ANALYSIS, INFORMATION PROCESSING AND CONTROL IN ECONOMIC, SOCIAL AND ECOLOGICAL SYSTEMS

Research goal:

The research is devoted to the problems of development and use of the methods of systems analysis of complex applied subjects of study, information processing, human influence on the subjects of study including the issues of analysis, modeling, optimization, improving management, and decision-making.

Aspects studied:

- Optimization
- Econophysics
- Ecology
- Agent-based models
- Financial networks
- Local payment systems
- Blockchain technique
- Big Data

Research highlights:

- Practical applications
- Interdisciplinary program

Career opportunities:

- Local cooperative community development
- Improvement of corporate culture
- FinTech and Big Data opportunity

Supervisor's specific requirements:

- Data analysis experience
- Skills in programming
- Blockchain experience
- Scientific publications (any 3 of 4 points)

Main publications:

- Berg, D. B. and Zvereva, O. M. (2015), "Identification of autopoietic communication patterns in social and economic networks", Communications in Computer and Information Science, vol. 542, pp. 286–294.
DOI: 10.1007/978-3-319-26123-2_28
- Berg, D. B., Shelomentsev, A. G., Khatmullina, O. I. and Taubayev, A. (2016) "Negative Interest Rates Policy, Economic Crisis and Environmental Management", 16th International Multidisciplinary Scientific GeoConference SGEM 2016, Albena, Bulgaria, June 28 – July 6, 2016, book 5, vol. 3, pp. 389–396.
DOI: 10.5593/SGEM2016/B53/S21.050. 15.02.17.
- Berg, D. B. and Simos, T. E. (2017), "High order computationally economical sixstep method with vanished phase-lag and its derivatives for the numerical solution of the Schrödinger equation", Journal of Mathematical Chemistry, vol. 55, pp. 987–1013.
DOI: 10.1007/s10910-016-0714-8
- Berg, D. B. and Zvereva, O. M. (2014), The program complex "Agent-based model of communication" (Communication model), Russian Federation, Pat. № 014618909.



Research supervisor:
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MATHEMATICAL MODELING, NUMERICAL METHODS AND PROGRAM COMPLEXES

Research goal:

The research is devoted to the development of fundamental principles and use of mathematical modeling, numerical methods and program complexes for solving fundamental and applied research problems in economics, technology and other areas. All works prepared within the frames of the research are to contain the original results from three areas: mathematical modeling, numerical methods and program complexes.

Aspects studied:

- Boundary-initial problems
- Nonlinear partial differential equations
- Series, heat transfer
- Permafrost
- Stefan problem

Research highlights:

Research is carried out in close cooperation with oil and gas industry enterprises.

Career opportunities:

The research carried out during the writing of the thesis will allow graduate students to work in scientific subdivisions of enterprises associated with the development of oil and gas fields and construction in the permafrost zone and also work in enterprises that are engaged in the design of geothermal stations.

Supervisor's specific requirements:

- Knowledge in computational mathematics and in theory of partial differential equations
- Programming skills in C++

Main publications:

- Filimonov, M. Yu. and Vaganova, N. A. (2019), "Simulation of Influence of Special Regimes of Horizontal Flare Systems on Permafrost", Lecture Notes in Computer Science, vol. 11386, pp. 233–240.
DOI: 10.1007/978-3-030-11539-5_25
- Vaganova, N. A. and Filimonov, M. Yu. (2019), "Simulation of Cooling Devices and Effect for Thermal Stabilization of Soil in a Cryolithozone with Anthropogenic Impact", Lecture Notes in Computer Science, vol. 11386, pp. 580–587.
DOI: 10.1007/978-3-030-11539-5_68

- Filimonov, M. Yu. (2019), "Representation of solutions of boundary value problems for nonlinear evolution equations by special series with recurrently calculated coefficients", Journal of Physics: Conf. Series, vol. 1268, pp. 012071.
DOI: 10.1088/1742-6596/1268/1/012071
- Filimonov, M. Yu. and Vaganova, N. A. "Simulation of Technogenic and Climatic Influences in Permafrost", Lecture Notes in Computer Science, vol. 9045, pp. 178–185.
DOI: 10.1007/978 3319 20239 6_18
- Vaganova, N. A. and Filimonov, M. Yu. (2015), "Computer simulation of nonstationary thermal fields in design and operation of northern oil and gas fields", AIP Conf. Proc., vol. 1690, 020016.
DOI: 10.1063/1.4936694
- Filimonov, M. Yu. and Vaganova, N. A. (2016) "Simulation of permafrost changes due to technogenic influences of different engineering constructions used in northern oil and gas fields", Journal of Physics: Conference Series, vol. 754, 112004.
DOI: 10.1088/1742-6596/754/11/112004
- Vaganova, N. A. and Filimonov, M. Yu. (2017), "A General Model of an Open Geothermal System", IOP Conf. Series: Journal of Physics: Conf. Series, vol. 820, 012010.
DOI: m10.1088/1742-6596/820/1/012010
- Filimonov, M. and Vaganova, N. (2017), "Numerical Simulation of Technogenic and Climatic Influence on Permafrost", Advances in Environmental Research, vol. 54, pp. 117–142.
ISBN: 978-1-53610-667-1



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SIGNAL PROCESSING FOR BIOMEDICAL ENGINEERING

Research goal:

Development of methods and software of different modality signals joint assessment for functional human research.

Aspects studied:

- Biomedical engineering
 - Processing of biomedical signals
 - Intelligent interfaces
- Nonlinear dynamics

Research highlights:

Investigation of the biomedical signals which are formed by functional processes of the human using functional diagnostics devices.

Development of software and algorithmic solutions to ensure the detection and quantitative evaluation of information patterns of biomedical signals.

Career opportunities:

An opportunity to acquire skills suitable for a research career in the exciting and growing field of information technologies for human health and wellness.

Supervisor's specific requirements:

- Basic knowledge of biomedical engineering or medical physics.
- Programming skills.

Main publications:

- Borisov, V., Syskov, A., and Kublanov, V. (2019), "Functional state assessment of an athlete by means of the brain-computer interface multimodal metrics", IFMBE Proceedings, vol. 68, no. 3, pp. 71–75.
DOI: 10.1007/978-981-10-9023-3_13
- Kublanov, V.S., Borisov, V.I., and Dolganov, A.Y. (2016), "Application of Multifractal Formalism in Study of the Role of Autonomic Regulation in Formation of Intrinsic Electromagnetic Radiation of the Brain", Biomedical Engineering, vol. 50, no. 1, pp. 30–34.
DOI: 10.1007/s10527-016-9581-7
- Borisov, V., Minin, A., Syskov, A. and Basko, V. (2018), "FHIR Data Model for Intelligent Multimodal Interface", 26th Telecommunications Forum – TELFOR2018, 20–21 November, Belgrade, Serbia, pp. 699–702.
DOI: 10.1109/TELFOR.2018.8611918



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SYSTEMS ANALYSIS, INFORMATION MANAGEMENT AND PROCESSING

Research goal:

The studies carried out within the frames of this research result in the development of new and improvement of existing methods and means of analysis of information processing and managing complex systems, as well as increasing efficiency of reliability and quality of technical systems.

Aspects studied:

- Fundamental and applied research on the system integration
- Expert systems and knowledge management systems
- Knowledge-based technologies
- Data science, big data, analytics, data acquisition, and management.
- Nanotechnology and neural networks

Research highlights:

- The studies are conducted in cooperation with the leading universities of South Korea and Kazakhstan
- Our research group seeks to conduct multi-disciplinary pre-competitive research in system analysis, information management, and processing

Career opportunities:

- We support your research skills and professional development through a range of training initiatives, resources and courses. For research students, our study offers the necessary skills to further your career, including courses such as scientific writing, presentation skills, project management, entrepreneurship, and communicating science to the public. Professional bodies organize various events and courses, some of which are aimed at postgraduate students. You may also be able to take advantage of opportunities to network with potential future employers, or train to become a graduate teaching assistant
- Rigorous academic standards ensure that your qualifications will be recognized and valued by professional organizations and employers throughout the world

Main publications:

- Kim, A., Kormyshev, V., Kwon, H., Safronov, M., and Tarasyev, A. (2015), "HIVinfection modeling", IFAC-Proceding Volumes, pp. 206–209.
DOI: 10.1016/j.ifacol.2015.11.086
- Kim, A., Kormyshev, V., Kwon, H., Safronov, M., and Tarasyev, A. (2015), "Results of HIV-infection model stabilization", IFAC-Proceding Volumes, pp. 210–213.
DOI: 10.1016/j.ifacol.2015.11.087
- Kim, A., Kormyshev, V., Kwon, H., Safronov, M., and Tarasyev, A. (2015), "HIVinfection model stabilization", IFAC-Proceding Volumes, pp. 214–217.
DOI: 10.1016/j.ifacol.2015.11.088
- Kormyshev, V. M., Medvedeva, M. A., Naboychenko, E. S., Prisyazhnyy, A. V., and Shamanov, A. P. (2016), "Detection of Failures in a Stator of Turbo-Generator on Early Stages of Their Evolution", AIP Conference Proceedings, vol. 1738.
DOI: 10.1063/1.4951877



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MATHEMATICAL MODELING, NUMERICAL METHODS AND PROGRAM COMPLEXES

Research goal:

Development of mathematical probabilistic models of economic and social processes.

Aspects studied:

- Modeling of competitive markets
- Modeling of consumer behavior
- Valuation of intangible capital
- Evaluation of the effectiveness of IT services
- Optimization of HFT trading strategies

Research highlights:

- Extensive use of mathematical methods and computer modeling
- Orientation on the practical use of the results obtained

Career opportunities:

Practical use of the results obtained within the framework of real consulting projects.

Supervisor's specific requirements:

- A good knowledge of higher mathematics (in particular, probability theory, differential equations, and statistics)
- Good computer skills
- Programming skills are welcomed

Main publications:

- Nizovtseva, I. and Sinitsyn, E. (2014), "Automated methodology combining assessments and developing solutions about interaction", Applied Mathematical Sciences, vol. 8, no. 61, pp. 3035–3041.
DOI: 10.12988/ams.2014.44254
- Bostrem, I. G., Ovtchinnikov, A. S., Sinitsyn, E. V. (2004), "Topological stripelike coreless textures with inner incommensurability in two-dimensional Heisenberg antiferromagnet", Phys. Rev. B, vol. 70, issue 18, 184406.
DOI: 10.1103/PhysRevB.70.184406



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MATHEMATICAL MODELING OF STOCHASTIC SYSTEMS

Research goal:

The aim is to train specialists in the field of mathematical modeling and monitoring of complex stochastic systems (including in economics and medicine), in applied statistics and multidimensional statistical analysis.

Aspects studied:

- Entropy modeling and control of multidimensional stochastic systems
- Methods of multivariate statistical analysis and diagnostics of complex system
- Methods of dependencies identification
- Risk-analysis of complex multidimensional systems

Research highlights:

- Entropy modeling for multidimensional stochastic systems
- Recognition of dependencies on the basis of structural differential schemes and inverse mapping.
- Robust method of diagnostic model identification on the basis of the least absolute deviations method.
- Diagnostics of complex systems using multidimensional statistical analysis methods
- Monitoring and risk management models in multidimensional stochastic systems

Supervisor's specific requirements:

- Knowledge of mathematics according to the university course
- Programming skills

Main publications:

- Tyrsin, A. N. (2016), Entropy modeling of multidimensional stochastic systems, Voronezh, Russian Federation, 156 p.
ISBN: 978-5-98222-890-1
- Panyukov, A. V. and Tyrsin, A. N. (2008), "Stable parametric identification of vibratory diagnostics objects", Journal of Vibroengineering, vol. 10, no. 2, pp. 142–146.
<https://www.jvejournal.com/article/10181>
- Tyrsin, A. N. and Serebryanskii, S. M. (2015), "Dependence identification in a time series on the basis of structural difference schemes", Optoelectronics, Instrumentation and Data Processing, vol. 51, no. 2, pp. 149–154.
DOI: 10.3103/S8756699015020077
- Tyrsin, A. N. and Gevorgyan, G. G. (2017), "Entropy management of Gaussian stochastic systems", Journal of Computational and Engineering Mathematics., vol. 4, no. 4, pp. 38–52.
DOI: 10.14529/jcem170404
- Tyrsin, A. N. and Surina, A. A. (2018), "Monitoring of risk of multidimensional stochastic system as tools for a research of sustainable development of regions", IOP Conference Series: Earth and Environmental Science, vol. 177, 012005, pp. 1–8.
DOI: 10.1088/1755-1315/177/1/012005



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RADIO SYSTEMS OF MICROWAVE AND MM-WAVE RANGES

Research goal:

Obtain knowledge and skills for independent research.

Aspects studied:

- Short-range radar, self-oscillating systems and autodynes
- Theory of self-oscillations in radio engineering
- Receiving and transmitting devices in the communication and radar systems

Research highlights:

The results of the research can be prepared in the form of a completed dissertation related to the development of microwave receiving modules and their application for short-range radar tasks, non-contact measurement of process parameters and communications.

Career opportunities:

Future scientific career is connected with the possibility of independently continuing the development of this direction.

Supervisor's specific requirements:

Knowledge of the theory and technology of microwave, as well as possess experience in calculation and design of microwave circuits using modern computer programs.

Main publications:

- Noskov, V. Ya., Ignatkov, K. A. and Chupahin, A. P. (2016), "Application of Two-Diode Autodynes in Devices for Radiowave Control of Product Dimensions", *Measurement Techniques*, vol. 59, no 7, pp. 715–721. DOI: 10.1007/s11018-016-1035-9.
- Noskov, V. Ya., Vasiliev, A. S., Ermak, G. P., Ignatkov, K. A. and Chupahin, A. P. (2017), "Fluctuation Features of Autodyne Radar with Frequency Modulation", *Radioelectronics and Communications Systems*, vol. 60, no. 3, pp. 123–131. DOI: 10.20535/S0021347017030049
- Noskov, V. Ya., Ignatkov, K. A., Chupahin, A. P., Vasiliev, A. S., Ermak, G. P. and Smolskiy, S. M. (2017), "Signals of Autodyne Sensors with Sinusoidal Frequency Modulation", *Radioengineering: Proceedings of Czech and Slovak Technical Universities and URSI Committers*, vol. 26, no. 4, pp. 1182–1190. DOI: 10.13164/re.2017.1182.
- Noskov, V. Ya., Ignatkov, K. A. and Chupahin, A. P. (2018), "Autodyne Effect of the System Involving Two Mutually Synchronized Oscillators under Strong Coupling", *Journal of Communications Technology and Electronics*, vol. 63, no. 2, pp. 180–188. DOI: 10.1134/S1064226918020080.
- Noskov, V. Ya. and Ignatkov, K. A. (2016), "Noise characteristics of autodynes with frequency stabilization by means of an external high-Q cavity", *Journal of Communications Technology and Electronics*, vol. 61, no. 9, pp. 1052–1063. DOI: 10.1134/S1064226916090102



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SYSTEM ANALYSIS AND MODELING

Research goal:

The study is aimed at formulating theoretical foundations, models, methods and software packages for decision-making in various areas.

Aspects studied:

- Decision support of business processes
- Logistics and manufacturing based on system analysis
- Simulation and intelligent systems
- Artificial intelligence
- Scheduling and control

Research highlights:

- Applying methods of system analysis and synthesis, decision-making, calculation experiments, and numerical methods
- Research and design of hybrid modeling and decision-making methods
- Big Data processing, knowledge processing

Career opportunities:

Obtaining skills of business analytics, consultants, task-setters, interdisciplinary project researchers

Supervisor's specific requirements:

- Skills for programming and design of databases, experience of working with data analysis systems, imitation modeling and decision-making systems.

Main publications:

- Aksyonov, K. A., Bykov, E. A., Aksyonova, O. P., Nevolina, A. L. and Goncharova, N. V. (2016), "Extension of the multi-agent resource conversion processes model: Implementation of agent coalitions", *International Conference on Advances in Computing, Communications and Informatics*, Jaipur, India, September 21–24, 2016, 7732110, pp. 593–597. DOI: 10.1109/ICACCI.2016.7732110
- Aksyonov, K. A., Bykov, E. A., Aksyonova, O. P., Goncharova, N. V. and Nevolina, A. L. (2016), "Application of the hybrid agents technology for control of the construction company", *WCECS2016 – World Congress on Engineering and Computer Science 2016*, San Francisco, USA, 19–21 October, 2016, vol. 2225, pp. 159–164. ISBN: 978-988140471-8



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PARALLEL ALGORITHMS FOR SOLVING THE GEOPHYSICAL PROBLEMS ON MULTIPROCESSOR COMPUTING SYSTEMS

Research goal:

The study is aimed at constructing fast direct and iterative methods and parallel algorithms for solving systems of linear and nonlinear equations applied to inverse geophysical problems and multicomponent diffusion problem with implementation for parallel computing systems and the development of software packages for efficient computing on parallel computing systems.

Aspects studied:

- Parallel direct algorithms for solving linear systems with block matrices on multicore and graphic processors
- Iterative gradient methods and parallel algorithms for solving inverse geophysical problems on parallel computing systems

Research highlights:

- Efficient methods and parallel algorithms for solving the SLAE with special block matrices in the geoelectrics and diffusion problems
- Fast and memory efficient gradient type methods for solving the inverse geophysical problems
- Parallel algorithms and software package for multicore CPUs and graphics GPUs processors incorporated in the Uran supercomputer on the basis of constructed methods

Career opportunities:

Computer science and solving applied problems in various spheres.

Supervisor's specific requirements:

It is necessary to be skilled in programming multicore CPUs and graphics GPUs processors.

Main publications:

- Akimova E. N., Belousov D. V. (2012), "Parallel algorithms for solving linear systems with block-tridiagonal matrices on multicore CPU with GPU", *Journal of Computational Science*, vol. 3, issue 6, pp. 445–449.
DOI: 10.1016/j.jocs.2012.08.004
- Akimova E. N., Belousov D. V., Misilov V. E. (2013), "Algorithms for solving inverse geophysical problems on parallel computing systems", *Numerical Analysis and Applications*, vol. 6, issue 2, pp. 98–110.
DOI: 10.1134/S199542391302002X

- Akimova E. N., Martyshko P. S., Misilov V. E. (2013), "Algorithms for solving the structural gravity problem in a multilayer medium", *Doklady Earth Sciences*, vol. 453, issue 2, pp. 1278–1281.
DOI: 10.1134/S1028334X13120180
- Akimova E. N., Martyshko P. S., Misilov V. E., Kosivets R. A. (2016), "An efficient numerical technique for solving the inverse gravity problem of finding a lateral density", *Applied Mathematics and Information Sciences*, vol. 10, no. 5, pp. 1681–1688.
DOI: 10.18576/amis/100506



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SYSTEM ANALYSIS, INFORMATION PROCESSING, SIMULATIONS, SOFTWARE ENGINEERING

Research goal:

In-depth study and understanding of system analysis, information processing, simulations, software engineering in various spheres

Aspects studied:

- System analysis, information management and processing
- Mathematics and software of computers complexes and computer networks
- Mathematical modeling, numerical methods and software complexes
- Theoretical foundations of informatics

Research highlights:

- focusing on both scientific research works and applications
- scientific cooperation with leading foreign scientists
- training of highly qualified scientific personnel in demand in science, education, industry and finance sphere

Career opportunities:

Employment in scientific, educational, industrial and financial structures of the Russian Federation.

Supervisor's specific requirements:

- Dedication, discipline, hard work
- Knowledge of programming languages and database management
- Experience of working in the field of data analysis
- Knowledge of software tools for modeling complex systems and processes.

Main publications:

- Kleeorin, Y., Safullin, N., Kleeorin, N., Porshnev, S., Rogachevskii, I. and Sokoloff, D. (2016), "The dynamics of Wolf numbers based on nonlinear dynamo with magnetic helicity: Comparisons with observations", *Monthly Notices of the Royal Astronomical Society*, vol. 460, no. 4, pp. 3960–3967. DOI: 10.1093/mnras/stw1267
- Zyuzin, V. V., Porshnev, S. V., Bobkova, A. O. and Bobkov, V. V (2016), "Studying features characterizing signatures of medical contours of the left ventricle on ultrasound images", *Pattern Recognition and Image Analysis*, vol. 26, no. 3, pp. 665–672. DOI: 10.1134/S1054661816030251
- Borodin, A., Mirvoda, S., Kulikov, I. and Porshnev, S. (2017), "Optimization of memory operations in generalized search trees of PostgreSQL", *Communications in Computer and Information Science*, vol. 716, pp. 224–232. DOI: 10.1007/978-3-319-58274-0_19
- Kiselev, Y., Ustalov, D. and Porshnev, S. (2016), "Eliminating fuzzy duplicates in crowdsourced lexical resources", *The 8th Global WordNet Conference*, Bucharest, Romania, January 27–30, 2016, pp. 161–167. ISBN: 978-973020728-6



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HIGH FREQUENCY DEVICES AND ANTENNAS

Research goal:

The study is aimed at obtaining a broad range of knowledge and skills related to high frequency devices and antennas.

Aspects studied:

- Electromagnetic theory and techniques
- Microstrip antennas and antenna arrays
- Antenna radomes
- Metamaterials utilization in microwave devices
- Electromagnetic scattering

Research highlights:

- Significant decrease of MW devices by means of usage of meta-structures
- Software with significantly higher productivity as compared to traditional software
- Designing effective antennas for various purposes

Career opportunities:

Companies related to designing software, devices, equipment and systems for microwave technology.

Supervisor's specific requirements:

Knowledge of electrodynamics and mathematics at an adequate level.

Main publications:

- Knyazev, S., Korotkov, A., Panchenko, B. and Shabunin, S. (2016), "Investigation of spherical and cylindrical Luneburg lens antennas by the Green's function method", *Conference Series: Materials Science and Engineering*, vol. 120, no. 1, 012011. DOI: 10.1088/1757-899X/120/1/012011
- Karpov, A., Knyazev, S., Lesnaya, L. and Shabunin, S. (2016), "Sandwich spherical and geodesic antenna radomes analysis", *10th European Conference on Antennas and Propagation, EuCAP 2016, Davos, Switzerland, 10–15 April 2016*, 7481389. DOI: 10.1109/EuCAP.2016.7481389
- Abdullin, R., Mitelman, Yu. and Shabunin, S. (2014), "Radiation Pattern of Leaky-Wave Antenna Based on Partially-Filled Rectangular Waveguide", *2014 Loughborough Antennas and Propagation Conference (LAPC), Loughborough, UK, 10–11 November 2014*, pp. 516–518. DOI: 10.1109/LAPC.2014.6996438

A photograph of a long, arched trellis covered in green and red leaves, leading to a bright opening at the end of a path. The trellis is made of dark metal or wood and is covered with dense foliage. The leaves are in various stages of autumn, with some being bright green and others turning red or purple. The path is made of gravel and is covered with fallen leaves. The background is bright and overexposed, suggesting a sunny day. The overall scene is peaceful and scenic.

Natural Sciences

*Aftab Alam Mohammad (India)
a doctoral candidate in Physics
and Astronomy and his supervisor
Professor Vladimir Ya. Shur
working on the research*

Duration of study: 4 years

Language: English or Russian

Entry requirements:

- Master's degree (or equivalent) in the related field
- B2 level of English or Russian
- Interview

Entrance exams:

- Foreign language (English/German/French)
- Physics and astronomy

Government scholarship is available.

See more information at:

urfu.ru



Research



Doctoral Programs in English



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THERMOPHYSICS AND THEORETICAL THERMOTECNICS

Research goal:

Development of physics and mathematical models of transport phenomena in gas mixtures and motion of highly disperse aerosols in inhomogeneous gases.

Aspects studied:

- The kinetic theory of motion of rarefied single-component gases and gas mixtures in capillaries under the influence of pressure, temperature and concentration gradients, as well as resonant optical radiation
- Kinetic theory of motion of fine aerosols in inhomogeneous gases

Research highlights:

Within the research we will be using analytical and numerical methods for solving the Boltzmann equation.

Career opportunities:

Defense of the thesis and further advancement in the field of science and education. The obtained knowledge can be applied in the development of vacuum technology, the design of separation of gas mixtures and monitoring of the state of the atmosphere.

