

Curriculum Vitae

MARK SKANDERA

Email: mas906@lehigh.edu
Web: www.lehigh.edu/mas906/
Office phone: (610) 758-3786
Home phone: (610) 838-7888
Fax: (610) 758-3767

Department of Mathematics
Lehigh University
Chandler Ullman Hall
17 Memorial Drive East
Bethlehem, PA 18015

Citizenship: United States.

Research interests:

Algebraic combinatorics: special bases of quantum groups and Hecke algebras, total nonnegativity, Hecke algebra characters, symmetric functions, polynomials with real zeros, partially ordered sets.

Education:

MASSACHUSETTS INSTITUTE OF TECHNOLOGY Cambridge, MA
September 1996 – May 2000
Ph.D., Applied Mathematics, May 2000. Thesis *Chain Polynomials and Permutation Statistics* supervised by Richard Stanley.

UNIVERSITY OF CALIFORNIA Berkeley, CA
September 1991 – May 1993
M.S., Operations Research, May 1992.

BROWN UNIVERSITY Providence, RI
September 1987 – May 1991
Sc.B., Applied Mathematics, May 1991.

Professional history:

LEHIGH UNIVERSITY Bethlehem, PA
August 2006 – present
Associate professor. Designing, teaching, and coordinating courses in calculus, linear algebra, algebra, combinatorics, statistics. Writing graduate comprehensive exams and qualifying exams. Advising undergraduate math majors and freshmen. Supervising undergraduate, doctoral, and other research.

Date: October 30, 2019

UNIVERSITY OF PENNSYLVANIA Philadelphia, PA
January 2009 – present
Visiting researcher. Studying Hecke algebra characters. Supervising doctoral and other research. Coorganizing combinatorics seminar.

UNIVERSIDAD DE LOS ANDES Bogotá, Colombia
July 2014 – July 2015
Visiting professor. Taught courses in calculus, algebra, combinatorics. Studied combinatorial interpretations of Hecke algebra characters.

HAVERFORD COLLEGE Haverford, PA
July 2005 – June 2006
Visiting assistant professor. Taught undergraduate courses in calculus, combinatorics. Supervised undergraduate theses. Organized mathematics colloquium.

INSTITUT MITTAG-LEFFLER Djursholm, Sweden
April 2005 – June 2005
Visiting researcher. Studied the dual canonical basis of $\mathcal{O}(SL_n\mathbb{C})$.

DARTMOUTH COLLEGE Hanover, NH
August 2003 – July 2005
John Wesley Young instructor. Taught undergraduate courses in calculus, combinatorics, differential equations, probability. Taught a graduate course in combinatorics. Supervised undergraduate research. Coorganized combinatorics seminar.

UNIVERSITY OF MICHIGAN Ann Arbor, MI
September 2000 – July 2003
VIGRE Postdoctoral fellow. Taught undergraduate courses in calculus, linear algebra, probability. Designed and taught a graduate course in combinatorics. Supervised undergraduate research. Coorganized combinatorics seminar.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY Cambridge, MA
September 1999 – December 2000
Linear algebra teaching assistant for Professor Gilbert Strang.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY Cambridge, MA
September 1998 – January 1999
Coordinator of Mathematics Tutoring Room and undergraduate grading.

BOSTON TREASURY SYSTEMS Cambridge, MA
BANCO SANTANDER Madrid, Spain
January 1994 – May 1996
Software engineer.

Articles in refereed journals:

1. “Bases of the quantum matrix bialgebra and induced sign characters of the Hecke algebra”, (with Justin Lambright and Ryan Kaliszewski), *J. Algebr. Comb.*, **49** no. 4 (2019), pp. 475–505.

Combinatorial interpretations are given for nonnegative integer coefficients of polynomials which relate natural bases of the quantum matrix bialgebra. These interpretations lead to a combinatorial formula for the evaluation of induced sign characters at “wiring diagram” products of Kazhdan-Lusztig basis elements of the Hecke algebra. This result is the first cancelation-free rule for evaluating all elements of a basis of the Hecke algebra trace space at all elements of a basis of the Hecke algebra.

2. “Evaluations of Hecke algebra traces at Kazhdan-Lusztig basis elements”, (with Sam Clearman, Matthew Hyatt, and Brittany Shelton), *Elec. J. Combin.*, **23** no. 2 (2016), #P2.7.

For all elements θ_q of four bases of the Hecke algebra trace space, and for Kazhdan-Lusztig basis elements $C'_w(q)$ corresponding to smooth permutations w , combinatorial formulas are given for the evaluations $\theta_q(q^{\frac{\ell(w)}{2}} C'_w(q))$. This confirms a conjecture of Haiman and proves a weakening of another. It also gives an algebraic interpretation of a result of Shareshian and Wachs.

3. “Tres lecciones en combinatoria algebraica. III: Aspectos combinatorios de los arreglos de hiperplanos”, (with Federico Ardila, Emerson León, Mercedes Rosas), *universo.math*, **1** no. 3 (2014), Artículo 3.

An expository article in Spanish presenting hyperplane arrangements from a combinatorial point of view.

4. “Tres lecciones en combinatoria algebraica. II: Funciones simétricas y teoría de representaciones”, (with Federico Ardila, Emerson León, Mercedes Rosas), *universo.math*, **1** no. 2 (2014), Artículo 5.

An expository article in Spanish introducing representation theory of the symmetric group and its connection to symmetric functions.

5. “Tres lecciones en combinatoria algebraica. I: Nonegatividad total”, (with Federico Ardila, Emerson León, Mercedes Rosas), *universo.math*, **1** no. 1 (2014), Artículo 5.

An expository article in Spanish about current problems in total nonnegativity and Schur nonnegativity.

6. “Bitableaux and zero sets of dual canonical basis elements”, (with Brendon Rhoades), *Ann. Comb.*, **15** no. 3 (2011), pp. 499–528.

