

Alejandro H. Morales

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Education

- 2007-2012 **Ph.D. Mathematics**, Massachusetts Institute of Technology, USA
advisor: Alexander Postnikov
Thesis: *Combinatorics of colored factorizations, flow polytopes, and matrices over finite fields*
- 2002-2007 **B. of Mathematics**, University of Waterloo, Canada

Employment history

- 2017- **Assistant Professor** tenure-track, University of Massachusetts, Amherst
Department of Mathematics and Statistics
- 2014-2017 **Hedrick Assistant Professor** non-tenure, University of California, Los Angeles
Department of Mathematics
mentor: Igor Pak
- 2012-2014 **CRM-ISM Postdoctoral Fellow**, Université du Québec à Montréal
Laboratoire de combinatoire et d'informatique mathématique
mentor: François Bergeron

Awards and Grants

- 2022-2025 **NSF Grant**, Combinatorics DMS-22030407, \$205,601
- 2019-2023 **NSF Grant**, Combinatorics DMS-1855536, \$150,000,
\$17,615 REU supplement
- 2017 **Admitted in research associate competition**, CNRS, France
- 2016-2018 **AMS-Simons Travel Grant**, \$5,000
- 2012 **Charles and Holly Housman Award for Teaching**, Math Department, MIT

Research Interests

My research is in enumerative and algebraic combinatorics. I study enumeration and asymptotics of skew tableaux, linear extensions of posets and objects related to Schubert polynomials using tools from algebra and bijections. This is related to an emergent area called *asymptotic algebraic combinatorics*. I also study a rich family of polytopes called *flow polytopes of graphs* related to representation theory and diagonal harmonics. In addition, I investigate the enumeration of factorizations of permutations and other groups using combinatorial and algebraic methods.

Advising and mentoring

postdocs	2020-	Theo Douvropoulos
	2019-2021	Laura Colmenarejo (now TT NCState)
graduate students	2019-2022	GaYee Park (postdoc LaCIM, UQAM)
	2022-	Jesse Selover
undergrad research	2022-	William Dugan
	2022	Pablo Castilla, Isaac MacArthur (UMass)
	2021	Maura Hegarty (UMass)
	2020	Peter Cassels (UMass)
	2019	Max Liu (Mount Holyoke)
highschool research	2018	Wilson Wang (UMass)
	2020, 2018	William Shi, Daniel Zhu (MIT PRIMES program)

Publications

Books

1. *Algebraic and Geometric Combinatorics: proceedings of ECCO*, with co-editors Federico Ardila, and Carolina Benedetti, Cambridge University Press, expected Spring 2023.

Preprints

1. *Hurwitz numbers for reflection groups II: Parabolic quasi-Coxeter elements*, with Theo Douvropoulos and Joel Brewster Lewis, 2022, arXiv:2209.00066
2. *The Newton polytope and Lorentzian property of chromatic symmetric functions*, with Jacob Matherne and Jesse Selover, 2022, arXiv:2201.07333, submitted
3. *Bijections and hidden symmetries for skew staircase shapes*, with Zachary Hamaker, Igor Pak, Luis Serrano, and Nathan Williams, 2021, arxiv:2103.09551, submitted

Papers

1. *Chromatic symmetric functions of Dyck paths and q -rook theory*, with Laura Colmenarejo and Greta Panova, 2020, arxiv:2104.07599, accepted *European Journal of Combinatorics*
Related extended abstract in Proceedings FPSAC, Israel 2021
2. *Column convex matrices, G -cyclic orders, and flow polytopes*, with Rafael S. González D'León, Christopher R. H. Hanusa and Martha Yip, 2021, arxiv:2107.07326, accepted *Discrete & Computational Geometry*
3. *Hurwitz numbers for reflection groups I: Generatingfunctionology*, with Theo Douvropoulos and Joel Brewster Lewis, 2021, *Enumerative Combinatorics and Applications*, Vol 2 (2022) Article #S2R20, arXiv:2112.03427
Related extended abstract in Proceedings FPSAC, Israel 2021
4. *Hook formulas for skew shapes IV. Increasing tableaux and factorial Grothendieck polynomials*, with Igor Pak and Greta Panova, *Zap. Nauchn. Sem. S.-Peterburg. Otdel. Mat. Inst. Steklov. (POMI)*, 507 (2021), Special issue in memory of S. Kerov, arXiv:2108.10140

