

Curriculum Vitae

SARA C. BILLEY

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Department of Mathematics  
University of Washington  
Box 354350  
Seattle, WA 98195-4350

*Citizenship: United States*

*Research interests:*

Algebraic combinatorics, Lie theory, computational algebraic geometry, probability and experimental mathematics: Affine Grassmannians, Schubert varieties, Schubert polynomials, flag manifolds, symmetric functions, root systems, Coxeter groups, diagonal harmonics, computer aided combinatorics, stochastic processes, complexity theory, fingerprint databases, and learning algorithms.

*Education:*

**University of California, San Diego**, Ph.D., Mathematics, June, 1994.

**University of California, San Diego**, M.A., Mathematics, September 1991.

**Massachusetts Institute of Technology**, B.S., Mathematics, June 1990.

*Ph.D Thesis Advisors: Mark Haiman and Adriano Garsia*

*Academic positions:*

UNIVERSITY OF WASHINGTON  
September 2009-present  
Professor of Mathematics. Seattle, WA

UNIVERSITY OF WASHINGTON  
September 2003-August 2009  
Associate Professor of Mathematics. Seattle, WA

MASSACHUSETTS INSTITUTE OF TECHNOLOGY  
1998-2003  
Assistant/Associate Professor of Applied Mathematics. Cambridge, MA

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Cambridge, MA

January 1994-1998

Applied Mathematics Instructor and NSF Postdoctoral Fellow under the mentorship of Richard Stanley. (on leave 1995)

UNIVERSITY OF CALIFORNIA

San Diego, CA

January 1995-December 1995

Presidential Postdoctoral Fellow under the mentorship of Nolan Wallach.

*Grants and awards:*

Inaugural Member of the American Mathematical Society Fellows program, 2012.

NSF Grant: DMS-1101017 "Combinatorial and Algebraic Aspects of Varieties" awarded June 2011 for five years. \$450,000.

Top Cited Author Award for an article published in Advances in Applied Math 2005-2010. Awarded August 2010.

NSF Grant: DMS-0754486 "REU Site: Inverse Problems for Electrical Networks" awarded 02/26/2008 for \$175,632.00. (co-PI with James Morrow and William Stein)

NSF Grant: DMS-0800978 "Computational/Combinatorial Considerations In Topology, Coxeter Groups, and Representation Theory" awarded for \$ 189,000.00.

Department of Mathematics Faculty Fellowship 2007-2009.

Royalty Research Grant awarded 2006.

Advance Grant awarded in 2004.

Class of 1922 Career Development Professorship awarded June 2001-2003.

Presidential Early Career Award for Scientists and Engineers (PECASE) awarded October 2000-2006 for \$500,000.

NSF Career Grant: DMS 0437359 "Combinatorial Structures in Algebra and Geometry" awarded 2000.

National Science Foundation Postdoctoral Fellowship in Mathematics 1994-1998.

University of California, Presidential Postdoctoral Fellowship, 1995-1997.

National Physical Science Consortium fellow 1990-1994 (first graduate).

*List of research publications:*

1. *Some Combinatorial Properties of Schubert Polynomials* (with W. Jockusch and R. Stanley) J. of Algebraic Comb. **(2) 4** (1993).
2. *RC-Graphs and Schubert polynomials*. (with N. Bergeron) Experimental Mathematics, Vol.2 (1993), No. 4.

