UNC GLOBAL

THE UNIVERSITY
of NORTH CAROLINA
at CHAPEL HILL

COLLEGE OF ARTS & SCIENCES

STUDY ABROAD OFFICE

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August 28, 2014
Administrative Board of the College of Arts and Sciences
Office of General Education
UNC-CH

Dear Colleagues,

Math in Moscow semester program, Russia

The Department of Mathematics and the Study Abroad Office are seeking your approval for a semester program in Moscow, Russia, to be available to UNC-Chapel Hill students commencing fall semester 2015.

Rationale

As the Study Abroad Advisory Board is aware, the Study Abroad Office has been diligently seeking programs that will be appropriate and interesting to UNC STEM students. And there are only a small number of study abroad programs designed specifically for Math majors. Moreover, we are also therefore aware that we are seeking approval for a program that will enroll only a very small number of UNC-CH students because the program is relevant primarily to Math majors.

The Department of Mathematics became aware of this program as a result of a Math major taking a year off from his studies to enroll in this program in the light of its high academic reputation. On returning to Chapel Hill, the student has shared his experience with Lynn Neddo (Continental Europe Programs Director), with faculty in the Department of Mathematics and with members of the Math Club. A number of faculty in the Department of Mathematics are well acquainted with some of the faculty in Moscow who teach on this program.

More complete information on this program is available here:

http://www.mccme.ru/mathinmoscow/index.php?page=1

A site visit to this program is anticipated for Spring 2015.

Description

The Math in Moscow program is sponsored by three universities: The Independent University of Moscow (IUM), the Higher School of Economics (HSE) and the Moscow Center for Continuous Mathematical Education (MCCME). The Independent University of Moscow (IUM), where the program is housed, is a small elite college for future research mathematicians. It was founded in 1991 at the initiative of a group of well-known Russian mathematicians, who now comprise the Academic Council of the University. Gifted young people obtain the highest possible mathematical education as well as broad possibilities for further research and teaching. In spite of its small size, the high level of students and professors makes the IUM one of the leading mathematical centers in Russia.

Courses and Faculty

A "Math in Moscow" semester lasts 15 weeks. Each student participating in the program may choose as many courses as desired from the wide range of courses offered. There are twenty-one math courses and two theoretical computer science courses. Besides math and computer science courses, two levels of Russian language are offered, as well as a course on Russian history, a course on the History of Mathematics and Science and a course on Russian literature. All courses, except for the Russian Language courses, are taught in English. We will require UNC-CH students to enroll at a minimum in the equivalent of 12 credits in order to maintain full-time student status.

Classes are small. This gives the teachers the opportunity to give an individual approach to every student. Mathematics courses are taught with emphasis on problem solving rather than memorizing theory: this emphasis is characteristic of the Moscow school of mathematics. Knowing that most students in the Math in Moscow program do not have as much math problem solving experience as Russian students of the same age, the teachers are very attentive to student feedback; quizzes, tests, informal discussions allow them to control the level of the course, making it accessible to all the students taking it.

Most of the teachers on this program are internationally recognized research mathematicians; all of them have considerable teaching experience in English, in the US and/or Canada. Professors P. Deligne (IAS, Princeton) and R. McPherson (IAS, Princeton) played crucial roles in founding the Independent University. Other faculty who often teach or lecture are Professors V.I. Arnold (Univ. Paris Dauphine and IUM), B.L. Feigin (IUM), S.P. Novikov (Univ. of Maryland), and V.A.Vassiliev (IUM), who have given plenary talks at International Congresses of Mathematicians. V.I. Arnold is an honorary member of numerous universities and the Crafoord Prize winner.

Sample faculty CVs and course syllabi are attached in appendices.

Academic Requirements and Credit

UNC-Chapel Hill students participating in this program will need to have a 3.0 GPA to be eligible, at least second year status, be motivated to study mathematics, be in good academic standing and have completed one semester of both advanced calculus and linear algebra. This program is primarily for students planning on majoring or minoring in Mathematics.

Although there is no need for prior Russian language study, students will be required to take a language course as this will help them navigate and get to know the local culture during their stay in Moscow.

TREQ credit will be awarded as long as the student receives a C or better in each course taken. The Math in Moscow office will send an official transcript of all completed courses to the home institution.

Logistics, Health and Safety

Facilities

All courses are taught at the Independent University of Moscow (IUM). The IUM is located in a building in the very heart of Moscow on a small quiet street near the historic Arbat, within walking distance from the Kremlin, the Bolshoi, the Rumyantsev library, the Pushkin Western Art Museum, and the cathedral of Christ the Savior.
In addition to lecture halls and classrooms, the IUM building has a library, a computer lab, a cafeteria, a small publishing house, and a bookshop for math books. All the students will have e-mail accounts, access to the Internet and to xerox machines, etc.

Housing

Each student will be provided with living quarters in a student dormitory at a reasonable distance from the IUM. A designated person at the IUM will help students to adjust to become a part of Moscow life, and give them information about food, shopping, eating out, transportation, and other everyday necessities. Students are met upon arrival at the airport (Sheremetyevo or Domodedovo).