Supervisor's specific requirements:

- Basic knowledge of hydrodynamics and kinetic theory of gases
- Basic knowledge of numerical methods for solving differential equations

Main publications:

- Chernyak, V. G. and Sograbi, T. V. (2019), "The role of molecule-surface interaction in thermophoresis of an aerosol particle", J. Aerosol Sci., vol. 128, pp. 62–71. DOI: 10.1016/j.jaerosci.2018.11.012
- Chernyak, V. G. and Polikarpov, A. P. (2010), "Light induced drift and heat transfer of onecomponent gas in a capillary", Journal of Statistical Physics, vol. 140, pp. 504–517. DOI: 10.1007/s10955-010-0001-1
- Chermyaninov, I.V. and Chernyak, V.G. (2014), "Thermo-optical pressure difference in onecomponent gas", Physics of Fluids, vol. 26, no. 9, pp. 092001. DOI: 10.1063/1.4894200
- Chermyaninov, I.V. and Chernyak, V.G. (2016), "Light-induced phenomena in one-component gas: The transport phenomena", Physics of Fluids, vol. 28, no 9, pp. 092007. DOI: 10.1063/1.4963114

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RADIATION PHYSICS AND SPECTROSCOPY OF ION BEAM SYNTHESIZED MATERIALS AND NANOCOMPOSITES FOR OPTOELECTRONIC APPLICATIONS

Research goal:

The study is aimed at training specialists in the field of condensed matter physics, especially the optical and luminescent properties of insulators containing point defects and nanoclusters.

Aspects studied:

Radiation physics and spectroscopy of ion-beam synthesized materials and nanocomposites for optoelectronic applications.

Research highlights:

A scientific group (Photonics & Optoelectronics) studies radiation physics and spectroscopy of disordered and low-sized systems (glasses, single crystals, thin films, quantum dots). In the framework of an international collaboration project, the team performs world-class research on optical, luminescent and electron emission properties of various host matrices containing nanometer scale particles formed by high-energy pulsed ion-beam irradiation. The host Institute of Physics and Technology offers access to IR-X-Ray range spectrometers, XRD, XPS and UPS characterization instruments, electron microscopy laboratory and ionizing radiation sources.

Career opportunities:

Upon achieving a candidate of science degree, the applicant has wide career opportunities in the institute including participation in many scientific projects and/or giving courses for students. In future, it is possible to occupy associate/full professor position.

Supervisor's specific requirements:

- MSc degree in experimental physics
- Theory/computer modeling background is also appreciated

Main publications:

- Zatsepin, A., Kuznetsova, Y., Zatsepin, D., Boukhvalov, D., Gavrilov, N. and Koubisy, M. (2019), "Electronic Structure and Optical Absorption in Gd-Implanted Silica Glasses", *Physica Status Solidi (a)*, vol. 216, no. 3, pp. 1800522. DOI: 10.1002/pssa.201800522

- Zatsepin, A. F., Zatsepin, D. A., Boukhvalov, D. W., Kuznetsova, Yu. A., Gavrilov, N. V., Shur, V. Ya., and Esin, A. A. (2019), "Local atomic configurations, energy structure, and optical properties of implantation defects in Gd-doped silica glass: An XPS, PL, and DFT study", *Journal of Alloys and Compounds*, vol. 796, pp. 77–85. DOI: 10.1016/j.jallcom.2019.04.303
- Zatsepin, A., and Kuznetsova, Y. (2018), "Down-conversion of UV radiation in erbium-doped gadolinium oxide nanoparticles", *Applied Materials Today*, vol.12, pp. 34–42. DOI: 10.1016/j.apmt.2018.04.001
- Zatsepin, A. F. and Biryukov, D. Yu. (2017), "The temperature behavior and mechanism of exciton luminescence in quantum dots", *Physical Chemistry Chemical Physics*, 19,28, pp. 18721–18730. DOI: 10.1039/C7CP03357E
- Zatsepin, A. F., and Buntov, E. A. (2013), "Synchrotron-Excited Photoluminescence Spectroscopy of Silicon- and Carbon-Containing Quantum Dots in Low Dimensional SiO₂ Matrices", *Silicon-based nanomaterials*, pp. 89–117. DOI: 10.1007/978-1-4614-8169-0_5
- Zatsepin, A. F., Biryukov, D. Y., and Slesarev, A. I. (2016), "Disordering effect on electronic mechanism of thermal destruction of GeE'-centers in glassy GeO₂", *Journal of Non-Crystalline Solids*, vol. 441, pp. 16–21. DOI: 10.1016/j.jnoncrysol.2016.03.008



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PHYSICS OF FERROELECTRICS AND RELATED MATERIALS

Research goal:

This research focuses on the experimental study of the ferroelectric domain structure, kinetics of the phase transformations and domain engineering, among other topics.

Aspects studied:

- Experimental study of the ferroelectric domain structure and its evolution in single crystals and ceramics
- Kinetics of the phase transformations
- Micro- and nanodomain engineering

Research highlights:

- The students will have access to modern analytical and technological equipment
- Wide collaboration with leading international scientific centers
- The research is supported by several grants of national foundations
- The Department staff is very friendly and you will have the opportunity to try over a hundred different types of green tea
- Publications of the obtained results in high-impact scientific journals

Career opportunities:

Postdoc positions at the universities all over the world due to work in world famous scientific group.

Supervisor's specific requirements:

Experience in experimental research in the field of materials science.

Main publications:

- Levlev, A. V., Jesse, S., Morozovska, A. N., Strelcov, E., Eliseev, E. A., Pershin, Y. V., Kumar, A., Shur, V. Ya. and Kalinin, S. V. (2014), "Intermittency, Quaziperiodicity, and Chaos during Scanning Probe Microscopy Tip-induced Ferroelectric Domain Switching", *Nature Physics*, vol. 10, pp. 59–66.
DOI: 10.1038/nphys2796
- Levlev, A. V., Morozovska, A. N., Eliseev, E. A., Shur, V. Ya. and Kalinin, S. V. (2014), "Ionic Field Effect and Memristive Phenomena in Single-point Ferroelectric Domain Switching", *Nature Communications*, vol. 5, 4545.
DOI: 10.1038/ncomms5545

- Levlev, A. V., Alikin, D., Morozovska, A. N., Varenyk, O. V., Eliseev, E. A., Kholkin, A. L., Shur, V. Ya. and Kalinin, S. V., (2015) "Symmetry Breaking and Electrical Frustration during Tip-Induced Polarization Switching in the Non-Polar Cut of Lithium Niobate Single Crystals", *ACS Nano*, vol. 9, no. 1, pp. 769–777.
DOI: 10.1021/nn506268g
- Shur, V. Ya., Akhmatkhanov, A. R. and Baturin, I. S. (2015), "Micro- and Nano-domain Engineering in Lithium Niobate", *Appl. Phys. Rev.*, vol. 2, pp. 040604 1–22.
DOI: 10.1063/1.4928591
- Shur, V. Ya., Esin, A. A., Alam, M. A. and Akhmatkhanov, A. R. (2017), "Superfast domain walls in KTP single crystals", *Appl. Phys. Lett.*, vol. 111, pp. 152907 1–5.
DOI: 10.1063/1.5000582



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WO-DIMENSIONAL SYSTEMS AND SEMI-CONDUCTOR HETERO-STRUCTURES

Research goal:

The research focuses on the experimental study of energy spectrum and electron transport in the quantum wells based on the HgTe/CdTe semi-conductor hetero-structures.

Aspects studied:

- The Shubnikov-de Haas oscillations
- The quantum Hall effect
- Quantum corrections to the conductivity
- Electron energy spectrum

Research highlights:

- Wide collaboration with leading national and international scientific centers
- We use modern cryogenic equipment

Career opportunities:

Researchers have a possibility to take postdoc position in many institutions of Russia and other countries.

Supervisor's specific requirements:

Experience of conducting experimental research in the area of semiconductor physics.

Main publications:

- Minkov, G. M., Aleshkin, V. Ya., Rut, O. E., Sherstobitov, A. A., Germanenko, A. V., Nestoklon, M. O., Dvoretzki, S. A., and Mikhailov, N. N. (2017), "Valence band energy spectrum of HgTe quantum wells with an inverted band structure", Phys. Rev. B., vol. 96, no. 3, 035310-1-8.
DOI: 10.1103/PhysRevB.96.035310
- Minkov, G. M., Germanenko, A. V., Rut, O. E., Sherstobitov, A. A., Nestoklon, M. O., Dvoretzki, S. A., and Mikhailov, N. N. (2016), "Spin-orbit splitting of valence and conduction bands in HgTe quantum wells near the Dirac point", Phys. Rev. B., vol. 93, 155304-1-10.
DOI: 10.1103/PhysRevB.93.155304
- Minkov, G. M., Germanenko, A. V., Rut, O. E., Sherstobitov, A. A., Dvoretzki, S. A., and Mikhailov, N. N. (2015), "Weak antilocalization of holes in HgTe quantum wells with a normal energy spectrum", Phys. Rev. B., vol. 91, 205302-1-8.
DOI: 10.1103/PhysRevB.91.205302



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HIGH PRESSURE RESEARCH ELECTROPHYSICAL PROPERTIES OF MULTICOMPONENT SEMICONDUCTORS AND DIELECTRICS

Research goal:

obtaining in-depth understanding of extreme influence (low temperatures, high-pressures, intense heat fluxes) on physical properties of solids

Aspects studied:

- Solid state physics, extreme influence on physical properties of solids
- Supervisor's specific requirements: fluence in English

Research highlights:

Scientific interests related to experimental solid state physics, the study of the extreme influence (low temperatures, high-pressures, intense heat fluxes) on physical properties of solids.

Career opportunities:

After graduate school, it is possible to work in scientific positions through grants and programs

Supervisor's specific requirements:

Fluence English. Russian language proficiency as part of the requirement for scientific communications. Experimental research. Experience in measuring electrical and magnetic characteristics of materials is desirable.

Main publications:

- Melnikova, N. V., Tebenkov, A. V., Sukhanova, G. V., Babushkin, A. N., Saipulaeva, L. A., Zakhvalinskii, V. S., Gabibov, S. F., Alibekov, A. G., and Mollaev, A. Yu. (2018), "Thermoelectric Properties of a Ferromagnetic Semiconductor Based on a Dirac Semimetal (Cd₃As₂) under High Pressure", Physics of the Solid State, vol. 60, no. 3, pp. 499–503.
DOI: 10.1134/S1063783418030174
- Melnikova, N. V., Kurochka, K. V., Tebenkov, A. V., and Babushkin, A. N. (2018), "Relative magnetoresistance in polycrystalline In-Cu chalcogenides under high pressure up to 50 GPa", Journal of Physics: Conference Series, vol. 946, 012088, pp. 1–7.
DOI: 10.1088/1742-6596/946/1/012088



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THE PHASE AND STRUCTURE TRANSFORMATIONS IN EXTRATERRESTRIAL SUBSTANCES (meteorite, lunar soil and dust).

Research goal:

In-depth study and understanding of phase and structure transformations in extraterrestrial substances

Aspects studied:

- Physical and mechanical properties of the meteoroids
- Protoplanetary matter in primitive meteorites
- Materials science problems in the asteroid and cometary impacts
- The structure and spectroscopy of minerals in meteorites
- Experimental simulation of impact processes

Research highlights:

- The study is conducted in collaboration with an international research group and supported by grants.

Career opportunities:

The job in planetary science laboratories around the world.

Supervisor's specific requirements:

Basic skills in analytic equipment and field experience

Main publications:

- Grokhovsky, V. J. and Bevan, A. W. R. (1983), "Plessite formation by discontinuous precipitation reaction from γ -Fe, Ni in Richardton (H5) ordinary chondrite", *Nature*, vol. 301, no. 5898, pp. 322–324.
DOI: 10.1038/301322a0
- Grokhovsky, V. I., Oshtrakh, M. I., Petrova, E. V. et al. (2009), "Mössbauer Spectroscopy with High Velocity Resolution in the Study of Iron-Bearing Minerals in Meteorites", *Eur. J. Mineral*, vol. 21, pp. 51–63.
DOI: 10.1127/0935-1221/2009/0021-1904
- Grokhovsky, V. I and Gladkovsky, S. V. (2010), "The Impact Mechanical Tests of Meteorites", *Meteorit. & Planet. Sci*, S1, vol. 45, A69.
DOI: 10.1111/j.1945-5100.2010.01051.x
- Popova, O. P., Jenniskens, P., Grokhovsky, V. I. et al. (2013), "Chelyabinsk Airburst, Damage Assessment, Meteorite Recovery, and Characterization" *Science*, vol. 342, no. 6162, pp. 1069–1073.
DOI: 10.1126/science.1242642

- Kohout, T., Gritsevich, M., Grokhovsky, V. et al. (2014), "Mineralogy, Reflectance Spectra, and Physical Properties of the Chelyabinsk LL5 Chondrite – Insight into Shock-Induced Changes in Asteroid Regoliths", *ICARUS*, vol. 228, pp. 78–85.
DOI: 10.1016/j.icarus.2013.09.027
- Kohout, T., Haloda, J., Halodová, P. et al. (2017), "Annama H chondrite – Mineralogy, physical properties, cosmic ray exposure, and parent body history", *Meteorit. & Planet. Sci*, vol. 52, pp. 1525–1541.
DOI: 10.1111/maps.12871

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REMOTE SENSING

Research goal:

Remote sensing of the atmosphere using high resolution infrared Fourier Transform satellite-based and ground-based spectrometers

Aspects studied:

- Radiative transfer
- Forward and inverse problems of atmospheric optics
- Radiation balance of the atmosphere
- Monitoring of GHGs and their isotopologues in the atmosphere

Research highlights:

The study is conducted in frame of collaboration with the international research groups: Atmosphere and Ocean Research Institute of the University of Tokyo (Prof. R. Imasu), Institute of Environmental Physics of the University of Bremen (Prof. J. Notholt) and supported by RFBR and RSF grants.

Career opportunities:

- Employee in the Ural Federal University
- Postdoc positions at overseas research centers in field of remote sensing of the atmosphere

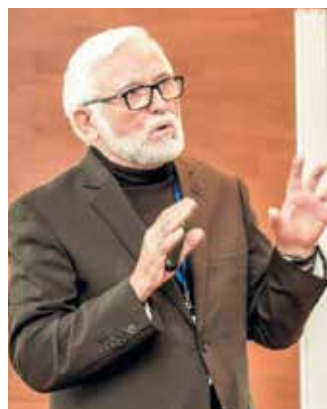
Supervisor's specific requirements:

- Good skills in programming and computations using FORTRAN
- Good English

Main publications:

- Zakharov, V. I., Imasu, R., Griбанov, K. G., Hoffmann, G. and Jouzel, J. (2004), "Latitudinal distribution of deuterium to hydrogen ratio in the atmospheric water vapor retrieved from IMG/ADEOS data", *Geophysical research letters*, vol. 31, no. 12, L12104.
DOI: 10.1029/2004GL019433.
- Zakharov, V. I. (2009), "Regarding Greenhouse Explosion", in Cracknell, A., Krapivin, V. and Varotsos, C. (eds.), *Global climatology and ecodynamics – Anthropogenic changes to Planet Earth*, Springer/PRAXIS, Chichester, UK, pp. 107–132.
DOI: 10.1007/978-3-540-78209-4_6
- Rokotyаn, N. V., Zakharov, V. I., Griбанov, K. G., Schneider, M., Bréon, F.-M., Jouzel, J., Imasu, R., Werner, M., Butzin, M., Petri, C., Warneke, T. and Notholt, J. (2014), "A posteriori calculation of $\delta^{18}\text{O}$ and δD in atmospheric water vapour from ground-based near-infrared FTIR retrievals of H_2^{16}O , H_2^{18}O , and HD^{16}O ", *Atmospheric Measurement Techniques*, vol. 7, pp. 2567–2580.
DOI: 10.5194/amt-7-2567-2014.

- Chesnokova, T. Yu., Chentsov, A. V., Rokotyаn, N. V. and Zakharov, V. I. (2016), "Impact of difference in absorption line parameters in spectroscopic databases on CO_2 and CH_4 atmospheric content retrievals", *Journal of Molecular Spectroscopy*, vol. 327, pp. 171–179.
DOI: 10.1016/j.jms.2016.07.001
- Dantec-Nedelec, S., Oettle, C., Wang, T., Guglielmo, F., Maignan, F., Delbart, N., Valdayskikh, V., Radchenko, T., Nekrasova, O., Zakharov, V., and Jouzel, J. (2017), "Testing the capability of ORCHIDEE land surface model to simulate Arctic ecosystems: Sensitivity analysis and site-level model calibration", *Journal of Advances in Modeling Earth Systems*, vol. 9, pp. 1212–1230.
DOI: 10.1002/2016MS000860.



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MODELING STRONGLY CORRELATED ELECTRON SYSTEMS

Research goal:

Elucidation of the mechanisms of formation of unusual physical properties of strongly correlated systems based on d- and f-elements

Aspects studied:

- Theory of high-temperature superconductivity
- Microscopic theory of exchange and exchange-relativistic interactions.
- Origin of optical and magnetic properties of strongly correlated compounds based on d- and f- elements.
- Modeling the phase transitions and topological structures

Research highlights:

- Elaboration of novel theoretical methods, mechanisms and nontrivial scenarios for unconventional physical properties of strongly correlated systems.
- The studies are conducted in collaboration with international research groups.

Career opportunities:

Successful graduates may proceed in their career in research labs of institutes of RAS, academic institutions and universities. They can apply for post-doc positions both in Russia and abroad.

Supervisor's specific requirements:

Computer skills and experience, knowledge of English, creativity and hard work.

Main publications:

- Moskvin, A. S. (2011), "True charge transfer gap in parent insulating cuprates", *Phys. Rev. B*, vol. 84, 075116.
DOI: 10.1103/PhysRevB.84.075116
- Moskvin, A. S. et al. (2012), "Direct evidence of the non-Zhang-Rice Cu^{3+} centers in $\text{La}_2\text{Li}_{0.5}\text{Cu}_{0.5}\text{O}_4$ ", *Phys. Rev. B*, vol. 86, 241107(R).
DOI: 10.1103/PhysRevB.86.241107
- Moskvin, A. S. (2013), "Perspectives of disproportionation driven superconductivity in strongly correlated 3d compounds", *J. Phys.: Condens. Matter*, vol. 25, 085601, pp. 1–16.
DOI: 10.1088/0953-8984/25/8/085601
- Moskvin, A. S. (2016), "Microscopic theory of Dzyaloshinskii-Moriya coupling and related exchange-relativistic effects", *JMMM*, vol. 400, pp. 117–120.
DOI: 10.1016/j.jmmm.2015.07.054
- Moskvin, A. S. and Panov, Yu. D. (2018), "Topological structures in a model cuprate", *J Supercond Nov Magn*, vol. 31, pp. 677–682.
DOI: 10.1007/s10948-017-4352-6



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ELECTRONIC EXCITATIONS AND RADIATION PHYSICS OF LUMINESCENT MATERIALS

Research goal:

Characterization of luminescent and optical materials (BeO , Y_2O_3 , LiB_3O_5 , $\text{Li}_2\text{B}_4\text{O}_7$, $\beta\text{-BaB}_2\text{O}_4$, $\text{CsLiB}_6\text{O}_{10}$, $\text{Li}_6\text{Re}(\text{BO}_3)_3$ (Re=Gd, Y, Eu), KB_5 , KABO, KBBF, APb_2X_5 (A=K, Rb; X=Cl, Br), SrAlF_5 , SrI_2 , LiF, NaF, ADP, KDP, DKDP and so on) undoped and doped with rare-earth ions

Research highlights:

Optical and luminescence spectroscopy with nanosecond time-resolution under excitation with photons (visible-UV-VUV-XUV), electron and ion beams, x-rays; thermo luminescence; ESR, EPR; computer simulations of actual processes; nuclear physics methods of analysis, see in detail at: <https://publons.com/researcher/2810362/igor-n-ogorodnikov/>

Career opportunities:

Work in Russian and foreign universities, scientific institutes of the Russian Academy of Sciences, post-doc abroad.

Supervisor's specific requirements:

Fluency in both English and Russian language, culture, knowledge of computer software.

Main publications:

- Pustovarov, V. A., Ogorodnikov, I. N., Isaenko, L. I., Lobanov, S. I., Goloshumova, A. A. and Naumov, D. Yu. (2018), "A luminescence spectroscopy study of new $\text{Li}_2\text{BaAl}_2\text{F}_{10}$ single crystal", *Optical Materials*, vol. 76, pp. 1–10.
DOI: 10.1016/j.optmat.2017.12.017
- Ogorodnikov, I. N., Petrenko, M. D. and Ivanov, V. Yu. (2018), "Low-Temperature Luminescence and Thermally Stimulated Luminescence of BeO : Mg Single Crystals", *Phys. Solid State*, vol. 60, no. 1, pp. 134–146.
DOI: 10.1134/S106378341801016X
- Ogorodnikov, I. N., Kiseleva, M. S., Vostrov, D. O. and Yakovlev, V. Yu. (2015), "Cathodoluminescence kinetics of $\text{Li}_6\text{GdB}_3\text{O}_9$ crystals", *J. Lumin*, vol. 158, pp. 252–259.
DOI: 10.1016/j.jlumin.2014.10.011
- Yavetskiy, R. P., Baumer, V. N., Danylenko, M. I., Doroshenko, A. G., Ogorodnikov, I. N., Petrusha, I. A., Tolmachev, A. V. and Turkevich, V. Z. (2014), "Transformation-assisted consolidation of Y_2O_3 : Eu^{3+} nanospheres as a concept to optical nanograin ceramics", *Ceram. Int.*, vol. 40, pp. 3561–3569.
DOI: 10.1016/j.ceramint.2013.09.072



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ELECTRONIC EXCITATIONS, LUMINESCENCE AND DEFECTS IN NEW FUNCTIONAL MATERIALS

Research goal:

Experimental study of electronic excitations (electrons, holes and excitons) in wide-gap inorganic functional materials using the methods of optical and time-resolved luminescence spectroscopy, synchrotron radiation

Aspects studied:

- Luminescent spectroscopy of rare-earth ions
- Energy conversion in scintillation detectors, materials of non-linear optics
- Fast radiation processes

Research highlights:

Collaboration with foreign colleagues, the use of advance equipment of Russian and foreign synchrotron radiation centers

Career opportunities:

Work in Russian and foreign universities, scientific institutes of the Russian Academy of Sciences and post-doc abroad

Supervisor's specific requirements:

Fluency in both English and Russian language, culture and knowledge of PC software

Main publications:

- Pustovarov, V. A., Ogorodnikov, I. N. and Omel'kov, S. I. (2018), "Luminescence of Impurity Ce^{3+} Centers in KH_2PO_4 : Ce Crystals", *Physics of the Solid State*, vol. 60, no. 1, pp. 147–152.
DOI: 10.1134/S1063783418010201
- Pustovarov, V. A., Trofimova, E. S., Kuznetsova, Yu. A. and Zatsepin, A. F. (2018), "Up-conversion Luminescence of Gd_2O_3 Nanocrystals Doped with Er^{3+} and Yb^{3+} Ions", *Technical Phys. Letters*, vol. 44, no. 7, pp. 622–625.
DOI: 10.1134/S106378501807026X
- Pustovarov, V. A., Ivanovskikh, K. V., Shi, Q., Huang, Y. and Bettinelli, M. (2018), "Impurity and Defect-related Luminescence of Ce^{3+} Doped $LiLa_3(SiO_4)_6O_2$ Crystals upon UV–VUV, X-ray and Cathode Ray Excitation", *Optical materials*, vol. 84, pp. 66–72.
DOI: 10.1016/j.optmat.2018.06.051
- Pustovarov, V. A., Smirnova, T. P., Lebedev, M. S., Gritsenko, V. A. and Kirm, M. (2016), "Intrinsic and defect related luminescence in double oxide films of Al–Hf–O system under soft X-ray and VUV excitation", *Journal of Luminescence*, vol. 170, part 1, pp. 161–167.
DOI: 10.1016/j.jlumin.2015.10.053



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ASTROCHEMISTRY

Research goal:

We study chemical evolution of star and planet forming regions of our Galaxy as well as in other stellar systems. Our goal is to understand the key mechanisms that drive the build-up of chemical complexity in the Universe and ultimately lead to the formation of complex organic and prebiotic matter.

Aspects studied:

Numerical simulations of chemistry in star and planet forming regions. Studies of molecular content of the interstellar medium via radio and infrared observations. Simulations of laboratory experiments of chemical processes carried out under physical conditions similar to that in the interstellar medium.