3. *An Abstract Definition of Schubert Polynomials*. University of California, San Diego, Ph.D. thesis 1994.
4. *Schubert polynomials for the classical groups*. (with M. Haiman) J. of the AMS, Vol.8, Num. 2, April 1995.
5. *Kostant polynomials and the cohomology ring for  $G/B$* , announcement. Proc. Natl. Acad. Sci. USA, Vol.94, pp. 29–32, January 1997.
6. *Kostant polynomials and the cohomology ring for  $G/B$* . Duke Math. J., Vol. 96, No. 1, pp. 205–224, 1999.
7. *Transition Equations for Isotropic Flag Manifolds*. Discrete Math., Special Issue devoted to the Conference in Taormina, Sicily, in honor of Adriano Garsia, vol. 193 (1998) pp. 69–84.
8. *Vexillary elements of the hyperoctahedral group* (with Tao Kai Lam). J. of Algebraic Combinatorics, v.8 (1998) pp. 139–152.
9. *Pattern avoidance and rational smoothness of Schubert varieties*. Advances in Math, vol. 139 (1998) pp. 141–156.
10. *The parabolic map* (with C. K. Fan and J. Losonczy) J. of Algebra, vol. 214 (1999).
11. *On the Singular Locus of a Schubert Variety* (with V. Lakshmibai). Journal of the Ramanujan Mathematical Society, 15 (2000), no. 3, 155–223.
12. *Kazhdan-Lusztig Polynomials for 321-hexagon-avoiding permutations*, (with Gregory Warrington). J. of Algebraic Combinatorics, (2001) v. 13, pp. 111–136.
13. *Maximal Singular Loci of Schubert Varieties in  $SL_n/B$*  (with Gregory Warrington). Trans. AMS. v. 355 (2003) pp. 3915–3945.
14. *Lower bounds for Kazhdan-Lusztig polynomials from patterns* (with Tom Braden). Transform. Groups 8 (2003), no. 4, 321–332.
15. *A vector partition function for the multiplicities of  $sl_k(C)$*  (with Victor Guillemin and Etienne Rassart). Journal of Algebra 278 (2004), no. 1, 251–293.
16. *Smoothness of Schubert varieties via patterns in root subsystems* (with Alexander Postnikov). Advances in Applied Mathematics Volume 34, Issue 3 , April 2005, Pages 447–466.
17. *Intersections of Schubert varieties and other permutation array schemes* (with Ravi Vakil). IMA Volumes in Mathematics and its Applications Volume 146: Algorithms in Algebraic Geometry, 2007, pages 21–54.

18. *Flag arrangements and triangulations of products of simplices* (with Federico Ardila). *Advances in Mathematics*, Volume 214, Issue 2, 1 October 2007, Pages 495-524.
19. *Embedded factor patterns for Deodhar elements in Kazhdan-Lusztig theory* (with Brant Jones). Special Issue of *Annals of Combinatorics* dedicated to Permutation Patterns. v. 11 (2007) pp. 285-333.
20. *Affine partitions and affine Grassmannians* with Stephen Mitchell. *Electronic Journal of Combinatorics*, Special Issue in honor of Anders Bjorner's 60th Birthday, R18, Volume 16(2), 2009.
21. *An appendix to: Permutations with Kazhdan-Lusztig polynomial  $P_{id,w}(q) = 1 + q^h$*  with Jonathan Weed and included in the article by Alexander Woo. *The Electronic Journal of Combinatorics* Volume 16(2), 2009. Published May 12, 2009.
22. *Smoothness and palindromic Schubert varieties in Affine Grassmannians* with Stephen Mitchell. *Journal of Algebraic Combinatorics* (2010) 31:169-216.
23. *A pattern characterization of rationally smooth affine Schubert varieties of type A*, joint with Andrew Crites. *J. Algebra* 361 (2012), 107.
24. *Rational smoothness and affine Schubert varieties of type A*, joint with Andrew Crites. Abridged version of the paper above. Accepted for a talk at FPSAC 2011 in Reykjavik, Iceland. DMTCS Proceedings 2011. Online <http://www.dmtcs.org/dmtcs-ojs/index.php/proceedings/issue/view/119>
25. *Singularities of generalized Richardson varieties* joint with Izzet Coskun. *Comm. Algebra* 40 (2012), no. 4.
26. *Affine dual equivalence and  $k$ -Schur positivity* with Sami Assaf. *J. Combinatorics* Volume 3 (2012), Number 3, 343–399.
27. *Permutations with given peak set* with Krzysztof Burdzy and Bruce Sagan. *Journal of Integer Sequences*, Vol. 16 (2013), Article 13.6.1. Also available at arXiv:1209.0693.
28. *Permutation patterns and the Edelman-Greene correspondence* joint with Brendan Pawlowski. Extended abstract accepted for a talk at FPSAC 2013 in Paris, France.
29. *Permutation patterns, Stanley symmetric functions and generalized Specht modules* joint with Brendan Pawlowski. *Journal of Combinatorial Theory, Series A*, 2014, (124), pp 85-120.
30. *Fingerprint Databases for Theorems* joint with Bridget Tenner. *Notices of the AMS*. Volume 60, Number 8, September 2013, pp 1034–1039.