5. *Refinements and Symmetries of the Morris identity for volumes of flow polytopes*, with William Shi, *Comptes Rendus Mathématique*, **359** (2021), 823-851, 2021, arxiv:2102.05825
6. *On the Okounkov-Olshanski formula for standard tableaux of skew shapes*, with Daniel Zhu, *Combinatorial Theory*, **2** (2022), no. 1, arXiv:2007.05006
Related extended abstract in Proceedings FPSAC, online 2020
7. *Counting linear extensions of posets with determinants of hook lengths*, with Alexander Garver, Jacob Matherne, Stefan Grosser, *SIAM Journal of Discrete Math (SIDMA)*, **35** (2021), 205-233, arxiv:2001.08822
Related extended abstract in Proceedings FPSAC, Israel 2021
8. *Kostant's partition function and magic multiplex juggling sequences*, with Christopher R. H. Hanusa, Pamela E. Harris, and Anthony Simpson, *Annals of Combinatorics*, **24** (2020), 439-473, arxiv:2001.03219, submitted
9. *Factorization problems in complex reflection groups*, with Joel Brewster Lewis, *Canadian Journal of Mathematics*, **73** (2021) 899-946, arxiv:1906.11961
Related extended abstract in Proceedings FPSAC, Slovenia 2019
10. *Towards a more algebraic footing for quantum field theory*, with David M. Jackson and Achim Kempf, *Journal of Physics A: Mathematical and Theoretical* **54** No. 285201, arxiv:1805.09812
11. *A combinatorial model for computing volumes of flow polytopes*, with Carolina Benedetti, Rafael S. González D'León, Christopher R. H. Hanusa, Pamela E. Harris, Apoorva Khare, and Martha Yip, *Transactions of the American Mathematical Society*, **372** (2019), 3369-3404, arxiv:1801.07684
Related extended abstract in Proceedings FPSAC, Dartmouth 2018
12. *Volumes and Ehrhart polynomials of flow polytopes*, with Karola Mészáros, *Mathematische Zeitschrift*, 293 (2019), 1369-1401, arxiv:1710.00701
13. *Asymptotics for the number of standard tableaux of skew shape and for weighted lozenge tilings*, with Igor Pak and Martin Tassy, accepted *Combinatorics Probability and Computing*, 2018, arxiv:1805.00992
14. *Asymptotics of principal evaluations of Schubert polynomials for layered permutations*, with Igor Pak and Greta Panova, *Proceedings of the American Mathematical Society*, **147** (2019), 1377-1389, arxiv:1805.04341
15. *Rook theory for the finite general linear group*, with Joel B. Lewis, **Experimental Mathematics** **29** (2020), 328–346, arxiv:1707.08192
Experimental Mathematics, (2018), arxiv:1707.08192
16. *Hook formulas for skew shapes III. Multivariate and product formulas*, with Igor Pak and Greta Panova, *Algebraic Combinatorics*, **2** (2019), 815–861, arxiv:1707.00931
17. *Why is $\pi < 2\phi$* , with Igor Pak and Greta Panova, 2016, *American Math Monthly*, **125** (2018), 715–723, math.ucla.edu/~ahmorales/papers/EulFib.pdf
18. *Flow polytopes and the space of diagonal harmonics*, with Ricky I. Liu and Karola Mészáros, *Canadian Journal of Mathematics*, **71** (2019), 1495–1521, arxiv:1610.08370