Research highlights:

We use state of the art theoretical approaches as well as world class observational facilities (IRAM 30m, NOEMA, ALMA, IRTF etc.) to conduct world class research. As of 2019, our lab is the only Max Planck Partner Group in Russia. Our academic partner is Center for Astrochemical Studies at the Max-Planck-Institute for Extraterrestrial Physics (CAS@MPE) in Munich, Germany.

Career opportunities:

Scientific career in world leading research institutions all over the World

Supervisor's specific requirements:

Fluent English is a must. Background in chemistry or astrophysics is highly desirable.

Main publications:

- Shingledecker, Ch. N., Vasyunin, A. I., Herbst, E., Caselli, P. (2019), "On Simulating the Proton-irradiation of O_2 and H_2O Ices Using Astrochemical-type Models, with Implications for Bulk Reactivity", *The Astrophysical Journal*, vol. 876, issue 2, article id., pp. 140, 10.
DOI: 10.3847/1538-4357/ab16d5
- Vasyunin, A. I., Caselli, P., Dulieu, F., Jiménez-Serra, I. (2017), "Formation of Complex Molecules in Prestellar Cores: A Multilayer Approach", *The Astrophysical Journal*, vol. 842, issue 1, article id., pp. 33, 18.
DOI: 10.3847/1538-4357/aa72ec
- Rivilla, V. M., Fontani, F., Beltrán, M. T., Vasyunin, A. I., Caselli, P., Martín-Pintado, J., Cesaroni, R. (2016), "The First Detections of the Key Prebiotic Molecule PO in Starforming Regions", *The Astrophysical Journal*, vol. 826, issue 2, article id., pp. 161, 8.
DOI: 10.3847/0004-637X/826/2/161

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- Vasyunin, A. I., Herbst, E. (2013), "Reactive Desorption and Radiative Association as Possible Drivers of Complex Molecule Formation in the Cold Interstellar Medium", *The Astrophysical Journal*, vol. 769, issue 1, article id., pp. 34, 9.
DOI: 10.1088/0004-637X/769/1/34
- Vasyunin, A. I., Herbst, E. (2013), "A Unified Monte Carlo Treatment of Gas-Grain Chemistry for Large Reaction Networks. II. A Multiphase Gas-surface-layered Bulk Model", *The Astrophysical Journal*, vol. 762, issue 2, article id., pp. 86, 21.
DOI: 10.1088/0004-637X/762/2/86



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MAGNETISM OF CHIRAL HELIMAGNETS

Research goal:

This research focuses on studying magnetic and optical properties of monoaxial chiral helimagnets and carry out theoretical analysis of their functionality in spintronics applications.

Aspects studied:

- Magnetism of low-dimensional magnetic systems
- Chiral helimagnets
- Renormalization group
- Electrodynamics

Research highlights:

- The study is carried out in close collaboration with the Center of Chiral Science (Hiroshima, Japan) and the University of Glasgow (UK)
- The study is supported by the Russian Fund of Basic Research

Career opportunities:

A possibility to proceed a career in Europe, United Kingdom, Canada and Japan.

Supervisor's specific requirements:

- Sufficient knowledge in mathematical analysis, mathematical physics and linear algebra
- Knowledge of computer is also crucial

Main publications:

- Tereshchenko, A. A., Ovchinnikov, A. S., Proskurin, I., Sinitsyn, E. V. and Kishine, J. (2018), "Theory of magnetoelastic resonance in a monoaxial chiral helimagnet", *Physical Review B*, vol. 97, Id. 184303.
DOI: 10.1103/PhysRevB.97.184303
- Goncalves, F. J. T., Sogo, T., Shimamoto, Y., Proskurin, I., Sinitsyn, V. E., Kousaka, Y., Bostrem, I. G., Kishine, J., Ovchinnikov, A. S. and Togawa, Y. (2018), "Tailored resonance in micrometer-sized monoaxial chiral helimagnets", *Physical Review B*, vol. 98, Id. 144407.
DOI: 10.1103/PhysRevB.98.144407
- Proskurin, I., Ovchinnikov, A. S., Kishine, J. and Stamps, R. L. (2018), "Excitation of magnon spin photocurrents in antiferromagnetic insulators", *Physical Review B*, vol. 98, Id. 134422.
DOI: 10.1103/PhysRevB.98.134422
- Proskurin, I., Ovchinnikov, A. S., Kishine, J. and Stamps, R. L. (2018), "Cavity optomechanics of topological spin textures in magnetic insulators", *Physical Review B*, vol. 98, Id. 220411.
DOI: 10.1103/PhysRevB.98.220411
- Togawa, Y., Kishine, J., Nosov, P. A., Koyama, T., Paterson, G. W., McVitie, S., Kousaka, Y., Akimitsu, J., Ogata, M. and Ovchinnikov, A. S. (2019), "Anomalous Temperature Behavior of the Chiral Spin Helix in CrNb₃S₆ Thin Lamellae", *Physical Review Letters*, vol. 122, Id. 017204.
DOI: 10.1103/PhysRevLett.122.017204



Research supervisor:
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RELATIONSHIP BETWEEN STRUCTURE AND DEFORMATION BEHAVIOR OF NATURAL MATERIALS (ROCKS, HARD TISSUES)

Research goal:

The research focuses on the study of the relationship between hierarchical structure and deformation behaviour of natural materials (REFRACTORY METALS, rocks and hard tissues).

Aspects studied:

- Mechanisms of stress accommodation in natural materials
- Evolution of hierarchical structure of rocks and hard tissues

Research highlights:

- Mechanical testing (compression, tension, bending, shearing, and indentation)
- Structure characterization (metallography, SEM, TEM, XRD)
- Crack growth and fracture surfaces

Career opportunities:

Research laboratories, universities, and commercial companies.

Supervisor's specific requirements:

Recommendation letter from MS supervisor and interview with expert or recommendation letter from community.

Main publications:

- Zaytsev, D. and Panfilov, P. E. (2014), "Deformation behavior of human enamel and dentin-enamel junction under compression", *Materials Science & Engineering*, vol. 34, pp. 15–21.
DOI: 10.1016/j.msec.2013.10.009
- Zaytsev, D. and Panfilov, P. E. (2014), "Deformation behavior of human dentin in liquid nitrogen: A diametral compression test", *Materials Science & Engineering C*, vol. 42, pp. 48–51.
DOI: 10.1016/j.msec.2014.05.011
- Zaytsev, D. and Panfilov, P. E. (2015), "Anisotropy of the mechanical properties of human enamel", *Materials Letters*, vol. 159, pp. 428–431.
DOI: 10.1016/j.matlet.2015.07.057
- Zaytsev, D. and Panfilov, P. E. (2016), "The strength properties of human dentinoenamel junction", *Materials Letters*, vol. 178, pp. 107–110.
DOI: 10.1016/j.matlet.2016.04.211

- Panfilov, P. E., Kabanova, A. A., Guo, J. and Zhang, Z. (2017), "Transmission electron microscopical study of teenage crown dentin on the nanometer scale", *Materials Science & Engineering C*, vol. 71, pp. 994–998.
DOI: 10.1016/j.msec.2016.11.016
- Zaytsev, D. V., Kochanov, A. N., Panteleev, I. A. and Panfilov, P. E. (2017), "Influence of the Scale Effect in Testing the Strength of Rock Samples", *Bulletin of the Russian Academy of Sciences: Physics*, vol. 81, no. 3, pp. 337–340.
DOI: 10.3103/S1062873817030406
- Borodin, E. N., Gutkin, M. Yu, Mikaelyan, K. N. and Panfilov, P. E. (2017), "Theoretical model of the plastic zone at the I-mode crack tip in dentin", *Scripta Materialia*, vol. 133, pp. 45–48.
DOI: 10.1016/j.scriptamat.2017.02.007



Research supervisor:
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DYNAMICAL EVOLUTION OF PLANETARY SYSTEMS

Research goal:

Research of orbital evolution of planetary systems, small bodies of the Solar System and artificial satellites of the Earth.

Aspects studied:

- Construction of semi-analytical theories of motion
- Research of long-time evolution and stability of planetary systems
- Research of dynamical evolution of small bodies of the Solar System
- Determination of stochastic properties of motion
- Application of the obtained results to real extrasolar systems

Research highlights:

- Research of dynamical evolution of planetary systems is made in collaboration with the Saint-Petersburg University
- Research of dynamical evolution of small bodies of the Solar System is made in collaboration with Adam Mickiewicz University in Poznan

Career opportunities:

Observational projects, numerical simulations as well as theoretical investigations can be carried out. Experimental in the fields of astrometric and photometric observations of small bodies of the Solar System, are also available.

Supervisor's specific requirements:

- Knowledge in Celestial Mechanics
- Programming skills in Fortran or C++

Main publications:

- Kuznetsov, E. D. and Avvakumova, E. A. (2019), "Dynamical evolution of space debris in the vicinity of GNSS regions", *Acta Astronautica*, vol. 158, pp. 140–147. DOI: 10.1016/j.actaastro.2018.02.001
- Kuznetsov, E. and Safronova, V. (2018), "Application of metrics in the space of orbits to search for asteroids on close orbits", *Planetary and Space Science*, vol. 157, pp. 22–27. DOI: 10.1016/j.pss.2018.04.011
- Perminov, A. S. and Kuznetsov, E. D. (2018), "Orbital Evolution of the Sun–Jupiter–Saturn–Uranus–Neptune Four-Planet System on Long-Time Scales", *Solar System Research*, vol. 52, no. 3, pp. 241–259. DOI: 10.1134/S0038094618010070



Research supervisor:
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EARLY STAGES OF STELLAR EVOLUTION AND MASERS

Research goal:

The research is focused on the theoretical modelling and analysis of observational data obtained with state of art instruments on the early stages of star formation.

Aspects studied:

- Masers, molecular lines, and radiative transfer
- Star formation and early stages of stellar evolution
- Stellar spectroscopy
- Astrophysical space projects

Research highlights:

The group has high experience in the data interpretation and theoretical modelling of star forming regions and young stars. We use cutting-edge instruments of the modern astronomy including Russian ones, take part in scientific programs of astrophysical space projects like flying RadioAstron, planned Millimetron, WSO-UV, and of course, use the instruments based in Kourvka astronomical observatory.

Career opportunities:

After PhD courses at UrFU, a successful researcher can stay here or take postdoc position in many astronomical institutions of Russia and other countries.

Supervisor's specific requirements:

Experience of conducting scientific research and writing scientific papers.

Main publications:

- Sobolev, A. M., Shakhvorostova, N. N., Alakoz, A. V., and Baan, W. A. (2017), "RadioAstron Maser Observations: a Record in Angular Resolution", *Astronomical Society of the Pacific Conference Series*, 510, pp. 20–31. ISBN: 978-1-58381-904-3
- Parfenov, S. Yu., Semenov, D. A., Henning, Th., Shapovalova, A. S., Sobolev, A. M., and Teague, R. (2017), "On the methanol emission detection in the TW Hya disc: the role of grain surface chemistry and non-LTE excitation", *Monthly Notices of the Royal Astronomical Society*, vol. 468, issue 2, pp. 20124–2031. DOI: 10.1093/mnras/stx624
- Ladeyschikov, D. A., Kirsanova, M. S., Tsvilev, A. P. and Sobolev, A. M. (2016), "Molecular emission in dense massive clumps from the star-forming regions S231-S235", *Astrophysical Bulletin*, vol. 71, Issue 2, pp. 208–224. DOI: 10.1134/S1990341316020085
- Gray, M. D., Baudry, A., Richards, A. M. S., Humphreys, E. M. L., Sobolev, A. M., and Yates, J. A. (2016), "The physics of water masers observable with ALMA and SOFIA: model predictions for evolved stars", *Monthly Notices of the Royal Astronomical Society*, vol. 456, Issue 1, pp. 374–404. DOI: 10.1093/mnras/stv2437

**Research supervisor:**

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MAGNETIC STRUCTURES AND MAGNETIC PHASE TRANSITIONS

Research goal:

The objective of the researches is focused on the study of magnetic structures and phase transitions in magnetoelectric, multiferroics and rare earth-3d-transition metal compounds using neutron diffraction and reflectometry.

Aspects studied:

- The TbNi_3 intermetallic compound undergoes two magnetic phase transitions. One is the second order transition from a paramagnetic state to an incommensurate phase. The other is the “commensurate – incommensurate first order transition.
- In the LiNiP_4 magnetoelectric the transitions from a commensurate phase to an incommensurate structure and further to a paramagnetic state, are accompanied by two peaks on the temperature dependence of the heat capacity.

Research highlights:

Students will carry out neutron experiments with devices installed on Joint Institute Nuclear Researches (Dubna, Russia), National Center “Kurchatovski Institute (Moscow, Russia), Korea Atomic Energy Research Institute (Daejeon, Korea Republic) and Paul Scherer Institute (Willigen, Switzerland).

Career opportunities:

The high flux reactor “Pik” will be operated in 2–3 years. This reactor is located in Gatchina (about 40 km from Saint-Petersburg). The high neutron flux is allowed to perform wide class of neutron experiments. PhD graduate students have a chance to work with horizontal neutron beams of the reactor “Pik”.

Supervisor’s specific requirements:

Knowledge of background of solid state physic, magnetism, X-ray, nuclear, and magnetic neutron scattering.

Main publications:

- Lee, S., Pirogov, A., Kang, M., Jang, K.-H., Yonemura, M., Kamiyama, T., Cheong, S.W., Gozzo, F., Shin, N., Kimura, H., Noda, Y. and Park, J.-G. (2008), “Giant magneto-elastic coupling in multiferroic hexagonal manganites”, *Nature*, 451, pp. 805–809.
DOI: 10.1038/nature06507
- Lee, H.-J., Choi, Y.-N., Lukoyanov, A. V., Gerasimov, E. G. and Pirogov, A. N. (2019), “Spontaneous and induced magnetic phase transitions in $\text{Tb}_{0.9}\text{Er}_{0.1}\text{Ni}_5$ ”, *J. Magn. Magn. Mat.*, 475, pp. 593–601.
DOI: 10.1016/j.jmmm.2018.12.004

**Research supervisor:**

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EXCHANGE COUPLED COMPOSITE HARD MAGNETIC MATERIALS

Research goal:

The research is focused on fundamental and hysteresis magnetic properties of modern hard magnetic materials and new methods of production of permanent magnets of arbitrary shapes.

Aspects studied:

- Synthesis of hard magnetic materials, including the use of additive technologies.
- Development of experimental methods of estimation and estimation of the intergranular exchange interaction constant in nanostructured hard magnetic materials.
- Development of models of magnetization reversal of modern hard magnetic materials.

Research highlights:

The research is carried out jointly with employees of the University of Bremen (UNI Bremen, Bremen, Germany), the Institute of Material Science and Condensed State Physics (IFW Dresden, Dresden, Germany), POZ-Progress LLC (Verkhnyaya Pyshma, Russia).

Career opportunities:

Specialists in the field of hard magnetic materials are in high demand in universities and research institutes, as well as in production.

Supervisor’s specific requirements:

Knowledge of the basics of magnetism, magnetism of solids, experience in measuring the magnetic properties of materials in a closed and open magnetic circuit.

Main publications:

- Bolyachkin, A. S., Ruta, S., Chantrell, R. W., Woodcock, T. G., Andreev, S. V., Selezneva, N. V. & Volegov, A. S. 2019, “Characterisation of high-anisotropy nanocrystalline alloys based on magnetic susceptibilities in the remanent state”, *Journal of Magnetism and Magnetic Materials*, vol. 486. 165270
DOI: 10.1016/j.jmmm.2019.165270
- Neznakhin, D. S., Andreev, S. V., Semkin, M. A., Selezneva, N. V., Volochaev, M. N., Bolyachkin, A. S., Kudrevatykh, N. V. & Volegov, A. S. 2019, “Structure and magnetic properties of $(\text{Sm}_{0.9}\text{Zr}_{0.1})\text{Fe}_{11}\text{Ti}$ alloys with ThMn_{12} -type structure”, *Journal of Magnetism and Magnetic Materials*, vol. 484, pp. 212–217.
DOI: 10.1016/j.jmmm.2019.04.030
- Bolyachkin, A. S., Volegov, A. S. & Kudrevatykh, N. V. 2015, “Intergrain exchange interaction estimation from the remanence magnetization analysis”, *Journal of Magnetism and Magnetic Materials*, vol. 378, pp. 362–366.
DOI: 10.1016/j.jmmm.2014.11.064



Research supervisor:
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MAGNETIC AND MAGNETORESISTIVE PROPERTIES OF FILM NANOSTRUCTURES

Research goal:

The research focuses on the study of the formation mechanisms of the magnetic and magnetoresistive properties of film nanostructures

Aspects studied:

- Conditions for the formation of exchange bias in the ferromagnetic – antiferromagnetic film structures.
- Mechanisms of formation and control of induced anisotropy.

Research highlights:

- Measurement of magnetic properties (hysteresis properties and their temperature dependences)
- Study of magnetization reversal processes using a Kerr magnetometer.
- Analysis of crystal structure and surface film structure.

Career opportunities:

Research laboratories, universities, commercial companies

Supervisor's specific requirements:

Recommendation letter from MS supervisor and interview with expert or recommendation letter from community.
Knowledge of Solid state physics at master level.

Main publications:

- Savin, P. A., Lepalovskij, V. N., Svalov, A. V., Vas'kovskiy, V. O., and Kurlyandskaya, G. V. (2014) "Effect of phase separation in an $\text{Fe}_2\text{ONi}_{80}/\text{Fe}_{50}\text{Mn}_{50}$ structure with exchange coupling," *Phys. Met. Metallograph.*, vol. 115, no. 9, pp. 856–863. DOI: 10.1134/S0031918X14070096
- Savin, P. A., Guzman, J. A., Lepalovskij, V. N., Svalov, A. V., Kurlyandskaya, G. V., Asenio, A. B., Vas'kovskiy, V. O., Vazques, M. V. (2016) "Exchange bias in sputtered FeNi/FeMn systems: effect of short low-temperature heat treatments", *JMMM*, vol. 402, pp. 49–54. DOI: 10.1016/j.jmmm.2015.11.027
- Yuvchenko, A. A., Lepalovskij, V. N., Savin, P. A., Gorkovenko, A. N., Kulesh, N. A., Vas'kovskiy, V. O. (2015), "Optimization of Functional Parameters of Magnetoresistive $\text{Fe}_{20}\text{Ni}_{80}/\text{Fe}_{50}\text{Mn}_{50}/\text{Fe}_{20}\text{Ni}_{80}$ Films", *IEEE Trans. Magn.*, vol. 51, 2500304. DOI: 10.1109/TMAG.2014.2362817



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MAGNETOACOUSTIC AND LOW TEMPERATURE ULTRASONIC PHENOMENA IN SOLIDS

Research goal:

The study is aimed at training specialists in the fields of condensed matter, physical acoustics (ultrasonics), low temperature physics, magnetism, physics of dielectrics and semiconductors.

Aspects studied:

- Ultrasonic analogue of the Faraday effect
- The Jahn-Teller effect in crystals with point defects: impurities and vacancies. Mechanisms of relaxation, parameters and symmetry properties of adiabatic potential energy surface
- Thermodynamic properties of dielectrics and semiconductors

Research highlights:

Experiments are done with the use of unique ultrasonic technique which can be found in a few international research centers (e. g., National High Magnetic Field Laboratory, Tallahassee, USA; Dresden High Magnetic Field Laboratory in the Helmholtz-Zentrum Dresden-Rossendorf, Germany).

Career opportunities:

Research centers, high-tech industry, and university staff.

Supervisor's specific requirements:

Knowledge of Solid state physics at master level.

Main publications:

- Averkiev, N. S., Bersuker, I. B., Gudkov, V. V., et al. (2019), "The Jahn-Teller Effect in Elastic Moduli of Cubic Crystals: General Theory and Application to Strontium Fluorite Doped with Chromium Ions", in van Asten M. (ed.), *Fluorites*, Nova Science Publishers Inc., New York, U.S., pp. 111–159. ISBN: 978-1-53615-205-0 (eBook); ISBN: 978-1-53615-204-3.
- Gudkov, V. V., Bersuker, I. B. (2012), "Experimental Evaluation of the Jahn-Teller Effect Parameters by Means of Ultrasonic Measurements. Application to Impurity Centers in Crystals", in Atanasov, M., Daul, C., Tregenna-Piggot, Ph. L. W. (ed.), in *Vibronic Interactions and the Jahn-Teller Effect: Theory and Applications*, Springer, Heidelberg, Germany, pp. 143–162. DOI: 10.1007/978-94-007-2384-9_7
- Gudkov, V. V. (2009), "Ultrasonic consequences of the Jahn-Teller effect", in Koppel, H., Yarkony, D. R., Barentzen, H. (ed.), *The Jahn-Teller Effect, Fundamentals and Implications for Physics and Chemistry*, Springer, Heidelberg, Germany, pp. 743–766. DOI: 10.1007/978-3-642-03432-9_23

Research supervisor:

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- Gudkov, V. V. and Gavenda, J. D. (2000), "Magnetoacoustic Polarization Phenomena in Solids", Springer-Verlag, New York, U.S., 218 p.
DOI: 10.1007/978-1-4612-1168-6
- Averkiev, N. S., Bersuker, I. B., Gudkov, V. V., et al. (2017), "Magnetic field induced tunnelling and relaxation between orthogonal configurations in solids and molecular systems", Physical Review B, vol. 96, 094431.
DOI: 10.1103/PhysRevB.96.094431

**Dominique Savio
Nsengiyumva
(Rwanda)**



I have chosen to study in Russia because I saw an **interesting program** which will help me to contribute to **improve human being life** as well as the environment.



Laboratory of chemical design
of new multifunctional oxide
materials



Duration of study: 4 years

Language: English or Russian

Entry requirements:

- Master's degree (or equivalent) in the related field
- B2 level of English or Russian
- Interview

Entrance exams:

- Foreign language
- Chemistry

Government scholarship is available.

See more information at:

urfu.ru



Research



Doctoral Programs in English



Research supervisor:

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MICROHETEROGENEITY AND CONDITIONS OF CRYSTALLIZATION OF METAL MELTS

Research goal:

Gaining better understanding of various physical and chemical aspects of metallurgical processes

Aspects studied:

- Physico-chemical aspects of metallurgical processes.
- Quality management of metal products in the chain "technology - structure - property".
- Microstructure, crystalline structure, phase composition and nanomechanical properties of highly entropic, nanocrystalline and volumetric amorphous alloys.

Research highlights:

- mental and theoretical study of the liquid - liquid phase transition conditions in liquid alloys.
- Physical metallurgy about the connection "technology - structure - property".
- Influence of the melting temperature on microstructure, crystalline structure, phase composition and nanomechanical properties of the ingot.

Career opportunities:

Preparation and defense of a dissertation, scientific articles in indexed journals, presentation of research results at scientific conferences and participation in grant activities.