31. *On meteors, earthworms and WIMPs* joint with Krzysztof Burdzy, Soumik Pal and Bruce Sagan. To appear in *Annals of Applied Probability*, Volume 25, Number 4 (August 2015), 1729-1779.
32. *Consequences of the Lakshmibai-Sandhya Theorem: the ubiquity of permutation patterns in Schubert calculus and related geometry* joint with Hiraku Abe. To appear in the *Proceedings of the Mathematical Society of Japan*, accepted March 2014.
33. *Coxeter-Knuth graphs and a signed Little map for type B reduced words* joint with Zachary Hamaker, Austin Roberts and Benjamin Young. *Electronic J. of Combinatorics*, Volume 21, Issue 4 (2014), Paper #P4.6
34. *Factoring peak polynomials* joint with Matthew Fahrbach and Alan Talmage. *DMTCS Proceedings FPSAC15*, 2015, 441452.
35. *Coefficients and roots of peak polynomials* joint with Matthew Fahrbach and Alan Talmage. To appear *Experimental Math* 2015.
36. *The Contributions of Stanley to the Fabric of Symmetric and Quasisymmetric Functions* with Peter McNamara. For a volume published by the AMS in honor of Richard Stanley, to appear in 2016.
37. *On the enumeration of tanglegrams and tangled chains* with Matjaž Konvalinka and Frederick A. Matsen IV. Submitted for publication. ArXiv: 1507.04976.
38. *Tanglegrams: a reduction tool for mathematical phylogenetics* with with Arnold Kas, Matjaž Konvalinka and Frederick A. Matsen IV. Submitted for publication. ArXiv:1507.04784.
39. *A bijective proof of Macdonald's reduced word formula* joint with Alexander Holroyd and Benjamin Young. In preparation.
40. *Rigid structures and branched polymers* joint with Dave Anderson. In preparation.
41. *Parabolic Double Cosets* joint with Matjaž Konvalinka, Kyle Peterson, William Slofstra, Bridget Tenner. In preparation.

*List of book publications:*

1. *Singular Loci of Schubert Varieties*. (with V. Lakshmibai) Progress in Mathematics, Birkhauser Boston, v. 182, 2000.

*Sequences added to Sloane's On-Line Encyclopedia of Integer Sequences:*

A058094, A061539, A061710, A144924, A165208, A180635, A180635, A223034, A223905, A224066, A224240, A224243 A224255, A224287, A224316, A224318, A246865, A258488, A258487, A258486.

*Invited addresses:*

Invited address for the annual "Mathematics Across the Cannon" event, co-sponsored by St. Olaf and Carleton Colleges in Northfield, Minnesota. April 2016

Invited speaker at the special session at the AMS/MAA Joint meetings entitled "Commutative Algebra". January 2016.

Invited speaker at 31st BAD\* Math Day (Bay Area Discrete Mathematics Day) San Francisco State University Saturday October 17, 2015

Invited speaker Discrete Mathematics Day At WPI September, 12, 2015.

Invited Speaker at BIRS weekend workshop on "Positivity in Algebraic Combinatorics" August 15-16, 2015.

Poster presentation FPSAC 2015 at KAIST in Daejeon South Korea, July 6-10, 2015.

Colloquium speaker at Ohio State University, March 26, 2015.

Plenary Speaker for Mathday 2015, University of Washington.

Invited speaker at Wachfest January 2015, Miami Florida.

Invited speaker at Neil Sloane's birthday conference entitled "Sloane75fest: Challenges of Identifying Integer Sequences" October 9-10, 2014.

AMS-MAA Invited Lecture at MathFest 2014, August 79, 2014, in Portland, Oregon. "What is the value of a computer proof in research and teaching?"

Invited lecturer in a 4-part series at "The 4th Encuentro Colombiano de Combinatoria (ECCO 2014). June 9-16, 2014, Bogat/'a, Colombia, Topic: "Quasisymmetric functions".

Colloquium at U.Illinois on March 13, 2014.

Combinatorics Seminar at University of California, Berkeley, Feb. 3, 2014.

Invited speaker for "Lie Groups, Lie Algebras and their Representations" workshop. Feb. 1-2, 2014 at Stanford University.