The transition matrix between these two bases of $\mathcal{O}(SL_n\mathbb{C})$, is shown to be unitriangular. Natural filtrations of the zero-weight space of $\mathbb{C}[x_{1,1}, \dots, x_{n,n}]$ defined in terms of dual canonical basis elements are shown to be equal to others defined in terms of bitableaux. Zero sets of dual canonical basis elements are related to repetition patterns among matrix rows and columns.

7. “Inequalities for symmetric means”, (with Allison Cuttler and Curtis Greene), *Europ. J. Combin.*, **32** no. 6 (2011), pp. 745–761.
New symmetric function inequalities are obtained. These generalize classical inequalities of Muirhead, Maclaurin and others.
8. “Generating functions for Hecke algebra characters”, (with Matjaz Konvalinka), *Canad. J. Math.*, **63** no. 2 (2011), pp. 413–435.
Generating functions for Hecke algebra characters are obtained by naturally quantizing those for symmetric group characters. These are shown to satisfy quantum analogs of identities due to Littlewood-Merris-Watkins, Goulden-Jackson, Muir, and others.
9. “Relations between the Clausen and Kazhdan-Lusztig representations of the symmetric group”, (with Charles Buehrle), *J. Pure Appl. Algebra*, **214** no. 5 (2010), pp. 689–700.
Kazhdan-Lusztig polynomials are used to construct Clausen’s irreducible S_n -modules as subspaces of $\mathbb{C}[x_{1,1}, \dots, x_{n,n}]$. The Kazhdan-Lusztig matrices are thus obtained without relying upon the Kazhdan-Lusztig preorders, and are shown to be related to the matrices of Clausen by a unitriangular transition matrix.
10. “Kazhdan-Lusztig immanants, II”, (with Brendon Rhoades), *Linear Multilinear Algebra*, **58** no. 1-2 (2010), pp. 137–150.
For each permutation whose one-line notation contains no decreasing subsequence of length k , the corresponding Kazhdan-Lusztig immanant is shown to vanish on all matrices having k equal rows or columns. The linear span of such immanants is related to products of k matrix minors.
11. “On the dual canonical and Kazhdan-Lusztig bases and 3412, 4231-avoiding permutations”, *J. Pure App. Algebra*, **212** (2008), pp. 1086–1104.
The dual canonical basis of $\mathcal{O}(SL_n\mathbb{C})$ is described in terms of immanants and Kazhdan-Lusztig polynomials. The difference between the dual canonical cone and the totally nonnegative elements of $\mathcal{O}(SL_n\mathbb{C})$ is related to singular Schubert varieties.
12. “The cluster basis of $\mathbb{Z}[x_{1,1}, \dots, x_{3,3}]$ ”, *Elec. J. Combin.*, **14** no. 1 (2007), #R76.
The set of cluster monomials for the cluster algebra of type D_4 is shown to contain a basis for this ring and to be related to the natural and dual canonical bases of the ring by unitriangular transition matrices.
13. “Multicomplexes and polynomials with real zeros” (with Jason Bell), *Discrete Math.*, **307** no. 6 (2006), pp. 668–682.
Each polynomial $a(z) = 1 + a_1z + \dots + a_dz^d$ in $\mathbb{N}[z]$ having only real zeros is shown to be the f -polynomial of a multicomplex. This implies that $a(z)$ is also the h -polynomial of a Cohen-Macaulay ring and the g -polynomial of a simplicial polytope. More results suggest that $a(z)$ is also the f -polynomial of a simplicial complex.
14. “Kazhdan-Lusztig immanants”, (with Brendon Rhoades), *J. Algebra*, **304** no. 2 (2006), pp. 793–811.

Functions generalizing the determinant are defined in terms of Kazhdan-Lusztig polynomials. These are shown to be totally nonnegative and Schur nonnegative, and to generalize the Temperley-Lieb immanants defined below. This implies the Schur nonnegativity of certain differences of products of skew Schur functions.

15. “Monomial nonnegativity and the Bruhat order”, (with Brian Drake, Sean Gerrish), *Elec. J. Combin.*, **11** no. 2 (2005), #R18.
A natural order concerning monomial nonnegativity is shown to be isomorphic to the Bruhat order.
16. “Temperley-Lieb immanants”, (with Brendon Rhoades), *Ann. Comb.*, **9** no. 4 (2005), pp. 451–494.
Functions generalizing the determinant are defined in terms of the Temperley-Lieb algebra. These are shown to be totally nonnegative and to provide a characterization of totally nonnegative polynomials constructed from products of pairs of matrix minors.
17. “Inequalities in minors of totally nonnegative matrices”, *J. Alg. Combin.*, **20** no. 2 (2004), pp. 195–211.
All inequalities of the form $\Delta_{S,S'}\Delta_{T,T'} \leq \Delta_{U,U'}\Delta_{V,V'}$ which hold for totally nonnegative matrices are characterized. The proof provides a combinatorial interpretation for the difference of the two products.
18. “Two new criteria for comparison in the Bruhat order”, (with Brian Drake, Sean Gerrish), *Elec. J. Combin.*, **11** no. 1 (2004), #N6.
Two natural orders concerning total nonnegativity and Schur nonnegativity are shown to be isomorphic to the Bruhat order.
19. “Total nonnegativity and $(\mathbf{3} + \mathbf{1})$ -free posets” (with Brian Reed), *J. Combin. Theory Ser. A.*, **103** (2003), pp. 237–256.
The class of $(\mathbf{3} + \mathbf{1})$ -free posets is related to the class of unit interval orders using totally nonnegative matrices. This relationship proves that the f -vector of a $(\mathbf{3} + \mathbf{1})$ -free poset is also the f -vector of a unit interval order.
20. “Interpretaciones del h -vector”, *Bol. Asoc. Mat. Ven.*, **2** (2001), pp. 141–174.
An expository article in Spanish about various interpretations of h -vectors, important results, and open problems.
21. “An Eulerian partner for inversions”, *Sém. Loth. Combin.*, **46** (2001), B46d.
A simple new Eulerian statistic “ stc ” is defined in order to be paired with the statistic INV in a result which asserts the equidistribution on S_n of (stc, INV) and (des, MAJ) .
22. “Dumont’s statistic on words”, *Elec. J. Combin.*, **8** no. 1 (2001), #R11.
Dumont’s permutation statistic is generalized to words. The generalized statistic is shown to be equidistributed with the word statistic des on the rearrangement class of

any word. This equidistribution is used to show that the h -vectors of certain distributive lattices are f -vectors of posets.

