

Dept. of Mathematical Sciences  
George Mason University  
4400 University Dr  
Fairfax, VA 22030

## Positions

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<b>George Mason University</b> , Department of the Mathematical Sciences, Fairfax, VA	
Term Assistant Professor	September 2020–present
Director of Outreach for the Mason Experimental Geometry Lab	September 2020–present
<b>University of Michigan</b> , Department of Mathematics, Ann Arbor, MI	
Parekh Family Fellow	September 2019–May 2020
Visiting Assistant Professor	September 2016–May 2020
RTG Postdoctoral Fellow	September 2016–August 2018

## Education

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<b>Tufts University</b> , Department of Mathematics, Medford, MA	MS 2013, PhD 2016
Mathematics	
<b>Advisor:</b> Professor Boris Hasselblatt	
<b>Hamilton College</b> , School of Arts and Sciences, Clinton, NY	BA 2011
Mathematics	

## Research Interests

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My research interests are in geometry, topology, and dynamical systems. More specifically, I am interested in geodesic flows, geometric structures on manifolds, convex projective structures, Hilbert geometries, Patterson-Sullivan theory, ergodic theory, thermodynamic formalism, symbolic dynamics, (nonuniformly) hyperbolic dynamical systems, and (rel) hyperbolic spaces and groups.

## Preprints and Publications

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- H. Bray and D. Constantine. *Entropy rigidity for finite volume strictly convex projective manifolds*. (preprint, submitted).
- H. Bray, R. Canary, and L-Y Kao. *Pressure metrics for deformation spaces of quasifuchsian groups with parabolics*. (preprint, submitted)
- H. Bray, D. Davis, K. Lindsey, and C. Wu. *The Shape of Thurston's Master Teapot*. (Accepted at Advances).
- H. Bray *Ergodicity of Bowen-Margulis measure for the Benoist 3-manifolds*. (To appear in Journal of Modern Dynamics, Volume 16, 2020, 305–329).
- H. Bray. *Geodesic flow of nonstrictly convex Hilbert geometries*. (To appear in Annales de L'Institut Fourier).
- I. Adeboye, H. Bray, and D. Constantine. *Entropy rigidity and Hilbert volume*. Discrete Contin. Dyn. Syst. Ser. A (2019) no. 39(4): 1731-1744. doi: 10.3934dcds.2019075.

## Grants and Awards

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<b>NSF conference grant: LG&amp;TBQ.</b> Co-PI Autumn Kent (\$40,000).	June 2019
<b>University of Michigan LS&amp;A conference mini-grant.</b> (\$2,500).	June 2019
<b>The Frederick Gehring Award for postdoctoral excellence.</b> University of Michigan Department of Mathematics	April 2019
<b>AMS Simons Research Travel Grant</b> (\$4,000).	2018-2021
<b>Outstanding Academic Scholarship Nominee</b> (Finalist). Tufts University Graduate School of Arts and Sciences.	April 2016
<b>Tufts Mathematics Distinguished Teaching Prize</b> for exceptional graduate student teaching.	October 2015
<b>The Robert P. Guertin Graduate Student Leadership Award.</b> Tufts University Graduate School of Arts and Sciences.	April 2015
<b>Graduate Institute for Teaching Fellowship.</b> Tufts University Graduate School of Arts and Sciences.	May – Dec 2015
<b>GEAR Graduate Internship Travel Grant</b> (\$3,100).	Aug 2016
<b>AMS Graduate Student Travel Grant.</b>	January 2016
<b>Tufts Graduate School of Arts &amp; Sciences Conference Travel Grant.</b>	2012 – 2014