Other activities

After the students arrive, before classes actually begin, several days are devoted to an orientation program, during which the students learn, among other things, to organize their lives in the new environment. There is an extensive excursion around Moscow to help find one's way around the city. Students are given a "Moscow Guide" and detailed map of the IUM neighborhood.

Students are also assisted in selecting a cultural program according to their tastes. Excursions and short trips to the Golden Ring near Moscow and to Saint Petersburg are arranged. The IUM has modest sports facilities (ping pong tables and a small field where mini-soccer games are held), and every attempt is made to help foreign students practice some other sport if they so desire.

Health and Safety

Currently the State Department website does give specific warning against travel of US citizens to North Caucasus region of Russia but there is no warning against travel to Moscow. The following is taken directly from the web site:

> *Acts of terrorism, including bombings and hostage takings, continue to occur in Russia, particularly in the North Caucasus region. However, in the past several years, Moscow and St. Petersburg have also been the targets of terrorist attacks. Additionally, between October 15 – December 30, 2013 there were three suicide bombings targeting public transportation in the city of Volgograd, two of which occurred during the same 24-hour period. Other bombings have occurred at Russian government buildings, airports, hotels, tourist sites, markets, entertainment venues, schools, and residential complexes, and on public transportation including subways, buses, trains, and scheduled commercial flights. Extremist groups occasionally threaten to set off bombs in market areas of major cities operated largely by migrant workers. Large-scale public events also present an attractive target for terrorists. There is no indication that U.S. institutions or citizens have been targets, but there is a general risk of U.S. citizens becoming victims of indiscriminate terrorist attacks. U.S. citizens in Russia should be aware of their personal surroundings and follow good security practices. U.S. citizens are urged to remain vigilant and exercise good judgment and discretion when using any form of public transportation. When traveling, U.S. citizens may wish to provide a friend, family member, or coworker a copy of their itinerary. U.S. citizens should avoid public demonstrations, whether properly authorized or not, and avoid any large crowds and public gatherings that lack enhanced security measures. Occasional peaceful demonstrations taking place near or in front of the U.S. Embassy or Consulates General do not generally interfere with public services, but U.S. citizens should avoid them when possible. Travelers should also exercise a high degree of caution and remain alert when patronizing restaurants, casinos, nightclubs, bars, theaters, etc., especially during peak hours of business. Ongoing regional tension associated with events in Ukraine could provoke anti-American actions in an unpredictable location or manner.*

During advising sessions and pre-departure orientation, the Study Abroad Office will ensure that students are fully aware of these risks with respect to terrorist incidents. And additional information and advice will be provided following arrival in Moscow. More generally, Moscow is a clean city with no slums or high risk districts. Public transportation is cheap and efficient. Some prudence, however, is required in Moscow as in any large city, particularly in special occasions (like soccer matches, night events, etc.). Pickpocketing still exists, especially in public transportation, night clubs, and pop-star concerts. Although racism is considered a crime both by the law and by public

opinion, there exist extremist racist groups (like skinheads) one should be aware of. Overall, the dangers of Moscow are no worse than those of a large city in the US. If a little caution is taken, students are highly unlikely to face any serious problems.

Medicine in Russia is inexpensive and efficient. In addition to the required UNC-CH HTH insurance, students are also covered with health insurance provided by one of the oldest Russian insurance companies "Ingosstrakh". In case of a sudden illness or an accident, the "Ingosstrakh" Service Center can provide full support in English.

Conclusion

We hope this proposal has given a clear representation of the Math in Moscow (Russia) semester program. We believe this program will be attractive to students who are interested in intensive math courses. We are happy to provide you with any additional information you might need to aid in your evaluations of this proposal.

Sincerely,

Richard McLaughlin 9/2/14

Dr. Richard McLaughlin, Chair of the Department of Mathematics Date

9.3.14

Dr. Robert Miles, Associate Dean: Study Abroad and International Exchanges Date

Appendices: course syllabi and Faculty CVs

Computability and Complexity

Vladimir V. Podolskii
podolskii@mi.ras.ru
http://www.mi.ras.ru/~podolskii/

Fall 2014

1. Informal introduction to algorithms. Adaptive and non-adaptive algorithms. Binary search. Lower bounds: counting argument, adversary method.

2. Computable functions, decidable sets, enumerable sets. Post's theorem. Diagonal argument. Uncomputable functions and undecidable sets. Universal computable function. Halting problem.

3. Gödel universal function. Rice-Uspensky's theorem. Fixed-point theorem. Program that prints its own text.

4. m-reducibility. m-completeness. Turing reducibility. Relativization.

5. Turing machines. Church-Turing thesis. Universal Turing machine.

6. Undecidability of the word problem for finitely presented semi-groups.

7. Time and space resources for Turing machines. Complexity class P. Time hierarchy theorem. Space hierarchy theorem.

8. Boolean circuits and formulae. Circuit complexity. Examples, upper and lower bounds. Counting argument. Complexity class P/poly. Relation between P and P/poly.