Invited speaker for special session "Geometric Applications of Algebraic Combinatorics" Jan 16-19, 2014 at AMS-MAA Joint Meeting in Baltimore.

UMASS, Amherst, Representation Theory Seminar February 14, 2013.

MIT, Combinatorics Seminar February 15, 2013.

Invited speaker for Sage Days 45: Multiple Dirichlet Series, Combinatorics, and Representation Theory (February 11 - 15, 2013) "Pattern avoidance in permutations with applications to symmetric functions".

Lightning talk at Reproducibility in Computational and Experimental Mathematics (December 10-14, 2012) "Canonical Representation of Theorems"

The 5th Mathematical Society of Japan Seasonal Institute, 2012 International summer school and conference on Schubert calculus. Invited to give 4 lectures. July 17-27.

Plenary speaker at Nebraska Conference for Undergraduate Women, Jan 27-29, 2012.

Invited speaker for special session “Geometry and Combinatorics in Flag Manifolds and Beyond for the AWM 40-year anniversary conference. September 17-18, 2011 at Brown University.

Plenary Speaker for CanaDAM 2011, June 1-4, 2011. Victoria.

Institute for Defense Analysis, San Diego. Talk. December 2010

Winter CMS Meeting invited speaker in special session on “Discrete Mathematics.” Vancouver 4-6 December 2010.

University of Kentucky, invited speaker at “Combinatorics 2010: Advances, Trends and Speculations” March 26, 2010.

AIM invited speaker at the ”Equivariant cohomology and Localization” Workshop 3-15-2010 -3-19-2010.

University of Kansas, Combinatorics Seminar, January 2010.

UW Algebra Seminar June 3, 2009.

MIT, Combinatorics Seminar May 6, 2009.

MSRI January 2009.

University of California, Santa Barbara colloquium, May 2008.

AMS Special Session on “Applications of Computer Algebra in Enumerative and Algebraic Combinatorics” in San Diego at joint meetings, January, 2008.

AMS Special Session on “Invariants of Lie Group Actions and Their Quotients” at Rutgers, October 2007.

University of North Carolina, two talks Colloquium and Lie Theory Seminar, September 2007.

IMA workshop entitled ”What is Algebraic Geometry” in Minneapolis on April 13-14, 2007

University of Michigan, Combinatorics Seminar, February 2007.

Lusztig’s 60th Birthday Conference held in Cambridge, MA, June 2006.

AMS-IMS-SIAM Joint Summer Research Conference on “Integer points in Polyhedra. Geometry, Number Theory, Representation Theory, Algebra, Optimization, Statistics” June 11-15, 2006 in Snowbird, Utah.

Summer Institute in Algebraic Geometry held at the University of Washington, August, 2005.

Formal Power Series and Algebraic Combinatorics (FPSAC), subsection devoted to Adriano Garsia June 2005.

University of British Columbia, Colloquium, March 2005.

University of California, Berkeley Colloquium, February 2005.

University of California, Davis, Combinatorics Seminar, November 2004.

Fall Western Section Meeting, Albuquerque, NM, October 2004.

Richard Stanley's 60th Birthday Conference, June 2004.

Formal Power Series and Algebraic Combinatorics (FPSAC) June 2004.

Summer Institute in Mathematics at UW July 2003-2006..

Mathday at University of Washington, March 2003, 2004, 2005.

Current Problems Seminar, University of Washington, October 2003, 2005.

Western Algebraic Geometry Seminar (WAGS), Bellingham, WA, November 2002.

AMS, Meeting in San Diego, January 2002, Special Session on The Theory and Applications of Symmetric Functions,

Northeastern Seminar December 2001

University of Wisconsin, (two talks) Colloquium and Lie Theory seminars, November 2001.

University of Michigan, Combinatorics Seminar October 2001.

Valley Discrete Math Day, October 2001.

Cornell University, September 2001.

Brandeis University, Fellowship of the ring, May 2001.

Massachusetts Institute of Technology, combinatorics seminar April 2001.

AMS, Central Section Meeting in Toronto, Canada on "Modern Schubert Calculus", September 22-24, 2000.

Classical Combinatorics: In Honor of Dominique Foata's 65th birthday, at Temple University, Philadelphia, July 7-9, 2000.

Combinatorics Seminar at UCSD, February 22, 2000.