## Mentoring

- First year orientation advisor on mathematics course options for honors students (University of Michigan) Summer 2020
- Marianne DeBrito, Andrew Nguyen, Marisa O’Gara (University of Michigan, undergraduates) Winter 2020  
*Entropy degeneration of ideal projective pants.*  
 Lab of geometry at Michigan. Co-supervised with postdoc Giuseppe Martone, with support from graduate student Mitul Islam.  
 (preprint authored by students submitted for publication)
- Robert Buckley, Grace O’Brien, Zoe Zhou (University of Michigan, undergraduates) Fall 2019  
*Growth rates of tent maps.*  
 Lab of Geometry at Michigan. With support from graduate student Yiwang Chen (University of Michigan, graduate student)  
 (preprint authored by Buckley, Chen, O’Brien, and Zhou submitted. Data in preparation for publication.)
- Steven Schaefer, Rudra Ranganathan, Hanissa Shamsuddin (University of Michigan, undergraduates) Fall 2018  
*3d printing nonstrictly convex projective structures.*  
 Lab of Geometry at Michigan. With support from graduate students Samantha Pinella and Robert Walker.
- Jennifer Jones-Baro (Centro de Investigacion en Matemáticas, undergraduate) and Adam Holeman (University of Montana, masters student) Summer 2017  
*Random walks on the fundamental group of the once punctured torus.*  
 Michigan REU program. Co-supervised with Caleb Ashley.

## Service and Leadership

- **Dissertation committee member** for doctoral candidate Samantha Pinella Apr 2020  
 University of Michigan, advised by Ralf Spatzier
- **Lab of Geometry at Michigan (LoGM)**  
 Director, instructor July 2017 – present  
 LoGM is Michigan’s chapter of the Geometry Labs United. Founded in January 2017, the goal of LoGM is to create avenues into mathematics research for enthusiastic undergraduates via mentoring, community, and visualization. Students in groups of 3-4 participate in semester-long research projects run by faculty with a graduate student assistant. At present, LoGM has consistently run 3-4 projects per semester.  
 The program addresses high and increasing demand by undergraduates for mathematics research opportunities, which were previously limited to Michigan’s extremely competitive and selective summer

REU program. The program also addresses demand by post-docs and graduate students for structured mentoring opportunities by matching mentors with qualified and enthusiastic students.

As director of LoGM, I have contributed substantially to the program development. In the 6 semesters I have directed LoGM, there have been 22 projects, and I have worked with 61 faculty and graduate student mentors and 70 undergraduate researchers. I have:

- Recruited, mentored, supported and managed research-active faculty leads who posed questions for undergraduate teams related to their current research.
- Recruited undergraduate researchers and assigned students to projects based on appropriate qualifications after careful review in an application process.
- Developed application materials and collaborated with several members of the mathematics department to effectively and responsibly evaluate student candidacy.
- Successfully applied to the University of Michigan curriculum committee to make LoGM a standard course offering from the Michigan mathematics department.
- Instructed and designed the LoGM course, independently developed original course material, and supervised collaborative development of original course material.

**Panelist JMM 2019 Association for Women in Mathematics Panel: Promoting Inclusion in Stem.**

16 Jan 2019

**Michigan Math Circle** for middle school students.

8 & 22 Mar 2018

**Wolverine Pathways**

Math circle leader for 8th and 11th graders on three different Saturdays in fall 2017.

Oct – Nov 2017

Wolverine Pathways is a program which, after completion, provides financial support for students from the greater Detroit metropolitan area to attend the University of Michigan if admitted. The math department has run math circles on a volunteer basis as part of the program.

**Mathematical Research Community Workshop on Dynamical Systems:** Smooth, Symbolic, and Measurable.

Assistant to the Organizers

June – July 2017

With two other assistants, helped the organizers set up certain components of the workshop, ran an ice-breaker activity for participants, and coauthored a summary of the results of the workshop as part of an NSF proposal to fund the MRC program.

**FEMMES (Females Excelling in Math, Engineering, and the Sciences) Capstone Event**

Activity facilitator for 4-6th grade girls

Nov 2016, Mar 2017, Nov 2017

**Tufts University Student Chapter of the Association for Women in Math (AWM)**

President

Sept 2014 – 2016

Vice President

Dec 2013 – Sept 2014

Cofounder

Dec 2013

As President of the Tufts student chapter of the AWM, I organized outreach activities at local high schools, panel discussions with women in mathematics from the greater Boston area, coffee & donuts meet-ups with female guest seminar speakers, and regular group meetings to create a community centered around encouraging the participation of underrepresented genders in mathematics.

