CURRICULUM VITAE

Oleksandr (Sasha) Tsymbaliuk

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Born: May 21, 1987, Kharkiv, Ukraine
Citizenship: Ukraine, USA

Research Interests

- Representation Theory and its connection to
Algebraic Geometry, Combinatorics, and Integrable Systems

Employment

- Assistant Professor — 2020–present
Purdue University
- Gibbs Assistant Professor — 2017–2020
Yale University
- Research Assistant Professor — 2014–2017
Simons Center for Geometry and Physics

Education

- PhD in Mathematics, Massachusetts Institute of Technology — 2009–2014
Thesis title: *The affine Yangian of* $\mathfrak{gl}_1$ *and the infinitesimal Cherednik algebras*
Thesis advisor: Prof. Pavel Etingof
- MS in Mathematics, Independent University of Moscow — 2004–2009
Thesis title: *Quantum affine Gelfand-Tsetlin bases and quantum toroidal algebra via* K*-theory of affine Laumon spaces*
Thesis advisor: Prof. Boris Feigin
- MS in Mathematics, Moscow State University (summa cum laude) — 2004–2009
Thesis title: *Heisenberg action in the equivariant* K*-theory of Hilbert schemes via shuffle algebra*
Thesis advisor: Prof. Ernest Vinberg

Research Visits

- Centre International de Rencontres Mathématiques (CIRM) — August 2023
Luminy, France
- Oberwolfach Research Institute for Mathematics (MFO) — July 2023
Oberwolfach, Germany
- Institut des Hautes Études Scientifiques (IHES) — May 2023
Bures-sur-Yvette, France
- Institut des Hautes Études Scientifiques (IHES) — July 2021
Bures-sur-Yvette, France
- Institut des Hautes Études Scientifiques (IHES) — May–July 2020
Bures-sur-Yvette, France — *Cancelled due to COVID-19*
- Institut des Hautes Études Scientifiques (IHES) — June–July 2019
Bures-sur-Yvette, France
- Institut des Hautes Études Scientifiques (IHES) — January 2019
Bures-sur-Yvette, France

- Kavli Institute for the Physics and Mathematics of the Universe (IPMU) and Research Institute for Mathematical Sciences (RIMS) Kashiwa and Kyoto, Japan — August 2018
- Max Planck Institut für Mathematik (MPIM) Bonn, Germany — July 2018
- Institut des Hautes Études Scientifiques (IHES) Bures-sur-Yvette, France — June–July 2017
- Max Planck Institut für Mathematik (MPIM) Bonn, Germany — June–July 2016
- Max Planck Institut für Mathematik (MPIM) Bonn, Germany — June 2015
- Research Institute for Mathematical Sciences (RIMS) Kyoto, Japan — January 2015
- Hebrew University of Jerusalem Jerusalem, Israel — Fall 2010

Grants, Awards and Fellowships

- NSF grant DMS-2302661 — 2023–2026
- NSF grant DMS-2001247 (changed to DMS-2037602 in 2020) — 2020–2024
- Yale Travel Grant — 2019–2020
- Yale Travel Grant — 2018–2019
- NSF grant DMS-1502497 (changed to DMS-1821185 in 2017) — 2015–2019
- SUNY Individual Development Award — 2015–2016
- JSPS Fellowship for Foreign Researchers — Winter 2015
- Akamai Presidential Fellowship, MIT — 2009–2010
- Dobrushin Fellowship, Independent University of Moscow — Fall 2008
- Dobrushin Fellowship, Independent University of Moscow — Spring 2008
- Dobrushin Fellowship, Independent University of Moscow — Spring 2007
- Silver Medal at the 45th International Mathematical Olympiad — July 2004

