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DOCTORAL PROGRAMS IN ENGLISH

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VITALY BAGAN

Vice Rector for Science

Dear readers,

You're holding a brochure, which may determine your future for years to come. You get to choose a promising cutting-edge field of scientific research – from quantum technologies to new materials, from genetics to artificial intelligence, from Arctic research to space exploration - and this brochure will help you make an educated choice.

MIPT is a leading Russian technical university, which is globally ranked in the top-50 in Natural Sciences and top-100 in Computer Science. You will study in an atmosphere of creativity, being surrounded by the exceptionally intelligent and motivated students, prominent faculty and leading researchers.

Doctoral training at MIPT is your launching pad for excelling in science like Nobel laureate Andre Geim, becoming a global technology leader like Valentin Gapontsev (IPG - Photonics) or Nikolay Storonsky (Revolut), or even a space researcher like astornaut Aleksandr Kaleri. The choice is yours!

Choose wisely!

MARINA NEVSKAYA

Vice Rector for International Affairs

Being a scientist means much more than making science one's career path. Being a scientist implies a unique way of thinking, worldview and personality. Being a scientist is not just an occupation, but a vocation.

Similarly, MIPT is more than a globally leading academic and research institution in such critical fields as physics, mathematics, IT, chemistry, biology, engineering and adjacent interdisciplinary studies (as indicated by global rankings). MIPT was founded with a mission of providing dedicated training for scientists and engineers in cutting edge areas of science and industry - which remains Phystech's core principle to this day. Our faculty and doctoral advisors are leading researchers in their fields representing best-in-class global institutions.

Admission to the MIPT doctoral training will become a springboard for your global science career. Just as importantly, it will make you an integral part of the distinguished community of talented individuals - passionate about science and striving to make the world a better place.

Marina Nevskaya

MATHEMATICS & MECHANICS

01.06.01

Duration of study: 4 years

Language: English or Russian

Entry requirements:

Master’s degree / equivalent in a related field

B2 level of English or Russian

Good track record of publications related to the topic of the intended research

Strong research proposal 1,500 - 3,500 words

VIRTUAL KNOT THEORY

Research supervisor:
Vassily Manturov
PhD, DSc

Supervisor's research interests:

- Knot theory, in particular, virtual knot theory.
- Study of topology and dynamics, in particular, by means of topological invariants valued in groups G{n}^{k}.
- Studying framed regular 4-graphs, in particular, graph minor theory.
- Combinatorial group theory.
- Chromatic numbers of spaces and lattices.
- Steiner networks.
- Self-interlocking structures.

Research highlights:

- Organized a series of Russian-Chinese conferences on knot theory (annual, since 2014).
- My application was the unique winner of Russia-Korea joint RFBR grant (2019).
- Winner Russia-China RFBR grants.
- Participant in a mega grant for the third time (presently in Novosibirsk State University; head of laboratory Louis H. Kauffman).
- Author of 7 monographs.
- Gave lectures in Chinese in Tsinghua and other universities of China; possess 13 other languages including French, German, Spanish etc.
- Holding a seminar in the Moscow State University since 2000, holding a seminar in Tsinghua, Yau institute, Mathematical Colloquium of BMSTU.
- One "Kruzhok" (student's seminar), (all four seminars run weekly online).
- Managing Editor of "Journal of Knot Theory and Its Ramifications".
- Three Ph.D. students defended in 2013,2014,2018 including one from Republic of Korea (now working in Russia).
- Professor of the Russian Academy of Sciences.

Supervisor's specific requirements:

Standard university algebra and topology courses, elements of knot theory; programming in Mathematics preferable.

Main publications:

- V.O. Manturov, I.M. Nikonov, "On Braids and Groups G{n}^{k}", Journal of Knot Theory and Its Ramifications, 24:10 (2015), 16 pp.
- V.O. Manturov, D.A. Fedoseev, I.M. Nikonov, S. Kim "Invariants and Pictures: Low-dimensional Topology and Combinatorial Group Theory" Series on Knots and Everything: Volume 66 May 2020 Pages: 388.
- V.O. Manturov "Parity in knot theory" Sbornik: Mathematics (2010), 201(5):693.

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GEOMETRIC GROUP THEORY, GEOMETRIC TOPOLOGY, HYPERBOLIC GEOMETRY, DISCRETE SUBGROUPS OF LIE GROUPS, ARITHMETIC GROUPS, REFLECTION GROUPS, COXETER POLYTOPES

Research supervisor:
Nikolay Bogachev
PhD

Supervisor's research interests:

I study geometric actions of groups on Riemannian manifolds and the corresponding quotient manifolds and orbifolds. Sometimes, if a group H acts on a metric space X properly discontinuously, then the quotient X/H is an orbifold or manifold with some nice geometric and combinatorial properties. Various examples of such actions are provided by the theory of hyperbolic reflection groups developed by Vinberg in 1967. A natural fundamental domain of a discrete group generated by reflections with respect to hyperplanes is a Coxeter polytope, which can be described in the sense of Coxeter diagrams/graphs. The modern research of discrete groups combines algebraic, geometric, topological, combinatorial, dynamical, and number theoretical approaches. Sometimes, computer experiments are very helpful.

Research highlights:

- In the framework of my research I collaborate with mathematicians from Switzerland, USA, Italy, Brazil, Germany, France, and Russia.
- My work was awarded by the Simons Foundation Prize for PhD students (2017, 2018), and also supported by grants of RSF, RFBR, Basis.

Supervisor's specific requirements:

- Algebra: groups, rings, modules, number fields.
- Linear algebra: vector spaces, linear maps and operators, bilinear and quadratic forms.
- Topology: topology of R^n, topological spaces and manifolds.
- Geometry: convex polyhedra, smooth manifolds, Riemannian manifolds.
- Python knowledge would be a benefit.

Main publications:

- N. Bogachev, From geometry to arithmeticity of compact hyperbolic Coxeter polytopes, 2020, arXiv:2003.11944.
- N. Bogachev, A. Kolpakov, On faces of quasi-arithmetic Coxeter polytopes, 2020, arXiv:2002.11445, to appear in Int.Math.Res.Notices.
- N. Bogachev, Classification of (1,2)-reflective anisotropic hyperbolic lattices of rank 4, Izvestiya Math, 2019, vol. 83:1, pp. 1-19.
- N. Bogachev, A. Perepechko, Vinberg's algorithm for integral hyperbolic lattices, Math. Notes, 2019.

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ASYMPTOTICAL PROPERTIES OF RANDOM STRUCTURES

Research supervisor:
Maksim Zhukovskii
PhD, DSc

Supervisor's research interests:

Logical limit laws, distribution of subgraphs in random graphs, percolation in graphs and random graphs, subgraph-saturation and weak saturation, logical complexity of graph properties and expressibility of first order and second order logics.

Research highlights:

Collaboration with international researchers.

Supervisor's specific requirements:

- PhD student should be familiar with basic notions and facts of calculus, combinatorics (in particular, graph theory), probability and stochastic processes.

Main publications:

- M.E. Zhukovskii, On the zero-one k-law extensions, European J. of Combinatorics,60(2017):66-81.
- L.B. Ostrovsky, M.E. Zhukovskii, Monadic second-order properties of very sparse random graphs, Annals of pure and applied logic, 2017, Vol. 168, pp. 2087-2101.
- A. Kupavskii, M. Zhukovskii, Short monadic second order sentences about sparse random graphs, SIAM J Disc Math, 2018, Vol. 32, No. 4, P. 2916-2940.
- O. Verbitsky, M. Zhukovskii, Tight bounds on the asymptotic descriptive complexity of subgraph isomorphism, ACM Transactions on Computational Logic, Volume 20, Issue 2, 2019.
- S.N. Popova, M.E. Zhukovskii, Existential monadic second order logic of undirected graphs: a disproof of the Le Bars conjecture, Annals of Pure and Applied Logic, 170 (2019) 505-514.

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MODELS, ALGORITHMS AND SOFTWARE IN APPLIED COMBINATORIAL OPTIMIZATION

Research supervisor:
Boris Goldengorin
PhD, DSc (Russian Academy of Sciences)
PhD (University of Groningen, The Netherlands)

Supervisor's research interests:

Data Correcting and Tolerance Based Algorithms representing a unified approach to modeling and solving problems in Applied Combinatorial Optimization, e.g. Preemptive Single Machine Scheduling, Maximization (Minimization) of Submodular (Supermodular) Functions, Pseudo-Boolean Polynomials in Multidimensional Big Data Aggregation, Max-Clique, Max-Cut (including Quadratic Cost Partition), Capacitated Vehicle Routing in Cloud Computations applied to Virtual and Physical Resources, Facility Locations, Cell Formation in Industrial Engineering some of which might be found on https://www.amazon.com/Boris-Goldengorin/e/B00AR073TE

Research highlights:

The aim of this program is to establish worldwide competitive Mathematical Models, Algorithms, and Software with the purpose to solve computationally intractable benchmark instances.

Supervisor's specific requirements:

- Advanced courses in Mathematical Programming, Discrete (Combinatorial) Optimization, Algorithms and Data Structures, Mathematical Statistics and Standard Software.
- Ability to design and implement algorithms including the proof of their correctness based on advanced data structures.
- At least 3 years' experience in C++, MATLAB, CPLEX or similar software.
- Shortlisted candidate will be invited for a 30-min skype interview and one week for implementation an algorithm with reported computational study.

Main publications:

- B. Goldengorin, D. Krushinsky, P.M. Pardalos. Cell Formation in Industrial Engineering, NY, Springer, 2013, 220 pp.
- B. Goldengorin, P.M. Pardalos. Data Correcting Approaches in Combinatorial Optimization, NY, Springer, 2012, 120 pp.

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THE NUMERICAL SIMULATION OF DYNAMICS PROBLEMS IN HETEROGENEOUS MEDIA

Research supervisor:
Vasily Golubev
PhD

Supervisor's research interests:

My research work is connected with the development of novel numerical methods for simulation of dynamic processes in complex media. Many phenomena and technological processes are described by hyperbolic systems of equations: the earthquake initiation, the seismic survey of oil and gas deposits, the non-destructive testing of composite materials, etc. In our research group, we are concentrated on the extension of the grid-characteristic method for more complicated medium models. Acoustic, anisotropic elastic, fluid-saturated porous and non-linear continuum approaches and approximations are investigated. The internal research software is developed on C++ language supporting OpenMP, MPI and GPGPU systems. We are seeking motivated young students interested to expand their scientific knowledge in the simulation area.

Research highlights:

- Participation in real-life research projects supported by RFBR, RSF and other scientific foundations.
- Presentation of obtained scientific results at major international conferences: EAGE, SEG, etc.
- Collaboration with specialists from oil and gas companies.
- Chance to achieve a good experience in a team of talented young people.

Supervisor's specific requirements:

- Strong background in numerical methods (finite-difference schemes, finite-volume methods, PDEs).
- Good knowledge of the physics of deformable solid media (acoustic, linear elasticity, visco-plasticity).
- Experience in programming: C++, Python, MPI and OpenMP technologies.
- Self-sufficiency, ability to deal with scientific papers.

Main publications:

- Golubev, V.I., Shevchenko, A.V. & Petrov, I.B. Simulation of Seismic Wave Propagation in a Multicomponent Oil Deposit Model. International Journal of Applied Mechanics. https://doi.org/10.1142/S1758825120500842 (2020)
- Petrov, I.B., Golubev, V.I. & Shevchenko, A.V. Problem of Acoustic Diagnostics of a Damaged Zone. Dokl. Math. 101, 250–253 (2020).
- Golubev, V.I., Shevchenko, A.V., Petrov, I.B. Taking into Account Fluid Saturation of Bottom Sediments in Marine Seismic Survey (2019) Doklady Mathematics, 100 (2), pp. 488-490.
- Golubev, V.I., Voinov, O.Y., Petrov, I.B. Seismic Imaging of Fractured Elastic Media on the Basis of the Grid-Characteristic Method (2018) Computational Mathematics and Mathematical Physics, 58 (8), pp. 1309-1315.
- Beklemysheva, K.A., Vasyukov, A.V., Golubev, V.I., Zhuravlev, Y.I. On the Estimation of Seismic Resistance of Modern Composite Oil Pipeline Elements (2018) Doklady Mathematics, 97 (2), pp. 184-187.

NUMERICAL METHODS OF OPTIMIZATION

Research supervisor:
Alexander Gasnikov
PhD, DSc

Supervisor's research interests:

- Stochastic optimization.
- Accelerated algorithms.
- Superposition of algorithms.
- Mathematical modeling of traffic flows (traffic assignment problems).

Supervisor's specific requirements:

- Mathematical analysis.
- Linear algebra.
- Probability theory.
- Computes Science.
- Python.

Main publications:

- A. Gasnikov, P. Dvurechensky, E. Gorbunov, E. Vorontsova, Daniil Selikhanovych and Cesar A. Uribe Optimal Tensor Methods in Smooth Convex and Uniformly Convex Optimization. Conference on Learning Theory. P. 1374–1391, 2019.
- A. Kroshnin, D. Dvinskikh, P. Dvurechensky, A. Gasnikov, N. Tupitsa and C.A. Uribe. On the Complexity of Approximating Wasserstein Barycenter. Proceedings of the 36th International Conference on Machine Learning, PMLR 97:3530-3540, 2019.
- Nesterov, Y., Gasnikov, A., Guminov, S., & Dvurechensky, P. (2020). Primal–dual accelerated gradient methods with small-dimensional relaxation oracle // Optimization Methods and Software, 1-38.

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STABLE COALITIONAL STRUCTURES AND OTHER TOPICS IN GAME THEORY

Research supervisor:
Daniil Musatov
PhD

Supervisor's research interests:

My scientific interests lie in various areas in game theory and mathematical modeling of economic and social processes, especially on the border with computer science. The research topics include, but are not limited to:

- Coalitional and migrational stability in jurisdiction partitions.
- Game-theoretic models of network formation via club structures.
- Computational complexity of finding an equilibrium in game-theoretic models.
- Models of fair division in groups and networks. Applications to determining a public project and to participatory budgeting.
- Rational interactive proofs.

Research highlights:

We have a joint research project on complex networks with Stefano Boccaletti from ICS-CNR (Florence, Italy). It is possible to work not only on game-theoretic models, but also on random graphs and hypergraphs. We are also in contact with leading Russian economic researchers from such universities as NES, HSE (Moscow and Saint Petersburg) and RANEPA.

Supervisor's specific requirements:

- Some experience in game theory, like a master-level one- or two-semester course.
- Knowledge of discrete mathematics and ability to learn new topics in it.
- Ability of designing and conducting computer experiments would be a benefit.
- No specific background in economics is needed.

Main publications:

- Musatov, D. V., A. V. Savvateev, and S. Weber (2016). "Gale–Nikaido–Debreu and Milgrom–Shannon: Communal interactions with endogenous community structures". In: Journal of Economic Theory 166, pp. 282–303.
- Golman, A. and D. Musatov (2019). "Approximate Coalitional Equilibria in the Bipolar World". In: Optimization and Applications. OPTIMA 2018. Ed. by Y. Evtushenko, M. Jaćimović, M. Khachay, Y. Kochetov, V. Malkova, and M. Posypkin. Vol. 974. Springer, pp. 512–526.

LINEAR ALGEBRA AND ITS APPLICATIONS

Research supervisor:
Alexander Guterman
PhD, DSc

Supervisor's research interests:

Combinatorial matrix theory; nonnegative matrices, graphs, and their applications; matrix invariants and maps preserving them; permanent and related matrix functions.

Research highlights:

Area of research belongs to a modern mathematics on the top level; there are possibilities to participate in scientific conferences and workshops and to interact with foreign scientists.

Supervisor's specific requirements:

- Basic classes in algebra and linear algebra.

Main publications:

- Majorization for (0,1)-matrices (with G. Dahl and P. Shteyner) Linear Algebra and Its Applications, 585, 2020, 147-163.
- Permanent Polya problem for additive surjective maps (with I.A. Spiridonov) Linear Algebra and Its Applications, 599, 2020, 140-155.
- Upper bounds for the length of non-associative algebras (with D.K. Kudryavtsev) Journal of Algebra, 544, 2020, 483-497.
- 2-words, their graphs and matrices (with E.M. Kreines and N.V. Ostroukhova) Zapiski Nauch. Sem. POMI, 482, 2019, 45-72.
- Graph characterization of fully indecomposable nonconvertible (0,1)-matrices with minimal number of ones (with M. Budrevich, G. Dolinar Gregor, B. Kuzma) Ars Mathematica Contemporanea, 17(1), 2019, 141-151.
- Krauter conjecture on permanents is true (with M.V. Budrevich) Journal of Combinatorial Theory – Series A, 162, 2019, 306-343.
- Majorization for matrix classes (with Geir Dahl and Pavel Shteyner) Linear Algebra and Its Applications, 555, 2018, 201-221.
- Extremal generalized centralizers in matrix algebras (with G. Dolinar, B. Kuzma, O. Markova) Communications in Algebra, 46(7), 2018, 3147-3154.

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AUTOMORPHISM GROUPS OF AFFINE ALGEBRAIC VARIETIES

Research supervisor:
Alexander Perepechko
PhD

Supervisor's research interests:

Affine algebraic varieties over algebraically closed fields represent a classical topic of algebraic geometry. Their automorphism groups are a rich domain of research that includes combinatorial representations of reductive group actions and birational self-maps. I am interested in topic of transitivity, additive actions, infinite-dimensional subgroups (called ind-groups), toric and T-varieties, and integer-point orbits on varieties corresponding to Diophantine equations.

Research highlights:

This research program involves international collaboration with research groups in the UK, Germany, and France.

Supervisor's specific requirements:

- Background in basic algebraic geometry.
- Acquaintance with algebraic groups.
- Python3 knowledge is preferable.

Main publications:

- (with Ivan Arzhantsev and Hendrik Süß) Infinite transitivity on universal torsors, Journal of the London Mathematical Society 89 (2014), no. 3, 762-778.
- (with Sergei Kovalenko and Mikhail Zaidenberg) On automorphism groups of affine surfaces, Advanced Studies in Pure Mathematics 75 (2017), Algebraic Varieties and Automorphism Groups, 207–286; arXiv:1511.09051.
- (with Andriy Regeta) When is the automorphism group of an affine variety nested?, preprint, arXiv:1903.07699.

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NUMERICAL SIMULATION OF SHOCK AND DETONATION WAVES PROPAGATION IN VARIOUS MEDIA

Research supervisor:
Pavel Utkin
PhD

Supervisor's research interests:

The research focuses on the development of the numerical algorithms for the simulations of flows of chemically reactive media (gaseous or heterogeneous) and its application to the study of the fundamental and practical problems. The examples include the simulation of the shock wave – coal dust layer interaction during the accident in the mine or the initiation of the supersonic combustion (detonation) in the chamber of the novel propulsion system.

Research highlights:

Student gets the practical skills in solving recent CFD problems in the field of compressible flows using high-performance computing.

Supervisor's specific requirements:

- Basic knowledge of continuum mechanics.
- Basic knowledge of numerical methods.
- Basic knowledge of C/C++ programming languages.

Main publications:

- Utkin, P.S. Numerical simulation of shock wave – dense particles cloud interaction using Godunov solver for Baer-Nunziato equations // International Journal of Numerical Methods for Heat & Fluid Flow. – 2019. – V. 29, No. 9. – P. 3225 – 3241. http://dx.doi.org/10.1108/HFF-10-2018-0587
- Lopato, A.I., Utkin, P.S. Numerical study of detonation wave propagation in the variable cross-section channel using unstructured computational grids // Journal of Combustion. – 2018. – V. 2018. – Article ID 3635797. – 8 P. http://dx.doi.org/10.1155/2018/3635797
- Lopato, A.I., Utkin, P.S. Towards second-order algorithm for the pulsating detonation wave modeling in the shock-attached frame // Combustion Science and Technology. – 2016. – V. 188, No. 11 – 12. – P. 1844 – 1856. http://dx.doi.org/10.1080/00102202.2016.1212570

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SINGULARITIES OF DIFFERENTIAL EQUATIONS AND THEIR APPLICATIONS

Research supervisor:
Alexey Remizov
PhD

Supervisor's research interests:

Singularities of ordinary differential equations in various fields, including differential geometry, calculus of variations, optimal control theory, dynamical systems, physics (singular Lagrangians), etc.
Related interests: geometry of vision, image reconstruction (inpainting), history of differential equations and differential geometry.

Research highlights:

Collaboration with foreign scientists and research centers.
For singularities of ordinary differential equations and differential geometry: University of Liverpool (UK), University of Sao Paolo (Brazil), several research centers in Japan (Kyoto, Sapporo). For image reconstruction: France (Ecole Polytechnique, Sorbonne University, University of Toulon).
We permanently apply for grants.

Supervisor's specific requirements:

- Strictly necessary for all topics: calculus, linear algebra, ordinary differential equations.
- For image reconstruction: + programming skills.
- For history of mathematics: + foreign languages (English, French, German).

Main publications:

- N. G. Pavlova, A. O. Remizov, Completion of the classification of generic singularities of geodesic flows in two classes of metrics, Izv. Math., 83:1 (2019), 104–123.
- O. Remizov, F. Tari, Singularities of the geodesic flow on surfaces with pseudo-Riemannian metrics, Geometriae Dedicata, 185:1 (2016), 131–153.
- O. Remizov, On the local and global properties of geodesics in pseudo-Riemannian metrics, Differ. Geom. Appl., 39 (2015), 36–58.
- U. Boscain, R.A. Chertovskih, J.P. Gauthier, D. Prandi, A.O. Remizov, Highly Corrupted Image Inpainting Through Hypoelliptic Diffusion, J. Math. Imaging Vis., 60:8 (2018), 1231–1245.
- U. Boscain, R.A. Chertovskih, J.P. Gauthier, A.O. Remizov, Hypoelliptic diffusion and human vision: a semidiscrete new twist, SIAM J. Imaging Sci., 7:2 (2014), 669–698.
- I.R. Shafarevich, A.O. Remizov, Linear Algebra and Geometry, Springer, Heidelberg, 2013, xxii+526 pp.

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ADDITIVE COMBINATORICS

Research supervisor:
Ilya Shkredov
PhD, DSc

Supervisor's research interests:

- Additive Combinatorics.
- Number Theory.
- Combinatorial Ergodic Theory.

We study various classical themes of Additive Combinatorics, the sum-product phenomenon, applications to Number Theory, Dynamical Systems, Computer Science, Classical Analysis, Growth in Groups and other mathematical fields.

Research highlights:

It will be a close contact with the mathematical community of Steklov Mathematical Inst., IPPI RAN, MSU and MIPT of course. Financial support of postdoctoral students is possible as well.

Supervisor's specific requirements:

- Mathematical papers in AC, NT or connected fields which use the methods or results of AC/NT.
- Background in Additive Combinatorics.
- Strong desire to do research.

Main publications:

- Shkredov, Ilya D. "On a problem of Gowers." Izvestiya: Mathematics 70.2 (2006): 385-425.
- Roche-Newton, Oliver, Misha Rudnev, and Ilya D. Shkredov. "New sum-product type estimates over finite fields." Advances in Mathematics 293 (2016): 589-605.
- Schoen, Tomasz, and Ilya D. Shkredov. "Roth's theorem in many variables." Israel Journal of Mathematics 199.1 (2014): 287-308.
- Konyagin, S.V., and I.D. Shkredov. "On sum sets of sets having small product set." Proceedings of the Steklov Institute of Mathematics 290.1 (2015): 288-299.

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MATHEMATICAL MODELING OF BIOLOGICAL FLUIDS FLOWS

Research supervisor:
Sergey Simakov
PhD

Supervisor's research interests:

The research covers reduced order mathematical modeling of the cardiovascular and respiratory systems, transport and control processes. Applications include the analysis of blood flow in the human body before and after vascular operations on removing stenoses, cardiac function in the presence of pathologies, microcirculation in the presence of tumor angiogenesis, metabolism during intensive physical exercise, etc.

Research highlights:

The research is performed in collaboration with partners from Institute of Numerical Mathematics RAS, Shanghai Jiao Tong University and King's College London. Applied tasks for mathematical modeling are stated in collaboration with medical partners from Sechenov University and Bakulev Scientific Center of Cardiovascular Surgery.

Supervisor's specific requirements:

- Master of science degree in the relevant field.
- Background in numerical methods for partial differential equations.
- Good programming skills (Fortran, C++).

Main publications:

- Y. Vassilevski, M. Olshanskii, S. Simakov, A. Kolobov, A. Danilov, Personalized Computational Hemodynamics: Models, Methods, and Applications for Vascular Surgery and Antitumor Therapy, Academic Press, 2020.
- N. Bessonov, A. Sequiera, S. Simakov, et.al., Methods of Blood Flow Modelling, Mathematical Modelling of Natural Phenomena, 11(1), p.1-25, 2016.
- S.S. Simakov, Modern methods of mathematical modeling of blood flow using reduced order methods, Computer Research and Modeling, 10(5), p.581-604, 2018.

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DISCRETE AND CONVEX GEOMETRY

Research supervisor:
Alexandr Polyanskii
PhD

Supervisor's research :

- Discrete and convex geometry.

Research highlights:

Possibility to collaborate with other (Russian and foreign) researchers of the Laboratory of Combinatorial and Geometric Structures

Supervisor's specific requirements:

- Good mathematical level (Linear Algebra, Discrete Mathematics, Functional Analysis).
- A possibility to do research at least 35 hours per week. (reading papers, tackling open mathematical problems, participating in discussions and etc.)

Main publications:

- Z. Jiang, A. Polyanskii, Proof of László Fejes Tóth's zone conjecture, Geometric and Functional Analysis, 27(6), (2017), 1367-1377.
- Z. Jiang, A. Polyanskii, Forbidden subgraphs for graphs of bounded spectral radius, with applications to equiangular lines, Israel Journal of Mathematics, 236, (2020), pages 393-421.
- A. Polyanskii, On almost-equidistant sets, Linear Algebra and its Applications, 563 (2019), 220-230.
- A. Kupavskii, A. Polyanskii, Proof of Schur's conjecture in R^d, Combinatorica, 37(6) (2017), 1181-1205.

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QUANTUM INFORMATION THEORY

Research supervisor:
Grigori Amosov
PhD, DSc

Supervisor's research interests:

- Quantum channels.
- Quantum dynamical semigroups.
- Positive operator valued measures.
- Singular perturbations of semigroups.
- Noncommutative operator graphs.
- Error corrections.
- Quantum tomography.

Research highlights:

The supervisor has been a member of Steklov Mathematical Institute of RAS since 2010. He is also a professor at MIPT and St-Petersburg State University.

Supervisor's specific requirements:

- Basic knowledge in Linear Algebra, Functional Analysis.
- Quantum Mechanics, Probability Theory.

Main publications:

- G. G. Amosov, "On classical capacity of Weyl channels", Quantum Information Processing, 19 (2020), 401 , 12 pp..
- G. G. Amosov, "On inner geometry of noncommutative operator graphs", Eur. Phys. J. Plus, 135 (2020), 865 , 6 pp.
- G. G. Amosov, A. S. Mokeev, A. N. Pechen, "Non-commutative graphs and quantum error correction for a two-mode quantum oscillator", Quantum Inf. Process., 19:3 (2020), 95 , 12 pp.
- G. G. Amosov, S. Mancini, V. I. Man'ko, "Tomographic portrait of quantum channels", Rep. Math. Phys., 81:2 (2018), 165–176
- G. G. Amosov, A. S. Mokeev, "On non-commutative operator graphs generated by covariant resolutions of identity", Quantum Inf. Process., 17 (2018), 325 , 11 pp.
- G. G. Amosov, S.N. Filippov, "Spectral properties of reduced fermionic density operators and parity superselection rule", Quantum Inf. Process., 16:1 (2017), 2 , 16 pp.
- G. G. Amosov, Ya. A. Korennoy, V. I. Man'ko, "Description and measurement of observables in the optical tomographic probability representation of quantum mechanics", Phys. Rev. A, 85 (2012), 052119 , 9 pp.

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NUMERICAL OPTIMIZATION AND COMPUTATIONAL OPTIMAL TRANSPORT

Research supervisor:
Pavel Dvurechensky
PhD

Supervisor's research interests:

- Optimization of algorithms.
- Optimal Transport.
- Algorithms for saddle-point problems and variational inequalities.
- Distributed optimization (parallel and decentralized).

Research highlights:

- Research is supported by RFBR, RSF and other scientific foundations.
- Participation in major international conferences on machine learning: ICML, COLT, NeurIPS.
- Collaboration with researchers in Germany, the Netherlands, USA.

Supervisor's specific requirements:

- Mathematical analysis.
- Linear algebra.
- Probability theory.
- Computer Science.
- Matlab/Python.
- Basic knowledge of optimization theory and methods is a bonus.

Main publications:

- Dvurechensky, P., Ostroukhov, P., Safin, K., Shtern, S., and Staudigl, M. Self-concordant analysis of Frank-Wolfe algorithms. International Conference on Machine Learning (2020), PMLR.
- Dvurechensky, P., Gorbunov, E., and Gasnikov, A. An accelerated directional derivative method for smooth stochastic convex optimization. European Journal of Operational Research (2020). https://doi.org/10.1016/j.ejor.2020.08.027
- Nesterov, Y., Gasnikov, A., Guminov, S., & Dvurechensky, P. Primal–dual accelerated gradient methods with small-dimensional relaxation oracle. Optimization Methods and Software (2020). https://doi.org/10.1080/10556788.2020.1731747
- A. Gasnikov, P. Dvurechensky, E. Gorbunov, E. Vorontsova, Daniil Selikhanovych and Cesar A. Uribe Optimal Tensor Methods in Smooth Convex and Uniformly Convex Optimization. Conference on Learning Theory. (2019), pp. 1374–1391 .
- A. Kroshnin, D. Dvinskikh, P. Dvurechensky, A. Gasnikov, N. Tupitsa and C.A. Uribe. On the Complexity of Approximating Wasserstein Barycenter. International Conference on Machine Learning (2019), PMLR, vol 97, pp.3530-3540.
- Dvurechensky, P., Dvinskikh, D., Gasnikov, A., Uribe, C. A., and Nedic, A. Decentralize and randomize: Faster algorithm for Wasserstein barycenters. In Advances in Neural Information Processing Systems 31 (2018), pp. 10783–10793.
- Dvurechensky, P., Gasnikov, A., and Kroshnin, A. Computational optimal transport: Complexity by accelerated gradient descent is better than by Sinkhorn's algorithm. International Conference on Machine Learning (2018), PMLR, vol. 80, pp. 1367–1376.
- Bogolubsky, L., Dvurechensky, P., Gasnikov, A., Gusev, G., Nesterov, Y., Raigorodskii, A. M., Tikhonov, A., and Zhukovskii, M. Learning supervised pagerank with gradient-based and gradient-free optimization methods. In Advances in Neural Information Processing Systems 29 (2016), pp. 4914–4922.

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AUTOMORPHISM GROUPS OF AFFINE ALGEBRAIC VARIETIES

Research supervisor:
Alexei Kanel-Belov
PhD, DSc
Professor of Bar-Ilan University (Israel)

Supervisor's research interests:

- Affine algebraic geometry Jacobian conjecture and Quantization. Famous Jacobian conjecture said, "Is it true that locally invertible polynomial mapping is globally invertible?" It was found that many questions of affine algebraic geometry and polynomial automorphism are in fact quantization problems. (see arXiv: math/0512171, and review https://arxiv.org/abs/1912.03759).
- Combinatorics of words. This subject has deep relations with almost all mathematics (such as dynamical systems, mathematical biology, group and ring theory), on the other hand – many problems do not demand much knowledge. Many problems related to Pisout conjecture, Rauzy fractals and billiards.
- More detailed description see my profile http://www.mathnet.ru/php/person.phtml?personid=8698&option_lang=eng

Research highlights:

- This research program involves international collaboration with research groups in the Israel, and France (ENS).
- Supervisor's specific requirements: for 1 – Background in basic algebraic geometry. and Acquaintance with algebraic groups.
- for 2 – basic calculus, some elementary knowledge on dynamical systems is preferable.

Main publications:

- Ilya Ivanov-Pogodayev, Alexey Kanel-Belov, Construction of infinite finitely presented nillsemigroup, 2014 , 160 pp., 131 figures, in Russian, arXiv: 1412.5221.
- Ya. Belov, "The local finite basis property and local representability of varieties of associative rings", Izv. Math., 74:1 (2010), 1–126.
- J. Kanel-Belov, A. V. Dyskin, Y. Estrin, E. Pasternak, I. A. Ivanov-Pogodaev, "Interlocking of convex polyhedra: towards a geometric theory of fragmented solids", Mosc. Math. J., 10:2, http://www.ams.org/distribution/mmj/vol10-2-2010/kanel-belov-etal.pdf (2010), 337–342 http://olympiads.mccme.ru/mmo/2000/mmo2000.htm, arXiv: 0812.5089
- Ya. Kanel-Belov, V. A. Voronov, D. D. Cherkashin, "On the chromatic number of infinitesimal plane layer", St. Petersburg Math. J., 29:5 (2018), 761–775.
- Ya. Kanel-Belov, M.L. Kontsevich, "The Jacobian conjecture is stably equivalent to the Dixmier conjecture", Mosc. Math. J., 7:2 (2007), 209–218 , arXiv: math/0512171.
- Alexei Kanel-Belov, Sergey Malev, Louis Rowen, Roman Yavich, "Evaluations of noncommutative polynomials on algebras: Methods and problems, and the Lvov-Kaplansky Conjecture", Symmetry Integrability Geom. Methods Applications,, 16 (2020), 071 , 61 pp., Special Issue on Algebra, Topology, and Dynamics in Interaction in honor of Dmitry Fuchs https://www.emis.de/journals/SIGMA/2020/071/
- Ya. Kanel-Belov, A. A. Chilikov, "On the Algorithmic Undecidability of the Embeddability Problem for Algebraic Varieties over a Field of Characteristic Zero", Math. Notes, 106:2 (2019), 299–302.
- 8. A.Belov-Kanel, Jie-Tai Yu., "Stable tameness of automorphisms of F<x,y,z> fixing z.", Selecta Mathematica, 18:4 (2012), 799–802 , arXiv: 1102.3292.

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MODELS OF INFLUENCE AND (MIS)INFORMATION PROCESSES IN SOCIAL NETWORKS

Research supervisor:
Ivan Kozitsin
PhD

Supervisor's research interests:

My interests include, but are not limited to:

- Opinion formation models.
- Models of complex networks.
- Models of (dis)information processes in online social networks.

Research highlights:

Our current project is focused on analysis of the opinion dynamics of Russian users of VKontakte (the most popular online social network in Russia) from the perspective of opinion formation models. Here, we actively use methods from different disciplines such as statistics, machine-learning, and agent-based modeling. There is also opportunity to perform other research on related topics.

Supervisor's specific requirements:

- Basic knowledge in calculus, linear algebra, ordinary differential equations, discrete mathematics, statistics, optimization theory, and ability to learn new topics in them.
- Some experience in game theory, machine learning, databases, and agent-based modeling.
- Ability of designing and conducting computer experiments (in Python, R).

Main Publications:

- Ivan Vladimirovich Kozitsin & Alexander Alexeyevich Belolipetskii (2019) Opinion convergence in the Krasnoshchekov model, The Journal of Mathematical Sociology, 43:2, 104-121, DOI: 10.1080/0022250X.2018.1531398
- Kozitsin, I.V., Chkhartishvili, A.G., Marchenko, A.M. et al. Modeling Political Preferences of Russian Users Exemplified by the Social Network Vkontakte. Math Models Comput Simul 12, 185–194 (2020). https://doi.org/10.1134/S2070048220020088
- Ivan V. Kozitsin (2020) Formal models of opinion formation and their application to real data: evidence from online social networks, The Journal of Mathematical Sociology, DOI: 10.1080/0022250X.2020.1835894

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QUANTUM DYNAMICS AND CONTROL

Research supervisor:
Alexander Pechen
PhD, DSc

Supervisor's research interests:

My research interests lie in the booming field of quantum technologies. This field is now actively developed across the world, including in Russia, due to multiple existing and prospective applications. Further progress requires solving various mathematical problems related with dynamics and control of quantum systems, especially of open quantum systems. My research includes diverse topics in mathematics of quantum technologies such as, in particular,

- Quantum control;
- Open quantum systems;
- Quantum stochastic processes;
- (un)computability;
- Quantum error correction;
- Laser-assisted isotope separation.

