

Tom Braden

Education

1991–1995 MIT Ph.D., June 1995. adviser: Robert MacPherson.
1990–1991 Cambridge University, Part III of the Mathematics Tripos.
1986–1990 University of Chicago, BA in Mathematics.

Employment

2013– Professor, University of Massachusetts Amherst.
2007–2013 Associate Professor, UMass.
2001–2007 Assistant Professor, UMass.
1997–2001 Benjamin Peirce Instructor, Harvard. On leave 1999-2000.
1995–1997 Member, Institute for Advanced Study

Visiting Positions

Spring 2021 Member, Institute for Advanced Study (virtual)
2015–2016 Visitor, Stony Brook University
2008–2009 Visiting Researcher, Reed College, Portland OR
Spring 2007 Visitor, Hebrew University Institute for Advanced Studies, Jerusalem.

Research Interests

Topology of singular spaces; perverse sheaves and intersection cohomology on singular algebraic varieties, and their interactions with representation theory and combinatorics of convex polytopes, hyperplane arrangements, and matroids; topology and representation theory of symplectic singularities.

Awards and grant support

NSF Graduate Fellow, 1991-94
Sloan Dissertation Fellow, 1994-95
NSF grant DMS-0201823, 2002-2005.
NSA grant H98230-08-1-0097, 2008-2010.
NSA grant H98230-11-1-0180, 2011-2013.

Publications

- [1] *Perverse sheaves on rank stratifications*, with Mikhail Grinberg. *Duke Math. J.* **96** (1999), no. 2, 317–362.
- [2] *Intersection homology of toric varieties and a conjecture of Kalai*, with Robert MacPherson. *Comment. Math. Helv.* **74** (1999), no. 3, 442–455.
- [3] *From moment graphs to intersection cohomology*, with Robert MacPherson. *Math. Ann.* **321** (2001), no. 3, 533–551.
- [4] *On the reducibility of characteristic varieties*. *Proc. Amer. Math. Soc.* **130** (2002), no. 7, 2037–2043.
- [5] *Perverse sheaves on Grassmannians*. *Canad. J. Math.* **54** (2002), no. 3, 493–532.
- [6] *Hyperbolic localization of intersection cohomology*. *Transform. Groups* **8** (2003), no. 3, 209–216.
- [7] *Lower bounds for Kazhdan-Lusztig polynomials from patterns*, with Sara Billey. *Transform. Groups* **8** (2003), no. 4, 321–332.
- [8] *Equivariant-constructible Koszul duality for dual toric varieties*, with Valery Lunts, *Adv. Math.* **201** (2006), no. 2, 408–453.
- [9] *Remarks on the combinatorial intersection cohomology of fans*, *Pure Appl. Math. Quart.* **2** (2006), no. 4, 1149–1186.
- [10] *Koszul duality for toric varieties*, *Trans. Amer. Math. Soc.* **359** (2007), 385–415.
- [11] *Equivariant Chow rings of quot schemes*, with Linda Chen and Frank Sottile, *Pacific J. Math.* **238** (2008), no. 2, 201–232.
- [12] *The hypertoric intersection cohomology ring*, with Nicholas Proudfoot, *Invent. Math.* **177** (2009), no. 2, 337–379.
- [13] *Gale duality and Koszul duality*, with A. Licata, N. Proudfoot and B. Webster, *Adv. Math.* **225** (2010), no. 4, 2002–2049.
- [14] *Localization algebras and deformations of Koszul algebras*, with A. Licata, C. Phan, N. Proudfoot and B. Webster, *Selecta Math.* **17** (2011), no. 3, 533–572.
- [15] *Hypertoric category \mathcal{O}* , with A. Licata, N. Proudfoot and B. Webster, *Adv. Math.* **231** (2012), nos. 3-4, 1487–1545.
- [16] Appendix to *Intersection cohomology complexes on low rank flag varieties*, by Geordie Williamson, *Math. Zeitschrift* **272** (2012), nos. 3–4, 697–727.
- [17] *Quantizations of conical symplectic resolutions I: local and global structure*, with N. Proudfoot and B. Webster, *Astérisque* **384** (2016), 1–73.
- [18] *Quantizations of conical symplectic resolutions II: category \mathcal{O} and symplectic duality*, with A. Licata, N. Proudfoot and B. Webster and an appendix by I. Losev, *Astérisque* **384** (2016), 75–179.
- [19] *Matroidal Schur algebras*, with C. Mautner, *J. Algebraic Combin.* **46** (2017), no. 1, 51–75.
- [20] *Ringel duality for perverse sheaves on hypertoric varieties*, with C. Mautner, *Adv. Math.* **344** (2019), 35–98.