9. Complexity class NP. Reductions. NP-hard and NP-complete problems. SAT problem is NP-complete. Other examples of NP-complete problems.

10. Complexity class coNP. coNP-completeness. Relations between P, NP and coNP. Complexity classes EXP and NEXP. Padding argument.

11. Space complexity. Complexity class PSPACE. Savitch's theorem. TQBF is PSPACE-complete. Characterization of PSPACE in terms of games.

12. Randomized computations. Examples. Complexity class BPP.

13. Relativizing techniques cannot solve P vs. NP problem.

The first part of the course (1-6) is covered by [3].

The second part of the course (7-13) is covered by [1]. The book [2] might also be helpful.

Grading policy. There will be take home assignments each week, written midterm after the first part of the course and written final exam in the end of the course. Home assignments will count for 40% of the entire grade, midterm will count for 20% of the grade and the final exam will count for 40% of the grade.

The grade A will be given for at least 70%, the grade B will be given for at least 50%, the grade C will be given for at least 30%.

References

[1] S. Arora and B. Barak. *Computational Complexity: A Modern Approach.* Cambridge University Press, New York, NY, USA, 1st edition, 2009.

[2] M. Sipser. *Introduction to the Theory of Computation.* Cengage Learning, 2012.

[3] N. Vereshchagin and A. Shen. *Computable Functions.* Student mathematical library. American Mathematical Society, 2003.

Basic Representation Theory

Course description. Representation Theory studies how a given group may act on vector spaces. It is a fundamental tool to study groups using linear algebra. Representation Theory plays an important role in many recent developments of mathematics and theoretical physics. The course aims to introduce basic concepts and results of the classical theory of complex representations of finite groups and simplest examples of representations of Lie groups and Lie algebras.

Prerequisites. To understand this course you need basic knowledge of Group Theory and a good knowledge of Linear Algebra. In other words you have to know basic facts about groups and you should feel comfortable when working with linear operators

Textbooks. The main textbook that covers the course is «Representation theory. A first course. » by W. Fulton, J. Harris. A good discussion of finite groups representations is also presented in the book «Linear Representations of Groups» by E.B. Vinberg.

Course outline.

1. Linear representations of groups. Definitions and examples.
Irreducible representations. Schur's Lemma. Complete reducibility.

2. Characters of representations. Number of irreducible characters.
Character tables and orthogonality relations. Group algebra.

3.First examples: abelian groups, dihedral group D_n , groups S_3 , S_4 , A_4.

4. Representations of symmetric groups, Young diagrams.

5. Examples of Lie groups and Lie algebras. Covering of SO(3,R) by SU(2).

6. Compact groups and their representations. Peter-Weyl theorem.

7. Representations of Lie algebra sl(2,C). Clebsch-Gordan decomposition.

8. Connection between representations of Lie groups and Lie algebras.

Grading policy. The grade will be computed according to the following rule: 60% for your weekly homeworks, 15% for a midterm open notes written exam in class and 25% for an open notes written final.

History of Mathematics and Science

S.G.Smirnov

1. The age of Galileo and Kepler = Middle Range at Scientific Era. Who were the main predecessors?
2. Abelard: Dialogues of teacher//student
   Thomas Aquinat: resurrectional Aristotle
   Jean Buridan et la Sorbonne in XIV century
   Lullius = Computer
   Oresme = Harmonic series diverges
3. Italian Algebraists of XVI century and Viete = father of Cryptography and Symbolic Algebra
4. Birth of New Astronomy (1609) and its highest achievements in XVII century. Roles of Huygens, Cassini, Kepler in Solar System mapping.
5. Newtonic era: how did he surpass Buridan, Galileo, Kepler? Differential Equations and Movements of Bodies.
6. Unsolved Problems in Newtonic Physics: Gravitation, Electricity, Magnetism, Chemistry. Who and when did solve them?
7. Discovery of Calculus by Newton, Huygens, and Leibniz. Why do we go the way of Leibniz? Bernoulli brothers and the Analytic Circle in Basel.
8. Birth of the great Academic Societies in Paris and London. Comparing biographies of Descartes, Fermat//Boyle, Wallis, Hook.
9. Creative Biography of Euler = Father of Analysis. Conquest of Berlin and Petersburg by New Science.
10. Chemical Revolution at 1766/1899: from Cavendish to (Volta + Dalton). From Elements to Atoms and the impact at Electricity.
11. French Revolution and its interaction with Science. Diderot, La Voisier, Monge, Fourier, Carnot, Cauchy.
12. British Atomists: Davy, Faraday, Crooks, Maxwell, Thomson.
13. Science in Russia: from Euler to Lobachevski, Mendeleev, Butlerov, etc. Russian Scientific Renaissance after 1860.
14. New Radioactive Universe. Rutherford, Curie, etc. Planetary Atom and its Nucleus.
15. Birth of Astrophysics: Kant, Herschel, Cepheides, Hubble, and Friedman. Big Bang Project.
16. Gauss Revolution in Algebra and Number Theory. His successors (Kummer, Dedekind) and their rivals (Hermite, Lindemann).
17. Geometric Revolution of Gauss, Riemann, Klein and its invasion into Physics (Einstein, Minkovski).
18. The Age of Poincare: from Modular Functions to Strange Attractors and Topology of Manifolds.
19. The Paradise of Cantor: General Set Theory and its applications to Algebra, Geometry, Calculus, Numbers.
20. The Paradise of Hilbert: Renaissance in Gottingen as compared with Bernoulli Renaissance in Basel.
21. Lusin Renaissance in Moscow, filial to the Gottingen Paradise.
22. Biochemical Revolution after 1850: Nucleus, Chromosomes, Genes (Fleming, Mendel, Hoppe-Seiler).
23. Pasteur, Koch and Medical Microbiology.
24. Einstein Revolution in Physics and Cosmology.

