

Darij Grinberg

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Field of research

algebraic combinatorics / Hopf algebras / Young tableaux / combinatorial representation theory / noncommutative algebra / invariant theory

Education and affiliations

- 2019–** [Assistant Professor](#) at [Drexel University](#).
- 2021** [Research in Pairs](#) (joint project with Tom Roby) at [Mathematisches Forschungsinstitut Oberwolfach](#) (July 18 – August 6).
- 2020** [Postdoctoral Fellow](#) at [Institut Mittag-Leffler](#) (January – March).
- 2019, 2020** [Leibniz Fellow](#) at [Mathematisches Forschungsinstitut Oberwolfach](#).
- 2016–2019** Dunham Jackson Assistant Professor at [University of Minnesota](#), working with Victor Reiner.
- 2016, June 3** Ph.D. in Mathematics at [Massachusetts Institute of Technology](#), advised by Alexander Postnikov. ([Thesis](#)¹.)
- 2011–2016** Graduate student at [Massachusetts Institute of Technology](#).
- 2011, July 1** Diploma (rough equivalent to M.S.) in Mathematics at the [Ludwig-Maximilians-Universität München](#) (Munich), with a minor in Computer Science. ([Thesis](#); comprehensive grade “very good”.)
- 2006–2011** Undergraduate at the [Ludwig-Maximilians-Universität München](#) (Munich).

Publications and preprints (peer-reviewed marked with #)

¹Thesis committee: Alexander Postnikov, Pavel Etingof, Ira Gessel.

All material in this thesis also appears in the preprints and papers listed below.

- 2023** *The Pak–Postnikov and Naruse skew hook length formulas: a new proof*, joint with Nazar Korniiichuk, Kostiantyn Molokanov, and Severyn Khomych, arXiv:2310.18275, submitted.
- 2023** *Commutator nilpotency for somewhere-to-below shuffles*, arXiv:2309.05340, preprint.
- 2023** *The enriched q -monomial basis of the quasisymmetric functions*, joint with Ekaterina A. Vassilieva, arXiv:2309.01118, submitted.
- 2023** *The Redei–Berge symmetric function of a directed graph*, joint with Richard P. Stanley, arXiv:2307.05569, preprint.
- # **2023** *Multislant matrices and Jacobi–Trudi determinants over finite fields*, joint with Omesh Dhar Dwivedi and Jonah Blasiak, arXiv:2302.07239, *Finite Fields and Their Applications* **91** (2023), 102262.
- # **2022** *The one-sided cycle shuffles in the symmetric group algebra*, joint with Nadia Lafrenière, arXiv:2212.06274, accepted in *Algebraic Combinatorics*.
- # **2022** *The entry sum of the inverse Cauchy matrix* (expository), arXiv:2301.09777, to appear in the *Mathematical Intelligencer* (DOI:10.1007/s00283-023-10268-4).
- # **2022** *Birational rowmotion on a rectangle over a noncommutative ring*, joint with Tom Roby, arXiv:2208.11156, *Combinatorial Theory* **3** (2023), issue 3, #7.
- # **2022** *On the principal minors of the powers of a matrix*, *Gazeta Matematica, Seria A, Anul XL (CXIX)*, nr. 1–2, 2022, arXiv:2204.07885v1.
- 2021** *The pre-Pieri rules*, arXiv:2110.03108.
- # **2021** *On the rank of Hankel matrices over finite fields*, joint with Omesh Dhar Dwivedi, arXiv:2109.05415, *Linear Algebra and its Applications* **641** (2022), pp. 156–181.
- # **2021** *On the square of the antipode in a connected filtered Hopf algebra*, arXiv:2109.02101, *Communications in Mathematics* **31** (2023), issue 1.
- 2021** *The path-missing and path-free complexes of a directed graph*, joint with Lukas Katthän, Joel Brewster Lewis, arXiv:2102.07894.
- # **2021** *The Pelletier–Ressayre hidden symmetry for Littlewood–Richardson coefficients*, *Combinatorial Theory* **1** (2021), #16, arXiv:2008.06128.
- # **2021** *The Elser nuclei sum revisited*, *Discrete Mathematics & Theoretical Computer Science* **23** (2021) no. 1, arXiv:2009.11527.