19. *Asymptotics of the number of standard Young tableaux of skew shapes*, with Igor Pak and Greta Panova, *European Journal of Combinatorics*, **70** (2018), 26–49, arxiv:1610.07561
20. *Hook formulas for skew shapes II. Combinatorial proofs and enumerative applications*, with Igor Pak and Greta Panova, *SIAM Journal of Discrete Math (SIDMA)*, **31** (2017), 1953–1989, 2016, arxiv:1610.04744
21. *Hook formulas for skew shapes I: q-analogues and bijections*, with Igor Pak and Greta Panova, *Journal of Combinatorial Theory Series A* **154** (2018), 350–405, arXiv:1512.08348
Related extended abstract in Proceedings FPSAC, Canada 2016, 899-910
22. *On flow polytopes, order polytopes, and certain faces of the alternating sign matrix polytope*, with Karola Mészáros and Jessica Striker, *Discrete & Computational Geometry*, **62** (2019), 128–163, arXiv:1510.03357 (major update V2. 2019)
23. *A robust generalization of the Legendre transform for QFT*, with Achim Kempf and David M. Jackson, *J. Phys. A*, **50** (2017), arxiv:1612.00462,
24. *The polytope of Tesler matrices*, with Karola Mészáros and Brendon Rhoades, *Sel. Math. New Ser.*, **23** (2017) arXiv:1409.8566
Related extended abstract in Proceedings FPSAC, Korea 2015, 205-216
25. *$GL_n(q)$ -analogues of factorization questions in \mathfrak{S}_n* , with Joel B. Lewis, *European J. Combin.* **58** (2016), arXiv:1511.00711
Related extended abstract in Proceedings FPSAC, Canada 2016, 755-766
26. *Some probabilistic trees with algebraic roots*, with Olivier Bernardi, *Electron. J. Combin.*, **23** (2016), arXiv:1501.01135
27. *Combinatorics of diagrams of permutations*, with Joel B. Lewis, *J. Combin. Theory Ser. A*, **137** (2016), 273-306, arXiv:1405.1608;
Related extended abstract in Proceedings FPSAC, USA 2014, 703-714
28. *Flow polytopes of signed graphs and the Kostant partition function*, with Karola Mészáros, *Int. Math. Res. Notices*, No 3 (2015), 830-871, arXiv:1208.0140
29. *New Dirac Delta function based methods with applications to perturbative expansions in quantum field theory and beyond*, with Achim Kempf and David M. Jackson, *J. Phys. A Math.*, **47** (2014), arXiv:1404.0747
30. *Structure and enumeration of $(3+1)$ -free posets*, with Mathieu Guay-Paquet and Eric Rowland, *Ann. Comb.*, **18**, No 4 (2014), 645-674 arXiv:1303.3652
Related extended abstract in Proceedings FPSAC, France 2013, 253-264
31. *Separation probabilities for products of permutations*, with Olivier Bernardi, Rosena R.X. Du, Richard P. Stanley, *Combin. Probab. Comput.*, **23**, No 2 (2014) 201-222, arXiv:1202.6471
32. *Counting trees using symmetries*, with Olivier Bernardi, *J. Combin. Theory Ser. A*, **123**, No 1 (2014) 104-122, arXiv:1206.0598
33. *Counting matrices over finite fields with support on skew Young and Rothe diagrams*, with Aaron J. Klein and Joel B. Lewis, *J. Algebraic Combin.*, **39**, No 2 (2014) 429-456, arXiv:1203.5804