**Tufts University Org. of Graduate Students in Mathematics**

Second Year Class Representative

Sept 2012 – Aug 2013

**MISE Math Camp**, Accra, Ghana

Instructed number theory for exceptional high school students in Ghana. The month long summer camp included three weeks of course work and culminated in one week of small groups research projects.

July 2012

## Memberships

American Mathematical Society (AMS)

## Conferences, Seminars, Workshops, and Visits

### Invited Presentations

- (Virtual, Covid-19) Max Dehn Seminar. Univ of Utah. Salt Lake City, UT 18 Nov 2020
- (Virtual, Covid-19) Geometry and Topology Seminar. Columbia University. New York, NY 10 Apr 2020
- Geometry and Discrete Groups Seminar. IHES. Bures-sur-Yvette, France 18 Nov 2019
- Perspectives on convex projective geometry. Sète, France 24 - 28 June 2019
- Boundaries of random walks. Brunswick, ME 4 - 6 June 2019
- Dynamics of group actions: a conference in the honor of Yves Benoist. Cetraro, Italy. 27 - 31 May, 2019
- Geometric Group Theory Seminar. Ohio State Univ. Columbus, OH 11 Apr 2019
- Joint Mathematics Meeting Special Session on Geometry Labs United: Research, Visualization, and Outreach. Baltimore, MD. 16 - 19 Jan 2019
- Conference on group actions and ergodic theory in geometry and topology. The Hamilton Mathematics Institute. Dublin, Ireland. 30 July - 3 Aug 2018
- Dynamics seminar. University of Chicago. Chicago, IL. 30 April 2018
- Joint Mathematics Meeting Special Session: Boundaries for groups and spaces. San Diego, CA. 10-13 Jan 2018
- Dynamical Systems Seminar. Northwestern Univ. Evanston, IL. 2 May 2017
- Junior Geometry and Topology in the Midwest Conference. Madison, WI. 22 Apr 2017
- Geometry and Topology Seminar. Univ. of Toronto. Toronto, ON, Canada. 13 Mar 2017
- Ergodic Theory/Probability Seminar. Ohio State Univ. Columbus, OH. 9 Feb 2017
- Complex Analysis, Dynamics, and Geometry seminar. University of Michigan. Ann Arbor, MI 28 Nov 2016
- Howard University Mathematics Colloquium. Washington, D.C. 4 Nov 2016
- Workshop in Dynamical Systems. Penn State University. State College, PA. 27-30 Oct 2016
- Minicourse on ergodic geometry in a nonuniformly hyperbolic setting (4 courses). University of Maryland, College Park, MD. 2-11 Aug 2016
- Dynamics and Algebra seminar. Wesleyan University. Middletown, CT. 26 April 2016
- Workshop on Dynamical Systems and Related Topics. University of Maryland. College Park, MD. 15-17 Apr 2016
- Dynamics seminar. University of Chicago. Chicago, IL. 15 Feb 2016
- Everytopic seminar. Brandeis University. Waltham, MA. 3 Dec 2015
- Poster; Midwest Dynamical Systems Meeting. Ohio State Univ. Columbus, OH. 31 Oct 2015
- Second Annual Graduate Student Math Conference, Brown University. 21 Feb 2015
- IRMA Master Class: student-postdoc seminar. Strasbourg, France. 12 May 2014
- Finsler Geometry and Applications. Galatasaray University, Turkey. Apr 2014
- Poster; School on Geometry and Dynamics. CIRM, Luminy, France. 31 Mar 2014
- Séminaire Teich. Aix-Marseille University, Marseille, France. 28 Mar 2014
- Young Mathematicians in Dynamical Systems. CIRM, Luminy, France. 29 Nov 2013

