Jeffrey F. Brock

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Professional Appointments

Yale University, New Haven, CT.

William S. Massey Professor of Mathematics, 2024–present.
Zhao and Ji Professor of Mathematics, 2019–2024.
Dean, School of Engineering & Applied Science, August 2019–present.
Dean of Science, Faculty of Arts and Sciences, January 2019–June 2022.
Professor, Department of Mathematics, 2018–present.

Brown University, Providence, RI.

Director, Data Science Initiative, 2016–2018.
Chair, Department of Mathematics, 2013–2017.
Deputy Director, ICERM, 2010–2013. *Associate Director*, 2013–2017.
Professor, Department of Mathematics, 2007–2018.
Associate Professor (with tenure), Department of Mathematics, 2003–2007.

University of Chicago, Chicago, IL.

Assistant Professor, Department of Mathematics, 2000–2003.

Stanford University, Stanford, CA.

Szegö Assistant Professor, *NSF Postdoc*, Department of Mathematics, 1997–2000.

Visiting Positions

Université Paul Sabatier, Toulouse, France.

Maître de Conférence invité, 2010. *Professeur invité*, 2015.

University of Texas, Austin, TX.

Donald D. Harrington Faculty Fellow, 2003–2004.

Education

University of California, Berkeley, CA.

Ph.D. in mathematics, 1997, under the supervision of Curtis T. McMullen.

Yale University, New Haven, CT.

B.A. Phi Beta Kappa, *Magna Cum Laude*, distinction in mathematics, 1992.

Research Interests

Hyperbolic geometry, group theory, low-dimensional topology, moduli spaces

Academic Honors

Elected Fellow, American Mathematical Society, 2017.
Simons Fellowship, (declined), 2016.
John Simon Guggenheim Fellow, 2008.
Donald D. Harrington Faculty Fellow, University of Texas at Austin 2003–2004.
NSF Postdoctoral Fellow, Stanford University, 1997–2000.
Alfred P. Sloan Doctoral Dissertation Fellow, U.C. Berkeley, 1996–1997.
Outstanding Graduate Student Instructor Award, U.C. Berkeley, 1996.
NSF Graduate Fellow, U.C. Berkeley, 1993–1996.
Stanley and DeForest Mathematics Prizes, Yale University, 1991 and 1992.

Publications

My scholarly publications in mathematics focus primarily on research problems in geometry and topology: broadly, this area investigates the dual nature of shape, from the study of their rigid structures on the one hand, to the study of their flexible deformations on the other. Fundamental investigations of their interplay have led to solutions to deep conjectures about the nature of topology in 3-dimensions. Recent applications in topological data analysis are motivating as well. My research to date focuses on the geometry and topology of low-dimensional manifolds, particularly on spaces with hyperbolic geometry or *negative curvature*.

My research in this vein resulted in our solution (with collaborators) to the *ending lamination conjecture* of William Thurston, in turn leading to the geometric classification theorem for hyperbolic 3-dimensional manifolds that are topologically finite. These findings led to many new questions about the interrelations of topological parameters and the geometries they predict, motivating my current work. More recently, I have worked to understand applications of geometry and topology to the analysis of massive and complex data sets.

In my ongoing research, I continue to investigate:

- hyperbolic 3-manifolds, Kleinian groups, and their parameter spaces
- Teichmüller spaces, moduli spaces, and their natural geometries, and
- geometrically defined flows on parameter spaces of hyperbolic manifolds.

Understanding the geometry and topology of 3-dimensional spaces helps us understand more deeply the nature of the space in which we live, from its physical properties to its fundamental structure, laying the framework and structure for future breakthroughs and developments across a range of disciplines.

Papers, in reverse chronological order:

- (With M. Bridgeman and K. Bromberg.) The Weil–Petersson gradient flow of renormalized volume and 3-dimensional convex cores. *Geometry & Topology* 27 (2023), 3183–3228.

· (With K. Bromberg, R. Canary, and Y. Minsky.) Windows, cores, and skinning maps. *Ann. Sci. Éc. Norm. Supér.* (4) 53 (2020), no. 1, 173–216.