- [21] *Kazhdan-Lusztig polynomials of matroids under deletion*, with A. Vysogorets, Electron. J. Combin. **27(1)**, 2020, #P1.17, 17pp.

Preprints

- [22] *A semi-small decomposition of the Chow ring of a Matroid*, with J. Huh, J. Matherne, N. Proudfoot and B. Wang. Preprint [arXiv:2002.03341](https://arxiv.org/abs/2002.03341).
- [23] *Singular Hodge theory for combinatorial geometries*, with J. Huh, J. Matherne, N. Proudfoot and B. Wang. Preprint [arXiv:2010.06088](https://arxiv.org/abs/2010.06088).
- [24] *Perverse sheaves on symmetric products of the plane*, with C. Mautner. Preprint [arXiv:2208.14351](https://arxiv.org/abs/2208.14351).

In preparation

- [25] *The moment graph of the semi-infinite Grassmannian*.

Mathematical software

MG: Macaulay 2 routines to compute equivariant intersection cohomology using moment graphs, available at <http://people.math.umass.edu/~braden/MG>.

Selected Invited Talks

- Modular perverse sheaves on symplectic singularities*, Workshop on Representation Theory and Geometry, IAS (online), March 2021.
- The top-heavy conjecture for vectors and matroids*, Members Seminar (virtual), IAS, Princeton, February 2021.
- Singular Hodge theory of matroids: intersection cohomology of matroids*, virtual combinatorics seminar, MIT, December 2020.
- Top-heaviness for vector configurations and matroids*, combinatorics seminar, Dartmouth College, November 2019.
- Complexes for low-degree IH and rigidity of polytopes and matroids*, workshop on algebra, geometry and combinatorics, Korea Institute for Advanced Study, Seoul, June 2019.
- Kazhdan-Lusztig polynomials of matroids*, UConn algebra seminar, March 2019.
- Mini-course (four talks) *Introduction to category \mathcal{O} and symplectic duality in the hypertoric setting*, in graduate/postdoc summer school in Geometric Representation Theory and Symplectic Varieties, Notre Dame, June 2018.
- Equivariant cohomology and intersection cohomology of a completion of a hyperplane arrangement*, Special Session on Arrangements of Hypersurfaces, AMS sectional meeting, Northeastern University, April 2018.
- A sufficient condition for a category of perverse sheaves to be highest weight*, Special Session on Representations and Related Geometry in Lie Theory, Joint Math Meetings, Atlanta GA, January 2017.
- Proving categories of perverse sheaves are highest weight*, workshop on symplectic varieties and geometric representation theory, University of North Carolina, Chapel Hill, October, 2016.

Modular representation theory and hypertoric varieties, algebra seminars at the University of Edinburgh and the University of Glasgow, June 2016.

Modular representation theory, Springer's resolution and hypertoric varieties, Algebraic geometry seminar, Stony Brook University, February 2016.

Undergraduate colloquium *Geometry of machines*; graduate colloquium *Deformations in topology and algebra*, Louisiana State University, January 2016.

Ringel duality and perverse sheaves on hypertoric varieties, Enveloping Algebras and Geometric Representation Theory, Mathematisches Forschungsinstitut Oberwolfach, Germany, May 2015.