### Conferences, seminars, and other activities organized

- IBL seminar lunch, University of Michigan. Jan - Apr 2020
- MAA Panel: So You're (Going to Be) a Postdoc: Now What? A Panel Discussion JMM 2020 16 Jan 2020
- LG&TBQ: a conference celebrating the work of diverse mathematicians in geometry, topology, and dynamics. 10-14 June 2019
- Dynamics Seminar, Tufts University. Sept 2014 – April 2016, Sept 2013 – Dec 2013
- Research in Pairs, with M. Crampon. CIRM, Luminy, France. May 2014

## Conferences and Workshops Attended

- 2018 Workshop in Dynamical Systems and Related Topics.  
State College, Pennsylvania. 4-7 Oct 2018
- Geometry Labs United 2017. Seattle, WA. 12-13 Aug 2017
- Mathematical Research Community Workshop on Dynamical Systems:  
Smooth, Symbolic, and Measurable. Snowbird Resort, UT. 18-24 June 2017
- Workshop on Moduli Spaces of Geometric Structures. IMS, Singapore. 15-19 Aug 2016
- Geometries, surfaces and representations of fundamental groups.  
University of Maryland, College Park, MD. 22-24 June 2016
- Fractal Geometry, Hyperbolic Dynamics and Thermodynamical Formalism.  
ICERM, Providence, RI. 7-11 Mar 2016
- Joint Mathematics Meetings. Seattle, WA. 6-9 Jan 2016
- AMS Fall Eastern Sectional Meeting. Rutgers Univ, New Brunswick, NJ. 14-15 Nov 2015
- Women In Mathematics In New England (WiMiN). Smith College, Northampton, MA. 19 Sept 2015
- MSRI Connections for Women: Dynamics on Moduli Spaces of Geometric Structures.  
Berkeley, CA. 15-16 Jan 2015
- MSRI Introductory Workshop: Dynamics on Moduli Spaces of Geometric Structures.  
Berkeley, CA. 20-23 Jan 2015
- ICTP-NLAGA School in Dynamical Systems and Ergodic Theory. Mbour, Senegal. 4-14 June 2014
- Master Class: Around Thurston-Grothendieck-Teichmüller theories. IRMA,  
Strasbourg, France. 9-17 May 2014
- Young Researchers in Geometric Group Theory. CIRM, Luminy, France. 20-24 Jan 2014
- Hyperbolicity and Dimension. CIRM, Luminy, France. 2-6 Dec 2013
- Beyond Uniform Hyperbolicity. Będlewo, Poland. 27 May – 6 June 2013

## Seminar Participation

- RTG working seminar on geometry, topology, and dynamics. University of  
Michigan. Sept 2016 – present
- Topology seminar. University of Michigan. Sept 2016 – present
- Geometric Group Theory and Topology Seminar. Tufts University. Sept 2014 – May 2016,  
Sept 2012 – Dec 2013
- Séminaire: Dynamique, Arithmétique et Combinatoire.  
Institut de Mathématiques de Marseille. Feb – Apr 2014
- Séminaire: Teich, Aix Marseille Université. Jan – Apr 2014
- Dynamics Seminar, Tufts University. Sept 2012 – Dec 2013
- Working seminar on Ergodic Geometry, Tufts University. Spring 2013

## Invited Guest

- Institute Des Hautes Études Scientifiques (IHES). Bures-sur-Yvette, France Nov 2019
- Centre International de Rencontres Mathématiques (CIRM). Luminy, France. Jan 2014 – Apr 2014

## Teaching Experience

### Primary Instructor: Calculus II (George Mason University)

- Fall 2020
- Virtual, hybrid sync/async, lecture and interactive components
- Managed all facets of my own section, including writing all assessments, as well as managing and mentoring 3 undergraduate learning assistants and a graduate teaching assistant.

### Primary Instructor: Mathematics for Elementary Teachers I (George Mason University)

- Fall 2020
- Virtual, synchronous, interactive course with minimal lecture
- Managed all facets of my own section and collaborated with another faculty member to transfer the course to a virtual format. Managed and mentored two undergraduate learning assistants.