· (With C. Leininger, B. Modami, and K. Rafi.) Limit sets of Weil–Petersson geodesics with nonminimal ending laminations. *J. Topol. Anal.* 12 (2020), 1–28.

· (With C. Leininger, B. Modami, and K. Rafi.) Limit sets of Teichmüller geodesics with minimal nonuniquely ergodic vertical foliation, II. *J. Reine Angew. Math.* 758 (2020), 1–66.

· (With C. Leininger, B. Modami, and K. Rafi.) Limit sets of Weil–Petersson geodesics. *Int. Math. Res. Not. IMRN* 2019, no. 24, 7604–7658.

· (With K. Bromberg, R. Canary, C. Lecuire, and Y. Minsky.) Local topology in deformation spaces of hyperbolic 3-manifolds II. *Groups Geom. Dyn.* 13 (2019), no. 3, 767–793.

· (With M. Bridgeman and K. Bromberg.) Schwarzian derivatives, projective structures, and the Weil–Petersson gradient flow for renormalized volume. *Duke Math. J.* 168 (2019), no. 5, 867–896.

· (With K. Bromberg.) Correction to "On the density of geometrically finite Kleinian groups." *Acta Math.* 219 (2017), 17–19.

· (With K. N. Keshavamurthy, O. P. Leary, L. H. Merck, B. Kimia, S. Collins, D. W. Wright, J. W. Allen, and D. Merck.) Machine learning algorithm for automatic detection of CT-identifiable hyperdense lesions associated with traumatic brain injury. *Proc. SPIE* 10134, Medical Imaging 2017: Computer-Aided Diagnosis, 101342G (2017).

· (With N. Dunfield.) Norms on the cohomology of hyperbolic 3-manifolds. *Invent. Math.* 210 (2017), no. 2, 531–558.

· (With K. Bromberg.) Geometric inflexibility of hyperbolic cone-manifolds. In *Hyperbolic Geometry and Geometric Group Theory*, Adv. Stud. Pure Math. 73 (2017), 47–64.

· (With K. Bromberg.) Inflexibility, Weil–Petersson distance, and volumes of fibered 3-manifolds. *Math. Res. Lett.* 23 (2016), 649–674.

· (With Y. Minsky, H. Namazi, and J. Souto.) Bounded combinatorics and uniform models for hyperbolic 3-manifolds. *J. Topol.* 9 (2016), no. 2, 451–501.

· (With B. Modami.) Recurrent Weil–Petersson geodesic rays with non-uniquely ergodic ending laminations. *Geometry & Topology* 19 (2015), 3565–3602.

· (With K. Bromberg, R. Canary, and C. Lecuire.) Convergence and divergence of Kleinian groups. *J. Topol.* 8 (2015), 811–841.

· (With N. Dunfield.) Injectivity radii of hyperbolic integer homology 3-spheres. *Geometry & Topology* 19 (2015), 497–523.

· (With K. Bromberg, R. Canary, and Y. Minsky.) Convergence properties of end invariants. *Geometry & Topology* 17 (2013), 2877–2922.

· (With R. Canary and Y. Minsky.) The classification of Kleinian surface groups II: the ending lamination conjecture. *Annals of Math.* 176 (2012), 1–149.

· Assembling surfaces from random pants: mixing, matching and correcting in the proofs of the surface-subgroup and Ehrenpreis conjectures. In *AMS Current Events Bulletin* (2012).

· (With K. Bromberg, R. Canary, and Y. Minsky.) Local topology of deformation spaces of hyperbolic 3-manifolds. *Geometry & Topology* 15 (2011), 1169–1224.

· (With H. Masur and Y. Minsky.) Asymptotics of Weil–Petersson geodesics II: bounded geometry and unbounded entropy. *Geom. & Funct. Anal.* 21 (2011), 820–850.

· (With K. Bromberg.) Geometric inflexibility and 3-manifolds that fiber over the circle. *J. Topology* 4 (2011), 1–38.