Publication List

- *Orthosymplectic Yangians*
  joint with R. Frassek
  Submitted; arχiv:2311.18818 (64pp, last update on 12/30/2023)
- *Orthosymplectic superoscillator Lax matrices*
  joint with R. Frassek
  To appear in **Letters in Mathematical Physics** (2024)
  arχiv:2309.14199 (27pp, last update on 01/12/2024)
- *Affine standard Lyndon words: A-type*
  joint with Y. Avdieiev
  Submitted; arχiv:2305.16299 (43pp, last update on 06/19/2023)
- *Shuffle algebras and their integral forms: specialization map approach in types B_n and G_2*
  joint with Y. Hu
  To appear in **International Math. Research Notices** (2024)

arχiv:2305.00810 (46pp, last update on 10/31/2023)

- *Difference operators via GKLO-type homomorphisms: shuffle approach and application to quantum Q-systems*
  Letters in Mathematical Physics 113 (2023), Paper No. 22, 43pp

- *Shuffle approach towards quantum affine and toroidal algebras*
  SpringerBriefs in Mathematical Physics (2023), xi+130pp
  DOI:10.1007/978-981-99-3150-7, ISBN:978-981-99-3150-7

- *Transfer matrices of rational spin chains via novel BGG-type resolutions*
  joint with R. Frassek and I. Karpov
  Communications in Mathematical Physics 400 (2023), 1–82

- *Rational Lax matrices from antidominantly shifted extended Yangians: BCD types*
  joint with R. Frassek
  Communications in Mathematical Physics 392 (2022), 545–619

- *Surface defects in gauge theory and KZ equation*
  joint with N. Nekrasov
  Letters in Mathematical Physics 112 (2022), Paper No. 28, 53pp

- *Quantum loop groups and shuffle algebras via Lyndon words*
  joint with A. Neguţ
  Advances in Mathematics 439 (2024), Paper No. 109482, 69pp
  DOI:10.1016/j.aim.2023.109482

- *Lax matrices from antidominantly shifted Yangians and quantum affine algebras: A-type*
  joint with R. Frassek and V. Pestun
  Advances in Mathematics 401 (2022), Paper No. 108283, 73pp

- *Shuffle algebra realizations of type A super Yangians and quantum affine superalgebras for all Cartan data*
  Letters in Mathematical Physics 110 (2020), 2083–2111

- *Duality of Lusztig and RTT integral forms of* $U_v(L\mathfrak{sl}_n)$
  Journal of Pure and Applied Algebra 225 (2021), no. 1
  Paper No. 106469, 14pp

- *Shifted quantum affine algebras: integral forms in type A*
  joint with M. Finkelberg (with appendices joint with A. Weekes)
  Arnold Mathematical Journal 5 (2019), 197–283

- *PBWD bases and shuffle algebra realizations for* $U_v(L\mathfrak{sl}_n), U_{v_1,v_2}(L\mathfrak{sl}_n), U_v(L\mathfrak{sl}(m|n))$ *and their integral forms*
  Selecta Mathematica (New Series) 27 (2021), Paper No. 35, 48pp

- *On Sevostyanov's construction of quantum difference Toda lattices*
  joint with R. Gonin
  International Math. Research Notices (2021), no. 12, 8885–8945

- *Multiplicative slices, relativistic Toda and shifted quantum affine algebras*
  joint with M. Finkelberg
  Representations and Nilpotent Orbits of Lie Algebraic Systems
  (special volume in honour of the 75th birthday of Anthony Joseph)
  Progress in Mathematics 330 (2019), 133–304