Research highlights:

- World-leading research supported by various grants and projects, participation in international collaborations, conferences.

Supervisor's specific requirements:

- General knowledge of quantum mechanics, interest either to rigorous mathematical analysis or to numerical optimization methods for quantum technology problems.

Main publications:

- D. I. Bondar, A. N. Pechen, "Non Computability and complexity of quantum control", Scientific Reports, 10, 1195 (2020).
- G. G. Amosov, A. S. Mokeev, A. N. Pechen, "Non-commutative graphs and quantum error correction for a two-mode quantum oscillator", Quantum Information Processing, 19:3 (2020).
- S. N. Filippov, G. N. Semin, A. N. Pechen, "Quantum master equations for a system interacting with a quantum gas in the low-density limit and for the semiclassical collision model", Phys. Rev. A, 101, 12114 (2020).
- K. A. Lyakhov, H. J. Lee, A. N. Pechen, "Some issues of industrial scale boron isotopes separation by the laser assisted retarded condensation (SILARC) method", Separation and Purification Technology, 176:4, 402–411 (2017).
- A.N. Pechen, N.B. Ilin, "Control landscape for ultrafast manipulation by a qubit", Journal of Physics A: Mathematical and Theoretical, 50:7, 75301 (2017).
- A. N. Pechen, A. S. Trushechkin, "Measurement-assisted Landau-Zener transitions", Phys. Rev. A, 91:5, 052316 (2015).
- A. N. Pechen, D. J. Tannor, "Are there traps in quantum control landscapes?", Phys. Rev. Lett., 106, 120402 (2011).
- A. Pechen, H. Rabitz, "Teaching the environment to control quantum systems", Phys. Rev. A, 73, 062102 (2006).

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GAME THEORY AND BEHAVIORAL ECONOMICS

Research supervisor:
Tatiana Kozitsina (Babkina)
PhD

Supervisor's research interests:

- Game theory.
- Behavioral economics.
- Behavioral finance.
- Mathematical modeling of social and economic processes.

Research highlights:

- Modern research topics as confirmed by Nobel prizes in recent years.
- Possibility to conduct laboratory experiments in behavior economics.
- Orientation on the publication in Scopus/WoS journals.

Supervisor's specific requirements:

- Mathematical analysis.
- Probability theory.
- Statistics.
- Python/R.

Main publications:

- Menshikov, I. S., Shklover, A. V., Babkina, T. S., & Myagkov, M. G. (2017). From rationality to cooperativeness: The totally mixed Nash equilibrium in Markov strategies in the iterated Prisoner's Dilemma. PloS one, 12(11), e0180754.
- Babkina, T., Myagkov, M., Lukinova, E., Peshkovskaya, A., Menshikova, O., & Berkman, E. T. (2016). Choice of the group increases intra-cooperation. CEUR Workshop Proceeding. Vol. 1627. P. 13—22.
- Lukinova, E., Babkina, T., Sedush, A., Menshikov, I., Menshikova, O., & Myagkov, M. (2017). Sociality is not lost with monetary transactions within social groups. CEUR Workshop Proceeding. Vol. 1968. P. 18—30.
- Peshkovskaya, A. G., Babkina, T. S., Myagkov, M. G., Kulikov, I. A., Ekshova, K. V., & Harriff, K. (2017). The socialization effect on decision making in the Prisoner's Dilemma game: An eye-tracking study. PloS one, 12(4), e0175492.

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NUMERICAL METHODS FOR NONSMOOTH OPTIMIZATION

Research supervisor:
Fedor Stonyakin
PhD

Supervisor's research interests:

- Methods for Convex Programming Problems.
- Methods for Variational Inequalities.
- Inexactness in Optimization.
- Adaptive Algorithms for Optimization Problems.
- Optimization Problems with Relative Accuracy.

Supervisor's specific requirements:

- Mathematical analysis.
- Linear Algebra.
- Analytical Geometry.
- Computes Science.
- Python.

Main publications:

- Bayandina, P. Dvurechensky, A. Gasnikov, F. Stonyakin, A. Titov. Mirror descent and convex optimization problems with non-smooth inequality constraint. // Lecture Notes in Mathematics. 2018. Vol. 2227, P. 181 – 213.
- F. S. Stonyakin, D. Dvinskikh, P. Dvurechensky, A. Kroshnin, O. Kuznetsova, A. Agafonov, A. Gasnikov, A. Tyurin, C. A. Uribe, D. Pasechnyuk, S. Artamonov. Gradient Methods for Problems with Inexact Model of the Objective. // In: M. Khachay et al. (Eds.): MOTOR 2019. Lecture Notes in Computer Science. 2019. Vol. 11548. P. 97 – 114.
- P. Dvurechensky, A. Gasnikov, E. Nurminsky and F. Stonyakin. Advances in Low-Memory Subgradient Optimization. // In: A. M. Bagirov et al.(eds.). Numerical Nonsmooth Optimization. State of the Art Algorithms. Springer Nature Switzerland AG 2020. P. 19 – 59.
- F. S. Stonyakin. On the Adaptive Proximal Method for a Class of Variational Inequalities and Related Problems. // Proceedings of the Steklov Institute of Mathematics. 2020. Vol. 309(1). P.S139 – S150.
- F. Stonyakin, E. Vorontsova and M. Alkousa. New Version of Mirror Prox for Variational Inequalities with Adaptation to Inexactness. // 10th International Conference on Optimization and Applications, OPTIMA-2019. Communications in Computer and Information Sciences. 2020. Vol. 1145. P. 427 – 442.

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FUNCTIONAL AND BAYESIAN DATA ANALYSIS

Research supervisor:
Vadim Strijov
PhD, DSc

Supervisor's research interests:

The goal of research in machine learning is the creation of optimal forecasting models. We must generate a family of models and select a model of an optimal structure. The model structure is a stochastic graph, it is a point in continuous space. The selection criterion is a differentiable function, so the optimization of a model structure goes smoothly. To generate models, we use methods of functional data analysis. To select models, we use methods of Bayesian inference.

Research highlights:

- Perform computational experiments to analyze models with applications in physics, chemistry, and biology.
- Collaborate with international research groups.
- Publish results in top-rated journals.

Supervisor's specific requirements:

- Algebra and Mathematical (functional) analysis.
- Stochastic processes and Statistics.
- Programming and writing skills.

Main publications:

- Bakhteev O.Y., Strijov V.V. Comprehensive analysis of gradient-based hyperparameter optimization algorithms // Annals of Operations Research, 2020: 1-15.
- Aduenko A.A., Motrenko A.P., Strijov V.V. Object selection in credit scoring using covariance matrix of parameter estimations // Annals of Operations Research, 2018, 260(1-2): 3-21.
- Motrenko A.P., Strijov V.V. Multi-way feature selection for ECoG-based brain-computer interface // Expert Systems with Applications, 2018, 114(30): 402-413.
- Katrutsa A.M., Strijov V.V. Comprehensive study of feature selection methods to solve multicollinearity problems according to evaluation criteria // Expert Systems with Applications, 2017, 76: 1-11.
- Kulunchakov A.S., Strijov V.V. Generation of simple structured Information Retrieval functions by genetic algorithm without stagnation // Expert Systems with Applications, 2017, 85: 221-230.

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COMPUTER VISION METHODS AND THEIR APPLICATIONS FOR ROBOTIC PLATFORMS

Research supervisor:
Dmitry Yudin
PhD

Supervisor's research interests:

- Computer vision methods based on deep neural networks.
- Autonomous vehicles and intelligent transport systems.
- Modern methods of simultaneous localization and mapping.
- Onboard systems of unmanned vehicles and mobile robots.
- Algorithms for automated labeling of 2D and 3D scenes.
- 3D reconstruction methods and their applications for virtual and augmented reality.
- Application of computer vision in control systems.

Research highlights

- The research program is devoted to a wide range of modern computer vision methods used in on-board systems of robotic platforms: small educational robots, drones, service robots and courier robots, full-size unmanned vehicles.
- PhD students have the opportunity to work with the most modern server and robotic equipment at the disposal of the Intelligent Transport Laboratory of the MIPT Center for Cognitive Modeling and the Scientific and Design Bureau of Computing Systems.
- Research of the developed methods and algorithms s carried out on the basis of embedded energy-efficient platforms NVidia Jetson Nano, TX2 and Xavier, Server GPU NVidia Tesla V100, the Clearpath Husky robot with UR5 manipulator and mobile autonomous vehicle based on KIA SOUL.

Supervisor's specific requirements:

- Mathematical analysis, Linear algebra, Probability theory.
- High skills in Python and C++.
- Deep learning frameworks PyTorch and/or Tensorflow.
- Robotic Operating System (ROS).

Main publications:

- Staroverov, D. A. Yudin, I. Belkin, V. Adeshkin, Y. K. Solomentsev, and A. I. Panov. Real-Time Object Navigation with Deep Neural Networks and Hierarchical Reinforcement Learning. IEEE Access, 2020.
- Yudin D., Adeshkin V., Dolzhenko A., Polyakov A., Naumov A. Roof Defect Segmentation on Aerial Images using Neural Networks. Advances in Neural Computation, Machine Learning, and Cognitive Research IV. Studies in Computational Intelligence, Vol. 925, 2020.
- Rezanov A., Yudin D. Deep Neural Networks for Orthophoto-based Vehicle Localization. Advances in Neural Computation, Machine Learning, and Cognitive Research IV. Studies in Computational Intelligence, Vol. 925, 2020.
- Yudin D. A., Skrynnik A., Krishtopik A., Belkin I., and Panov A. I. Object Detection with Deep Neural Networks for Reinforcement Learning in the Task of Autonomous Vehicles Path Planning at the Intersection. Optical Memory & Neural Networks (Information Optics), Vol. 28 № 4, 2019.

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AI, ROBOTICS, PATH PLANNING

Research supervisor:
Konstantin Yakovlev
PhD

Supervisor's research interests:

- Artificial Intelligence.
- Intelligent Robotics.
- AI planning, path planning.
- Motion planning.
- Multi-agent path finding.
- Heuristic search.
- Multi-agent systems.

Research highlights

My general research interests lie in Artificial Intelligence and Robotics and more specifically in Path and motion planning. I'm a part of a group that extensively studies Multi-agent Path Finding (MAPF) and develops state-or-the-art planners which use heuristic search techniques as their basis. We are interested in two lines of research within MAPF: i) Developing provably complete and optimal algorithms that do not rely on numerous limiting assumptions, i.e. are able to handle continuous time and space, take kinematic constraints of agents into account etc., ii) Developing MAPF algorithms that work fast and scale well to large numbers of agents, making them suitable for real-world applications (e.g. automated warehouses). Besides Path Planning, I'm also involved in SLAM research, in particular - monocular vision based SLAM. My students develop fast vSLAM methods suitable for execution in real time under tough computational constraints (e.g. when running onboard a compact mobile robot). vSLAM, however, is not my primary research interest.

Supervisor's specific requirements:

- Solid background in Math/CS (specifically – discrete mathematics, graph theory).
- C++/Python (at least 2-3 years of experience).
- Robotic Operating System (ROS) is a plus.
- Published papers in the areas of AI, Robotics, Path/motion planning is a plus.

Main publications:

- Andreychuk A., Yakovlev K., Atzmon D., Stern R. Multi-Agent Pathfinding with Continuous Time // In Proceedings of the 28th International Joint Conference on Artificial Intelligence (IJCAI 2019). pp. 39-45.
- Yakovlev K., Andreychuk A., Vorobyev V. Prioritized Multi-Agent Path Finding for Differential Drive Robots // In Proceedings of the 2019 European Conference on Mobile Robots (ECMR 2019). pp. 1-6.
- Soboleva N., Yakovlev K. GAN Path Finder: Preliminary results // In Proceedings of the 42nd German Conference on Artificial Intelligence (KI 2019). pp. 316-324.
- Panov A.I., Suvorov R., Yakovlev K.S. (2018) Grid Path Planning with Deep Reinforcement Learning: Preliminary Results // In Proceedings of the 8th Annual International Conference on Biologically Inspired Cognitive Architectures (BICA 2017). pp. 347–353. Elsevier.
- Yakovlev, K., Andreychuk, A. (2017) Any-Angle Pathfinding for Multiple Agents Based on SIPP Algorithm. In Proceedings of the 27th International Conference on Automated Planning and Scheduling (ICAPS 2017). pp. 586-593.

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OPEN QUANTUM SYSTEMS

Research supervisor:
Alexander Teretenkov
PhD

Supervisor's research interests:

I study a wide range of problems in the theory of open quantum systems. But there are several topics which I am especially interested in:

- Exactly solvable Gorini-Kossakowski-Sudarshan-Lindblad equations, especially the generalizations of the equations with generators which are quadratic in creation and annihilation operators.
- Exactly solvable models of non-Markovian quantum evolutions, especially by pseudo mode method generalizations.
- Perturbative derivation of master equations both by projective and stochastic limit methods, especially in the case when it could be done for all the orders of perturbation theory.

Research highlights:

The theory of open quantum systems is a theoretical basis of modern spectroscopy, quantum optics, quantum measurement theory, quantum thermodynamics and has a wide range of physical applications. It belongs to the intersection of cutting edges of physics and mathematics. There is a very wide and active community providing a great number of conferences, seminars and grant possibilities.

Supervisor's specific requirements:

- Basic knowledge of theory of open quantum systems (circa Chapters 2-3 in H.P.Breuer and F.P. Pettruchione's book "Theory of open quantum systems").
- Basic but solid skills in usual mathematical subjects: linear algebra, ordinary and partial differential equations, probability theory, stochastic processes, and in usual physical subjects: electrodynamics, quantum mechanics, statistical physics.

Main publications:

- A. E. Teretenkov, "Irreversible quantum evolution with quadratic generator: Review", Infin. Dimens. Anal. Quantum Probab. Relat. Top., 22:4 (2019), 19300019.
- A. E. Teretenkov, "Dynamics of Moments for Quadratic GKSL Generators", Math. Notes, 106:1 (2019), 151–155.
- A. E. Teretenkov, "Non-Markovian evolution of multi-level system interacting with several reservoirs. Exact and approximate", Lobachevskii J. Math., 40:10 (2019), 1587–1605.
- S. V. Kozyrev, A. A. Mironov, A. E. Teretenkov, I. V. Volovich, "Flows in nonequilibrium quantum systems and quantum photosynthesis", Infin. Dimens. Anal. Quantum Probab. Relat. Top., 20:4 (2017), 1750021.
- A. M. Chebotarev, A. E. Teretenkov, "Singular value decomposition for the Takagi factorization of symmetric matrices", Appl. Math. Comput., 234 (2014), 380–384.
  Web cite: http://www.mathnet.ru/php/person.phtml?option_lang=rus&personid=76513

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PHYSICS & ASTRONOMY

03.06.01

Duration of study: 4 years

Language: English or Russian

Entry requirements:

Master’s degree / equivalent in a related field

B2 level of English or Russian

Good track record of publications related to the topic of the intended research

Strong research proposal 1,500 - 3,500 words

PRECISION MEASUREMENT OF NEUTRINO OSCILLATION PARAMETERS IN THE JUNO EXPERIMENT

Research supervisor:
Maxim Gonchar
PhD

Supervisor's research interests:

Neutrino oscillations, oscillation parameter measurement, reactor electron antineutrino, Daya Bay and JUNO experiments, detector simulation and reconstruction, statistical data analysis, high performance fitting.

Research highlights:

- Cutting edge neutrino science, unique experiment.
- Large international collaboration.
- Data taking starts in 2022.
- Extra financial support from JINR.

Supervisor's specific requirements:

Basic knowledge:
- Physics of Elementary Particles.
- Statistical data analysis.

Advanced programming skills, including knowledge of:
- Linux, shell.
- C++: stdlib, ROOT.
- Python: scipy/numpy, matplotlib, jupyter,...
- Geant4 (desirable).

Main publications

- "Neutrino Physics with JUNO", F.P.An et al, arXiv: 1507.05613 [physics.ins-det].
- "Study of the wave packet treatment of neutrino oscillation at Daya Bay", F.P.An et al., arXiv: 1608.01661 [hep-ex].
- "Measurement of electron antineutrino oscillation based on 1230 days of operation of the Daya Bay experiment", F.P.An et al., arXiv:1610.04802 [hep-ex]
- "GNA: new framework for statistical data analysis", A.Fatkina et al., arXiv: 1903.05567 [cs.MS].

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QUANTUM INFORMATION THEORY

Research supervisor:
Sergey Filippov
PhD, Head of the Laboratory of Quantum Information Theory

Supervisor's research interests:

- Quantum Technologies.
- Quantum Measurements.
- Quantum Information Theory.
- Entanglement and Separability.
- Dynamics of Open Quantum Systems.
- Quantum Channels.
- Geometry of Quantum States.
- Quantum Computers and Computing.
- Tensor Networks.
- Machine Learning.

Research highlights:

World-leading research with publications in the best journals in the field of Quantum Physics and Mathematical Physics such as Physical Review Letters, Physical Review A, Journal of Mathematical Physics. A broad network of collaborators in Finland, Poland, Slovakia, and Czech Republic.

Supervisor's specific requirements:

Exceptionally good knowledge of linear algebra and quantum mechanics.

Main publications:

- I.A. Luchnikov, S.V. Vintskevich, D.A. Grigoriev, S.N. Filippov. Machine learning non-Markovian quantum dynamics // Physical Review Letters 124, 140502 (2020).
- S.N. Filippov and K.V. Kuzhamuratova. Quantum informational properties of the Landau–Streater channel // J. Math. Phys. 60, 042202 (2019).
- I.A. Luchnikov, S.V. Vintskevich, H. Ouerdane, and S.N. Filippov. Simulation Complexity of Open Quantum Dynamics: Connection with Tensor Networks // Physical Review Letters 122, 160401 (2019).
- S.V. Vintskevich, D.A. Grigoriev, S.N. Filippov. Effect of an incoherent pump on two-mode entanglement in optical parametric generation // Physical Review A 100, 053811 (2019).
- S.N. Filippov, V.V. Frizen, D.V. Kolobova. Ultimate entanglement robustness of two-qubit states against general local noises // Physical Review A 97, 012322 (2018).
- S.N. Filippov, T. Heinosaari, L. Leppajarvi. Simulability of observables in general probabilistic theories // Phys. Rev. A 97, 062102 (2018).
- S.N. Filippov, D. Chruscinski. Time deformations of master equations // Phys. Rev. A 98, 022123 (2018).
- S.N. Filippov. Lower and upper bounds on nonunital qubit channel capacities // Reports on Mathematical Physics 82, 149-159 (2018).
- S.N. Filippov, K. Yu. Magadov. Positive tensor products of qubit maps and n-tensor-stable positive qubit maps // J. Phys. A: Math. Theor. 50, 055301 (2017).
- I.A. Luchnikov, S.N. Filippov. Quantum evolution in the stroboscopic limit of repeated measurements // Phys. Rev. A 95, 022113 (2017).
- F. Benatti, D. Chruscinski, S. Filippov. Tensor power of dynamical maps and positive versus completely positive divisibility // Phys. Rev. A 95, 012112 (2017).
- S.N. Filippov, J. Piilo, S. Maniscalco, M. Ziman, Divisibility of quantum dynamical maps and collision models // Phys. Rev. A 96, 032111 (2017).

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THEORETICAL PARTICLE PHYSICS AND COSMOLOGY

Research supervisor:
Dmitry Gorbunov
PhD, DSc

Supervisor's research interests:

Quantum field theory, physics beyond the Standard Model of particle physics (supersymmetry, grand unification, hidden sectors and portals, etc.), neutrino physics, astroparticle physics and cosmology (dark matter models, inflation and reheating, baryogenesis).

Research highlights:

Typically, the group members participate in 2-3 projects supported by Scientific Foundations. There are also special prizes and awards for PhD students from the Institute for Nuclear Research. The group has scientific relations (collaborations, visits, etc) with theory divisions of EPFL (Lausanne), Manchester University, ULB (Brussels), ETH (Zurich), Munich University, Prague University.

Supervisor's specific requirements:

- Quantum field theory (e.g. Peskin & Scroeder).
- Classical Theory of Gauge Fields (e.g. Rubakov).
- Standard Model of particle physics (symmetries, strong and electroweak interactions, Higgs mechanism, etc, e,g, Okun).
- Math: calculus, differential and integral equations, Group Theory, matrix theory.

Main publications:

- Phenomenology of GeV-scale Heavy Neutral Leptons Kyrylo Bondarenko, Alexey Boyarsky (Leiden U.), Dmitry Gorbunov (Moscow, INR & Moscow, MIPT), Oleg Ruchayskiy (Bohr Inst.). May 22, 2018. 54 pp. Published in JHEP 1811 (2018) 032.
  DOI: 10.1007/JHEP11(2018)032
  e-Print: arXiv:1805.08567.
- On sgoldstino interpretation of the diphoton excess S.V. Demidov (Moscow, INR), D.S. Gorbunov (Moscow, MIPT & Moscow, INR). Dec 17, 2015. 4 pp. Published in JETP Lett. 103 (2016) no.4, 219-222, Pisma Zh.Eksp. Teor.Fiz. 103 (2016) no.4, 241-244 INR-TH-2015-036.
  DOI: 10.1134/S0021364016040044
  e-Print: arXiv:1512.05723.
- Relic Gravity Waves and 7 keV Dark Matter from a GeV scale inflaton F. Bezrukov (CERN & Connecticut U. & RIKEN BNL), D. Gorbunov (Moscow, INR & Moscow, MIPT). Mar 18, 2014. 5 pp. Published in Phys. Lett. B736 (2014) 494-498.
  DOI: 10.1016/j.physletb.2014.07.060
  e-Print: arXiv:1403.4638.
- Distinguishing between R2-inflation and Higgs-inflation F.L. Bezrukov (Connecticut U. & RIKEN BNL & Munich U., ASC), D.S. Gorbunov (Moscow, INR).

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THEORETICAL PARTICLE PHYSICS AND COSMOLOGY

Nov 2011. 4 pp. Published in Phys.Lett. B713 (2012) 365-368 LMU-ASC-72-11.
DOI: 10.1016/j.physletb.2012.06.040
e-Print: arXiv:1111.4397.

- Scalaron the mighty: producing dark matter and baryon asymmetry at reheating D.S. Gorbunov, A.G. Panin (Moscow, INR). Sep 2010. 6 pp. Published in Phys.Lett. B700 (2011) 157-162.
  DOI: 10.1016/j.physletb.2011.04.067
  e-Print: arXiv:1009.2448.
- Light inflaton Hunter's Guide F. Bezrukov (Heidelberg, Max Planck Inst. & Moscow, INR), D. Gorbunov (Moscow, INR). Dec 2009. 22 pp. Published in JHEP 1005 (2010) 010
  DOI: 10.1007/JHEP05(2010)010
  e-Print: arXiv:0912.0390.
- On initial conditions for the Hot Big Bang F. Bezrukov (Moscow, INR & ITPP, Lausanne & Heidelberg, Max Planck Inst.), D. Gorbunov (Moscow, INR), M. Shaposhnikov (ITPP, Lausanne). Dec 2008. 22 pp. Published in JCAP 0906 (2009) 029
  DOI: 10.1088/1475-7516/2009/06/029
  e-Print: arXiv:0812.3622.

STUDY OF POLARIZED AND UNPOLARIZED STRUCTURE OF HADRONS IN HADRONIC COLLISIONS

Research supervisor:
Alexey Guskov
PhD, DSc

Supervisor's research interests:

Spin physic with polarized proton and deuteron beams at the NICA SPD project. Structure of pion and kaon at the future COMPASS++/AMBER project (CERN).

Research highlights:

The Spin Physics Detector (SPD) is one of the main detectors planned at the NICA collider that is a Mega science project.

Supervisor's specific requirements:

- C++, Linux.
- ROOT, Geant4, experience in MC simulation.
- Statistics, passage of particles through matter, detectors, particle physics, hadron physics.
- Fluent English.

Main publications:

- PRL 114 (2015) 062002.
- PLB 772 (2017) 854).
- PRL 119 (2017) 112002.

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EXPERIMENTAL SEARCH FOR NEUTRINOLESS DOUBLE BETA DECAY OF 76GE

Research supervisor:
Konstantin Gusev
PhD

Supervisor's research interests:

TThe LEGEND experiment is designed to search for neutrino less double beta (0νββ) decay of ^{76}Ge. LEGEND will operate with bare germanium semiconductor detectors (enriched in Ge-76) directly immersed in liquid argon instrumented to readout argon scintillations for vetoing background events. Thanks to these approach in the predecessor GERDA experiment the background level was reduced down to the unprecedented value of 10^{-3} counts keV^{-1} kg^{-1} yr^{-1}. In order to further reduce any background interruptions in LEGEND experiment, the R&D for novel germanium detector types, new ultra-low background construction materials and the effective methods of argon scintillation readout is being constantly performed by our JINR group together with our international collaborators. Our group has solid experience achieved at the design, preparation and integration phases of the GERDA experiment as well as during operating of the experiment and the analysis of data. This will help the JINR group to keep the strong position in the LEGEND project. However, we are willing to enlarge the analysis part of our group – so we are looking for the candidate who will work mainly for the modelling and data analysis.

Research highlights:

LEGEND is truly world-wide collaboration includes about 240 scientists from 47 institutions. The especially good connection our group has with The Technical University of Munich (Germany) and Max Planck Institute for Nuclear Physics, Heidelberg (Germany), so some working visits there are expected as well as to Gran Sasso National Laboratory in Italy, where the first phase of LEGEND will take place. The successful candidate is expected to join the international LEGEND data analysis team.

Supervisor's specific requirements:

- Candidates are expected to hold a master degree in particle or nuclear physics.
- Programming experience is highly recommended.
- The experience with data analysis is an advantage.
- Good communication skills (English) and readiness to travel are mandatory.

Main publications:

- "Probing Majorana neutrinos with double-β decay", Science 365 (2019) 1445.
- "Improved Limit on Neutrino less Double-β Decay of ^{76}Ge from GERDA Phase II", PRL 120 (2018) 132503.
- "Upgrade for Phase II of the GERDA Experiment", EPJC 78 (2018) 388.
- "Background-free search for neutrino less double-β decay of ^{76}Ge with GERDA", Nature 544 (2017) 47.

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LOW BACKGROUND EXPERIMENTS ON BASIC NUCLEAR AND PARTICLE PHYSICS

Research supervisor:
Lev Inzhechik
PhD, Head of Laboratory of Nuclear Experiments Methods

Supervisor's research interests:

Neutrino physics, double beta-decay, cosmic muons of high energy. Underground low background experiments – collaboration with underground labs: LNGS (Italy), LSC (Spain), Callio Lab (Finland), BNO (Russia). Methods of low background measurements and engineering of unique equipment.

Research highlights:

Participation in international collaborations and projects: GERDA, LEGEND, EMMA Mu-monitor. Cooperation with underground labs: LNGS (Italy), LSC (Spain), Callio Lab (Finland), BNO (Russia). Active interaction with leading German, Swiss, Italian, Spanish, Finnish, Russian and Polish universities and research institutes that take part in the collaborations. Participation in teaching of students and involving them into research (desirable).

Supervisor's specific requirements:

- General physics, mathematics, nuclear physics and computing in the frame of standard programs of a classic university.
- Theoretical physics – to be acquainted with main topics and recent models of basic interactions and particles.
- Engineering for nuclear experiments: electronics, detectors, cryogenics, vacuum, etc. – desirable.

Main publications:

- Cosmic-ray muon flux at Canfranc Underground Laboratory. Eur.Phys.J. C79 (2019) no.8, 721.
- Improved Limit on Neutrinoless Double-ββ Decay of 76Ge from GERDA Phase II. Phys.Rev.Lett. 120 (2018) no.13, 132503.
- Background free search for neutrinoless double beta decay with GERDA Phase II. Nature 544 (2017) 47.

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MACHINE LEARNING APPLICATIONS IN ASTRO-PARTICLE PHYSICS

Research supervisor:
Oleg Kalashev
PhD, DSc

Supervisor's research interests:

Machine learning applications for search for the sources of ultra-high energy cosmic rays, determination of their composition, determination of blazars' redshifts from multi-wavelength photometry, search for a unified model of different gamma-ray pulsar populations.using multimessenger approach to constrain dark matter models and scenarios of ultra-high-energy cosmic ray and neutrino origin.

Research highlights:

You will join the international group of scientists working on the most challenging problems in modern astrophysics. Our group is a member of the Telescope Array collaboration.

Supervisor's specific requirements:

- Deep knowledge of probability theory and statistics.
- Good python and C++ programming skills.
- Base knowledge of astroparticle physics and cosmology.
- Base knowledge in supervised and unsupervised machine learning.

Main publications:

- "Using Deep Learning in Ultra-High Energy Cosmic Ray Experiments" Conf Ser 1525 (ACAT 2019).
- Prospects of detecting a large-scale anisotropy of ultra-high-energy cosmic rays from a nearby source with the K-EUSO orbital telescope, Oleg Kalashev, Maxim Pshirkov, Mikhail Zotov, JCAP 09 (2019) 034.
- Identifying nearby sources of ultra-high-energy cosmic rays with deep learning, Oleg Kalashev, Maxim Pshirkov, Mikhail Zotov e-Print: 1912.00625, JCAP 2020.
- Dark matter component decaying after recombination: constraints from diffuse gamma-ray and neutrino flux measurements, Oleg E. Kalashev, Mikhail Yu. Kuznetsov, Yana V. Zhezher, JCAP 10 (2019).
- Cosmic infrared background excess from axionlike particles and implications for multimessenger observations of blazars, Oleg E. Kalashev, Alexander Kusenko, Edoardo Vitagliano, Phys.Rev.D 99 (2019) 2.

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STUDIES OF HADRON PRODUCTION MECHANISMS IN PROTON-PROTON COLLISIONS AT THE LHC ENERGY VIA INCLUSIVE SPECTRA MEASUREMENTS OF LIGHT NEUTRAL MESONS

Research supervisor:
Yuri Kharlov
PhD, DSc, Head of the Laboratory of Fundamental Interactions

Supervisor's research interests

Experimental studies of photon and hadron production in high-energy collision of protons and heavy ions at the Large Hadron Collider at CERN; strong interactions; deconfined state of matter of quarks and gluons; detectors for high-energy physics experiments; electromagnetic calorimetry; methods of big data analysis; detector calibration; Monte Carlo simulations.

Research highlights

The research will be performed within the international collaboration ALICE at the Large Hadron Collider Experiment in the European Organization for Nuclear Research CERN. The ALICE experiment has started operating in 2009 and will continue collecting data for analysis at least till 2030. The physics program of ALICE is focused on fundamental properties of hot and dense quark-gluon matter at extremely high temperature created in ultra-relativistic collisions of proton and ion beams at the energies 5-14 TeV in the center-mass system. The measurements of direct photon and hadron spectra is a sensitive probe for the initial state of collisions, for transport properties of a parton passing through the quark-gluon matter, and for fragmentation of partons to observable hadrons. A PhD student will be involved in processing of data from the ALICE precise electromagnetic calorimeter which requires data quality validation, calorimeter calibration, development of analysis software, analyzing of petabytes of recorded data using the world-wide distributed computing system GRID. Among duties of a student, detector maintenance and operation, participating in the experiments shifts during data taking will be considered as a part of service work.

Supervisor's specific requirements

- A good candidate should demonstrate a knowledge of general and theoretical physics in the field of elementary particle physics, should know relativistic classical kinematics.
- A candidate should be familiar with phenomenology of particle physics, experimental methods in high-energy physics, particle interactions with matter.
- Knowledge of mathematics such as mathematical analysis, linear algebra, statistics is mandatory.
- Programming skills in C++, Pythons, bash are needed. A student should be able to understand the source code in these languages and write the own software packages.

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STUDIES OF HADRON PRODUCTION MECHANISMS IN PROTON-PROTON COLLISIONS AT THE LHC ENERGY VIA INCLUSIVE SPECTRA MEASUREMENTS OF LIGHT NEUTRAL MESONS

- Good communication skills and ability to present the proper results for a large English-speaking audience is one of the essential requirement for working in a large international collaboration.
- Experience in Linux at the user level and basic knowledge is Linux system administration is needed. Experience in LaTeX for text processing is welcome.

Main publications

- S. Acharya et al. [ALICE Collaboration], Calibration of the photon spectrometer PHOS of the ALICE experiment, JINST 14 (2019) 05, P05025, DOI: 10.1088/1748-0221/14/05/P05025.
- J. Adam et al. [ALICE Collaboration], Jet-like correlations with neutral pion triggers in pp and central Pb–Pb collisions at 2.76 TeV, Phys.Lett. B763 (2016) 238-250, DOI: 10.1016/j.physletb.2016.10.048.
- J. Adam et al. [ALICE Collaboration], Direct photon production in Pb-Pb collisions at \sqrt{s{NN}} = 2.76 TeV, Phys.Lett. B754 (2016) 235-248, DOI: 10.1016/j.physletb.2016.01.020.
- S. Acharya et al. [ALICE Collaboration], Calibration of the photon spectrometer PHOS of the ALICE experiment, JINST 14 (2019) no.05, P05025, DOI: 10.1088/1748-0221/14/05/P05025.
- Y. Kharlov, Performance of Calorimetry in ALICE, PoS LHCP2018 (2018) 231, DOI: 10.22323/1.321.0231.
- S. Acharya et al. [ALICE Collaboration], Neutral pion and eta meson production at mid-rapidity in Pb-Pb collisions at √sNN = 2.76 TeV, Phys.Rev. C98 (2018) no.4, 044901, DOI: 10.1103/PhysRevC.98.044901.
- S. Acharya et al. [ALICE Collaboration], Neutral pion and eta meson production in p-Pb collisions at √sNN=5.02 TeV, Eur.Phys.J. C78 (2018) no.8, 624, DOI: 10.1140/epjc/s10052-018-6013-8.
- S.Acharya et al. [ALICE Collaboration], pi0 and eta meson production in proton-proton collisions at √s=8 TeV, Eur.Phys.J. C78 (2018) no.3, 263, DOI: 10.1140/epjc/s10052-018-5612-8.
- S.Acharya et al. [ALICE Collaboration], Production of pi0 and eta mesons up to high transverse momentum in pp collisions at 2.76 TeV, Eur.Phys.J. C77 (2017) no.5, 339, DOI: 10.1140/epjc/s10052-017-4890-x.
- S.Acharya et al. [ALICE Collaboration], Measurement of the inclusive isolated photon production cross section in pp collisions at √s= 7 TeV, Eur.Phys.J. C79 (2019) no.11, 896, DOI: 10.1140/epjc/s10052-019-7389-9
- S.Evdokimov et al., The ALICE CPV Detector, KnE Energ.Phys. 3 (2018) 260-267, DOI: 10.18502/ken.v3i1.1752.

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HEAVY ION COLLISIONS AT HIGH ENERGIES

Research supervisor:
Alexey Aparin
PhD

Supervisor's research interests:

Main research activity is dedicated to analysis of STAR experiment data on heavy ion collisions. It involves research of charged particle production, correlation analysis of net-protons, particle femtoscopy. Generally, group activities lay in the fields of light flavor spectra and bulk properties investigations.

Research highlights:

Our group is a part of STAR collaboration. It implies involvement in collaboration activities. Short term visits to other STAR groups outside Russia are possible.

Supervisor's specific requirements:

- Linux, C/C++, LaTex.
- Basics of quantum mechanics.
- Experimental particle physics.
- Basics of particle acceleration and principles of particle detection.

Main publications:

- Beam energy dependence of jet-quenching effects in Au+Au collisions at s_{NN} = 7.7, 11.5, 14.5, 19.6, 27, 39, and 62.4 GeV, Phys. Rev. Lett., 121 (2018) n.3, 032301.
- Measurement of interaction between antiprotons, Nature, 527 (2015), 345-348.
- Global Λ hyperon polarization in nuclear collisions: evidence for the most vortical fluid, Nature, 548 (2017), 62-65.

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QUANTUM GRAVITY AND COSMOLOGY

Research supervisor:
Andrei Barvinsky
PhD, DSc

Supervisor's research interests:

Mathematical methods of quantum field theory and quantum gravity, quantum cosmology and physics of the early quantum Universe, inflation theory, dark energy problem.

Research highlights:

Synthesis of mathematical methods and applications in physics of the very early Universe and relativistic cosmology.

Supervisor's specific requirements:

- Basic knowledge of quantum field theory.
- Foundations of general relativity.
- Basic methods of mathematical physics.