- 2020** *Three variations on the linear independence of grouplikes in a coalgebra*, joint with Gérard Duchamp, Vincel Hoang Ngoc Minh, arXiv:2009.10970.
- # **2020** *Petrie symmetric functions*, arXiv:2004.11194, Algebraic Combinatorics **5**, issue 5 (2022), pp. 947–1013.
- 2020** *The Bhargava greedoid as a Gaussian elimination greedoid*, arXiv:2001.05535, submitted.
- # **2020** *An efficiently computable characterization of stability and instability for linear cellular automata*, joint with Alberto Dennunzio, Enrico Formenti, Luciano Margara, Journal of Computer and System Sciences **122** (2021), pp. 63–71. (See arXiv:1907.08565 for a preliminary version of this paper that includes my contribution.)
- # **2020** *Chaos and ergodicity are decidable for linear cellular automata over $(\mathbb{Z}/m\mathbb{Z})^n$* , joint with Alberto Dennunzio, Enrico Formenti, Luciano Margara, Information Sciences **539** (2020), pp. 136–144. (A fragment of this paper that includes my contribution.)
- # **2020** *Dynamical Behavior of Additive Cellular Automata over Finite Abelian Groups*, joint with Alberto Dennunzio, Enrico Formenti, Luciano Margara, Theoretical Computer Science **843** (2020), pp. 45–56.
- # **2020** *Proof of three conjectures on determinants related to quadratic residues*, joint with Zhi-Wei Sun, Lili Zhao, arXiv:2007.06453, Linear and Multilinear Algebra **70** (2022), no. 19, pp. 3734–3746.
- # **2019** *A greedoid and a matroid inspired by Bhargava’s p -orderings*, joint with Fedor Petrov, arXiv:1909.01965, Electronic Journal of Combinatorics **28** (3) (2021), #P3.6.
- 2019** *Commutators, matrices and an identity of Copeland*, arXiv:1908.09179.
- # **2019** *A double Sylvester determinant*, arXiv:1901.11109, Ars Mathematica Contemporanea [S.l.], v. **20**, n. 2, pp. 261–274.
- # **2019** *Multiline queues with spectral parameters*, joint with Erik Aas and Travis Scrimshaw, arXiv:1810.08157, Communications in Mathematical Physics **374** (3), pp. 1743–1786.
- # **2019** *The n body matrix and its determinant*, joint with Peter J. Olver, arXiv:1802.02900, SIAM Journal on Applied Algebra and Geometry **3**(1) (2019), pp. 67–86.
- # **2018** *Shuffle-compatible permutation statistics II: the exterior peak set*, arXiv:1806.04114, Electronic Journal of Combinatorics **25** (2018), Paper #P4.17.