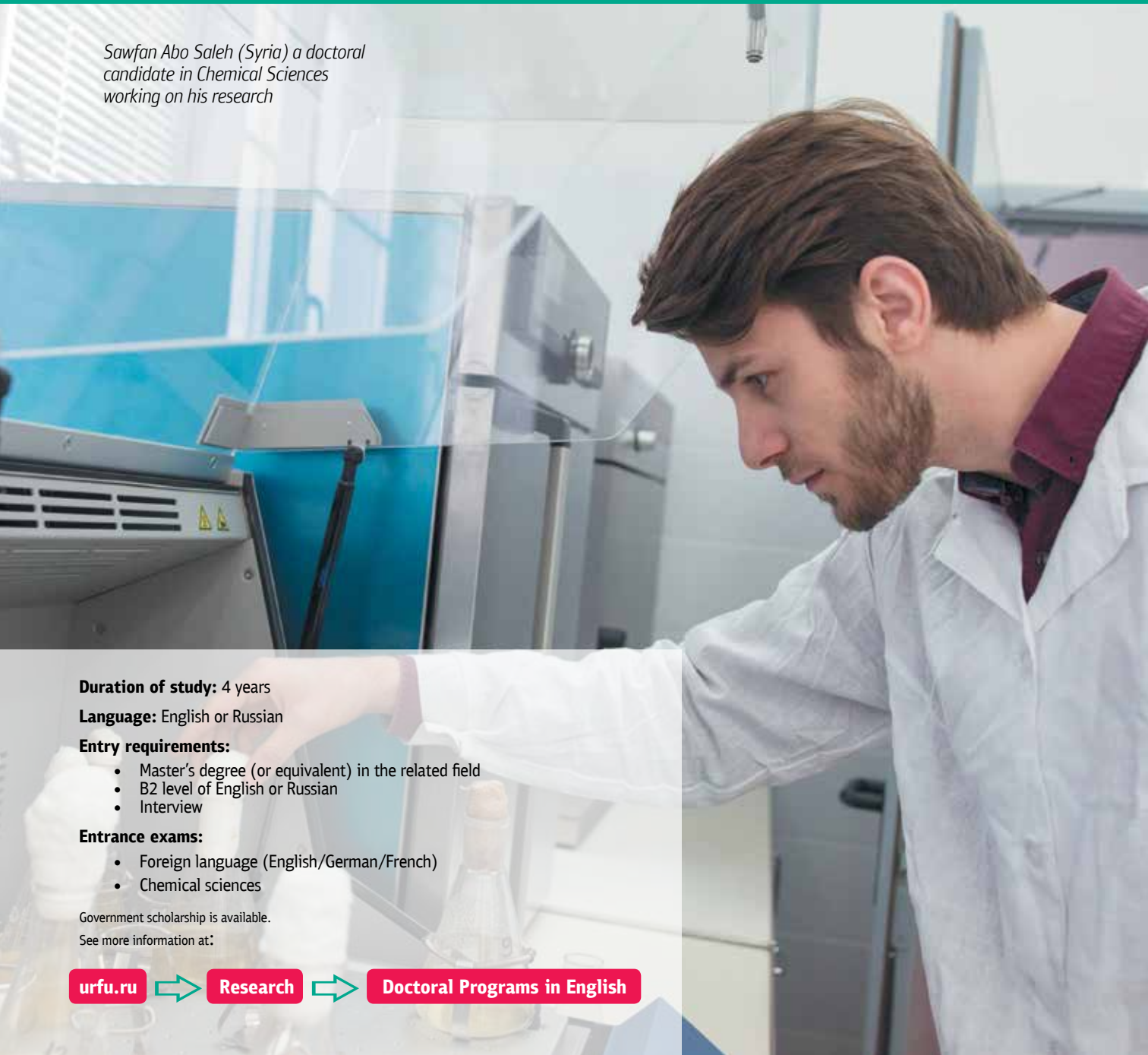
Supervisor's specific requirements:

Knowledge of the basics of physical and colloidal chemistry; understanding of the methods for studying the properties of materials (physical, chemical and mechanical); interest in pursuing career opportunities.

Main publications:

- Chikova, O. A., Sinitsin, N. I., V'yukhin, V. V. (2019) "Parameters of the Microheterogeneous Structure of 110G13L Liquid Steel", Russian Journal of Physical Chemistry A, vol. 93, no. 8, pp. 1435–1442. DOI: 10.1134/S0036024419080065
- Chikova, O. A., Nikitin, K. V., Moskovskikh, O. P., Tsepelev, V. S. (2016), "Viscosity and electrical conductivity of liquid hypereutectic alloys Al-Si", Acta Metallurgica Slovaca, vol. 22, no. 3, pp. 153–163 DOI: 10.12776/ams.v22i3.774
- Finkelstein, A., Schaefer, A., Chikova, O. A., Borodianskiy, K. (2017) "Study of Al-Si alloy oxygen saturation on its microstructure and mechanical properties", Materials, vol. 10, no. 7, art. № 786. DOI: 10.3390/ma10070786
- Shmakova, K. Yu., Chikova, O. A., Tsepelev, V. S. (2016), "Viscosity of liquid Cu-Sn alloys", Physics and Chemistry of Liquids, vol. 56, no. 1, pp. 1–8. DOI: 10.1080/00319104.2016.1233184

Sawfan Abo Saleh (Syria) a doctoral candidate in Chemical Sciences working on his research



Duration of study: 4 years

Language: English or Russian

Entry requirements:

- Master's degree (or equivalent) in the related field
- B2 level of English or Russian
- Interview

Entrance exams:

- Foreign language (English/German/French)
- Chemical sciences

Government scholarship is available.

See more information at:

urfu.ru



Research



Doctoral Programs in English



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ATOM-EFFICIENT METHODOLOGIES IN ORGANIC CHEMISTRY. SYNTHESIS OF COMPOUNDS POSSESSING ANTIVIRAL ACTIVITY AND CATALYSTS

Research goal:

Fundamental and applied research in the field of heterocyclic compounds functionalization using atom-efficient approaches. Synthesis of organic substances possessing antiviral activity and chiral catalysts.

Aspects studied:

- Organic synthesis
- Heterocyclic compounds
- C-H Functionalization methodology
- Green chemistry
- Chiral ligands
- Biological activity

Research highlights:

- Atom-effective, highly selective and environmentally benign methods of organic and organometallic synthesis of drugs, chiral catalysts, and organic materials, on the basis of heterocyclic compounds, mainly azines and azoloazines
- Application of highly selective and atom-efficient reactions: (hetero)condensation reactions, direct metal-catalysed functionalizations of the C(sp²)-H bond in (hetero)aromatics (including the formation of new C-X, X=C, N, O, P, S chemical bonds), metal-catalysed cross-coupling reactions, non-catalysed by transition metals oxidative cross-coupling reactions of n-deficient (hetero)aromatic compounds (SNH reactions), asymmetric synthesis reactions

Career opportunities:

Graduates will be in high demand in research laboratories involved in the study of novel biologically active compounds, ligands for asymmetric synthesis and novel organic materials.

Supervisor's specific requirements:

- Well knowledgeable in organic and medicinal chemistry, methods for identification of organic compounds
- Sufficient skills in synthesis

Research supervisor:

Prof. Oleg N. Chupakhin,
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Main publications:

- Charushin, V. and Chupakhin, O., (2014), "Metal Free C-H Functionalization of Aromatics. Nucleophilic Displacement of Hydrogen" in Maes, B. U. W., Cossy, J., Polanc, S., (Eds.), the series Topics in Heterocyclic Chemistry, Springer, Switzerland, vol. 37, 283 p.
DOI: 10.1007/978 3319 07019 3
- Khalymbadzha, I. A., Chupakhin, O. N., Fatykhov, R. F., Charushin, V. N., Schepochkin, A. V., and Kartsev, V. G. (2016), "Transition-Metal-Free Cross-Dehydrogenative Coupling of Triazines with 5,7-Dihydroxycoumarins", Synlett, vol. 27, no. 18, pp. 2606–2610.
DOI: 10.1055/s 0035–1562794
- Utepova, I. A., Trestsova, M. A., Chupakhin, O. N., Charushin, V. N., and Rempel, A. A. (2015), "Aerobic oxidative C-H/C-H coupling of azaaromatics with indoles and pyrroles in the presence of TiO₂ as a photocatalyst", Green Chem., vol. 17, pp. 4401–4410.
DOI: 10.1039/C5GC00753D

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ATOM-EFFICIENT METHODOLOGIES IN ORGANIC CHEMISTRY. SYNTHESIS OF COMPOUNDS POSSESSING ANTIBACTERIAL ACTIVITY

Research goal:

Fundamental and applied research in the field of heterocyclic compounds functionalization using atom-efficient approaches. Synthesis of organic substances possessing antibacterial activity.

Aspects studied:

- Organic synthesis
- Heterocyclic compounds
- C-H Functionalization methodology
- Green chemistry
- Ligands
- Biological activity

Research highlights:

- Effective methods of targeted organic and organometallic synthesis of high-tech knowledge-based functional materials, drugs and their precursors on the basis of heterocyclic compounds, mainly azines and benzazines, including fluorinated, chiral and annulated ones
- Application of selective atom-efficient reactions, such as but not limited to: addition reactions, (hetero) condensation reactions, Diels-Alder reactions, C–C and C–X crosscoupling reactions, including catalytic

Career opportunities:

Graduates will be in demand in research laboratories involved in the study of novel biologically active molecules and components for advanced optical materials.

Supervisor's specific requirements:

- Well knowledgeable in organic and medical chemistry, and methods for identification of organic compounds
- Sufficient skills in synthesis

Main publications:

- Sarkar, A., Santra, S., Kundu, S. K., Hajra, A., Zyryanov, G. V., Chupakhin, O. N., Charushin, V. N., and Majee, A. (2016), "A decade update on solvent and catalyst-free organic neat reactions: a step forward towards sustainability", Green Chemistry, vol. 18, no. 16, pp. 4475–4525.
DOI: 10.1039/c6gc01279e
- Lipunova, G. N., Nosova, E. V., Charushin, V. N., and Chupakhin, O. N. (2016), "Synthesis and antitumour activity of 4-aminoquinazoline derivatives", Russian Chemical Reviews, vol. 85, pp. 759–793.
DOI: 10.1070/RCR4591



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ATOM-EFFICIENT METHODOLOGIES IN ORGANIC CHEMISTRY. SYNTHESIS OF COMPOUNDS POSSESSING ANTIVIRAL ACTIVITY

Research goal:

Fundamental and applied research in the field of heterocyclic compounds functionalization using atom-efficient approaches. Synthesis of organic substances possessing anti-viral activity.

Aspects studied:

- Organic synthesis
- Heterocyclic compounds
- C-H Functionalization methodology
- Green chemistry
- Ligands
- Biological activity

Research highlights:

Development of original bioactive compounds based on the heterocyclic scaffold – antiviral drug candidates.

Career opportunities:

The graduates acquire expertise in organic chemistry and can be employed in both research laboratories and R&D centers in Russia and abroad.

Supervisor's specific requirements:

Profound knowledge in organic and medicinal chemistry, methods for the synthesis, purification, and identification of organic compounds.

Main publications:

- Rusinov, V. L., Sapozhnikova, I. M., Bliznik, A. M., Chupakhin, O. N., Charushin, V. N., Spasov, A. A., Vassiliev, P. M., Kuznetsova, V. A., Rashchenko, A. I., and Babkov, D. A. (2017), "Synthesis and Evaluation of Novel [1,2,4]Triazolo[5,1-c][1,2,4]-triazines and Pyrazolo[5,1-c][1,2,4]triazines as Potential Antidiabetic Agents", *Archiv der Pharmazie*, vol. 350, no. 5, 1600361.
DOI: 10.1002/ardp.201600361
- Savateev, K. V., Ulomsky, E. N., Fedotov, V. V., Rusinov, V. L., Sivak, K. V., Lyubishin, M. M., Kuzmich, N. N., and Aleksandrov, A. G. (2017), "6- itrotriazolo[1,5-a] pyrimidines as promising structures for pharmacotherapy of septic conditions", *Russian Journal of Bioorganic Chemistry*, vol. 43, no. 4, pp. 421–428.
DOI: 10.1134/S1068162017040094

- Gorbunov, E. B., Rusinov, G. L., Ulomsky, E. N., Rusinov, V. L., Charushin, V. N., and Chupakhin, O. N. (2016), "C-H functionalization of triazolo[a]-annulated 8-azapurines", *Tetrahedron Letters*, vol. 57, no. 21, pp. 2303–2305.
DOI: 10.1016/j.tetlet.2016.04.052
- Khalymbadzha, I. A., Shestakova, T. S., Subbotina, J. O., Eltsov, O. S., Musikhina, A. A., Rusinov, V. L., Chupakhin, O. N., Karpenko, I. L., Jasko, M. V., Kukhanova, M. K., Deev, S. L. (2014), "Synthesis of acyclic nucleoside analogues based on 1,2,4-triazolo[1,5-a]pyrimidin 7- ones by one-step Vorbrüggen glycosylation", *Tetrahedron*, vol. 70, no. 6, pp. 1298–1305.
DOI: 10.1016/j.tet.2013.12.051

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**HETEROCYCLIC CHEMISTRY****Research goal:**

The research focuses on the syntheses of heterocycles on the basis of CF₃-containing synthons.

Aspects studied:

- Synthesis and reactivity of trifluoromethylated oxygen-containing heterocycles and nitroalkenes
- Reactions of 1, 3-dipolar cycloaddition

Research highlights:

The students will have access to modern synthetic and analytical equipment.

Career opportunities:

Work in the field of synthetic organic chemistry at scientific institutions and pharmaceutical firms.

Supervisor's specific requirements:

- Deep knowledge of organic chemistry
- Good experimental skills: synthesis of organic substrates and organization of chemical experiment

Main publications:

- Obydenov, D. L., Pan'kina, E. O. and Sosnovskikh, V. Y. (2016), "Synthesis of Diketohexenoic Acid Derivatives by Alkenylation of Indoles and Pyrroles with 4-Pyrones", *Journal of Organic Chemistry*, vol. 81, pp. 12532–12539. DOI: 10.1021/acs.joc.6b02364
- Buev, E. M., Moshkin, V. S. and Sosnovskikh, V. Y. (2016), "Reagents for Storage and Regeneration of Nonstabilized Azomethine Ylides: Spiroanthraceneoxazolidines", *Organic Letters*, vol. 18, pp. 1764–1767. DOI: 10.1021/acs.orglett.6b00475
- Sosnovskikh, V. Y., Korotaev, V. Y., Kutyashev, I. B., Barkov, A. Y. and Safrygin, A. V. (2016), "One-pot synthesis of functionalized benzo[c]coumarins and their precursors via the reaction of 2-(polyfluoroalkyl)chromones with 4-alkyl-3-cyanocoumarins", *RSC Advances*, vol. 6, pp. 58188–58202. DOI: 10.1039/C6RA12492E

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**TECHNOLOGY FOR ORGANIC SYNTHESIS****Research goal:**

Study in the area of organic chemistry, synthesis of five-membered heterocyclic compounds based on the reaction of azides, enamines and thioamides.

Aspects studied:

- Organic chemistry
- Heterocyclic compounds
- Biological activity

Research highlights:

Synthesis of biologically active compounds including compounds with anticancer and antiviral activities.

Career opportunities:

After graduating from PhD courses you will gain expertise in organic chemistry and can be employed by laboratories in Russia and other countries.

Supervisor's specific requirements:

Well knowledgeable in organic chemistry.

Main publications:

- Beryozkina, T., Bakulev, V., Dianova, L., Berseneva, V., Slepukhin, P., Leban, J., Kalaba, P., Aher, N. Y., Ilic, M., Sitte, H. H. and Lubec, G. (2016), "Design and Synthesis of N-Sulfonylamidines of Modafinilic Acid", *Synthesis*, vol. 48, no. 7, pp. 1046–1054. DOI: 10.1055/s-0035-1561350
- Belyaev, N. A., Beryozkina, T. V., Bakulev, V. A., Eltsov, O. S. and Lubec, G. (2018), "Diastereoselective synthesis of 1,2,3-triazolines fused with pentane and dihydropyran rings", *Chemistry of Heterocyclic Compounds*, vol. 54, pp. 984–988. DOI: 10.1007/s10593-018-2382-z
- Belskaya, N. P., Eliseeva, A. I., and Bakulev, V. A. (2015), "Hydrazones as substrates for cycloaddition reactions", *Russian Chemical Reviews*, vol. 84, no. 12, pp. 1226. DOI: 10.1070/RCR4463
- Richter, J., Ullah, K., Xu, P. F., Alschner, V., Blatz, A., Peifer, C., Halekotte, J., Leban, J., Vitt, D., Holzmann, K., Bakulev, V., Pinna, L. A., Henne-Bruns, D., Hillenbrand, A., Kornmann, M., Leithauser, F., Bischof, J. and Knippschild, U. (2014), "Effects of altered expression and activity levels of CK1 delta and epsilon on tumor growth and survival of colorectal cancer patients", *International Journal of Cancer*, vol. 136, no. 12, pp. 2799–2810. DOI: 10.1002/ijc.30114
- Filimonov, V. O., Dianova, L. N., Galata, K. A., Beryozkina, T. V., Novikov, M. S., Berseneva, V. S., Eltsov, O. S., Lebedev, A. T., Slepukhin, P. A. and Bakulev, V. A. (2017), "Switchable Synthesis of 4,5-Functionalized 1,2,3-Thiadiazoles and 1,2,3-Triazoles from 2-Cyanothioacetamides under Diazo Group Transfer Conditions", *J. Org. Chem.*, vol. 82, 4056. DOI: 10.1021/acs.joc.6b02736



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PHYSICAL CHEMISTRY OF OXIDE SYSTEMS: THERMODYNAMICS, STRUCTURE, PROPERTIES

Research goal:

Study of synthesis routes, stability, crystal structure and functional properties of complex oxides by means of both experimental and theoretical approaches.

Aspects studied:

- Objects of study
Complex oxides perspective for various applications, such as: electrodes in electrochemical devices, catalysts for oxidation-reduction processes, membrane for oxygen separation, sensor materials, semiconductors, and so on
- Areas of investigations
Thermodynamic stability, phase equilibria, crystal and defect structure, oxygen non-stoichiometry and functional properties

Research highlights:

- Phase equilibria in oxide systems and thermodynamic stability of oxides
- Crystal structure of complex oxides
- Oxygen non-stoichiometry and defect structure of complex oxides (experimental study and modeling)
- Measurements of functional properties (electrical conductivity, Seebeck coefficient, thermal expansion, oxygen permeability)

Career opportunities:

Obtained skills can be applied in future research activities, engineering of solid oxide fuel cells, semiconductors, thermoelectrics, etc. Also received knowledge can serve as a basis for future teaching activity.

Supervisor's specific requirements:

- Good experimental skills: synthesis of solid materials and organization of physicochemical experiment
- Basic knowledge of crystal chemistry, chemical thermodynamics, chemical kinetics, and electrochemistry
- Thoroughness, reliability and efficiency

Main publications:

- Volkova, N. E., Mychinko, M. Yu., Golovachev, I. B., Makarova, A. E., Bazueva, M. V., Zyaikin, E. I., Gavrilova, L. Ya. and Cherepanov, V. A. (2019), "Structure and properties of layered perovskites $Ba_{1-x}Ln_xFe_{1-y}Co_yO_{3-\delta}$ (Ln = Pr, Sm, Gd)", *Journal of Alloys and Compounds*, vol. 784, pp. 1297–1302.
DOI: 10.1016/j.jallcom.2018.12.391
- Gilev, A. R., Kiselev, E. A., Mychinko, M. Yu. and Cherepanov, V. A. (2019), "Topotactic synthesis, crystal structure and oxygen non-stoichiometry of ordered $NdBaMnFeO_{6-\delta}$ ", *Materials Research Bulletin*, vol. 113, pp. 1–5.
DOI: 10.1016/j.materresbull.2018.12.037



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ATOM-EFFICIENT METHODOLOGIES IN ORGANIC SYNTHESIS AND MATERIALS SCIENCE

Research goal:

Fundamental research in the field of synthesis of new organic functional materials, chemosensors and bioactive compounds.

Aspects studied:

- Synthetic, organic and biomolecular chemistry
- Highly reactive organic intermediates
- Photoluminescent detection of bioactive compounds and technogenic waste
- Photochemistry
- Supramolecular chemistry and Molecular recognition
- Coordination chemistry

Research highlights:

Dr. Prof. Grigoriy V. Zyryanov has often adopted unconventional synthetic approaches and methods in his research and this has led to the development of new synthetic strategies in the synthesis of new and efficient chemosensors, ligands for metal cations, photonic materials and biologically active compounds.

Career opportunities:

Positions are open for post-docs and PhD students.

Supervisor's specific requirements:

- Good knowledge in synthetic organic, physical or applied chemistry
- Good analytical and problem-solving skills
- Good experience in using physico-chemical methods of analysis of organic compounds

Main publications:

- Palacios, M. A., Wang, Z., Montes, V. A., Zyryanov, G. V. and Anzenbacher, Jr. P. (2008), "Rational design of a minimal size sensor array for metal ion detection", *Journal of American Chemical Society*, vol. 130, pp. 10307–10314.
DOI: 10.1021/ja802377k
- Zyryanov, G. V., Palacios, M. A. and Anzenbacher, Jr. P. (2007), "Rational design of a fluorescence turn-on sensor array for phosphates in blood serum", *Angewandte Chemie International Edition*, vol. 46, pp. 7849–7852.
DOI: 10.1002/anie.200702611
- Esipenko, N. A., Koutnik, P., Minami, T., Mosca, L., Lynch, V. M., Zyryanov, G. V. and Anzenbacher, Jr. P. (2013), "First supramolecular sensors for phosphonate anions", *Chemical Science*, vol. 135, pp. 7705–7712.
DOI: 10.1039/C3SC51407B

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- Kovalev, I. S., Taniya, O. S., Slovesnova, N. V., Kim, G. A., Santra, S., Zyryanov, G. V., Kopchuk, D. S., Majee, A., Charushin, V. N. and Chupakhin, O. N. (2016), "Fluorescent Detection of 2,4-DNT and 2,4,6-TNT in Aqueous Media by Using Simple Water-Soluble Pyrene Derivatives", Chemistry – An Asian Journal, vol. 11, pp. 775–781.
DOI: 10.1002/asia.201501310
- Sarkar, A., Santra, S., Kundu, S. K., Hajra, A., Zyryanov, G. V., Chupakhin, O. N., Charushin, V. N. and Majee, A. (2016), "A decade update on solvent and catalyst-free neat organic reactions: A step forward towards sustainability", Green Chemistry, vol. 18, pp. 4475–4525.
DOI: 10.1039/c6gc01279e



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SYNTHESIS OF NEW MONO-, POLY- AND MACROCYCLIC ORGANIC PHOTSENSITIVE MATERIALS (ORGANIC PHOTONICS)

Research goal:
Design and synthesis of new organic materials for molecular electronics.

- Aspects studied:**
- Reactions of heterocyclization of functional hydrazones, enamines and ylidenes
 - Investigation of the mechanism of organic reactions using theoretical and experimental methods
 - Synthesis and investigation of the organic compounds with photoactive properties

- Research highlights:**
- New efficient synthetic methods have been developed and a series of new heterocyclic compounds possessing biological activity (fungicidal activity, compounds trigger apoptosis) and interesting optical properties (fluorescence) have been obtained
 - The behavior of small molecular fluorophores (2-aryl-1,2,3-triazoles, 4,5-dihydrotriazoles, arylhydrazonothiazoles, etc.) under excitation was studied by the experimental methods and quantum mechanical calculations
 - A new approach leading to the generation of azomethine ylides under mild conditions was proposed and a series of analogous of natural alkaloids (pyrrolo[3,4-a]pyrrolizines, etc) were synthesized efficiently by 1,3-dipolar cycloaddition
 - A novel reaction electrocyclization which represents a new approach for the synthesis of heterocyclic systems on the basis of bicyclic tetrahydro-1,2,4-triazines have been discovered

Career opportunities:
After graduating from the PhD program, you will obtain expertise in organic synthesis, spectroscopy and organic photoactive materials and be employed by research centers in Russia and other countries.

- Supervisor's specific requirements:**
- Theoretical knowledge in aspects of organic chemistry
 - Fundamental knowledge and skills for the spectral investigation of the structural features of organic molecules and organic reaction mechanisms
 - Good experimental skills applicable in synthesis of organic compounds, their separation and purification

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Main publications:

- Lugovik, K. I., Eltyshev, A. K., Benassi, E., and Belskaya, N. P. (2017), "Synthesis of 5-Acyl 2-Amino 3-Cyanothiophenes: Chemistry and Fluorescent Properties", Chem. – An Asian J., vol. 12, pp. 2410–2415.
DOI: 10.1002/asia.201700721
- Lugovik, K. I., Popova, A. V., Eltyshev, A. K., Benass, I. E., and Belskaya, N. P. (2017), "Synthesis of Thiazoles Bearing Aryl Enamine/Aza-enamine Side Chains: Effect of the π -Conjugated Spacer Structure and Hydrogen Bonding on Photophysical Properties", Eur. J. Org. Chem., pp. 4175–4187.
DOI: 10.1002/ejoc.201700518
- Eliseeva, A. I., Nesterenko, O. O., Slepukhin, P. A., Benassi, E., and Belskaya, N. P. (2017), "Synthesis and Fluorescent Behaviour of 2-Aryl-4, 5-dihydro-1H-1,2,4-triazoles", J. Org. Chem., vol. 1, pp. 86–100.
DOI: 10.1021/acs.joc.6b02144
- Belskaya, N. P., Lugovik, K. I., Bakulev, V. A., Bauer, J., Kitanovic, I., Holenya, P., Zakhartsev, M., and Wöfl, S. (2016), "The new facile and straightforward method for the synthesis of 4H-1,2,3-thiadiazolo[5,4-b]indoles and determination of their antiproliferative activity", Eur. J. Med. Chem., vol. 108, pp. 245–257.
DOI: 10.1016/j.ejmech.2015.11.011

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MODERN SYNTHETIC METHODS IN THE DESIGN OF HETEROCYCLE-BASED ADVANCED MATERIALS

Research goal:

Development of the C (sp^2)-H bond functionalization methodology in (hetero) aromatic and non-aromatic systems as an atom-efficient approach towards novel advanced organic materials.