23. “A Characterization of $(\mathbf{3} + \mathbf{1})$ -free posets”, *J. Combin. Theory Ser. A.*, **93** no. 2 (2001), pp. 231–241.
 $(\mathbf{3} + \mathbf{1})$ -free posets are characterized in terms of their antiadjacency matrices. This characterization relates $(\mathbf{3} + \mathbf{1})$ -free posets to totally nonnegative matrices and gives an easy proof that the corresponding f -polynomials have only real zeros.

Articles to appear in refereed journals:

1. “Total nonnegativity and induced sign characters of the Hecke algebra”, (with Adam Clearwater), (2019). Certain products of Kazhdan-Lusztig basis elements of the Hecke algebra are related to totally nonnegative polynomials previously studied by Stembridge and others. A combinatorial formula is given for the evaluation of induced sign characters at these products.

Articles in refereed conference proceedings:

1. “Total nonnegativity and induced sign characters of the Hecke algebra”, (with Adam Clearwater), in *Proceedings of the 31st annual Conference on Formal Power Series and Algebraic Combinatorics*, 2019. Ljubljana, Slovenia. (Shorter version of the submitted manuscript coauthored with Clearwater.)
2. “Bases of the quantum matrix bialgebra and induced sign characters of the Hecke algebra”, (with Justin Lambricht and Ryan Kaliszewski), in *Proceedings of the 30th annual Conference on Formal Power Series and Algebraic Combinatorics*, 2018. Hanover, New Hampshire.
 (Shorter version of the journal article coauthored with Lambricht and Kaliszewski.)
3. “Evaluations of Hecke algebra characters at Kazhdan-Lusztig basis elements”, (with Sam Clearman, Matthew Hyatt, and Brittany Shelton), in *Proceedings of the 25th annual Conference on Formal Power Series and Algebraic Combinatorics*, 2013. Paris, France.
 A combinatorial formula is given for the evaluation of induced sign characters of the Hecke algebra at certain Kazhdan-Lusztig basis elements. This proves that the quantum chromatic symmetric functions of Shareshian and Wachs are generating functions for Hecke algebra characters. (Part of journal article coauthored with Clearman, Hyatt, and Shelton.)
4. “Hecke algebra characters and quantum chromatic symmetric functions”, (with Sam Clearman and Brittany Shelton), in *Proceedings of the 24th annual Conference on Formal Power Series and Algebraic Combinatorics*, 2012. Nagoya, Japan.
 A combinatorial conjecture is given for the evaluation of induced sign characters of

the Hecke algebra at certain Kazhdan-Lusztig basis elements. Part of the proof of the conjecture is given, and connections to the quantum chromatic symmetric functions of Shareshian and Wachs are explained. (Part of journal article coauthored with Clearman, Hyatt, and Shelton.)

5. “Path tableaux and combinatorial interpretations of immanants for class functions on S_n ”, (with Sam Clearman and Brittany Shelton), in *Proceedings of the 23rd annual Conference on Formal Power Series and Algebraic Combinatorics*, 2011. Reykjavik, Iceland.

Combinatorial interpretations are given for the evaluation of certain class immanants at totally nonnegative matrices. This strengthens a result of Stembridge and provides evidence in favor of a conjecture of Stembridge. (Part of journal article coauthored with Clearman, Hyatt, and Shelton.)

6. “Combinatorial formulas for double parabolic R -polynomials”, (with Justin Lambright), in *Proceedings of the 22nd annual Conference on Formal Power Series and Algebraic Combinatorics*, 2010. San Francisco.

Combinatorial interpretations are given for nonnegative integer coefficients of polynomials which arise as entries in transition matrices relating natural bases of Hecke algebra modules, and relating natural bases of the quantum polynomial ring. Special cases of these polynomials are double parabolic generalizations of Dyer’s modified R -polynomials

7. “A preorder-free construction of the Kazhdan-Lusztig representations of Hecke algebras of the symmetric group”, (with Charles Buehrle), in *Proceedings of the 22nd annual Conference on Formal Power Series and Algebraic Combinatorics*, 2010. San Francisco. Kazhdan-Lusztig polynomials are used to construct irreducible Hecke algebra modules as subspaces of the quantum polynomial ring, and special bases of these modules. This work provides quantum analogs of two previous constructions of irreducible S_n -modules, due to Clausen and to the authors. Matrices corresponding to the authors’ bases agree with those obtained differently by Kazhdan and Lusztig, while avoiding the Kazhdan-Lusztig preorders.

8. “Double parabolic Kazhdan-Lusztig polynomials and an immanant formulation of the dual canonical basis”, (with Justin Lambright), in *Proceedings of the 21st annual Conference on Formal Power Series and Algebraic Combinatorics*, 2009. Linz, Austria.

Double parabolic generalizations of Kazhdan-Lusztig polynomials and R -polynomials are shown to appear naturally in modules associated to $\mathcal{O}_q(SL_n\mathbb{C})$, and to possess properties analogous to those of the traditional polynomials. The dual canonical basis of $\mathcal{O}_q(SL_n\mathbb{C})$ is expressed in terms of quantum immanants.

9. “Relations between the Clausen and Kazhdan-Lusztig representations of the symmetric group”, (with Charles Buehrle), in *Proceedings of the 21st annual Conference on*

Formal Power Series and Algebraic Combinatorics, 2009. Linz, Austria.
(Shorter version of journal article of the same name.)