Main publications:

- A.O. Barvinsky, D. Blas, M. Herrero-Valea, S.M. Sibiryakov, and C.F. Steinwachs, Renormalization of Hořava gravity, Phys. Rev. D 93, 064022.
- A.O. Barvinsky, A. Yu. Kamenshchik, C. Kiefer, A.A. Starobinsky and C. Steinwachs, Asymptotic freedom in inflationary cosmology with a non-minimally coupled Higgs field, JCAP 12(2009)003.
- A.O. Barvinsky, A. Yu. Kamenshchik, C. Kiefer, A.A. Starobinsky and C. Steinwachs, Higgs boson, renormalization group, and naturalness in cosmology, EPJC 72 (2012) 2219.

MIXED CONVECTION OF LIQUID METALS

Research supervisor:
Ivan Belyaev
PhD

Supervisor's research interests:

- MHD – affected heat transfer of uncompressible media.
- Turbulence signal processing.
- Liquid metal measurements and operation.

Research highlights:

- Research activity in a field of liquid metal and molten salts heat transfer.
- Experimental methods development on velocity and temperature measurements.
- Application of the liquid metal experimental facility (HELMEF) in the research program.
- Improvement of signal processing and experimental skills.

Supervisor's specific requirements:

- Experience in experimental thermophysics.
- Base of LabView, Python, ParaView.
- Heat transfer, Magnetohydrodynamics, Signal Processing, Turbulence base courses should be passed.

Main publications:

- Belyaev I. A. et al. On-off intermittency and hard turbulence in the flow of fluid in the magnetic field // Chaos. – 2019. – Т. 29. – №. 8. – С. 083119.
- Belyaev I. A. et al. Temperature correlation velocimetry technique in liquid metals //Flow Measurement and Instrumentation. – 2017. – Т. 55. – С. 37-43.
- Listratov Y. et al. Liquid Metal Mixed Convection in an Annulus with Twisted Tape //Applied Thermal Engineering. – 2020. – С. 115350.

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RELATIVISTIC AND PLASMA ASTROPHYSICS

Research supervisor:
Vasily Beskin
PhD, DSc

Supervisor's research interests

Radio Pulsars (neutron star magnetosphere, radio emission mechanisms, propagation of waves in the pulsar magnetosphere).
Active Galactic Nuclei (relativistic jets, black hole magnetosphere).

Research highlights:

- Collaboration with Princeton University (Princeton, USA).
- Flatiron Institute (New York, USA).
- Grenoble observatory (Grenoble, France).

Supervisor's specific requirements:

- General Relativity.
- Plasma Physics.
- MHD.

Main publications

- V.S. Beskin, A.V. Gurevich, Ya.N. Istomin. Physics of the Pulsar Magnetosphere. Cambridge University Press, Cambridge, 1993.
- V.S. Beskin MHD Flows in Compact Astrophysical Objects. Springer, Heidelberg, 2010.

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DEVELOPMENT AND APPLICATION OF BIGDATA ANALYSIS SYSTEMS FOR STUDIES OF QUARK-GLUON MATTER PROPERTIES IN HEAVY-ION COLLISIONS

Research supervisor:
Dmitry Blau
PhD

Supervisor's research interests

Study of quark-gluon matter properties in heavy-ion collisions at accelerator facilities, such as LHC (CERN), RHIC (USA), FAIR (Germany), and NICA (Russia). In particular, studies of photons and neutral mesons at ALICE experiment at LHC by analysis of data acquired since the beginning of the data taking (in 2009), detector upgrade, preparation of software for data taking, reconstruction and simulations for future measurements. For future experiment CBM at FAIR, simulations and new methods development are performed for collective flow studies. For future experiment MPD at NICA, simulations of direct photons and performance studies are carried out.

Research highlights

Research program is devoted for a broad spectra of topics, which are connected to studies of strong-interacting matter, and thus, the possibility is provided to cover all up-to-date research areas of interest in the world. The unique photon spectrometer of ALICE experiment is the largest contribution of Russian Federation to the ALICE experiment (more than 6 million Swiss francs), at the moment this detector is under upgrade for the future data taking periods. Research is carried out with tight collaboration with world scientific centers – CERN (Switzerland), GSI (Germany), JINR (Russia), NRC "Kurchatov Institute" (Russia). Currently scientific supervisor (Blau D.S.) is a leader of RSCF grant project dedicated to the same topic.

Supervisor's specific requirements:

- Nuclear physics, physics of elementary particles.
- Programming (C++, ROOT).
- Methods of statistical analysis of data.

Main publications

- Blau D. "Performance of the ALICE electromagnetic calorimeters in LHC Runs 1 and 2 and upgrade projects", Journal of Instrumentation 15 (2020) C03025.
- Blau D. "Calibration of the ALICE PHOS calorimeter", Journal of Physics: Conference Series 1390 (2019) 012113.
- Blau D. et. al, "Performance studies for collective flow measurements with CBM at FAIR", J. Phys.: Conf. Ser. 1390 012027 (2019).
- Blau D. "Direct photon production in pp, p-Pb and Pb-Pb collisions: results from ALICE", EPJ Web of Conferences 222, 02001 (2019).
- Blau D., Acharaya S. et al. (ALICE Collaboration), "Direct photon elliptic flow in Pb–Pb collisions at

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DEVELOPMENT AND APPLICATION OF BIGDATA ANALYSIS SYSTEMS FOR STUDIES OF QUARK-GLUON MATTER PROPERTIES IN HEAVY-ION COLLISIONS

$\sqrt{s_{NN}}$ = 2.76 TeV" TeV", Physics Letters B 789 (2019) 308-322.

- Blau D. "π0-hadron correlations in pp, p-Pb and Pb-Pb collisions at ALICE", Journal of Physics: Conference Series 798 1 (2017) 012052. DOI: 10.1088/1742-6596/798/1/012052
- Blau D, Ablyazimov T et al. (CBM Collaboration) "Challenges in QCD matter physics -The scientific programme of the Compressed Baryonic Matter experiment at FAIR", Eur. Phys. J. A (2017) 53: 60.
- Blau D, Adare A et al. (PHENIX Collaboration) "Azimuthally anisotropic emission of low-momentum direct photons in Au + Au collisions at $\sqrt{s_{NN}}$ = 200 GeV", Physical Review C – Nuclear Physics (2016) 94 (6), 064901.
- Blau D, Adam J et al. (ALICE Collaboration) "Direct photon production in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV", Physics Letters B 754 (2016) pp. 235-248.
- Blau D, Abelev B et al. (ALICE Collaboration) "Neutral pion production at midrapidity in pp and Pb–Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV", European Physical Journal C (2014) 74 (10), 3108, pp. 1-20.
- Blau D, Abelev B et al. (ALICE Collaboration) "Neutral pion and η meson production in proton-proton collisions at $\sqrt{s}$ = 0.9 TeV and $\sqrt{s}$ = 7 TeV", Physics Letters B (2012) 717 (1-3), pp. 162-172.

SUPERCONDUCTING SPINTRONICS

Research supervisor:
Irina Bobkova
PhD

Supervisor's research interests:

Quantum condensed matter theory, including quantum materials based on hybrid structures under equilibrium and nonequilibrium conditions, superconducting spintronics, magnetization dynamics, magnonics and caloritronics.

Research highlights:

Our group have intense working relationships with leading research groups in the field (Finland, Germany, Norway). Students are rapidly involved into active research and international scientific cooperation, present their work at various international conferences.

Supervisor's specific requirements:

We are looking for strongly motivated candidates. Knowledge of a standard university course of quantum mechanics is necessary, and skills of numerical computations are desirable.

Main publications:

- V. Bobkova, A. M. Bobkov, "Injection of nonequilibrium quasiparticles into Zeeman-split superconductors: A way to create long-range spin imbalance", Phys. Rev. B 93, 024513 (2016).
- V. Bobkova, A. M. Bobkov, Alexander A. Zyuzin, and Mohammad Alidoust, "Magnetoelectrics in disordered topological insulator Josephson junctions", Phys. Rev. B 94, 134506 (2016).
- I.V. Bobkova, A.M. Bobkov, and M.A. Silaev "Gauge theory of the long-range proximity effect and spontaneous currents in superconducting heterostructures with strong ferromagnets", Phys. Rev. B 96, 094506 (2017).
- D.S. Rabinovich, I. V. Bobkova, A. M. Bobkov, and M. A. Silaev, "Chirality selective spin interactions mediated by the moving superconducting condensate", Phys. Rev. B 98, 184511 (2018).
- D.S. Rabinovich, I.V. Bobkova, A.M. Bobkov, and M.A. Silaev, "Resistive State of Superconductor-Ferromagnet-Superconductor Josephson Junctions in the Presence of Moving Domain Walls" Phys. Rev. Lett. 123, 207001 (2019).

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STRANGE HYPERON PRODUCTION AND SEARCH FOR NUCLEAR MATTER WITH STRANGENESS IN PROTON-PROTON AND HEAVY ION COLLISIONS WITH ALICE AT THE LARGE HADRON COLLIDER

Research supervisor:
Alexander Borissov
PhD

Supervisor's research interests

Investigations in high energy heavy ion physics on the base of the data taking and analysis of ALICE experiment at the LHC at CERN.

Research highlights

ALICE (A Large Ion Collider Experiment) is a heavy-ion detector on the Large Hadron Collider (LHC) at CERN. It is designed to study the physics of strongly interacting matter at extreme energy densities in proton-proton and heavy ion collisions, where a phase of matter referred to as a quark-gluon plasma is formed.

The first observation of Σ^0 and anti- Σ^0 hyperons in proton-proton collisions at LHC with ALICE allows one its detailed analysis and simulations in proton-proton and lead-lead collisions on the base of ALICE data accumulated in 2010-2018.

Another topic is connected with the search and investigations of hyper-nuclei, i.e. nuclei with non-zero strangeness, produced at the LHC energies, service work and participation in data taking in the ALICE experiment in the next running period.

Research is based on analysis of huge amount of data recorded by the ALICE experiment from proton-proton, proton-lead and lead-lead collisions at LHC.

During my work in the ALICE experiment at CERN since 2010, I supervised several master and Ph.D. students from Germany, Russia, South Korea and USA. The results of my research have been published in several ALICE papers.

Supervisor's specific requirements

- Base knowledge of nuclear and particle physics and kinematics of particle production on the collider experiments.
- Base knowledge of the particle detectors used in high energy physics.
- Knowledge of Linux system, C++ language and ROOT package.
- Interest for the statistical analysis of big amount of data.
- Interest for the work in the international collaboration with the travels to CERN near Geneva.

Main publications

- J. Adam et al. (ALICE Collaboration), Enhanced production of multi-strange hadrons in high-multiplicity proton-proton collisions, Nature Physics 13 (2017) 535-539, arXiv:1606.07424v2.
- J. Adam et al. (ALICE Collaboration), Production of \Sigma(1385) and \Xi(1530) in p-Pb collisions at \sqrt{NN} = 5.02 TeV, Eur. Phys. J. C 77 (2017) 389, arXiv:1701.07797 [nucl-ex].
- S. Acharya et al. (ALICE Collaboration), Investigation of the p–Σ^0 interaction via femtoscopy in pp collisions, Phys. Let. B, 805, 2020, 135419, axXiv:1910.14407.

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COLD NEUTRON MODERATORS AND RESEARCH OF RADIATION RESISTANCE

Research supervisor:
Maksim Bulavin
PhD

Supervisor's research interests:

Cold neutron moderators for neutron sources included compact neutron sources, cold moderators design and materials researches, cold neutron spectrum measurements, cryogenics and vacuum techniques. Research of radiation resistance of different materials and equipment from big science and mega science projects (LHC, NICA, ITER, DEMO, ESS etc).

Research highlights:

In this program we use unique equipment for new projects of cold neutron moderators and irradiation facilities and cooperate with leading world science organizations. Financial support is possible.

Supervisor's specific requirements:

- Nuclear physics.
- Neutron activation analysis.
- Spectrometers.

Main publications:

- The world's first pelletized cold neutron moderator at a neutron scattering facility / M. Shabalin [et al.] // Nuclear instruments and methods in physics, section B. – 2014. – Vol. 320. – P. 70-74.
- Pelletized cold moderator of the IBR-2 reactor: current status and future development / M. Bulavin et al // Journal of Physics: Conference Series 746 (2016) 012031.
- Gain factor of the pelletized cold neutron moderator at 22K / M.V. Bulavin [et al.] // Journal of surface investigation: x-ray, synchrotron and neutron techniques, 2020, Vol. 14, №3, pp. 434-436.
- Irradiation facility at the IBR-2 reactor for investigating material radiation hardness / M. Bulavin et al // Physics of Particles and Nuclei Letters 12(2):344-348, March 2015.
- Metal Hall sensors for the new generation fusion reactors of DEMO scale / I. Bolshakova et al // Nuclear Fusion 57(11), June 2017.
- Experimental Evaluation of Stable Long Term Operation of Semiconductor Magnetic Sensors at ITER Relevant Environment / I. Bolshakova // Nuclear Fusion 55(8):083006, August 2015.
- Light yield and radiation hardness studies of scintillator strips with a filler / D. Chokheli et al // Nuclear Instr. And Methods in Physics Res. A, https://doi.org/10.1016/j.nima.2019.03.087, Vol. 930, pp 87-94.

SUPERCONDUCTING PROPERTIES INVESTIGATION OF 2G HTS WIRE IN HIGH MAGNETIC FIELD AND TEMPERATURE FROM 4.2 TO 77K

Research supervisor:
Pavel Degtyarenko
PhD

Supervisor's research interests:

Investigation of:

- Critical current of 2G HTS wire in high magnetic field and temperature from 4.2 to 77K.
- Irreversibility field and temperature for 2G HTS wire without/with artificial pinning centers.
- Superconducting properties of irradiated 2G HTS wire.
- Losses in 2G HTS wire without/with artificial pinning centers.

Supervisor's specific requirements:

- Knowledge of quantum physics, field theory, statistical physics and electrodynamic of continua.
- Knowledge of solid-state physics and theory of superconductors, include the physics of phase transition.
- COMSOL.
- Mathcad.
- Origin.
- Python.
- C++.

Main publications:

- Pavel N. Degtyarenko et al / Microstructure and superconducting properties of high-rate PLD-derived $GdBa_2Cu_3O_{7-\delta}$ coated conductors with BaSnO3 and BaZrO3 pinning centers // Sci. Rep., 9:15235, 2019.
- Pavel N. Degtyarenko,et al / Energy dependent structure of Xe ion tracks in YBCO and the effect on the superconductive properties in magnetic fields // J. Appl. Phys. 126, 145106, 2019.
- Pavel N. Degtyarenko et al / The influence of BaSnO3 artificial pinning centres on the resistive transition of 2G HTS wire in magnetic field / Supercond. Sci. and Tech, 33(4), 045003, 2020.

SPINTRONIC HETEROSTRUCTURES FOR THZ SIGNALS DETECTION AND GENERATION

Research supervisor:
Dmitry Kalyabin
PhD

Supervisor's research interests:

Investigation of physical effects arising during spin waves propagation and spin current flow along 2D and 3D micro- and nanoscale heterostructures formed by ferromagnets, heavy metals, semiconductors and carbon-based materials for fundamental basis development of magonics spintronics components and its pairing with convenient semiconductor electronics with ultra-large-scale integration.

Research highlights:

- Technological and experimental equipment to create and study nanoscale magnetic samples.
- Additional founding by Russian Foundation for Basic Research and Russian Science Foundation.

Supervisor's specific requirements:

- Basics of solid state physics.
- Advanced knowledge of physics of magnetic phenomena.
- Analytical, numerical or experimental methods of magnetic properties study.
- Basics of analytic geometry, computational mathematics, computer programming.

Main publications:

- Magnonics: a new research area in spintronics and spin wave electronics. Phys. Usp. 58 1002–1028.
- Nonreciprocity of edge modes in 1D magnonic crystal. JMMM Volume 378, 15 March 2015, Pages 313-319.
- Surface spin waves propagation in tapered magnetic stripe. Journal of Applied Physics 126, 173907.

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PLASMA OF ASTROPHYSICS

Research supervisor:
Vladimir Dogiel
PhD, DSc

Supervisor's research interests:

Active processes of energy release in the Galaxy. Kinetic equations for cosmic rays and magnetic turbulence in the interstellar medium and in compact astrophysical objects.

Research highlights:

Collaboration with colleagues from Muenchen and Berlin and from Taiwan.

Supervisor's specific requirements:

- Methods of theoretical analysis.

Main publications:

- Brerezinskii, V.S, Bulanov, S.V., Dogiel V.A., Ginzburg V.L., Ptuskin V.S. Monograph "Astrophysics of Cosmic Rays".

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EXPERIMENTAL SPECTROSCOPY OF LIGHT MESONS

Research supervisor:
Yury Khokhlov
PhD

Supervisor's research interests:

- Multiparticle systems of mesons in exclusive reactions at high energies.
- Resonance production and decays.
- Experimental technique.
- Particles detection.
- Analyses methods.

Research highlights:

Experiments are conducted on the base of the VES setup of the largest East-European accelerator facility U-70 (IHEP, Protvino) and the COMPASS setup at SPS (CERN).

Supervisor's specific requirements:

- Relativistic kinematics, Field theory, QED.
- Basics of particles physics.
- Basics of particle detection.
- Programming with C(++) and Linux.

Main publications:

- First Measurement of Chiral Dynamics in \pi^- \ gamma -> \pi^- \pi^- \pi^+. COMPASS Collaboration (C. Adolph et al.). Phys.Rev.Lett. 108 (2012) 192001.
- Measurement of radiative widths of a2(1320) and π2(1670). COMPASS Collaboration (C. Adolph et al.). Eur.Phys.J. A50 (2014) 79.
- Observation of a New Narrow Axial-Vector Meson a1(1420). COMPASS Collaboration (C. Adolph et al.). Phys. Rev. Lett. 115, 082001 (2015).
- Study of the reaction \pi– A -> \pi+\pi-\pi- A at large statistics with VES setup. I. Kachaev et al.. Phys. Atom.Nucl. 78 (2015) no.13, 1474-1477.
- Analysis of the reaction \pi- Be -> \pi-\pi0\pi0 Be at VES. D.Ryabchikov et al. AIP Conf.Proc. 1701 (2016) 040020.

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GENETIC CONTROL OF GENETIC STABILITY

Research supervisor:
Nataliya Koltovaya
PhD, DSc

Supervisor's research interests:

- Genetic stability (nuclear and mitochondrial).
- Epigenetic modifications.
- Regulatory chemical modifications of enzymes.
- Computer modeling of proteins.
- Genetic control of radio resistance and DNA stability.

Research highlights:

Collaboration with Russian Scientific Centers, Universities and foreign Scientific Institutions.

Supervisor's specific requirements:

- Molecular biology.
- Genetics.
- Biochemistry.

Main publications:

- Koltovaya N, et al. Induction of mutations by heavy ion beams in yeast Saccharomyces cerevisiae. Frontiers in Physics. 2020, in press.
- Dushanov EB Koltovaya NA. Effect of substitution Pro32Thr on the interaction between dimer subunits of human phosphatase ITPA. Cur. Enzyme Inhibition. 2019. 15 (1): 46-54.
- Koltovaya N.A. DNA damage-independent cell cycle arrest in the yeast Saccharomyces cerevisiae. Radiation Biology. Radioecology. 2018. 58 (1): 5-14 (in Russian)
- Koltovaya N.A. Kinase CDK1/CDC28 and control of DNA integrity in yeast Saccharomyces cerevisiae. Radiation Biology. Radioecology. 2017. 57 (6): 573-590 (in Russian).
- Koltovaya N.A. Kinase cascade of DNA damage checkpoint. In: Genetics, Evolution and Radiation. Springer. 2016. ISBN 978-3-319-48837-0. DOI 10.1007/978-3-319-48838-7. P. 125-140.

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INTERACTIONS IN THE MODEL MEMBRANES MIMICKING PRECLINICAL CONFORMATIONAL DISEASES

Research supervisor:
Norbert Kučerka
PhD, DSc, Deputy Director for Science Frank Laboratory of Neutron Physics Joint Institute for Nuclear Research

Supervisor's research interests:

- Lipid membrane structure and dynamics.
- Role of hydration in model and biological membranes.
- Effects of membrane surrounding ions on its properties.
- Interactions of Ab-peptides with lipid membranes.
- Incorporation of amyloid-beta peptides into the membrane.
- Neutron and X-ray scattering techniques.
- Densitometry, calorimetry, fluorescence, optical methods.

Research highlights:

Closer look at modern problems of fluid membranes
Research approaches utilize unique on-site facilities:

- Neutron scattering on pulsed neutron reactor.
- Raman spectroscopy on multimodal optical platform.
- MD simulations on computer cluster.

Research project is supported by Russian Science Foundation Collaboration with Slovakia, Czechia, Germany, Canada.

Supervisor's specific requirements:

- Physical chemistry.
- Work in chemical laboratory.
- Biophysical thermodynamics.
- Experimental methods for membrane biophysics: some of scattering methods, optical methods, calorimetry.

Main publications:

- Ivankov O.,..., Kučerka N.: Interactions in the model membranes mimicking preclinical conformational diseases; Advances in Biomembranes and Lipid Self-Assembly; Elsevier (2020).
- Kučerka N., Uhríková D.: Biophysical perspectives of lipid membranes through the optics of neutron and X-ray scattering; Biological Membranes; deGruyter (2019).
- Kučerka N., Gallová J., Uhríková D.: The Membrane Structure and Function Affected by Water; Chemistry and Physics of Lipids 221 (2019) 140-144.
- Kučerka N., ..., Uhríková D.: Calcium and zinc differentially affect the structure of lipid membranes; Langmuir 33 (2017) 3134-3141.
- Kučerka N., ..., Katsaras J.: Structural Significance of Lipid Diversity as Studied by Small Angle Neutron and X-ray Scattering; Membranes 5/3 (2015) 454-472.
- Drolle E., Kučerka N., ..., Leonenko Z.: Effect of melatonin and cholesterol on the structure of DOPC and DPPC membranes; BBA 1828 (2013) 2247-2254.

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NUCLEAR PHYSICS WITH NEUTRONS

Research supervisor:
Yuri Kopatch
PhD

Supervisor's research interests:

- Tagged neutron method.
- Nuclear fission (neutron induced and spontaneous).
- Violation of fundamental symmetries (T- and P-violation in neutron-induced reactions).
- Neutron lifetime.

Research highlights:

Participation in several research projects can be proposed for the student:

- Using the TANGRA setup, consisting of an ING-27 tagged neutron generator and a set of gamma-ray and/or neutron detectors for elemental analysis and investigation of nuclear reactions.
- Nuclear fission studies, including research on ternary/quaternary fission, T-odd effects in fission, neutron and gamma-ray emission from fission. Collaboration with IPHC (Strasbourg) is possible.
- Participation in the CERN nTof project.

Supervisor's specific requirements:

The applicant is expected to have at least basic knowledge of nuclear physics, data analysis and nuclear electronics. Specific requirements:

- Programming skills, knowledge of programming languages, preferably C/C++.
- Experience with ROOT framework (root.cern.ch).
- Monte Carlo simulations, specifically using GEANT4 toolkit (geant4.cern.ch).
- Experience with digitizers and digital data processing.

Main publications:

- Grozdanov D. et al, Physics of Atomic Nuclei. 2020.,Vol. 83, no. 3., P. 384–390.
- Chietera A. et al, The European Physical Journal A – Hadrons and Nuclei. 2018. T. 54. № 6. C. 98.
- Gagarski A et al, Physical Review C. 2016. T. 93. № 5. C. 054619.

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NEUTRON GRAPHIC INVESTIGATIONS OF SU-PRAMOLECULAR STRUCTURES BY SAS

Research supervisor:
Alexander Kuklin
PhD

Supervisor's research interests:

(condensed matter and small angle scattering technique) molecular biology(structure of proteins, crystallization process, lipid membranes), material science, phase transition in membranes and colloids, high hydrostatic pressure research, Structure of polymers (liquid crystal polymers, dendrimers, track membranes), structure of materials (soils, ribbons, powders), nanosized effects, fractal objects, theory and methods of small angle scattering.

Research highlights:

Top topic of scientific field, unique methods and instrumentation, include complimentary methods and possibility to do measurement on large scale spectrometry (YuMO spectrometer), synchrotron facility (ESRF, Desy), collaboration with some International Centeras well as.

Supervisor's specific requirements:

- MSc (Physics, Chemistry, Biology, Material Science).
- Russian or English Language.
- Computer (Origin, Office).
- Analytic ability.

Main publications:

- A. Kuklin, D. Zabelskii, I. Gordeliy, J. Teixeira, A. Brûlet, V. Chupin, Vadim Cherezov, Valentin Gordeliy. On the origin of the Anomalous Behavior of Lipid Membrane properties in the Vicinity of the chain-Melting phase transition. Scientific reports 10 (1), 1-8.
- Vlasov, A.V.; Kovalev, K.V.; Marx, S.-H.; Round, E.S.; Gushchin, I.Y.; Polovinkin, V.A.; Tsoy, N.M.; Okhrimenko, I.S.; Borshchevskiy, V.I.; Büldt, G.D.; et al. Unusual features of the c-ring of F1FO ATP synthases. Sci. Rep. 2019, 9, 18547.
- D.V. Zabelskii, A.V. Vlasov, Yu L. Ryzhykau, T.N. Murugova, M. Brennich, D.V. Soloviov, O.I. Ivankov, V.I. Borshchevskiy, A.V. Mishin, A.V. Rogachev, A. Round, N.A. Dencher, G. Büldt, V.I. Gordeliy, A.I. Kuklin. Ambiguities and completeness of SAS data analysis: investigations of apoferritin by SAXS/SANS EID and SEC-SAXS methods. In Journal of Physics: Conference Series (Vol. 994, No. 1, p. 012017). IOP Publishing.
- Cherny, A.Y., Anitas, E.M., Osipov, V., & Kuklin, A.I. (2019). The structure of deterministic mass and surface fractals: theory and methods of analyzing small-angle scattering data. Physical Chemistry Chemical Physics. Vol: 21 Issue: 24 pages.: 12748-12762.
- A.I. Kuklin, A.V. Rogachev, D.V. Soloviov, O.I. Ivankov, Yu S. Kovalev, P.K. Utrobin, S.A. Kutuzov, A.G. Soloviev, M.I. Rulev and V.I. Gordeliy. Neutronographic investigations of supramolecular structures on upgraded small-angle spectrometer YuMO. IOP Conf. Series: Journal of Physics: Conf. Series 848 (2017), 1, 012010. DOI:10.1088/1742-6596/848/1/012010
- A.N. Ozerin, D.I. Svergun, V.V. Volkov, A.I. Kuklin, V.I. Gordeliy, A.Kh. Islamov, L.A. Ozerina and D.S. Zavorotnyuk. The spatial structure of dendritic macromolecules, J. Appl. Cryst. (2005). 38, 996–1003.

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TUNNELING AND ANDREEV SPECTROSCOPY OF HIGH-TEMPERATURE SUPERCONDUCTORS

Research supervisor:
Tatiana Kuzmicheva
PhD

Supervisor's research interests:

Experimental study of the superconducting order parameter and its temperature dependence in novel multiple-band superconductors using tunneling techniques. Estimation of the gap symmetry, coupling constants, partial band parameters from the experiment.

Research highlights:

We use a unique break-junction technique in order to create Josephson SIS and Andreev SNS nanojunctions (S – superconductor, N – normal metal, I – insulator). The spectroscopy of such junctions provides direct and high-resolution probe of the superconducting order parameter, its symmetry and temperature dependence, those crucial for understanding the mechanisms of unconventional superconductivity. Our studies are partially made in collaboration with Russian (MSU, IP SB RAS) and foreign (IFW Dresden, Bern University) institutions, and supported by Russian Science Foundation, Ministry of Higher Education and Science, Russian Foundation for Basic Research, and Russian Academy of Sciences.

Supervisor's specific requirements:

- Taken lecture courses: condensed matter physics, low-dimensional systems, superconductivity, tunneling effects in superconductors.
- Software: Office, OriginLab, LaTex; desirably Wolfram Mathematica, LabView.
- Desirable skills: radioelectronics, cryogen experiment.

Main publications:

- T.E. Kuzmicheva, et al., Phys. Rev. B 100, 144504 (2019).
- T.E. Kuzmicheva, et al., Phys. Rev. B 97, 235106 (2018).
- T.E. Kuzmicheva, et al., Phys. Rev. B 95, 094507 (2017).

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SUPER CONFORMAL INDICES, SEIBERG DUALITIES AND SPECIAL FUNCTIONS

Research supervisor:
Vyacheslav Spiridonov
PhD, DSc

Supervisor's research interests:

Theory of modern special functions emerging in exact computations of partition functions in 2, 3, 4, 5, 6 dimensional supersymmetric field theories, corresponding super conformal indices and Seiberg dualities. Exactly solvable 2d lattice models of Ising type, 2d conformal field theories, star-triangle relation and Yang-Baxter equation. Theory of elliptic hypergeometric functions and elliptic integrable systems.

Research highlights:

The research requires mathematically minded approach in the Dirac style: physics suggests the mathematical objects for investigation, and exact formulas derived via mathematical logic help to understand the physics behind. Successful students may get additional financial support from research grants.

Supervisor's specific requirements:

- Knowledge of quantum mechanics, basic quantum field theory and statistical mechanics.
- Knowledge of supersymmetry and gauge field theory (with the corresponding group-theoretical background).
- Ability to use Latex, Mapple or Mathematica.
- Sufficient knowledge of real and complex analysis.

Main publications:

- V.P. Spiridonov, G.S. Vartanov, Elliptic hypergeometry of supersymmetric dualities, Commun. Math. Phys. 304 (2011) 797.
- S.E. Derkachov, V.P. Spiridonov, Yang-Baxter equation, parameter permutations, and the elliptic beta integral, Russian Math. Surveys 68 (2013) 1027.
- V.P. Spiridonov, Essays on the theory of elliptic hypergeometric functions, Russian Math. Surveys 63 (2008) 405.
- V.P. Spiridonov, Universal superpositions of coherent states and self-similar potentials, Phys. Rev. A 52 (1995) 1909.
- G.A. Sarkissian, V.P. Spiridonov, The endless beta integrals, arXiv:2005.01059 [math-ph].

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ASTROPARTICLE PHYSICS

Research supervisor:
Prof. Sergey Troitsky
PhD, DSc, Corr. member of RAS

Supervisor's research interests:

- Origin of high-energy radiation in the Universe (cosmic rays, gamma rays and neutrinos).
- The Universe as a laboratory of particle theory (axions, axion-like particles, neutrinos, dark matter etc.).
- Particle theory beyond the Standard Model.

Research highlights:

- Research at the intersection of particle physics and astrophysics.
- Work with real observational and experimental data. but in connection with particle-theory problems.

Supervisor's specific requirements:

- Particle physics (at the Master level).
- Astrophysics (at the beginner's level).
- Statistics (to work with data).
- CORSIKA; GEANT welcome.

Recent publications:

- Observational evidence for the origin of high-energy neutrinos in parsec-scale nuclei of radio-bright active galaxies, Astrophys. J. 894 (2020) 101.
- On the impact of magnetic-field models in galaxy clusters on constraints on axion-like particles from the lack of irregularities in high-energy spectra of astrophysical sources, Phys.Lett.B 802 (2020) 135252.
- Carpet-2 search for PeV gamma rays associated with IceCube high-energy neutrino events, JETP Lett. 109 (2019) 226.
- Constraining the photon coupling of ultra-light dark-matter axion-like particles by polarization variations of parsec-scale jets in active galaxies, JCAP 02 (2019) 059.
- Search for anomalous features in gamma-ray blazar spectra corrected for the absorption on the extragalactic background light, JCAP 12 (2019) 002.

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MODERN OPTICAL DEVICES AND SINGLE PHOTONS

Research supervisor:
Alexei Vitukhnovsky
PhD, DSc, Head of Laboratory of 3D printing of MIPT
Head of Vavilov Luminescence Department of Lebedev Physical Institute RAS

Supervisor's research interests:

- Photonic Integrated Circuits (PICs) based on 0D and 2D Single Photon Sources (SPE).
- Creating 3D Connectors (PWB) Using Direct Laser Writing – Stimulated Emission Depletion (DLW-STED).
- PIC components: SPEs, SPE amplifiers (resonators, patch antennas), connectors, active elements, detectors.
- SPE study of different dimensions (0D, 1D, 2D, 3D).
- The study of optical quantum correlations in 3D nanostructures created by the DLW – STED method.

Photonic integrated circuits (PIC) are becoming increasingly complex, incorporating thousands of photonic devices on a single chip. Studies of modern optical devices are proposed: photon chips (PIC), photon sources (both "ordinary" and "Fock" – single), as well as various schemes for receiving and transmitting photons to active elements and detectors.

Complex photonic-integrated circuits (PIC) may have strongly non-planar topologies that require waveguide crossings (WGX) when realized in single-layer integration platforms. The number of WGX increases rapidly with the complexity of the circuit, in particular when it comes to highly interconnected optical switch topologies. Here, we present a concept for WGX-free PIC that relies on 3D-printed freeform waveguide overpasses (WOP).

Research highlights:

Research and optimization of photonic elements are required to implement hybrid photonic schemes with integrated various single-photon sources.

Research is provided with the most modern equipment:

- Femtosecond laser system DLW-STED (MIPT).
- Installation of DLW Nano scribe Professional (Germany) –MIPT.
- Set-up for research of optical connections (PWB).
- Laser confocal microscope MicroTimes 200 with a TCSP attachment with a time resolution.
- Capabilities of the MIPT Sharing Center with the appropriate equipment https://mipt.ru/about/departments/ckpn
- Capabilities of the Lebedev Physical Institute (LPI) Sharing Center with appropriate equipment http://sites.lebedev.ru/en/cac/
- And much more /The 3D printing laboratory of functional microstructures at the MIPT has close ties with the renowned P. N. Lebedev Physical Institute of the Russian Academy of Sciences, the Institute of Organometallic Chemistry of the Russian

MODERN OPTICAL DEVICES AND SINGLE PHOTONS

Academy of Sciences, Moscow State Pedagogical University, and also has partners at the University of Bristol (Great Britain) and the Lausanne Federal Polytechnic School.

Supervisor's specific requirements:

- The future PhD student must have a high level of preparation: a university course in general physics, additional knowledge in optics and solid state physics. Be able to use modern Software (as minimum Excel, Word, Power Point, etc.).

Main publications (most recent):

- M. Zabolotskii, A. Katsaba, S. Ambrozevich, A. Vitukhnovsky, R. Vasiliev, "Reversible and Irreversible Degradation of CdS/ZnSe Nanocrystals Capped with Oleic Acid"//Physica Status Solidi–Rapid Research Letters (Q1), April 2020 https://doi.org/10.1002/pssr.202000167
- R.D. Zvagelsky, D.A. Chubich, D.A. Kolymagin, E.V. Korostylev, V.V. Kovalyuk, A.I. Prokhodtsov, A.V. Tarasov, G.N. Goltsman and A.G. Vitukhnovsky "Three-dimensional polymer wire bonds on a chip: morphology and functionality"//J.Phys.D-Applied Physics (Q1), May 2020, available on-line.
- N. Kurochkin; S. Eliseev; A. Vitukhnovsky, "Plasmon resonance in nanopatch antennas with triangular nanoprisms"//Optik (Q2), 185(2019)716-720.
- A.V. Gritsienko, N.S. Kurochkin, A.G. Vitukhnovsky, A.S. Selyukov, I.V. Taydakov and S.P. Eliseev "Radiative characteristics of nanopatch antennas based on plasmonic nanoparticles of various geometry and tris(2,2'-bipyridine) ruthenium(II) hexafluorophosphate"// Journal of Physics D: Applied Physics, Q1, 52(32) (2019)325107.
- Roman B. Vasiliev, Alexander I. Lebedev, Elizabeth P. Lazareva, Natalia N. Shlenskaya, Vladimir B. Zaytsev, Alexei G. Vitukhnovsky, Yuanzhao Yao, and Kazuaki Sakoda, "High-energy exciton transitions in quasi-two-dimensional cadmium chalcogenide nanoplatelets"// Phys. Rev. B, Q2, 95 (2017) 165414.