Aspects studied:

- Comprehensive study of structure and reactivity for heterocyclic compounds
- Atom- and stage-efficient methodologies for C–C and C–N bonds formation in the design of bi- and polyfunctional heterocyclic compounds
- Synthesis and application of organometallic reagents in prospective retrosynthetic schemes

Research highlights:

- Effective synthetic approaches towards novel heterocyclic derivatives of ferrocene, calixarene, carborane, nitroxide radicals have been developed. In particular, a number of 2H-imidazole motif-based biheterocyclic ensembles that are of interest in medical chemistry and materials science have been synthesized.

Career opportunities:

Research activities in leading scientific and educational centers, as well as in industrial companies, specializing in the field of organic synthesis and related areas.

Supervisor's specific requirements:

- Deep knowledge of the organic chemistry theoretical aspects
- Skills of modern methods for the isolation and spectral identification of organic substances
- Practice of organic synthesis and laboratory equipment handling
- Scientific literature sources and data bases application skills

Main publications:

- Mampuys, P., Moseev, T. D., Varaksin, M. V., De Houwer, J., Vande Velde, C. M. L., Chupakhin, O. N., Charushin, V. N. and Maes, B. U. W. (2019), "Synthesis of Functionalized Pyrazin-2(1H)-ones via Tele-Nucleophilic Substitution of Hydrogen Involving Grignard Reactants and Electrophiles", Organic Letters, vol. 21, no. 8, pp. 2699–2703.
DOI: 10.1021/acs.orglett.9b00681
- Akulov, A. A., Varaksin, M. V., Charushin, V. N. and Chupakhin, O. N. (2019), "Direct Functionalization of C (sp^2)-H Bond in Nonaromatic Azaheterocycles: Palladium-Catalyzed Cross-Dehydrogenative Coupling (CDC) of 2H-Imidazole 1-Oxides with Pyrroles and Thiophenes", ACS Omega, vol. 4, no. 1, pp. 825–834.
DOI: 10.1021/acsomega.8b02916

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- Varaksin, M., Moseev, T., Chupakhin, O., Charushin, V. and Trofimov, B. (2017), "Metal-free C-H functionalization of 2H-imidazole 1-oxides with pyrrolyl fragments in the design of novel azaheterocyclic ensembles", *Organic and Biomolecular Chemistry*, vol. 15, no. 39, pp. 8280–8284. DOI: 10.1039/c7ob01999h
- Galliamova, L. A., Varaksin, M. V., Chupakhin, O. N., Slepukhin, P. A. and Charushin, V. N. (2015), "Heterocyclic and Open-Chain Carboranes via Transition-Metal-Free C-H Functionalization of Mono- and Diazine-N-oxides", *Organometallics*, vol. 34, no. 21, pp. 5285–5290. DOI: 10.1021/acs.organomet.5b00736
- Varaksin, M. V., Utepova, I. A., Chupakhin, O. N. and Charushin, V. N. (2012), "Palladium(II)-catalyzed oxidative C-H/C-H coupling and eliminative S_N^H reactions in direct functionalization of imidazole oxides with indoles", *Journal of Organic Chemistry*, vol. 77, no. 20, pp. 9087–9093. DOI: 10.1021/jo301618b

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BENZAZINES DERIVATIVES POSSESSING BIOLOGICAL ACTIVITY AND LUMINESCENT PROPERTIES

Research goal:

Fundamental and applied research in the field of benzazine derivatives (quinolones, quinazolines, quinoxalines, benzothiazines). Development of effective synthetic approaches to heterocyclic compounds possessing luminescent properties and biological activity.

Aspects studied:

- Synthesis of new benzazines including fluorine-containing derivatives
- Synthesis of new materials for optoelectronic devices
- Ligands
- Difluoroboron and metal complexes
- Tuberculostatic and antiviral activity

Research highlights:

- Effective methods synthesis of structural fragments in functionalized π -conjugated systems on the basis of benzazines
- Development of fluorinated benzazines possessing biological activity

Career opportunities:

Graduates will be in demand in research laboratories involved in the study of novel biologically active molecules and components for advanced optical materials.

Supervisor's specific requirements:

- Well knowledgeable in organic and medical chemistry and methods for identification of organic compounds
- Sufficient skills in synthesis

Main publications:

- Lipunova, G. N., Nosova, E. V., Charushin, V. N. and Chupakhin, O. N. (2018), "Functionalized quinazolines and pyrimidines for optoelectronic materials", *Current Organic Synthesis*, vol. 15, no. 6, pp. 793–814. DOI:10.2174/1570179415666180622123434
- Moshkina, T. N., Nosova, E. V., Lipunova, G. N., Valova, M. S. and Charushin, V. N. (2018), "New 2, 3-Bis (5-arylthiophen-2-yl)quinoxaline Derivatives: Synthesis and Photophysical Properties", *Asian Journal of Organic Chemistry*, vol. 7, no. 6, pp. 1080–1084. DOI: 10.1002/ajoc.201800217
- Nosova, E. V., Batanova, O. A., Lipunova, G. N., Kotovskaya, S. K., Slepukhin, P. A., Kravchenko, M. A. and Charushin, V. N. (2019), "Synthesis and antitubercular evaluation of fluorinated 2-cycloalkylimino substituted 1,3-benzothiazin-4-ones", *Journal of Fluorine Chemistry*, vol. 220, pp. 69–77. DOI: 10.1016/j.jfluchem.2019.02.009

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SOLID STATE CHEMISTRY, PHYSICAL CHEMISTRY

Research goal:

The primary focus of this research is to the study of structure, physical-chemical properties of solid electrolyte and electrode materials.

Aspects studied:

- Bismuth containing compounds
- Structural studies
- Impedance spectroscopy

Research highlights:

The research team you will join is young, tolerant, joint and helpful; and involved in international collaboration (UK, Belarus).

Career opportunities:

Getting postgraduate degree from the Ural Federal University opens the way to postdoc positions in many universities.

Supervisor's specific requirements:

- Sufficient background in physical chemistry
- Readiness to manage working by hands (electrodes, furnaces – teaching is included)

Main publications:

- Kaimieva, O. S., Danilova, V. V., Kruzikov, D. A., Buyanova, E. S. and Petrova, S. A. (2017), "The Solid Solutions Based on Lanthanum Manganite as the Cathod Materials for Bismuth-Containing Solid Electrolytes", Russian Journal of Electrochemistry, vol. 53, no. 8, pp. 852–858.
DOI: 10.1134/S1023193517080080
- Buyanova, E. S., Mikhailovskaya, Z. A., Emel'yanova, Yu. V., Levina, A. A., Morozova, M. V., Petrova, S. A. and Tarakina, N. V. (2017), "Production and Characteristics of Substituted Lanthanum Niobate $\text{LaNb}_{1-x}\text{W}_x\text{O}_{4+6}$ ", Russian Journal of Inorganic Chemistry, vol. 62, no. 2, pp. 211–217.
DOI: 10.1134/S0036023617020048
- Buyanova, E. S., Emel'yanova, Yu. V., Morozova, M. V., Krylov, A. A. and Nikolaenko, I. V. (2018), "BIFEVOX Composites: Manufacture and Characterization", Russian Journal of Inorganic Chemistry, vol. 63, no. 10, pp. 1297–1302.
DOI: 10.1134/S0036023618100042
- Mikhaylovskaya, Z. A., Petrova, S. A., Abrahams, I., Buyanova, E. S., Morozova, M. V. and Kellerman, D. G. (2018), "Structure and conductivity in iron-doped $\text{Bi}_{26}\text{Mo}_{10}\text{O}_{69-6}$ ", Ionics, vol. 24, no. 12, pp. 3983–3994.
DOI: 10.1007/s11581-018-2543-1
- Mikhaylovskaya, Z. A., Petrova, S. A., Buyanova, E. S. and Morozova, M. V. (2019), " $\text{Bi}_{26}\text{Mo}_{10}\text{O}_{69}$ -based solid solution with nonmetal dopants: synthesis and properties", Solid State Ionics, vol. 331, pp. 30–36.
DOI: 10.1016/j.ssi.2018.12.014



Aws Ghanem (Syria)

I am grateful that my scientific supervisor, and the department of ecology provided me with all necessary tools, analysis, modern devices and also in coordinating with advisers and experts from other organizations.

I am living a great and a unique stage of my life in the Ural Federal University and I am really happy and satisfied to live and study in Russia.

*Dominique Savio Nsengiyumva
(Rwanda) doing his research in the
program 'Biosciences'*

Duration of study: 4 years

Language: English or Russian

Entry requirements:

- Master's degree (or equivalent) in the related field
- B2 level of English or Russian
- Interview

Entrance exams:

- Foreign language (English/German/French)
- Biosciences

Government scholarship is available.

See more information at:

urfu.ru



Research



Doctoral Programs in English



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IMMUNOCHEMISTRY, BIOCHEMISTRY AND IMMUNOBIOTECHNOLOGY

Research goal:

Development of scientific research in the field of immunochemistry, biochemistry, immunobiotechnology, and implementation of their results in practice.

Aspects studied:

- Development of test systems for immunochemical analysis methods in medicine, pharmacy, biotechnology
- Study of the biochemical and immunological mechanisms in the development of experimental pathology and search of ways of their pharmacological correction
- Development of theoretical bases of biotechnology immunobiological preparations

Research highlights:

Development of immunochemical test systems for the determination of chemical compounds in biological material and environmental objects. In vitro testing of immunotropic properties of new chemical compounds – potential medicines.

Career opportunities:

After graduating from the PhD program you get expertise on biochemistry, immunochemistry and immunobiotechnology and can be employed in laboratories and plants of Russia and other countries

Supervisor's specific requirements:

- A university degree in chemistry, biology, biotechnology or pharmacy
- Research experience in the above mentioned areas
- Knowledge of the methods used in immunology, molecular genetics, genetic engineering, proteomics, separation and purification of biopolymers is recommended

Main publications:

- Gankovskaya, L. V., Svitich, O. A., Chereshevnev, V. A., Karaulov, A. V., Chereshevnev, M. V., Guseva, M. R., Gavrilo, T. V., Grechenko, V. V., Miroshnichenkova A. M., and Zverev V. V. (2014), "Diverse Expression of Toll-Like Receptor-9 and β -Defensin-2 in Corneal Cells during Herpes Simplex Virus-1 Keratitis", International Trends in Immunity, vol. 2, no. 3, pp. 128–133.
[HTTP://researchpub.org/journal/iti/number/vol2-no3/vol2-no3-5.pdf](http://researchpub.org/journal/iti/number/vol2-no3/vol2-no3-5.pdf)

- Baeva, T. A., Gein, S. V., Kuyukina, M. S., Ivshina, I. B., Kochina, O. A., and Chereshevnev, V. A. (2014), "Effect of Glycolipid Rhodococcus Biosurfactant on Secretory Activity of Neutrophils In Vitro", Bulletin of Experimental Biology and Medicine, vol. 157, no. 2, pp. 238–242.

DOI: 10.1007/s10517-014-2534-9

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PLANT PHYSIOLOGY AND BIOCHEMISTRY

Research goal:

Researches focused on the physiological, biochemical and molecular mechanisms of plant growth and development in normal and stress conditions and elaboration of fundamental basis for plant biotechnologies.

Aspects studied:

- Sink-source relations in plants
- Developmental and ecological aspects of photosynthesis
- Plant tolerance
- Molecular physiology of plants

Research highlights:

- The study includes both theoretical and practical courses in plant molecular physiology and biotechnology.
- The students will have the opportunity to conduct research for their thesis in the Center for Fundamental Biotechnology and Bioengineering headed by the supervisor and will participate in laboratory and field studies, as well as field trips.
- The students will pursue their research in international team with the opportunity to do a part of their research in foreign partner universities.

Career opportunities:

The graduates can be demanded both in research institutions and industry dealing with plant biology and biotechnology, innovative agriculture and food biotechnology in Russia and abroad.

Supervisor's specific requirements:

Advanced knowledge in plant physiology and biochemistry, as well as skills in molecular technics.

Main publications:

- Kalinina, T. A., Shakhmina, Yu. S., Glukhareva, T. V., Morzherin, Yu. Yu., Fan, Z. J., Borzenkova, R. A., Skolobanova, E. S. and Kiseleva, I. S. (2014), "1,2,3-thiadiazolyl isocyanates in the synthesis of biologically active compounds. Study of the cytotoxic activity of N-(4-methyl-1,2,3-thiadiazolyl-5-yl)-N-(4-methylphenyl)urea", *Chemistry of Heterocyclic Compounds*, vol. 50, no. 7, pp. 1039–1046.
DOI: 10.1007/s10593-014-1561-9
- Ermoshin, A., Shatunova, S. and Kiseleva, I. (2015), "White clover cell culture tolerance to copper ions", *Journal of Biotechnology*, vol. 208, no. 20, pp. 115.
DOI: 10.1016/j.jbiotec.2015.06.362

- Mukhin, V. A., Patova, E. N., Kiseleva, I. S., Neustroeva, N. V. and Novakovskaya, I. V. (2016), "Mycetobiont symbiotic algae of wood-decomposing fungi", *Russian Journal of Ecology*, vol. 47, no. 2, pp. 133–137.
DOI: 10.1134/S1067413616020089
- Ermoshin, A. A., Kiseleva, I. S., Bortsova, S. A., Sanaeva, Y. V. and Alekseeva, V. V. (2016), "Morphological features of the transgenic tobacco plant shoot expressing the 3-hydroxy-3-methylglutaryl-CoA reductase (HMG1) gene in the direct and reverse orientations towards the promoter", *Russian Journal of Developmental Biology*, vol. 47, no. 1, pp. 216–222.
DOI: 10.1134/S1062360416040044
- Darkazanli, M., Kiseleva, I. and Darkazanli, K. (2018), "Genetic Diversity of E. coli O157: H7 Isolated from Some Leafy Greens, Irrigated by Aleppo River, Using Random Amplified Polymorphic DNA (RAPD) Marker", *Russ. Agricult. Sci.*, vol. 44, p. 146.
DOI: 10.3103/S1068367418020039



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AMPHIBIAN FUNCTIONAL ECOLOGY IN NATURAL AND MAN-TRANSFORMED ENVIRONMENT

Research goal:

The main objective of the research is to improve and develop a new methodology based on ecological functional analysis of amphibian ecophysiology, morphogenesis specific and its ecological mechanisms in natural populations of amphibians under effect of natural and anthropogenic environmental factors. The general theoretical significance of this area can be briefly described as functional amphibian ecology. This approach allows using the new parameters in the assessment of potential risks to human and animal populations under the effect of pollution and urbanization.

Aspects studied:

- Population ecology of amphibian
- Effects of environmental changes on populations and ecosystems
- Ecological physiology
- Problems of adaptation
- Morphogenesis
- Ontogenetic stability
- Problems of evolution in natural and man-transformed environment
- Urban ecology

Research highlights:

Making complex of researches on the different hierarchic levels of structural organization (organism, population, community) and functional specificity in natural amphibian populations as a central point of investigations. Possibility of cooperation with Helmholtz center (Germany, Leipzig), Institute of cytology and genetics RAS, Siberian division (Novosibirsk), and Institute of Plant and Animal Ecology RAS, Ural division (Ekaterinburg).

Career opportunities:

- Experience of research realization in the field of urban ecology, morphogenesis diversification in natural populations, functional ecology, coevolution, bioindication, ecological monitoring, and conservation of amphibian populations
- The results can be used as a basement for developing an optimal strategy of biodiversity conservation, monitoring and environmental health evaluation

Supervisor's specific requirements:

Knowledge on animal ecology, evolution, and morphogenesis.

Main publications:

- Baitimirova, E. A., Vershinin, V. L. (2017), "Interpopulation Variability in Growth and Puberty Rates in Male Moor Frogs (*Rana arvalis* Nilsson, 1842)", *Contemporary Problems of Ecology*, vol. 10, issue 1, pp. 9–16.
DOI: 10.1134/S1995425517010024
- Vershinin, V. L., Bersin, D. L., Vershinina, S. D. (2016), "Amphibian teratology – possible adaptive and evolutionary interpretations", *Vestnik of St. Petersburg State University, Series 3 – Biology*, issue 3, pp. 36–40. (in Russian).
DOI: 10.21638/11701/spbu03.2016.307
- Vershinin, V. L., Vershinina, S. D., Berzin, D. L., Zmeeva, D. V., Kinev, A. V. (2015), "Longterm observation of amphibian populations inhabiting urban and forested areas in Yekaterinburg, Russia", *Sci. Data* 2, article id. 150018
DOI: 10.1038/sdata.2015.18
- Vershinin, V. L. and Vershinina, S. D. (2013), "Physiological similarity of morphs due to homologous alleles in representatives of the Ranidae family", *Uspekhi sovremennoi Biologii*, vol. 113, no. 5, pp. 516–523. (in Russian).
<http://elibrary.ru/item.asp?id=20819522>
- Vershinin, V. L. and Vershinina, S. D. (2013), "Comparative Analysis of Hemoglobin Content in Four Species of Anurans from the Ural Uplands", *Doklady Biological Sciences*, vol. 450, issue 1, pp. 155–157.
DOI: 10.1134/S0012496613030137

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BIODIVERSITY AND ECOLOGY OF PLANT AND FUNGI IN A CHANGING WORLD

Research goal:

The research focuses on training specialists in Botany, Mycology, Ecology of Plants and Fungi, familiar with classical methods of field researches as well as high-tech experimental methods.

Aspects studied:

- Mycology: fungi biodiversity, geography, ecology, physiology
- Botany: plant biodiversity, ecology, ethnobotany
- Ecology: carbon and nitrogen cycles of the forest ecosystem, greenhouse gases, emission
- Biotechnology: medicinal fungi, biodiversity, molecular genetics

Research highlights:

Work involves a combination of field and experimental studies.

Career opportunities:

After graduating from the PhD program you got expertise on the ecology of fungi and plants, plant pathology, biodeterioration of woody plant and woody substances, using of fungi in biotechnology and can find a job in Russia and other countries.

Supervisor's specific requirements:

University degree in Botany, Mycology, Ecology.

Main publications:

- Mukhin, V. A., Neustroeva, N. V., Patova, E. N., Novakovskaya, I. V. and Kiseleva, I. S. (2016), "Mycetobiont symbiotic algae of wood-decomposing fungi", *Russian Journal of Ecology*, T. 47, no. 2, pp. 133–137.
DOI: 10.1134/S1067413616020089
- Voronin, P. Yu., Mukhin, V. A., Velivetskaya, T. A., Ignat'ev, A. V. and Kuznetsov, V. V. (2017), "Isotope composition of carbon and nitrogen in tissues and organs of *Betula pendula*", *Russian Journal of Plant Physiology*, T. 64, no. 2, pp. 184–189.
DOI: 10.1134/S102144371701017
- Gitarskiy, M. L., Zamolodchikov, D. G., Mukhin, V. A., Grabar, V. A., Diyarova, D. K. and Ivashchenko, A. I. (2017), "Carbon Fluxes from Coarse Woody Debris in Southern Taiga Forests of the Valdai Upland", *Russian Journal of Ecology*, vol. 48, no. 6, pp. 539–544.
DOI: 10.1134/S1067413617060030

- Mukhin, V. A., Neustroeva, N. V., Patova, E. N. and Novakovskaya I. V. (2018), "Lichen-like Symbiotic Associations of Wood-decaying Fungi and Algae. I. Biodiversity and Ecology of Photobionts", *The fourth International Scientific Conference on Ecology and Geography of Plants and Plant Communities*, 16–19 April, 2018, Ekaterinburg, Russia, pp. 134–142.
DOI: 10.18502/cls.v4i7.3231
- Mukhin, V. A., Knudsen, H., Kotiranta, H., Corfixen, P. and Kostitsina, M. V. (2018), "Wood-decaying Basidiomycetes Associated with Dwarf Siberian Pine in Northeast Siberia and the Kamchatka Peninsula", *The fourth International Scientific Conference on Ecology and Geography of Plants and Plant Communities*, 16–19 April, 2018, Ekaterinburg, Russia, pp. 125–133.
DOI: 10.18502/cls.v4i7.3230
- Mukhin, V. A., Zhuykova, E. V. and Badalyan, S. M. (2018), "Genetic Variability of the Medicinal Tinder Bracket Polypore, *Fomes fomentarius* (Agaricomycetes), from the Asian Part of Russia", *International Journal of Medicinal Mushrooms*, vol. 20, no. 6, pp. 561–568.
DOI: 10.1615/IntJMedMushrooms.2018026278.
- Mukhin, V. A., Patova, E. N., Sivkov, M. D., Novakovskaya, I. V. and Neustroeva, N. V. (2018), "Diversity and Nitrogen-Fixing Activity of Phototrophic Mycetobionts of Xylotrophic Fungi", *Russian Journal of Ecology*, vol. 49, no. 5, pp. 406–412.
DOI: 10.1134/S1067413618050090



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PLANT BIODIVERSITY, BIOGEOGRAPHY, BIOLOGICAL INVASIONS, URBAN ECOLOGY AND WEEDS

Research goal:

In-depth study of various aspects of plant biodiversity, biogeography, biological invasions, urban ecology and weeds

Aspects studied:

Biodiversity: Research on plant biodiversity, determinative factors (geographical, climatic, anthropogenic), quantitative evaluation of these factors according to their importance with the use of mathematical and statistical data processing methods.

Biogeography: Research on spatial structure of biodiversity, regional floras comparison, biotic homogenization and differentiation analysis.

Biological Invasions: Study on invasive species, their dispersal in secondary area and intrusion into natural plant communities and invasive plants pathway analysis.

Urban ecology: Research on biodiversity, patterns of formation and ecological importance of urban ecosystem plant component.

Weed plants: Research on biodiversity of weeds, its regional and latitudinal variations and weeds ecobiological features.

Research highlights:

Work involves a combination of field and experimental studies.

Career opportunities:

Botany and Ecology.

Supervisor's specific requirements:

University degree in Botany and Ecology.

Main publications:

- Tretyakova, A.S. (2016), "Regularities of distribution of alien plants in anthropogenic habitats of Sverdlovsk oblast", *Rus. J. of Biol. Invasions*, vol. 7, no. 1, pp. 77–83.
DOI: 10.1134/S2075111716010100

DOI: 10.1134/S2075111716010100

- Veselkin, D. V., Tretyakova, A. S., Senator, S. A., Saksonov, S. V., Mukhin, V. A. and Rozenberg, G. S. (2017), "Geographical Factors of the Abundance of Flora in Russian Cities", *Doklady Earth Sciences*, vol. 476, part 1, pp. 1113–1115.
DOI: 10.1134/S1028334X1709029X

DOI: 10.1134/S1028334X1709029X

- Tretyakova, A. S., Veselkin, D. V., Senator, S. A. and Golovanov, Ya. M. (2018), "Factors of Richness of Urban Floras in the Ural-Volga Region", *Russian Journal of Ecology*, vol. 49, no. 3, pp. 201–208.
DOI: 10.1134/S1067413618030098

DOI: 10.1134/S1067413618030098



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SYSTEMATICS AND ECOLOGY OF LICHENISED ASCOMYCETES

Research goal:

The research is focused on studies of biodiversity and systematics of lichens and revealing interactions of lichens and rocky substrate on the level of species and communities.

Aspects studied:

- Diversity, taxonomy and nomenclature of selected groups of lichens
- Diversity of lichen species on different rock types
- Ecological requirements of species and structure of saxicolous communities
- Role of secondary lichen metabolites
- Taxonomy and nomenclature of separate groups of lichens
- Substrate endemism in lichens

Research highlights:

The study is conducted in collaboration with an international research group within International Society on Serpentine Ecology (ISES) and supported by RFBR grants.

Career opportunities:

Due to experience in obtaining systematically meaningful information and field ecological data as well as using diverse software, a successful graduate may proceed his or her career in systematics of particular groups of lichenised ascomycetes, ecological monitoring, and environmental assessment.

Supervisor's specific requirements:

Elementary skills in determination of lichens, TLC and field experience.