25. N.Bohr School in Quantum Physics. Its leaders: Heisenberg, Pauli, Dirac, Schredinger.
26. Leaders of Moscow Mathematics after 1920: Kolmogorov, Alexandrov, Gelfand, Lavrentiev. Moscow System of Mathematical Circles and Olympiads, its leaders (Lusternik, Schklyarski, etc.)
27. Birth of Soviet School in Physics: biographies of Kapitsa, Semenov, Landau, and Kurchatov.
28. Genetic Revolution in XX century: from Morgan to (Crick + Watson).
29. Post-war generation of Moscow Mathematics (Postnikov + Novikov), (Schafarevich + Manin), (Kolmogorov + Arnold).
30. New World of Elementary Particles and their discovers: Rutherford, Dirac, Yukava, Feymann, Gell-Mann, (Salam + Weinberg).
31. Founding Fathers of Genetic Engineering and Bioinformatics.

Sources for individual work on memoirs

1. I. Asimov's Biographical Encyclopedia of Science and Technology.
2. Biographical Encyclopedia of Nobel prize winners
3. C.Reid. Hilbert (biography).
4. J.D.Watson. Double Helix.

Examples of topics for memoirs

1. Comparing the Boubaki group in Paris with Moscow Mathematicians after 1945.
2. Revolutions in Russian Science and the impact of political revolutions: Peter I epoch and Lenin epoch.
3. Monge and Lagrange: their lots in the French Revolution.
4. Women in Mathematics: Sophia Kovalevskaya and Sophie Germaine.
5. Mathematicians producing Revolutions in Science: Descartes and Poincare.
6. Great Experimenters in Physics: Faraday and Rutherford.

Grading policy. There will be biweekly take home assignments, that will count for 60% of the entire grade. Individual memoirs will count for 30% and their presentations for the remaining 10%.

RIEMANN SURFACES

INSTRUCTOR GEORGE SHABAT

FALL 2014

Introduction. The true domain of definition of an analytic function; abstract Riemann surfaces.

Classical examples of analytic continuation. Elliptic integrals and their generalizations; hypergeometric functions; conformal maps; Schwartz-Christoffel integrals; conformal equivalence between the unit disc and the hyperbolic polygons.

Compact Riemann surfaces. Atlases with holomorphic neighborhood relations and complex structures; sheaf of holomorphic functions; holomorphic and meromorphic vector fields and differentials; Riemann-Roch problem; Riemann existence theorem; genus; holomorphic maps.

Abelian integrals. Differentials of the 1st, 2nd and 3rd kind; a representation of a general differential as a sum of these and a differential of a meromorphic function; integration; period matrix; Riemann bilinear relations; Torelli theorem.

Uniformization. Universal coverings of Riemann surfaces of finite type; Fuchsian groups; examples of explicit calculations.

Classification of Riemann surfaces. Moduli spaces of Riemann surfaces of finite type; their dimension; singularities; approaches via period matrices and Fuchsian groups; open problems.

Time permitting, some applications to mathematical physics will be briefly discussed.

Most part of the course will be covered by classical books like Gunning "Lectures on Riemann surfaces"and Farkas and Kra "Riemann surfaces"; however, the modern terminology will be used and the corresponding references to the online-available courses will be provided.

Grading policy. There will be weekly take home assignments, that will count for 50% of the entire grade. The midterm exam will count for 20%. The final exam and possible individual projects will count for the remaining 30%.

Curriculum Vitae

Full name: Alexei V. Penskoi

Year of birth: 1973

Nationality: Russian Federation

Address: Independent University of Moscow, Bolshoy Vlasyevskiy pereulok 11, 119002 Moscow Russia

Web-page: `http://www.mccme.ru/~penskoi`

Education:

M.Sc., Mathematics (with highest honours), 1995, Moscow State University

Title of Thesis: Discrete Lagrangian systems on the Virasoro group

Advisor: Prof. A. P. Veselov

Cand.Sc., Mathematics, 1998, Moscow State University

Title of Thesis: Geometry and Hamiltonian formalism of integrable lattices

Advisor: Prof. A. P. Veselov

Ph.D., Mathematics, 2001, Université de Montréal

Title of Thesis: Nonlinear ordinary differential equations with superposition principles

Advisor: Prof. P. Winternitz

Positions held since receiving the Ph.D.:

2001 – 2004 Postdoctoral Fellow, Centre de Recherches Mathématiques, Université de Montréal

2004 – 2011 Associate Professor, Bauman Moscow State Technical University

2004 – 2013 Lecturer, Independent University of Moscow

2008 – 2010 Director of Undergraduate Studies, Independent University of Moscow

Current Positions:

Associate Professor, Moscow State University (2007–...)