10. “The Cluster basis of $\mathbb{Z}[x_{1,1}, \dots, x_{3,3}]$ ”, in *Proceedings of the 20th annual Conference on Formal Power Series and Algebraic Combinatorics*, 2008. Valparaiso, Chile.
(Essentially the same as journal article of the same name.)
11. “A Quantization of a theorem of Goulden and Jackson”, (with Matjaž Konvalinka), in *Proceedings of the 20th annual Conference on Formal Power Series and Algebraic Combinatorics*, 2008. Valparaiso, Chile.
(Shorter version of journal article coauthored with Konvalinka.)
12. “Inequalities for symmetric means”, (with Allison Cuttler and Curtis Greene), in *Proceedings of the 19th annual Conference on Formal Power Series and Algebraic Combinatorics*, 2007. Tianjin, China.
(Shorter version of journal article coauthored with Cuttler and Greene.)
13. “Kazhdan-Lusztig immanants III: transition matrices between canonical bases of immanants”, (with Brendon Rhoades), in *Proceedings of the 19th annual Conference on Formal Power Series and Algebraic Combinatorics*, 2007. Tianjin, China.
(Shorter version of 2009 journal article coauthored with Rhoades.)

Other manuscripts and publications:

1. *User’s Guide for the NIST Computer Security Bulletin Board*. (With Marianne Swanson.) Technical report NISTIR 4933. National Institute of Standards and Technology, Gaithersburg, MD. (1991).

Grants:

CONFERENCE GRANT National Science Foundation
January 2012 – December 2014
Division of Mathematical Sciences grant number 1303789, (\$44,620.00).

CONFERENCE GRANT National Security Agency
January 2012 – December 2013
Mathematical Sciences Program grant number 898230-13-1-0263, (\$21,780.00).

YOUNG INVESTIGATORS GRANT National Security Agency
January 2011 – December 2012
Mathematical Sciences Program grant number 091027, (\$29,428.00).

STANDARD GRANT National Science Foundation
September 2007 – August 2010
Division of Mathematical Sciences grant number 0701227, (\$137,506.00).

REIDLER GRANT
Summer 2007
Summer support (\$10,000.00).

Lehigh Mathematics Dept.

Invited presentations:

Combinatorics Seminar, University of Virginia. November, 2019.
Combinatorics Seminar, Université Paris Diderot. October, 2019.
Midwest Combinatorics Conference (plenary speaker), Rochester. October, 2019.
Combinatorics Seminar, Universidad de los Andes, Bogotá. September, 2019.
Lie Theory Seminar, Rutgers. March, 2019.
Applied Algebra Seminar, York University. February, 2019.
Workshop on Hessenberg Varieties, Banff, Canada. October, 2018.
Combinatorics Seminar, University of Pennsylvania. October, 2018.
Mathematics Colloquium, Lehigh University. September, 2018.
Algebra Seminar, Georgia Tech. March, 2018.
Combinatorics Seminar, University of Florida. March, 2018.
Combinatorics Seminar, University of Pennsylvania. November, 2017.
Combinatorics Seminar, SUNY Binghamton. October, 2017.
Combinatorics Seminar, Cornell University. October, 2017.
Combinatorics Seminar, UC-Berkeley. April, 2017.
Combinatorics Seminar, University of Florida. March, 2017.
Combinatorics Seminar, University of Minnesota. November, 2016.
Students' Combinatorics Seminar, University of Minnesota. November, 2016.
Combinatorics Seminar, University of Pennsylvania. August, 2016.
Encuentro Colombiano de Combinatoria, Medellín, Colombia. June, 2016.
Combinatorics Seminar, University of Miami. March, 2016.
Algebra Seminar, Universidade Federal do Pará, Belém, Brazil. January, 2016.
Algebra Seminar, Universidade de São Paulo, Brazil. January, 2016.
Combinatorics Seminar, Pontificia Universidad Javieriana, Bogotá. April, 2015.
Mathematics Lecture, Escuela de Aviación del Ejército, Bogotá. March, 2015.
Jornada de Combinatoria, Universidad Distrital, Bogotá. January, 2015.
Coloquio Latinoamericano de Álgebra, Lima, Perú. December, 2014.
Mathematics Colloquium, Universidad de los Andes, Bogotá. September, 2014.
Combinatorics Seminar, Universidad de los Andes, Bogotá. August, 2014.
Richard Stanley Birthday Conference, MIT. June, 2014.
Algebra Seminar, Universidad Autónoma de México, Morelia. March 2014.

Combinatorial Algebra conference, Dalhousie University, Halifax. January, 2014.
Combinatorics Seminar, Drexel University. October, 2013.
Combinatorics Seminar, Universidad Politécnica de Madrid, Spain. June, 2013.
Combinatorics Seminar, University of Miami. March, 2013.
Combinatorics Seminar, LaCIM, Montreal. October, 2012.
Encuentro Colombiano de Combinatoria, Bogotá, Colombia. June, 2012.
Deformation Theory Seminar, University of Pennsylvania. May, 2012.
Combinatorics Seminar, UC-Berkeley. May, 2012.
Algebra Seminar, Tulane University. April, 2012.
Combinatorics Seminar, University of Miami. March, 2012.
Combinatorics Seminar, University of Talca, Chile. January, 2012.
Combinatorics Seminar, University of Miami. March, 2011.
Combinatorics Seminar, University of Pennsylvania. February, 2011.
Workshop on Quasisymmetric Functions, Banff, Canada. November 2010.
Combinatorics Seminar, University of Pennsylvania. October, 2009.
Algebra Seminar, Tulane University. April, 2009.
Mathematics Colloquium, Bryn Mawr College. March, 2009.
Combinatorics Seminar, LaCIM, Montreal. February, 2009.
Deformation Theory Seminar, University of Pennsylvania. February, 2009.
Combinatorics Seminar, Drexel University. January, 2009.
AMS special session, Bloomington, Indiana. April, 2008.
Combinatorics Seminar, Rutgers University. April, 2008.
Mathematics Colloquium, University of Miami. December, 2007.
CMS winter meeting, London, Ontario. December, 2007.
Coloquio Latinoamericano de Álgebra, Medellín, Colombia. July, 2007.
REU seminar, Lafayette College. June 2007.
Guest lecture, Drexel University. June, 2007.
Combinatorics Seminar, UC-Berkeley. April, 2007.
Combinatorics Seminar, University of Western Ontario. November, 2006.
AMS special session, Fayetteville, Arkansas. November, 2006.
Undergraduate Math Club Seminar, Lehigh University. October, 2006.
Combinatorics Seminar, University of Washington. May, 2006.
Mathematics Colloquium, Wellesley College. February, 2006.
Mathematics Colloquium, Lehigh University. February, 2006.
Mathematics Colloquium, Arizona State University. February, 2006.
Mathematics Colloquium, University of Kentucky. February, 2006.