University of Pennsylvania, Mathematics Colloquium, October 13, 1999.

Moore Instructor's Conference at MIT, October 9, 1999.

City University of Hong Kong, Combinatorics Seminar June 2, 1999.

Tamkang University, Tamsui, Taiwan. Combinatorics Seminar May 27, 1999.

Princeton University, Representation Theory and Combinatorics seminar. April 15, 1999.



AMS special session on Geometry and Lie Groups, Tucson Arizona, November 13-15, 1998

Conference on Algebraic Combinatorics and Applications, Oakland University, Rochester, Michigan. May 1-3, 1998

AMS special session on Algebraic Combinatorics, Louisville Kentucky, March 20 - 21, 1998

George Washington University combinatorics seminar, July 1997.

Oberwolfach session on Schubert Varieties, April 1997.

AMS special session on Algebraic Combinatorics, San Diego, January 1997.

MSRI during the Posets and Enumerative Combinatorics Workshop, October 1996.

Massachusetts Institute of Technology, combinatorics seminar October 1996.

Massachusetts Institute of Technology, combinatorics seminar May 1996.

Thurnau Germany, Summer School on Degeneracy Loci and Schubert Varieties, June 1995.

California Institute of Technology, combinatorics seminar April 1995.

University of California San Diego, combinatorics seminar April 1995.

Smith College Regional Conference, December 1994.

Massachusetts Institute of Technology, combinatorics seminar November 1994.

Northeastern University, September 1994.

Conference in Honor of Adriano Garsia, Taormina, Sicily, July 1994.

University of Chicago, algebraic geometry seminar May 1994.

S.I.A.M. minisymposium on Algebraic Combinatorics, Philadelphia, July 1993.

Smith College Regional Conference, December 1992.

#### *Workshops Organized:*

##### MITTAG-LEFFLER INSTITUTE

Co-proposing a semester in 2018-2019 entitled “Algebraic Combinatorics; with a focus on enumeration, random processes and zeros of polynomials” with Svante Linusson, Petter Br den, and Sylvie Corteel.

##### MATHFEST

Co-organized an invited session entitled “Computational Aspects of Algebra, Geometry and Combinatorics” at Mathfest, August 2014.

ICERM = INSTITUTE FOR COMPUTATIONAL AND EXPERIMENTAL RESEARCH  
IN MATHEMATICS

Co-organized a workshop entitled “Whittaker Functions, Schubert calculus and Crystals” with Dan Bump and Cristian Lenart (March 4-8, 2013).

ICERM = INSTITUTE FOR COMPUTATIONAL AND EXPERIMENTAL RESEARCH  
IN MATHEMATICS

Co-organizing a semester entitled ”Automorphic forms, combinatorial representation theory, and multiple Dirichlet series” with Dan Bump, Ben Brubaker, Gautam Chinta, Dorian Goldfeld, Solomon Friedberg, Jeff Hoffstein, Anne Schilling, and Nicolas Thiery. Spring 2013.

AMS 2012 SPRING WESTERN SECTION MEETING

Co-organizing a session entitled “Algebraic Combinatorics” Honolulu, HI, March 2012, with Federico Ardila, Kelli Talaska, and Lauren Williams

BANFF INTERNATIONAL RESEARCH STATION

Co-organized a workshop entitled “Quasisymmetric Functions” with Lou Billera and Richard Stanley in November 2010.

FORMAL POWER SERIES AND ALGEBRAIC COMBINATORICS (FPSAC)

Program committee co-chair along with Victor Reiner for FPSAC 2010.

AMS 2008 FALL WESTERN SECTION MEETING

Co-organizing a session entitled “Combinatorial Representation Theory” Vancouver, CA, October 2008 with Stephanie van Willigenburg and Alexander Kleshchev.

AMS WESTERN SECTION MEETING

Co-organized a session entitled “Algebraic Combinatorics and Geometry,” Eugene Oregon, Nov. 2005 with Mark Haiman.

BANFF INTERNATIONAL RESEARCH STATION

Co-organized a workshop entitled “Recent advances in algebraic combinatorics” with Ian Goulden, Curtis Greene, David Jackson, Richard Stanley in May 2003.