Director of Graduate Studies, Independent University of Moscow (2008–...)

Member of the Independent University of Moscow Executive Board (2009–...)

Full Professor, Independent University of Moscow (2013–...)

Associate Professor, National Research University "Higher School of Economics" (2013–...)

Researcher, Laboratoire J.-V.Poncelet (UMI 2615 CNRS) (2014–...)

Research Interests: Geometry & Mathematical Physics

(i) Spectral geometry.

(ii) Integrable systems and their geometry (especially methods of algebraic geometry in integrable systems, integrable Hamiltonian PDEs, integrable systems on lattices, discrete Lagrangian systems).

(iii) Applications of Lie groups and algebraic groups to differential equations.

(iv) Related areas (Spectral Theory, Algebraic Geometry, Representation Theory, Lie Groups etc).

Selected recent talks:

June 2014: Lectures at IV Summer School on Geometric Methods in Mathematical Physics, Moscow.

March 2014: Geometry Seminar of Saint Petersburg Department of V.A.Steklov Institute of Mathematics of the Russian Academy of Sciences.

March 2014: Saint Petersburg Mathematical Society.

July 2013: Lectures at II School on Physics and Geometry, Białowieża, Poland.

May 2013: "Globus" Seminar, Independent University of Moscow.

March 2013: Geometry, Topology and Mathematical Physics Seminar, Moscow State University.

March 2013: Analysis Seminar, McGill University, Montréal, Canada.

December 2012: "Applications of Analysis: Game Theory, Spectral Theory and Beyond", A workshop in honor of Yakar Kannai's 70th birthday, The Weizmann Institute of Science, Rehovot, Israel.

November 2012: "Séminaire Mathématique Physique", Institut de Mathématiques de Bourgogne, Dijon, France.

November 2012: Symposium "Adventures in mathematical physics", Centre Jacques Cartier, Lyon, France.

October/November 2012: Workshop "Geometric Structures in Integrable Systems", Moscow State University.

June 2012: "Workshop on Geometry of Eigenvalues and Eigenfunctions", Centre de recherches mathématiques, Université de Montréal.

January 2012: Workshop "Integrability — modern variations" during the Hausdorff Trimester Program "Integrability in Geometry and Mathematical Physics", Hausdorff Research Institute for Mathematics, Bonn University.

September 2011: La 88ème rencontre entre physiciens théoriciens et mathématiciens: Discrétisation en mathématiques et en physique, IRMA, Université de Strasbourg.

June 2011: International conference "Differential Equations and Related Topics" dedicated to Ivan G. Petrovskii, Moscow State University.

March 2011: Séminaire "Spectral geometry", Université de Montréal.

February 2011: Seminar in Geometry and Topology, Weizmann Institute of Science.

List of Publications:

[1] Alexei V. Penskoi, Generalized Lawson tori and Klein bottles. To appear in Journal of Geometric Analysis. Preprint `arXiv:1308.1628`.

[2] Penskoi, A. V. Metrics extremal for eigenvalues of Laplace-Beltrami operator on surfaces. Uspekhi Mat. Nauk 68 (2013), no. 6, 107-168 (Russian). Translation to appear in Russian Math. Survey.

[3] Alexei V. Penskoi, Extremal spectral properties of Otsuki tori. Mathematische Nachrichten 286 (2013), no. 4, 379–391. Preprint arXiv:1108.5160.

[4] Penskoi, A. V. Extremal spectral properties of Lawson tau-surfaces and the Lamé equation. Moscow Math. J. 12 (2012), no. 1, 173–192. Preprint arXiv:1009.0285.

[5] Penskoi, A. V. Integrable systems and the topology of isospectral manifolds. Teor. Mat. Fiz. 155 (2008), no. 1, 140-146 (Russian). Translation in Theor. Math. Phys. 155 (2008), no. 1, 627–632. MR 2009m:37167. Preprint arXiv:0705.0805.

[6] Penskoi, A. V. The Volterra system and topology of the isospectral variety of zero-diagonal Jacobi matrices. Uspekhi Mat. Nauk 62 (2007), no. 3, 213-214 (Russian). Translation in Russian Math. Surveys, 62 (2007), no. 3, 626–628. MR 2008m:37098. Preprint math-ph/0701061.

[7] Oblomkov, A.A., Penskoi, A. V. Laplace transformations and spectral theory of two-dimensional semi-discrete and discrete hyperbolic Schrödinger operators. Int. Math. Res. Not. 2005, no. 18, 1089–1126. MR 2006e:47070. Preprint math-ph/0311036.