SUSTAINABLE ENERGY AND FUELS

Research supervisor:
Mikhail Vlaskin
PhD, DSc, Head of Laboratory

Supervisor's research interests:

- Metals as carbon-free fuel.
- Microalgae for sustainable environment and biofuel production.
- Thermal decomposition of hydrocarbons into carbon and hydrogen.
- Waste-to-energy, municipal solid waste utilization.
- Natural gas storage and transportation in the form of gas hydrate.
- Functional nano-structured materials based on carbon or metal oxides.

Research highlights:

Highly demanded subjects, international recognition and cooperation, high scientific level, interaction with industrial partners, practice-oriented research, unique experimental facilities and territories.

Supervisor's specific requirements:

- Computer literacy.
- Spoken English.
- Strong motivation.
- Success at the previous place of work / study.
- Leadership experience.

Main publications:

- Shkolnikov E.I., Zhuk A.Z., Vlaskin M.S. Aluminum as energy carrier: Feasibility analysis and current technologies overview // Renewable and Sustainable Energy Reviews. 2011. vol. 15. № 9. p. 4611-4623. https://doi.org/10.1016/j.rser.2011.07.091. Q1. IF=10.556.
- Vlaskin M.S., Shkolnikov E.I., Bersh A.V., Zhuk A.Z., Lisicyn A.V., Sorokovikov A.I., Pankina Y.V. An experimental aluminum-fueled power plant // Journal of Power Sources. 2011. vol. 196. № 20. p. 8828-8835. https://doi.org/10.1016/j.jpowsour.2011.06.013 Q1. IF=7.467.
- Shkolnikov E., Vlaskin M., Iljukhin A., Zhuk A., Sheindlin A. 2 W power source based on air-hydrogen polymer electrolyte membrane fuel cells and water-aluminum hydrogen micro-generator // Journal of Power Sources. 2008. vol. 185. № 2. p. 967-972. https://doi.org/10.1016/j.jpowsour.2008.09.062 Q1. IF=7.467.
- Arora N., Jaiswal K.K., Kumar V., Vlaskin M.S., Nanda M., Pruthi V., Chauhan P.K. Small-scale phyco-mitigation of raw urban wastewater integrated with biodiesel production and its utilization for aquaculture // Bioresource Technology. 2020. vol. 297. p. 122489. https://doi.org/10.1016/j.biortech.2019.122489 Q1. IF=6.669.
- Kostyukevich Y., Zherebker A., Vlaskin M.S., Borisova L., Nikolaev E. Microprobe for the Thermal Analysis of Crude Oil Coupled to Photoionization Fourier Transform Mass Spectrometry // Analytical Chemistry. 2018. vol. 90. № 15. p. 8756-8763. https://doi.org/10.1021/acs.analchem.8b02043 Q1. IF=6.350.
- Buryakovskaya O.A., Vlaskin M.S., Ryzhkova S.S. Hydrogen production properties of magnesium and magnesium-based materials at low temperatures in reaction with aqueous solutions // Journal of

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Alloys and Compounds. 2019. vol. 785. p. 136-145. https://doi.org/10.1016/j.jallcom.2019.01.003
Q1. IF=4.175.

- Vlaskin M.S., Dudoladov A.O., Buryakovskaya O.A., Ambaryan G.N. Modelling of aluminum-fuelled power plant with steam-hydrogen enthalpy utilization // International Journal of Hydrogen Energy. 2018. vol. 43. № 9. p. 4623-4631. https://doi.org/10.1016/j.ijhydene.2018.01.023
Q1. IF=4.084.
- Ambaryan G.N., Vlaskin M.S., Dudoladov A.O., Meshkov E.A., Zhuk A.Z., Shkolnikov E.I. Hydrogen generation by oxidation of coarse aluminum in low content alkali aqueous solution under intensive mixing // International Journal of Hydrogen Energy. 2016. vol. 41. № 39. p. 17216-17224. https://doi.org/10.1016/j.ijhydene.2016.08.005
Q1. IF=4.084.
- Dudoladov A.O., Buryakovskaya O.A., Vlaskin M.S., Zhuk A.Z., Shkolnikov E.I. Generation of hydrogen by aluminium oxidation in aquaeous solutions at low temperatures // International Journal of Hydrogen Energy. 2016. vol. 41. № 4. p. 2230-2237. https://doi.org/10.1016/j.ijhydene.2015.11.122
Q1. IF=4.084.
- Vlaskin M.S., Shkolnikov E.I., Bersh A.V. Oxidation kinetics of micron-sized aluminum powder in high-temperature boiling water // International Journal of Hydrogen Energy. 2011. vol. 36. № 11. p. 6484-6495. https://doi.org/10.1016/j.ijhydene.2011.02.131
Q1. IF=4.084.
- Vlaskin M.S., Shkolnikov E.I., Lisicyn A.V., Bersh A.V., Zhuk A.Z. Computational and experimental investigation on thermodynamics of the reactor of aluminum oxidation in saturated wet steam // International Journal of Hydrogen Energy. 2010. vol. 35. № 5. p. 1888-1894. https://doi.org/10.1016/j.ijhydene.2009.12.061
Q1. IF=4.084.
- Kumar V., Kumar S., Chauhan P.K., Verma M., Bahuguna V., Joshi H.C., Ahmad W., Negi P., Sharma N., Ramola B., Rautela I., Nanda M., Vlaskin M.S. Low-temperature catalyst based Hydrothermal liquefaction of harmful Macroalgal blooms, and aqueous phase nutrient recycling by microalgae // Scientific Reports. 2019. vol. 9. № 1. p. 11384.
https://doi.org/10.1038/s41598-019-47664-w
Q1. IF=4.011.
- Shkolnikov E.I., Shaitura N.S., Vlaskin M.S. Structural properties of boehmite produced by hydrothermal oxidation of aluminum // Journal of Supercritical Fluids. 2013. vol. 73. p. 10-17.
https://doi.org/10.1016/j.supflu.2012.10.011. Q1. IF=3.481
- Kostyukevich Y.I., Vlaskin M.S., Zherebker A., Grigorenko A.V., Borisova L., Nikolaev E.N. High resolution mass spectrometry study of the bio-oil samples produced by thermal liquefaction of microalgae in different solvents // Journal of the American Society for Mass Spectrometry. 2019. vol. 30 № 4. p. 605-614.
https://doi.org/10.1007/s13361-018-02128-9
Q1. IF=3.202.

EXPERIMENTAL STUDY OF COMBUSTION AND EXPLOSION IN GASES

Research supervisor:
Vladislav Volodin
PhD

Supervisor's research interests:

Acceleration of flame in hydrogen-air and hydrocarbon-air mixtures. Mechanisms of flame instability and their influence on the dynamics of propagation. The interaction of the flame front with obstacles and walls.

Research highlights:

Research is carried out using unique 13Y3 and VBK-2 explosive chambers, allowing large-scale experiments at the Institute.

Supervisor's specific requirements:

- Basic knowledge of hydrodynamics and chemical kinetics.
- Initial skills of experimental work.
- Using software for text design, graphing and data processing.

Main publications:

- V. Golub, A. Korobov, A. Mikushkin, V. Petukhov, V. Volodin, Propagation of a hemispherical flame over a heat-absorbing surface, Proceedings of the Combustion Institute, 2019, vol. 37, 2583–2589.
- V. Golub, A. Elyanov, A. Korobov, A. Mikushkin, V. Petukhov, V. Volodin, Influence of heat absorption on hydrogen-air flame instability, Experimental Thermal and Fluid Science, 2019, vol. 109, 109845.
- A.I. Gavrikov, V.V. Golub, A.Yu. Mikushkin, V.A. Petukhov, V.V. Volodin, Lean hydrogen-air premixed flame with heat loss, International Journal of Hydrogen Energy, 2019, vol. 44, 109845.

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MULTIPARTICLE EFFECTS IN THE DESCRIPTION OF EQUILIBRIUM AND NON-EQUILIBRIUM NUCLEAR MATTER

Research supervisor:
Dmitry Voskresensky
PhD, DSc

Supervisor's research interests:

Theoretical description of in-medium effects in equilibrium and non-equilibrium nuclear matter prepared in nucleus-nucleus collisions, existing in compact stars (neutron and hybrid stars), being forming in supernovas. Description of various phase transformations in these systems.

Research highlights:

Cooperation with foreign scientists.

Supervisor's specific requirements:

- Standard course of mathematics for Universities, Course of Theoretical Physics: Chapters: Mechanics, Classical field theory, Statistical physics (including basics of condensed matter physics), Quantum mechanics, Quantum field theory, Physical kinetics.

Main publications:

- A.B. Migdal, E.E. Saperstein, M.A. Troitsky and D.N. Voskresensky, Pion degrees of freedom in nuclear matter, Phys. Rep. 192 (1990) No 4,5,6, 179-437.
- Yu. B. Ivanov, J. Knoll and D.N. Voskresensky, Resonance transport and kinetic entropy, Nucl. Phys. A672 (2000) 313-356.
- D.N. Voskresensky, M. Yasuhira, T. Tatsumi, Charge screening at first order phase transitions and hadron-quark mixed phase, Nucl. Phys. A723 (2003) 291-339.
- E.E. Kolomeitsev, K.A. Maslov an D.N. Voskresensky, Delta isobars in relativistic mean-field models with sigma-scaled hadron masses and couplings, Nucl. Phys. A 961, 106 (2017).

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UNSTABLE STATES IN DISSOCIATION OF RELATIVISTIC NUCLEI IN NUCLEAR TRACK EMULSION

Research supervisor:
Pavel Zarubin
PhD, DSc

Supervisor's research interests:

Nuclear track emulsion (NTE) is used at the JINR Nuclotron in the BECQUEREL experiment http://becquerel.jinr.ru/ to study the clustering in light stable and radioactive nuclei in the relativistic approach. The identification of the relativistic decays of ^{8}Be and ^{9}B pointed out the possibility to search for triples of α particles in the Hoyle state (HS) in the relativistic dissociation. ^{8}Be and HS are considered as the simplest states of the α-particle Bose – Einstein condensate. The 6th excited state 0^{+}_{6} of the ^{16}O nucleus is considered as a 4α-condensate. These observations indicate the possibility of their manifestation of dissociation of medium and heavy nuclei. In addition, the ^{9}B and HS nuclei can serve as bases in the nuclear molecules. It is hoped that the rapid progress in image analysis will give a whole new dimension to the use of the NTE method in the study of nuclear structure in the relativistic approach. The solution of the tasks set requires investment in modern automated microscopes and the reconstruction of NTE technology at a modern level. At the same time, such a development will be based on the classical NTE method.

Research highlights:

NTE allows one to study production of such ensembles in full with record angular resolution and identification He and H isotopes. Electronic experiments in this direction run into fundamental difficulties. Therefore, the NTE method retains its uniqueness as the composition analysis tool in the relativistic fragmentation cone. The experiment is based on own capabilities of developing NTE layers and measurements of nuclear interactions on microscopes keeping the "world monopoly" on information about multi-particle relativistic nuclear ensembles.

Supervisor's specific requirements:

- Motivation for MS or PhD degree in nuclear physics.
- Readiness for concentrated work using microscopes.

Main publications:

A status of research and relevant references are submitted to publication in the Topical issue of EPJ A on nuclear clustering https://arxiv.org/abs/2004.10277.

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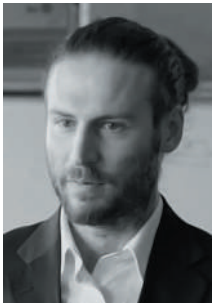
ULTRACOLD RYDBERG ATOMS AND ULTRACOLD PLASMA



Research supervisor:
Boris Zelener
PhD, DSc

Supervisor's research interests:

Quantum optics, lasers cooling, magneto-optical trap, non-lineal coherent effects, strongly coupled plasma, Rydberg atoms, atomic physics, laser physics, field and matter interaction physics, numerical simulations of physical processes, method Monte-Carlo and molecular dynamics.

Research highlights:

The investigation will use unique equipment that meets the best international standards in ultracold atoms experiments. The laboratory actively interacts with foreign scientists and research centers, including Princeton University. Laboratory graduate students receive a scholarship.

Supervisor's specific requirements:

The applicant must know quantum physics, quantum optics, laser physics, plasma physics, higher mathematics and programming.

Main publications

- Bobrov A. A., Physics of Plasmas, 27(1), 010701. (2020).
- Bobrov A. A., Physics of Plasmas, 26(8), 082102. (2019).
- Zelener, B. B., JETP Letters, 110(12), 761-765. (2019).
- Sautenkov, V.A., Optics Communications, 431, pp. 131-135. (2019).
- Sautenkov, V.A., Journal of the Optical Society of America B: Optical Physics, 35 (7), pp. 1546-1551. (2018).
- Butlitsky, M.A., Journal of Chemical Physics, 141 (2), 024511. (2014).
- Zelener, B.B., JETP Letters, 98 (11), pp. 670-674. (2014).
- Zelener, B.B., JETP Letters, 100 (6), pp. 366-370. (2014).

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INVESTIGATION OF LOW-DIMENSIONAL HETEROSTRUCTURES WITH POLARIZED NEUTRON REFLECTOMETRY

Research supervisor:
Vladimir Zhaketov
PhD

Supervisor's research interests:

Polarized neutron reflectometry (PNR) is powerful method for investigation of different low-dimensional heterostructures. Our investigations mostly dedicated to superconducting-ferromagnetic heterostructures. Such systems are very perspective for such areas of technology and applied physics as quantum computing, spintronics and neuromorphic computing. Simultaneously we develop PNR method for possibility of registration secondary radiation (γ-quanta, charged particles). This additional mode greatly expands possibility of classical PNR.

Research highlights:

During this program you have possibility to work at unique equipment as spectrometer REMUR (reactor IBR-2). Including such difficult technics as low-temperature cryostat and other. Our scientific group collaborate with many Russian and foreign scientific centers, such as PNPI and Max Planck Institute. There are possible different finance programs for PHD-students, such as JINR scholarships and grants of Russian foundation for basic research.

Supervisor's specific requirements:

- A lot of enthusiasm.
- Experimental skills.
- Programming (mostly, Matlab).
- General education in physics.

Main publications:

- V.D. Zhaketov et al. // arXiv preprint arXiv:1911.03669.
- V.D. Zhaketov et al. // JETP, vol. 129, No. 2, pp. 258-276.
- V.D. Zhaketov et al. // JETP, vol. 125, No. 3, pp. 480-494.

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SOLAR ACTIVITY AND SPACE WEATHER

Research supervisor:
Ivan Zimovets
PhD

Supervisor's research interests:

Various phenomena of solar activity, with the emphasis on the most energetic ones affecting space weather, such as solar flares, coronal mass ejections (CMEs), solar energetic particles (acceleration, radiation, transport in the corona and interplanetary space).

Research highlights:

Multiwave Solar Physics – analysis of observational data in broad spectral ranges (from gamma-rays to radio waves) from various ground-based and space observatories.
Interaction with leading foreign scientists and research centers in Europe, USA, and China.

Supervisor's specific requirements:

- Strong background in plasma physics, including electrodynamics and MHD.
- Interest and experience in advanced data analysis, big data.
- Programming in IDL, Python.

Supervisor's main publications:

- Zimovets I.V., Wang R., Liu Y.D., et al. Magnetic structure of solar flare regions producing hard X-ray pulsations // J. Atm. Sol.-Terr. Phys., 174, 2018.
- Zimovets I.V., Nakariakov V.M. // Excitation of kink oscillations of coronal loops: statistical study. Astron. & Astrophys., 577, 2015.
- Zimovets I., Vilmer N., Chian A.C.-L., et al. Spatially resolved observations of a split-band type II radio burst // Astron. & Astrophys., 547, 2012.
- Nakariakov V.M., Zimovets I.V. Slow Magnetoacoustic Waves in Two-Ribbon Flares // Astrophys. J. Lett., 730, 2, L27, 2011.

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APPLICATION OF NEUTRON ACTIVATION ANALYSIS IN ENVIRONMENTAL STUDIES

Research supervisor:
Inga Zinicovscaia
PhD

Supervisor's research:

Wastewater treatment using different type of sorbents
Nanotoxicology.
Survey of atmospheric heavy metal deposition using moss as bio monitor.
Assessment of food, medicinal plants quality.

Research highlights:

Unique facility with possibility of determination of more than 45 elements in samples.
Wide network of national and international collaboration.
Possibility of performing analysis on the atomic-absorption spectrometer, complementary to neutron activation analysis.

Supervisor's specific requirements:

- Knowledge in gamma spectrometry.
- Knowledge in chemistry.
- User of Statistica, Origin software.

Main publications.

For more publications please visit
https://www.researchgate.net/profile/IngaZinicovscaia

- I. Zinicovscaia, D. Grozdov, N. Yushin, D. Abdusamadzoda1, S.F. Gundorina, E. Rodlovskaya, O. Kristavchuk. Metal removal from chromium containing effluents by Saccharomyces cerevisiae. Desalination and Water Treatment, 2020, 178:254-270.
- I. Zinicovscaia, A. Safonov, K. Boldyrev, S. Gundorina, N. Yushin, O. Petuhov, N. Popova. Selective metal removal from chromium-containing synthetic effluents using Shewanella xiamenensis biofilm supported on zeolite. Environmental Science and Pollution Research, 2020; 27:10495–10505 https://doi.org/10.1007/s11356-020-07690-y
- L. Cepoi, I. Zinicovscaia, L. Rudi, T. Chiriac, V. Miscu, S. Djur, L. Strelkova, K. Vergel, P. Nekhoroshkov. Growth and heavy metals accumulation by Spirulina platensis biomass from multicomponent copper containing synthetic effluents during repeated cultivation cycles. Ecological Engineering, 142 (2020) 105637, DOI: 10.1016/j.ecoleng.2019.105637.
- M. Shammas, I. Zinicovscaia, D. Humelnicu, L. Cepoi, V. Nirwan, Š. Demčák, A. Fahmi. Bioinspired elelctrospun hybrid nanofibers based on biomass templated within polymeric matrix for metal removal from wastewater. Polymer Bulletin, 2020, 77:3207–3222, DOI: 10.1007/s00289-019-02916-7.
- I. Zinicovscaia, D. Grozdov, N. Yushin, A.Ivlieva, E. Petritskaya, D. Rogatkin. Neutron activation analysis as a tool for tracing the accumulation of silver nanoparticles in tissues of female mice and their offspring. Journal of Radioanalytical and Nuclear Chemistry, 2019, 322, 1079–1083, DOI:10.1007/s10967-019-06746-9.
- K. Vergel, I. Zinicovscaia, N. Yushin, M. V. Frontasyeva. Heavy metal atmospheric deposition study in Moscow region, Russia. Bulletin of Environmental Contamination and Toxicology, 2019, 103(3), 435-440 DOI: 10.1007/s00128-019-02672-4.
- I. Zinicovscaia, A. Ciocarlan, L. Lupascu, A. Aricu, I. Dragalin, N. Ciocarlan, N. Yushin. Investigation of elemental content and antimicrobial activity of Tanacetum corymbosum (L.) Sch. Bip. Journal of

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APPLICATION OF NEUTRON ACTIVATION ANALYSIS IN ENVIRONMENTAL STUDIES

Radioanalytical and Nuclear Chemistry 2019, 321(1), 349-354, DOI: 10.1007/s10967-019-06590-x.

- I. Zinicovscaia, R. Sturza, I. Gurmeza, K. Vergel, S. Gundorina, Gh. Duca. Metal bioaccumulation in the soil-leaf-fruit system determined by neutron activation analysis. Journal of Food Measurement and Characterization, 2019, 13(1): 592-601, DOI: 10.1007/s11694-018-9972-4.

LINEAR AND NON-LINEAR WAVES IN MICROSTRUC-TURED OPTICAL MEDIA

Research supervisor:
Yaroslav Kartashov
PhD, DSc

Supervisor's research interests:

- New soliton states and approaches to control of the propagation of light in optical lattices.
- Multidimensional and surface solitons.
- Non-diffracting beams.
- Effects of spin-orbit interaction in optics and physics of Bose-Einstein condensates.
- Nonlinear topological insulators.
- Polariton condensates.

In the works of Y.V. Kartashov, various types of solitons with previously unknown symmetries in optical lattices, local and nonlocal nonlinear media were introduced. He predicted new unusual propagation regimes of high-intensity light beams in periodic media, discovered parabolic and spiral propagation trajectories, resonant transverse oscillations of solitons, complete suppression or enhancement of diffraction spreading, resonant transformations of the spatial structure of beams. His works on the induction of optical gratings using different classes of non-diffracting beams are well known. He predicted and experimentally observed three-dimensional spatiotemporal solitons – light bullets. Surface waves are predicted at the boundaries between periodic media with different physical properties. In a series of works on nonlinear topological insulators, edge topological solitons in polariton condensates, Bose-Einstein condensates, and also topological Floquet solitons were introduced.

Research highlights:

Our laboratory of nonlinear optics studies nonlinear optical waves in spatially inhomogeneous media, self-action effects for radiation with high peak intensities, solitons, and the physics of topological insulators. The work is connected with the experimental observation and theoretical description of the propagation of topological solitons, self-consistent non-diffracting high-intensity light beams, in nonlinear topological insulators – unique optical structures based on arrays of helicoidal optical fibers. Topological solitons propagate only along the boundary of such a structure, without penetrating into its depth, and do not scatter even at significant defects in the structure, that opens unique possibilities for transmitting excitations in such structures without radiative or scattering losses, designing topological lasers whose characteristics are not subject to fluctuations. Studies of nonlinear topological insulators are at the forefront of modern nonlinear optics. The group works closely with experimentalists from the Institute of Photonic Sciences (Barcelona), the University of Rostock (Germany), Shanghai Zhao Tong University (China), the University of Lisbon (Portugal) and other groups.

Supervisor's specific requirements:

- Knowledge of the fundamentals of nonlinear optics, theoretical and mathematical physics.
- Programming skills in Fortran, Matlab, or C ++.
- Experience with modern data visualization packages, such as Origin.
- Experience of experimental work will be considered as an advantage of candidate.
- Good knowledge of English.

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LINEAR AND NON-LINEAR WAVES IN MICROSTRUC-TURED OPTICAL MEDIA

Supervisor's main publications:

- Y.V. Kartashov, D.V. Skryabin, "Modulational instability and solitary waves in polariton topological insulators," Optica, vol. 3, n. 11, p. 1228-1236 (2016).
- Y.V. Kartashov, G.E. Astrakharchik, B.A. Malomed, L. Torner, "Frontiers in multidimensional self-trapping of nonlinear fields and matter," Nature Reviews Physics, vol. 1, p. 185-197 (2019).
- P. Wang, Y. Zheng, X. Chen, C. Huang, Y.V. Kartashov, L. Torner, V.V. Konotop, F.Ye, "Localization and delocalization of light in photonic moiré lattices," Nature, vol. 577, n. 7788, p. 42-46 (2020).
- S.K. Ivanov, Y.V. Kartashov, A. Szameit, L. Torner, V.V. Konotop, "Vector topological edge solitons in Floquet insulators," ACS Photonics, vol. 7, n. 3, p. 735-745 (2020).
- Z. Zhang, R. Wang, Y. Zhang, Y.V. Kartashov, F. Li, H. Zhong, H. Guan, K. Gao, F. Li, Y. Zhang, M. Xiao, Observation of edge solitons in photonic graphene, Nature Communications, vol. 11, paper 1902 (2020).

Research supervisor:
Alexander Povolotsky
PhD

Supervisor's research interests:

My research is concentrated on the field of nonequilibrium statistical physics, specifically on the stochastic systems of interacting particles like asymmetric exclusion process, e.t.c. The main goal is to study universal laws governing the evolution of large nonequilibrium stochastic systems. We mainly deal with the special integrable models using the advantage of them being exactly solvate.

Supervisor's specific requirements:

- Probability theory and stochastic processes.
- Statistical physics.
- Standard mathematical courses: algebra, analysis, complex variables e.t.c.

Main publications:

- Povolotsky A.M. On the integrability of zero-range chipping models with factorized steady states. Journal of Physics A: Mathematical and Theoretical. 2013 Nov 1;46(46):465205.
- A.M. Povolotsky, V.B. Priezzhev Determinant solution for the totally asymmetric exclusion process with parallel update Journal of Statistical Mechanics: Theory and Experiment 2006 (07), P07002.
- A.M. Povolotsky, Bethe ansatz solution of zero-range process with nonuniform stationary state, Physical Review E 69 (6), 061109.

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QUANTUM COHERENT PHENOMENA AT NANOSCALE

Research supervisor:
Andrew Semenov
PhD

Supervisor's research interests:

Quantum mesoscopic physics of hybrid metallic and superconducting nanostructures. Interplay between interactions, disorder and quantum coherence in electronic transport phenomena. Application of modern quantum field theory methods to condensed matter physics and related topics.

Research highlights:

Combination of modern theoretical approaches with deep physical understanding of the considered systems.

Supervisor's specific requirements:

- Deep knowledge of quantum mechanics, quantum field theory and statistical physics.
- Basic computer skills.
- Motivation.

Main publications:

- Andrew G. Semenov and Andrei D. Zaikin. "Full counting statistics of quantum phase slips." Physical Review B 99.9 (2019): 094516.
- Andrew G. Semenov and Andrei D. Zaikin. "Persistent currents in quantum phase slip rings." Physical Review B 88.5 (2013): 054505.
- Andrew G. Semenov and Andrei D. Zaikin. "Quantum phase slip noise." Physical Review B 94.1 (2016): 014512.
- Andrew G. Semenov and Andrei D. Zaikin. "Supercurrent dephasing by electron-electron interactions." Physical Review B 91.2 (2015): 024505.
- Andrew G. Semenov. "On the macroscopic quantization in mesoscopic rings and single-electron devices." Physics Letters A 380.24 (2016): 2111-2115.

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APPLICATION OF LOW TEMPERATURE PLASMAS FOR FLOW CONTROL

Research supervisor:
Ivan Moralev
PhD

Supervisor's research interests:

Research and development of the flow-control devices, based on low temperature plasma (plasma actuators). Development of plasma-based systems for boundary layer transition control, noise reduction in aeroacoustics problems, flow separation. Study of barrier discharge physics, including electrode processes, memory effects and ionic wind generation. Combustion and mixing control using gas discharges.

Research highlights:

Laboratory of plasma flow control and plasma assisted combustion is one of the leading research units in its area. The laboratory is equipped by two wind-tunnel-subsonic for low turbulent research and blowdown supersonic facility. Measurement techniques for flow quantities includes particle imaging velocimetry and high-speed shadow imaging. Study of the discharge physics is performed using short exposure (2ns) camera and high speed oscilloscopes. The lab is involved into the international cooperation with Ecole Polytechnique, and occasionally participates in the cooperative projects with leading aerospace centers in Europe (DLR, Onera, Nottingham University). The financial support can be provided, depending on applicant results and current situation in laboratory.

Supervisor's specific requirements:

Mandatory:

- Fluency in English or Russian .
- High education in Physics/Physical Engineering.
- Bold experience with MATLAB.

Desirable:

- Basic knowledge of gas dynamics or low temperature plasmas.
- General experience in experimental work in physics.

Main publications:

- Moralev, I. et al. Localized micro-discharges group dielectric barrier discharge vortex generators: Disturbances source for active transition control. Proc IMechE Part G J Aerosp. Eng. 234, 42–57 (2020).
- Moralev, I. A., et.al. Damping of the longitudinal streak in the boundary layer by 'plasma panel' actuator. J. Phys. D. Appl. Phys. 52, 304003 (2019).
- Moralev, I., Selivonin, I. & Ustinov, M. On the stochastic forcing of the boundary layer by plasma actuators. Exp. Fluids 60, 177 (2019).
- Selivonin, I. V, et.al.Effect of electrode degradation on the electrical characteristics of surface dielectric barrier discharge. PSST. 27, 85003 (2018).
- Moralev, I., et.al. Effect of the discharge constriction in DBD plasma actuator on the laminar boundary layer. Int. J. Heat Mass Transf. 116, 1326–1340 (2018).

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MACHINE LEARNING TECHNIQUES FOR EVENT RECONSTRUCTION IN JUNO

Research supervisor:
Yury Malyshkin
PhD

Supervisor's research interests:

Reconstruction of event characteristics with the use of modern machine learning techniques for Jiangmen Underground Neutrino Observatory being constructed in China.

Research highlights:

- Work in an international collaboration.
- The most advanced detector of the kind.
- Opportunity to join the experiment at the time of its launch (in 2022).

Supervisor's specific requirements:

- Basic knowledge of nuclear and elementary particle physics.
- Strong programming and data analysis skills (Python, NumPy, SciPy).
- Understanding of machine learning principles and experience of their usage.
- Extra financial support from JINR.

Main publications:

- F. An. et al. (JUNO collaboration), "Neutrino Physics with JUNO", Journal of Physics G: Nuclear and Particle Physics, 43(3), 2016. [arXiv: 1507.05613].

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QUANTUM EFFECTS IN STRONGLY CORRELATED AND QUANTUM MATERIALS

Research supervisor:
Leonid Morgun
PhD

Supervisor's research interests:

Quantum materials (DSM, WSM, TI), strongly correlated electrons in Si MOSFET, low temperature transport and thermodynamic properties of superconductors.

Research highlights:

The research will be done in Ginzburg Center for High-Temperature Superconductivity and Quantum Materials of Lebedev Physical Institute that seven Nobel prize winners worked in.
The experimental facilities include the nanofabrication technology line in the clean room and vast variety of measurement facilities implying low-temperature (below to 10 mK) and high magnetic field (up to 21 T) experiments.

Supervisor's specific requirements:

The applicant should be familiar with experimental methods of solid-state investigation and confident in condensed matter physics, especially with such topics as:

- Superconductivity or Topological matter.
- Electronic band structure.
- Quantum physics.

Data acquisition and processing techniques are strongly advised (Python, OriginLab).

Main publications:

- Observation of subkelvin superconductivity in Cd3As2 thin films. Phys. Rev. B 99, 094512 (2019).
- Probing Spontaneous Spin Magnetization and Two-Phase State in Two-Dimensional Correlated Electron System. JSNM volume 30, pages 783–787(2017).
- Novel energy scale in the interacting two-dimensional electron system evidenced from transport and thermodynamic measurements. Phys. Rev. B 93, 235145 (2016).

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SEARCH OF NEW PHENOMENA BEYOND STANDARD MODEL WITH ATLAS DETECTOR ON LHC

Research supervisor:
Alexey Myagkov
PhD

Supervisor's research interests

Despite the numerous successes of the Standard Model (SM), it cannot describe many experimental facts – the existence of dark matter, the problems of naturalness and other. One of the main task for experiments on LHC is to find the ways how to extend the SM. It could be searches of new resonances or symmetries, deviations from SM predictions.

Research highlights:

ATLAS (CERN, Geneve, Swiss) is one of the biggest detector of the world. It is multipurpose devise to study huge amount of different reactions. All studies are realized by multinational groups.

Supervisor's specific requirements:

- The base knowledge is required in high energy physics and particle physics.
- Experience with C++, python and Linux is required.

Main publications

- Searches for heavy diboson resonances in pp collisions at sqrt(s)=13 TeV with ATLAS detector JHEP 1609 (2016) 173.
- Searches for heavy ZZ and WZ resonances in the llqq and vvqq final states in pp collisions at sqrt(s)=13 TeV with ATLAS detector JHEP 1803 (2018) 009.
- Search for the electroweak diboson production in association with a high-mass dijet system in semileptonic final states in pp collisions at sqrt(s)=13 TeV with ATLAS detector Phys Rev D100 (2019) no 3 032007.

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PROPERTIES OF MESOSCOPIC SYSTEMS

Research supervisor:
Rashid Nazmitdinov
PhD, DSc

Supervisor's research interests:

My research activity is devoted to a few directions:

- Transport phenomena in mesoscopic systems.
- Regular and chaotic features of finite quantum systems.
- Effect of various semiconductors on efficiency of solar cells.

The main focus in the first research line is the investigation of spin-orbital interaction on the spin current in graphene, quantum dots and two-dimensional nanostructures. This study is useful for construction of various nanodevices that can be used as building blocks for nanoelectronics. It will also help to understand fundamental features of spintronics. In the mesoscopic systems there is a strong interplay between classical (macroscopic) and quantum (microscopic) degrees of freedom. Very often we have to deal with nonintegrable systems. However, many properties of such systems can be analyzed in terms of classical periodic orbits. The second research line is devoted to analysis of the conditions that allow to illuminate hidden symmetries in the classical analogues of corresponding quantum systems. As a result, these symmetries manifest themselves in the corresponding quantum spectra as specific integrals of motion, that could elucidate their quantum properties. One of the main challenge of the modern photovoltaics is a construction of efficient thin-film technology. My third research line is devoted to analysis of various physical conditions that would allow to increase power conversion efficiency of thin-film solar cells based on perovskite semiconductors.

Research highlights:

The main goal of my research is to find fundamental laws that would be useful for creation of various nano systems for technological applications.

Supervisor's specific requirements:

Good physical and mathematical background, knowledge of programming languages such as Mathematica, Maple, CI, Fortran.

Main publications

- J.L. Birman, R.G. Nazmitdinov, V.I. Yukalov, "Effects of symmetry breaking in finite quantum systems" Physics Reports 526 (2013) pp.1-91.
- R.G. Nazmitdinov, A. Puente, M. Cerkaski, and M. Pons, "Self-organization of charged particles in circular geometry" Phys.Rev.E95(2017)026602.
- F. Bonin-Ripoll, Ya. B. Martynov, G. Cardona, R.G. Nazmitdinov, R. Pujol-Nadal "Synergy of the ray tracing+carrier transport approach: On efficiency of perovskite solar cells with a black reflector" Solar Energy Materials and Solar Cells 200 (2019)110050.
- M. Pudlak, R.G. Nazmitdinov " Klein collimation by rippled graphene superlattice" J. Phys.: Condens. Matter 31 (2019)495301.
- R.G. Nazmitdinov, "From Chaos to Order in Mesoscopic Systems" Phys.Part.Nucl.Lett.16(2019)159.

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DEVELOPMENT OF THE INTENSE SOURCE OF LOW-ENERGY NEUTRONS

Research supervisor:
Alexander Nezvanov
PhD

Supervisor's research interests:

More than ten years ago, we discovered the intense reflection of low-energy neutrons from nano-dispersed media. Since then,
The FLNP JINR has been studying the interaction of neutrons with diamond nanoparticle powders. At the moment, there are no worldwide analogues of the nanostructured reflectors of very cold neutrons created by us. The accumulated knowledge and collaborations with industrial partners allow us to move on to creating intensive sources of such neutrons. Their appearance will give a new pulse to both neutron studies of condensed matter and the study of fundamental interactions.

Research highlights:

The planned research allows us to welcome candidates from different spheres: physicists, mathematicians, chemists, engineers, programmers, and so on. The estimated tasks include working together with ionizing radiation sources at mega-science installations with our colleagues from Institut Laue-Langevin (France), Heinz Maier-Leibnitz Zentrum (Germany), North Carolina State University (USA), etc. The research is supported by national and international scientific grants, including the CREMLINplus grant of the European Commission under Horizon 2020.

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Supervisor's specific requirements:

- FOR PHYSICISTS: General knowledge in quantum mechanics;
- FOR MATHEMATICIANS: Experience in Monte Carlo methods for particle trajectories simulation or a specialized software;
- FOR CHEMISTS: A qualification in inorganic chemistry;
- FOR ENGINEERS: Experience in cryogenics, particle detection;
- FOR PROGRAMMERS: Common skills of software development.

All the requirements only reflect the directions of the part of planned tasks in the frame of the research. They are welcome, but not strictly mandatory.

Main publications:

- Bosak A., Dideikin A., Dubois M., Ivankov O., Lychagin E., Muzychka A., Nekhaev G., Nesvizhevsky V., Nezvanov A., Schweins R., Strelkov A., Vul' A. and Zhernenkov K., Materials 13, 3337 (2020).
- V. V. Nesvizhevsky, M. Dubois, Ph. Gutfreund, E. V. Lychagin, A. Yu. Nezvanov, and K. N. Zhernenkov, Phys. Rev. A 97, 023629 (2018).
- A. Yu. Nezvanov, Doctoral dissertation. Communauté Université Grenoble Alpes (2018).
- V. A. Artem'ev, A. Yu. Nezvanov, and V. V. Nesvizhevsky, Crystallogr. Rep. 61, 84 (2016).