· (With H. Masur and Y. Minsky.) Asymptotics of Weil–Petersson geodesics I: ending laminations, recurrence and flows. *Geom. & Funct. Anal.* 19 (2010), 1229–1257.

· Taming the field of hyperbolic 3-manifolds. In *Annual Report of the Clay Mathematics Institute, 2009*, 10–18.

· (With H. Masur.) Coarse and synthetic Weil–Petersson geometry: quasi-flats, geodesics, and relative hyperbolicity. *Geometry & Topology* 12 (2008), 2453–2495.

· (With D. Margalit.) Weil–Petersson isometries via the pants complex. *Proc. Amer. Math. Soc.* 135 (2007), 795–803.

· (With J. Souto.) Algebraic limits of geometrically finite manifolds are tame. *Geom. & Funct. Anal.* 16 (2006), 1–39.

· (With B. Farb.) Curvature and rank of Teichmüller space. *Amer. J. Math.* 128 (2006), 1–22.

· The Weil–Petersson visual sphere. *Geometriae Dedicata* (2005), 1–18.

· (With K. Bromberg.) On the density of geometrically finite Kleinian groups. *Acta Math.* 192 (2004), 33–93.

· (With K. Bromberg, R. Evans, and J. Souto.) Tameness on the boundary and Ahlfors' measure conjecture. *Publ. Math. I.H.É.S.* 98 (2003), 145–166.

· The Weil–Petersson metric and volumes of 3-dimensional hyperbolic convex cores. *J. Amer. Math. Soc.* 16 (2003), 495–535.

· Weil–Petersson translation distance and volumes of mapping tori. *Comm. Anal. Geom.* 11 (2003), 987–999.

- (With K. Bromberg.) Cone-manifolds and the density conjecture. In *Kleinian Groups and Hyperbolic 3-Manifolds*, London Math. Soc. Lecture Note Ser., Cambridge University Press, 2003.
- Pants decompositions and the Weil–Petersson metric. In *Complex Manifolds and Hyperbolic Geometry*, Amer. Math. Soc., Providence, 2002.
- Iteration of mapping classes and limits of hyperbolic 3-manifolds. *Invent. Math.* 143 (2001), 523–570.
- Boundaries of Teichmüller spaces and end-invariants for hyperbolic 3-manifolds. *Duke Math. J.* 106 (2000), 527–552.
- Continuity of Thurston's length function. *Geom. & Funct. Anal.* 10 (2000), 741–797.
- Iteration of mapping classes on a Bers slice: examples of algebraic and geometric limits of hyperbolic 3-manifolds. In *Lipa's Legacy*, J. Dodziuk and L. Keen, eds., Proceedings of the Bers Colloquium, 1997, 81–106.
- (With M. Alfaro et al.) The standard double bubble in $\mathbf{R}^2$ uniquely minimizes perimeter. *Pacific J. Math.* 159 (1993), no. 1, 47–59.
- (With C. Adams et al.) Almost alternating links. *Topology Appl.* 46 (1992), no. 2, 151–165.

Preprints are linked from `jeffbrock.net/publications`.