[8] Penskoi, A. V. Canonically conjugate variables for the periodic Camassa-Holm equation. Nonlinearity 18 (2005), no. 1, 415–421. MR 2005h:37168. Preprint math-ph/0211048.

[9] Penskoi, A. V. Symmetries and Lagrangian time-discretizations of Euler equations, *Superintegrability in classical and quantum systems,* 145–153, CRM Proc. Lecture Notes, 37, *Amer. Math. Soc., Providence, RI,* 2004. MR 2005h:37146. Preprint math-ph/0407029.

[10] Penskoi, A. V., Winternitz, P. Discrete matrix Riccati equations with superposition formulas. J. Math. Anal. Appl. 294 (2004), no. 2, 533–547. MR 2006a:34007. Preprint math-ph/0305053.

[11] Penskoi, A. V., Veselov, A. P. Discrete Lagrangian systems on the Virasoro group and Camassa-Holm family. Nonlinearity 16 (2003), no. 2, 683–688. MR 2004a:37108. Preprint math-ph/0209037.

[12] Penskoi, A. V. Lagrangian time-discretization of the Hunter-Saxton equation. Phys. Lett. A 304 (2002), no. 5-6, 157–167. MR 2003j:35283. Preprint math-ph/0201035.

[13] Penskoi, A. V. Ordinary differential equations with superposition formulae, II: Parabolic subgroups of the symplectic group. J. Phys. A 35 (2002) 425–434. MR 2003k:34019.

[14] Penskoi, A. V. Generalized matrix Riccati equations with superposition formulae. J. Phys. A 34 (2001), no. 3, 609–615. MR 2003k:34023.

[15] Oblomkov, A. A.; Penskoi, A. V. Two-dimensional algebro-geometric difference operators. J. Phys. A 33 (2000), no. 50, 9255–9264. MR 2002e:39056. Preprint `math-ph/0010024`.

[16] Penskoi, A. V. Lagrangian time-discretization of the Korteweg-de Vries equation. Phys. Lett. A 269 (2000), no. 4, 224–229. MR 2001d:37118.

[17] Veselov, A. P.; Penskoi, A. V. Algebro-geometric Poisson brackets for difference operators, and the Volterra system. (Russian) Dokl. Akad. Nauk 366 (1999), no. 3, 299–303. Translation in Doklady Mathematics 59 (1999), no. 3, 391–394. MR 2001b:37105.

[18] Penskoi, A. V. The Volterra lattice as a gradient flow. Regul. Khaoticheskaya Din. 3 (1998), no. 1, 76–77. MR 99j:58157. Preprint `math-ph/0011041`.

[19] Veselov, A. P.; Penskoi, A. V. On algebro-geometric Poisson brackets for the Volterra lattice. Regul. Chaotic Dyn. 3 (1998), no. 2, 3–9. MR 2000d:37091. Preprint `math-ph/0010027`.

[20] Penskoi, A. V. Canonically conjugate variables for the Volterra system with periodic boundary conditions. (Russian) Mat. Zametki 64 (1998), no. 1, 115–128. Translation in Math. Notes 64 (1998), no. 1-2, 98–109. MR 2000f:37103.

[21] Penskoi, A. V. Discrete Lagrangian systems on the Virasoro group. (Russian) Vestnik Moskov. Univ. Ser. I Mat. Mekh. 1996, no. 4, 99–102. Translation in Moscow Univ. Math. Bull. 51 (1996), no. 4, 52–54. MR 99g:58064.

Curriculum Vitae
Anton Khoroshkin

Date/Place of birth	August 20, 1981, Moscow, Russia
Marital status	Married, 3 children
Current address	Higher School of Economics, Faculty of mathematics 7 Vavilova Str. Moscow, Russia
Phone	+7-495-3358506
E-mail	akhoroshkin@hse.ru
Home pages	http://mysbfiles.stonybrook.edu/~akhoroshkin/ http://www.math.ethz.ch/~khorosh/

Education

9.02.2007	Ph.D. Moscow State University, Dept. of Mechanics and Mathematics, Chair of Algebra Title: "Formal geometry and algebraic invariants of geometric structures" Supervisors: Prof. Boris Feigin and Prof. Mikhail Zaicev
2003–2006	Graduate student at the Independent University of Moscow, Moscow State University and École Polytechnique (Palaiseau, France).
25.06.2003	Diploma (with distinction) in Pure and Applied Mathematics at Moscow State University
22.05.2003	Diploma in Pure Mathematics at the Independent University of Moscow
1998–2003	Undergraduate student at the Independent University of Moscow Supervisor: Boris Feigin
1998–2003	Undergraduate student at the Moscow State University Supervisor: Mikhail Zaicev.

Research Interests:

Homological algebra, representation theory, algebraic topology, mathematical physics.
In particular, questions originated in noncommutative geometry, operad theory, Lie algebra cohomology and related combinatorics.