*Other professional activities:*

AMERICAN MATHEMATICAL SOCIETY

Member at Large on the Council, 2005-2008,

Prize Selection Committee, 2015,

Western Section Program Committee, 2014-2016.

ASSOCIATION OF WOMEN IN MATHEMATICS

faculty sponsor for the UW student chapter, 2015-present,

Policy and Advocacy Committee, beginning fall 2015.

CENTER FOR COMMUNICATIONS RESEARCH, SAN DIEGO  
Consulting/Focus Board Member, 2011-2014.

ADVANCES IN MATHEMATICS  
Editor, 2004-present.

JOURNAL OF COMBINATORICS  
Editor, 2010-present.

COMBINATORICS SEMINAR ORGANIZER  
At MIT from 1996-2002. At UW from 2003-present with Isabella Novik.

UW/PACIFIC SCIENCE CENTER ADVISORY FACULTY TEAM March 2005-present.

INDO-U.S. FRONTIERS OF SCIENCE SYMPOSIUM Sponsored by the National  
Academy of Science, held January 9-11 in Bangalore India.

FORMAL POWER SERIES AND ALGEBRAIC COMBINATORICS  
Program committee member, 1998, 2001, 2005.

NATIONAL SCIENCE FOUNDATION  
Reviewer and panel member 2000,2002,2003,2007, 2009, 2010.

NATIONAL PHYSICAL SCIENCE CONSORTIUM January, 2002-present  
Mentor.

CENTER FOR COMMUNICATIONS RESEARCH Summers 1994 and 1996.  
Research consultant during SCAMP.

IBM - CAMBRIDGE RESEARCH CENTER Summers of 90 and 91.  
Programming for a statistical software package.

*Postdoctoral Advisees:*

Federico Ardila (2005), David Anderson (2009-2012), Andrew Berget (2011-  
2014), Vasu Tewari (2015-2018).

*PhD Thesis students:*

1. Gregory Warrington (Harvard University), Ph.D 2001.
2. Etienne Rassart (MIT), Ph.D March, 2004.
3. Brant Jones (University of Washington), Ph.D. May 2007.
4. Beth Kelly (University of Washington), Ph.D. August 2007.

5. Kurt Luoto (University of Washington), Ph.D June 2009.
6. Andrew Crites (University of Washington), Ph.D June 2011.
7. Brendan Pawlowski (University of Washington), Ph.D July 2014.
8. Austin Roberts (University of Washington), Ph.D June 2014.
9. Jair Taylor (University of Washington), Ph.D expected June 2016.
10. Joshua Swanson (University of Washington), Ph.D expected June 2017.
11. Connor Ahlback (University of Washington), Ph.D expected June 2017.

*Master's Thesis students:*

1. Tao Tran (MIT) Master's thesis August 2003.
2. Mary Solbrig (University of Washington), Master's thesis August 2013.
3. Anh Huynh (University of Washington), Master's thesis December 2013.

*Undergraduate Thesis students:*

1. Ruth Davidson (University of Washington), Undergraduate thesis December 2008.
2. Henry Kvinge (University of Washington), Undergraduate thesis March 2010.
3. Natalie Hobson (University of Washington), Undergraduate thesis March 2012.
4. Patrick Lenning (University of Washington), Undergraduate thesis expected June 2015.

*Undergraduate research students:*

Mark Bennett (2015) Matthew Fahrback and Alan Talmage (2013-2014) Lee Spires, Natalie Hobson, Kun Ling (2011-12) Adam Mosher (2010), Eva Fornaeus, Alexander Leaf, Hannah Manuel, John Pardo, and Zhen Wei (REU 2010) Henry Kvinge (2009-2010), Ruth Davidson (2008-2009), Chris Fox and Morgan Eichwald (2009), Jonathan Weed (2008), Kristen Boreman and Catherine Porter (2007), Tom Boothby, Sean Howe and Emily Kirkman, (2007) Richard Kelley (2005), Abinav Kumar (2001), Sarah Kowitz (2001), Dug Eichelberger (2001), Mike Walsh(2000), Edward Early (1999), Ephrem Paredes (1998), Anna Khasin (1997), Jessica Maia (1997), Jorge Rodriguez (1997), Jan Skotheim (1997), Lynn Mirales (1996), Matthew Berman (1996), Gillian Bidgood (1996), Anna Khasin (1996).