

Matthew Badger

Curriculum Vitae

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Employment and Visiting Positions

UNIVERSITY OF CONNECTICUT

- Assistant Professor, Department of Mathematics, Fall 2014 – *present*

STONY BROOK UNIVERSITY

- James H. Simons Instructor, Department of Mathematics, Fall 2011 – Spring 2014.

VISITING POSITIONS

- PCMI, Harmonic Analysis, July 2018.
- MSRI, Harmonic Analysis, January – March 2017.
- IPAM, Interactions Between Analysis and Geometry, March – June 2013.

Education

UNIVERSITY OF WASHINGTON

- Ph.D. in Mathematics, August 2011. *Thesis advisor:* Tatiana Toro.
- M.S. in Mathematics, August 2008.

UNIVERSITY OF PITTSBURGH

- B.S. in Mathematics, April 2006.
- B.A. in Political Science, April 2006.

Research Interests

My main research focus is on the **Geometry of Sets and Measures** that appear in various types of classical analysis. I am especially interested in problems from geometric measure theory and in higher-dimensional (3D+) analogues of geometric function theory in the complex plane (2D).

BUZZWORDS

Geometric Measure Theory, Rectifiable Measures, Elliptic PDE in Rough Domains, Harmonic Measure, Modulus of Curves and Measures, AND Quasiconformal Mappings

Grants and Fellowships

- NSF 1650546, “CAREER: Analysis and Geometry of Measures”, 2017–2022, \$410,000
- NSF 1500382, “Geometry of Sets and Measures”, 2015–2018, \$120,000
- NSF Mathematical Sciences Postdoctoral Research Fellowship, 2012–2015, \$150,000
- RTG Graduate Fellowship, Inverse Problems & PDE, University of Washington, 2009–2010 and 2010–2011.
- VIGRE Graduate Fellowship, University of Washington, 2006–2007.

Thesis Students

- Lisa Naples (supervised 2016–present), passed General Exam 12/2017, currently 4th year PhD student at UConn. Excepted graduation 5/2020.

Postdoctoral Fellows

- Murat Akman, Evarist Gine Postdoctoral Fellow at UConn, 2016–present.
- Vyron Vellis, Postdoctoral Fellow at UConn, 2016–present. Awarded standard NSF grant as a postdoc at UConn in 2018.

Publications

1. Harmonic polynomials and tangent measures of harmonic measure, *Rev. Mat. Iberoam.* **27** (2011), no. 3, 841–870. arXiv:0910.2591
2. Null sets of harmonic measure on NTA domains: Lipschitz approximation revisited, *Math. Z.* **270** (2012), no. 1–2, 241–262. arXiv:1003.4547
3. Flat points in zero sets of harmonic polynomials and harmonic measure from two sides, *J. London Math. Soc.* **87** (2013), no. 1, 111–137. arXiv:1109.1427
4. (with James T. Gill, Steffen Rohde and Tatiana Toro) Quasisymmetry and rectifiability of quasispheres, *Trans. Amer. Math. Soc.* **366** (2014), no. 3, 1413–1431. arXiv:1201.1581
5. Beurling’s criterion and extremal metrics for Fuglede modulus, *Ann. Acad. Sci. Fenn. Math.* **38** (2013), 677–689. arXiv:1207.5277
6. (with Raanan Schul) Multiscale analysis of 1-rectifiable measures: necessary conditions, *Math. Ann.* **361** (2015), no. 3–4, 1155–1172. arXiv:1307.0804
7. (with Jonas Azzam and Tatiana Toro) Quasiconformal planes with bi-Lipschitz pieces and extensions of almost affine maps, *Adv. Math.* **275** (2015), 195–259. arXiv:1403.2991
8. (with Stephen Lewis) Local set approximation: Mattila-Vuorinen type sets, Reifenberg type sets, and tangent sets, *Forum Math. Sigma* **3** (2015), e24, 63 pp. arXiv:1409.7851
9. (with Raanan Schul) Two sufficient conditions for rectifiable measures, *Proc. Amer. Math. Soc.* **144** (2016), no. 6, 2445–2454. arXiv:1412.8357
10. (with Murat Akman, Steve Hofmann, and José María Martell) Rectifiability and elliptic measures on 1-sided NTA domains with Ahlfors-David regular boundaries. *Trans. Amer. Math. Soc.* **369** (2017), no. 8, 5711–5745. arXiv:1507.02039
11. (with Max Engelstein and Tatiana Toro) Structure of sets which are well approximated by zero sets of harmonic polynomials, *Anal. PDE.* **10** (2017), no. 6, 1455–1495. arXiv:1509.03211
12. (with Raanan Schul) Multiscale analysis of 1-rectifiable measures II: characterizations. *Anal. Geom. Metr. Spaces* **5** (2017), no. 1, 1–39. arXiv:1602.03823
13. (with Vyron Vellis) Geometry of measures in real dimensions via Hölder parameterizations. *J. Geom. Anal.* (2018), doi:10.1007/s12220-018-0034-2, 40 pp. arXiv:1706.07846

PREPRINTS

14. Generalized rectifiability of measures and the identification problem. Preprint, submitted. arXiv:1803.10022
15. (with Lisa Naples and Vyron Vellis) Hölder curves and parameterizations in the Analyst’s Traveling Salesman theorem. Preprint, submitted. arXiv:1806.01197
16. (with Max Engelstein and Tatiana Toro) Regularity of the singular set in a two-phase problem for harmonic measure with Hölder data. Preprint, submitted. arXiv:1807.08002

IN PREPARATION

17. (with Murat Akman) Free boundary regularity for harmonic measure on multi-phase configurations.