Selected Invited Presentations

2018–*present*

- *Three-manifolds after Perelman*, Differential Geometry Seminar, University of Torino, Torino, Italy, 2026.
- *Clay Research Conference*, Plenary Speaker, Mathematical Institute, University of Oxford, Oxford, UK, 2025.
- *Exploring Geometry*, Invited Speaker, University of Fribourg, Fribourg, Switzerland, 2025.
- *1, 2, 3: Curves, surfaces, and 3-manifolds*, Nahsholim, Israel, 2023.
- *Geometry, Probability, and their Synergies in les Diablerets*, Plenary Speaker, les Diablerets, Switzerland, 2023.
- *Geometry, Arithmetic, and Groups*, Plenary Speaker, Austin, TX, 2022.
- *Noteworthy Math: the math of music and the music of math*, Guest Speaker (virtual), MoMath, New York, NY, 2021.
- *Frontiers of Analysis and Geometry of Teichmüller Spaces*, Invited Speaker, Tsinghua Sanya International Mathematics Forum, Sanya, China, 2020.
- *Geometric Data Analysis*, Invited Speaker, University of Chicago, Chicago, IL, 2019.
- *Multiple Perspectives on Geometric Inequalities*, Invited Speaker, Centre de Recerca Matemàtica, Barcelona, Spain, 2019.
- *Model Driven Discovery & the Science of Data*, Invited Speaker, RedHat Research Day, Boston, MA, 2019.
- *Representation varieties and geometric structures in low dimensions*, Invited Speaker, Mathematics Institute, University of Warwick, Warwick, UK, 2018.
- *Workshop on Geometry of Teichmüller Space*, Invited Speaker, Fields Institute, Toronto, ON, 2018.

2015–2017

- *Geometric Topology in Low Dimensions*, Invited Speaker,
  Mathematics Institute, University of Warwick, Warwick, UK, 2017.
- *Teichmüller Theory and Geometric Structures on 3-manifolds*, Invited Speaker,
  University of Luxembourg, 2017.
- *Geometric Topology in Cortona*, Minicourse Speaker, Cortona, Italy, 2017.

- *Geometry, Topology and Dynamics of Moduli Spaces*, Main Speaker, Singapore, 2016.
- *Advanced School on Geometric Group Theory and Low-Dimensional Topology*, Lecturer in three hour mini-course at ICTP, Trieste, Italy, 2016.
- *Geometric Topology, Geometric Group Theory & Dynamical Systems*, Invited Speaker, Inter-University Centre Dubrovnik, Croatia, 2015.
- *Classical and quantum hyperbolic geometry and topology*, Main Speaker, Université Paris Sud, Paris, France, 2015.
- *Hyperbolic Geometry and Minimal Surfaces*, IMPA. Rio de Janeiro, Brazil, 2015.

2011–2014

- *The 10th William Rowan Hamilton Geometry and Topology Workshop*, Public Lecture. Dublin, Ireland, 2014.
- *Hyperbolic Geometry and Geometric Group Theory - ICM Satellite Conference*, Plenary Speaker. Tokyo, Japan, 2014.
- *Teichmüller theory and surfaces in 3-manifolds*, Main Speaker. Centro De Giorgi, Scuola Normale Superiore, Pisa, Italy, 2014.
- *Wasatch Topology Conference*, Park City, UT, 2014.
- *The 9th William Rowan Hamilton Geometry and Topology Workshop*, Dublin, Ireland, 2013.
- *The XXII Nevanlinna Colloquium*, Plenary Speaker. Helsinki, Finland, 2013.
- *Hyperbolic Geometry and Mapping Class Groups*, three-lecture graduate minicourse. Pisa, Italy, 2013.
- *Geometric Topology in Cortona*, Plenary Speaker. Cortona, Italy, 2013.
- *Geometric Structures on Surfaces*, summer@ICERM minicourse. Providence, RI, 2013.
- *The Poincaré Symposium*, Brown University, Providence, RI, 2012.
- *Tech Topology Conference*, Georgia Institute of Technology, Atlanta, GA, 2012.
- *Gear Junior Retreat*, Three lecture mini-course on *Combinatorial Teichmüller Theory*. Urbana, IL, 2012.
- *Rigidity and Flexibility in Dimensions 2, 3, and 4*, Steve Kerckhoff's Birthday Conference. Luminy, France, 2012.
- *Immersed Surfaces in Three-Manifolds* Institut Henri Poincaré, Paris, France, 2012.

- *Current Events Bulletin* One-hour invited talk at the Joint Meetings of the American Mathematical Society. Boston, MA, 2012.
- *The hyperbolic and Riemannian geometry of surfaces and other manifolds - A conference in honor of Peter Buser*, Ascona, Switzerland, 2011.
- *The 7th William Rowan Hamilton Geometry and Topology Workshop*, Invited to give mini-course on Teichmüller theory, Dublin, Ireland, 2011.
- *Aspects of hyperbolicity in geometry, topology, and dynamics – A workshop in honor of Caroline Series' 60th Birthday*, Warwick, England, 2011.