- *Classical limits of quantum toroidal and affine Yangian algebras*
  Journal of Pure and Applied Algebra 221 (2017), no. 10, 2633–2646
- *Several realizations of Fock modules for toroidal $\ddot{U}_{q,d}(\mathfrak{sl}_n)$*
  Algebras and Representation Theory 22 (2019), 177–209
- *Homomorphisms between different quantum toroidal and affine Yangian algebras*
  joint with M. Bershtein
  Journal of Pure and Applied Algebra 223 (2019), no. 2, 867–899
- *Bethe subalgebras of $U_q(\widehat{\mathfrak{gl}_n})$ via shuffle algebras*
  joint with B. Feigin
  Selecta Mathematica (New Series) 22 (2016), 979–1011
- *The affine Yangian of $\mathfrak{gl}_1$ revisited*
  Advances in Mathematics 304 (2017), 583–645
- *Infinitesimal Hecke algebras of $\mathfrak{so}_N$*
  Journal of Pure and Applied Algebra 219 (2015), no. 6, 2046–2061
- *Infinitesimal Cherednik algebras as W-algebras*
  joint with I. Losev
  Transformation Groups 19 (2014), no. 2, 495–526
- *Representations of infinitesimal Cherednik algebras*
  joint with F. Ding
  Representation Theory (electronic) 17 (2013), 557–583
- *Equivariant K-theory of Hilbert schemes via shuffle algebra*
  joint with B. Feigin
  Kyoto Journal of Mathematics 51 (2011), no. 4, 831–854
- *Quantum affine Gelfand–Tsetlin bases and quantum toroidal algebra via K-theory of affine Laumon spaces*
  Selecta Mathematica (New Series) 16 (2010), 173–200

Teaching Experience

- Lecturer for *Quantum Groups and Applications* (Purdue) Spring 2024
- Lecturer for *Linear Algebra* (Purdue) Spring 2024
- Lecturer for *Lie Algebras* (Purdue) Fall 2023
- Lecturer for *Linear Algebra* (Purdue) Fall 2022
- Lecturer for *Linear Algebra* (Purdue) Spring 2022
- Lecturer for *Infinite dimensional Lie algebras* (Purdue) Spring 2021
- Lecturer for *Linear Algebra* (Purdue) Fall 2020
- Lecturer for *Calculus of Functions of Several Variables* (Yale) Fall 2019
- Lecturer for *Shuffle approach towards quantum toroidal algebras* March 2019
  (Crash-course, Tokyo University of Marine Science and Technology)
- Lecturer for *Infinite dimensional Lie algebras and applications* (Yale) Spring 2019
- Lecturer for *Introduction to Representation Theory* (Yale) Fall 2018
- Lecturer for *Calculus of Functions of Several Variables* (Yale) Fall 2018
- Lecturer for *Topics in Quantum Groups* (Yale) Spring 2018

- Lecturer for *Calculus of Functions of Several Variables* (Yale) Fall 2017
- Head instructor for *Mathematical Thinking* (Stony Brook) Fall 2016
- Lecturer for *Calculus B* (Stony Brook) Fall 2015
- Section leader for *Calculus IV with Applications* (Stony Brook) Fall 2014
- Teaching assistant for *Real Analysis* (MIT) Spring 2014
- Section leader for *Multivariable Calculus* (MIT) Fall 2012
- Grader for the following courses at MIT: 2011–2013
  Real and Functional Analysis, Calculus, Commutative Algebra, Introduction to Arithmetic Geometry, Algebraic Groups

Mentoring Experience

- Mentoring a team of high school students from Ukraine May 2022–present
  Yulia's Dream – initiative under MIT PRIMES program
  Research program for exceptional high school students from Ukraine
  Y. Avdieiev, A. Tsymbaliuk, *Affine standard Lyndon words: A-type*
  Submitted; arχiv:2305.16299, 32pp
- Mentoring two undergraduate students at Purdue since Fall 2021
  Emerging Leaders Science Scholar program
  for students in STEM fields from historically underrepresented groups
- Mentoring a high school student Summer 2020
  H. Cui, *Correlation functions of quantum toroidal $\mathfrak{gl}_1$ algebra*
  Journal of Mathematics Research 13 (2021), no. 2, 7–20
  H. Cui, *Correlation functions of quantum toroidal $\mathfrak{gl}_n$ algebra*
  Journal of Mathematics Research 14 (2022), no. 4, 94–105
- Mentoring an MIT undergraduate student Winter 2014
  MIT Directed Reading Program
- Mentoring a high school student 2011–2013
  MIT PRIMES program
  F. Ding, A. Tsymbaliuk, *Representations of infinitesimal Cherednik algebras*
  Representation Theory (electronic) 17 (2013), 557–583
  Awards: With our project, F. Ding won the 4th Prize at 2012 Intel STS US national competition and became 2012 Davidson Fellow Laureate

