

The IUM report to the Simons foundation, 2022

November 3, 2022

Introduction

The Simons foundation supported two programs launched by the IUM: Simons stipends for students and graduate students; Simons IUM fellowships.

5 applications were received for the Simons stipends contest. The selection committee consisting of *Yu.Ilyashenko (Chair)*, *G.Dobrushina*, *G.Kabatyanski*, *S.Lando*, *I.Paramonova (Academic Secretary)*, *A.Sossinsky*, *M.Tsfasman* awarded Simons stipends for 2022 year to the following students and graduate students:

1. Bobrova, Irina Alexandrovna
2. Vinokurov, Denis Igorevich
3. Morozov, Egor Alexandrovich
4. Spiridonov, Igor Alexandrovich

15 applications were received for the Simons IUM fellowships contest. The selection committee consisting of *Yu.Ilyashenko (Chair)*, *G.Dobrushina*, *B.Feigin*, *I.Paramonova (Academic Secretary)*, *A.Sossinsky*, *M.Tsfasman*, *V.Vassiliev* awarded Simons IUM-fellowships to the following researches:

1. Bogachev, Vladimir Igorevich
2. Fonarev, Anton Vyacheslavovich
3. Gorodentsev, Alexei Lvovich
4. Kalmynin, Alexander Borisovich
5. Loginov, Konstantin Valeryevich
6. Medvedev, Vladimir Olegovich
7. Penskoi, Alexei Victorovich
8. Pushkar, Petr Evgenyevich
9. Ryabichev, Andrei Dmitrievich
10. Shaposhnikov, Stanislav Valeryevich
11. Smirnov, Evgeni Yuryevich
12. Sossinsky, Alexei Bronislavovich
13. Zhgoon, Vladimir Sergeevich

The report below is split in two sections corresponding to the two programs above. The first subsection in each section is a report on the research activities. It consists of the titles

of the papers published or submitted in the first half year of 2022. The second subsection of each section is devoted to conferences and some most important seminar talks. The last subsection of the second section is devoted to the lists of the courses given by the winners of the Simons IUM fellowships. Most of these courses are innovative, as required by the rules of the contest for the Simons IUM fellowships.

The IUM highly appreciates that in this difficult and tragic times the Simons foundation found it possible to support the Independent University of Moscow. We cordially thank Jim Simons, David Spergel and Yuri Tschinkel for their generous help.

Program: Simons stipends for students and graduate students

Research

Irina Bobrova

[1] With V. Retakh, V. Rubtsov, G. Sharygin

A fully noncommutative analog of the Painlevé IV equation and a structure of its solutions

arXiv:2205.05107, *submitted to Journal of Physics A: Mathematical and Theoretical.*

[2] With V. Sokolov

Non-abelian Painlevé systems with generalized Okamoto integral

arXiv:2206.10580, *submitted to the Contemporary Mathematics, AMS.*

Denis Vinokurov

[1] With A. V. Penskoi

Index of superminimal tori in spheres

Manuscript in preparation.

Egor Morozov

[1] On the index of bipolar surfaces to Otsuki tori

arXiv.org preprint arXiv:2207.06008

Igor Spiridonov

[1] The top homology group of the genus 3 Torelli group

arXiv:2208.10326 *submitted to Journal of Topology.*

Scientific conferences and seminar talks

Irina Bobrova

[1] “Diffieties, Cohomological Physics, and Other Animals (Alexandre Vinogradov Memorial Conference)”, Moscow, December, 13 – 17. Talk “Matrix Painlevé equations”

[2] “Integrable systems and their applications”, Sochi, September, 12 – 17. Talk “Non-commutative generalisations of the fourth Painlevé equation”

[3] “Ufa Autumn Mathematical School-2022”, Moscow, September, 28 – October, 2. Talk “Non-abelian Painlevé systems with generalized Okamoto integral”

Denis Vinokurov

Topological Data Analysis Seminar (National Research University — Higher School of Economics, Math Department)

Talk “Stability of Persistence Diagrams”, March 24, 2022.

Egor Morozov

[1] “Number Theory and Geometry” in Memory of Alexey Zykin, Moscow, June, 16. Talk “On the index of bipolar surfaces to Otsuki tori”

[2] IUM Spectral Geometry Seminar, Moscow, April, 9, 16. Talk “A Generalization of Sturm’s Oscillation Theorem”

Igor Spiridonov

[1] Weekly seminar of Laboratory of algebraic geometry, March. Talk “On the homology of the Torelli group and the Johnson kernel”

[2] Algebraic topology and its applications, Postnikov memorial seminar, February. Talk “On the top homology of the Torelli group and the Johnson kernel”

Program: Simons IUM fellowships**Research****Vladimir Bogachev**

[1] Bogachev V.I. Kantorovich problems with a parameter and density constraints. *Siberian Math. J.* 63 (2022), N 1, 34–47.