2005–2010

- Fourth *de Brún Workshop on Group Actions* (four-lecture minicourse), NUI Galway, Galway, Ireland. 2010
- *Geometry and Analysis of Riemann Surfaces and Their Moduli* (Scott Wolpert's birthday conference), U. Maryland, College Park, MD. 2010
- *Geometry Topology and Dynamics of Character Varieties*, NUS, Singapore. 2010
- *Advanced School and Workshop on Discrete Groups in Complex Geometry*, ICTP, Trieste, Italy. 2010
- *M. E. Hamstrom Memorial Lecture*, University of Illinois, Urbana-Champaign. 2010
- *Dynamics and Geometry of Teichmüller Space*, Luminy, France. 2009
- The *Evans-Hall Memorial Lecture*, Emory University, Atlanta, GA. 2009
- The *Julia Wells Bower Lecture*, Connecticut College, New London, CT. 2009
- *MSRI-Evans Lecture*, Berkeley, CA, 2007.
- William Thurston's 60th Birthday Conference, Princeton, NJ, 2007.
- *Teichmüller Space and Outer Space*, Marseille, France, 2007
- Geometry of Moduli Spaces, Stanford, CA, 2007.
- MAA Invited Address, AMS-MAA National Meetings, New Orleans, LA, 2007.
- Three-lecture series, *3-Manifolds After Perelman*, Edinburgh, Scotland, 2006.
- Three-lecture series, *Trois Journées de Topologie à Orsay*, Orsay, France, 2005.
- Low-dimensional topology meeting, Oberwolfach, Germany, 2005.
- *Geometry and Topology of Three Manifolds*, Trieste, Italy, 2005.

pre-2005

- AMS Invited Address, Pittsburgh, PA, 2004.
- Wesleyan Geometric Analysis Conference, Middletown, CT, 2004.
- Main Lecturer, VIGRE mini-course, Salt Lake City, UT, 2004.
- Cornell Topology Festival, Ithaca, NY, 2004.
- IUC conference on Teichmüller space and moduli space, Chicago, IL, 2003.
- *Wasatch Topology Conference*, Salt Lake City, UT 2002.
- Georgia Topology Conference, Athens, GA, 2002.
- Plenary Address, *Ahlfors-Bers Colloquium*, Storrs, CT, 2001.
- *Kleinian Groups and Hyperbolic 3-Manifolds*, Warwick, England, 2001.
- *Iberoamerican Congress on Geometry*, Guanajuato, Mexico, 2001.
- Bay Area Topology Seminar, Stanford, CA, 1999.

Grant Support

- PI, NSF REU Site Grant DMS-2050398, 4/2021–8/2024. *Summer Undergraduate Math Research at Yale*. Ian Adelstein Co-PI. Extends Yale-funded summer undergraduate research program to external students. Amount $400,000.

- Co-PI, NSF CCF TRIPODS+X Grant, 9/2018–9/2021 *From Data Science to Neuroscience* Amount $300,000. Nicholas Turk-Browne, PI, Damon Clark, John Lafferty co-PI.

- PI, NSF CCF TRIPODS Institute Grant 1740741, 9/2017–8/2022 *Foundations of Model Driven Discovery from Massive Data*. Amount: $1,482,177. Eli Upfal, Stuart Geman, Bjorn Sandstede, Joseph Hogan, Co-PIs.

- NSF Grants DMS-1608759 (Brown) and DMS-1849892 (Yale), 9/2016–8/2022. *Rigidity, Volume, and Combinatorics in Hyperbolic Geometry*. Amount: $402,228.

- NSF Conference Grant DMS-1439369, 5/2014–4/2015. *Mapping Class Groups and Teichmüller Theory*, May 7–14, 2014. Amount: $30,000.