- 2017** *Noncommutative Abel-like identities.*
- # **2017** *On binomial coefficients modulo squares of primes*, arXiv:1712.02095, *Integers* **19** (2019), A14.
- # **2017** *Critical groups for Hopf algebra modules*, joint with Jia Huang, Victor Reiner, arXiv:1704.03778, *Mathematical Proceedings of the Cambridge Philosophical Society* **168** (2020), no 3., pp. 473–503.
- # **2017** *t-unique reductions for Mészáros’s subdivision algebra*, arXiv:1704.00839, *SIGMA* **14** (2018), 078, 34 pages.
- 2016** *From Chio Pivotal Condensation to the Matrix-Tree theorem*, joint with Karthik Karnik, Anya Zhang, arXiv:1606.08193 (report of student research).
- 2016** *Generalized Whitney formulas for broken circuits in ambigraphs and matroids*, arXiv:1604.03063.
- 2016** *The Bernstein homomorphism via Aguiar-Bergeron-Sottile universality*, arXiv:1604.02969.
- # **2016** *Proof of a conjecture of Bergeron, Ceballos and Labbé*, joint with Alexander Postnikov, arXiv:1603.03138, *New York Journal of Mathematics* **23** (2017), pp. 1581–1610.
- # **2015** *Double posets and the antipode of QSym*, arXiv:1509.08355, *Electronic Journal of Combinatorics* **24** (2017), Paper #P2.22.
- # **2015** *Refined dual stable Grothendieck polynomials and generalized Bender-Knuth involutions*, joint with Pavel Galashin and Gaku Liu, arXiv:1509.03803, *Electronic Journal of Combinatorics* **23** (2016), Paper #P3.14.
- 2015** *The signed random-to-top operator on tensor space (draft)*, arXiv:1505.01201.
- # **2014** *Dual immaculate creation operators and a dendriform algebra structure on the quasisymmetric functions*, arXiv:1410.0079, *Canadian Journal of Mathematics* **69** (2017), pp. 21–53.
- 2014** *Hopf Algebras in Combinatorics*, joint with Victor Reiner, arXiv:1409.8356 (extended lecture notes).
- # **2014** *Iterative properties of birational rowmotion*, joint with Tom Roby, arXiv:1402.6178. This has been published as two papers due to its length:

- *Iterative Properties of Birational Rowmotion I: Generalities and Skeletal Posets*, [Electronic Journal of Combinatorics](#) **23** (2016), Paper #P1.33;
 - *Iterative Properties of Birational Rowmotion II: Rectangles and Triangles*, [Electronic Journal of Combinatorics](#) **22** (2015), Paper #P3.40.
- # 2013 *Boolean Witt vectors and an integral Edrei-Thoma theorem*, joint with James Borger, arXiv:1311.5031, [Selecta Mathematica](#) **22** (2), pp. 595–629.
- 2011 *Poincaré-Birkhoff-Witt type results for inclusions of Lie algebras*, diploma thesis (link to updated version) under supervision of Andreas Rosenschon and guidance by Damien Calaque and Giovanni Felder. The thesis has not been submitted to a journal but has already been cited twice.
- 2011 *Zeckendorf family identities generalized*, arXiv:1103.4507.
- 2007– Various [problems and solutions](#) submitted to mathematical journals.
- # 2002–2004 Four publications in *Forum Geometricorum* on elementary geometry: *The Apollonius Circle as a Tucker Circle* (2002), joint with Paul Yiu; *On the Kosnita point and the reflection triangle* (2003); *Orthopoles and the Pappus Theorem* (2004), joint with Atul Dixit; *A Generalization of the Kiepert Hyperbola* (2004), joint with Alexei Myakishev; and problem 11025 proposed in the *American Mathematical Monthly* (joint with Floor van Lamoen).

Conference proceedings (peer-reviewed marked with #)

- 2024 Darij Grinberg, *A Solomon Mackey formula for graded bialgebras*, arXiv:2401.14648, talk given at CATMI 2023 Bergen.
- 2024 Darij Grinberg, Nadia Lafrenière, *The somewhere-to-below shuffles in the symmetric group and Hecke algebras (extended abstract)*, submitted to FPSAC 2024.
- # 2023 Darij Grinberg, Tom Roby, *Birational rowmotion over noncommutative rings (extended abstract)*, Séminaire Lotharingien de Combinatoire, 89B.50 (2023), 12 pp. (FPSAC 2023).
- # 2023 Darij Grinberg, Ekaterina A. Vassilieva, *The algebra of extended peaks (extended abstract)*, Séminaire Lotharingien de Combinatoire, 89B.46 (2023), 12 pp. (FPSAC 2023).
- # 2022 Darij Grinberg, Ekaterina A. Vassilieva, *A q -deformation of enriched P -partitions (extended abstract)*, Séminaire Lotharingien de Combinatoire, 86B.78 (2022), 12 pp. (FPSAC 2022).