Main publications:

- Paukov, A. G. (2009), "The Lichen Flora of Serpentine Outcrops in the Middle Urals of Russia", *Northeastern Naturalist*, vol. 16, special Issue 5, pp. 341–350.
DOI: 10.1656/045.016.0525

DOI: 10.1656/045.016.0525

- Paukov, A. G., Teptina, A. Yu., and Pushkarev, E. V. (2015), "Heavy metal uptake by chemically distinct lichens from *Aspicilia* spp. growing on ultramafic rocks", *Australian Journal of Botany*, vol. 63, pp. 111–118.
DOI: 10.1071/BT14255

DOI: 10.1071/BT14255

- Paukov, A., Nordin, A., Roux, C., Moon, K. H., and Davydov, E. (2017), "Lectotypification and synonymization of some *Aspicilia* species (Megasporeaceae, Ascomycota) described by A. Hue from Korea and Japan", *Phytotaxa*, vol. 291, no. 1, pp. 94–98.
DOI: 10.11646/phytotaxa.291.1.10

DOI: 10.11646/phytotaxa.291.1.10



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ENVIRONMENTAL BIOTECHNOLOGY FOR NATURAL AND TECHNOGENIC ENVIRONMENT

Research goal:

The research focuses on obtaining and sharing a broad range of knowledge for utilization of beneficial microbes, plants and organic amendments for remediation and restoration of natural and technogenic disturbed sites.

Aspects studied:

- Environmental pollution
- Microbial biotechnology
- Environmental monitoring and assessment
- Health impact due to metal pollution
- Organic amendments
- Bioremediation using high biomass plant

Research highlights:

- Phytoremediation of water and soil
- Environmental Microbiology
- Heavy metal assessment
- Solid and Hazardous waste management
- Environmental stress in plants
- Sustainable waste management

Career opportunities:

Graduates can work at leading international technical universities, research institutions and industrial companies dealing with preparation of bioformulation/biofertilizer, pollution control board, and environmental impact assessment companies.

Supervisor's specific requirements:

- Fluent in English
- Skills in using academic literature databases
- Knowledge of biotechnological and environmental equipments.
- Working experience with MS-EXCEL/statistical software.
- Basic knowledge of plant, soil and water contamination.

Main publications:

- Kumar, A., Tripti, Maleva, M., Kiseleva, I., Maiti, S.K., and Morozova, M. (2019), "Toxic metal(loid)s contamination and potential human health risk assessment in the vicinity of century-old copper smelter, Karabash, Russia", *Environmental Geochemistry and Health*. In-Press

DOI: 10.1007/s10653-019-00414-3

- Kumar, A. and Tripti (2018), "High ACC deaminase producing copper and nickel tolerant rhizobacteria enhances metal tolerance and seedling growth of Indian mustard plant", *New Biotechnology*, vol. 44, 90.
DOI: 10.1016/j.nbt.2018.05.944

- Tripti, Kumar, A., Usmani, Z., Kumar, V., and Anshumali (2017), "Biochar and flyash inoculated with plant growth promoting rhizobacteria act as potential biofertilizer for luxuriant growth and yield of tomato plant", *Journal of Environmental Management*, vol. 190, pp.20–27.
DOI: 10.1016/j.jenvman.2016.11.060

- Kumar, A., Maiti, S.K., Tripti, Prasad, M.N.V., and Singh, R.S. (2017), "Grasses and legumes facilitate phytoremediation of metalliferous soils in the vicinity of an abandoned chromite-asbestos mine", *Journal of Soils and Sediments*, vol. 17, no. 5, pp. 1358–68.
DOI: 10.1007/s11368-015-1323-z

- Kumar, A. and Maiti, S.K. (2015), "Effect of organic manures on the growth of *Cymbopogon citratus* and *Chrysopogon zizanioides* for the phytoremediation of chromite-asbestos mine waste: a pot scale experiment", *International Journal of Phytoremediation*, vol. 17, no. 5, pp. 437–447.
DOI: 10.1080/15226514.2014.910174

- Kumar, A. and Maiti, S.K. (2015), "Assessment of potentially toxic heavy metal contamination in agricultural fields, sediment, and water from an abandoned chromiteasbestos mine waste of Roro hill, Chaibasa, India", *Environmental Earth Sciences*, vol. 74, no. 3, pp. 2617–2633.
DOI: 10.1007/s12665-015-4282-1

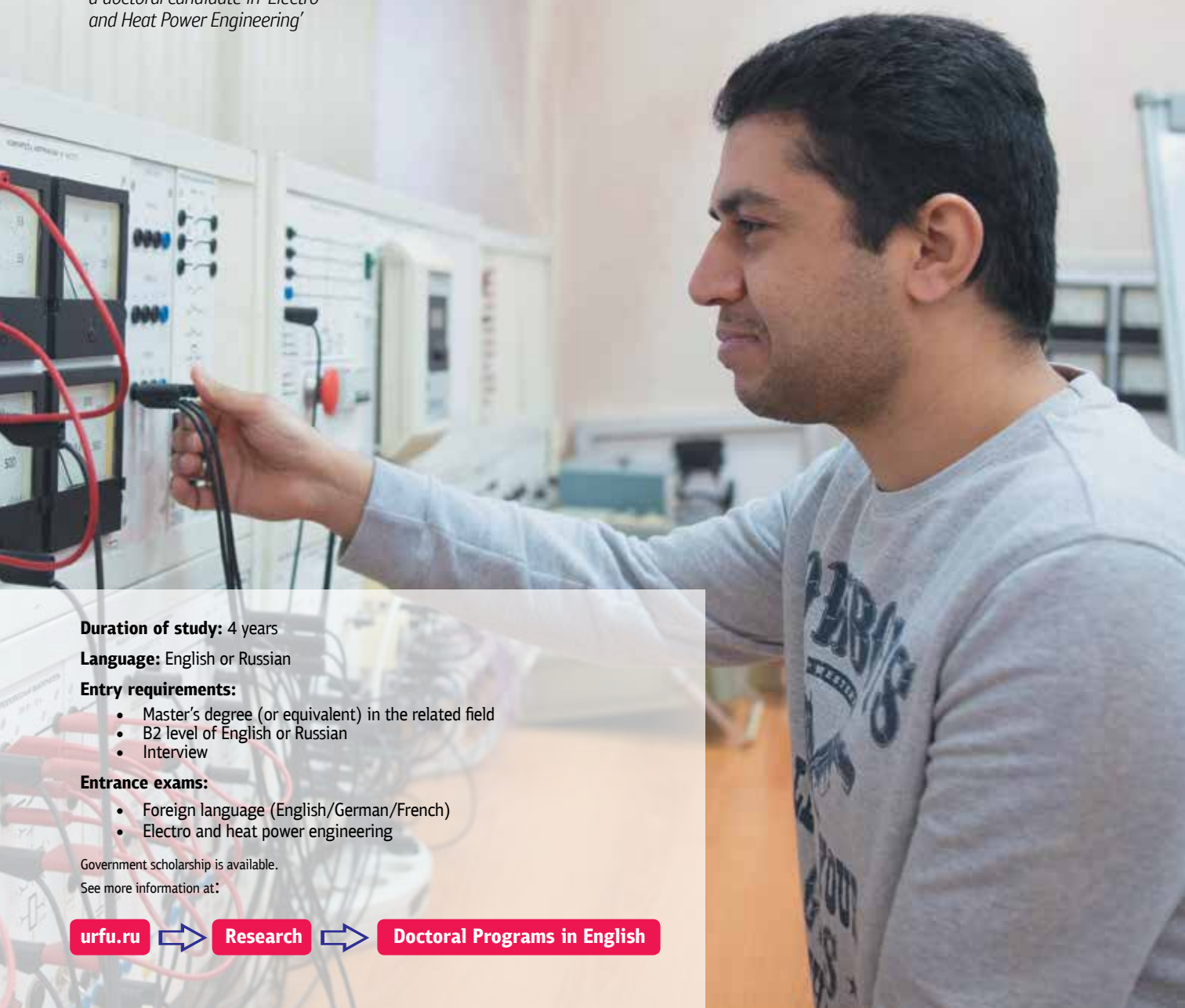
- Ahirwal, J., Kumar, A., Pietrzykowski, M. and Maiti, S.K. (2018), "Reclamation of coal mine spoil and its effect on Technosol quality and carbon sequestration: a case study from India", *Environmental Science and Pollution Research*, vol. 25, no. 28, pp. 27992–28003.
DOI: 10.1007/s11356-018-2789-1

- Maleva, M., Borisova, G., Chukina, N., and Kumar, A. (2017), "Urea increased nickel and copper accumulation in the leaves of *Egeria densa* (Planch.) Casp. And *Ceratophyllum demersum* L. during short-term exposure", *Ecotoxicology and Environmental Safety*, vol. 148, pp. 152–159.
DOI: 10.1016/j.ecoenv.2017.10.012

Engineering



*Mahmoud Mahrous Amery Aref (Egypt)
a doctoral candidate in 'Electro
and Heat Power Engineering'*



Duration of study: 4 years

Language: English or Russian

Entry requirements:

- Master's degree (or equivalent) in the related field
- B2 level of English or Russian
- Interview

Entrance exams:

- Foreign language (English/German/French)
- Electro and heat power engineering

Government scholarship is available.

See more information at:

urfu.ru



Research



Doctoral Programs in English



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ENERGY-INFORMATIONAL MODELS OF FUNCTIONING AND DEVELOPMENT OF POWER SUPPLY SYSTEMS FOR MEGALOPOLISES

Research goal:

The study is aimed at training specialists in the field of constructing and monitoring technical conditions of power supply systems.

Aspects studied:

- Adaptive and multi-level information systems, decision support for management tasks and objectives of the development of power supply systems of large cities
- Structures of storing information about objects and the individual elements of the urban power grid
- Methods indicative analysis of the functional state of electrical equipment and assessment modes of power supply systems in general

Research highlights:

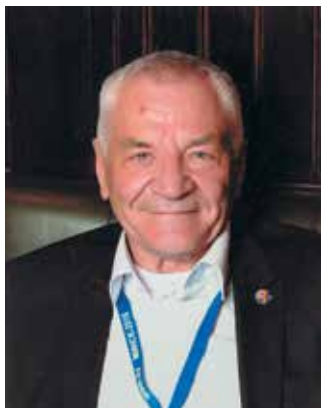
Development of systematic and analytical thinking, ability to predict situation development and decision outcomes, ability to think realistically and on a large scale.

Career opportunities:

Employment and research in the field of technologies, which involve creating energy-efficient systems for power transporting, distribution and use.

Main publications:

- Manusov, V., Matrenin, P. and Kokin, S. (2017), "Swarm intelligence algorithms for the problem of the optimal placement and operation control of reactive power sources into power grids", International Journal of Design and Nature and Ecodynamics, vol. 12, no. 1, pp. 101–112.
DOI: 10.2495/DNE-V12-N1-101-112
- Djararov, N., Grozdev, Z., Bonev, M., Djararova, J., Pazderin, A. and Kokin, S. (2016), "Adaptive control of wind PMSG", 17th International Scientific Conference on Electric Power Engineering, Prague, Czech Republic, May 16–18, 2016, 7521828.
DOI: 10.1109/EPE.2016.7521828

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HIGHLY EFFICIENT ENERGY CONVERSION AND GENERATION TECHNOLOGIES BASED ON FOSSIL FUELS

Research goal:

The aim of the research is to create highly effective and ecological technologies for energy generation using fossil and industrial fuels.

Aspects studied:

- Solid fuels combustion and gasification technologies
- Complex thermodynamic calculations for IG Cpower plants
- CFD modeling for the entire gasifier processes
- Kinetics experiments with coal and biomass
- High-temperature air heating technologies
- GT operating on LCV syngas

Research highlights:

- Analysis of modern academic literature with the use of major international databases: Web of Science, Scopus, ScienceDirect, etc.
- Conducting experimental research using university facilities as well as best equipment in Russia and foreign countries
- Calculating heat schemes for electric power plants using advanced specialized software: Aspen Plus, Thermoflow, Epsilon, etc.
- 3D modeling of perspective heat and energy processes using calculation hydrodynamics methods (CFD) with high – productive computers
- Joint research (collaboration) with the leading national and foreign scientific centers (IT SB RAS, TU Freiberg, HIT)

Career opportunities:

- International energy generation companies
- Leading international technical universities and research centers

Supervisor's specific requirements:

- Fluent English (basic Russian language will be an advantage)
- Skills in using academic literature databases
- Awareness of modern power technologies and trends in heating and power technologies development
- Mastering main experimental methods including thermal analysis (thermogravimetric analysis, etc.)
- Ability to calculate basic heat schemes for electric power stations
- Skills in modeling heat and power devices using calculation hydrodynamics methods (CFD)
- Experience in publishing articles in high – rating journals and presenting reports at international conferences

Main publications:

- Ryzhkov, A., Bogatova, T. and Gordeev, S. (2018), "Technological solutions for an advanced IGCC plant", Fuel, vol. 214, pp. 63-72.
DOI: 10.1016/j.fuel.2017.10.099
- Ryzhkov, A. F., Abaimov, N. A., Donskoi, I. G. and Svishev, D. A. (2018), "Modernization of Air-Blown Entrained-Flow Gasifier of Integrated Gasification Combined Cycle Plant", Combustion, Explosion and Shock Waves, vol. 54, no. 3, pp. 337-344.
DOI: 10.1134/S0010508218030103



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ELECTROMECHANICAL MOTION CONTROL SYSTEM

Research goal:

The study is aimed at training specialists in the field of modern automated electric drives, simulation mathematic modeling and design of electro-mechanic of AC/DC systems.

Aspects studied:

- Simulation of electric drives and technological machines and mechanisms, including real-time simulation
- Analysis and optimization of the electric drive behavior for energy datum
- Development and research of electrified transport systems
- Development of expert systems for the assessment of the state of machine units on the basis of the variables of the electric drive

Research highlights:

Available equipment allows to create program simulators of electro-mechanic systems with semi-conductor converters of variable complexity and topology (AC/DC, AC/AC, DC/AC, DC/DC). The use of FPGA in controllers allows to use «hardware-in-the-loop» (HIL) technology, returning object variables from the simulation model at a frequency of no less than 1 MHz. The use of such simulators is the most effective in conducting and adjusting control systems of electric drives of complex technological machines and equipment such as metallurgical machines electric drives, transportation and hoisting machines, traction devices, etc.

Career opportunities:

Research and employment in the field of energy effective electric drives, power supply and electromagnetic compatibility, electric drive systems modeling, design, and regulation (using National Instruments equipment), electric drives testing, cost minimization, etc.

Supervisor's specific requirements:

- Knowledge of Si, VHDL
- Experience with Matlab and LabVIEW
- Knowledge of electro-mechanics, power converters and automation control theory

Main publications:

- Zyuzev, A. M., Mudrov, M. V., and Nesterov, K. E. (2016), "PHIL-system for electric drives application", 9th International Conference on Power Drives Systems, ICPDS2016. DOI: 10.1109/ICPDS.2016.7756687



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TECHNOLOGICAL TRANSPORT SYSTEM BASED ON LINEAR ELECTRIC DRIVE

Research goal:

The study is aimed at training specialists in the field of construction and operation of linear electric motors in industry and transportation.

Aspects studied:

- Constructions and modes of operation of transport systems on the basis of linear synchronous and asynchronous electric motors
- Induction systems of technological transport of conductive fluids (molten metals)
- Electrodynamic processes in multi-layer massive conductive secondary elements
- Calculations of thermal processes and design of cooling systems in unequally loaded linear motors
- Numerical modeling of electromagnetic and thermal processes in induction devices with non-continuous magnet cores on the basis of detailed equivalent circuit

Research highlights:

Study of linear electric motor types, their theory, mathematic models and methods of calculating their characteristics as well as exploitation peculiarities.

Career opportunities:

Graduates can work at teaching, research institutions and industrial companies dealing with linear electric motors for industry and transport.

Supervisor's specific requirements:

Applicant must have master degree in the field of electromechanics or electric motors.

Main publications:

- Dmitrievskii, V., Goman, V., Sarapulov, F., Prakht, V. and Sarapulov, S. (2016), "Choice of a numerical differentiation formula in detailed equivalent circuits models of linear induction motors", International Symposium on Power Electronics, Electrical Drives, Automation and Motion, SPEEDAM 2016, 28 July 2016, pp. 458–463 DOI: 10.1109/SPEEDAM.2016.7525888
- Sarapulov, F.N., Sarapulov, S.F., and Frizen, V.E. (2015), "Use of detailed equivalent circuit method for investigation of electromagnetic, thermal and hydrodynamic processes in induction electric engineering units", Acta Technica CSAV (Ceskoslovensk Akademie Ved), vol. 60, no. 2, pp. 131–153.



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MODERNIZATION OF DESIGN AND OPERATIONAL PROCESSES FOR STEAM TURBINES EQUIPMENT BASED ON MODERN IT

Research goal:

The study is aimed at training specialists in the design and operation of steam turbine equipment. The second goal is to explore the possibilities of using “smart” technologies, such as the Internet of Things (IoT) to optimize the effectiveness of steam turbine equipment.

Aspects studied:

- Problems of aerohydrodynamical vibration initiation of turbine elements during operation
- Modernization of design methods for layout of the equipment based on modern technologies
- Modernization of design methods for steam turbines equipment based on modern technologies
- CAD, CAM and CAE applications for design and operation processes improvement

Research highlights:

- In accordance with the life cycle methodology support, a conceptual model of the information support system during life cycle main stages of steam turbine unit is suggested
- A system for designing water heaters of steam–turbine installations based on uniting standards, reference information and some numerical procedures with design procedures via wide use of parameterization is developed
- A system for the automated design of oil coolers for steam turbines is developed

Career opportunities:

Specialists in the field of CAD/CAM/CAE-technologies for the design of machinery are in high demand in industry, science and business.

Supervisor's specific requirements:

Knowledge in the field of thermodynamics, CAD – technologies (Autocad, Creo Parametric), CAE-technologies (Creo Simulate, Ansys Fluent) is necessary.

Main publications:

- Brezgin, V. I., Brodov, Yu. M. and Kultishev, A. Yu. (2017), “Improvement of Steam Turbine Operational Performance and Reliability with using Modern Information Technologies”, International Conference on Problems of Thermal Physics and Power Engineering (PTPPE2017), 9–11 October 2017, Moscow, Russia, 012246.
DOI: 10.1088/1742–6596/891/1/012246

- Aronson, K. E., Brezgin, V. I., Brodov, Y. M., Gorodnova, N. V., Kultyshev, A. Y., Tolmachev, V. V. and Shablova, E. G. (2016), “Development of requirements on safety cases of machine industry products for power engineering”, Thermal Engineering, vol. 63, no. 14, pp. 1003–1015.
DOI: 10.1134/S0040601516140032
- Brezgin, V. I., Brodov, Y. M. and Brezgin, D. V. (2015), “Increasing reliability of system water heaters for steam–turbine installations at the design stage”, Thermal Engineering (Teploenergetika), vol. 62, no. 14, pp. 1032–1037.
DOI: 10.1134/S0040601515140037

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MANAGED DYNAMICAL SYSTEMS WITH INCOMPLETE INFORMATION IN ENGINEERING AND ECONOMICS

Research goal:

The study is focused on training highly qualified specialists in the field of mathematical modeling of technical and economics objects for solving control problems.

Aspects studied:

- Minimax observation and control problems for dynamical systems
- Numerical methods of forming solutions for control problems
- Adaptive control systems for mechanical objects
- Information systems for economics dynamical systems
- Intellectual information systems for technical objects

Research highlights:

- Training highly qualified specialists capable of developing dynamic models and methods for solving problems of optimal estimation and control for complex technical and economic objects
- Training highly qualified specialists capable of developing intelligent information systems for optimizing management decisions for complex dynamical technical and economic objects
- Studying several academic disciplines on educational programs for training specialists in the field of mathematical modeling and management processes

Career opportunities:

- Researcher in a large corporation to design and develop navigation and control systems of complex dynamical objects
- Specialist in the design and development of computer software systems to solve optimal control problems of complex technical and economic objects in large IT-firms
- Teaching students in educational programs for training specialists in mathematical modeling and control processes

Supervisor's specific requirements:

A degree in the field of Applied Mathematics or Engineering.

Main publications:

- Shorikov, A. F. and Butsenko, E. V. (2017), Prognozirovaniye i optimizatsiya rezultata upravleniya investitsionnykh proektirovaniyem [Forecasting and optimization of the result of investment project management], URSS, Moscow, Russian Federation, 272 p. (in Russian)
ISBN: 978-5-9710-4771-1

- Shorikov, A. F. (2017), "Algorithm for solving of two-level hierarchical minimax program control problem of final state the regional socio-economic system in the presence of risks", The 9th International Conference: «Application of Mathematics in Technical and Natural Sciences (AMiTaNS'17)», Albena, Bulgaria, June 21–26, 2017, vol. 1985, pp. 050012-1-11.
DOI: 10.1063/1.5007384
- Shorikov, A. F. (2018), "Minimax Program Terminal Control in Two-Level Hierarchic Nonlinear Discrete Dynamical System", Journal of Mathematical Sciences, vol. 230, no. 5, pp. 808–812.
DOI: 10.1007/s10958-018-3795-z
- Shorikov, A. F. (2018), "Algorithm for Solving of Two-Level Hierarchical Minimax Adaptive Control Problem in a Linear Discrete-Time Dynamical System", IFAC PapersOnLine, vol. 51, no. 32, pp. 838–843.
DOI: 10.1016/j.ifacol.2018.11.441
- Shorikov, A. F. (1996), "An Algorithm for a Posteriori Minimax Estimation of States of Discrete Dynamic Systems. II", Automation and Remote Control, vol. 57, no. 9, pp. 1335–1343.
<https://elibrary.ru/item.asp?id=13234236>
- Shorikov, A. F. (2004), "Problem of Adaptive Minimax Control for Pursuit-Evasion Process", Information Processing: Recent Mathematical Advances in Optimization and Control, Mathematical and Computational Sciences, pp. 1–10.
DOI: 10.1016/S1474-6670(17)35159-5
- Shorikov, A. F. (2005), "An Algorithm of Adaptive Minimax Control for Pursuit-Evasion in Discrete Dynamical Systems with Several Pursuers", Journal of Computer and Systems Sciences International, vol. 44, no. 5, pp. 761–776.
<https://elibrary.ru/item.asp?id=13475768>
- Shorikov, A. F. (2014), "Minimax program control for the approach process in a two-level hierarchical discrete dynamical system", Automation and Remote Control, vol. 75, no. 3, pp. 458–469.
DOI: 10.1134/S0005117914030047



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ELECTROTECHNOLOGIES IN METALLURGY

Research goal:

Finding solution for electromagnetic and heat tasks using modern digital modeling packages

Aspects studied:

- Electrotechnology
- Electromagnetic field theory
- Magnetic hydrodynamics
- Transformation technology

Research highlights:

Extensive experience in modern digital packages for modeling electromagnetic and heat tasks.

Career opportunities:

Companies dealing with electrometallurgy

Supervisor's specific requirements:

Knowledge of electromagnetic fields theory. Ability to work with CAD software

Main publications:

- Sarapulov, S., Kazakbaev, V., Prakht, V., Dmitrievskii, V., Oshurbekov, S. (2019), "Efficiency analysis of low electric power drives employing induction and synchronous reluctance motors in pump applications", *Energies*, vol. 12, issue 6, 1144. DOI: 10.3390/en12061144
- Sarapulov, S., Dmitrievskii, V., Prakht, V., Kazakbaev, V. (2018), "Optimal design of a high-speed single-phase flux reversal motor for vacuum cleaners", *Energies*, vol. 11, issue 12, 3334. DOI: 10.3390/en11123334
- Sarapulov, S. F., Frizen, V. E., Smolianov, I. A. (2018), "Induction crucible furnace with reactive power nonsymmetrical compensation of inductor sections", *Proceedings of 2018 20th International Symposium on Electrical Apparatus and Technologies (SIELA)*. DOI: 10.1109/SIELA.2018.8447132
- Sarapulov, S., Sarapulov, F., Smolyanov, I. (2017), "Research of thermal regimes of linear induction motor", *Proceedings of 2017 18th International Conference on Computational Problems of Electrical Engineering (CPEE)*. DOI: 10.1109/CPEE.2017.8093079
- Sarapulov, S., Sarapulov, F., Smolyanov, I. (2017), "Compensated linear induction motor characteristics research by detailed magnetic equivalent circuit", *Proceedings of 2017 International Conference on Industrial Engineering, Applications and Manufacturing (ICIEAM)*. DOI: 10.1109/ICIEAM.2017.8076314



Sawfan Abo Saleh
(Syria)

Ural Federal could not have provided me with a better experience of university life. The staff and students are all friendly, the **course is brilliant**, the social life is great and the campus provides a **safe and friendly environment** to live in!