Employment experience

2013 –	Higher School of Economics, faculty of mathematics, Moscow
2011 – 2013	Simons postdoc fellowship at Simons Center for Geometry&Physics (Stony Brook, NY)
2008 – 2011	ETH postdoc fellowship at Swiss Federal Institute of Technology Zurich (ETH Zurich)
2007 – 2013	Research associate at the Institute of Theoretical and Experimental Physics
2007 – 2008	Postdoc at the French-Russian mathematics laboratory in Moscow, CNRS,
2007 – 2008	Postdoc at the Departement of Mathematics, Stockholm University,
2003 – 2007	Research assistant at the Institute of Theoretical and Experimental Physics,
2003 – 2005	Teaching assistant, Independent University of Moscow.
2000 – 2003	Teaching assistant in a specialized mathematical class High school 57, Moscow,

Teaching experience

Undergraduate course "MATH 312/AMS 351 Applied algebra", Fall 2012, Stony Brook University
Graduate course/seminar "K-functor in Algebraic geometry" Spring 2011, ETH Zurich.
Graduate course "Homological algebra", Fall 2010, ETH Zurich.
Graduate course/seminar "Symmetric functions and Representation theory", Spring 2010, ETH Zurich.
Graduate course "Quadratic algebras and Koszul duality", Spring 2009, ETH Zurich.
Coorganizer of the research seminar "Talks in mathematical physics", Fall 2009 – 2011, ETH Zurich.
A short course on "Operads and Koszulness", 2007, Stockholm University.
Coorganizer of the research seminar "Homological/homotopical methods in geometry&physics", 2005-2007, ITEP, Moscow
An advanced graduate course "Noncommutative geometry, deformation theory and Duflo isomorphism", Fall 2004, Independent University of Moscow (*in Russian*).
Classes for courses of different levels of Algebra, Topology and Calculus, 2002-2006, IUM (Moscow).
Classes for advanced mathematics in specialized math. class High school 57, Moscow, 2000 – 2003.

Administrative duties

Journal referee for:
Int.Math.Res.Notes, J.of Algebra, J.Gen. Lie Theory Appl., Mat.Zametki, Functional anal. and appl.
Coorganizer of the conference:
"Representation theory and Quantization", January 25-29, 2010, FIM, ETH Zurich
(see the webpage *http://www.math.ethz.ch/~khorosh/swiss-rus10/home.html*)

Invited talks

Colloquium, University of Edinburgh, Edinburgh, 2013
Informal Mathematical Physics Seminar, Columbia University, New York City, 2013
Representation Theory Seminar, Michigan State University, East Lansing, MI, 2013
Algebraic Geometry Seminar, University of Michigan, Ann Arbor, MI, 2013
Colloquium talk, Kansas State University, Manhattan, 2013
Colloquium talk, Weizmann Institute, 2013
Algebra Seminar, Technion, Haifa, 2013
Combinatorics Seminar, Bar Ilan, Tel Aviv, 2013
Representation Theory Seminar, MIT, Cambridge, 2012,
Infinite-Dimensional Algebra Seminar, MIT, Cambridge, 2012,
Experimental Mathematics Seminar, State University of New Jersey, Rutgers, 2012,
Seminar on Algebra, University of Oregon, Eugene, 2012,
Seminar on Algebra, Geometry&Physics, Stony Brook University, 2012,
Topology seminar, Stony Brook University 2012,
Representation Theory and Related Topics Seminar, North Eastern University, 2012,
String theory seminar, US Davis, 2012
Algebraic geometry seminar, Stanford University, 2012
Seminar on Representation Theory, Geometry&Combinatorics, University of California, Berkeley, 2012
Math.Phys group seminar Korteweg-de Vries Institute for Mathematics, 2011
Seminar on Lie theory, Weizmann Institute of Science, 2010, 2013
Seminar on Homological&homotopical methods in geometry, Higher School of Econ., Moscow, 2010.
Seminar on mathematical physics, Institute for Advanced Studies, Dublin, 2009.
Seminar on Lie theory, Genève, 2009, 2010, 2011, 2013
Seminar on algebra, Paris, Institut Henry Poincare, 2009
Seminar on mathematical physics, Kyoto University, 2008, 2009
Conference "Conf.Field Theory, Integrable models&Liouville Gravity", Chernogolovka, Russia, June, 2009.
Algebra-topology seminar, ETH, Zürich 2009, 2011
Talks in Mathematical physics, ETH, Zürich 2008, 2011, 2013
Workshop "Classical&Quantum Integrable Systems", IHEP, Protvino, Russia, January, 2008
Conference "Lie groups and physics", Twente, December, 2007.
Workshop,*Swiss-Rus. seminar on "Moduli spaces&physics",* University of Zürich, December, 2007.
Series of lectures for group of Math.Physics, Chalmers University of Technology, Göteborg, 2007.
Algebra&Geometry seminar, The Royal institute of technology, Stockholm, 2007, 2006.
Seminar on algebra, Norwegian University of Science and Technology, Trondheim, 2006
Seminar Algebres enveloppantes, Institut Mathematique de Jusssieu, Paris 13, 2006
Conference "Low–dimensional mathematics", Saint-Petersburg, 06/2006
Seminar on mathematical physics, Université d'Angers 2004, 2005
Seminar on Low-Dimensional Mathematics PDMI, SPb, 2003
The meeting of the "Mathematical Society" PDMI, Saint-Petersburg, 2003
Seminar of the chair of Higher Algebra, Moscow State University, 2005, 2007
Seminar "Selected algebraic questions" Moscow State University, 2000, 2003, 2006, 2009,
Seminar on Lie groups and theory of invariants Moscow State University, 2003, 2005.
Seminar on representation theory, Independent University of Moscow, 2000-2009,
Seminar on Riemann surfaces, Lie algebras&Mathematical physics IUM Moscow, 2003-2009,
Seminar of the French-Russian mathematics laboratory, IUM Moscow, 2006-2008,
Seminar on Charecteristic classes&intersection theory, IUM Moscow 2007-2011,