Deformation Theory Seminar, University of Pennsylvania. December, 2005.
Algebra Seminar, University of Notre Dame. November, 2005.
Applied Algebra Seminar, York University. November, 2005.
Combinatorics Seminar, University of Minnesota. October, 2005.
AMS special session, Bard College. October, 2005.
Mathematics Colloquium, Bryn Mawr College. September, 2005.
Combinatorics Seminar, University of Pennsylvania. September, 2005.
Discrete Math Day, Worcester Polytechnic Institute. September, 2005.
Undergraduate Math Club Seminar, University of Connecticut. September, 2005.
Combinatorics Seminar, Institut Mittag-Leffler, Djursholm, Sweden. May, 2005.
Combinatorics Seminar, Brandeis University. March, 2005.
Combinatorics Seminar, University of Pennsylvania. March, 2005.
Mathematics Colloquium, Haverford College. March, 2005.
Combinatorics Seminar, Northeastern University. January, 2005.
Mathematics Colloquium, North Carolina State University. January, 2005.
Mathematics Colloquium, College of William and Mary. January, 2005.
CMS Winter Meeting, Montreal. December, 2004.
Combinatorics Seminar, Dartmouth. October, 2004.
Mathematics Colloquium, University of Texas at El Paso. September 2004.
Richard Stanley Birthday Conference, MIT. June, 2004.
Mathematics Colloquium, University of Miami. March, 2004.
Mathematics Seminar, Middlebury College. February, 2004.
Combinatorics Seminar, Dartmouth. October, 2003.
Combinatorics Seminar, LaCIM, Montreal. September, 2003.
Combinatorics Seminar, MIT. September, 2003.
Lecture series, Universidad de los Andes, Bogotá. March, 2003.
Mathematics Colloquium, Iowa State University. February, 2003.
Applied Algebra Seminar, York University. October, 2002.
Commutative Algebra Seminar, University of Michigan. September, 2002.
Mathematics Colloquium, University of New South Wales, Sydney. July, 2002.
Mathematics Colloquium, Wesleyan University. March, 2002.
Combinatorics Seminar, Michigan State University. March, 2002.
Combinatorics Seminar, University of Michigan. February, 2002.
AMS Annual Meeting, San Diego. January, 2002.
Mathematics Colloquium, Dartmouth. October, 2001.
Lecture series, Universidad Simón Bolívar, Caracas. June, 2001.

Combinatorics Seminar, University of Minnesota. March, 2001.
Mathematical Challenges of the 21st Century, UCLA. August, 2000.
Combinatorics Seminar, MIT. May, 2000.
Combinatorics Seminar, University of Michigan. February, 2000.
Combinatorics Seminar, Texas A&M. February, 2000.
Incontro Italiano di Combinatoria Algebrica. Maratea, Italy. October, 1999.
AMS special session, Providence College. October, 1999.
CoNE Conference, Smith College. September, 1999.
Mathematics Colloquium, Universidad Rey Juan Carlos, Madrid. June, 1999.
Combinatorics Seminar, MIT. May, 1999.

Refereed presentations:

FPSAC Conference, Ljubljana, Slovenia. July, 2019.
FPSAC Conference, Hanover, NH. July, 2018.
FPSAC Conference, Paris. June, 2013.
FPSAC Conference, Nagoya. July, 2012.
FPSAC Conference, Reykjavik. July, 2011.
FPSAC Conference, San Francisco. August, 2010. (2 papers)
FPSAC Conference, Linz, Austria. July, 2009. (2 papers)
FPSAC Conference, Valparaiso, Chile. June, 2008. (2 papers)
FPSAC Conference, Tianjin, China. July, 2007. (2 papers)
FPSAC Conference, San Diego, CA. June, 2006.
FPSAC Conference, Taormina, Italy. June, 2005.
FPSAC Conference, Vancouver. June, 2004.
FPSAC Conference, Vadstena, Sweden. June, 2003.
FPSAC Conference, Melbourne. July, 2002.
FPSAC Conference, Moscow. June, 2000.
FPSAC Conference, Barcelona. June, 1999.

Conference sessions chaired:

AMS special session in algebraic combinatorics, Penn State University (joint with Peter McNamara). Fall, 2009.

Teaching:

- **Calculus** Used text by Stewart, except as noted.
 - Dartmouth Math 3, 8, 9: Calculus I, II, Honors Calculus II.
 - U. Los Andes Math 1214, 1215: Calculus II, Honors Calculus II.
 - Haverford Math 113–115: Calculus I, II. Used text by Hughes-Hallet et. al.
 - U. Michigan Math 116: Calculus II. Used text by Hughes-Hallet et. al.
 - U. Michigan Math 156: Honors Applied Calculus II.
 - Lehigh Math 21, 22, 23: Calculus I, II, III. (Course coordinator for II.)
 - Lehigh Math 31: Honors Calculus I. Used text by Salas, Hille & Etgen.

- **Combinatorics**
 - Dartmouth Math 28: Combinatorics. Used Bogart’s guided discovery text.
 - Haverford Math 395: Topics in Combinatorics. No text.
 - Lehigh Math 251: Combinatorics. No text.
 - Lehigh Math 252: Combinatorics. Used texts by Rosen, Bona.
 - Lehigh Math 261: Discrete Structures. Used text by Rosen.
 - U. Andes Math 2113: Algebraic and Enumerative Combinatorics. Used texts by Bona, Stanley, Rodríguez.
 - Lehigh Math 305: (graduate and undergraduate) Algebraic and Enumerative Combinatorics. Designed course and used text by Bona.
 - U. Michigan Math 565: (graduate) Combinatorics. Designed course and wrote lecture notes.
 - Dartmouth Math 118: (graduate) Combinatorics. Used text by Stanley.