Duration of study: 4 years

Language: English or Russian

Entry requirements:

- Master's degree (or equivalent) in the related field
- B2 level of English or Russian
- Interview

Entrance exams:

- Foreign language (English/German/French)
- Nuclear, Thermal and Renewable Energy and Related Technologies

Government scholarship is available.

See more information at:

urfu.ru ➡ **Research** ➡ **Doctoral Programs in English**

*Akram Hamzah Abed Al-Janabi (Iraq)
a doctoral candidate in 'Nuclear, Thermal
and Renewable Energy and Related
Technologies'*



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COMPLEX ENERGY SYSTEMS

Research goal:

The study is aimed at training specialists in the field of improving and introducing equipment for using renewable energy sources and two-phase flows in power machines pipelines.

Aspects studied:

- Dosimetry and protection from ionizing radiation
- Vibration of pipelines with two-phase flows in NPP equipment
- Main and auxiliary equipment of renewable energy sources
- Heat pumps, biogas plants, solar PV system and vacuum collectors, wind turbines
- Optimization of energy systems based on renewable energy sources

Research highlights:

- Research and improvement of RES equipment functioning modes
- Creation of software for optimizing complex energy systems based on RES
- Participation in innovation projects aimed at implementing RES
- Researching two-phase flows using experimental vibro-diagnostic stand
- Designing effective passive devices for decreasing pipeline vibrations at power plants

Career opportunities:

- Implementing projects of power industry objects based on renewable energy sources (RES)
- Management of small innovation enterprises dealing with RES, designing power industry objects and infrastructure with the use of RES
- Managing power industry objects (heat and power supply) of an object, company, area, region
- Managing municipal, regional and republican sectors of implementing and developing RES
- Organization of international cooperation in the field of introducing innovative power objects using RES

Supervisor's specific requirements:

- Knowledge of physics, peculiar features of design, installation and exploitation of all main renewable energy sources (on the basis of wind, solar, hydro and geothermal energy)
- Ability to use methods of RES calculation
- Skills in reading heat and electric schemes
- Experience in using applied software for calculating power supply objects on RES

Main publications:

- Velkin, V.I. and Shcheklein, S.E. (2017), "Influence of RES Integrated Systems on Energy Supply Improvement and Risks", Problemy Ekorozwoju, vol. 12, no. 1, pp. 123–129.
<https://elibrary.ru/item.asp?id=29468408>
- Arbuzova, E., Shcheklein, S. and Velkin, V. (2015), "Features of biogas technology application in severe climatic conditions", Energy And Sustainability V: Special Contributions, pp. 347–359.
DOI: 10.2495/ESS140311

Duration of study: 4 years

Language: English or Russian

Entry requirements:

- Master's degree (or equivalent) in the related field
- B2 level of English or Russian
- Interview

Entrance exams:

- Foreign language (English/German/French)
- Chemical Technology

Government scholarship is available.

See more information at:



*Kingsley Duru (Nigeria)
a doctoral candidate
in Chemical Technology
working on his research*



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CHEMICAL TECHNOLOGIES FOR THE SYNTHESIS OF NANOSTRUCTURED FILMS OF SEMICONDUCTOR AND OTHER FUNCTIONAL MATERIALS

Research goal:

The study is aimed at training specialists in the field of chemical technology of synthesis of thin-film functional materials for electronic engineering, micro- and nanoelectronics, photonics, and sensor technology.

Aspects studied:

- Synthesis of new thin-film materials sensitive to the IR spectral domain
- Synthesis of new materials for efficient solar energy conversion
- Synthesis of new materials for chemical sensors and environmental monitoring
- Colloidal chemical synthesis of quantum dots
- Investigation of the effect of water solution history on chemical reactions

Research highlights:

The conditions of the hydrochemical synthesis of thin films on various nature substrates for more than 40 binary and ternary compounds of sulphides and selenides of metals of various functional purposes have been developed. For the first time, films of the perovskite and kesterite structure for solar radiation converters were obtained by chemical bath deposition.

Career opportunities:

Graduates will be in demand in research laboratories and in enterprises of optoelectronics and nanoelectronics, as well as sensor technology.

Supervisor's specific requirements:

Deep knowledge of physical and colloid chemistry, as well as analytical reasoning.

Main publications:

- Markov, V. F., Tretyakova, N. A., Maskaeva, L. N., Bakanov, V. M. and Muhamedzyanov, H. N. (2012), "Hydrochemical synthesis, structure, semiconductor properties of films of substitutional $Pb_{1-x}Sn_xSe$ solid solutions", *Thin Solid Films*, vol. 520, no. 16, pp. 5227–5231.
DOI: 10.1016/j.tsf.2012.03.100
- Markov, V. F. and Maskaeva, L. N. (2014), "Nucleation and mechanism of metal sulfide film growth using deposition by thiocarbamide", *Russian Chemical Bulletin*, vol. 63, no. 7, pp. 1523–1532.
DOI: 10.1007/s11172014 0630
- Smirnova, Z. I., Maskaeva, L. N., Markov, V. F., Voronin, V. I. and Kuznetsov, M. V. (2015), "Incubation of PbSe Thin Films in a Tin(II) Salt Aqueous Solution: Modification and Ion-Exchange Reactions", *J. of Materials Science and Technology*, vol. 31, no. 1, pp. 790–797.
DOI.org/10.1016/j.jmst.2015.06.003



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MULTI-COMPONENT REACTIONS AT INTERFACES: A PROMISING TECHNOLOGY FOR ORGANIC SYNTHESIS

Research goal:

Fundamental and applied research in the field of multi-component reactions and colloidal chemistry. Preparation of polysaccharide microgels, liposomes and complex drug delivery systems.

Aspects studied:

- Acceleration of the Passerini and Ugi reactions in aqueous emulsions and micellar solutions
- Finding of novel MCRs in multi-phase aqueous systems
- Formation of polysaccharide microgels via MCRs
- Preparation of novel drug delivery carriers including composite liposomes

Research highlights:

Creation of novel drug delivery systems using multicomponent reactions in aqueous solutions. Synthesis of microgels on the basis of cellulose, pectin, chitosan and other polysaccharides. Preparation of liposomes coated with modified polysaccharides.

Career opportunities:

Graduates will be in demand in university research laboratories as well as corporate R&D departments involved in the pharmaceutical development and technology.

Supervisor's specific requirements:

- Knowledgeable in organic and colloidal chemistry, methods for identification of organic compounds
- Good skills in organic synthesis
- Experience in pharmaceutical technology

Main publications:

- Shulepov, I. D., Kozhikhova, K. V., Panfilova, Y. S., Ivantsova, M. N., and Mironov, M. A. (2016), "One-pot synthesis of cross-linked sub-micron microgels from pure cellulose via the Ugi reaction and their application as emulsifiers", *Cellulose*, vol. 23, pp. 2549–2559.
DOI: 10.1007/s10570016 0957 3
- Kozhikhova, K. V., Ivantsova, M. N., Tokareva, M. I., Shulepov, I. D., Tretiyakov, A. V., Shaidarov, L. V., Rusinov, V. L., and Mironov, M. A. (2016), "Preparation of chitosan-coated liposomes as a novel carrier system for the antiviral drug Triazavirin", *Pharmaceutical Development and Technology*, pp. 1–9.
DOI: 10.1080/10837450.2016.1242624
- Kovaleva, E. G., Molochnikov, L. S., Venkatesan, U., Marek, A., Stepanova, D. P., Kozhikhova, K. V., Mironov, M. A., and Smirnov, A. I. (2016), "Acid-Base Properties of Nanoconfined Volumes of Anodic Aluminum Oxide Pores by EPR of pH-Sensitive Spin Probes", *Journal of Physical Chemistry C*, vol. 120, no. 5, pp. 2703–2711.
DOI: 10.1021/acs.jpcc.5b10241



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PRODUCTION OF NEW MATERIALS FOR ELECTROCHEMICAL POWER ENGINEERING

Research goal:

The research is aimed at obtaining new materials by electrolysis of molten mediums.

Aspects studied:

The study of the thermodynamics and kinetics of electrode processes in molten salts.

Research highlights:

- Solubility and electrode potential of alkaline earth metals, kinetics of electrode processes in halide melts
- Kinetic parameters of electrode processes on different materials in aluminum melts

Career opportunities:

Research activities in the field of high-temperature electrochemistry.

Supervisor's specific requirements:

Fundamental knowledge of electrochemical system thermodynamics and main methods of electrochemical processes investigation.

Main publications:

- Arkhipov, P., Kholkina, A., and Zaykov, Y. (2016), "EMF measurements in the Liquid Pb/PbCl₂-KCl/Pb-Sb-Bi system", *Journal of the Electrochemical Society*, vol. 163, no. 2, pp. H30-H35.
DOI: 10.1149/2.0511602jes
- Galashev, A. E., Rakhmanova, O. R., and Zaikov, Y. P. (2016), "Defect silicene and graphene as applied to the anode of lithium-ion batteries: Numerical experiment", *Physics of the Solid State*, vol. 58, no. 9, pp. 1850–1857.
DOI: 10.1134/S1063783416090146
- Pershin, P., Khalimullina, Yu., Arkhipov, P., and Zaikov, Yu. (2014), "The electrodeposition of lead in LiCl-KCl-PbCl₂ and LiCl-KCl-PbCl₂-PbO melts", *Journal of the Electrochemical Society*, vol. 161, no. 14, pp. D824-D830.
DOI: 10.1149/2.0051501jes
- Zaikov, Yu. P., Isakov, A. V., Zakiryanova, I. D., Reznitskikh, O. G., Chemezov, O. V. and Redkin, A. (2014) "Interaction between SiO₂ and a KF-KCl-K₂SiF₆ Melt", *Journal of Physical Chemistry B*, vol. 118, pp. 1584–1588.
DOI: 10.1021/jp4086816
- Zaikov, Yu. P., Batukhtin, V. P., Shurov, N. I., Ivanovskii, L. E., and Suzdaltsev, A. V. (2014), "Calcium production by the electrolysis of molten CaCl₂ – Part I. Interaction of calcium and copper-calcium alloy with electrolyte", *Metallurgical and Materials Transactions B*, vol. 45, pp. 961–967.
DOI: 10.1007/s11663-013-9990-x



Research supervisor:
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ELECTROCRYSTALLIZATION OF METALS IN COMPACT AND DISPERSED FORM

Research goal:

The research is aimed at studying the structure and regularities in formation of dendritic and spongy metal deposits with special properties for the creation of a new electrode materials and technologies (3D prototype).

Aspects studied:

- Research on the influence of electrolysis conditions on the structural and morphological characteristics of the dispersed deposits
- Study of regularities of anode processes on active metal

Research highlights:

- Prediction of dynamics of the electrodeposition and properties of dendritic deposits of metals depending on the conditions and modes of electrolysis
- Analysis of the mechanism of anodic dissolution of metals and zinc-rich composite coatings

Career opportunities:

Research activities in the field of electrochemical processes and corrosion protection.

Supervisor's specific requirements:

- Knowledge of the fundamentals of electrochemical kinetics
- Knowledge of the elements of mathematical statistics
- Good experimental skills, experience in application of general methods of the study of electrochemical processes

Main publications:

- Ostanina, T. N., Rudoi, V. M., Nikitin, V. S., Darintseva, A. B. and Demakov, S. L. (2017), "Change in the physical characteristics of the dendritic zinc deposits in the stationary and pulsating electrolysis", *Journal of Electroanalytical Chemistry*, vol. 784, pp. 13–24.
DOI: 10.1016/j.jelechem.2016.11.063
- Ostanina, T. N., Rudoi, V. M., Patrushev, A. V., Darintseva, A. B. and Farlenkov, A. S. (2015), "Modelling the dynamic growth of copper and zinc dendritic deposits under the galvanostatic electrolysis conditions", *Journal of Electroanalytical Chemistry*, vol. 750, pp. 9–18.
DOI: 10.1016/j.jelechem.2015.04.031
- Ostanina, T. N., Rudoi, V. M., Darintseva, A. B., Cheretaeva, A. O., Demakov, S. L. and Patrushev, A. V. (2014), "Effect of the polarization conditions on structural properties of zinc dendritic deposits", *Powder Metallurgy and Metal Ceramics*, vol. 52 (9–10), pp. 489–497.
DOI: 10.1007/s11106014 9551 0
- Ostanina, T. N., Rudoi, V. M., Ovsyannikova, A. N., Malkov, V. B. (2010), "Magnesium alloys spontaneous dissolution features under external anodic polarization in presence of inhibitors", *Russian Journal of Electrochemistry*, vol. 46, no. 6, pp. 707–713.
DOI: 10.1134/S1023193510060169



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SURFACE CHEMISTRY OF HYDRATED POROUS AND NANOSTRUCTURES MATERIALS; ADSORPTION AND HETEROGENEOUS CATALYSIS INCLUDING ENZYMATIC CATALYSIS FOOD CHEMISTRY AND BIO- AND CHEMICAL TECHNOLOGY FOR FUNCTIONAL FOODSTUFFS DESIGN AND BIOMEDICINE

Research goal:

The research focuses on production and electro surface characterization of different hydrated pure and composite organic, bioorganic and inorganic porous and nanostructured materials using EPR spectroscopy and pH sensitive nitroxide radicals as spin probes and labels. It is also aimed at studying a relationship between electrostatic, acid-base, adsorption and catalytic properties of these materials in a variety of processes for the purpose of optimizing functionalized materials for different applications including processing the natural polysaccharides by enzymes immobilized on oxide systems. Food science- and biotechnology-related research involves chemical extraction and biotechnological production of valuable biologically active substances (BAS) from industrial wastes and plant raw materials, their characterization as well as design of new foodstuffs with fortified BAS and application in preventive medicine of socially significant deceases and for wellbeing.

Aspects studied:

- Surface electrochemistry of hydrated nanoporous and nanostructured materials
- EPR spectroscopy of transition metal ions complexes and nitroxides as spin probes and labels in solid-state objects
- Sorption and catalytic studies of ion-exchange resins, cellulose – inorganic hydrogels composites and nanoporous oxides of Al, Ti, Zr, Si in different processes
- Homogenous and heterogeneous enzymatic catalysis
- Food Chemistry of biologically active substances and Biotechnology
- Foodstuffs enriched with biologically active substances

Research highlights:

Production and characterization of heterogeneous catalysts, EPR spectroscopy of pH sensitive nitroxide radicals as spin probes and labels, acidic and enzymatic catalysis of organic compounds and natural polysaccharides, Food chemistry of isoflavones, chaga mushroom-containing BAS, Chlorella algae growth factor etc., Design of food stuffs based on brewing wastes, isoflavones, astaxanthin, bioiodine and bio selenium etc.

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Career opportunities:

Employment as a researcher in research institutes and public and private universities, employment in the industries related to the production of functional materials including nanomaterials, as well as in the companies dealing with manufacturing heterogeneous catalysts such as Haldor Topsoe A/O (Denmark), UOP (USA), Axens (France), Johnson Matthey (UK), OOO «NIAP-Catalyst» (Russia) etc. Ph.D. holders in food chemistry and biotechnology can seek for a job in production quality control, product and new biotechnologies development and innovation in food and drink industries Danone, Heineken etc.).

Supervisor's specific requirements:

- Strong motivation and creativity;
- Basic knowledge in inorganic, physical chemistry, homogeneous and heterogeneous catalysis including enzymatic catalysis/ food chemistry, biotechnology, food technology; any knowledge and skills in medicine is highly desired
- Good experimental chemical/biotechnological skills

Main publications:

- Duru, K., Kovaleva, E. G., Danilova, I. G. and van der Bijl, P. (2019), "The pharmacological potential and possible molecular mechanisms of action of *Inonotus obliquus* from preclinical studies", *Phytotherapy Research*, ptr.6384. DOI: 10.1002/ptr.6384
- Duru, K. C., Kovaleva, E. G., Danilova, I. G. and Belousova, A. V. (2019), "Production and Assessment of Novel Probiotic Fermented Oat Flour Enriched with Isoflavones", *LWT*, vol. 111, pp. 9–15. DOI: 10.1016/j.lwt.2019.04.102
- Duru, K. C., Kovaleva, E. G., Danilova, I. G., van der Bijl, P. and Belousova, A. V. (2018), "The potential beneficial role of isoflavones in Type 2 Diabetes mellitus", *Nutrition Research*, vol. 59, pp. 1–15. DOI: 10.1016/j.nutres.2018.06.005
- Kovaleva, E. G., Molochnikov, L. S., Antonov, D. O., Tambasova (Stepanova), D. P., Hartmann, M., Tsmokalyuk, A. N., Marek, A. and Smirnov, A. I. (2018), "Proton Activity in Nanochannels Revealed by Electron Paramagnetic Resonance of Ionizable Nitroxides: A Test of the Poisson–Boltzmann Double Layer Theory", *J. Phys. Chem. C*, vol. 122, no. 35, pp. 20527–20538. DOI: 10.1021/acs.jpcc.8b04938
- Duru K. C., Kovaleva, E. G., Danilova, I. G., van der Bijl, P. and Belousova, A. V. (2018), "The potential beneficial role of isoflavones in Type 2 Diabetes mellitus", *Nutrition Research*, vol. 59, pp. 1–15. DOI: 10.1016/j.nutres.2018.06.005

- Kovaleva, E. G., Molochnikov, L. S., Stepanova, D. P., Pestov, A. V., Trofimov, D. G., Kiriluyuk, I. A. and Smirnov, A. I. (2017), "Interfacial Electrostatic Properties of Hydrated Mesoporous and Nanostructured Alumina Powders by Spin Labeling EPR", *Cell Biochemistry and Biophysics*, vol. 75, pp. 159–170. DOI: 10.1007/s12013-016-0767-0
- Adadi, Parise, Kovaleva, E. G., Glukhareva, T. V., and Shatunova, S. A. (2017), "Biotechnological production of non-traditional beer", *AIP Conference Proceedings*, vol. 1886, 020098, pp. 1–13. DOI: 10.1063/1.5002995
- Kovaleva, E. G., Molochnikov, L. S., Venkatesan, U., Marek, A., Stepanova, D. P., Kozhikhova, K. V., Mironov, M. A. and Smirnov, A. I. (2016), "Characterization of Acid-base Properties of Low Cost Nanoporous Anodic Aluminum Oxide Membranes by EPR of pH-sensitive Spin Probes", *J. Phys. Chem. C*, vol. 120, pp. 2703–2711. DOI: 10.1021/acs.jpcc.5b10241
- Kovaleva, E. G., Molochnikov, L. S., Golovkina, E. L., Hartmann, M., Kirilyuk, I. A. and Grigoriev, I. A. (2015), "Electrical potential near hydrated surface of ordered mesoporous molecular sieves assessed by EPR of molecular pH-probes", *Microporous & Mesoporous Materials*, vol. 203, pp. 82. DOI: 10.1007/s00723-015-0704-1

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DEVELOPMENT OF NONENZYMATIC METHODS OF ELECTROCHEMICAL IMMUNOASSAY AND DETERMINATION OF DIAGNOSTICALLY SIGNIFICANT PARAMETERS

Research goal:

The research is aimed at studying and investigating the synthesis of nanomaterials as well as their application as signal forming labels and elements, sensitive components of transducers in developments of new nonenzymatic electrochemical methods and sensors for quantitative determination of infectious agents and diagnostically significant parameters (urea, creatinine, cholesterol, etc.). The study of interactions of different nanomaterials with living cells.

Aspects studied:

- Nanomaterials
- Electrochemically active nanocomposites
- Voltammetry
- Electrocatalysis
- Immunoassay

Research highlights:

Theoretical and practical principles for creating new nonenzymatic electrochemical immunoassay method and sensor using magnetic nanocomposites/nanoparticles acting as a signal-forming label are formulated. Optimal conditions for obtaining magnetic electrochemically active nanocomposites were chosen. On the experimental data basis an algorithm for a hybrid immunoelectrochemical analysis method of various bacteria content determination in real objects using synthesized electroactive nanocomposite particles / nanoparticles as a signal-forming label has been developed. Studies on the use of inorganic electrocatalysts in the oxidation of cholesterol in water-organic and aprotic media have been carried out. A nonenzymatic electrochemical method for the determination of cholesterol using inorganic electrocatalysts (gold and silver nanoparticles, as well as potassium thiocyanate and nickel (II) and cobalt (II) chlorides) as a sensitive element and molecular imprinted polymers synthesized on the surface of magnetite and silicon oxide nanoparticles was developed. A hardware platform for express analysis based on a milli-fluid slide was developed.

Career opportunities:

- Work in the research laboratory
- Participation in the implementation of scientific projects
- Teaching Analytical Chemistry

Supervisor's specific requirements:

- Basic knowledge in analytical and physical chemistry
- Experimental skills
- High motivation for the scientific creative activities
- Conscientiousness

Main publications:

- Malakhova, N., Tsmokalyuk, A., Ivoilova, A., Tumashov, A., Rusinov, V., Ivanova, A. and Kozitsina, A. (2019), "Development and Validation of Voltammetric Method for Quantitation of New Antiviral Drug Triazavirin using Bare Carbon Screen-Printed Electrodes", *Analytical and Bioanalytical Electrochemistry*, vol. 11, no. 3, pp. 292–303. [http://www.abechem.com/No.%203-2019/2019,%2011\(3\),%20292-303.pdf](http://www.abechem.com/No.%203-2019/2019,%2011(3),%20292-303.pdf)
- Kozitsina, A. N., Svalova, T. S., Malysheva, N. N., Okhokhonin, A. V., Vidrevich, M. B. and Brainina, K. Z. (2018), "Sensors based on bio and biomimetic receptors in medical diagnostic, environment, and food analysis (Review)", *Biosensors*, vol. 8, no. 2, № 35. DOI: 10.3390/bios8020035
- Okhokhonin, A. V., Domanskyi, S., Filipov, Y., Gamella, M., Kozitsina, A. N., Privman, V. and Katz, E. (2018), "Biomolecular Release from Alginate-modified Electrode Triggered by Chemical Inputs Processed through a Biocatalytic Cascade – Integration of Biomolecular Computing and Actuation", *Electroanalysis*, vol. 30, no. 3, pp. 426–435. DOI: 10.1002/elan.201700810
- Malysheva, N. N., Svalova, T. S., Zhdanovskikh, V. O., Glazyrina, Yu. A., Kozitsina, A. N. and Matern, A. I. (2014), "Nonenzymatic electrochemical method for determination of the measles virus antigen using the synthesized IgG-(Fe₃O₄-SiO₂) conjugate as the signal label", *Russian chemical bulletin*, vol. 7, no. 63, pp. 1633–1638. DOI: 10.1007/s11172-014-0646-z
- Kozitsina, A. N., Malysheva, N. N., Utepova, I. A., Glazyrina, Yu. A., Matern, A. I., Brainina, Kh. Z. and Chupakhin, O. N. (2015), "An enzyme free electrochemical method for the determination of E. coli using Fe₃O₄ nanocomposites with a SiO₂ shell modified by ferrocene", *Journal of Analytical Chemistry*, vol. 70, no. 5, pp. 540–545. DOI: 10.1134/S1061934815050068
- Kozitsina, A. N., Okhokhonin, A. V. and Matern, A. I. (2016), "Amperometric detection of cholesterol using cobalt (II) chloride as an electrocatalyst in aprotic media", *Journal of Electroanalytical Chemistry*, vol. 772, pp. 89–95. DOI: 10.1016/j.jelechem.2016.04.029
- Okhokhonin, A. V., Saraeva, S. Yu., Matern, A. I. and Kozitsina, A. N. (2017), "Enzymeless Determination of Cholesterol Using Gold and Silver Nanoparticles as Electrocatalysts", *Journal of Analytical Chemistry*, vol. 72, no. 5, pp. 296–304. DOI: 10.1134/S1061934817040116

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INVESTIGATION OF ANTIOXIDANT AND ANTIRADICAL ACTIVITY

Research goal:

Research and development of new approaches for the determination of the integral parameter of antioxidant (AOA) and antiradical activity (ARA) of the individual compounds and samples with complex matrix (food, pharmaceuticals, biological objects, etc.), by electrochemical methods and EPR spectroscopy.