Workshops "Petrovskie chteniya, Volga-2002, Volga-2004" Kazan 06/2002, 06/2004
Math.Physics and Harmonical analysys seminar, ITEP, Moscow, Russia 2004 – 2006
Math.Physics and Representation theory seminar, ITEP, Moscow, 2006–2008

Prizes

Special diploma in Moebius Contest (2006),
Honorable mention in Euler foundation contest (2007).
Russian Federation president award (2008).
ITEP young scientists award (2002, 2003, 2004, 2005, 2006, 2007).
Research grants from Russian Foundation for Basic Research (each year starting from 2006).

List of publications

Submitted:

1. "Lie algebra cohomology representing characteristic classes of flags of foliations"
   Preprint available at math.arxiv.org:1303.1889, 30pp.

2. "On generating series of finitely presented operads" (with D. Piontkovski),
   Preprint available at math.arxiv.org:1202.5170, 32pp. *Submitted to* Jounal of Algebra.

Accepted or Published:

3. "Macdonald Polynomials and BGG reciprocity for current algebras"
   (with A. Berenstein, M. Bennet, V. Chari, S. Loktev)
   Selecta Mathematica. (to appear) // *Preprint available at* math.arxiv.org:1207.2446, 19pp.

4. "Quillen Homology for operads via Gröbner bases" (with V. Dotsenko),
   Documenta Mathematica. 18 (2013) pp. 707–747

5. "Hypercommutative operad as a homotopy quotient of BV." (with N. Markarian and S. Shadrin)
   Communications in Mathematical Physics, Volume 322, Issue 3 (2013), pp. 697–729

6. "Shuffle Algebras, Homology and Conccecutive Pattern Avoidance" (with V. Dotsenko),
   Algebra & number theory, 7:3 (2013) pp.673–700

7. "Using homological duality in consecutive pattern avoidance" (with B. Shapiro)
   Electronic J. of Combinatorics, vol.18(2), 2011, 17 pp.

8. "Gröbner bases for operads" (with V. Dotsenko)
   Duke Math. J. 153 (2010), no. 2, 363–396.

9. "On syzygies of highest weight orbits." (with A. L. Gorodentsev and A. N. Rudakov)
   Moscow Seminar on Mathematical Physics. II, 79120, Amer. Math. Soc. Transl. Ser. 2, 221, Amer. Math. Soc., Providence, RI, 2007

10. "Quadratic algebras related to the bihamiltonian operad" (with M. Bershtein and V. Dotsenko)
    IMRN 2007, no. 24, Art. ID rnm122, 30 pp.

11. "Character formulas for the operad of two compatible brackets and for the bi-Hamiltonian operad"
    (with V. Dotsenko)
    Funct. Anal. Appl. 41 (2007), no. 1, 1–17

12. "Syzygies of some quadratic varieties and their connection with the cohomology of Lie algebras"
    Russian Math. Surveys 61 (2006), no. 5, 990–992

13. "Lie algebra of formal vector fields extended by formal g-valued functions"
    Zap. Nauchn. Sem. S.-Peterburg. Otdel. Mat. Inst. Steklov. (POMI) 335 (2006), 205–230; translation in J. Math. Sci. (N. Y.) 143 (2007), no. 1, 2816–2830,

Preprints:

14. "Anick-type resolutions and consecutive pattern avoidance" (with V. Dotsenko)
Preprint available at math.arXiv:1002.2761, 16 pp.

15. "Free resolutions via Gröbner bases" (with V. Dotsenko)
Preprint available at math.arxiv:0912.4895, 24 pp.

16. "Lie algebra of formal vector fields that preserve the foliation structure"
preprint in russian ITEP-TH-09/07, available as VINITI RAS, N1376-B2006, – 2006, – 38pp.

17. "Koszul operads and distributive lattices"
Preprint ITEP-TH available at http://ellib.itep.ru/Mathphys/psfiles/05_95.ps

Articles in preparation:

18. "Highest weight categories and Macdonald polynomials"

19. "On formality theorems for framed little discs operad" (with N. Markarian),

20. "Gröbner bases for dioperads" (with V. Dotsenko),

21. "On Hilbert series of wheeled operads"