- # **2021** Darij Grinberg, Ekaterina A. Vassilieva, *Weighted posets and the enriched monomial basis of $QSym$ (extended abstract)*, Séminaire Lotharingien de Combinatoire, 85B.58 (2021), 12 pp. (FPSAC 2021).
- # **2020** Darij Grinberg, *The Petrie symmetric functions (extended abstract)*, Séminaire Lotharingien de Combinatoire 84B.61 (2020), 12 pp. (FPSAC 2020).
- # **2020** Darij Grinberg, Fedor Petrov, *The Bhargava greedoid (extended abstract)*, Séminaire Lotharingien de Combinatoire 84B.47 (2020), 12 pp. (FPSAC 2020).
- # **2020** Alberto Dennunzio, Enrico Formenti, Darij Grinberg, Luciano Margara, *From Linear to Additive Cellular Automata*, Leibniz International Proceedings in Informatics (LIPIcs), Volume 168 (ICALP 2020).
- # **2019** Darij Grinberg, *A quotient of the ring of symmetric functions generalizing quantum cohomology (extended abstract)*, Séminaire Lotharingien de Combinatoire 82B.86 (2019), 12 pp. (FPSAC 2019).
- # **2018** Erik Aas, Darij Grinberg, Travis Scrimshaw, *Multiline queues with spectral parameters (extended abstract)*, Séminaire Lotharingien de Combinatoire, 80B.46 (2018), 12 pp. (FPSAC 2018).
- # **2017** Darij Grinberg, *Double Posets and the Antipode of $QSym$ (extended abstract)*, Séminaire Lotharingien de Combinatoire, 78B.33 (2017), 12 pp. (FPSAC 2017).
- # **2014** Darij Grinberg, Tom Roby, *The order of birational rowmotion (extended abstract)*, DMTCS Proceedings vol. AT, 26th International Conference on Formal Power Series and Algebraic Combinatorics (FPSAC 2014), pp. 753–764.

Teaching

- 2024** lecturer at Drexel University in [Math 221 \(Discrete Mathematics\)](#).
- 2024** lecturer at Drexel University in [Math 701 \(Algebraic Combinatorics\)](#).
- 2023** lecturer at Drexel University in [Math 235 \(Mathematical Problem Solving\)](#).
- 2023** lecturer at Drexel University in [Math 530 \(Graph Theory\)](#).
- 2023** lecturer at Drexel University in [Math 332 \(Abstract Algebra II: Rings and Fields\)](#).
- 2023** lecturer at Drexel University in [Math 221 \(Discrete Mathematics\)](#).

- 2022–2023** mentor in [Yulia's Dream](#) (a section of [the MIT's PRIMES program](#)), supervising a team of three Ukrainian students writing a paper on algebraic combinatorics.
- 2022** lecturer at Drexel University in [Math 222 \(Enumerative Combinatorics\)](#).
- 2022** lecturer at Drexel University in [Math 530 \(Graph Theory\)](#).
- 2021** lecturer at Drexel University in [Math 235 \(Mathematical Problem Solving\)](#).
- 2021** lecturer at Drexel University in [Math 220 \(Introduction to Mathematical Reasoning\)](#).
- 2021** lecturer at Drexel University in [Math 504 \(Advanced Linear Algebra and Matrix Analysis\)](#).
- 2021** lecturer at Drexel University in [Math 701 \(Algebraic Combinatorics\)](#).
- 2021** lecturer at Drexel University in [Math 533 \(Abstract Algebra I: Rings and Modules\)](#).
- 2020** lecturer at Drexel University in [Math 235 \(Mathematical Problem Solving\)](#).
- 2019** lecturer at Drexel University in [Math 201 \(Linear Algebra\)](#).
- 2019** lecturer at Drexel University in [Math 222 \(Enumerative Combinatorics\)](#).
- 2019** lecturer at UMN in [Math 4281 \(Introduction to Modern Algebra\)](#).
- 2018** lecturer at UMN in [Math 5705 \(Enumerative Combinatorics\)](#).
- 2018** lecturer at UMN in [Math 4707 \(Combinatorics\)](#).
- 2017** lecturer at UMN in [Math 4990 and Math 4707 \(two combinatorics classes\)](#).
- 2017** lecturer at UMN in [Math 5707 \(Graph Theory\)](#).
- 2016** lecturer at UMN in [Math 4242 \(Applied Linear Algebra\)](#).
- 2012–2015** mentor in [the MIT's PRIMES program](#), supervising [two projects](#) (2012, 2013) by William Kuszmaul and [one](#) (2014) by Eric Neyman, as well as a reading course by two new students (2015). In 2015, I was sponsored by a [George Lusztig PRIMES mentorship](#).
- 2015** teaching assistant at MIT in 18.781 (Theory of Numbers) by Ju-Lee Kim.
- 2014** teaching assistant and recitation leader at MIT in 18.06 (Linear Algebra) by Alexander Postnikov.