Aspects studied:

- Antioxidants and free radicals
- Antioxidant activity
- Antiradical activity
- Electrochemical methods of analysis
- EPR spectroscopy

Research highlights:

- A potentiometric method of determining AOA and ARA of solutions is based on measuring the electrode potential shift observed when the analyzed sample is inserted into the medium containing a mediator system
- General principles and theoretical and practical approaches to the use of potentiometry in order to measure integrated AOA and ARA substantiated. Confirmed the choice of the oxidizer as a mediator of electron transfer in the antioxidant/oxidant system and the conditions required for a chemical reaction between antioxidants and the components of the mediator system
- The data obtained by using the potentiometric method and other methods described in the literature have shown good correlation, high self-descriptiveness, and reliability. The data have demonstrated the feasibility and prospects for using potentiometry for measuring AOA and ARA in a variety of materials, including individual antioxidants → nutritional → Supplements → food → bio-substrates
- New approaches to the study of ARA using EPR spectroscopy

Career opportunities:

- Work in the research laboratory
- Participation in the implementation of scientific projects
- Teaching Analytical Chemistry

Supervisor's specific requirements:

Knowledge of analytical chemistry, physical chemistry and fundamental biochemistry.

Main publications:

- Ivanova, A. V., Gerasimova, E. L., Gazizullina, E. R., Okulova, Ya. A., Matern, A. I. and Rusinov, V. L. (2018), "Investigation of the antioxidant and antiradical activity of drugs intended for the treatment of ophthalmic disorders", *Pharmaceutical Chemistry Journal*, vol. 52, no. 8, pp. 694–699.
DOI: 10.1007/s11094-018-1883-5
- Ivanova, A. V., Gerasimova, E. L. and Gazizullina, E. R. (2019), "New antiradical capacity assay with the use potentiometric method", *Analytica Chimica Acta*, vol. 1046, pp. 69–76.
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- Ivanova, A. V., Gerasimova, E. L., Gazizullina, E. R., Popova, K. G., and Matern, A. I. (2017), "Study of the Antioxidant Activity and Total Polyphenol Concentration of Medicinal Plants", *Journal of Analytical Chemistry*, vol. 72, no. 4, pp. 415–420.
DOI: 10.1134/S1061934817040049
- Ivanova, A. V., Gerasimova, E. L., Gazizullina, E. R., Kozitsina, A. N. and Matern, A. I. (2016), "Kinetics of the thermal decomposition of 2,2'-azobis(2-methylpropionamide) dihydrochloride studied by the potentiometric method using metal complexes", *Journal Russian Chemical Bulletin*, vol. 65, no. 2, pp. 419–424.
DOI: 10.1007/s11172-016-1315-1
- Ivanova, A. V., Gerasimova, E. L. and Brainina, Kh. Z. (2015), "Potentiometric Study of Antioxidant Activity: Development and Prospects", *Critical Reviews in Analytical Chemistry*, vol. 45, no. 4, pp. 311–322.
DOI: 10.1080/10408347.2014.910443
- Ivanova, A. V., Gerasimova, E. L., Kravets, I. A. and Matern, A. I. (2015), "Potentiometric Determination of Water-Soluble Antioxidants Using Metal Complexes", *Journal of Analytical Chemistry*, vol. 70, no. 2, pp. 173–177.
DOI: 10.1134/S1061934815020069
- Brainina, Kh. Z., Gerasimova, E. L., Kasaikina, O. T. and Ivanova, A. V. (2011), "Antioxidant Activity Evaluation Assay Based on Peroxide Radicals Generation and Potentiometric Measurement", *Analytical Letters*, vol. 44, no. 8, pp. 1405–1415.
DOI: 10.1080/00032719.2010.512687
- Brainina, Kh. Z., Alyoshina, L. V., Gerasimova, E. L., Kazakov, Ya. E., Beykin, Ya. B., Belyaeva, S. V., Usatova, T. I., Inzhevatova, O. V., Ivanova, A. V. and Khodos, M. Ya. (2009), "New Electrochemical Method of Determining Blood and Blood Fractions Antioxidant Activity", *Electroanalysis*, vol. 21, pp. 618–624.
DOI: 10.1002/elan.200804458
- Brainina, Kh. Z., Ivanova, A. V., Sharafutdinova, E. N., Lozovskaya, E. L. and Shkarina, E. I. (2007), "Potentiometry as a method of antioxidant activity investigation", *Talanta*, vol. 71, pp. 13–18.
DOI: 10.1016/j.talanta.2006.03.018



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MID-INFRARED FIBER-OPTICAL MATERIALS AND DEVICES

Research goal:

- The research is aimed at training of high-skilled specialists in mid-infrared material science, optics and photonics
- New elemental base of photonics: crystals, fibers, optical products and optical layers

Aspects studied:

- Hydrochemical synthesis of high-purity metal halides
- Crystal growth by Bridgman technique
- IR fiber photonic structure simulation
- Development of crystalline fiber scintillators
- Development of mid-infrared fiber-optical devices

Research highlights:

- Investigation of new phase diagram
- Crystal growth
- Simulation and fabrication of the photonic structure of IR fibers
- Fabrication of optical elements

Career opportunities:

- Work in the innovation and implementation center "Center of Infrared Fiber Technologies"
- High-tech production in the field of fiber optics and photonics in MID-IR region
- Work at the largest enterprises in Russia and abroad

Supervisor's specific requirements:

- Decent experimental skills in material synthesis
- Basic knowledge of fiber optics and photonics
- Diligence and responsibility

Main publications:

- Zhukova, L., Korsakov, A., Korsakova, E. and Zharikov, E. (2014), "Structure modeling and growing $\text{AgCl}_x\text{Br}_{1-x}$, $\text{Ag}_{1-x}\text{Tl}_x\text{Br}_x\text{I}_{1-x}$, and $\text{Ag}_{1-x}\text{Tl}_x\text{Cl}_y\text{Br}_{1-y-z}$ crystals for infrared fiber optics", *Journal of Crystal Growth*, vol. 386 pp. 94–99. DOI: 10.1016/j.jcrysgro.2013.09.045
- Korsakov, A., Vrublevsky, D., Korsakov, V. and Zhukova, L. (2015), "Investigating the optical properties of polycrystalline $\text{AgCl}_{1-x}\text{Br}_x$ ($0 \leq x \leq 1$) and $\text{Ag}_{0.95}\text{Tl}_{0.05}\text{Br}_{0.95}\text{I}_{0.05}$ for IR engineering", *Applied Optics*, vol. 54, no. 26, pp. 8004–8009. DOI: 10.1364/AO.54.008004

- Salimgareev, D. D., Lvov, A. E., Korsakova, E. A., Korsakov, A. S. and Zhukova, L. V. (2019), "Crystals of $\text{AgBr} - \text{TlBr}_{0.46}\text{I}_{0.54}$ system: Synthesis, structure, properties, and application", *Materials Today Communications*, 100551. DOI: 10.1016/j.mtcomm.2019.100551
- Korsakova, E., Lvov, A., Salimgareev, D., Korsakov, A., Markham, S., Mani, A., Silien, C., Syed, T. A. M. and Zhukova, L. (2018), "Stability of MIR transmittance of silver and thallium halide optical fibres in ionizing β - and γ -radiation from nuclear reactors", *Infrared Physics and Technology*, vol. 93, pp. 171–177. DOI: 10.1016/j.infrared.2018.07.031
- Lvov, A., Salimgareev, D., Korsakov, M., Korsakov, A. and Zhukova, L. (2017), "Structure modeling and manufacturing PCFs for the range of 2–25 μm ", *Optical Materials*, vol. 73, pp. 337–342. DOI: 10.1016/j.optmat.2017.08.033
- Korsakov, A. S., Lvov, A. E., Vrublevsky, D. S. and Zhukova, L. V. (2016), "Investigating the light stability of solid-solution-based AgCl-AgBr and AgBr-TlI crystals", *Chinese Optics Letters*, vol. 14, no. 2, 020603. DOI: 10.3788/COL201614.020603



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CHEMICAL TECHNOLOGIES FOR THE SYNTHESIS OF NANOSTRUCTURED FILMS OF SEMICONDUCTOR AND OTHER FUNCTIONAL MATERIALS

Research goal:

The study is aimed to train highly qualified engineers for semiconductor materials industry and academic researchers in the field of chemical technology of creating new functional materials for photovoltaics and infrared detectors.

Aspects studied:

- Hydrochemical synthesis of nanostructured binary chalcogenide thin solid films and their supersaturated substitutional solid solutions for photovoltaic absorbers and infrared detectors.
- Thermodynamic and kinetic aspects of hydrochemical deposition of new chalcogenide semiconductor materials for generating electric power by using solar energy.
- Research of effects of synthesis conditions on the mechanisms underlying the growth of nanostructured chalcogenide thin solid films.
- Investigation of structural, morphological, photoelectrical and optical properties of hydrochemically deposited chalcogenide thin solid films.

Research highlights:

- The development of understanding the conditions of the hydrochemical synthesis also called chemical bath deposition for producing high-quality thin solid films at relatively low temperatures (usually lower than 80 °C) on various substrates such as glass slides and crystalline glass-ceramic plates for optoelectronic and photovoltaic applications.
- Suggesting, for the first time, the layer-by-layer chemical bath deposition with further annealing for obtaining thin solid films with perovskite and kesterite structure for solar cell applications.

Career opportunities:

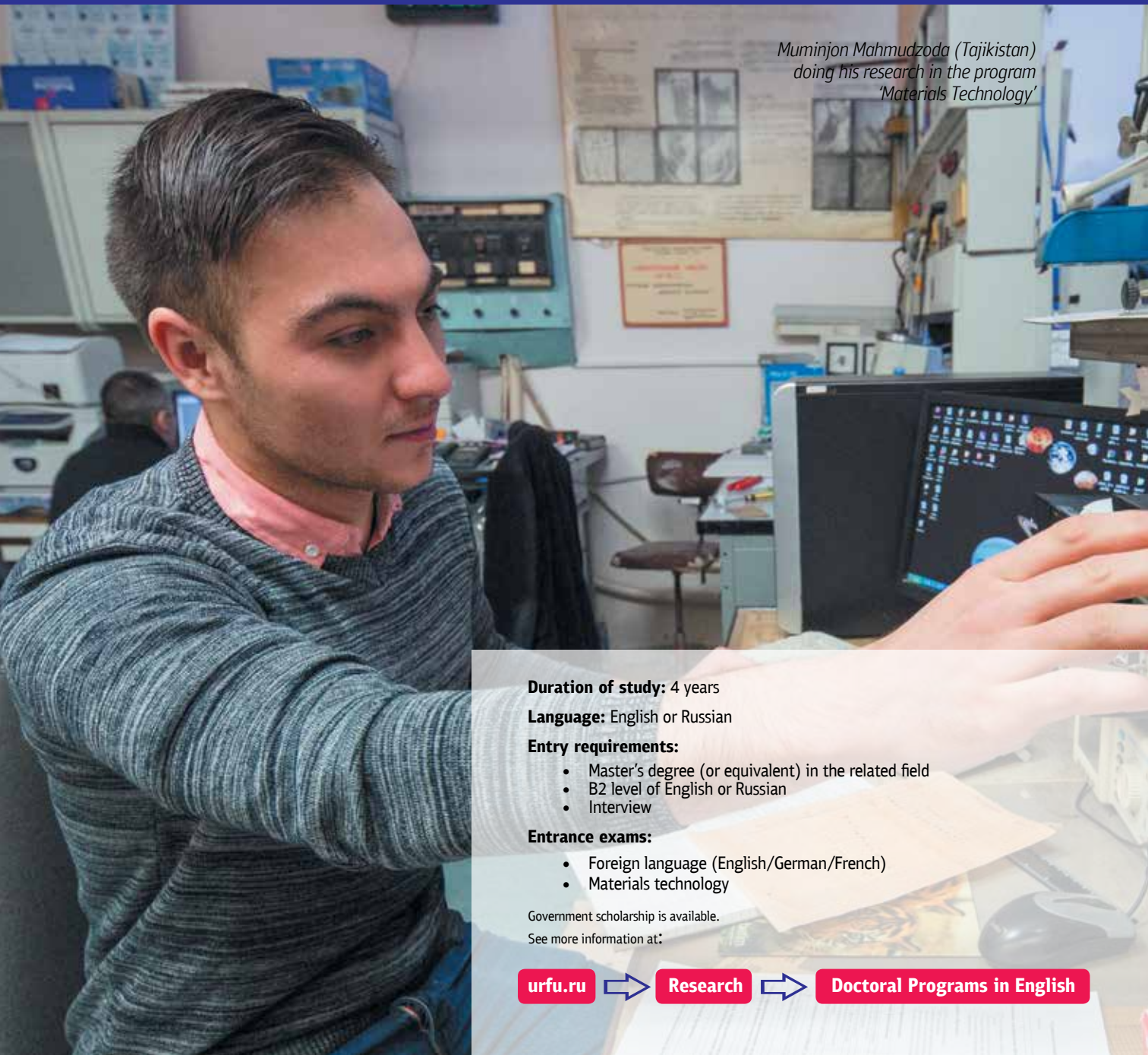
Students, who have successfully completed the training program and have participated in the original research activities, can work for modern high-tech laboratories and enterprises developing research-intensive products for photovoltaics, optoelectronics and nanoelectronics.

Supervisor's specific requirements:

- Deep knowledge in the field of physical and colloid chemistry.
- Experience in organizing and monitoring scientific research work process.

Main publications:

- Maskaeva, L. N., Markov, V. F., Mostovshchikova, E. V., Voronin, V. I., Pozdin, A. V. and Sougata Santra (2018), "Influence of calcium doping on structural, morphological and optical properties of chemically deposited PbS films", J. of alloys and compounds, vol. 766, pp. 402–409.
DOI: 10.1016/j.jallcom.2018.06.263
- Forostyanaya, N. A., Maskaeva, L. N., Smirnova, Z. I., Markov, V. F. and Kuznetsov, M. V. (2018), "Formation of Solid Solutions via Solid-State Lead Diffusion in Chemically Deposited CdS Films", Thin solid films, vol. 657, pp. 101–109.
DOI: 10.1016/j.tsf.2018.04.031
- Vaganova, I. V., Maskaeva, L. N., Voronin, V. I., Markov, V. F. and Bamburov, V. G. (2019), "A New Approach in X-ray Diffraction Study of the Microstructure of Films of Supersaturated Substitutional Solid Solutions $Cd_xPb_{1-x}S$ ", Doklady Chemistry, vol. 484, no. 2, pp. 37–40.
DOI: 10.1134/S0012500819020071
- Maskaeva, L. N., Fedorova, E. A., Markov, V. F., Kuznetsov, M. V., Lipina, O. A. and Pozdin, A. V. (2018), "Copper(I) Selenide Thin Films: Composition, Morphology, Structure, and Optical Properties", Semiconductors, vol. 52, no. 10, pp. 1334–1341.
DOI: 10.1134/S1063782618100111
- Maskaeva, L. N., Markov, V. F., Fedorova, E. A., Berg, I. A., Samigullina, R. F. and Voronin, V. I. (2017), "Structure and Thermal Stability of Nanostructured Precursor Powders of Copper (I) Sulfide and Selenide", Russ. J. of Applied Chemistry, vol. 90, no. 10, pp. 1572–1578.
DOI: 10.1134/S1070427217100032



*Muminjon Mahmudzoda (Tajikistan)
doing his research in the program
'Materials Technology'*

Duration of study: 4 years

Language: English or Russian

Entry requirements:

- Master's degree (or equivalent) in the related field
- B2 level of English or Russian
- Interview

Entrance exams:

- Foreign language (English/German/French)
- Materials technology

Government scholarship is available.

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Research



Doctoral Programs in English



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PHASE AND STRUCTURAL TRANSFORMATIONS IN METAL ALLOYS

Research goal:

The study is aimed at obtaining qualifications of a researcher capable of formulating and solving academic and industrial tasks in the field of material sciences and new materials technologies.

Aspects studied:

- Effect of alloying, external factors (deformation, including intensive, heat treatment, surface hardening treatment) on the regularities of the structure and properties formation
- Developing metallic alloys with high strength-to-weight ratio and heat resistance

Research highlights:

Combination of fundamental and modern research methods.

Career opportunities:

Due to their qualification, graduates can be employed in academic, industrial or civil spheres.

Supervisor's specific requirements:

Basic knowledge in demography and data analysis (SPSS or others) Responsibility in performing stated tasks.

Main publications:

- Popov, A. A., Rossina, N. G. and Popova, M. A. (2013), "The effect of alloying on the ordering processes in near-alpha titanium alloys", Materials Science and Engineering A, vol. 564, pp. 284–287.
DOI: 10.1016/j.msea.2012.11.043
- Popov, A. A. and Popova, M. A (2017), "Isothermal diagrams of precipitation of silicide and aluminide phases in refractory titanium alloys", Metal Science and Heat Treatment, vol. 58, 11–12, pp. 662–666.
DOI: 10.1007/s11041-017-0075-3
- Lobanov, M. L., Danilov, S. V., Pastukhov, V. I., Khrunyk, Y. Y. and Popov, A. A. (2016), "The crystallographic relationship of molybdenum textures after hot rolling and recrystallization", Materials and Design, vol.109, pp. 251–255.
DOI: 10.1016/j.matdes.2016.06.103



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THE COMPLEX OF TECHNOGENIC WASTES PROCESSING TECHNOLOGIES BY PYROMETALLURGICAL METHOD FOR STEEL AND CONSTRUCTION INDUSTRIES RESOURCE BASE EXPANSION AND ENVIRONMENT STRESS REDUCTION

Research goal:

Analyzing various aspects of processing technologies for steel and construction industries.

Aspects studied:

- Steel modification, alloying, deoxidation, ferroalloys
- Alkaline earths, rare earths, ferroaluminum, iron aluminide alloy
- Phase composition, structure, mechanical properties, removal of nonmetallic inclusions, vacuumization, slag heterogenization

Research highlights:

Opportunity to work with unique equipment, use original calculation methods, master new knowledge on the influence of components on physical and structural state of slab and metal alloys.

Career opportunities:

Employment at industrial companies, research institutions.

Main publications:

- Leontiev, L. I., Sheshukov, O. Y., Mikheenkoy, M. A. and Nekrasov, I. V. (2016), "Yegiazaryan Optimization of the phase composition of high-calcium-content slag for stabilization and the obtaining of hydraulic properties", *International Journal of Materials Research*, vol. 107, no. 3, pp. 269–276. DOI: 10.3139/146.111334
- Sivtsov, A. V., Sheshukov, O. Y., Tsymbalist, M. M., Nekrasov, I. V. and Egiazar'yan, D. K. (2015), "The Valve Effect of an Electric ARC and Problems in Controlling Electric-ARC Furnaces", *Metallurgist*, vol. 59, no. 3, pp. 380–385. DOI: 10.1007/s11015 015 0113 6
- Ermakova, V. P., Smirnova, V. G., Kataev, V. V., Sheshukov, O. Y., Konashkov, V. V., Ovchinnikova, L. A. and Marshuk, L. A. (2014), "Effect of aluminum-containing additives on the homogeneity of melt and structure of aluminum cast iron", *Metal Science and Heat Treatment*, vol. 56, no. 3–4, pp. 118–123. DOI: 10.1007/s11041-014-9716-y



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MATERIAL SCIENCE

Research goal:

Structural materials with special physicochemical properties.

Aspects studied:

- Nitrogen-containing steel with high physicomechanical and corrosion properties
- Severe plastic deformation, surface modification during ion implantation and laser welding of high-nitrogen steels.

Research highlights:

- Comprehensive study of the structure of materials using modern methods of physical metallurgy, as well as electrochemistry.
- Cooperation with colleagues from other cities of Russia and countries of Europe and Asia

Career opportunities:

Scientific activity and management of research teams in industrial enterprises or teaching science to students.

Supervisor's specific requirements:

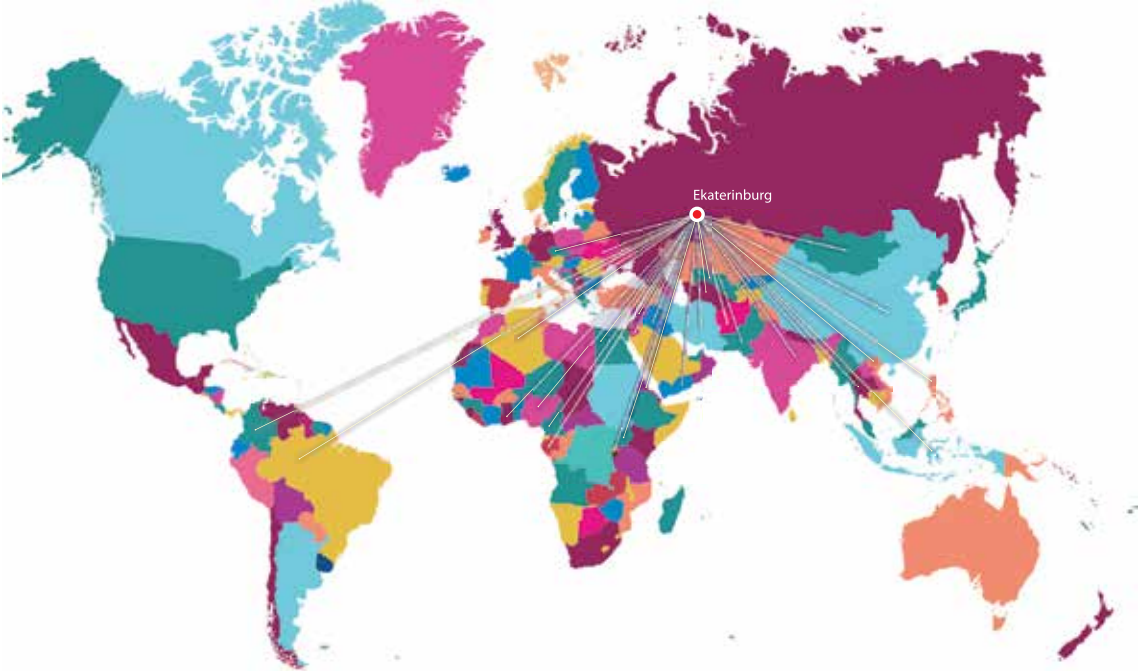
- Passion for science and the desire to learn new things.
- Possession of any skills and ability to learn new.

Main publications:

- Berezovskaya, V. V., Raskovalova, Yu. A., Merkushkin, E. A. and Valiev, R. Z. (2016), "TWIP-Effect in Nickel-Free High-Nitrogen Austenitic Cr – Mn Steels", *Metal Science and Heat Treatment*, vol. 57, no. 11, pp. 656–662. DOI: 10.1007/s11041-016-9938-2
- Berezovskaya, V. V., Ozerets, N. N. and Ovchinnikov, V. V. (2017), "Study of the structure and properties of austenitic steels upon nitrogen implantation" *Actual problems of strength: LIX International Conference, Tolyatti, Russian Federation, September 05–08, 2017*, pp. 60–61. (in Russian) <http://www.issp.ac.ru/ebooks/conf/Toliatti-2017.pdf>
- Merkushkin, E. A., Berezovskaya, V. V. and Shpaidel, M. (2017), "Prediction of Corrosive Characteristics of High-Nitrogen Austenite Steels Based on Correlation Equation of Pitting Potential" *Inorganic Materials: Applied Research*, vol. 8, no. 4, pp. 491–493. DOI: 10.1134/S2075113317040189
- Berezovskaya, V., Raskovalova, Yu. and Uimin, M. (2018), "Effect of the Structural State of High-Nitrogen Cr-Mn-Mo Steel on Mechanical and Magnetic Properties" in Syngellakis, S. and Connor, J. J. (eds.), *Advanced Methods and Technologies in Metallurgy in Russia, Innovation and Discovery in Russian Science and Engineering* Springer, Cham, Switzerland, pp. 35–42. DOI: 10.1007/978-3-319-66354-8_5



OUR CURRENT INTERNATIONAL PHD STUDENTS ENROLMENT MAP*



Algeria
Egypt
Gabon
Palestine
Jordan
Iran
Pakistan
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Bangladesh
Afghanistan
Armenia

Ghana
Yemen
India
Indonesia
Iraq
Kazakhstan
Cameroon
Colombia
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Rwanda

Syria
Lebanon
Vietnam
Turkmenistan
Ukraine
Brazil
Nigeria
Philippines
The Czech Republic
Eritrea

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