TERAHERTZ SPINTRONICS AND MAGNONICS OF FERRO- AND ANTIFERROMAGNETS

Research supervisor:
Sergey Nikitov
PhD, DSc

Supervisor's research interests:

Theoretical and experimental study of mechanisms of electric current, mechanical stresses and electric potential influences on physical properties of conducting and dielectric ferro- and antiferromagnetic heterostructures having eigenfrequencies in the microwave and terahertz frequency range, to investigate nonequilibrium processes in these structures, and to develop concepts of signal processing and logic devices based on antiferromagnets, magnonic networks and nanoelements under the influence of Dzyaloshinskii-Moriya interaction in the microwave and terahertz frequency regime.

Research highlights:

- Technological and experimental equipment to create and study nanoscale magnetic samples.
- Collaboration with leading research groups(Prof. Dr. Dirk Dr. Grundler – Ecole Polytechnique Fédérale de Lausanne(EPFL), Laboratory of Nanoscale Magnetic Materials and Magnonics; Michal Mruczkiewicz – Institute of Electrical Engineering Slovak Academy of Sciences (IEE SAS), Physics and Technology at Nanoscale; Philippe Pernod – Institute of Electronics Microelectronics and Nano Technology, Ecole Centrale de Lille;A. I. Stognij – Scientific-Practical Materials Research Centre of NAS of Belarus, Belarus).
- Additional founding by Russian Foundation for Basic Research and Russian Science Foundation.

Supervisor's specific requirements:

- Basics of solid state physics.
- Advanced knowledge of physics of magnetic phenomena.
- Analytical, numerical or experimental methods of magnetic properties study.
- Basics of analytic geometry, computational mathematics, computer programming.

Main publications:

- Magnonics: a new research area in spintronics and spin wave electronics. Phys. Usp. 58 1002–1028.
- Towards graded-index magnonics: Steering spin waves in magnonic networks. Phys. Rev. B 92, 020408R.
- Voltage-Controlled Anisotropy and Current-Induced Magnetization Dynamics in Antiferromagnetic-Piezoelectric Layered Heterostructures. PHYSICAL REVIEW APPLIED 13, 044080 (2020).

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QUANTITATIVE TEXTURE ANALYSIS

Research supervisor:
Dmitry Nikolayev
PhD

Supervisor's research interests:

Crystallographic texture is a collection of crystalline orientations in a polycrystalline sample. The importance of a texture lies first in its direct relationship with material properties and second as a method of fingerprinting the material history. My research interests are connected with neutron texture measurements, processing and interpretations of constructional, geological, biological and ceramic samples.

Research highlights:

Neutron texture measurements are fulfilled at the SKAT diffractometer situated at beamline 7 of the pulsed reactor IBR2 in the FLNP JINR. Most of the samples are provided from German, Polish, Russian, Romanian and Czech universities.

Supervisor's specific requirements:

- Crystallography
- Programming
- Strong mathematical background

Main publications:

- Nikolaev D., Lychagina T., Pakhnevich A. Experimental neutron pole figures of minerals composing the bivalve mollusc shells // Springer Nature Appl. Sci. 2019. V. 1 № 344, https://doi.org/10.1007/s42452-019-0355-1
- D. Nikolayev, T. Lychagina, A.A. Zisman, E. Yashina Directly verifiable neutron diffraction technique to determine retained austenite in steel Advanced Engineering Materials, vol. 20, 2018, https://doi.org/10.1002/adem.201700559
- T. Lychagina, D. Nikolayev Quantitative comparison of the measured crystallographic textures, Journal of Applied Crystallography, 2016, 49(4), 1290-1299.

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OPTICAL PROPERTIES OF CARBON NANOSTRUCTURES

Research supervisor:
Elena Obraztsova
PhD

Supervisor's research interests:

Our research interests are focused on synthesis, comprehensive optical characterization and new applications of carbon nanostructured materials (single-wall carbon nanotubes, graphene, carbon onions, carbon peapods, graphene nanoribbons inside carbon nanotubes and on metallic surfaces. Main applications are: ultrafast beam modulators for solid state lasers and transparent conductive electrodes.

Research highlights:

We are one of the first laboratories in Russia started studies of single-wall carbon nanotubes and graphene. We have a whole line of equipment for studies of carbon nanomaterials from synthesis to applications. We have a close collaboration with laboratories in Finland, France, Spain, Taiwan, Vietnam. 14 PhD theses have been defended under my supervision since 2000.

Supervisor's specific requirements:

- University degree in Physics.
- Strong background in condensed matter physics and optics.
- Skills in experimental optics and laser physics.

Main publications:

- W. Wenseleers, I.I. Vlasov, E. Goovaerts, E.D. Obraztsova, A.S. Lobach, A. Bouwen "Efficient Isolation and Solubilization of Pristine Single Wall Nanotubes in Bile Salt Micelles", Advanced Functional Materials 14 (2004) 1105-1112.
- Max A. Solodyankin, Elena D. Obraztsova, Anatoly S. Lobach, Alexander I. Chernov, Anton V. Tausenev, Vitaly I. Konov, Evgueni M. Dianov "1.93 mm mode-locked thulium fiber laser with a carbon nanotube absorber", Optics Letters 33 (2008) 1336-1338.
- A.A. Tonkikh, V.I. Tsebro, E.A. Obraztsova, D.V. Rybkovskiy, A.S. Orekhov, I.I. Kondrashov, E.I. Kauppinen, A.L. Chuvilin, E.D. Obraztsova "Films of filled single-wall carbon nanotubes as a new material for high-performance air-sustainable transparent conductive electrodes operating in a wide spectral range", Nanoscale 11 (2019) 6755–6765.

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SCIENTIFIC SOFTWARE AND DATA ANALYSIS IN NON-ACCELERATOR PARTICLE PHYSICS

Research supervisor:
Alexander Nozik
PhD

Supervisor's research interests:

Current primary focus of the research is the development of a new generation of scientific software for particle physics and beyond. In the near future, we intend to work on data acquisition and control systems as well as parallel and distributed tools for Monte-Carlo simulations. Also, we continue our work in Troitsk nu-mass and IAXO collaboration as well as BAT collaboration.

Research highlights:

All scientists use software in their work: data acquisition, storage and analysis as well as simulations and device control. Everything relies on a software, yet there are only several groups in the world, who work on a development of new approaches to the software development for science.
Our group works closely with JetBrains company and is a part of JetBrains Research foundation. Currently we work primarily in Kotlin language. We are also members of several international collaborations (Troitsk nu-mass, TRISTAN, IAXO, BM@N, BAT).

Supervisor's specific requirements:

- Capable to work independently.
- Motivation to work hard, learn and improve skills.
- Knowledge of application development in any programming language and motivation
  AND / OR A background in particle physics
  AND /OR A background and mathematical statistics.

Main publications:

- Kotlin language for science and Kmath library (https://dx.doi.org/10.1063/1.5130103).
- Statistical time analysis for regular events with high count rate (https://dx.doi.org/10.1088/1748-0221/14/06/P06008).
- Physics potential of the International Axion Observatory (IAXO) (https://dx.doi.org/10.1088/1475-7516/2019/06/047).
- A white paper on keV sterile neutrino dark matter (https://dx.doi.org/10.1088/1475-7516/2017/01/025).
- Upper limit on the electron antineutrino mass from the Troitsk experiment (https://dx.doi.org/10.1103/PhysRevD.84.112003).

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MATERIAL SCIENCE OF QUANTUM MATERIALS

Research supervisor:
Kirill Pervakov
PhD

Supervisor's research interests:

The main research interest is Material Science of Superconductors and Non-trivial Topological Matter.
The area of expertise includes phase diagrams, crystal structure design, synthesis and crystal growth, mechanical alloying, X-ray diffractometry, electronic microscopy and its application (EDS, EBSD, Auger spectroscopy).
Concerning the materials, we deal with iron-based superconductors (IBS) and its application, superconductors with magnetic atoms, new bismuth-based materials, transition metal dichalcogenides, tin arsenide-based materials and other new quantum materials.

Research highlights:

The research will be done in Ginzburg Center for High-Temperature Superconductivity and Quantum Materials of Lebedev Physical Institute that seven Nobel prize winners worked in. It equipped well with modern experimental equipment and has full-cycle investigation from synthesis to low-temperature experiment. The equipment used in the Center allows one to investigate a wide variety of materials include air-sensitive materials that became more and more actual in scientific research.

The Center has successful collaborations with many foreign institutions. Among them are IFW (Germany), PSI (Switzerland), DLS (UK), St. Andrew's University (UK).

Supervisor's specific requirements:

The applicant should be familiar with experimental methods of solid-state investigation (no experience is required) and confident in condensed matter physics and/or chemistry, especially with such topics as:

- Superconductivity or Topological matter.
- Electronic band structure.
- Crystallography.
- Quantum physics.
- Electrophysics.

Coding (LabView, Python etc.) is not mandatory but is an advantage.

Main publications:

- Electronic structure and superconductivity of the non-centrosymmetric Sn_4As_3, New J. Phys. in press https://doi.org/10.1088/1367-2630/ab890a (2020).
- Synthesis of electron- and hole-doped bulk $BaFe_2As_2$ superconductors by mechanical alloying, Ceramics International 46 (7), pp. 8625-8630 (2020).
- Electronic band structure and superconducting properties of SnAs, Phys. Rev. B 100, 184514 (2019).
- Critical Current and Microstructure of FeSe Wires and Tapes Prepared by PIT Method, IEEE Transactions on Appl. Supercond. 29 (3), pp. 1-5 (2019).
- Superconducting properties of $Ba(Fe_{1-x}Nix)_2As_2$ thin films in high magnetic fields, Appl. Phys. Lett. 110, 022601 (2017).

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PLASMA ASTROPHYSICS, COMPARATIVE PLAN-ETARY ATMOSPHERES

Research supervisor:
Arakel Petrosyan
PhD, DSc

Supervisor's research interests:

Theoretical and numerical studies of turbulence and waves in rotating astrophysical plasma flows and in planetary atmospheres. Development of multiscale solar activity models involving Rossby waves activity. Kinetics of rotating plasma, energy cascades in turbulence in rotating plasma flows in kinetic description. Development of advanced numerical tools in rotating plasma kinetics. Particulate flows in plasma astrophysics and applications to planets originations. Computational physics and extremal computations.

Research highlights:

Our group is conducting studies on theoretical aspects of astrophysical and planetary fluid dynamics, and using supercomputer technologies in solving problems of plasma astrophysics and planetary physics. The work involves close collaboration with scientists from Hugh Altitude Observatory in National Center of Atmospheric Research (Boulder, Colorado), Max Planck Institute for Solar System Research (Göttingen, Germany), Max Planck Institute for Astronomy (Heidelberg, Germany).

Supervisor's specific requirements:

- Basic knowledge of plasma physics or fluid dynamics.
- Basic knowledge of partial differential equations.
- Basic knowledge of numerical methods for differential equations.
- Basic programming skills in C++.

Supervisor's main publications:

- A. Chernyshov, K.V. Karelsky, A.S. Petrosyan, Three-dimensional modeling of compressible magnetohydrodynamic turbulence in the local interstellar medium, Astrophysical Journal, Vol. 686, pp.1137 (2008).
- A. Petrosyan et al., Turbulence in the Solar Atmosphere and Solar Wind, Space Sci. Rev., 156: 135-238 (2010).
- A. Petrosyan et al., The Martian Atmospheric Boundary Layer, Reviews of Geophysics, 49, RG3005/2011.
- A.A. Chernyshov, K.V. Karelsky, A.S. Petrosyan, Subgrid-scale modeling for the study of compressible magnetohydrodynamic turbulence in space plasmas, Phys. Usp., 57, 421–452 (2014).
- Miesch, M., Petrosyan, A. et al., Large-Eddy Simulations of Magnetohydrodynamic Turbulence in Heliophysics and Astrophysics, Space Sci. Rev. 194: 97 (2015).
- Klimachkov D.A., Petrosyan A.S., Parametric Instabilities in Shallow Water Magnetohydro-dynamics of Astrophysical Plasma in External Magnetic Field, Phys. Lett. A, 381, p.106 (2017).
- Petrosyan A. et al., Shallow Water Magnetohydro-dynamics in Plasma Astrophysics. Waves, Turbulence, and Zonal Flows, Atmosphere 11(4), 314 (2020).

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APPLICATIONS OF THE TAGGED NEUTRONS METHOD

Research supervisor:
Mikhail Sapozhnikov
PhD, DSc

Supervisor's research interests:

Tagged neutrons method is the technique of the distant non-destructive elemental analysis of the substances. Based on the irradiation of the object by fast 14 MeV neutrons and registration of the gamma quanta from reactions of the inelastic scattering. Used for on-line determination of the elemental content of coal, cement, different ores on a conveyor, detection of diamonds inside kimberlite, detectors of explosives etc.

Research highlights:

Research is carried out using unique Russian-made neutron generators. One of them was working 6 years at the Martian rover Curiosity Project. Joint Institute for Nuclear Research in Dubna is a large international scientific center with plenty of possibilities for physicists. Financial support is possible.

Supervisor's specific requirements:

General background in the experimental nuclear physics or basic knowledge of the methods of experimental data treatment in general and processing of the gamma-ray spectra in particular.

Main publications:

- V.Yu. Aleksakhin et al., Detection of diamonds in kimberlite by the tagged neutron method.
- Nuclear Instruments and Methods, A 785 (2015) 9.
- V.M. Bystritsky et al., DViN – stationary setup for identification of explosives. Physics of Particles and Nuclei Letters, 5 (2008)441.
- V.Yu. Aleksakhin et al., Use of the Tagged Neutron Technique for Detecting Dangerous Underwater Substances,Physics of Particles and Nuclei Letters, 10 (2013) 860.

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NEUTRINO PHYSICS

Research supervisor:
Yury Shitov
PhD

Supervisor's research interests:

- Search for neutrino less double beta decay.
- Measurements of reactor antineutrinos.
- Search for coherent elastic neutrino scattering on nuclei (CENNS).
- Techniques of measurement of ultra-low levels of radioactive background.

Research highlights:

Our group contributes significantly to a number of world leading experiments: GERDA/LEGEND, NEMO-3 /SuperNEMO, DANSS, etc. We have many years of experience working with scientific groups from around the world – all the leading centers of neutrino physics. Financial support will be provided.

The Ph.D. student will have a unique opportunity:

- To work in international collaborations on the edge of modern physics.
- To work in advanced facilities.
- To obtain fundamental world-class results in the field of neutrino physics.
- To publish solid papers.
- To get excellent material for thesis.
- Get a brilliant start to a scientific career thanks to join work with leading physicists from around the world.

Supervisor's specific requirements:

The candidate must have a serious background in the field of computer physics. The main tasks for him will be the analysis of experimental data using modern software. Basic programming knowledge is required, algorithms, an object-oriented approach. Knowledge of Python and C ++ is highly desirable. Ideally, be familiar with the ROOT software environment (https://root.cern.ch/), the GEANT4 simulation package (http://geant4.web.cern.ch/). Knowledge of machine (deep) learning (ML) techniques and Big Data processing is a fantastic advantage.

Main publications:

- E. Rukhadze et al. Investigation of double beta decay of 58Ni at the Modane Underground Laboratory // J.Phys.Conf.Ser. 1342 (2020) no.1, 012041.
- R. Arnold et al. Search for the double-beta decay of 82Se to the excited states of 82Kr with NEMO-3 NEMO-3 Collaboration, arXiv:2001.06388 [physics.ins-det], accepted for publication in Nuclear Physics A.
- R. Arnold et al. Detailed studies of 100Mo two-neutrino double beta decay in NEMO-3 // Eur.Phys.J. C79 (2019) no.5, 440.
- N.I. Rukhadze et al., Investigating the Double Beta Decay of 58Ni // Bull.Russ.Acad.Sci.Phys. 82 (2018) no.6, 708-711, Izv.Ross.Akad.Nauk Ser.Fiz. 82 (2018) no.6.
- R. Arnold et al. Final results on 82Se double beta decay to the ground state of 82Kr from the NEMO-3 experiment Eur.Phys.J. C78 (2018) no.10, 821.

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PROPERTIES OF REFRACTORY SUBSTANCES AT ULTRA-HIGH TEMPERATURES

Research supervisor:
Mikhail Sheindlin
PhD, DSc

Supervisor's research interests:

Development of the advanced methods for studying of high temperature properties of materials at very high temperatures using laser heating and the "exploding wire" techniques. Study of high temperature behavior of graphite and liquid carbon and phase relations in the UHTC carbides and related materials.

Research highlights:

Use of unique self-made methods and equipment for studying of the various UHTCs at extremely high temperatures.

Supervisor's specific requirements:

- High education in physics or in non-organic chemistry.
- Clear desire and interest to be engaged in the experimental research.

Main publications:

- Mikhail Sheindlin, Timerkhan Falyakhov, Sergey Petukhov, Georgii Valyano, Andrey Vasin, Recent advances in the study of high-temperature behaviour of non-stoichiometric TaCx, HfCx and ZrCx carbides in the domain of their congruent melting point, Adv Appl Ceram, 2018, 117, Nov, 48-55
- Rachel Pflieger, Jean-Yves Colle, Igor Iosilevskiy and Michael Sheindlin. Urania vapor composition at very high temperatures. J. of Applied Physics, 109, 033501 (2011).
- C. Ronchi and M. Sheindlin. Melting point of MgO. J. of Applied Physics, 90, No.7 (2001), p.3325-3331.

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THEORY OF WAVE PROCESSES IN SPACE PLASMA

Research supervisor:
David Shklyar
PhD, DSc

Supervisor's research interests:

- Wave propagation in the magnetosphere and ionosphere.
- Wave-particle interactions in the Earth's radiation belts.
- Analysis and interpretation of satellite data on energetic particle fluxes and multicomponent wave measurements.

Research highlights:

The research is performed in collaboration with colleagues from various Russian scientific-research institutes, as well as with researches from Czech Republic and France. The research is based on satellite data available on Internet. Limited support from Russian Foundation for Basic Research might be possible.

Supervisor's specific requirements:

Mastery of the following courses is required:

- Mechanics.
- Classical theory of field.
- Electrodynamics of condensed media.
- Basics of plasma physics.
- Basics of MATLAB.

Main publications:

- D.R. Shklyar (2011), Wave-particle interactions in marginally unstable plasma as a means of energy transfer between energetic particle populations. Physics Letters A 375 1583-1587.
- Shklyar D. R., and I. V. Kuzichev (2014), Ion energization by ELF wave packets formed of lightning-induced emission in the low-altitude magnetosphere, Geophys. Res. Lett., 41, DOI:10.1002/2013GL058692.
- Vavilov, D. I., and D. R. Shklyar (2014), Ionospherically reflected proton whistlers, J. Geophys. Res. Space Physics, 119, 99789991, DOI:10.1002/2014JA020510.
- Shklyar, D. R. (2017), Energy transfer from lower energy to higher-energy electrons mediated by whistler waves in the radiation belts, J. Geophys. Res. Space Physics, 122, 640-655, DOI:10.1002/2016JA023263.
- D.R. Shklyar, S.A. Prokhorenko (2020), Reflection from the ionosphere and exit to the ground of whistler wave packets: A dynamical model // Journal of Atmospheric and Solar-Terrestrial Physics. Vol. 201. P. 1-11. https://doi.org/10.1016/j.jastp.2020.105222

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THEORETICAL CONDENSED MATTER PHYSICS

Research supervisor:
Alexey Sokolik
PhD

Supervisor's research interests:

- Electronic properties of graphene.
- Fast dynamics of electron gas in graphene after laser pump.
- Bose-Einstein condensation and superfluidity.
- Superconductivity in novel materials.
- Quantum virial theorem and its generalizations.
- Magneto plasmons in low-dimensional systems.

Research highlights:

- Quantum-mechanical and quantum field-theoretical methods.
- Research of novel materials and nanostructures (graphene, topological insulators, metasurfaces etc.).
- Participation in research grants.

Supervisor's specific requirements:

- Good knowledge of quantum mechanics and solid state physics.
- Knowledge of second quantization and quantum many-body methods.

Main publications:

- Yu.E. Lozovik, A.A. Sokolik, Electron-hole pair condensation in graphene bilayer, JETP Lett. 87, 55 (2008).
- D.K. Efimkin, Yu.E. Lozovik, A.A. Sokolik, Collective excitations on a surface of topological insulator, Nanoscale Res. Lett. 7, 163 (2012).
- D.K. Efimkin, Yu.E. Lozovik, A.A. Sokolik, Electron-hole pairing in a topological insulator thin film, Phys. Rev. B 86, 115436 (2012).
- A.A. Sokolik, Yu.E. Lozovik, Many-body filling factor dependent renormalization of Fermi velocity in graphene in strong magnetic field, Phys. Rev. B 99, 085423 (2019).
- A.A. Melnikov, A.A. Sokolik, A.V. Frolov, S.V. Chekalin, E.A. Ryabov, Anisotropic ultrafast optical response of terahertz pumped graphene, Appl. Phys. Lett. 114, 191107 (2019).
- A.A. Sokolik, A.D. Zabolotskiy, Yu.E. Lozovik, Virial theorem, boundary conditions, and pressure for massless Dirac electrons, Ann. Phys. 412, 168001 (2020).

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QUANTUM NANOPLASMONICS & NANOPHOTONICS

Research supervisor:
Pavel Melentiev
PhD

Supervisor's research interests:

Interdisciplinary experimental research based on use quantum properties of light and beyond. The main field of research includes quantum nanoplasmonics, quantum nanophotonics and their numerous applications, including bio imaging, biosensing, quantum sensors.

Research highlights:

Our research is conducted with use of state-of –the-art equipment arranged in a modern laboratory having clean room facilities. The research is supported by collaboration with the best theoretical and technological laboratories. We have strong relations with the well-known scientific laboratories from the US, Europe, Australia, Japan. All our students are financially supported by current scientific grants of our laboratory.

Supervisor's specific requirements:

- Ultra-strong motivation.
- Perfect English.
- High level of self-discipline.
- Solid physical background.
- Experimental background in optics, lasers, vacuum equipment, microscopy, photon detection.

Main publications:

- P.N. Melentiev et al. "Open-Type SPP Waveguide with Ultrahigh Bandwidth up to 3.5 THz", ACS Photonics 6,1425-1433 (2019).
- V.I. Balykin, P.N. Melentiev "Optics and spectroscopy of individual plasmonic nanostructure" Phys. Usp. 61, 133 (2018).
- P. Melentiev et al. "Plasmonic nano laser for intracavity spectroscopy and sensorics", Appl. Phys. Lett. 111, 213104 (2017).
- P.N. Melentiev et al. "Split Hole Resonator: A nanoscale UV light source" Nano Letters 16, 1138-1142 (2016).

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THEORETICAL SOFT MATTER PHYSICS: CHARGED COLLOIDS, POLYMERS, IONOMERS, DIPOLAR LIQUID CRYSTALS, COARSE-GRAINED SIMULATIONS

Research supervisor:
Elshad Allahyarov
PhD, DSc

Supervisor's research interests:

Theory and simulation of nanocomposite materials for energy storage applications.

- Theory and simulation of dipolar systems in restricted areas and on manifold surfaces.

Research highlights:

- Development of new composite materials for supercapacitors.
- Investigation of new morphologies in dipolar systems in restricted areas, the role of dipole-dipole correlations.
- I collaborate with the groups of Prof. Lowen from HHU Duesseldorf in Germany, and Prof. Zhu from CWRU Cleveland in the US.

Supervisor's specific requirements:

- Analytical skills in physics and mathematics.
- Coding in C++, Matlab, and Fortran is a must.
- Abilities to run Molecular Dynamics, Monte-Carlo, FEM simulations are greatly desired.

Main publications:

- https://www.nature.com/articles/ncomms8110
- https://onlinelibrary.wiley.com/doi/full/10.1002/adts.202000005
- https://pubs.rsc.org/en/content/articlehtml/2018/sm/c8sm01790e

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NONLINEAR WAVE STRUCTURES IN PHYSICAL, CHEMICAL AND BIOLOGICAL SYSTEMS

Research supervisor:
Vladimir Gubernov
PhD, DSc

Supervisor's research interests:

Nonlinear waves:

- Stability, dynamics and interaction of the solitary waves and fronts; Evans function method, combustion waves, waves in chemical reactions, solitons in Bose-Einstein condensate.

Chaotic dynamics:

- Chaos in radiophysics, chaotic dynamics of nonlinear waves.

Biophysics:

- Turing and non-Turing mechanisms of pattern formation; modeling of self-organization in biological and chemical systems; tumor growth.

Combustion waves:

- Instabilities in combustion, combustion waves and pattern formation in premixed and diffusion flames.

Research highlights:

- The currently open research topics are focused on asymptotic and numerical analysis of nonlinear waves in combustion systems. There is an opportunity to work in the field of experimental studies of flame structure and dynamics including laser diagnostics of reacting flows. Close collaboration with the world's leading research groups is expected.

Supervisor's specific requirements:

- Bachelor or Masters degree in Applied Mathematics, Nonlinear physics, Laser physics, Combustion, Numerical Modelling.
- Fluent English.

Main publications:

- Yakupov E. O., Gubernov V. V., Polezhaev A. A. Mathematical modeling of spatiotemporal patterns formed at a traveling reaction front //Chaos. – 2020. – T. 30. – №. 8. – C. 083147.
- Nechipurenko S. et al. Experimental observation of diffusive-thermal oscillations of burner stabilized methane-air flames //Combustion and Flame. – 2020. – T. 213. – pp. 202-210.
- Gubernov V. V., Bykov V., Maas U. Hydrogen/air burner-stabilized flames at elevated pressures // Combustion and Flame. – 2017. – T. 185. – pp. 44-52._

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PHOTO-PROCESSES IN THE FIELD OF ULTRA-SHORT LASER PULSES

Research supervisor
Valeriy Astapenko
PhD, DSc

Supervisor' research interests

- Photoabsorption of ultra-short laser pulses (USLP) by atoms, molecules and nanoparticles.
- Elastic and inelastic scattering of USLP by various targets.
- Scattering of USLP in plasmas.
- Interaction of USLP with vibrational systems.
- Laser-assisted processes.

Research highlights:

- Collaboration with Sorbonne University.
- École Polytechnique (France).
- Aix Marseille Université (France).

Supervisor's specific requirements:

- Classical electrodynamics.
- Quantum mechanics.
- Computational skills.

Main publications:

- Rosmej F.B., Astapenko V. A., Lisitsa V. S. Plasma Atomic Physics. Springer International Publishing. 2021. – 638 p. ISBN 978-3-030-05966-8.
- V.Astapenko. Polarization Bremsstrahlung on atoms, plasmas, nanostructures and solids Springer. 2013. – 374 p. ISBN 1615-5653.
- V.Astapenko. Interaction of ultrafast electromagnetic pulses with matter SpringerBriefs in Physics. 2013. – 94 p. ISBN 2191-5423.
- V.A.Astapenko. Polarization and Interference Effects in Radiation Processes. Cambridge Scientific Publishers Ltd, 2006. –197 p. ISBN 978-1-90486-850-7.

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CHEMICAL SCIENCES

04.06.01

Duration of study: 4 years

Language: English or Russian

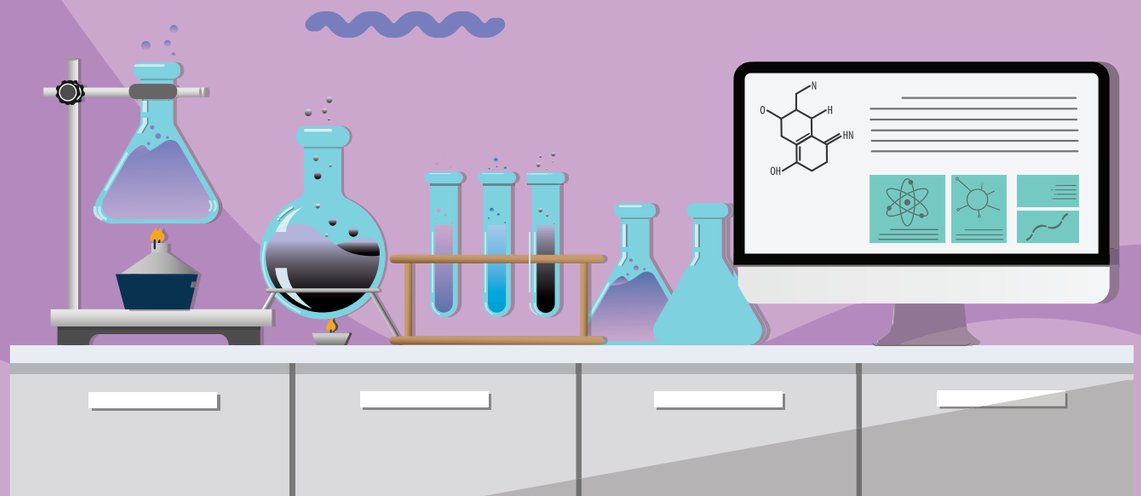
Entry requirements:

Master’s degree / equivalent in a related field

B2 level of English or Russian

Good track record of publications related to the topic of the intended research

Strong research proposal 1,500 - 3,500 words



SUPRAMOLECULAR CHEMISTRY

Research supervisor:
Natalia Lobova
PhD

Supervisor's research interests:

Since the 1980th supramolecular chemistry also known as the chemistry of weak interactions become one of the most interesting fields of chemistry. This discipline describes the relations between receptor and substrate, host and guest. This approaches leads us to nature-like technologies such as sensor systems, molecular machines and devices.. My interest concerns to fluorescent systems, organic dyes and their complexes with cavitands.

Research highlights:

As it was shown earlier, the molecular machines based on organic dyes are able to work in aqueous media. Our goal is development of different approaches to novel effective molecular devices for sensor systems or dyes for laser technics. Our work was supported by grants from the Russian Science Foundation and the Russian Foundation for Basic Research.

Supervisor's specific requirements:

- Physical chemistry.
- Organic chemistry.
- Physics.
- Confident user in Word, Excel, PowerPoint, Origin, ChemDraw.
- Analytical chemistry background is welcome.

Main publications:

- Martyanov T.P., Vedernikov A.I., Ushakov E.N., Sazonov S.K., Aleksandrova N.A., Lobova N.A., Kuz'mina L.G., Howard J. A.K., Alfimov M.V., Gromov S.P. "Pseudodimeric complexes of 4-styrylpyridine derivatives: structure–property relationships and a stereospecific [2+2]-cross-photocycloaddition in solution." // Dyes Pigments.-2020.-V. 172.-107825. https://doi.org/10.1016/j.dyepig.2019.107825. (Q1).
- Vedernikov A.I., Lobova N.A., Kuz'mina L.G., Fomina M.V., Strelenko Y.A., Howard J.A.K., Gromov S.P. "Self-assembly of cucurbiturils and cyclodextrins to supramolecular millstones with naphthalene derivatives capable of translocations in the host cavities." // New. J. Chem.-2019.-V. 43.-No. 9.-P. 3673-3689. DOI: 10.1039/c8nj04685a.
- Gromov S.P., Vedernikov A.I., Lobova N.A., Kuz'mina L.G., Dmitrieva S.N., Strelenko Yu.A., Howard J.A.K. "Synthesis, Structure, and Properties of Supramolecular Photoswitches Based on Ammonioalkyl Derivatives of Crown-Ether Styryl Dyes" // J. Org. Chem.-2014.-V. 79.-No. 23.-P. 11416–11430.

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THEORETICAL INVESTIGATION OF ELECTRONIC STRUCTURE OF MOLECULES

Research supervisor:
Alexander Mitin
PhD, DSc

Supervisor's research interests:

Theoretical investigation of electronic structure of molecules by ab initio methods. Development of the new methods, numerical algorithms, and computer programs of ab initio methods.

Supervisor's specific requirements:

- Knowledge of the ab initio methods: Hartree-Fock, configuration interaction, coupled cluster, density functional.
- Experience with ab initio programs: Molpro, Gaussian, CFour, or similar.

Main publications:

- A.V. Mitin, Unusual chemical bonding in the beryllium dimer and its twelve vibrational levels, Chem. Phys. Lett., 2017, 682, 30 (2017).
- A.V. Mitin and C. Van Wüllen, Two-Component Relativistic Density Functional Calculations of the Dimers of the Halogens from Bromine through Element 117 Using Effective Core Potential and All-Electron Methods, J. Chem. Phys., 124, 064305 (2006).
- A.V. Mitin, J. Baker, P. Pulay, An Improved 6-31G* Basis Set for First-Row Transition Metals, J. Chem. Phys., 118, 7775 (2003).

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OPTICAL PROPERTIES OF CARBON NANOSTRUCTURES

Research supervisor:
Elena Obraztsova
PhD

Supervisor's research interests:

Our research interests are focused on synthesis, comprehensive optical characterization and new applications of carbon nanostructured materials (single-wall carbon nanotubes, graphene, carbon onions, carbon peapods, graphene nanoribbons inside carbon nanotubes and on metallic surfaces. Main applications are: ultrafast beam modulators for solid state lasers and transparent conductive electrodes.

Research highlights:

We are one of the first laboratories in Russia started studies of single-wall carbon nanotubes and graphene. We have a whole line of equipment for studies of carbon nanomaterials from synthesis to applications. We have a close collaboration with laboratories in Finland, France, Spain, Taiwan, Vietnam. 14 PhD theses have been defended under my supervision since 2000.

Supervisor's specific requirements:

- University degree in Physics.
- Strong background in condensed matter physics and optics.
- Skills in experimental optics and laser physics.

Main publications:

- W. Wenseleers, I.I. Vlasov, E. Goovaerts, E.D. Obraztsova, A.S. Lobach, A. Bouwen "Efficient Isolation and Solubilization of Pristine Single Wall Nanotubes in Bile Salt Micelles", Advanced Functional Materials 14 (2004) 1105-1112.
- Max A. Solodyankin, Elena D. Obraztsova, Anatoly S. Lobach, Alexander I. Chernov, Anton V. Tausenev, Vitaly I. Konov, Evgueni M. Dianov "1.93 mm mode-locked thulium fiber laser with a carbon nanotube absorber", Optics Letters 33 (2008) 1336-1338.
- A.A. Tonkikh, V.I. Tsebro, E.A. Obraztsova, D.V. Rybkovskiy, A.S. Orekhov, I.I. Kondrashov, E.I. Kauppinen, A.L. Chuvilin, E.D. Obraztsova "Films of filled single-wall carbon nanotubes as a new material for high-performance air-sustainable transparent conductive electrodes operating in a wide spectral range", Nanoscale 11 (2019) 6755–6765.

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NOVEL SYNTHETIC METHODOLOGY OF CONDUCTING POLYMERS AND COMPOSITES

Research supervisor:
Ekaterina Zolotukhina
PhD, DSc

Supervisor's research interests:

Conducting polymers, electrochemical deposition, synthesis of electroactive polymers and composites, their application for electrocatalysis and sensors design and testing, flow electrodes, supercapacitors, PEDOT-PSS composites, novel methodology of metal/salts/metal oxides – conductive polymers composites synthesis.

Research highlights:

- New synthetic approach to conducting/ion-exchange polymer composites.
- High-level electrochemical methodology of research work Interaction with the leading European research centers.

Supervisor's specific requirements:

- Background in the theoretical and applied electrochemistry (high level).
- Basic skills of work with Auto lab PGSTAT 302 or analogues with Nova 1.11.
- 50% per year attendance in Russian laboratory (IPCP RAS).

Main publications:

- Journal of Solid State Electrochemistry 2019 (23) 251-258. 10.1007/s10008-018-4129-2.
- Electrochimica Acta 2020 (345) 136164. 10.1016/j.electacta.2020.136164.
- Electrochimica Acta. 2015 (179) 364–371. 10.1016/j.electacta.2015.03.227.