- 2013** teaching assistant at MIT in 18.310A (Principles of Discrete Applied Mathematics) by Neil Olver, and in 18.S996 (Category Theory for Scientists) by David Spivak.
- 2009** teaching assistant and recitation leader at LMU Munich in a Euclidean geometry class by Rudolf Fritsch.
- 2007** teaching assistant and recitation leader at LMU Munich in an Abstract Algebra I class by Hans-Jürgen Schneider.

Selected talks

- 2023** at [George Washington University 2023](#) and [Temple University 2023](#) on one-sided cycle shuffles in the symmetric group algebra.
- 2023** at [IPAC \(Important Papers in Algebraic Combinatorics, a zoom seminar\) 2023](#) and at [SLC 90 \(Bad Boll\) 2023](#) and in [Haverford College 2023](#) and at [Combinatorics and Arithmetic for Physics \(IHES\) 2023](#) on Redei-Berge symmetric functions.
- 2023** at [CATMI \(Category Theory at Work in Computational Mathematics and Theoretical Informatics\) 2023](#) on natural endomorphisms of connected graded bialgebras.
- 2023** at [Algebraic and Combinatorial Perspectives in the Mathematical Sciences 2023](#) on chromatic symmetric functions and their generalizations.
- 2023** at [KTH \(Stockholm\)](#) on noncommutative birational rowmotion.
- 2022** at [MIT \(Combinatorics seminar\)](#) on noncommutative birational rowmotion.
- 2022** at [Waterloo Algebraic Combinatorics Seminar](#) and at [Oberseminar Kombinatorik Bochum](#) and at [Combinatorics and Arithmetic for Physics \(IHES\) 2022](#) on one-sided cycle shuffles in the symmetric group algebra.
- 2022** at [New York Number Theory Zoom Seminar](#) on greedoids from ultrametric spaces and phylogenetic trees (with solutions to exercises).
- 2021** at [BIRS, Kelowna](#) and at [Combinatorics and Arithmetic for Physics \(IHES\) 2021](#) on noncommutative birational rowmotion.
- 2020** at [Algebraic and Combinatorial Perspectives in the Mathematical Sciences 2020](#) on the Pelletier–Ressayre symmetry of Littlewood–Richardson coefficients.
- 2020** at [Institut Mittag-Leffler](#) and at [Rutgers Experimental Mathematics Seminar \(more introductory version of the talk\)](#) on greedoids from ultrametric spaces and phylogenetic trees.