[2] Bogachev V.I., Malofeev I.I. Nonlinear Kantorovich problems depending on a parameter. *Izvestia Irkutsk Univ.* 41 (2022), 96–106.

[3] Bogachev V.I., Shaposhnikov A.V., Wang F.-Y. Sobolev–Kantorovich inequalities under $CD(0, \infty)$ condition. *Communications in Contemporary Mathematics.* 2022. V. 24, N 5, Paper N 2150027, 27 pp.

[4] Bogachev V.I. Pointwise conditions for membership of functions in weighted Sobolev classes. *Functional Analysis and Its Applications* 56 (2022), N 2, 86–100.

[5] Bogachev V.I., Rezbayev A.V. Existence of solutions to the nonlinear Kantorovich problem of optimal transportation. *Mathematical Notes* 112 (2022), N 3, 369–377.

[6] Bogachev V.I. The Kantorovich problem of optimal transportation of measures: new directions of research. *Uspehi Matem. Nauk (Russian Math. Surveys)* 77 (2022), N 5, 3–52. <https://doi.org/10.4213/rm10074>

[7] Bogachev V.I., Kosov A.D., Shaposhnikov A.V. Regularity of solutions to Kolmogorov equations with perturbed drifts. *Potential Analysis.* DOI 10.1007/s11118-021-09954-9.

Anton Fonarev

[1] Duality of Kuznetsov–Polishchuk exceptional collections on Grassmannians in preparation.

Alexei Gorodentsev

I have no interesting results of my own, but I am glad that Mikhail Dronev, 2nd year undergraduate student I've supervised, proved that every fully faithful triangulated functor $\text{Perf } X \rightarrow \text{DQCoh } Y$ is a Fourier-Mukai transform for any projective scheme X and any quasi compact separated scheme Y (without any other restrictions on the schemes!).

Alexander Kalmyin

[1] With R. Dietmann, C. Elsholtz, S.V. Konyagin and J.A. Maynard, Longer gaps between values of binary quadratic forms, *International Mathematical Research Notices*, DOI:10.1093/imrn/rnac130

We prove new lower bounds on large gaps between integers that are sums of two squares or are represented by any binary quadratic form of discriminant D , improving the results of Richards.

[2] Quadratic characters with positive character sums (arXiv:2105.06910), accepted for publication in *Mathematika*

Let \mathcal{L}^+ be the set of all primes p for which the Legendre symbols $\left(\frac{\cdot}{p}\right)$ mod p have non-negative partial sums. We prove the estimate

$$|\mathcal{L}^+ \cap [1, x]| \ll \frac{x}{\ln x (\ln \ln x)^{c-o(1)}},$$

where $c \approx 0.0368$.

Konstantin Loginov

[1] Maximal log Fano manifolds are generalized Bott towers
(joint with J. Moraga)

We prove that maximal log Fano manifolds are generalized Bott towers. As an application, we prove that in each dimension, there is a unique maximal snc Fano variety satisfying Friedman's d-semistability condition.

Journal of Algebra, vol. 612, 2022, 110–146, doi.org/10.1016/j.jalgebra.2022.08.004.

[2] Jordan property for groups of bimeromorphic self-maps of complex manifolds with large Kodaira dimension.

We prove that the image of the pluricanonical representation of a group of bimeromorphic automorphisms of a complex manifold has bounded finite subgroups. As a consequence, we show that the group of bimeromorphic automorphisms of an n -dimensional complex manifold whose Kodaira dimension is at least $n - 2$, satisfies the Jordan property.

arXiv:2209.12032, 2022.

Vladimir Medvedev

[1] On the index of the critical Möbius band in \mathbb{B}^4

arXiv:2112.04883. To appear in the *Journal of Geometric Analysis*

[2] An index upper bound for non-orientable minimal surfaces in the n-dimensional Euclidean space
arXiv:2204.07972. Submitted to *Mathematische Nachrichten*.

Alexei Penskoï

[1] With D. Vinokurov
Index of superminimal tori in spheres
Manuscript in preparation.

Petr Pushkar

[1] With M.Tyomkin
Enhanced Bruhat decomposition and Morse theory
to appear in International Mathematics Research Notices
[2] With M.Tyomkin
On differential matrix in Morse complex
to appear in Russian Mathematical Surveys, 2022.
[3] With M.Tyomkin
On Bruhat numbers of strong Morse function
to appear in Doklady Mathematics

Andrei Ryabichev

[1] Maps of manifolds of the same dimension with prescribed Thom-Boardman singularities
arXiv:1810.10990, *submitted to Journal of the London Mathematical Society*

Stanislav Shaposhnikov

[1] With V.I.Bogachev, M.Rockner
Applications of Zvonkin's transform to stationary Kolmogorov equations
accepted to *Doklady Mathematics*, V.506, 2022.
[2] With V.I.Bogachev, M.Rockner
Zvonkin's transform and the regularity of solutions to double divergence form elliptic equations
arXiv: 2203.01000, *to appear in Communications in Partial Differential Equations*

Evgeni Smirnov

[1] (with Anna Tutubalina) Pipe dreams for Schubert polynomials of the classical groups
// *European Journal of Combinatorics*. 2023. Vol. 107. Article 103613.
[2] (with Anna Tutubalina) Symmetric Functions. Introductory Course. Draft of a book, in Russian, circa 130 pages.