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BIOLOGICAL SCIENCES

06.06.01

Duration of study: 4 years

Language: English or Russian

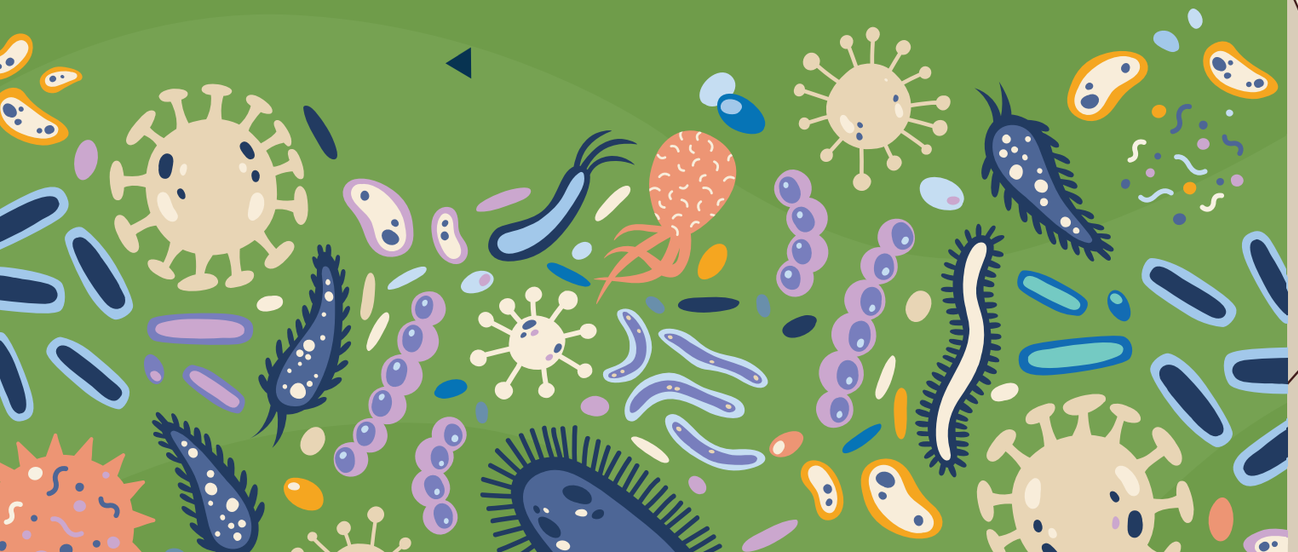
Entry requirements:

Master’s degree / equivalent in a related field

B2 level of English or Russian

Good track record of publications related to the topic of the intended research

Strong research proposal 1,500 - 3,500 words



BIOINFORMATICS, GENETICS AND MOLECULAR BIOLOGY PROJECTS FOCUSED ON TREATMENT OF DISEASES

Research supervisor:
Pavel Volchkov
PhD, Head of Genome Engineering Laboratory

Supervisor's research interests:

Biochemistry, Genetics and Molecular Biology, Medicine Immunology and Microbiology, Regenerative medicine, Stem cells, Bioinformatics, Gene Therapy, Cell Therapy.

Research highlights:

- Research based on resolution of globally relevant issues byway of cutting edge methods. Search for permanent genetics-based resolutions for modern issues.
- High quality laboratory equipment and all necessary facilities for an outstanding world level research.
- Projects in collaboration with world leading universities and research centers, e.g. Harvard University (USA), Uppsala University (Sweden), Lions Eye Institute (Australia).

Supervisor's specific requirements:

- Master degree in molecular biology, immunology, embryology, microbiology, biochemistry, genetics or bioinformatics.
- Practical skills in a methods of molecular and cell biology.
- Data analysis skills (e.g. Python programming).
- Soft skills, teamwork skills.

Main publications:

- Wen L, Ley RE, Volchkov PY, Stranges PB, Avanesyan L, Stonebraker AC, et al. Innate immunity and intestinal microbiota in the development of Type 1 diabetes. Nature 2008;455:1109-13. https://doi.org/10.1038/nature07336
- Yurkovetskiy L, Burrows M, Khan AA, Graham L, Volchkov P, Becker L, et al. Gender bias in autoimmunity is influenced by microbiota. Immunity 2013;39:400-12. https://doi.org/10.1016/j.immuni.2013.08.013
- Riddell J, Gazit R, Garrison BS, Guo G, Saadatpour A, Mandal PK, et al. Reprogramming committed murine blood cells to induced hematopoietic stem cells with defined factors. Cell 2014;157:549-64. https://doi.org/10.1016/j.cell.2014.04.006
- Lagarkova MA, Volchkov PY, Lyakisheva AV, Philonenko ES, Kiselev SL. Diverse epigenetic profile of novel human embryonic stem cell lines. Cell Cycle 2006;5:416-20. https://doi.org/10.4161/cc.5.4.2440
- Buzdin A, Gogvadze E, Kovalskaya E, Volchkov P, Ustyugova S, Illarionova A, et al. The human genome contains many types of chimeric retrogenes generated through in vivo RNA recombination. Nucleic Acids Res 2003;31:4385-90.

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STUDY OF ANTIMICROBIAL RESISTANCE MECHANISMS AND BIOMARKERS OF INFLAMMATION AND THE DEVELOPMENT OF MOLECULAR ASSAYS FOR INFECTIOUS DISEASES AND PATHOLOGY

Research supervisor:
Dmitry Gryadunov
PhD, DSc, Head of Laboratory for Molecular Diagnostics Technologies, vice-director, IMB RAS

Supervisor's research interests:

Study of molecular mechanisms of drug resistance in bacteria and viruses, design of specialized DNA and protein microarrays, development of nucleic acids amplification and hybridization techniques, state-of-the-art technologies in molecular biology and molecular diagnostics, genomics of socially significant and biowarfare infectious agents, complete integrated microfluidic device design, engineering of portable systems for real-time clinical and forensic diagnostics.

Research highlights:

We developed, patented and implemented in clinical practice an original technology of hydrogel microarrays. This platform serves as a basis for a number of state-of-the-art approaches for a multiplex analysis of DNA and the protein biomarkers of socially significant diseases, including the molecular genetics, immunological, and epidemiological aspects of pathogenesis.

Supervisor's specific requirements:

- Nucleic acids amplification methods.
- Nucleic acids isolations methods.
- NGS and Sanger sequencing.
- Genetic engineering/ cloning methods.
- Bioinformatics tools (knowledge of Python/R/etc. languages is welcome).
- Statistical methods of analysis.

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Main publications:

- Shaskolskiy B, Dementieva E, Kandinov I, Chestkov A, Kubanov A, Deryabin D, et al. Genetic diversity of Neisseria gonorrhoeae multi-antigen sequence types in Russia and Europe. International Journal of Infectious Diseases 2020;93:1-8. https://doi.org/10.1016/j.ijid.2020.01.020
- Savvateeva EN, Rubina AY, Gryadunov DA. Biomarkers of Community-Acquired Pneumonia: A Key to Disease Diagnosis and Management. Biomed Res Int 2019;1701276. https://doi.org/10.1155/2019/1701276
- Kubanov A, Solomka V, Plakhova X, Chestkov A, Petrova N, Shaskolskiy B, et al. Summary and Trends of the Russian Gonococcal Antimicrobial Surveillance Programme, 2005-2016. Journal of Clinical Microbiology 2019;57:e02024-18. https://doi.org/10.1128/JCM.02024-18
- Gryadunov DA, Shaskolskiy BL, Nasedkina TV, Rubina AY, Zasedatelev AS. The EIMB hydrogel microarrays technology: thirty years later. Acta Naturae 2018;10(4):4-18. https://doi.org/10.32607/20758251-2018-10-4-4-18
- Zimenkov DV, Nosova EY, Kulagina EV, Antonova OV, Arslanbaeva LR, Isakova AI, et al. Examination of bedaquiline- and linezolid-resistant Mycobacterium tuberculosis isolates from the Moscow region. J Antimicrob Chemother 2017;72:1901-6. https://doi.org/10.1093/jac/dkx094

HUMAN STEM CELL REPROGRAMMING FOR REGENERATIVE BIOMEDICINE

Research supervisor:
Erdem Dashinimaev
PhD

Supervisor's research interests:

- Human induced pluripotent stem cells.
- Direct reprogramming of human somatic cells.
- Genome editing using CRISPR/Cas9 methods.
- CRISPR-a screening of reprogramming factors.
- Single cell RNA-seq analysis.

Research highlights:

- A well-equipped scientific laboratory, which has almost all the necessary tools to perform work on the declared topics.
- Young friendly team of like-minded people, favorable atmosphere of creativity.
- Setting up the appropriate level of research work for publication in international scientific journals.

Supervisor's specific requirements:

- Level of knowledge of two languages – Russian and English at a confident level (or only English, but at an excellent level).
- Residence in MIPT "Zuzino" hostel, because the laboratory is located near the metro station "Troparevo" (south-west) and the travel time from Dolgoprudny takes more than 1.5 hours.
- Acceptance of the fact that for a successful project in the field of cell biology it is necessary to work in the laboratory 5 days a week plus sometimes weekends.

Main publications:

- Dashinimaev EB, Artyuhov AS, Bolshakov AP, Vorotelyak EA, Vasiliev AV. Neurons Derived from Induced Pluripotent Stem Cells of Patients with Down Syndrome Reproduce Early Stages of Alzheimer's Disease Type Pathology in vitro. J Alzheimers Dis 2017;56:835-47. https://doi.org/10.3233/JAD-160945
- Artyuhov AS, Dashinimaev EB, Mescheryakova NV, Ashikhmina AA, Vorotelyak EA, Vasiliev AV. Detection of small numbers of iPSCs in different heterogeneous cell mixtures with highly sensitive droplet digital PCR. Mol Biol Rep 2019;46:6675-83. https://doi.org/10.1007/s11033-019-05100-2
- Artyukhov AS, Dashinimaev EB, Tsvetkov VO, Bolshakov AP, Konovalova EV, Kolbaev SN, et al. New genes for accurate normalization of qRT-PCR results in study of iPS and iPS-derived cells. Gene 2017;626:234-40. https://doi.org/10.1016/j.gene.2017.05.045

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PLANT GENOMICS AND TRANSCRIPTOMICS

Research supervisor:
Artem Kasianov
PhD

Supervisor's research interests:

De novo genome assembly of plant genomes. Functional annotation of plant genomes. Transcriptomics and regulation in plants.

Research highlights:

My main research interests are in the field of plant genomics and transcriptomics. Currently, the main objects of research are the genomes and transcriptomes of plants such as F. esculentum and C. bursa-pastoris. You will be able to De novo assemble genomes, annotate them, and understand how genes works in plant.

Supervisor's specific requirements:

- Ability to work in Unix like operating systems.
- Ability to program in scripting programming languages such as Python or Perl.
- Interest in Plant science.

Main publications:

- Klepikova AV, Kasianov AS, Gerasimov ES, Logacheva MD, Penin AA. A high resolution map of the Arabidopsis thaliana developmental transcriptome based on RNA-seq profiling. Plant J 2016;88:1058-70. https://doi.org/10.1111/tpj.13312
- Kasianov AS, Klepikova AV, Kulakovskiy IV, Gerasimov ES, Fedotova AV, Besedina EG, et al. High-quality genome assembly of Capsella bursa-pastoris reveals asymmetry of regulatory elements at early stages of polyploid genome evolution. The Plant Journal 2017;91:278-91. https://doi.org/10.1111/tpj.13563
- Klepikova AV, Kulakovskiy IV, Kasianov AS, Logacheva MD, Penin AA. An update to database TraVA: organ-specific cold stress response in Arabidopsis thaliana. BMC Plant Biology 2019;19:49. https://doi.org/10.1186/s12870-019-1636-y

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MOLECULAR NEUROBIOLOGY OF MEMORY

Research supervisor:
Pavel Balaban
PhD, DSc, Corr. member of RAS
Head of Cellular Neurobiology of Learning Laboratory, director, INHAN RAS

Supervisor's research interests:

Neurobiological investigation of learning and memory with the aim to understand molecular mechanisms of epigenetic regulation of neuronal functioning. Synaptic plasticity mechanisms, optogenetics, thermogenetics and chemogenetics as innovative instruments for neurobiological research. Maintenance and modification of the long-term memory, invertebrate models for neurophysiological research.

Research highlights:

Unique complex of behavioral, electrophysiological and molecular biological approaches in one lab. Biological subjects from cultured cells, invertebrate animals, mammals. Optical recording of electrical and molecular events in one cell or in a network, including in vivo optical recording of 30-40 neurons in free behaving animals.

Supervisor's specific requirements:

- Devotion to Science.
- Good English.
- Knowledge of Biophysics.
- Knowledge of Matlab programming.

Main publications:

- Xu C, Li Q, Efimova O, Jiang X, Petrova M, K Vinarskaya A, et al. Identification of Immediate Early Genes in the Nervous System of Snail Helix lucorum. ENeuro 2019;6(3). https://doi.org/10.1523/ENEURO.0416-18.2019
- Romanova DY, Smirnov IV, Nikitin MA, Kohn AB, Borman AI, Malyshev AY, Balaban PM, Moroz LL. Sodium action potentials in placozoa: Insights into behavioral integration and evolution of nerveless animals. Biochem Biophys Res Commun 2020;19:S0006-291X(20)31565-5. http://doi.org/10.1016/j.bbrc.2020.08.020
- Balaban PM. Molecular Mechanism of Memory Modification. Neurosci Behav Physi 2018;48:734-40. https://doi.org/10.1007/s11055-018-0624-2
- Ermakova YG, Lanin AA, Fedotov IV, Roshchin M, Kelmanson IV, Kulik D, et al. Thermogenetic neurostimulation with single-cell resolution. Nat Commun 2017;22(8):15362. http://doi.org/10.1038/ncomms15362
- Borodinova AA, Kuznetsova MA, Alekseeva VS, Balaban PM. Histone acetylation determines transcription of atypical protein kinases in rat neurons. Scientific Reports 2019;9:4332. https://doi.org/10.1038/s41598-019-40823-z
- Roshchin MV, Matlashov ME, Ierusalimsky VN, Balaban PM, Belousov VV, et al. A BK channel-mediated feedback pathway links single-synapse activity with action potential sharpening in repetitive firing. Sci Adv 2018;4(7):eaat1357. http://doi.org/10.1126/sciadv.aat1357

GLOBAL PROFILING OF UBIQUITIN-PROTEASOME SYSTEM FUNCTIONING AND PROTEIN TURNOVER

Research supervisor:
Alexey Belogurov
PhD, DSc
Head of Laboratory of Hormonal Regulation Proteins, IBCh RAS

Supervisor's research interests:

Study of molecular mechanisms of proteasome machinery, including specific inhibitors of immunoproteasome for the treatment of autoimmune diseases, investigation of ubiquitin metabolism and global profiling of the cellular ubiquitinome, probing of the ubiquitin-proteasome system utilizing genome editing techniques.

Research highlights:

We developed technique for the ubiquitin fluorescence tracking and now are using this methodology to provide comprehensive understanding of ubiquitin-proteasome system dynamics on the previously unreachable state of the art.

Supervisor's specific requirements:

- DNA cloning and protein expression.
- PAGE and WB techniques.
- Flow cytometry.
- Eukaryotic cells maintaining.
- Transfection/transduction procedures.

Main publications:

- Kudriaeva A, Kuzina ES, Zubenko O, Smirnov IV, Belogurov A. Charge-mediated proteasome targeting. The FASEB Journal 2019;33:6852-66. https://doi.org/10.1096/fj.201802237R
- Stepanov AV, Markov OV, Chernikov IV, Gladkikh DV, Zhang H, Jones T, et al. Autocrine-based selection of ligands for personalized CAR-T therapy of lymphoma. Sci Adv 2018;4:eaau4580. https://doi.org/10.1126/sciadv.aau4580
- Lomakin Y, Kudriaeva A, Kostin N, Terekhov S, Kaminskaya A, Chernov A, et al. Diagnostics of autoimmune neurodegeneration using fluorescent probing. Scientific Reports 2018;8:12679. https://doi.org/10.1038/s41598-018-30938-0
- Ivanova VV, Khaiboullina SF, Gomzikova MO, Martynova EV, Ferreira AM, Garanina EE, et al. Divergent Immunomodulation Capacity of Individual Myelin Peptides—Components of Liposomal Therapeutic against Multiple Sclerosis. Front Immunol 2017;8. https://doi.org/10.3389/fimmu.2017.01335
- Lomakin Y, Arapidi GP, Chernov A, Ziganshin R, Tcyganov E, Lyadova I, et al. Exposure to the Epstein-Barr Viral Antigen Latent Membrane Protein 1 Induces Myelin-Reactive Antibodies In Vivo. Front Immunol 2017;8. https://doi.org/10.3389/fimmu.2017.00777
- Belogurov A, Zakharov K, Lomakin Y, Surkov K, Avtushenko S, Kruglyakov P, et al. CD206-Targeted Liposomal Myelin Basic Protein Peptides in Patients with Multiple Sclerosis Resistant to First-Line Disease-Modifying Therapies: A First-in-Human, Proof-of-Concept Dose-Escalation Study. Neurotherapeutics 2016;13:895-904. https://doi.org/10.1007/s13311-016-0448-0
- Belogurov A, Kuzina E, Kudriaeva A, Kononikhin A, Kovalchuk S, Surina Y, et al. Ubiquitin-independent proteosomal degradation of myelin basic protein contributes to development of neurodegenerative autoimmunity. FASEB J 2015;29:1901-13. https://doi.org/10.1096/fj.14-259333

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RADIATION BIOPHYSICS/ ONCOLOGY/ DRUG DISCOVERY

Research supervisor:
Sergey Leonov
MD, PhD, Head of Laboratory for the Development of Innovative Drugs and Agricultural Biotechnology

Supervisor's research interests:

- DNA repair and Aging.
- Mechanobiology of Cancer cells.
- Extracellular vesicles and cancer dissemination.
- New biomarkers of cancer invasiveness and radio resistance.
- Pharmacological modulation of EMT, stemness and radio resistance.
- Natural products for microbiology, oncology and aging.

Research highlights:

- High Content Imaging & Analysis Platform.
- Development a novel technology for the early detection of triple negative breast cancer.
- High Throughput Target Identification and Validation Platform for Drug Discovery.
- Joint projects in Oncology (Prof. Alexis GAUTREAU, CNRS, France), Biotechnology of natural compounds (UNERA Luxembourg S.A) and System Biology (Prof. Jens Schwamborn, The University of Luxembourg and Prof. Hans V. Westerhoff, VU University Amsterdam).
- In vivo aging and neurodegeneration model on Caenorhabditis elegans.

Supervisor's specific requirements:

- MS in Biology and/or Biotechnology or related disciplines.
- Hands-on experience with basic biochemical & biophysical and molecular biology methods.
- Proficient in the use of Microsoft Office packages.
- Problem-solving skills, ability to work under time pressure and get results.
- Desirable: knowledge and motivated interest in above mentioned research of our Lab.

Main publications:

- Brel VK, Artyushin OI, Chuprov-Netochin RN, Leonov SV, et al. Synthesis and biological evaluation of indolylglyoxylamide bisphosphonates, antimitotic microtubule-targeting derivatives of indibulin with improved aqueous solubility. Bioorganic & Medicinal Chemistry Letters 2020;30(23), 127635. https://doi.org/10.1016/j.bmcl.2020.127635
- Marusich E, Mohamed H, Afanasev Y, Leonov S. Fatty Acids from Hermetia illucens Larvae Fat Inhibit the Proliferation and Growth of Actual Phytopathogens. Microorganisms 2020; 8, 1423. https://doi.org/10.3390/microorganisms8091423
- Pustovalova M, Alhaddad L, Smetanina N, Chigasova A, Blokhina T, Chuprov-Netochin R, et al. The p53-53BP1-Related Survival of A549 and H1299 Human Lung Cancer Cells after Multifractionated Radiotherapy Demonstrated Different Response to Additional Acute X-ray Exposure. Int J Mol Sci 2020;21. https://doi.org/10.3390/ijms21093342
- Ustyantseva EI, Medvedev SP, Vetchinova AS, Illarioshkin SN, Leonov SV, Zakian SM. Generation of an induced pluripotent stem cell line, ICGi014-A, by reprogramming peripheral blood mononuclear cells from a patient with homozygous D90A mutation in SOD1 causing Amyotrophic lateral sclerosis. Stem Cell Research 2020;42:101675. https://doi.org/10.1016/j.scr.2019.101675

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BIG GENETIC DATA MANAGEMENT FOR TRANSLATIONAL BIOSCIENCES AND CLINICAL ONCOLOGY

Research supervisor:
Anton Buzdin
PhD, DSc
Head of Translational Genome Bioinformatics Laboratory

Supervisor's research interests:

We try to crosslink complex genomic and transcriptomic patterns with human pathology to develop new generation of molecular diagnostic tests. Our primary expertise is within oncology where we developed several platforms predicting cancer drug efficacies using molecular pathway activation data deduced using patient's high throughput molecular profiles.

Research highlights:

Most of our projects are international collaborations with the top biomedical institutes in all around the world. We believe a good student project in our field should lead to a paper in a highly ranked journal or two.

Supervisor's specific requirements:

- Skills in wet-lab work OR programming.
- Good knowledge of molecular biology and genetics OR expertise in AI/ML applications.
- Excellent communication and text writing skills.
- Enthusiastic and creative.

Main publications:

- Buzdin A, Sorokin M, Garazha A, Glusker A, Aleshin A, Poddubskaya E, et al. RNA sequencing for research and diagnostics in clinical oncology. Semin Cancer Biol 2020;60:311-23. https://doi.org/10.1016/j.semcancer.2019.07.010
- Suntsova M, Gaifullin N, Allina D, Reshetun A, Li X, Mendeleeva L, et al. Atlas of RNA sequencing profiles for normal human tissues. Scientific Data 2019;6:36. https://doi.org/10.1038/s41597-019-0043-4
- Zolotovskaia MA, Tkachev VS, Seryakov AP, Kuzmin DV, Kamashev DE, Sorokin MI, et al. Mutation Enrichment and Transcriptomic Activation Signatures of 419 Molecular Pathways in Cancer. Cancers (Basel) 2020;12. https://doi.org/10.3390/cancers12020271

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GLOBAL PUBLIC HEALTH AND INTERNATIONAL HEALTH DEVELOPMENT

Research supervisor:
Sergey Soshnikov
PhD

Supervisor's research interests:

- Public Health.
- Medical Data Analysis.
- Biostatistics.
- Clinical Research.
- Mathematical Models of Diseases.
- Preliminary Estimates.
- Causes of Death.
- Risk Factors.
- Prevalence.
- Incidence.
- Global Burden of Diseases.
- Local Burden of Diseases.
- Mental Health.
- Disability-Adjusted Life Year (DALY).
- International Health Development.

Research highlights:

- Has 18 years of works in Public Health, has a strong local and international network of scientific teams and colleagues in the field of Medicine, Mathematics, and other sciences.
- Working closely with the World Health Organization, University of Washington, and Central Michigan University.
- A strong list of publications and high-level conferences talks.

Supervisor's specific requirements:

- Knowledge / Desire to study programming, building databases.
- Availability of start-up or advanced knowledge in R, Python or other statistical programming languages.
- Desire to help in improving the health of people around the world.

Main publications:

- Haagsma JA, James SL, Castle CD, Dingels ZV, Fox JT, Hamilton EB, et al. Burden of injury along the development spectrum: associations between the Socio-demographic Index and disability-adjusted life year estimates from the Global Burden of Disease Study 2017. Inj Prev 2020;26:i12-26. https://doi.org/10.1136/injuryprev-2019-043296
- Vos T, Barber RM, Bell B, Bertozzi-Villa A, Biryukov S, Bolliger I, et al. Global, regional, and national incidence, prevalence, and years lived with disability for 301 acute and chronic diseases and injuries in 188 countries, 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. The Lancet 2015;386:743-800. https://doi.org/10.1016/S0140-6736(15)60692-4
- Lopatin AS, Ivanchenko OA, Soshnikov SS, Mullol J. Cyclamen europaeum improves the effect of oral antibiotics on exacerbations and recurrences of chronic rhinosinusitis: a real-life observational study (CHRONOS). Acta Otorhinolaryngol Ital 2018;38:115-23. https://doi.org/10.14639/0392-100X-1342

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COMPUTATIONAL BIOLOGY OF REGULATION OF TRANSCRIPTION INITIATION

Research supervisor:
Vsevolod Makeev
PhD, DSc, Corr. member of RAS
Head of Department of Computational Systems Biology, VIGG RAS

Supervisor's research interests:

- Algorithms.
- Optimization.
- Gene expression.
- Transcription factors.
- DNA-protein interactions.
- Big data.

Research highlights:

Analysis of large datasets of transcriptomics (bulk and single cell), genomics (including DNA modifications) and DNA-protein interaction. Interaction with data providers (experimentalists) in principal research centers within international consortia.

Supervisor's specific requirements:

- Computational programming (R and Python).
- Statistics, Data analysis.
- Understanding of biology of transcription regulation.

Main publications:

- Vorontsov IE, Fedorova AD, Yevshin IS, Sharipov RN, Kolpakov FA, Makeev VJ, et al. Genome-wide map of human and mouse transcription factor binding sites aggregated from ChIP-Seq data. BMC Research Notes 2018;11:756. https://doi.org/10.1186/s13104-018-3856-x
- Kulakovskiy IV, Vorontsov IE, Yevshin IS, Sharipov RN, Fedorova AD, Rumynskiy EI, et al. HOCOMOCO: towards a complete collection of transcription factor binding models for human and mouse via large-scale ChIP-Seq analysis. Nucleic Acids Res 2018;46:D252-9. https://doi.org/10.1093/nar/gkx1106
- Afanasyeva MA, Putlyaeva LV, Demin DE, Kulakovskiy IV, Vorontsov IE, Fridman MV, et al. The single nucleotide variant rs12722489 determines differential estrogen receptor binding and enhancer properties of an IL2RA intronic region. PLoS One 2017;12:e0172681. https://doi.org/10.1371/journal.pone.0172681

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STUDY OF THE ANTIMICROBIAL ACTIVITY OF THE FAT OF THE FLY LARVA HERMETIA ILLUCENS IN MEDICINE, VETERINARY MEDICINE AND AGROBIOTECHNOLOGY

Research supervisor:
Elena Marusich
PhD

Supervisor's research interests:

- Discovery of new modulators of plants growth and development
- Neurotoxicity of human Aβ1-42 amyloid on Caenorhabditis elegans model
- Search for alternative to antibiotic compounds of natural origin able to fight against pathogenic microorganisms
- In vivo aging and neurodegeneration model on Caenorhabditis elegans
- State-of-the-art technologies in Molecular and Cell biology

Research highlights:

My main research interests is in the field of new drugs development and assessment of their efficacy. Specifically, we study the antimicrobial activity of the extract from Hermetia illucens fly larva fat against pathogens in agriculture, veterinary and medicine. As a participant of Roscosmos project, we investigate the combined effect of low radiation and galactic cosmic rays on living nematodes organism Caenorhabditis legans. Another project focus of the geroprotective activity study of Vitaferin-A derivatives based on Caenorhabditis elegans model with application of innovative computer technologies and devices.We collaborate with international groups in USA, Germany, Luxemburg, Japan. The laboratory is well-equipped by all necessary to perform innovative scientific research. The work team of friendly, young and v-creative people.

Supervisor's specific requirements:

- Good knowledge of Molecular biology, Microbiology, Medicine
- Practical skills in basic Molecular and Cell biology methods
- Ability to work with little or no supervision
- Great self-organized, focused on the details, to be responsive and get results in time
- Excellent communication and text writing skills.
- Enthusiastic and creative in problem solving

Main publications:

- Louboutin JP, Chekmasova AA, Marusich E, Chowdhury JR, Strayer DS. Efficient CNS gene delivery by intravenous injection. Nat Methods 2010;7(11):905-7. https://doi.org/10.1038/nmeth.1518.
- Louboutin JP, Marusich E, Fisher-Perkins J, Dufour JP, Bunnell BA, Strayer DS. Gene transfer to the rhesus monkey brain using SV40-derived vectors is durable and safe. Gene Ther 2011;18(7):682-91. https://doi.org/10.1038/gt.2011.13
- Agrawal L, Louboutin JP, Marusich E, Reyes BA, Van Bockstaele EJ, Strayer DS. Dopaminergic neurotoxicity of HIV-1 gp120: reactive oxygen species as signaling intermediates. Brain Res 2010;1306:116-30. http://doi: 10.1016/j.brainres.2009.09.113
- Chuprov-Netochin R, Neskorodov Y, Marusich E, Mishutkina Y, Volynchuk P, Leonov S, Skryabin K, Ivashenko A, Palme K, Touraev A. Novel small molecule modulators of plant growth and development identified by high-content screening with plant pollen. BMC Plant Biol 2016;6;16(1):192. https://doi.org/10.1186/s12870-016-0875-4

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BIOINFORMATICS

Research supervisor:
Alexey Stupnikov
PhD

Supervisor's research interests:

Our works involve, but not limited to studying and using the concept of Differential Gene Expression for RNA-seq data. We have earlier explored various aspects of RNA-seq based data properties, models performance and quality assessment. Currently we recruit this approach for inferring the problem of Chemical Reprogramming, which is a process of transforming cells from one tissue type to another with assistance of specific chemical agents.

Research highlights:

The scope of our group's research is inference the process of chemical reprogramming with computational methods. The project will require to access generated data with machine learning techniques as well as design and implement new models and tools. The candidate is expected to get involved in collaborations with experimental groups both internationally in European research centers and locally. The results of the projects are intended to be published in high impact journals.

Supervisor's specific requirements:

MS in Bioinformatics, Computer Science or related quantitative field.

- Programming skills in Python/R and Unix shell scripting.
- Understanding general concepts of Molecular Biology.
- Profound writing and communication skills.

Main publications:

- Imada EL, Sanchez DF, Collado-Torres L, Wilks C, Matam T, Dinalankara W, et al. Recounting the FANTOM CAGE-Associated Transcriptome. Genome Res 2020;30:1073-81. https://doi.org/10.1101/gr.254656.119
- Mazin PV, Shagimardanova E, Kozlova O, Cherkasov A, Sutormin R, Stepanova VV, et al. Cooption of heat shock regulatory system for anhydrobiosis in the sleeping chironomid Polypedilum vanderplanki. Proc Natl Acad Sci U S A 2018;115:E2477-86. https://doi.org/10.1073/pnas.1719493115

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COMPUTATIONAL BIOLOGY/BIOINFORMATICS/ DATA ANALYSIS

Research supervisor:
Yulia Medvedeva
PhD, Head of Laboratory of Bioinformatics of Cellular Technologies

Supervisor's research interests:

Development of bioinformatics tools and resources for regulatory genomics, cell fate engineering and drug repurposing. Computational investigation of regulatory transcriptomics and epigenomics in application to normal and pathological processes.

Research highlights:

The scope of our group's research includes studies of the fundamental mechanisms of genome regulation that can be applied to solving practical tasks, such as cell conversion and drug repositioning. Our projects require usage and development of modern bioinformatics tools and machine learning techniques to process chemical, biological and biomedical data. Our group is a member of international consortia, such as FANTOM, GREEKS, Human Cell Atlas. The candidate is expected to get involved in collaborations with computational and experimental groups both internationally and locally. Our research is supported by different Foundations, after a trial period the committed candidate can be supported financially. The results of the projects are intended to be published in high impact journals.

Supervisor's specific requirements:

- Degree in Bioinformatics, Computer Science or related quantitative field; degree in Biology can be considered if accompanied with strong programming skills.
- Programming skills in Python/R and Unix shell scripting.
- Understanding general concepts of Molecular Biology.
- Profound writing and communication skills.

Main publications:

- Bonetti A, Agostini F, Suzuki AM, Hashimoto K, Pascarella G, Gimenez J, et al. RADICL-seq identifies general and cell type-specific principles of genome-wide RNA-chromatin interactions. Nature Communications 2020;11:1018. https://doi.org/10.1038/s41467-020-14337-6
- Lioznova AV, Khamis AM, Artemov AV, Besedina E, Ramensky V, Bajic VB, et al. CpG traffic lights are markers of regulatory regions in human genome. BMC Genomics 2019;20:102. https://doi.org/10.1186/s12864-018-5387-1
- Hon C-C, Ramilowski JA, Harshbarger J, Bertin N, Rackham OJL, Gough J, et al. An atlas of human long non-coding RNAs with accurate 5' ends. Nature 2017;543:199-204. https://doi.org/10.1038/nature21374

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MOLECULAR NEUROBIOLOGY

Research supervisor:
Alexander Vassilevski
PhD, Head of Laboratory
of Molecular Instruments
for Neurobiology, IBCh RAS

Supervisor's research interests:

- Molecular mechanisms of pain.
- Structure and modulation of ion channels.
- Ion channel ligands as drug hits and leads.
- Natural venoms and neurotoxins.

My interests lie in the field of neurobiology and protein science. My current work is aimed at discovering novel natural modulators of neuroreceptors, utilizing them as research tools in neuroscience and providing lead structures for drug design.

Research highlights:

- Unique infrastructure of the Shemyakin-Ovchinnikov Institute.
- International collaborations with leading neuroscientists.
- Grant opportunities.
- Widest collection of animal venoms.

My lab is involved in several cross-border collaborative projects. Together with Jan Tytgat (KU Leuven) we characterize a panel of ion channel ligands with unique selectivity. In partnership with Tim Hucho (University of Cologne) we investigate new tools to manipulate intracellular signaling cascades in sensory neurons. And with Dimitri Kullmann (UCL Institute of Neurology) we find substances that affect mutant ion channels implicated in diseases.

Supervisor's specific requirements:

- BSc or MSc.
- Major in biochemistry or molecular biology.

Main publications:

- Grishin EV, Savchenko GA, Vassilevski AA, Korolkova YV, Boychuk YA, Viatchenko-Karpinski VY, et al. Novel peptide from spider venom inhibits P2X3 receptors and inflammatory pain. Annals of Neurology 2010;67:680-3. https://doi.org/10.1002/ana.21949
- Männikkö R, Shenkarev ZO, Thor MG, Berkut AA, Myshkin MY, Paramonov AS, et al. Spider toxin inhibits gating pore currents underlying periodic paralysis. PNAS 2018;115:4495-500. https://doi.org/10.1073/pnas.1720185115
- Twomey EC, Yelshanskaya MV, Vassilevski AA, Sobolevsky AI. Mechanisms of Channel Block in Calcium-Permeable AMPA Receptors. Neuron 2018;99:956-968.e4. https://doi.org/10.1016/j.neuron.2018.07.027

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TRANSLATIONAL NEUROSCIENCE

Research supervisor:
Allan Kalueff
PhD, DSc, Scientific Director of Laboratory of Molecular Biology, Neuroscience and Bioscreening

Supervisor's research interests:

We utilize animal models (rodents and especially zebrafish) to study neurobiological and molecular mechanisms of the brain, and their pharmacological correction. We create animal models of various complex brain disorders, including both psychiatric and neurological. We apply cell technologies to dissect the role of neurons and neuroglia in these mechanisms, with a specific focus on stress and neuroinflammation. We also study brain-altering drugs and how they affect brain functions on behavioral, neurochemical, genetic, genomic and epigenetic levels. Our lab is also involved in CNS drug screening and discovery.

Research highlights:

Our lab is a fast-paced research team actively publishing in esteemed international journals. We collaborate with multiple international colleagues (China, UK, US, Brazil).

Supervisor's specific requirements:

- Be smart, fast, ambitious, hardworking and eager to learn new things.
- No 'slow' or 'lazy' people are allowed in the lab.
- Background in Biology, Medicine or Chemistry.
- Interest in Neuroscience. Prior research experience is a bonus, especially in neuroscience or drug research.
- Be careful with experiments and pay attention to detail.
- Be able to analyze data and write scientific texts well.
- Being good with computers will be helpful.

Main publications:

- Cheresiz SV, Volgin AD, Evsyukova AK, Bashirzade AAO, Demin KA, Abreu MS de, et al. Understanding neurobehavioral genetics of zebrafish. Journal of Neurogenetics 2020;34:203-15. https://doi.org/10.1080/01677063.2019.1698565
- Wang J, Li Y, Lai K, Zhong Q, Demin KA, Kalueff AV, et al. High-glucose/high-cholesterol diet in zebrafish evokes diabetic and affective pathogenesis: The role of peripheral and central inflammation, microglia and apoptosis. Prog Neuropsychopharmacol Biol Psychiatry 2020;96:109752. https://doi.org/10.1016/j.pnpbp.2019.109752
- de Abreu MS, Genario R, Giacomini ACVV, Demin KA, Lakstygal AM, Amstislavskaya TG, et al. Zebrafish as a Model of Neurodevelopmental Disorders. Neuroscience 2020;445:3-11. https://doi.org/10.1016/j.neuroscience.2019.08.034

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FUNCTIONAL GENOMICS / GENE ENGINEERING / DRUG DISCOVERY

Research supervisor:
Vassili Lazarev
PhD, DSc
Head of Laboratory
of Genetic Engineering,
FRCC PCM FMBA

Supervisor's research interests:

- Discovery of new antimicrobial, thrombolytic and anticoagulant protein and peptides.
- Recombinant protein production.
- Genome editing.