- NSF Grant, DMS-1207572, 7/2012–6/2016. *Combinatorics, Models, and Bounds in Hyperbolic Geometry*. Amount: $290,498.

- Co-PI, NSF Mathematical Sciences Research Institute Grant, DMS-0931908. *The Institute for Computational and Experimental Research in Mathematics*.

  Amount: $15,495,376.

- NSF Grant, DMS-0906229, 9/2009–8/2013. *Teichmüller theory, Kleinian groups, and the complex of curves*. Amount: $210,754.

- NSF FRG Grant, DMS-0553694, (Co-PIs Bromberg, Canary, and Minsky), 7/2006–6/2011. *Geometry and Deformation Theory of Hyperbolic 3-Manifolds*. Amount: $238,971.

- NSF Grant DMS-0505442, 7/2005–6/2009. *Effective Rigidity, Combinatorial Models and Parameter Spaces for Low-Dimensional Hyperbolic Manifolds*. Amount: $140,864.

- NSF Grants DMS-0204454 (Chicago) and DMS-0354288 (Brown), 6/2002–6/2005. *The Classification Problem for Hyperbolic 3-Manifolds*. Amount: $101,601.

- Postdoctoral Associate, NSF Research Grant DMS-0072133, 2000–2002.

- NSF Mathematical Sciences Postdoctoral Research Fellow, Stanford, 1997–2000.

Service

- Co-Director, *SUMRY: Summer Undergraduate Mathematics Research at Yale*, 2021–present (NSF REU Site, 2021–2024).
- Organizer, *Random and Arithmetic Structures in Topology*, Fall 2020 MSRI program.
- Chair, Scientific Advisory Board, Heidelberg Institute for Theoretical Studies (HITS), November 2026–present; member, 2019–present.
- Scientific Advisory Board, Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany, 2023–present.
- Task Force on Undergraduate Admissions, convened by the Dean of Yale College, 2025–2026.
- Executive Committee, Lower Hillhouse Avenue campus planning, Yale University.
- Planning Committee, Physical Sciences & Engineering Building, Yale University.
- Steering Committee, Wu Tsai Institute, Yale University.
- Steering Committee, Institute for Foundations of Data Science (FDS), Yale University.
- Committee on Science Policy, American Mathematical Society, 2018–2021.
- Chair, School of Engineering & Applied Science Tenure and Appointments Committee (SEASTAC), Yale University, July 2026–present.
- Physical Sciences and Engineering Advisory Committee, Yale University, 2018–2026.
- Diversity Committee, Brown Mathematics Department, 2017–2018.
- Organizer, Summer@ICERM Program, *Topological Data Analysis*. ICERM, 2017.
- Scientific Advisory Board, ICERM, 2017–2019.
- Committee on Committees, American Mathematical Society, 2017–2018.
- Steering Committee, Brown University Data Science Initiative, 2015.
- Co-Chair, Search Committee, ICERM Director, 2014–2015.
- Graduate Admissions Committee, Department of Mathematics, Brown University, 2012.
- Tenure Promotion and Appointments Committee, Department of Mathematics, Brown University, 2010–2012.
- Organizer, *Geometry and Dynamics in Surfaces and 3-Manifolds, II*, Summer 2009 FRG conference.
- Director of Undergraduate Studies, Department of Mathematics, Brown University, 2008–2009.
- Undergraduate Science Education Committee, Brown University, 2006–2007.
- Organizer, *Kleinian groups and Teichmüller Theory*, Fall 2007 MSRI program.
- Organizer, *Geometry and Dynamics in Surfaces and 3-Manifolds*, Spring 2007 FRG conference.

- Colloquium Chair, Department of Mathematics, Brown University, 2004–2006.
- Senior Appointments Committee, Department of Mathematics, Brown University, 2005–2006.
- Tamarkin Assistant Professor Committee, Department of Mathematics, Brown University, 2004–2005.
- Organizer, *Tameness in Texas*, Harrington Conference at U.T. Austin, 2004.

Editorial Work

Editorial Board, Journal of Topology. 2018–January 2027.