Ringel duality and perverse sheaves on hypertoric varieties, Representation Theory and Geometry of Symplectic Resolutions, Northeastern University, Boston, May 2015.

Recent developments in modular sheaf theory, (three lectures) summer school on geometric representation theory, RIMS, Kyoto, July 2014.

Ringel duality and perverse sheaves on hypertoric varieties, conference in geometric representation theory, RIMS, Kyoto, July 2014.

Working with parity sheaves, AIM-style workshop/presentation with C. Mautner, at Southeastern Lie Theory Workshop, Louisiana State U., May 2013.

Quantizations of symplectic resolutions and their representation theory, at meeting "Representation theory and symplectic algebraic geometry", CIRM, Marseille, France, July 2012.

Geometry and representation theory of hypertoric varieties, in meeting "Topological methods in toric geometry, symplectic geometry and combinatorics" at Banff International Research Station, November 2010.

Representation theory of hyperplane arrangements, UConn Colloquium, October 2010.

Hypertoric category \mathcal{O} , in workshop "Sheaves in representation theory", Sabhal Mór Ostaig, Isle of Skye, Scotland, May 2010.

Deformations of standard Koszul algebras and localization in equivariant cohomology, Geometry/Physics seminar, Northwestern University, May 2010.

Introduction to GKM theory, in workshop "Localization techniques in equivariant cohomology", AIM, Palo Alto, March 2010.

Symplectic duality and hypertoric varieties, in meeting "Toric geometry", Mathematisches Forschungsinstitut Oberwolfach, Germany, January 2009.

The Geometry of bar-and-joint Machines, Reed College colloquium, October 2008.

Toric and hypertoric varieties: topology and combinatorics, topology seminar, Wesleyan University, April 2008.

Hypertoric varieties and Gale duality, in special session on algebraic combinatorial geometry, AMS meeting, NYU, March 2008.

Category \mathcal{O} for hyperplane arrangements, GASC seminar, Northeastern University, November 2007.

A ring structure on intersection cohomology of hypertoric varieties, special session on toric varieties, AMS meeting, Rutgers, New Brunswick, NJ, October 2007.

Hyperplane arrangements and hypertoric varieties, workshop on Combinatorics and Topology, Institute for Advanced Studies, Hebrew University, Jerusalem, June 2007.

Counting faces of polytopes and geometry of toric varieties (two talks), Basic Notions seminar, mathematics department, Hebrew University, April and May 2007.

Polytope duality and Koszul duality, IAS, Hebrew University, March 2007.

Combinatorics of arrangements and topology of hypertoric varieties, in meeting “Geometric and Topological Combinatorics”, Oberwolfach, Germany, January 2007.

Equivariant intersection cohomology of toric varieties and applications, international conference on Toric Topology, Osaka City University, May 2006.

Semi-infinite moment graphs, in special session “Algebraic Groups” at AMS sectional meeting, Durham, NH, April 2006.

Rigidity of polytopes and toric varieties, University of Connecticut math department colloquium, March 2006.

Hypertoric varieties and Gale duality of hyperplane arrangements, Combinatorics seminar, UC Berkeley, March 2006.

Intersection cohomology of hypertoric varieties and Gale duality, meeting “Convexity and Algebraic Geometry”, Oberwolfach, Germany, February 2006.

Convex polytopes and intersection cohomology, colloquium, Albert-Ludwigs-Universität, Freiburg, Germany, January 2006.

Koszul duality for perverse sheaves on dual toric varieties, Boston University Geometry seminar, April 2005.

Stanley’s convolution and Koszul duality for dual affine toric varieties, in special session “Algebraic Geometry and Combinatorics”, AMS sectional meeting, Santa Barbara, April 2005.

Equivariant cohomology of Quot schemes, IAS, Princeton, NJ, January 2005.