Supervisor's specific requirements:

- Background knowledge in molecular biology, biological chemistry.
- Hands-on experience with basic gene engineering and protein chemistry methods.
- Excellent communication and text writing skills.

Main publications:

- Baskova IP, Kalabushev SN, Akhaev DN, Bobrovsky PA, Manuvera VA, Lazarev VN. Role of isopeptidolysis in the process of thrombolysis. Thrombosis Research 2018;165:18-23. https://doi.org/10.1016/j.thromres.2018.03.007
- Rubtsova M, Naraykina Y, Vasilkova D, Meerson M, Zvereva M, Prassolov V, et al. Protein encoded in human telomerase RNA is involved in cell protective pathways. Nucleic Acids Res 2018;46:8966-77. https://doi.org/10.1093/nar/gky705
- Grafskaia EN, Nadezhdin KD, Talyzina IA, Polina NF, Podgorny OV, Pavlova ER, et al. Medicinal leech antimicrobial peptides lacking toxicity represent a promising alternative strategy to combat antibiotic-resistant pathogens. European Journal of Medicinal Chemistry 2019;180:143-53. https://doi.org/10.1016/j.ejmech.2019.06.080
- Podgorny OV, Polina NF, Lazarev VN. Isolation and Propagation of Single Inclusion-Derived Chlamydia Using Laser Microdissection. In: Brown AC, editor. Chlamydia trachomatis: Methods and Protocols, New York, NY: Springer; 2019, p. 137-50. https://doi.org/10.1007/978-1-4939-9694-0_10
- Fesenko I, Kirov I, Kniazev A, Khazigaleeva R, Lazarev V, Kharlampieva D, et al. Distinct types of short open reading frames are translated in plant cells. Genome Res 2019;29:1464-1477. https://doi.org/10.1101/gr.253302.119
- Babenko VV, Podgorny OV, Manuvera VA, Kasianov AS, Manolov AI, Grafskaia EN, et al. Draft genome sequences of Hirudo medicinalis and salivary transcriptome of three closely related medicinal leeches. BMC Genomics 2020;21:331. https://doi.org/10.1186/s12864-020-6748-0

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HUMAN NEUROSCIENCE

Research supervisor:
Alexey Sedov
PhD

Supervisor's research interests:

Neuronal mechanism of motor control in normal state and movement disorders.
Pathophysiological mechanisms of Parkinson's disease, dystonia and other movement disorders
Functional role of oscillation and synchronization in normal and pathological brain activity.
New approaches for Deep Brain Stimulation (DBS) of basal ganglia in patients with movement disorders.

Research highlights:

We get unique data from basal ganglia and thalamus recorded by micro– and macroelectrodes during neurosurgery procedures in patients with movement disorders.
We collaborate with Case Western Reserve University (Cleveland, USA) and Max Planck Institute for Human Cognitive and Brain Sciences (Leipzig, Germany).
We have grants funded by the Russian Science Foundation and Russian Fund for Basic Research.

Supervisor's specific requirements:

- Biophysics, neurophysiology.
- Mathematical methods of data analysis.
- Python, MATLAB (desirable).

Main publications:

- Sedov A, Usova S, Semenova U, Gamaleya A, Tomskiy A, Beylergil SB, et al. Pallidal Activity in Cervical Dystonia with and Without Head Tremor. Cerebellum 2020;19:409-18. https://doi.org/10.1007/s12311-020-01119-5
- Sedov A, Usova S, Semenova U, Gamaleya A, Tomskiy A, Crawford JD, et al. The role of pallidum in the neural integrator model of cervical dystonia. Neurobiology of Disease 2019;125:45-54. https://doi.org/10.1016/j.nbd.2019.01.011
- Filyushkina V, Popov V, Medvednik R, Ushakov V, Batalov A, Tomskiy A, et al. Hyperactivity of Basal Ganglia in Patients With Parkinson's Disease During Internally Guided Voluntary Movements. Front Neurol 2019;10. https://doi.org/10.3389/fneur.2019.00847
- Myrov V, Sedov A, Belova E. Neural activity clusterization for estimation of firing pattern. Journal of Neuroscience Methods 2019;311:164-9. https://doi.org/10.1016/j.jneumeth.2018.10.017
- Sedov A, Popov V, Shabalov V, Raeva S, Jinnah HA, Shaikh AG. Physiology of midbrain head movement neurons in cervical dystonia. Mov Disord 2017;32:904-12. https://doi.org/10.1002/mds.26948

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EXPERIMENTAL CANCER RESEARCH

Research supervisor:
Alexander Shtil
MD, PhD, DSc
Head of Molecular Oncobiology Laboratory, IGB RAS

Supervisor's research interests:

I have started two research laboratories in Moscow: 1) Mechanisms of Tumor Cell Death at Blokhin Cancer Center and 2) Molecular Oncobiology at the Institute of Gene Biology, Russian Academy of Sciences. Also, I founded a cancer biology group at ITRMO University, St. Petersburg and a team at the Dept. of Chemistry, Moscow State University. My research interests include molecular and cell biology of anticancer drug resistance, anticancer drug design, and medicinal chemistry of anticancer drugs. Currently these multidisciplinary groups consist of researchers <35 years, MS and PhD students.

Research highlights:

We collaborate with international groups in the US and France. In 2018-2020 we have a mega grant funded by the Russian Federation Government on transcriptional reprogramming in cancer (Prof.I.Roninson, supervisor; USA). We have support from RFBR as well.

Supervisor's specific requirements:

- Devotion to research.
- BS level in basic biochemistry/molecular biology.
- Fluent English and commitment to scientific writing

Main publications:

- Ivanova ES, Tatarskiy VV, Yastrebova MA, Khamidullina AI, Shunaev AV, Kalinina AA, et al. PF-114, a novel selective inhibitor of BCR-ABL tyrosine kinase, is a potent inducer of apoptosis in chronic myelogenous leukemia cells. International Journal of Oncology 2019;55:289-97. https://doi.org/10.3892/ijo.2019.4801
- Roninson IB, Gyorffy B, Mack Z, Shtil AA, Shtutman MS, Chen M, Broude EV. Identifying cancers impacted by CDK8/19. Cells 2019;8,821-836. http://doi.org/10.3390/cells8080821
- Sagnou M, Novikov FN, Ivanova ES, Alexiou P, Stroylov VS, Titov IY, et al. Novel curcumin derivatives as P-glycoprotein inhibitors: Molecular modeling, synthesis and sensitization of multidrug resistant cells to doxorubicin. European Journal of Medicinal Chemistry 2020;198:112331. https://doi.org/10.1016/j.ejmech.2020.112331
- Tikhomirov AS, Litvinova VA, Andreeva DV, Tsvetkov VB, Dezhenkova LG, Volodina YL, et al. Amides of pyrrole- and thiophene-fused anthraquinone derivatives: A role of the heterocyclic core in antitumor properties. European Journal of Medicinal Chemistry 2020;199:112294. https://doi.org/10.1016/j.ejmech.2020.112294
- Marsova MV, Odorskaya MV, Novichkova MD, Polyakova VS, Abilev SK, et al. The antioxidant Lactobacillus brevis 47f strain protects murine intestine from enteropathy induced by 5-fluorouracil. Microorganisms 2020;8,876. http://doi.org/10.3390/microorganisms8060876
- Beniaminov AD, Chashchina GV, Livshits MA, Kechko OI, Mitkevich VA, et al. Discrimination between G/C binding sites by olivomycin A is determined by kinetics of the drug-DNA interaction. Int J Mol Sci 2020;21:E5299. http://doi.org/10.3390/ijms21155299

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INVESTIGATION OF GROWTH AND MICROENVIRONMENT OF THE GLIOBLASTOMA

Research supervisor:
Julian Rozenberg
PhD

Supervisor's research interests:

Research interests of our lab are in the fields of transcriptional regulation and cancer development and treatment. Specifically, we are interested in glioblastomas and astrocytomas – the deadliest neurological tumors. In our lab, we systematically investigate specific combinations of mutations, metabolic and epigenetic changes that provide growth advantage and immunological suppression. By rational design and screening, we are trying to identify molecules that would target a specific glioblastoma molecular subtype.

Research highlights:

In our work, we use primary surgically removed tumors and, in collaboration with colleagues across the globe, we developing less-invasive methods to understand patient-specific conditions that lead to favorable outcome and help in the development of the better treatment options. We support further international careers for our students and will assist in grant applications for their professional growth.

Supervisor's specific requirements:

- Ability to read and understand English language.
- Knowledge of the molecular and cancer biology.
- Bioinformatics skills are encouraged.
- The most important – interest and enthusiastic approach to science. Ability to work hard and smart.

Main publications:

- Rozenberg JM, Taylor JM, Mack CP. RBPJ binds to consensus and methylated cis elements within phased nucleosomes and controls gene expression in human aortic smooth muscle cells in cooperation with SRF. Nucleic Acids Res 2018;46:8232-44. https://doi.org/10.1093/nar/gky562.
- Rishi V, Bhattacharya P, Chatterjee R, Rozenberg J, Zhao J, Glass K, et al. CpG methylation of half-CRE sequences creates C/EBPα binding sites that activate some tissue-specific genes. PNAS 2010;107:20311-6. https://doi.org/10.1073/pnas.1008688107.
- Belousov A, Titov S, Shved N, Garbuz M, Malykin G, Gulaia V, et al. The Extracellular Matrix and Biocompatible Materials in Glioblastoma Treatment. Front Bioeng Biotechnol 2019;7. https://doi.org/10.3389/fbioe.2019.00341.
- Gulaia V, Kumeiko V, Shved N, Cicinskas E, Rybtsov S, Ruzov A, et al. Molecular Mechanisms Governing the Stem Cell's Fate in Brain Cancer: Factors of Stemness and Quiescence. Front Cell Neurosci 2018;12. https://doi.org/10.3389/fncel.2018.00388.
- Mikhailova V, Gulaia V, Tiasto V, Rybtsov S, Yatsunskaya M, Kagansky A. Towards an advanced cell-based in vitro glioma model system. AIMS Genet 2018;5:91-112. https://doi.org/10.3934/genet.2018.2.91

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COMPUTER SCIENCE & COMPUTER FACILITIES

09.06.01

Duration of study: 4 years

Language: English or Russian

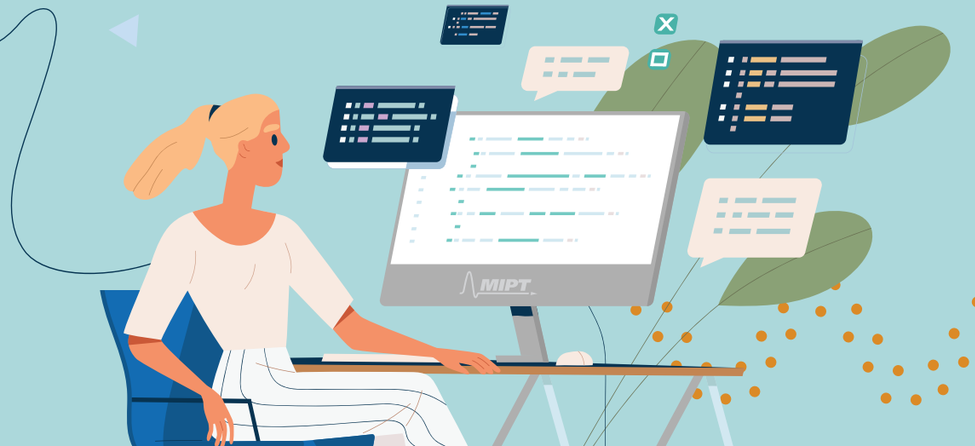
Entry requirements:

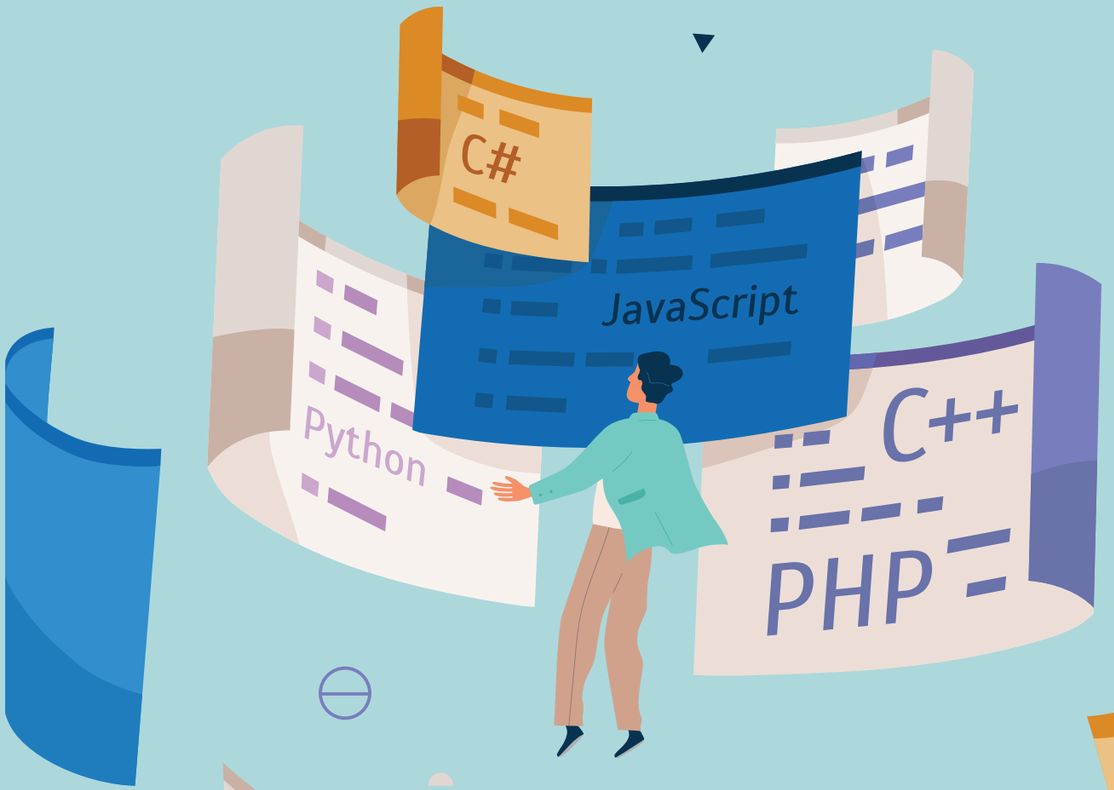
Master’s degree / equivalent in a related field

B2 level of English or Russian

Good track record of publications related to the topic of the intended research

Strong research proposal 1,500 - 3,500 words





DEVELOPMENT OF FINITE DIFFERENCE SCHEMESAND NUMERICAL SIMULATION OF NEUTRONS OR RADIATION TRANSPORT PROCESSES UNDER CONDITION OF STRONG INTERACTION WITH MATTER

Research supervisor:
Elena Aristova
PhD, DSc

Supervisor's research interests:

Modelling of physical processes in active zones of fast reactors or thermonuclear targets is conjugated with numerical solving of high order transport equation. High dimensionality of this equation and dependence of its coefficients on state of matter leads to necessity of effective dimensionality reduction. Methods for numerical solving both high and low order transport equations are developing and applying in physical and technical problems.

Supervisor's specific requirements:

- Course of functional analysis.
- Full courses of general and theoretical physics.
- High programming skills in the C++ or Fortran.
- Knowledge of parallel algorithms.

Main publications:

- Aristova E.N., Rogov B.V. Bicompact scheme for the multidimensional stationary linear transport equation // Applied Numerical Mathematics, v. 93, p.3-14, July 2015.
- Rozanov V.B., Aristova E.N. et al.Interaction of laser radiation with a low-density structured absorber // Journal of Experimental and Theoretical Physics, 2016, Vol. 122, No 2, pp. 256-276.
- Aristova E.N., Baydin D.F., et al. Core Design of Long Life-Cycle Fast Reactors Operating Without Reactivity Margin // International congress on advances in nuclear power plants, Proceedings of ICAPP'12, June 24-28, 2012, Chicago, USA, paper 12255, Curran Associates, Inc., (2012), pp.1064-1071.
- Aristova E.N., Simulation of radiation transport in channel on the basis of quasi-diffusion method // Transport Theory and Statistical Physics, v.37 (05-07), p. 483-503, 2008.

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GEOMETRIC GROUP THEORY, GEOMETRIC TOPOLOGY, HYPERBOLIC GEOMETRY, DISCRETE SUBGROUPS OF LIE GROUPS, ARITHMETIC GROUPS, REFLECTION GROUPS, COXETER POLYTOPES

Research supervisor:
Nikolay Bogachev
PhD

Supervisor's research interests:

I study geometric actions of groups on Riemannian manifolds and the corresponding quotient manifolds and orbifolds. Sometimes, if a group H acts on a metric space X properly discontinuously, then the quotient X/H is an orbifold or manifold with some nice geometric and combinatorial properties. Various examples of such actions are provided by the theory of hyperbolic reflection groups developed by Vinberg in 1967. A natural fundamental domain of a discrete group generated by reflections with respect to hyperplanes is a Coxeter polytope, which can be described in the sense of Coxeter diagrams/graphs. The modern research of discrete groups combines algebraic, geometric, topological, combinatorial, dynamical, and number theoretical approaches. Sometimes, computer experiments are very helpful.

Research highlights:

- In the framework of my research I collaborate with mathematicians from Switzerland, USA, Italy, Brazil, Germany, France, and Russia.
- My work was awarded by the Simons Foundation Prize for PhD students (2017, 2018), and also supported by grants of RSF, RFBR, Basis.

Supervisor's specific requirements:

- Algebra: groups, rings, modules, number fields.
- Linear algebra: vector spaces, linear maps and operators, bilinear and quadratic forms.
- Topology: topology of R^n, topological spaces and manifolds.
- Geometry: convex polyhedra, smooth manifolds, Riemannian manifolds.
- Python knowledge would be a benefit.

Main publications:

- N. Bogachev, From geometry to arithmeticity of compact hyperbolic Coxeter polytopes, 2020, arXiv:2003.11944.
- N. Bogachev, A. Kolpakov, On faces of quasi-arithmetic Coxeter polytopes, 2020, arXiv:2002.11445, to appear in Int.Math.Res.Notices.
- N. Bogachev, Classification of (1,2)-reflective anisotropic hyperbolic lattices of rank 4, Izvestiya Math, 2019, vol. 83:1, pp. 1-19.
- N. Bogachev, A. Perepechko, Vinberg's algorithm for integral hyperbolic lattices, Math. Notes, 2019.

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NUMERICAL METHODS FOR PDE, COMPUTATIONAL FLUID DYNAMICS

Research supervisor:
Aleksandr Chikitkin
PhD

Supervisor's research interests:

- Numerical simulation of high-speed flows around complex-shaped bodies.
- High-order numerical methods.
- Parallel high-performance computing.
- Finite-volume methods.
- Numerical methods for kinetic equations.
- Machine learning methods for CFD.

Research highlights:

- Work in collaboration with leading researchers from University of Manchester, University of Trento.
- Access to supercomputer (>1000 cores).
- Publications in high quality journals.

Supervisor's specific requirements:

- Master of Science degree in a relevant field.
- Strong background in basic numerical methods.
- Good programming skills (One of Fortran/ C++ / Python).
- Fluent English.

Some background in aerodynamics, finite-volume methods, CFD simulations is an advantage.

Main publications:

- Chikitkin, A., Utyuzhnikov, S., Petrov, M., & Titarev, V.. (2020). Non-overlapping Domain Decomposition for Modeling Essentially Unsteady Near-wall Turbulent Flows. Computers & Fluids, 104506.
- Chikitkin, A.V., Kornev, E.K., & Titarev, V.A. (2019). Numerical solution of the Boltzmann equation with S-model collision integral using tensor decompositions. arXiv preprint arXiv:1912.04582.
- Chikitkin, A.V., & Rogov, B.V. (2019). Family of central bicompact schemes with spectral resolution property for hyperbolic equations. Applied Numerical Mathematics, 142, 151-170.
- Titarev, V.A., Utyuzhnikov, S.V., & Chikitkin, A.V. (2016). OpenMP+ MPI parallel implementation of a numerical method for solving a kinetic equation. Computational Mathematics and Mathematical Physics, 56(11), 1919-1928.

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MODELS, ALGORITHMS AND SOFTWARE IN APPLIED COMBINATORIAL OPTIMIZATION

Research supervisor:
Boris Goldengorin
PhD, DSc (Russian Academy of Sciences)
PhD (University of Groningen, The Netherlands)

Supervisor's research interests:

Data Correcting and Tolerance Based Algorithms representing a unified approach to modeling and solving problems in Applied Combinatorial Optimization, e.g. Preemptive Single Machine Scheduling, Maximization (Minimization) of Submodular (Supermodular) Functions, Pseudo-Boolean Polynomials in Multidimensional Big Data Aggregation, Max-Clique, Max-Cut (including Quadratic Cost Partition), Capacitated Vehicle Routing in Cloud Computations applied to Virtual and Physical Resources, Facility Locations, Cell Formation in Industrial Engineering some of which might be found on https://www.amazon.com/Boris-Goldengorin/e/B00AR073TE

Research highlights:

The aim of this program is to establish worldwide competitive Mathematical Models, Algorithms, and Software with the purpose to solve computationally intractable benchmark instances.

Supervisor's specific requirements:

- Advanced courses in Mathematical Programming, Discrete (Combinatorial) Optimization, Algorithms and Data Structures, Mathematical Statistics and Standard Software.
- Ability to design and implement algorithms including the proof of their correctness based on advanced data structures.
- At least 3 years' experience in C++, MATLAB, CPLEX or similar software.
- Shortlisted candidate will be invited for a 30-min skype interview and one week for implementation an algorithm with reported computational study.

Main publications:

- B. Goldengorin, D. Krushinsky, P.M. Pardalos. Cell Formation in Industrial Engineering, NY, Springer, 2013, 220 pp.
- B. Goldengorin, P.M. Pardalos. Data Correcting Approaches in Combinatorial Optimization, NY, Springer, 2012, 120 pp.

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INVESTIGATION OF WAVE PHENOMENA USING COMPUTATIONAL EXPERIMENTS

Research supervisor:
Alena Favorskaya
PhD, DSc

Supervisor's research interests:

The study of solutions of the boundary value problem of elastic and acoustic wave equations using the author's method, based on a combination of analytical approaches and computational experiments. The development of numerical methods for solving this boundary-value problem, primarily from the family of grid-characteristic ones.

Research highlights:

- Possible financial support for graduate student.
- Possible publications in top rated journals.
- Possible payment of trips and reports at international conferences.

Supervisor's specific requirements:

Mandatory disciplines:
- Computational Mathematics.
- Tensor Calculus.
- Software development (C ++, Python).
- High-performance computer systems (user's experience, parallel programming).

Desired Disciplines:
- Geophysics, Seismic Prospecting.
- Inverse Problems.
- Migration.
- Ultrasonic non-destructive testing.

Main publications:

- Favorskaya, A.V., Zhdanov, M.S., Khokhlov, N.I., Petrov, I.B. Modelling the wave phenomena in acoustic and elastic media with sharp variations of physical properties using the grid-characteristic method (2018) Geophysical Prospecting, 66 (8), pp. 1485-1502.
- Favorskaya, A.V., Petrov, I.B. A novel method for investigation of acoustic and elastic wave phenomena using numerical experiments (2020) Theoretical & Applied Mechanics Letters, in print.
- Favorskaya, A. A novel method for wave phenomena investigation (2019) Procedia Computer Science, 159, pp. 1208-1215.
- Favorskaya, A.V. Elastic wave scattering on a gas-filled fracture perpendicular to plane P-wave front (2020) Systems and Technologies, 173, pp. 213-224.
- Favorskaya, A.V., Petrov, I.B. The Use of Full-Wave Numerical Simulation for the Investigation of Fractured Zones (2019) Mathematical Models and Computer Simulations, 11 (4), pp. 518-530.
- Petrov, I.B., Favorskaya, A.V., Khokhlov, N.I. Grid-characteristic method on embedded hierarchical grids and its application in the study of seismic waves (2017) Computational Mathematics and Mathematical Physics, 57 (11), pp. 1771-1777.

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NUMERICAL METHODS OF OPTIMIZATION

Research supervisor:
Alexander Gasnikov
PhD, DSc

Supervisor's research interests:

- Stochastic optimization.
- Accelerated algorithms.
- Superposition of algorithms.
- Mathematical modeling of traffic flows (traffic assignment problems).

Supervisor's specific requirements:

- Mathematical analysis.
- Linear algebra.
- Probability theory.
- Computes Science.
- Python.

Main publications:

- A. Gasnikov, P. Dvurechensky, E. Gorbunov, E. Vorontsova, Daniil Selikhanovych and Cesar A. Uribe Optimal Tensor Methods in Smooth Convex and Uniformly Convex Optimization. Conference on Learning Theory. P. 1374–1391, 2019.
- A. Kroshnin, D. Dvinskikh, P. Dvurechensky, A. Gasnikov, N. Tupitsa and C.A. Uribe. On the Complexity of Approximating Wasserstein Barycenter. Proceedings of the 36th International Conference on Machine Learning, PMLR 97:3530-3540, 2019.
- Nesterov, Y., Gasnikov, A., Guminov, S., & Dvurechensky, P. (2020). Primal–dual accelerated gradient methods with small-dimensional relaxation oracle // Optimization Methods and Software, 1-38.

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THE NUMERICAL SIMULATION OF DYNAMICS PROBLEMS IN HETEROGENEOUS MEDIA

Research supervisor:
Vasily Golubev
PhD

Supervisor's research interests:

My research work is connected with the development of novel numerical methods for simulation of dynamic processes in complex media. Many phenomena and technological processes are described by hyperbolic systems of equations: the earthquake initiation, the seismic survey of oil and gas deposits, the non-destructive testing of composite materials, etc. In our research group, we are concentrated on the extension of the grid-characteristic method for more complicated medium models. Acoustic, anisotropic elastic, fluid-saturated porous and non-linear continuum approaches and approximations are investigated. The internal research software is developed on C++ language supporting OpenMP, MPI and GPGPU systems. We are seeking motivated young students interested to expand their scientific knowledge in the simulation area.

Research highlights:

- Participation in real-life research projects supported by RFBR, RSF and other scientific foundations.
- Presentation of obtained scientific results at major international conferences: EAGE, SEG, etc.
- Collaboration with specialists from oil and gas companies.
- Chance to achieve a good experience in a team of talented young people.

Supervisor's specific requirements:

- Strong background in numerical methods (finite-difference schemes, finite-volume methods, PDEs).
- Good knowledge of the physics of deformable solid media (acoustic, linear elasticity, visco-plasticity).
- Experience in programming: C++, Python, MPI and OpenMP technologies.
- Self-sufficiency, ability to deal with scientific papers.

Main publications:

- Golubev, V.I., Shevchenko, A.V. & Petrov, I.B. Simulation of Seismic Wave Propagation in a Multicomponent Oil Deposit Model. International Journal of Applied Mechanics. https://doi.org/10.1142/S1758825120500842 (2020)
- Petrov, I.B., Golubev, V.I. & Shevchenko, A.V. Problem of Acoustic Diagnostics of a Damaged Zone. Dokl. Math. 101, 250–253 (2020).
- Golubev, V.I., Shevchenko, A.V., Petrov, I.B. Taking into Account Fluid Saturation of Bottom Sediments in Marine Seismic Survey (2019) Doklady Mathematics, 100 (2), pp. 488-490.
- Golubev, V.I., Voinov, O.Y., Petrov, I.B. Seismic Imaging of Fractured Elastic Media on the Basis of the Grid-Characteristic Method (2018) Computational Mathematics and Mathematical Physics, 58 (8), pp. 1309-1315.
- Beklemysheva, K.A., Vasyukov, A.V., Golubev, V.I., Zhuravlev, Y.I. On the Estimation of Seismic Resistance of Modern Composite Oil Pipeline Elements (2018) Doklady Mathematics, 97 (2), pp. 184-187.

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LINEAR ALGEBRA AND ITS APPLICATIONS

Research supervisor:
Alexander Guterman
PhD, DSc

Supervisor's research interests:

Combinatorial matrix theory; nonnegative matrices, graphs, and their applications; matrix invariants and maps preserving them; permanent and related matrix functions.

Research highlights:

Area of research belongs to a modern mathematics on the top level; there are possibilities to participate in scientific conferences and workshops and to interact with foreign scientists.

Supervisor's specific requirements:

- Basic classes in algebra and linear algebra.

Main publications:

- Majorization for (0,1)-matrices (with G. Dahl and P. Shteyner) Linear Algebra and Its Applications, 585, 2020, 147-163.
- Permanent Polya problem for additive surjective maps (with I.A. Spiridonov) Linear Algebra and Its Applications, 599, 2020, 140-155.
- Upper bounds for the length of non-associative algebras (with D.K. Kudryavtsev) Journal of Algebra, 544, 2020, 483-497.
- 2-words, their graphs and matrices (with E.M. Kreines and N.V. Ostroukhova) Zapiski Nauch. Sem. POMI, 482, 2019, 45-72.
- Graph characterization of fully indecomposable nonconvertible (0,1)-matrices with minimal number of ones (with M. Budrevich, G. Dolinar Gregor, B. Kuzma) Ars Mathematica Contemporanea, 17(1), 2019, 141-151.
- Krauter conjecture on permanents is true (with M.V. Budrevich) Journal of Combinatorial Theory – Series A, 162, 2019, 306-343.
- Majorization for matrix classes (with Geir Dahl and Pavel Shteyner) Linear Algebra and Its Applications, 555, 2018, 201-221.
- Extremal generalized centralizers in matrix algebras (with G. Dolinar, B. Kuzma, O. Markova) Communications in Algebra, 46(7), 2018, 3147-3154.

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ADDITIVE COMBINATORICS

Research supervisor:
Ilya Shkredov
PhD, DSc

Supervisor's research interests:

- Additive Combinatorics.
- Number Theory.
- Combinatorial Ergodic Theory.

We study various classical themes of Additive Combinatorics, the sum-product phenomenon, applications to Number Theory, Dynamical Systems, Computer Science, Classical Analysis, Growth in Groups and other mathematical fields.

Research highlights:

It will be a close contact with the mathematical community of Steklov Mathematical Inst., IPPI RAN, MSU and MIPT of course. Financial support of postdoctoral students is possible as well.

Supervisor's specific requirements:

- Mathematical papers in AC, NT or connected fields which use the methods or results of AC/NT.
- Background in Additive Combinatorics.
- Strong desire to do research.

Main publications:

- Shkredov, Ilya D. "On a problem of Gowers." Izvestiya: Mathematics 70.2 (2006): 385-425.
- Roche-Newton, Oliver, Misha Rudnev, and Ilya D. Shkredov. "New sum-product type estimates over finite fields." Advances in Mathematics 293 (2016): 589-605.
- Schoen, Tomasz, and Ilya D. Shkredov. "Roth's theorem in many variables." Israel Journal of Mathematics 199.1 (2014): 287-308.
- Konyagin, S.V., and I.D. Shkredov. "On sum sets of sets having small product set." Proceedings of the Steklov Institute of Mathematics 290.1 (2015): 288-299.

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STABLE COALITIONAL STRUCTURES AND OTHER TOPICS IN GAME THEORY

Research supervisor:
Daniil Musatov
PhD

Supervisor's research interests:

My scientific interests lie in various areas in game theory and mathematical modeling of economic and social processes, especially on the border with computer science. The research topics include, but are not limited to:

- Coalitional and migrational stability in jurisdiction partitions.
- Game-theoretic models of network formation via club structures.
- Computational complexity of finding an equilibrium in game-theoretic models.
- Models of fair division in groups and networks. Applications to determining a public project and to participatory budgeting.
- Rational interactive proofs.

Research highlights:

We have a joint research project on complex networks with Stefano Boccaletti from ICS-CNR (Florence, Italy). It is possible to work not only on game-theoretic models, but also on random graphs and hypergraphs. We are also in contact with leading Russian economic researchers from such universities as NES, HSE (Moscow and Saint Petersburg) and RANEPA.

Supervisor's specific requirements:

- Some experience in game theory, like a master-level one- or two-semester course.
- Knowledge of discrete mathematics and ability to learn new topics in it.
- Ability of designing and conducting computer experiments would be a benefit.
- No specific background in economics is needed.

Main publications:

- Musatov, D. V., A. V. Savvateev, and S. Weber (2016). "Gale–Nikaido–Debreu and Milgrom–Shannon: Communal interactions with endogenous community structures". In: Journal of Economic Theory 166, pp. 282–303.
- Golman, A. and D. Musatov (2019). "Approximate Coalitional Equilibria in the Bipolar World". In: Optimization and Applications. OPTIMA 2018. Ed. by Y. Evtushenko, M. Jaćimović, M. Khachay, Y. Kochetov, V. Malkova, and M. Posypkin. Vol. 974. Springer, pp. 512–526.

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AUTOMORPHISM GROUPS OF AFFINE ALGEBRAIC VARIETIES

Research supervisor:
Alexander Perepechko
PhD

Supervisor's research interests:

Affine algebraic varieties over algebraically closed fields represent a classical topic of algebraic geometry. Their automorphism groups are a rich domain of research that includes combinatorial representations of reductive group actions and birational self-maps. I am interested in topic of transitivity, additive actions, infinite-dimensional subgroups (called ind-groups), toric and T-varieties, and integer-point orbits on varieties corresponding to Diophantine equations.

Research highlights:

This research program involves international collaboration with research groups in the UK, Germany, and France.

Supervisor's specific requirements:

- Background in basic algebraic geometry.
- Acquaintance with algebraic groups.
- Python3 knowledge is preferable.

Main publications:

- (with Ivan Arzhantsev and Hendrik Süß) Infinite transitivity on universal torsors, Journal of the London Mathematical Society 89 (2014), no. 3, 762-778.
- (with Sergei Kovalenko and Mikhail Zaidenberg) On automorphism groups of affine surfaces, Advanced Studies in Pure Mathematics 75 (2017), Algebraic Varieties and Automorphism Groups, 207–286; arXiv:1511.09051.
- (with Andriy Regeta) When is the automorphism group of an affine variety nested?, preprint, arXiv:1903.07699.

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ASYMPTOTICAL PROPERTIES OF RANDOM STRUCTURES

Research supervisor:
Maksim Zhukovskii
PhD, DSc

Supervisor's research interests:

Logical limit laws, distribution of subgraphs in random graphs, percolation in graphs and random graphs, subgraph-saturation and weak saturation, logical complexity of graph properties and expressibility of first order and second order logics.

Research highlights:

Collaboration with international researchers.

Supervisor's specific requirements:

- PhD student should be familiar with basic notions and facts of calculus, combinatorics (in particular, graph theory), probability and stochastic processes.

Main publications:

- M.E. Zhukovskii, On the zero-one k-law extensions, European J. of Combinatorics,60(2017):66-81.
- L.B. Ostrovsky, M.E. Zhukovskii, Monadic second-order properties of very sparse random graphs, Annals of pure and applied logic, 2017, Vol. 168, pp. 2087-2101.
- A. Kupavskii, M. Zhukovskii, Short monadic second order sentences about sparse random graphs, SIAM J Disc Math, 2018, Vol. 32, No. 4, P. 2916-2940.
- O. Verbitsky, M. Zhukovskii, Tight bounds on the asymptotic descriptive complexity of subgraph isomorphism, ACM Transactions on Computational Logic, Volume 20, Issue 2, 2019.
- S.N. Popova, M.E. Zhukovskii, Existential monadic second order logic of undirected graphs: a disproof of the Le Bars conjecture, Annals of Pure and Applied Logic, 170 (2019) 505-514.

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HIGH-ORDER NUMERICAL METHODS FOR HYPERBOLIC EQUATIONS WITH APPLICATIONS TO AERODYNAMICS, RAREFIED GAS DYNAMICS AND PARALLEL COMPUTING

Research supervisor:
Vladimir Titarev
PhD, DSc

Supervisor's research interests:

Dr Titarev is a specialist in the field of computational fluid dynamics and associated numerical analysis. His research interests include the Boltzmann equation with model collision integrals, hyperbolic conservation laws and numerical methods, very high-order essentially non-oscillatory methods in particular, for partial differential equations with applications in gas dynamics, rarefied flows, reactive multiphase flows as well as non-linear elasticity.