- **Differential Equations**
 - Dartmouth Math 23: Differential Equations. Used text by Boyce & DiPrima.

- **Linear and Abstract Algebra**
 - U. Michigan Math 214: Linear Algebra. Used text by Lay.
 - Lehigh Math 205: Linear Methods. Used text by Peterson & Sochacki.
 - Lehigh Math 243: (undergraduate) Abstract Algebra. Used text by Rotman.
 - U. Andes Math 3101: (undergraduate) Fields and Galois Theory. Used text by Reid.

- Lehigh Math 321: (graduate) Coxeter Groups and Bruhat Order. Designed course and used text by Björner & Brenti.
- Lehigh Math 321: (graduate) Linear Groups and Lie Algebras. Designed course and used text by Rossman.
- Lehigh Math 321/472: (graduate and undergraduate) Representation Theory. Designed course and used text by Sagan.
- Lehigh Math 327: (graduate) Abstract Algebra I. Used text by Artin.
- Lehigh Math 428: (graduate) Abstract Algebra II. Used texts by Artin, Rotman.
- Lehigh Math 450: (graduate) Algebraic Geometry. Used text by Smith et. al.

• **Probability and Statistics**

- U. Michigan Math 425: Probability. Used text by Ross.
- Dartmouth Math 20: Discrete Probability. Used text by Grinstead & Snell.
- Lehigh Math 231: Probability and Statistics. Used text by Montgomery & Runger.

Undergraduate research supervision:

1. *Evaluation of induced trivial characters of the Hecke algebra.* (dePaul Miller, Desai Xie. Fall 2017 – Spring 2018.) Combinatorially interpreting these evaluations in terms of wiring diagrams, path tableaux, and statistics on these.
2. *An extension of Gantmacher’s theorem.* (Matthew Kilgore. Fall 2012 – Spring 2013.) Reproved a theorem of Gantmacher, using modern terminology. Stated and proved an extension which Gantmacher mentions only implicitly in his text *Matrix Theory* (1959). Supervised Kilgore’s undergraduate honors thesis.
3. *Subtraction-free Laurent polynomial expressions arising from the cluster algebra of type D_4 .* (Will Dearden, Eric Nalisnick, Lindsey Smith, Justin Sonntag, Percy Li. Fall 2010 – Spring 2012.) Expressed all minors of a generic 3×3 matrix as subtraction-free Laurent polynomials in the variables of each of the 34 clusters of the cluster algebra of type D_4 . Conjecturing necessary conditions on monomials for their appearances in the numerators and denominators of these Laurent polynomials. Supervised Sonntag’s undergraduate honors thesis.
4. *Inequalities for symmetric functions of degree 3.* (Jeffrey Kroll, Jonathan Lima, Rengyi Xu. Summers 2008 – 2009, with Curtis Greene.) Characterized homogeneous degree three symmetric functions $f(x)$ which evaluate nonnegatively on all $x \in \mathbb{R}_{\geq 0}^n$.
5. *The cluster basis for $\mathbb{Z}[x_{1,1}, \dots, x_{2,2}]$.* (Adam Yusko. Fall 2007.) Proved the equality of the cluster and dual canonical bases for this ring.

6. *Combinatorial interpretation of monomial immanants.* (Sam Clearman, Kaitlyn Peterson, Daniel Studenmund. Spring 2006.) Found interpretations for special cases of these immanants.
7. *Symmetric function inequalities.* (Allison Cuttler. Fall 2005 – Spring 2006, with Curtis Greene.) Generalized Maclaurin’s symmetric function inequalities. Wrote an undergraduate thesis.
8. *Duality in quantum groups.* (Neelesh Tiruvilumala. Winter – Spring 2005, with Rosa Orellana.) Studied the Hopf algebra duality between $\mathcal{O}_q(SL_n\mathbb{C})$ and $\mathcal{U}_q(\mathfrak{sl}_n\mathbb{C})$. Included this and projects 16, 18 in an undergraduate thesis.
9. *Schur nonnegative symmetric functions.* (Laura Brill, John-Paul Lewicke, Katie McIntyre, Geoff Scott. Winter 2005.) Studied a poset of skew Schur functions.
10. *Schur nonnegativity and the Kronecker product.* (Stephanie Mathews, Carlo Ordonez, Anca Tohaneanu. Fall 2004, with Rosa Orellana.) Studied the Schur expansion of symmetric functions defined in terms of the Kronecker product.
11. *The Schur nonnegativity of Temperley-Lieb immanants.* (Hunter Brooks, Fernando Delgado, Jesse Wolfson. Summer 2004.) Studied jeu-de-taquin-like algorithms to express Temperley-Lieb immanants of Jacobi-Trudi matrices as sums of Schur functions.
12. *Schur nonnegative symmetric functions.* (Hunter Brooks, John-Paul Lewicke, Valery Pechatnikov, Neelesh Tiruvilumala. Fall 2004, with Rosa Orellana.) Studied Kazhdan-Lusztig immanants and related symmetric functions.
13. *Kazhdan-Lusztig immanants.* (Brendon Rhoades. Summer 2004.) Used the Kazhdan-Lusztig basis to define new immanants which are totally nonnegative and Schur nonnegative. Proved the Schur nonnegativity of Temperley-Lieb immanants.
14. *Path tableaux and immanants.* (Kiran Parkhe, Neelesh Tiruvilumala. Summer 2004.) Generalized Lindström’s Lemma to interpret some irreducible character immanants.
15. *Subtraction-free Laurent polynomials.* (Charlie Chen, Ali Husain, John-Paul Lewicke, Brian Zhao. Winter – Spring 2004.) Used Maple and cluster algebras to express totally nonnegative immanants as subtraction-free Laurent polynomials in matrix minors.
16. *Schur nonnegativity conjectures.* (Jason Asher, Sanjay Banerjee, Erik Jacobson, Andrei Prokopiw. Fall 2003 – Winter 2004.) Studied conjectures of Bergeron et. al., Fomin et. al.
17. *Totally nonnegative polynomials.* (Brian Drake, Sean Gerrish, Zachary Pavlov, Brendon Rhoades. Summer 2003.) Found three new characterizations of the Bruhat order, and a class of totally nonnegative f -immanants which forms a basis for the span of other known totally nonnegative polynomials.