### Primary Instructor and course creator: The Lab of Geometry at Michigan, LoGM (University of Michigan)

- Fall 2019, Winter 2020
- Created the course in Fall 2019 as an extension of the existing Lab of Geometry program.
- Recruited and managed collaborators Samuel Hansen (University of Michigan mathematics librarian) and Rachel Webb (University of Michigan mathematics PhD student)
- Designed a course in which students learned technical skills, presentation skills, writing skills, project management skills, and more, in a project-focused course on topics in modern mathematics research that are beyond the scope of the standard department curriculum.
- Supervised the development of original course material. Reviewed and assessed material developed by collaborators for technical and presentation focused modules. Both independently and collaboratively developed remaining original course material, including syllabi, assessments, rubrics, feedback and evaluation forms, and more. All material development informed by modern research on best practices in mathematics education.

**Primary Instructor:** Linear Algebra, IBL (University of Michigan)

- Fall 2017, Fall 2018, Winter 2019, and Fall 2019
- Total of 7 sections taught
- Managed all facets of my own section, including writing daily short quizzes.
- Contributed to development of homework and exams.
- Developed new worksheet material and refined existing material.
- Taught the course in an Inquiry Based Learning (IBL) style.

**Primary Instructor:** Exploration in Probability, IBL (University of Michigan)

- Winter 2017
- Managed all facets of my own section, including writing all quizzes and major assessments. Managed and mentored 1 undergraduate course assistant.
- Taught the course in an Inquiry Based Learning (IBL) style.

**Primary Instructor:** Intro to Topology, IBL (University of Michigan)

- Fall 2016
- Managed all facets of my own section, including writing all exams. Managed and mentored 1 undergraduate course assistant.
- Contributed new course material to an existing repository.
- Taught the course in an Inquiry Based Learning (IBL) style.

**Online Course Moderator and Research Assistant**

Poincaré Institute for Mathematics Education.

- Sept 2012 – Aug 2014
- Moderated online discussion, composed and edited course materials, provided supplementary office hours using Adobe Connect.

**Primary Instructor:** Applied Calculus II (Tufts University)

- Fall 2015
- Managed my own section: this included delivering all lectures.
- Collaborated with a mentor to produce course materials, including the syllabus, weekly quizzes, exams, in-class activities, and other resources.
- Experimental teaching: during select class periods, created and shared video lectures electronically with students to view preceding class time, then assigned activities and problems during class. Assigned exercises to engage students actively in the material every class period.
- Wrote Mathematica CDFs to supplement course material.

**Primary Instructor:** The Mathematics of Social Choice (Tufts University)

- Spring 2015, Fall 2014
- Managed my own section: included delivering the lectures and generating all course materials, such as the syllabus, homework, daily quizzes, exams, and other resources.
- Wrote Mathematica CDFs to supplement course material.

## Pedagogical Training

**Assistant to the organizers** for the **IBL Workshop** at the University of Michigan. August 2020

- In August 2020, the annual three day Inquiry Based Learning (IBL) workshop was held in virtual format with focus on interactive teaching in a virtual classroom.
- As assistant to the organizers, I supported organizers as a teaching assistant in the working sessions, held discussions on topics such as Gutiérrez's framework for "(re)humanizing mathematics," and prepared a short presentation on the relationships between equity and teaching practices in the classroom.

**Learning community on inclusive teaching.** University of Michigan Winter 2018, 2019, 2020

**IBL working seminar.** University of Michigan Sept 2016 - May 2020

**IBL Workshop.** University of Michigan Aug 2016 & Aug 2017

- The annual three day IBL workshop consists of observing and analyzing an inquiry-based learning (IBL) classroom on mathematical proof, which extends to semi-monthly lunches with discussion on IBL techniques and ideologies in mathematics.

**Michigan Teaching Training** Aug 2016

- Michigan has an extensive teacher training program for new hires, run by the math department in conjunction with the Michigan Center for Research on Learning and Teaching (CRLT).

**Graduate Institute for Teaching (GIFT).** Tufts University May-Dec 2016

- The Tufts Graduate Student Institute for Teaching (GIFT) awards fellowships on a competitive basis across all fields of scholarship at Tufts. Teaching fellows participate in an intensive summer workshop on pedagogy before working with a faculty mentor in the classroom the following semester.