Talks

- Michigan State University, Seminar in Cluster Algebras November 2023
- Ohio State University, Representations and Lie theory Seminar October 2023
- Purdue University, Bridge to Research Seminar April 2023
- UIUC, Integrability and Representation Theory Seminar March 2023
- SCGP, Workshop "Geometric Representation Theory, Integrability, and Supersymmetric Gauge Theories" September 2022
- University of Saskatchewan, Geometry, Algebra and Physics Seminar May 2022
- University of Denver, Spring 2022 Western AMS Sectional Meeting May 2022
  Special session "Some modern developments in the theory of vertex algebras"
- Purdue University, Spring 2022 Central AMS Sectional Meeting March 2022
  Special session "Integrability, Symmetry and Physics"

- Tufts University, Spring 2022 Eastern AMS Sectional Meeting — March 2022
  Special session "Macdonald theory and beyond"
- MIT, Infinite-Dimensional Algebra Seminar — March 2022
- Perimeter Institute, Mathematical Physics Seminar — March 2022
- Purdue University, Mathematical Physics Seminar — March 2022
- Purdue University, Bridge to Research Seminar — November 2021
- GRT, Online Representation Theory Seminar — June 2021
- Paris Algebra Seminar — May 2021
- Ohio State University, Representations and Lie algebras Seminar — April 2021
- Purdue University, Bridge to Research Seminar — April 2021
- Skoltech Center for Advanced Studies, Math-Physics Seminar — March 2021
- UMass Amherst, Representation Theory Seminar — March 2020
- UC Berkeley, String-Math Seminar — September 2019
- ETH, Conference "Representation Theory and Integrable Systems" — August 2019
  Zurich, Switzerland
- Yale University, Geometry, Symmetry and Physics Seminar — March 2019
- Auburn University, Spring 2019 Southeast AMS meeting — March 2019
  Special session "Geometric Methods in Representation Theory"
- Tokyo University of Marine Science and Technology, 3 talks — March 2019
  Crash-course "Shuffle approach towards quantum toroidal algebras"
  Tokyo, Japan
- Tokyo University, 2 talks at Workshop "Infinite Analysis 2019: — March 2019
  Quantum Symmetries and Integrable Systems"
  Tokyo, Japan
- Purdue University, Colloquium — December 2018
- University of Virginia, Colloquium — December 2018
- SCGP, Workshop "Vertex Algebras and Gauge Theory" — December 2018
- Columbia University, Informal Mathematical Physics Seminar — December 2018
- U. Wisconsin-Madison, Algebra and Algebraic Geometry Seminar — October 2018
- MIT, Geometric Representation Theory Seminar — September 2018
- RIMS, Representation Theory Seminar — August 2018
  Kyoto, Japan
- IPMU, Mathematics–String Theory Seminar — August 2018
  Kashiwa, Japan
- CIME School "Geometric Representation Theory and Gauge Theory" — June 2018
  Cetraro, Italy
- Fields Institute, Geometric Representation Theory Seminar — April 2018
  Toronto, Canada
- UC Riverside, Colloquium — February 2018
- Yale University, Geometry, Symmetry and Physics Seminar — November 2017
- Ohio State University, Representations and Lie algebras Seminar — August 2017
- QGM, QGM weekly seminar — June 2017
  Aarhus, Denmark