34. *Bijections and symmetries for the factorizations of the long cycle*, with Olivier Bernardi, *Adv. in Appl. Math.*, **50**, No 5 (2013) 702-722, [arXiv:1112.4970](#)
35. *Direct bijective computation of the generating series for 2 and 3-connection coefficients of the symmetric group*, with Ekaterina Vassilieva, *Electron. J. Combin.*, **20**, No 2 (2013), [arXiv:1101.3614](#);
Related extended abstract in Proceedings FPSAC, Austria 2009, 663-674
36. *Matrices with restricted entries and q -analogues of permutations*, with Joel B. Lewis, Ricky Liu, Greta Panova, Steven V Sam, Yan Zhang, *J. of Combin.*, **2**, No 3 (2012) 355-396, [arXiv:1011.4539](#);
Related extended abstract in Proceedings FPSAC, Iceland 2011, 645-656
37. *$E7(7)$ constraints on counterterms in $N=8$ supergravity*, with N. Beisert, H. Elvang, D. Z. Freedman, M. Kiermaier, S. Stieberger, *Phys. Lett. B*, **694**, No 3 (2010) 265-271, [arXiv:1009.1643](#)
38. *On the group-like behaviour of the Le-Murakami-Ohtsuki Invariant*, with D. M. Jackson and I. Moffatt, *J. Knot Theory Ramifications*, **16**, No 6 (2007) 699-718, [arXiv:QA/0511452](#)

Conference Proceedings

1. *Efficient routing for cost effective scale-out data architectures*, with Ashwin Narayan, Anna King, Vuk Markovic, Natalia Postawa, K. Ashwin Kumar, and Petros Efstathopoulos, 2016, [arXiv:1606.08884](#), short paper Proceedings MASCOTS 2016, London, 424-429
2. *How to (path-) integrate by differentiating*, with Achim Kempf and David M. Jackson, DICE2014, Castiglioncello, *J. Phys.: Conf. Ser.* **626** (2015) 012015
3. *Bijective evaluation of the connection coefficients of the double coset algebra*, with Ekaterina Vassilieva, 2010, [arXiv:1011.5001](#);
Related extended abstract in Proceedings FPSAC, Iceland 2011, 681-692
4. *On the Structure of QFT in the Particle Picture of the Path Integral Formulation*, with D. M. Jackson and A. Kempf, 2008, [arXiv:0810.4293](#);

Conference Talks

- virtual talk REU, ICERM, July 2022
- ISM Discovery School on Hessenberg varieties and symmetric functions, ISM, Montreal, June 2022
- AIM workshop Ehrhart polynomials: inequalities and extremal constructions, AIM, San Jose, May 2022
- Joint Math meetings, AMS special session on Latinxs in Combinatorics, virtual April 2022
- Contributed talk by coauthor, Formal Power Series and Algebraic Combinatorics Conference (FPSAC 2021), virtual January 2022

- SIAM Algebraic Geometry Conference, session Rank-Metric and Subspace Codes, virtual August 2021
- MATRIX, Integrability Combinatorics and Finite Temperature program, contributed talk, virtual January 2021
- Invited talk, Algebra, Geometry and Combinatorics Day XX, virtual, hosted by DePaul University, December 2020
- Invited talk, Discrete Math Day of the NorthEast, virtual hosted by SUNY Albany, April 2020
- IPAM, Workshop Asymptotic Algebraic Combinatorics, Los Angeles, February 2020
- Institut Mittag Leffler, Combinatorics and Random Processes, Djursholm, Sweden, January 2020
- Invited speaker, 34th Clemson Mini-Conference on Discrete Mathematics and Algorithms, Clemson, October 2019
- Contributed talk by coauthor, Formal Power Series and Algebraic Combinatorics Conference (FPSAC 2019), Ljubljana, Slovenia, July 2019
- Canadam 2019, Invited minisymposia Enumerative combinatorics, Vancouver, May 2019
- AMS Sectional Meeting, special session combinatorial commutative algebra and polyhedral geometry, Hartford, April 2019
- BIRS Banff, Workshop Asymptotic Algebraic Combinatorics, Banff, March 2019
- Joint Math meetings, AMS special session Latinx math, Baltimore, January 2019
- CRM 50th Anniversary, Conference Algebra and Combinatorics at LaCIM, Montreal, QC, Canada, September 2018
- ICM Satellite Meeting: A Pan-Hemispheric Celebration of Mathematics in Miami , Miami, July 2018
- AMS Sectional Meeting, special session on Combinatorial Representation Theory, Boston, MA. April 2018
- CMS winter meeting, session Symmetric Functions and Generalizations, Waterloo, Canada, December 2017
- Scientific symposia session, SACNAS, Salt Lake City, October 2017
- AMS sectional meeting, session, Polynomials in enumerative, algebraic, and geometric combinatorics, Buffalo, September 2017