Research highlights:

The possible program of research may include investigation of high-order methods on unstructured meshes, implicit time-accurate schemes for kinetic equations with stiff source terms. The emphasis will be on applications to complex problems.

Supervisor's specific requirements:

- Knowledge of basic numerical methods to solve PDEs, integration and differentiation.
- Good working skills in programming in Fortran 90/2003 or C.
- Basic knowledge of compressible gas dynamics.
- Basic knowledge of parallel computing is a bonus.

Main publications:

- V.A. Titarev, A.A. Frolova, V.A. Rykov, P.V. Vashchenkov, A.A. Shevyrin, Ye.A. Bondar. Comparison of the Shakhov kinetic equation and DSMC method as applied to space vehicle aerothermodynamics // Journal of Computational and Applied Mathematics. 2020. V. 364. P. 1-12. DOI: 10.1016/j.cam.2019.112354.
- V.A. Titarev. Application of model kinetic equations to hypersonic rarefied gas flows // Computers and Fluids. 2018. V. 169. P. 62-70.
- P. Tsoutsanis, V.A. Titarev and D. Drikakis. WENO schemes on arbitrary mixed-element unstructured meshes in three space dimensions // Journal of Computational Physics. 2011. V. 230, N. 4. P. 1585-1601.
- M. Dumbser, M. Käser, V.A. Titarev and E. F. Toro. Quadrature-free non-oscillatory finite volume schemes on unstructured meshes for nonlinear hyperbolic systems // Journal of Computational Physics. 2007. V. 221, N.2. P. 693-723.
- V.A. Titarev and E.F. Toro. ADER schemes for three-dimensional nonlinear hyperbolic systems // Journal of Computational Physics. 2005. V. 204. N. 2. P. 715-736.
- V.A. Titarev and E.F. Toro. Finite-volume WENO schemes for three-dimensional conservation laws // Journal of Computational Physics. 2004. V. 201, N. 1. P. 238-260.

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DISCRETE AND CONVEX GEOMETRY

Research supervisor:
Alexandr Polyanskii
PhD

Supervisor's research :

- Discrete and convex geometry.

Research highlights:

Possibility to collaborate with other (Russian and foreign) researchers of the Laboratory of Combinatorial and Geometric Structures

Supervisor's specific requirements:

- Good mathematical level (Linear Algebra, Discrete Mathematics, Functional Analysis).
- A possibility to do research at least 35 hours per week. (reading papers, tackling open mathematical problems, participating in discussions and etc.)

Main publications:

- Z. Jiang, A. Polyanskii, Proof of László Fejes Tóth's zone conjecture, Geometric and Functional Analysis, 27(6), (2017), 1367-1377.
- Z. Jiang, A. Polyanskii, Forbidden subgraphs for graphs of bounded spectral radius, with applications to equiangular lines, Israel Journal of Mathematics, 236, (2020), pages 393-421.
- A. Polyanskii, On almost-equidistant sets, Linear Algebra and its Applications, 563 (2019), 220-230.
- A. Kupavskii, A. Polyanskii, Proof of Schur's conjecture in R^d, Combinatorica, 37(6) (2017), 1181-1205.

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NUMERICAL SIMULATION OF SHOCK AND DETONATION WAVES PROPAGATION IN VARIOUS MEDIA

Research supervisor:
Pavel Utkin
PhD

Supervisor's research interests:

The research focuses on the development of the numerical algorithms for the simulations of flows of chemically reactive media (gaseous or heterogeneous) and its application to the study of the fundamental and practical problems. The examples include the simulation of the shock wave – coal dust layer interaction during the accident in the mine or the initiation of the supersonic combustion (detonation) in the chamber of the novel propulsion system.

Research highlights:

Student gets the practical skills in solving recent CFD problems in the field of compressible flows using high-performance computing.

Supervisor's specific requirements:

- Basic knowledge of continuum mechanics.
- Basic knowledge of numerical methods.
- Basic knowledge of C/C++ programming languages.

Main publications:

- Utkin, P.S. Numerical simulation of shock wave – dense particles cloud interaction using Godunov solver for Baer-Nunziato equations // International Journal of Numerical Methods for Heat & Fluid Flow. – 2019. – V. 29, No. 9. – P. 3225 – 3241. http://dx.doi.org/10.1108/HFF-10-2018-0587
- Lopato, A.I., Utkin, P.S. Numerical study of detonation wave propagation in the variable cross-section channel using unstructured computational grids // Journal of Combustion. – 2018. – V. 2018. – Article ID 3635797. – 8 P. http://dx.doi.org/10.1155/2018/3635797
- Lopato, A.I., Utkin, P.S. Towards second-order algorithm for the pulsating detonation wave modeling in the shock-attached frame // Combustion Science and Technology. – 2016. – V. 188, No. 11 – 12. – P. 1844 – 1856. http://dx.doi.org/10.1080/00102202.2016.1212570

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MODELS OF INFLUENCE AND (MIS)INFORMATION PROCESSES IN SOCIAL NETWORKS

Research supervisor:
Ivan Kozitsin
PhD

Supervisor's research interests:

My interests include, but are not limited to:

- Opinion formation models.
- Models of complex networks.
- Models of (dis)information processes in online social networks.

Research highlights:

Our current project is focused on analysis of the opinion dynamics of Russian users of VKontakte (the most popular online social network in Russia) from the perspective of opinion formation models. Here, we actively use methods from different disciplines such as statistics, machine-learning, and agent-based modeling. There is also opportunity to perform other research on related topics.

Supervisor's specific requirements:

- Basic knowledge in calculus, linear algebra, ordinary differential equations, discrete mathematics, statistics, optimization theory, and ability to learn new topics in them.
- Some experience in game theory, machine learning, databases, and agent-based modeling.
- Ability of designing and conducting computer experiments (in Python, R).

Main Publications:

- Ivan Vladimirovich Kozitsin & Alexander Alexeyevich Belolipetskii (2019) Opinion convergence in the Krasnoshchekov model, The Journal of Mathematical Sociology, 43:2, 104-121, DOI: 10.1080/0022250X.2018.1531398
- Kozitsin, I.V., Chkhartishvili, A.G., Marchenko, A.M. et al. Modeling Political Preferences of Russian Users Exemplified by the Social Network Vkontakte. Math Models Comput Simul 12, 185–194 (2020). https://doi.org/10.1134/S2070048220020088
- Ivan V. Kozitsin (2020) Formal models of opinion formation and their application to real data: evidence from online social networks, The Journal of Mathematical Sociology, DOI: 10.1080/0022250X.2020.1835894

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NUMERICAL OPTIMIZATION AND COMPUTATIONAL OPTIMAL TRANSPORT

Research supervisor:
Pavel Dvurechensky
PhD

Supervisor's research interests:

- Optimization of algorithms.
- Optimal Transport.
- Algorithms for saddle-point problems and variational inequalities.
- Distributed optimization (parallel and decentralized).

Research highlights:

- Research is supported by RFBR, RSF and other scientific foundations.
- Participation in major international conferences on machine learning: ICML, COLT, NeurIPS.
- Collaboration with researchers in Germany, the Netherlands, USA.

Supervisor's specific requirements:

- Mathematical analysis.
- Linear algebra.
- Probability theory.
- Computer Science.
- Matlab/Python.
- Basic knowledge of optimization theory and methods is a bonus.

Main publications:

- Dvurechensky, P., Ostroukhov, P., Safin, K., Shtern, S., and Staudigl, M. Self-concordant analysis of Frank-Wolfe algorithms. International Conference on Machine Learning (2020), PMLR.
- Dvurechensky, P., Gorbunov, E., and Gasnikov, A. An accelerated directional derivative method for smooth stochastic convex optimization. European Journal of Operational Research (2020). https://doi.org/10.1016/j.ejor.2020.08.027
- Nesterov, Y., Gasnikov, A., Guminov, S., & Dvurechensky, P. Primal–dual accelerated gradient methods with small-dimensional relaxation oracle. Optimization Methods and Software (2020). https://doi.org/10.1080/10556788.2020.1731747
- A. Gasnikov, P. Dvurechensky, E. Gorbunov, E. Vorontsova, Daniil Selikhanovych and Cesar A. Uribe Optimal Tensor Methods in Smooth Convex and Uniformly Convex Optimization. Conference on Learning Theory. (2019), pp. 1374–1391 .
- A. Kroshnin, D. Dvinskikh, P. Dvurechensky, A. Gasnikov, N. Tupitsa and C.A. Uribe. On the Complexity of Approximating Wasserstein Barycenter. International Conference on Machine Learning (2019), PMLR, vol 97, pp.3530-3540.
- Dvurechensky, P., Dvinskikh, D., Gasnikov, A., Uribe, C. A., and Nedic, A. Decentralize and randomize: Faster algorithm for Wasserstein barycenters. In Advances in Neural Information Processing Systems 31 (2018), pp. 10783–10793.
- Dvurechensky, P., Gasnikov, A., and Kroshnin, A. Computational optimal transport: Complexity by accelerated gradient descent is better than by Sinkhorn's algorithm. International Conference on Machine Learning (2018), PMLR, vol. 80, pp. 1367–1376.
- Bogolubsky, L., Dvurechensky, P., Gasnikov, A., Gusev, G., Nesterov, Y., Raigorodskii, A. M., Tikhonov, A., and Zhukovskii, M. Learning supervised pagerank with gradient-based and gradient-free optimization methods. In Advances in Neural Information Processing Systems 29 (2016), pp. 4914–4922.

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GAME THEORY AND BEHAVIORAL ECONOMICS

Research supervisor:
Tatiana Kozitsina (Babkina)
PhD

Supervisor's research interests:

- Game theory.
- Behavioral economics.
- Behavioral finance.
- Mathematical modeling of social and economic processes.

Research highlights:

- Modern research topics as confirmed by Nobel prizes in recent years.
- Possibility to conduct laboratory experiments in behavior economics.
- Orientation on the publication in Scopus/WoS journals.

Supervisor's specific requirements:

- Mathematical analysis.
- Probability theory.
- Statistics.
- Python/R.

Main publications:

- Menshikov, I. S., Shklover, A. V., Babkina, T. S., & Myagkov, M. G. (2017). From rationality to cooperativeness: The totally mixed Nash equilibrium in Markov strategies in the iterated Prisoner's Dilemma. PloS one, 12(11), e0180754.
- Babkina, T., Myagkov, M., Lukinova, E., Peshkovskaya, A., Menshikova, O., & Berkman, E. T. (2016). Choice of the group increases intra-cooperation. CEUR Workshop Proceeding. Vol. 1627. P. 13—22.
- Lukinova, E., Babkina, T., Sedush, A., Menshikov, I., Menshikova, O., & Myagkov, M. (2017). Sociality is not lost with monetary transactions within social groups. CEUR Workshop Proceeding. Vol. 1968. P. 18—30.
- Peshkovskaya, A. G., Babkina, T. S., Myagkov, M. G., Kulikov, I. A., Ekshova, K. V., & Harriff, K. (2017). The socialization effect on decision making in the Prisoner's Dilemma game: An eye-tracking study. PloS one, 12(4), e0175492.

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NUMERICAL METHODS FOR NONSMOOTH OPTIMIZATION

Research supervisor:
Fedor Stonyakin
PhD

Supervisor's research interests:

- Methods for Convex Programming Problems.
- Methods for Variational Inequalities.
- Inexactness in Optimization.
- Adaptive Algorithms for Optimization Problems.
- Optimization Problems with Relative Accuracy.

Supervisor's specific requirements:

- Mathematical analysis.
- Linear Algebra.
- Analytical Geometry.
- Computes Science.
- Python.

Main publications:

- Bayandina, P. Dvurechensky, A. Gasnikov, F. Stonyakin, A. Titov. Mirror descent and convex optimization problems with non-smooth inequality constraint. // Lecture Notes in Mathematics. 2018. Vol. 2227, P. 181 – 213.
- F. S. Stonyakin, D. Dvinskikh, P. Dvurechensky, A. Kroshnin, O. Kuznetsova, A. Agafonov, A. Gasnikov, A. Tyurin, C. A. Uribe, D. Pasechnyuk, S. Artamonov. Gradient Methods for Problems with Inexact Model of the Objective. // In: M. Khachay et al. (Eds.): MOTOR 2019. Lecture Notes in Computer Science. 2019. Vol. 11548. P. 97 – 114.
- P. Dvurechensky, A. Gasnikov, E. Nurminsky and F. Stonyakin. Advances in Low-Memory Subgradient Optimization. // In: A. M. Bagirov et al.(eds.). Numerical Nonsmooth Optimization. State of the Art Algorithms. Springer Nature Switzerland AG 2020. P. 19 – 59.
- F. S. Stonyakin. On the Adaptive Proximal Method for a Class of Variational Inequalities and Related Problems. // Proceedings of the Steklov Institute of Mathematics. 2020. Vol. 309(1). P.S139 – S150.
- F. Stonyakin, E. Vorontsova and M. Alkousa. New Version of Mirror Prox for Variational Inequalities with Adaptation to Inexactness. // 10th International Conference on Optimization and Applications, OPTIMA-2019. Communications in Computer and Information Sciences. 2020. Vol. 1145. P. 427 – 442.

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FUNCTIONAL AND BAYESIAN DATA ANALYSIS

Research supervisor:
Vadim Strijov
PhD, DSc

Supervisor's research interests:

The goal of research in machine learning is the creation of optimal forecasting models. We must generate a family of models and select a model of an optimal structure. The model structure is a stochastic graph, it is a point in continuous space. The selection criterion is a differentiable function, so the optimization of a model structure goes smoothly. To generate models, we use methods of functional data analysis. To select models, we use methods of Bayesian inference.

Research highlights:

- Perform computational experiments to analyze models with applications in physics, chemistry, and biology.
- Collaborate with international research groups.
- Publish results in top-rated journals.

Supervisor's specific requirements:

- Algebra and Mathematical (functional) analysis.
- Stochastic processes and Statistics.
- Programming and writing skills.

Main publications:

- Bakhteev O.Y., Strijov V.V. Comprehensive analysis of gradient-based hyperparameter optimization algorithms // Annals of Operations Research, 2020: 1-15.
- Aduenko A.A., Motrenko A.P., Strijov V.V. Object selection in credit scoring using covariance matrix of parameter estimations // Annals of Operations Research, 2018, 260(1-2): 3-21.
- Motrenko A.P., Strijov V.V. Multi-way feature selection for ECoG-based brain-computer interface // Expert Systems with Applications, 2018, 114(30): 402-413.
- Katrutsa A.M., Strijov V.V. Comprehensive study of feature selection methods to solve multicollinearity problems according to evaluation criteria // Expert Systems with Applications, 2017, 76: 1-11.
- Kulunchakov A.S., Strijov V.V. Generation of simple structured Information Retrieval functions by genetic algorithm without stagnation // Expert Systems with Applications, 2017, 85: 221-230.

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COMPUTER VISION METHODS AND THEIR APPLICATIONS FOR ROBOTIC PLATFORMS

Research supervisor:
Dmitry Yudin
PhD

Supervisor's research interests:

- Computer vision methods based on deep neural networks.
- Autonomous vehicles and intelligent transport systems.
- Modern methods of simultaneous localization and mapping.
- Onboard systems of unmanned vehicles and mobile robots.
- Algorithms for automated labeling of 2D and 3D scenes.
- 3D reconstruction methods and their applications for virtual and augmented reality.
- Application of computer vision in control systems.

Research highlights

- The research program is devoted to a wide range of modern computer vision methods used in on-board systems of robotic platforms: small educational robots, drones, service robots and courier robots, full-size unmanned vehicles.
- PhD students have the opportunity to work with the most modern server and robotic equipment at the disposal of the Intelligent Transport Laboratory of the MIPT Center for Cognitive Modeling and the Scientific and Design Bureau of Computing Systems.
- Research of the developed methods and algorithms is carried out on the basis of embedded energy-efficient platforms NVidia Jetson Nano, TX2 and Xavier, Server GPU NVidia Tesla V100, the Clearpath Husky robot with UR5 manipulator and mobile autonomous vehicle based on KIA SOUL.

Supervisor's specific requirements:

- Mathematical analysis, Linear algebra, Probability theory.
- High skills in Python and C++.
- Deep learning frameworks PyTorch and/or Tensorflow.
- Robotic Operating System (ROS).

Main publications:

- Staroverov, D. A. Yudin, I. Belkin, V. Adeshkin, Y. K. Solomentsev, and A. I. Panov. Real-Time Object Navigation with Deep Neural Networks and Hierarchical Reinforcement Learning. IEEE Access, 2020.
- Yudin D., Adeshkin V., Dolzhenko A., Polyakov A., Naumov A. Roof Defect Segmentation on Aerial Images using Neural Networks. Advances in Neural Computation, Machine Learning, and Cognitive Research IV. Studies in Computational Intelligence, Vol. 925, 2020.
- Rezanov A., Yudin D. Deep Neural Networks for Orthophoto-based Vehicle Localization. Advances in Neural Computation, Machine Learning, and Cognitive Research IV. Studies in Computational Intelligence, Vol. 925, 2020.
- Yudin D. A., Skrynnik A., Krishtopik A., Belkin I., and Panov A. I. Object Detection with Deep Neural Networks for Reinforcement Learning in the Task of Autonomous Vehicles Path Planning at the Intersection. Optical Memory & Neural Networks (Information Optics), Vol. 28 № 4, 2019.

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AI, ROBOTICS, PATH PLANNING

Research supervisor:
Konstantin Yakovlev
PhD

Supervisor's research interests:

- Artificial Intelligence.
- Intelligent Robotics.
- AI planning, path planning.
- Motion planning.
- Multi-agent path finding.
- Heuristic search.
- Multi-agent systems.

Research highlights

My general research interests lie in Artificial Intelligence and Robotics and more specifically in Path and motion planning. I'm a part of a group that extensively studies Multi-agent Path Finding (MAPF) and develops state-or-the-art planners which use heuristic search techniques as their basis. We are interested in two lines of research within MAPF: i) Developing provably complete and optimal algorithms that do not rely on numerous limiting assumptions, i.e. are able to handle continuous time and space, take kinematic constraints of agents into account etc., ii) Developing MAPF algorithms that work fast and scale well to large numbers of agents, making them suitable for real-world applications (e.g. automated warehouses). Besides Path Planning, I'm also involved in SLAM research, in particular - monocular vision based SLAM. My students develop fast vSLAM methods suitable for execution in real time under tough computational constraints (e.g. when running onboard a compact mobile robot). vSLAM, however, is not my primary research interest.

Supervisor's specific requirements:

- Solid background in Math/CS (specifically – discrete mathematics, graph theory).
- C++/Python (at least 2-3 years of experience).
- Robotic Operating System (ROS) is a plus.
- Published papers in the areas of AI, Robotics, Path/motion planning is a plus.

Main publications:

- Andreychuk A., Yakovlev K., Atzmon D., Stern R. Multi-Agent Pathfinding with Continuous Time // In Proceedings of the 28th International Joint Conference on Artificial Intelligence (IJCAI 2019). pp. 39-45.
- Yakovlev K., Andreychuk A., Vorobyev V. Prioritized Multi-Agent Path Finding for Differential Drive Robots // In Proceedings of the 2019 European Conference on Mobile Robots (ECMR 2019). pp. 1-6.
- Soboleva N., Yakovlev K. GAN Path Finder: Preliminary results // In Proceedings of the 42nd German Conference on Artificial Intelligence (KI 2019). pp. 316-324.
- Panov A.I., Suvorov R., Yakovlev K.S. (2018) Grid Path Planning with Deep Reinforcement Learning: Preliminary Results // In Proceedings of the 8th Annual International Conference on Biologically Inspired Cognitive Architectures (BICA 2017). pp. 347–353. Elsevier.
- Yakovlev, K., Andreychuk, A. (2017) Any-Angle Pathfinding for Multiple Agents Based on SIPP Algorithm. In Proceedings of the 27th International Conference on Automated Planning and Scheduling (ICAPS 2017). pp. 586-593.

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ELECTRONICS, RADIO ENGINEERING AND COMMUNICATION SYSTEMS

11.06.01

Duration of study: 4 years

Language: English or Russian

Entry requirements:

Master’s degree / equivalent in a related field

B2 level of English or Russian

Good track record of publications related to the topic of the intended research

Strong research proposal 1,500 - 3,500 words

FUTURE WIRELESS NETWORKS

Research supervisor:
Evgeny Khorov
PhD

Supervisor's research interests:

Evgeny Khorov is a world-level expert in wireless networks doing research on future Wi-Fi and 5G+ systems. In his early thirties, he has authored over 100 papers and led many national and international projects sponsored by academia foundations and industry. He is also a voting member and contributor of IEEE 802.11 that develops and standardizes Wi-Fi. His research interests are related to QoS provisioning for future applications in wireless networks, multiple channels access, resource allocation in dense networks, multi-antennae systems, and the Internet of Things. He has designed numerous algorithms and protocols that were highly evaluated by the community and industry and won a dozen prestigious awards.

Research highlights:

- Research+ Innovation + Standardization.
- Work on future technologies that will change our life.
- International conferences, top journals.
- Participation in industrial and academic projects.
- Friendly team.

Supervisor's specific requirements:

- Understanding of telecommunication protocols.
- Good knowledge in math and physics.
- C++, Python.
- Strong will to success.

Main publications:

- E. Khorov, A. Krasilov, I. Selnitskiy, I.F. Akyildiz. A Framework to Maximize the Capacity of 5G Systems for Ultra-Reliable Low-Latency Communications. IEEE Transactions on Mobile Computing, 2020.
- E. Khorov, I. Levitsky, I.F. Akyildiz. Current Status and Directions of IEEE 802.11be, the Future Wi-Fi 7. IEEE Access, 2020.
- E. Khorov, A. Kureev, I. Levitsky, I.F. Akyildiz. Prototyping and Experimental Study of Non-Orthogonal Multiple Access in Wi-Fi Networks. IEEE Networks, 2020.
- E. Khorov, A. Kiryanov, A. Lyakhov, G. Bianchi. A Tutorial on IEEE 802.11ax High-Efficiency WLANs. IEEE Communications Surveys & Tutorials, Vol. 21, Issue 1, Firstquarter 2019.
- D. Bankov, E. Khorov, A. Lyakhov. LoRaWAN Modeling and MCS Allocation to Satisfy Heterogeneous QoS Requirements. Sensors 2019. Vol. 19. No. 19. P. 1-23.
- E. Khorov, A. Krotov, A. Lyakhov, R. Yusupov, M. Condoluci, M. Dohler, I.F. Akyildiz. Enabling the Internet of Things with Wi-Fi Halow-Performance Evaluation of the Restricted Access Window. IEEE Access, Vol. 7, pp. 127402-127415, 2019.

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SPINTRONIC HETEROSTRUCTURES FOR THE SIGNALS DETECTION AND GENERATION

Research supervisor:
Dmitry Kalyabin
PhD

Supervisor's research interests:

Investigation of physical effects arising during spin waves propagation and spin current flow along 2D and 3D micro- and nanoscale heterostructures formed by ferromagnets, heavy metals, semiconductors and carbon-based materials for fundamental basis development of magonics spintronics components and its pairing with convenient semiconductor electronics with ultra-large-scale integration.

Research highlights:

- Technological and experimental equipment to create and study nanoscale magnetic samples.
- Additional founding by Russian Foundation for Basic Research and Russian Science Foundation.

Supervisor's specific requirements:

- Basics of solid state physics.
- Advanced knowledge of physics of magnetic phenomena.
- Analytical, numerical or experimental methods of magnetic properties study.
- Basics of analytic geometry, computational mathematics, computer programming.

Main publications:

- Magnonics: a new research area in spintronics and spin wave electronics. Phys. Usp. 58 1002–1028.
- Nonreciprocity of edge modes in 1D magnonic crystal. JMMM Volume 378, 15 March 2015, Pages 313-319.
- Surface spin waves propagation in tapered magnetic stripe. Journal of Applied Physics 126, 173907.

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TERAHERTZ SPINTRONICS AND MAGNONICS OF FERRO- AND ANTIFERROMAGNETS

Research supervisor:
Sergey Nikitov
PhD, DSc

Supervisor's research interests:

Theoretical and experimental study of mechanisms of electric current, mechanical stresses and electric potential influences on physical properties of conducting and dielectric ferro- and antiferromagnetic heterostructures having eigenfrequencies in the microwave and terahertz frequency range, to investigate nonequilibrium processes in these structures, and to develop concepts of signal processing and logic devices based on antiferromagnets, magnonic networks and nanoelements under the influence of Dzyaloshinskii-Moriya interaction in the microwave and terahertz frequency regime.

Research highlights:

- Technological and experimental equipment to create and study nanoscale magnetic samples.
- Collaboration with leading research groups(Prof. Dr. Dirk Dr. Grundler – Ecole Polytechnique Fédérale de Lausanne(EPFL), Laboratory of Nanoscale Magnetic Materials and Magnonics; Michal Mruczkiewicz – Institute of Electrical Engineering Slovak Academy of Sciences (IEE SAS), Physics and Technology at Nanoscale; Philippe Pernod – Institute of Electronics Microelectronics and Nano Technology, Ecole Centrale de Lille;A. I. Stognij – Scientific-Practical Materials Research Centre of NAS of Belarus, Belarus).
- Additional founding by Russian Foundation for Basic Research and Russian Science Foundation.

Supervisor's specific requirements:

- Basics of solid state physics.
- Advanced knowledge of physics of magnetic phenomena.
- Analytical, numerical or experimental methods of magnetic properties study.
- Basics of analytic geometry, computational mathematics, computer programming.

Main publications:

- Magnonics: a new research area in spintronics and spin wave electronics. Phys. Usp. 58 1002–1028.
- Towards graded-index magnonics: Steering spin waves in magnonic networks. Phys. Rev. B 92, 020408R.
- Voltage-Controlled Anisotropy and Current-Induced Magnetization Dynamics in Antiferromagnetic-Piezoelectric Layered Heterostructures. PHYSICAL REVIEW APPLIED 13, 044080 (2020).

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MULTIMEDIA PROCESSING AND TRANSMISSION

Research supervisor:
Alexander Dvorkovich
PhD, DSc, Corr. member of RAS

Supervisor's research interests:

- Video compression.
- Audio compression.
- Multimedia wireless transmission.
- Telecommunication systems.
- Quality assessment for multimedia processing and transmission.
- Satellite communications.

Research highlights:

- Practical implementation of new developed algorithms.
- Collaboration with ITU and ITU Academies.

Supervisor's specific requirements:

- Digital signal processing.
- MATLAB.
- C/C++.

Main publications:

- Viktor P. Dvorkovich, Alexander V. Dvorkovich. Theory, Practice and Metrology of Audio-Visual Systems (2 volumes). – Moscow: Technosphera, 2019. – 1396 p. – ISBN 978-5-94836-578-7 [in Russian].
- Alexander V. Dvorkovich, Gennady Yu. Gryzov, Dam Trong Nam, Viktor P. Dvorkovich. The Modified Traditional Motion Compensation Method in Video Compression Applications // 2019 Sixth International Conference on Engineering and Telecommunication – EnT 2019. Proceedings. 20-21 November 2019, Moscow, Russia.
- V.P. Dvorkovich, A.V. Dvorkovich. Synthesis of High-Performance Window Functions Using Minimization of Difference Between Its Waveform and Spectrum // Lecture Notes in Computer Science LNCS 11965. Distributed Computer and Communication Networks. 22nd International Conference, DCCN 2019, Moscow, Russia, September 23–27, 2019. Revised Selected Papers. PP. 151-161.
- Dam Trong Nam, Gennady Yu. Gryzov, Alexander V. Dvorkovich, Viktor P. Dvorkovich. Nonlinear quantization method for wavelet-based video codec // 2018 Fifth International Conference on Engineering and Telecommunication – EnT 2018. Proceedings. 15-16 November 2018, Moscow, Russia, PP. 25-29.
- Alexander V. Dvorkovich, Viktor P. Dvorkovich, Vladimir A. Irtyuga, Kirill S. Mityagin. Field Tests of Digital Terrestrial Multimedia Broadcasting System RAVIS // 2018 Fifth International Conference on Engineering and Telecommunication – EnT 2018. Proceedings. 15-16 November 2018, Moscow, Russia, PP. 3-7.
- Kirill Bystrov, Alexander Dvorkovich, Viktor Dvorkovich, Gennady Gryzov. Usage of Video Codec Based on Multichannel Wavelet Decomposition in Video Streaming Telecommunication Systems // V.M. Vishnevsky et al. (Eds.), Distributed Computer and Communication Networks, 20th International Conference, DCCN 2017, Moscow, Russia, September 25-29, 2017, CSIS 700, PP. 108-119.

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ARTIFICIAL INTELLIGENCE IN SECURE INFO COMMUNICATIONS

Research supervisor:
Alexey Nazarov
PhD, DSc

Supervisor's research interests:

- Cloud computing.
- Next Generation Network.
- Quality of Service.
- Info Security.
- Multiple measurements.
- Cloud programming systems and tools.

Research highlights:

- Practical implementation of new developed algorithms and methods.
- Collaboration with ITU.

Supervisor's specific requirements:

- Hadoop.
- MATLAB.
- C/C++.

Main publications:

(In Scopus)

- Anshita Dhoot, A.N. Nazarov & Alireza Nik Aein Koupaei 2020, 'A security Risk Model for Online Banking System', paper presented in the annual Collection of scientific works of International Scientific Conference "2020 SYSTEMS OF SIGNALS GENERATINGAND PROCESSING IN THE FIELD OF ON BOARD COMMUNICATIONS", (IEEE Conference #48371), Moscow Technical University of Communication and Informatics (MTUCI), Institute of Electrical and Electronics Engineers (IEEE), Media Publisher Ltd, 2020, 5 p.
  DOI: 10.1109/IEEECONF48371.2020.9078655]
- A.N. Nazarov, Alireza Nik Aein Koupaei, Anshita Dhoot, Asyraf Azlan & Seyed Milad Ranaei Siadat 2020, 'Mathematical Modelling of Infrastructure as a Service', paper presented in the annual Collection of scientific works of International Scientific Conference "2020 SYSTEMS OF SIGNALS GENERATINGAND PROCESSING IN THE FIELD OF ON BOARD COMMUNICATIONS", (IEEE Conference #48371), Moscow Technical University of Communication and Informatics (MTUCI), Institute of Electrical and Electronics Engineers (IEEE), Media Publisher Ltd, 2020, 7 p.
  DOI: 10.1109/IEEECONF48371.2020.9078629
- Nazarov A.N. Processing streams in a monitoring cluster. Rossiiskii technologicheskii zhurnal = Russian Technological Journal. 2019; Vol. 7, № 6, pp. a54-65.
  https://doi.org/10.32362/2500-316X-2019-7-6-56-67
- A.N. Nazarov, D.V. Pantiukhin, I.M. Voronkov & M.A. Nazarov 2019 'Intelligent monitoring of cyber attacks '// Proceedings of International Conference on the topic Industry Interactive Innovation in Science, Engineering and Technology (I3SET2019) during 13th & 14th December 2019, JIS College of Engineering (An Autonomous Institute, West Bengal, India), 11 p.
- D.V. Pantiukhin, I.M. Voronkov & A.N. Nazarov 2019 'Intelligent methods for intrusion detection in local area networks'// Proceedings of VI International Conference program "Actual Problems of System and Software Engineering (APSSE 2019)", 12 p.
- Nazarov A., Sychev A, Alireza Nik Aein Koupaei, Sanjeev Kumar Ojha, & Himanshu Rai 2019, 'Statistical compaction of a monitoring cloud cluster

ARTIFICIAL INTELLIGENCE IN SECURE INFO COMMUNICATIONS

resource when processing streaming services' // Proceedings of 6-th International Conference Engineering & Telecommunication – En&T-2019. Moscow, MIPT. November 20-21, 2019, 4 p, DOI: 10.1109/EnT47717.2019.9030598.

- Nazarov. A. & Alireza Nik Aein Koupaei 2019, 'An Architecture Model for Active Cyber Attacks on IntelligenceInfo-communicationSystems:Application Based on Advance System Encryption(AES-512) Using Pre-Encrypted Search Table and Pseudo-Random Functions(PRFs)' // Proceedings of 6-th International Conference Engineering & Telecommunication – En&T-2019. Moscow, MIPT. November 20-21, 2019, 6 p, DOI: 10.1109/EnT47717.2019.9030541.
- Alexey N. Nazarov, Artem K. Sychev, Ilia M. Voronkov. The Role of Datasets when Building Next Generation Intrusion Detection Systems // Proceedings of the International Conference "Wave Electronics and its Application in Information and Telecommunication Systems (WECONF)".IEEE # 47647. Saint Petersburg State University of Aerospace Instrumentation. June 03-07, 2019, 4 p., DOI: 10.1109/WECONF.2019.8840124.
- Nazarov A. & Alireza Nik Aein Koupaei 2019, 'Models of risk of attack of University infocommunication system', paper presented in the annual Collection of scientific works of International Scientific Conference "2019 SYSTEMS OF SIGNALS GENERATINGAND PROCESSING IN THE FIELD OF ON BOARD COMMUNICATIONS", (IEEE Conference #46544), Moscow Technical University of Communication and Informatics (MTUCI), Institute of Electrical and Electronics Engineers (IEEE), Media Publisher Ltd, 2019, 8 p. DOI: 10.1109/SOSG.2019.8706780.
- A. Nazarov, A. Sychev. The risk-models and risk-criteria for information confrontation in social media // Proceedings IEEE International Conference on Advances in Computing, Communication Control and Networking (ICACCCN-2018), pp.302-306. IEEE Conference Record Number: #43907 IEEE ISBN No. # 978-1-5386-4119-4, DOI: 10.1109/ICACCCN.2018.8748308.
- Alexey N. Nazarov, Abhishek Vaish, Ilia M. Voronkov, Sunakshi Singh, Nitish Kumar Ojha. Methodology for Detecting Traces of Preparation for Cyber Attacks // Proceedings of 5th International Conference Engineering & Telecommunication – En&T-2018. Moscow, MIPT. November 15-16, 2018, 4 p., DOI: 10.1109/EnT-MIPT.2018.00010.
- Alexey N. Nazarov, Ilia M. Voronkov, Sergei A. Zhestkov. The Approaches to Assessing the Quality and Security of Mobile Application Content // Proceedings of 5th International Conference Engineering & Telecommunication – En&T-2018. Moscow, MIPT. November 15-16, 2018, 11 p, DOI: 10.1109/EnT-MIPT.2018.00011.
- Susmita Das, Sudipta Paul, Sanjeev Kumar Ojha, Biswarup Neogi, Alexey Nazarov, Joydev Ghosh, Sudeshna Ghosh. On Design and Implementation of an Artificial Lower Limb // International Journal of Sensors, Wireless Communications and Control, Volume 8, Issue 2, 2018, pp.100-108. DOI: 10.2174/2211556007666180606075218.
- Nazarov A. & Mikhalevich, I 2018, 'Methodology development and implementation of protected hardware and software platform based on the existing', paper presented in the annual Collection of scientific works of International conference "2018 Systems of signals generating and processing in the field of on board communications", (IEEE Conference #43917), Moscow. New York, NY, USA: IEEE Catalog Number CFP 18O83-ART, 2018. – 3p. DOI: 10.1109/SOSG.2018.8350623. https://ieeexplore.ieee.org/document/8350623/

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Application Pros:

- Get acquainted with promising supervisor's publications, check his/her profile in Scopus and WoS (we have attached QR-codes to their profiles in Google Scholar, Research Gate etc., to give you an opportunity to carefully study their research papers and to make sure that promising supervisor's area of research is well-aligned with yours).
- Prepare a detailed research proposal (1500-3500 words, depending on the scientific field), coordinated with the research field of the supervisor you'd like to work with.
- Provide a list of publications (please note that a particularly good publication list will have a significantly positive impact on the final decision on your application).
- During the interview with a future supervisor, discuss your future topic of research (it must be formulated jointly by your supervisor and you) and the council where you will defend your final PhD thesis.

Avoidable Cons:

- We do not recommend you to send an identical proposal to every university you apply to - try to make it more personalized and oriented to the particular supervisor(s)
- Do not copy anyone's proposal, do not send us the proposal you downloaded from the internet (being the leading university in Russia in IT, we will find an opportunity to check it for plagiarism!))
- As you contact the prospective supervisor DO NOT address to him/her questions about application procedure, accommodation, living expenses, student's insurance and stuff like these – this is the work of the admission officers!

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