Plenary Talks

- “Open Problems about Curves, Sets, and Measures”. 8th Ohio River Analysis Meeting. Lexington, Kentucky. March 2018.

Other Invited Research Talks

- Research program seminar. PCMI Harmonic Analysis. Park City, Utah. July 2018.
- Rainwater seminar. University of Washington, Seattle, Washington. May 2018.
- AMS special session on Analysis and Geometry in Non-smooth Spaces. Eastern Sectional Meeting. Boston, Massachusetts. April 2018.
- AMS special session on Regularity of PDEs in Rough Domains. Eastern Sectional Meeting. Boston, Massachusetts. April 2018.
- AMS special session on Analysis at the Intersection of Geometric Measure Theory and Partial Differential Equations. Western Sectional Meeting. Portland, Oregon. April 2018.
- Analysis and PDE seminar. University of Kentucky. Lexington, Kentucky. March 2018.
- 3rd Northeast Analysis Network Meeting. Syracuse, New York. September 2017.
- Geometric Measure Theory conference. Warwick, United Kingdom. July 2017.
- Harmonic analysis seminar. MSRI. Berkeley, California. March 2017.
- Conference on “Analysis on Metric Spaces.” University of Pittsburgh. March 2017.
- Analysis seminar. Brown University. Providence, RI. October 2016.
- Analysis and PDE seminar. University of Cincinnati. Cincinnati, Ohio. April 2016.
- Rainwater seminar. University of Washington. Seattle, Washington. March 2016.
- Analysis and probability seminar. University of Connecticut. Storrs. March 2016.
- AMS Special Session on Analysis and Geometry in Nonsmooth Metric Measure Spaces. Joint Mathematics Meetings. Seattle, Washington. January 2016.
- Minisymposium, “New Trends in Elliptic and Parabolic PDEs” SIAM conference—Analysis of PDE. Scottsdale, Arizona. December 2015.
- Rainwater seminar. University of Washington. Seattle, Washington. May 2015.
- Analysis seminar. Brown University. Providence, Rhode Island. April 2015.
- Analysis seminar. University of Missouri. Columbia, Missouri. April 2015.
- Colloquium. Worcester Polytechnic Institute. Worcester, Massachusetts. March 2015.
- Geometry seminar. University of Jyväskylä. Jyväskylä, Finland. February 2015.
- Geometric analysis seminar. University of Helsinki. Helsinki, Finland. February 2015.
- Analysis seminar. Fordham University. Bronx, New York. November 2014.
- Ahlfors-Bers Colloquium VI. Yale University. New Haven, Connecticut. October 2014.
- Analysis and probability seminar. University of Connecticut. Storrs. September 2014.
- Dynamical systems seminar. Stony Brook University and the Institute for Mathematical Sciences. Stony Brook, New York. May 2014.
- Colloquium. University of Connecticut. Storrs, Connecticut. January 2014.
- Rainwater seminar. University of Washington. Seattle, Washington. January 2014.
- Analysis seminar. University of Illinois, Urbana-Champaign. November 2013.
- Analysis seminar. Syracuse University. Syracuse, New York. October 2013.

- AMS Special Session on Harmonic Analysis and Partial Differential Equations. Louisville, Kentucky. October 2013.
- AMS Special Session on Analysis, Dynamics and Geometry in and around Teichmüller spaces. Ames, Iowa. April 2013.
- Analysis seminar. Temple University. Philadelphia, Pennsylvania. February 2013.
- Complex analysis seminar. University of Washington. Seattle. January 2013.
- Perspectives in HA, GMT, and PDE, and their applications to SCV. Temple University. Philadelphia, Pennsylvania. September 2012.
- Simons Postdoctoral Fellows Meeting. Simons Center for Geometry and Physics. Stony Brook, New York. April 2012.
- Complex analysis seminar. University of Washington. Seattle. January 2012.
- Dynamical systems seminar. Stony Brook University and the Institute for Mathematical Sciences. Stony Brook, New York. September 2011.
- AMS Special Session on Geometric Aspects of Analysis and Measure Theory. Eastern Sectional Meeting. Ithaca, New York. September 2011.
- AMS Special Session on Harmonic Analysis and PDE. Joint Mathematics Meetings. New Orleans, Louisiana. January 2011.
- Analysis seminar. Brown University. Providence, RI. December 2010.
- Harmonic analysis seminar. Université Paris-Sud XI. Orsay, France. April 2010.
- Rainwater seminar. University of Washington. Seattle, Washington. February 2010.
- Harmonic analysis conference. Centre de Recerca Matemàtica (CRM). Bellaterra, Spain. June 2009.
- Rainwater seminar. University of Washington. Seattle, Washington. May 2009.