Alexei Sossinsky

Introduction to Knot Theory, Lecture Notes, 157 pages, MCCME Publications, 2022

Vladimir Zhgoon

[1] On the problem of periodicity of continued fraction expansions of \sqrt{f} for cubic polynomials f over algebraic number fields

Platonov, V.P., Zhgoon, V.S., Petrunin, M.M. Sbornik Mathematics, 2022, 213(3), 412–442

[2] On the Existence of B -Root Subgroups on Affine Spherical Varieties Avdeev, R.S., Zhgoon, V.S. Doklady Mathematics, 2022, 105(2), 51–55

[3] G. V. Fedorov, V. S. Zhgoon, M. M. Petrunin, Yu. N. Shteinikov, On the Parametrization of Hyperelliptic Fields with S -Units of Degrees 7 and 9, Math. Notes, 112:3 (2022), 451–457

Scientific conferences and seminar talks

Vladimir Bogachev

[1] “Algebra, algebraic geometry, and number theory“. Memorial conference for academician Igor Rostislavovich Shafarevich. Moscow, Russia, Steklov Mathematical Institute, June 6, 2022. Talk “Distributions of polynomials in random variables“.

[2] The 7th International school-seminar “Nonlinear Analysis and Extremal Problems“, Irkutsk, July 15-20 <https://conference.icc.ru/event/5/> Talk “Geometry and topology of the spaces of measures“.

[3] “International Probability Conference dedicated to the 90th birthday of Ildar Ibragimov“, Euler International Mathematical Institute, Saint-Petersburg, Russia, September 30 - October 2, 2022. <https://indico.eimi.ru/event/1041/> Talk “Nonlinear Kantorovich problems and Hausdorff distances between plans“.

Alexander Kalmynin

[1] Talk “Fourier interpolation and modular forms“, seminar Functional analysis and noncommutative geometry, Higher School of Economics

[2] Talk “Linear independence of time-frequency shifts“, seminar Functional analysis and noncommutative geometry, Higher School of Economics

[3] Talk “Modularity in transcendence theory“, seminar Automorphic forms and applications, Higher School of Economics

Konstantin Loginov

[1] Imperial College London, MAGIC seminar, October 2022. Talk “Jordan property for groups of bimeromorphic self-maps of complex manifolds“,

[2] Lunts dacha seminar, July 2022. Talk “Siegel sets and period maps“

[3] MMP learning seminar, UCLA, online, April 2022. Talk “Jordan property for Cremona groups“

Vladimir Medvedev

[1] Conference “Geometry days in Novosibirsk — 2022“, Novosibirsk, August 29 - September, 2 Talk “The Morse index of a minimal surface of higher codimension“

[2] Moscow, April, 23 Talk "An index upper bound for non-orientable minimal surfaces in the n -dimensional Euclidean space" at "Spectral Geometry Seminar" (Independent University of Moscow and Interdisciplinary Scientific Center J.-V. Poncelet, ISCP, UMI 2615)

Alexei Penskoï

[1] Non-commutative Geometry Seminar (Moscow State University, Math Department)
Talk "Geometric optimisation of eigenvalues of the Laplace-Beltrami operator and minimal/harmonic maps to spheres", May 5, 2022.

Petr Pushkar

there were no talks in the spring

Andrei Ryabichev

[1] Summer school "Geometrical methods in mathematical physics", Moscow oblast, Krasnovidovo, July 5 – 10

Talk "Maps of manifolds with prescribed singularities"

Stanislav Shaposhnikov

[1] Conference "Nonlinear Analysis and Extremal Problems" 15.07.2022-22.07.2022, Irkutsk, Russia.

Talk "Nonlinear Fokker–Planck–Kolmogorov equations"

[2] Conference "O.A.Ladyzhenskaya centennial conference on PDEs", 16.07.2022-22.07.2022, Euler International Mathematical Institute, St.Petersburg, Russia.