18. *Algebraic integers and balanced simplicial complexes.* (Andrew Clark, Sean Gerrish, Brian Polk, Chia-Ying Lee. Spring 2003.) Studied Maclaurin's inequalities for conjugate algebraic integers and f -polynomials of balanced simplicial complexes.
19. *The poset of lattice path partitions.* (Brian Drake, Brendon Rhoades, Ed Wong. Spring 2003.) Used set partitions to describe totally nonnegative polynomials.
20. *Polynomials with real zeros and multicomplexes.* (Katie Bach. Fall 2002.) Studied functions characterizing the sequences which count monomials in multicomplexes.
21. *Totally nonnegative polynomials.* (Brian Drake, Zachary Pavlov, Andrew Wagner. Fall 2002.) Used products of matrix minors to describe totally nonnegative polynomials.
22. *Polynomials with real zeros and simplicial complexes.* (Katie Bach, Walter Dulaney, Eric Hendrickson. Summer 2002.) Studied functions characterizing the integer sequences which count faces in simplicial complexes.
23. *Inequalities in products of minors of totally nonnegative matrices.* (Michal Ostrowski, Nina Palmo, Zachary Pavlov, Randy Pistor. Summer 2002.) Used Temperley-Lieb algebras to state inequalities satisfied by minors of totally nonnegative matrices.
24. *A generalization of the Robinson-Schensted Correspondence.* (Eric Hendrickson, Joe McClain, Randy Pistor. Spring 2002.) Studied the Robinson-Schensted Correspondence and generalizations implied by Gasharov's result on $(\mathbf{3} + \mathbf{1})$ -free posets.
25. *Enumeration of $(\mathbf{3} + \mathbf{1})$ -free posets* (Pedro Cabezas, Frederick Juarez, Michal Ostrowski, Brian Reed, Ted Thorbeck. Fall 2001 – Spring 2002.) Used total nonnegativity to prove that the f -vector of a $(\mathbf{3} + \mathbf{1})$ -free poset is also the f -vector of a unit interval order.
26. *Enumeration of simplicial complexes.* (Joe McClain. Fall 2001.) Studied functions characterizing the integer sequences which count faces in simplicial complexes.
27. *Enumeration of polynomials with real zeros.* (Jeff Allotta. Summer 2001.) Studied inequalities satisfied by the coefficients of polynomials which have only real zeros.
28. *Dumont's statistic and descents.* (Jeff Allotta, Erin Ealba, Vivek Shende, Brian Young. Spring 2001.) Studied permutation statistics and bijections.

Graduate, but nondoctoral, research supervision:

ADAM CLEARWATER University of Pennsylvania Mathematics Dept.
 November 2017 – November 2018
 Studying the evaluation of Hecke algebra traces and interpreting these in terms of planar networks, tableaux, and statistics on these.

LUKE FISCHINGER Lehigh Mathematics Dept.
February 2017 – May 2017
Studied the evaluation of various Hecke algebra characters at Kazhdan-Lusztig basis elements.

KYLE CELANO Lehigh Mathematics Dept.
October 2016 – December 2016
Proved the (known) characterization of the symmetric group Bruhat order as the componentwise order on certain matrices. This characterization is proved incorrectly in two well-known textbooks.

ALEX HALPERIN Lehigh Mathematics Dept.
June 2011 – September 2012
Studied mathematical writing and a partial order on matrix minors defined in terms of Schur functions and Jacobi-Trudi matrices.

SAM CLEARMAN Lehigh Mathematics Dept.
June 2010 – August 2011
Studied combinatorial interpretations for the evaluation of monomial and power sum immanants at totally nonnegative matrices.

AYDIN GEREK Lehigh Mathematics Dept.
August 2009 – December 2010
Studied cluster algebras, rational functions of matrix minors, and the dual canonical basis.

Doctoral research supervision:

JONGWON KIM University of Pennsylvania Mathematics Dept.
October 2018 – present
Combinatorially interpreting the evaluations of irreducible type- C Hecke algebra characters at Kazhdan-Lusztig basis elements, when these belong to $\mathbb{N}[q]$.

SAM CLEARMAN Lehigh Mathematics Dept.
June 2012 – December 2015
Studying combinatorial interpretations for the evaluation of induced trivial characters of the Hecke algebra at certain Kazhdan-Lusztig basis elements.

BRITTANY SHELTON Lehigh Mathematics Dept.
September 2010 – May 2012
Studied combinatorial interpretations for the evaluation of induced sign characters of the Hecke algebra at certain Kazhdan-Lusztig basis elements.

JUSTIN LAMBRIGHT
September 2008 – May 2011
Formulated double-parabolic generalizations of special basis results for Hecke algebras and quantum groups.

Lehigh Mathematics Dept.

CHARLES BUEHRLE
May 2008 – May 2010
Related Kazhdan-Lusztig's Hecke algebra modules to other modules within a polynomial ring in n^2 noncommuting variables.

Lehigh Mathematics Dept.

BRENDON RHOADES
September 2004 – May 2008
Coadvised thesis (with Victor Reiner of the University of Minnesota) on applications of the dual canonical basis to the cyclic sieving phenomenon.

University of Minnesota Mathematics Dept.

Postdoctoral mentoring:

RYAN KALISZEWSKI
September 2016 – December 2017
Studied combinatorial interpretations for the evaluation of monomial traces of the Hecke algebra at certain Kazhdan-Lusztig basis elements. Proved a formula for the interpretation of induced sign characters at all elements of a certain “wiring diagram” basis of the Hecke algebra. Mentored Kaliszewski on professional activities.