- MIT, Geometric Representation Theory Seminar — May 2017
- UC Santa Cruz, Colloquium — February 2017
- ESI, Conference "Geometry and Representation Theory" — January 2017
  Vienna, Austria
- UC Davis, Algebra and Discrete Mathematics Seminar — November 2016
- Brown University, Theoretical Physics Seminar — November 2016
- Uppsala Universitet, Representation Theory Conference 2016 — June 2016
  Uppsala, Sweden
- Northeastern University — March 2016
  Geometry, Physics, and Representation theory Seminar
- SCGP, Program "Geometric representation theory" — January 2016
- Temple University, Algebra Seminar — November 2015
- Yale University, Geometry, Symmetry and Physics Seminar — April 2015
- Tokyo University, Infinite Analysis Seminar — January 2015
  Tokyo, Japan
- RIMS, Representation Theory Seminar — January 2015
  Kyoto, Japan
- CUNY, Representation Theory Seminar — October 2014
- Northeastern University, Graduate student seminar — April 2014
- MIT-NEU, Graduate seminar on
  Quantum Cohomology and Representation Theory — February 2014
- ETH Zurich, Talks in theoretical sciences — November 2013
  Zurich, Switzerland
- Northeastern University, Graduate student seminar — April 2013
- Harvard-MIT, Graduate student seminar in — April 2012
  Geometric Representation Theory
- Harvard-MIT, Graduate student seminar in — September 2011
  Geometric Representation Theory
- Harvard-MIT, Graduate student seminar — April 2011
  Geometric Representation Theory
- Harvard-MIT, Graduate student seminar — February 2011
  Geometric Representation Theory
- Hebrew University, Representation theory Seminar — October 2010
  Jerusalem, Israel
- Boston University, Geometry Seminar — April 2010
- MIT, Infinite Dimensional Algebra Seminar — March 2010
- Clay Mathematics Institute — March 2010
  Workshop "Macdonald Polynomials and Geometry"

Professional Activities

- **Grant reviews**
  - Served as an external reviewer for NSERC Discovery Grants — 2023
  - Served on the NSF review panel — 2021
  - Served as an external reviewer for NSERC Discovery Grants — 2021
  - Served on the NSF review panel — 2016

- **Editorial service**
  Referee for the following journals:
  - Advances in Mathematics
  - Algebras and Representation Theory
  - Annales scientifiques de l'École normale supérieure
  - Arkiv för Matematik
  - Canadian Journal of Mathematics
  - Communications in Mathematical Physics
  - Duke Mathematical Journal
  - International Mathematics Research Notices
  - Inventiones mathematicae
  - Journal de l'École polytechnique–Mathématiques
  - Journal of Algebra
  - Journal of Algebra and its Applications
  - Journal of Pure and Applied Algebra
  - Journal of the American Mathematical Society
  - Letters in Mathematical Physics
  - Moscow Mathematical Journal
  - Nuclear Physics B
  - Publications Mathématiques de l'IHÉS
  - Representation Theory (electronic journal of the AMS)
  - Selecta Mathematica (New Series)
  - SIGMA
  - Transformation Groups

  Reviewer for:
  - Mathematical Reviews
  - zbMATH Open

- **Seminars**
  - Coorganizing *Mathematical Physics* seminar at Purdue — since 2021
  - Coorganized Yale seminar *Geometry, Symmetry and Physics* — 2017–2020
  - Organized *SCGP Postdoc* seminar — 2015–2016

- **Conferences organized**
  - Coorganizing AMS Sectional Meeting at San Francisco State University — May, 2024
  - Coorganized AMS Sectional Meeting at Purdue University — March, 2022
  - Coorganized AMS Sectional Meeting at Purdue University — April, 2020 *Cancelled due to COVID-19*

- **Community Service**
  - Judge for the 2023 Purdue Undergraduate Research Conference — April 2023
  - Judge for the 34th Annual Hoosier Science and Engineering Fair — April 2022
  - Judge for the 2022 Purdue Undergraduate Research Conference — April 2022