Equivariant localization and intersection cohomology., in conference “Geometry, Combinatorics and Algebraic Groups, on the occasion of the sixtieth birthday of Robert MacPherson”, IAS, Princeton, NJ, Fall 2004.

Equivariant Cohomology of Quot Schemes, in special session in Modern Schubert Calculus, AMS sectional meeting, Evanston, IL, Fall 2004.

Presentation of MG: software to compute equivariant (intersection) cohomology with moment graphs, at Park City Mathematics Institute, Summer 2004.

Cohomology of intersections of opposite Bruhat cells, SIAM Conference on Discrete Mathematics, Nashville, TN, Summer 2004.

Toric Koszul duality, in special session on Algebraic geometry and topology, AMS sectional meeting, Tallahassee, FL, Spring 2004

Torsion in intersection cohomology of Schubert varieties in meeting “Algebraische Gruppen”, Mathematisches Forschungsinstitut Oberwolfach, Spring 2004.

Koszul duality for sheaves on toric varieties, in meeting “Convex bodies and algebraic geometry”, Tokyo Institute of Technology, Fall 2003.

g- and h-polynomials of non-rational polytopes—recent progress, in meeting “Topological and geometric combinatorics”, Mathematisches Forschungsinstitut Oberwolfach, Spring 2003.

Torsion in intersection cohomology of Schubert varieties, IAS, Princeton, NJ, Spring 2003.

Supervision of Ph.D. students

Advised: Chris McDaniel (Ph.D. 2010), Stephen Oloo (Ph.D. 2016), and Shuo Lin (current)

Committee member for: Christine von Renesse, Molly Fenn, Patrick Boland, Garret Cahill, Jennifer Koonz, Elizabeth Drellich, Tobias Wilson, Ben Johnson, Tom Shelly, Bradley Willocks, Huy Le, and Sam Glennon, and outside member for Louis Theran, John Bowers and Huaike Guo.

Seminar and conference organization

Co-organizer of workshop “Representation Theory and Combinatorics of Torus Links”, UMass, July 2017.

Organized a working seminar at UMass on quiver varieties: Spring 2006.

Co-organizer of special session “Combinatorial methods in equivariant topology”, at AMS Fall 2006 sectional meeting, Storrs, CT.

Co-organizer of department Representation Theory Seminar, 2009-2018.

Co-director of Five College Valley Geometry Seminar, 2006-2007.

Departmental and University service

Associate Head, 2018–2020

Director of Graduate Program, Sept. 2011-2015 and 2022-.

Member, Graduate council of the faculty senate and Academic Standards Curriculum Committee, 2012–2015.

Graduate Admissions Committee, 2002-07 and 2010/11, director of admissions 2009/10.

Graduate Affairs Committee, 2006-08.

Faculty search committee, elected member 2004/05, 2007/08, 2012/13, 2016/17.

Member, Department Personnel Committee, 2009-11, 2016-2018, and chair 2021-22.

Qualifying exam committees for topology and geometry exams.

Reader for three undergraduate honors theses.

Outside service

Member, AMS eastern section program committee, 2014–2015, chair 2015.

Member, NSF grant panel, 2015 and 2022.

Refereeing for miscellaneous journals, including Journal of the American Mathematical Society, *Inventiones Mathematicae*, *Annals of Mathematics*, *Advances in Mathematics*, *Compositio Mathematica*, *Selecta Mathematica*, *Journal of Algebra* and *Transactions of the AMS*.

Reviewing for Mathematical Reviews.

Grant reviewing for the NSF, NSA, NSERC, ANR (France).

————— Leisure interests

Performing Central Javanese gamelan music since 1990, mostly with the Boston Village Gamelan (Gamelan Laras Tentrem), the New York Indonesian Consulate gamelan (Kusuma Laras), and the Smith College gamelan ensemble. Major performances in Yogyakarta, Boston, New York (joint with the Brooklyn Philharmonic), and Saint Paul, MN.