UPCOMING INVITED TALKS

- AMS special session on Harmonic Analysis and PDE. Southeastern Sectional Meeting. Fayetteville, Arkansas. November 2018.
- AMS special session on Harmonic Analysis, Partial Differential Equations, and Applications. Joint Mathematics Meeting. Baltimore, Maryland. January 2019.
- AMS special session on Interactions between GMT, PDE, and Harmonic Analysis. Honolulu, Hawaii. March 2019.

Invited Mini Courses

- *Introduction to Geometry of Sets and Measures*, 3 lectures, $4\frac{1}{2}$ hours. Progress in Harmonic Analysis and Geometric Measure Theory. Temple University. April 2014.

Professional Activities

- Local organizer for AMS Eastern Sectional Meeting. Hartford, Connecticut. April 2019.
- Organizer of “Geometric and Harmonic Analysis: a Conference for Graduate Students”. University of Connecticut. March 2019. Co-organized with Murat Akman, Vyron Vellis. Website at: <http://gaha2019.math.uconn.edu/>
- Organizer of “Nonsmooth Analysis: a Workshop for Postdocs”. University of Connecticut. November 2017. Website at: <http://nonsmooth2017.math.uconn.edu/>
- Co-organizer (with Vasileios Chousionis): AMS Special Session in Geometric Aspects of Harmonic Analysis. Fall Eastern Sectional Meeting. Brunswick, Maine. September 2016.

- Co-organizer (with Chris Bishop and Raanan Schul): AMS Special Session in Geometric Measure Theory and Its Applications. Spring Eastern Sectional Meeting. Stony Brook, New York. March 2016.
- Chair of organizing committee for the UConn Special Semester in Nonsmooth Analysis. University of Connecticut. Department of Mathematics. Fall 2015. Co-organized with Vasileios Chousionis, Masha Gordina, Luke Rogers, and Sasha Teplyaev.
- Co-organizer (with Jim Gill and Joan Lind): AMS Special Session in Complex Analysis, Probability and Metric Geometry. Spring Southeastern Sectional Meeting. Knoxville, Tennessee. March 2014.
- Co-organizer (with Theresa Anderson, Nathan Pennington, Eric Stachura): AMS Special Session in Harmonic Analysis, PDE, and Geometric Measure Theory. Joint Mathematics Meetings. San Diego. January 2013.
- TA for Summer Graduate Courses in Geometric Measure Theory. MSRI. July 2011.
- Organized a series of “Professional Development Sessions” for the mathematics graduate students at University of Washington, 2010 – 2011.
- Served on 2 NSF Review Panels
- Refereed papers for multiple journals, including
 - ▷ Ann. Sci. Éc. Norm. Supér. ▷ Duke Math. J. ▷ Geom. Func. Anal.
 - ▷ Invent. Math. ▷ J. Amer. Math. Soc. ▷ J. Anal. Math.
 - ▷ J. Eur. Math. Soc. (JEMS) ▷ J. Geom. Anal. ▷ Nonlinear Anal.
 - ▷ Proc. Amer. Math. Soc. ▷ Rev. Mat. Iberoamericana
- Reviewer for *Mathematical Reviews*, 27 reviews, 2012–2017.

Teaching Experience

UNIVERSITY OF CONNECTICUT

Graduate Courses

- Math 5010 Topics in Analysis: Geometric Measure Theory **Fall 2018**
- Math 5111 Measure Theory & Integration **Spring 2018**
- Math 5120 Complex Analysis **Spring 2016**
- Math 5110 Introduction to Modern Analysis **Fall 2015**
- Math 5110 Introduction to Modern Analysis **Fall 2014**

Undergraduate Courses – Math Majors

- Math 3150 Analysis I **Fall 2017**
- Math 3150 Analysis I **Fall 2016**
- Math 4110 Introduction to Modern Analysis **Fall 2015**
- Math 4110 Introduction to Modern Analysis **Fall 2014**

Undergraduate Courses – Service Courses

- Math 2410 Elementary Differential Equations **Fall 2016**
- Math 2410 Elementary Differential Equations **Spring 2016**
- Math 1131 Calculus I **Summer 2015**

STONY BROOK UNIVERSITY

Graduate Courses

- Math 550 Real Analysis II **Spring 2014**
- Math 638 Topics in Real Analysis: Brownian Motion and Harmonic Measure **Fall 2013**

Undergraduate Courses – Math Majors

- Math 322 Analysis in Several Dimensions

Spring 2012

Undergraduate Courses — Service Courses

- Math 211 Introduction to Linear Algebra
- Math 125 Calculus A (Differential Calculus)
- Math 126 Calculus B (Integral Calculus)

Fall 2012**Fall 2011****Fall 2011**

UNIVERSITY OF WASHINGTON

Undergraduate Courses — Service Courses

- Math 309 Linear Analysis
- Math 308 Matrix Algebra with Applications
- Math 308 Matrix Algebra with Applications

Fall 2010
Winter 2010
Summer 2008