Talks in Seminars

- **Colloquia:** Reed (virtual March 2022), Waterloo (January 2020), Wesleyan (October 2018), Tulane (March 2018),
- **Seminars:** Berkeley (virtual March 2021), Brandeis (October 2018), Brown (November 2018), Cornell (virtual March 2022), Dartmouth College (May 2019, November 2017), Michigan State (virtual February 2022), MIT (February 2018, April 2018, March 2020), New York combinatorics seminar (virtual December 2020), San Francisco State University (February 2021), UCSD (virtual April 2021), UIUC (February 2021), UMass Amherst (September 2017), Vermont (October 2021), University of Washington (virtual June 2020), Waterloo (May 2018)
- **Student seminars:** UMass (2018, 2019, 2022), Smith (2017)

Professional service

- Handling Editor, Combinatorial Theory, 2021-
- Committee member evaluation group Mathematics and Statistics, NSERC, Canada, 2022-2024.
- Refereeing:

Adv. in Math.	Electron. J. Combin.
Bull. London Math. Soc.	J. Algebraic Combin.
Proc. ANALCO17	J. Combin. Theory Ser. A
Australas. J. of Combin.	Proc. Amer. Math. Soc.
Canad. J. Math.	Proc. FPSAC 2015, 17, 18, 19, 20, 21
Discrete Math.	SIAM J. Discrete Math.
- Steering Committee member, Encuentro Colombiano de Combinatoria (ECCO) 2022, Colombia, 2022-2024
- Scientific Committee co-chair, Encuentro Colombiano de Combinatoria (ECCO) 2022, Colombia, June 2022
- Scientific Committee member, Formal Power Series and Algebraic Combinatorics Conference (FPSAC) 2022, India, July 2022
- Chair organizing committee, Formal Power Series and Algebraic Combinatorics Conference (FPSAC) 2020 online, July 2020
- Co-organizer, BIRS workshop asymptotic algebraic combinatorics, March 2019
- Co-organizer, discrete math seminar, UMass Amherst, January 2018 - , Combinatorics seminar, UCLA, October 2014 - May 2017
- Organizing committee: c_2 invariant meets rook theory, Berlin 2019, Discrete Math Days of the NorthEast 2019, FPSAC 2018 Dartmouth, SOCALDM 2017, SOCALDM 2016 Los Angeles, CombStructPQFT 2016 Burnaby, Colombian combinatorics conferences (ECCO 2012, ECCO 2014, ECCO 2016, ECCO 2018, DIAS 2020)

Selected Conferences

- Oberwolfach Workshop Enumerative Combinatorics, Oberwolfach Germany, December 2022
- ISM Discovery School on Hessenberg varieties, Montreal, June 2022
- AIM Workshop Ehrhart polynomials: inequalities and extremal constructions, May 2022
- AIM SQuaRE, Computing volumes of flow polytopes, 2019, 2020, 2021, 2022
- AIM SQuaRE, Asymptotics of Standard Young Tableaux 2020, 2021, 2023
- AIM Latinx Mathematician Research Community, virtual, June 2021
- CanaDAM 2019, 2021 (virtual)
- FPSAC conference 2018, 2020, 2021
- Oberwolfach Workshop Enumerative Combinatorics, Oberwolfach Germany, May 2018