Lehigh Mathematics Dept.

MATTHEW HYATT
September 2012 – May 2015
Discovered and proved combinatorial interpretations for the evaluation of power sum traces of the Hecke algebra at certain Kazhdan-Lusztig basis elements. Mentored Hyatt on professional activities.

Lehigh Mathematics Dept.

Lehigh University service:

AD-HOC COMMITTEE ON RECREATIONAL SWIMMING
September 2017 – present
Chairing committee of faculty, staff, students, and family members who wish to improve recreational swimming at Lehigh. Coordinated interviews of aquatics directors at all Patriot League schools and the University of Pennsylvania regarding aquatic staffing, safety procedures, and finances of pool management. Submitted a summary report to the provost. Interviewed directors of athletics and risk management at the University of Pennsylvania.

University

FACULTY COMMITTEE ON STUDENT LIFE
September 2017 – present

University

Evaluating applications for Lehigh bLUeprint grant. Planning events to encourage faculty - student interaction.

COLLEGE OF BUSINESS DEAN SEARCH COMMITTEE University
May 2013 – November 2013
Searched for new dean of the Lehigh College of Business.

STUDY ABROAD FACULTY POLICY BOARD University
September 2011 – May 2013
Evaluated students' applications to enroll in programs not previously approved by Lehigh.

GRADUATE PROGRAM REVIEW COMMITTEE FOR CHEMISTRY DEPARTMENT
College of Arts and Sciences
February 2018 – April 2018
Interviewed faculty, staff, and graduate students in the Chemistry Department. Submitted a summary report and recommendations to School of Arts and Sciences.

GRADUATE PROGRAM REVIEW COMMITTEE FOR EARTH AND ENVIRONMENTAL SCIENCES DEPARTMENT
College of Arts and Sciences
March 2017 – April 2017
Interviewed faculty, staff, and graduate students in the Earth and Environmental Sciences Department. Submitted a summary report and recommendations to School of Arts and Sciences.

MATHEMATICS MAJOR ADVISOR College of Arts and Sciences
September 2010 – present
Counseling students about course choices, REU and graduate programs.

FIRST-YEAR ADVISOR College of Arts and Sciences
September 2008 – May 2016
Organized presentations about Lehigh for new students. Counseling students about course choices.

GRADUATE COMMITTEE Mathematics Dept.
March 2016 – present
Designed a poster to publicize mathematics graduate program. Coordinating distribution of the poster to improve Mathematics Department recruiting of minorities, students from competitive undergraduate institutions, and students from foreign countries.

POSTDOCTORAL HIRING COMMITTEE Mathematics Dept.
September 2011 – February 2012, April 2017 – present

Helping to solicit faculty volunteers to mentor postdoctoral instructors, and to select and order a short list of candidates proposed by potential mentors.

FACULTY ADVISOR FOR GSIMS CLUB Mathematics Dept.
June 2009 – present

Helping graduate students to organize an intercollegiate mathematics seminar, obtain funding for outside speakers, and give presentations at other universities.

DEPARTMENT MAA/EPADEL LIAISON Mathematics Dept.
September 2008 – present

Communicating with department about programs organized by the Mathematical Association of America.

ALGEBRA QUALIFYING EXAM COMMITTEE Mathematics Dept.
August 2007 – present

Writing and grading doctoral qualifying exams in algebra.

COMBINATORICS QUALIFYING EXAM COMMITTEE Mathematics Dept.
August 2007 – present

Writing and grading doctoral qualifying exams in combinatorics.

THESIS COMMITTEES Mathematics Dept.
June 2007 – present

Reading and evaluating Lehigh doctoral theses. Helping students improve theses.

UNDERGRADUATE COMMITTEE Mathematics Dept.
September 2006 – present

Recommending department policies, course changes, student awards. Providing guidance to other mathematics major advisors.

COMPREHENSIVE EXAM COMMITTEE Mathematics Dept.
December 2009 – August 2011, December 2015 – August 2017

Wrote and graded doctoral comprehensive exams.

COMMITTEE TO REVISE MATHEMATICS MAJOR Mathematics Dept.
February 2017 – October 2017

Proposed changes in mathematics major requirements and course offerings. Coordinated revisions in the area of differential equations.

APPLIED ALGEBRA HIRING COMMITTEE Mathematics Dept.
April 2015 – March 2016

Helped advertise and select a candidate for tenure-track opening in mathematics department.

CHAIR'S ADVISORY COMMITTEE
September 2007 – June 2008, September 2012 – May 2016
Helped chair set department policies and resolve conflicts. Mathematics Dept.

COLLOQUIUM COMMITTEE
September 2012 – Spring 2013
Planned schedule of invited speakers with Daniel Conus. Mathematics Dept.

Professional service:

CAGE SEMINAR ORGANIZING COMMITTEE
September 2018 – present
Helping plan combinatorics and algebraic geometry seminar for Philadelphia area colleges, including Penn, Drexel, Haverford, Swarthmore, Bryn Mawr, Lehigh. University of Pennsylvania

EXTERNAL DOCTORAL THESIS COMMITTEES
September 2012 – present
Reading and evaluating Penn doctoral theses. Helping students improve theses. University of Pennsylvania

PROPOSAL REVIEWER
January 2010 – present
Reading and evaluating grant proposals. National Security Agency

REFeree
September 2000 – present
Reading and evaluating submitted manuscripts. Helping authors improve these. (various journals)

ORGANIZING COMMITTEE
September 2011 – December 2015
Wrote grant proposals annually and submitted these to the NSA and NSF to obtain funding for the international conferences on Formal Power Series and Algebraic Combinatorics. Awarded funding to young conference participants. FPSAC conference series

EXTERNAL UNDERGRADUATE THESIS COMMITTEES
June 2007
Read and evaluated Lafayette undergraduate theses. Helped students. Lafayette College

Other activities:

Speaking Spanish, Italian, French, Portuguese.
Organizing English conversation groups for foreign students and professionals.
Organizing vocal harmony ensemble.
Swimming, running, biking.
Dancing salsa, rueda de casino.