Talk "On the Kolmogorov equations with coefficients of low regularity"

Evgeni Smirnov

[1] Midsummer Day's Dream conference, Weizmann Institute of Science, Rehovot, Israel, June 27, 2022 Talk: Arrays with strings and Grothendieck polynomials

[2] Algebra seminar, University of Haifa, Israel, June 2, 2022

Talk: Pipe dreams for Schubert polynomials of the classical groups

[3] Algebra seminar, Technion, Haifa, Israel, June 9, 2022

Talk: Arrays with strings and Grothendieck polynomials

Alexei Sossinsky

Papadopoulos Geometry seminar, June 2022, Stasbourg. Talk: "Knot Energy – Theory, Applications, Videos"

Vladimir Zhgoon

[1] Algebra, algebraic geometry, and number theory. Memorial conference for academician Igor Rostislavovich Shafarevich (June 6, 2022, Steklov Mathematical Institute, Moscow)

Talk: On B -normalized additive subgroups in spherical varieties

[2] Geometry, algebra and representation theory, 2-3 July 2022, MIPT

Talk: On B -normalized additive subgroups in spherical varieties

Teaching

Vladimir Bogachev

- [1] Calculus. Independent University of Moscow, 2 year students, 2 hours per week.
- [2] Functional analysis for financial mathematics, Moscow State University, 3 year students, 2 hours per week.
- [3] Locally convex spaces, distributions, and Fourier transform. Lectures for PhD students, Moscow State University, 2 hours per week.

Anton Fonarev

- [1] Algebra 3: Introduction to Commutative and Homological Algebra. Independent University of Moscow, II year students, 2 hours per week.

Alexei Gorodentsev

- [1] Algebra, Independent University of Moscow, II year students, 4 hours per week.
- [2] Linear Algebra and Geometry, Math. Dep. Higher School of Economics, I year students, 6 hours per week.

Alexander Kalmynin

- [1] Algebra-1. Independent University of Moscow, 1st year students, 2 hours per week.
- [2] Introduction to contemporary problems in number theory. Independent University of Moscow, 3-5th year students, 2nd semester of 2021/2022, 2 hours per week
- [3] Gauss class number problem (jointly with A.M. Levin), Higher School of Economics, Department of Mathematics, Research seminar, 1st semester of 2022/2023, 2 hours per week

Konstantin Loginov

- [1] Introduction to birational geometry-2, Independent University of Moscow, 2 hours per week. [2] Topology II. Math in Moscow, Independent University of Moscow, lectures and problem sessions, 3 hours per week.
- [3] K-stability of Fano varieties seminar, Independent University of Moscow, 2 hours per week.

Vladimir Medvedev

- [1] Theory of minimal submanifolds-II, Independent University of Moscow, III-V year students, February-May 2022, 2 hours per week.
- [2] Linear Algebra. Higher School of Economics, I year students, January-May 2022, 4 hours per week.

Alexei Penskoï

- [1] Differential Geometry. Independent University of Moscow, II year students, 4 hours per week (lecture 2 hours + exercise class 2 hours).
- [2] Topology-I. "Math in Moscow" program at the Independent University of Moscow & NRU HSE for undergraduate students from the U.S. and Canada, 4 hours per week (lecture 2 hours + exercise class 2 hours).
- [3] Applications of Differential Geometry, Moscow State University, IV-V year students, lecture 2 hours per week.

[4] Classical Differential Geometry, Moscow State University, I year students, exercise class 2 hours per week.

[5] Topology. National Research University — Higher School of Economics, II year students, exercise class 3 hours per week.

Petr Pushkar

[1] Complex analysis. Independent University of Moscow, 2 year students, 2 hours per week.

[2] Introduction to differential geometry Higher School of Economics, 2 hours per week.

Andrei Ryabichev

[1] Flexible problems in differential geometry. Independent University of Moscow, 3–5 year students, 2 hours per week.

[2] Elements of geometric and differential topology. Independent University of Moscow, 3–5 year students, 2 hours per week.

Stanislav Shaposhnikov

[1] Analysis and geometry on the space of probability measures, Independent University of Moscow, III year students, 2 hours per week.

[2] Partial differential equations, Faculty of Mathematics, Higher School of Economics, III year students, 4 hours per week.

Evgeni Smirnov

[1] Symmetric Functions. IUM, 2 hours per week.

[2] Modern Algebra. HSE and New Economic School Joint B.Sc. program. 2 hours of lectures and 2 hours of exercise classes per week.

[3] Discrete Mathematics. HSE, Department of Mathematics. 3 hours of lectures and 3 hours of exercise classes per week.

Alexei Sossinsky

Topology-1, IUM, 1 year students, 2 hours per week.

Vladimir Zhgoon

[1] Introduction to homological and commutative algebra. Independent University of Moscow, Math in Moscow, Spring 2022, 2 hours per week.

[2] Introduction to algebraic groups and invariant theory. Higher school of economics, Spring 2022, 2 hours per week.

Yulij Ilyashenko

President of the Independent University of Moscow