- 2020** at [Institut Mittag-Leffler](#) on the Petrie symmetric functions.
- 2019** at [Drexel University](#) and at [University of Minnesota \(Combinatorics seminar\)](#) on generalized quantum cohomology.
- 2018** at [University of Connecticut \(Algebra seminar\)](#) and at [Massachusetts Institute of Technology \(Combinatorics seminar\)](#) on generalized quantum cohomology.
- 2018** at [Dartmouth College Hanover](#) on shuffle-compatible permutation statistics.
- 2018** at [Leibniz Universität Hannover](#) on multiline queues.
- 2018** at [University of Minnesota Student Combinatorics Seminar, Minneapolis](#) on the diamond lemma (expository talk).
- 2018** at [University of Washington, Seattle](#) and at [University of Illinois Urbana-Champaign \(slightly streamlined version of above talk\)](#) on shuffle-compatible permutation statistics; also, [expository pre-talk for the latter talk](#).
- 2017** at [University of Wisconsin, Madison](#) on critical groups of Hopf algebra modules.
- 2017** at [Combinatorial Algebra meets Algebraic Combinatorics, UQAM, Montréal](#), and at [Cornell \(slightly extended version of Montréal talk\)](#) on function-field analogues of Witt vectors.
- 2016** at [AMS Sectional Meeting, University of St. Thomas, Minneapolis](#) on signs of reduced expressions.
- 2016** at the [Combinatorics Seminar at Brandeis](#) and at [Massachusetts Institute of Technology \(thesis defense\)](#) on quasisymmetric functions.
- 2015** at [University of Minnesota Combinatorics Seminar, Minneapolis](#) and at [AMS Sectional Meeting, Chicago](#) on refined dual stable Grothendieck polynomials.
- 2014** at [The Applied Algebra Seminar, York University, Toronto](#) on birational rowmotion.
- 2014** at [Arbeitsgemeinschaft Diskrete Mathematik, Vienna](#) on birational rowmotion.
- 2013** at [University of Connecticut](#) on integer-valued polynomials (expository talk).

Various contributions

2021– Co-organizing [the CAGE \(Combinatorics, Algebra, and Geometry\) Seminar](#) at Drexel University and University of Pennsylvania in the academic years 2021–2024.

2022–2023 Organizing [the Drexel Mathematics Colloquium](#).

2022 Organizing – jointly with Tom Roby – a virtual miniconference: [Birational Combinatorics, June 8, 2022](#).

2018 Organizing committee of [SageDays@ICERM, July 2018](#).

2012– [Programming and code review](#) for the [SageMath](#) project.

2010– Member of [MathOverflow](#) and [math.stackexchange](#), contributing over 500 answers.

2006– Grading/coordination in mathematical contests, including the [International Mathematical Olympiad](#) (2009 and 2011) and [Putnam Competition](#) (2020 and 2021). Administering the Putnam Competition at Drexel University (2020, 2021, 2023). Proposal of problems for the Putnam Competition (2023 B5 and B6).

2005– Mathematical exposition at various levels (mostly undergraduate) on [web-site](#).

Research mentored/advised

2014 [Eric Neyman, *Cylindric Young Tableaux and their Properties*, arXiv:1410.5039](#), mentored through the [MIT PRIMES](#) project.

2013 [William Kuszmaul, *A New Approach to Enumerating Statistics Modulo \$n\$* , arXiv:1402.3839](#), mentored through the [MIT PRIMES](#) project.

2012 [William Kuszmaul, *Counting Permutations Modulo Pattern-Replacement Equivalences for Three-Letter Patterns*, Electron. J. Comb., Volume 20, Issue 4 \(2013\), #P10](#), mentored through the [MIT PRIMES](#) project.

Awards and honors

2022 [2021-22 Devereux Award for Junior Faculty at Drexel University](#).

2015 [George Lusztig PRIMES mentorship](#) for “exceptional mentor service in past years”.

2008 first place in the 15th [Vojtěch Jarník Annual International Mathematical Competition](#) (a contest for university students).

2006–2011 scholarship from the [Studienstiftung des Deutschen Volkes](#).

2006 gold medal in the [International Mathematical Olympiad](#).

2004–2005 silver medals in the International Mathematical Olympiad.

2003–2006 Bundessieger (national-level award) in the [Bundeswettbewerb Mathematik Deutschland](#) (German national mathematical olympiad).