

Max Engelstein

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Employment

Assistant Professor (tenure-track), University of Minnesota, Twin Cities, Fall 2019–Present

C.L.E. Moore Instructor/NSF Postdoc, MIT, Fall 2016–Spring 2019.

Sponsoring Scientist: Professor David Jerison

NSF Postdoctoral Fellowship, Summer 2017–Summer 2020

Huneke Endowed Postdoctoral Fellow, MSRI program on Harmonic Analysis, Spring 2017.

Mentor: Professor Svitlana Mayboroda

Education

Ph.D. Mathematics, University of Chicago, 2016.

M.S. Mathematics University of Chicago, 2012.

Advisor: Professor Carlos Kenig

Thesis Title: Free Boundary Problems for Harmonic and Caloric Measures

Visited Professor Tatiana Toro at the University of Washington, Seattle. Winter and Spring 2015.

B.S. Mathematics, Yale University, 2010.

Distinction in Major

Publications and Preprints

Published or to Appear

1. "A Two-Phase Free Boundary Problem for Harmonic Measure." *Ann. Sci. École Norm. Sup.*, **49** (2016), 859-905.
2. with M. Badger and T. Toro. "Structure of sets which are well approximated by zero sets of harmonic polynomials." *Analysis & PDE*. **10** (2017), 1455-1495.
3. "A Free Boundary Problem for the Parabolic Poisson Kernel." *Adv. Math.*, **314** (2017), 835-947.
4. "Parabolic NTA domains in \mathbb{R}^2 ." *Comm. P.D.E.* **42** (2017) 1524-1536.
5. with N. Edelen. "Quantitative stratification for some free-boundary problems." *Trans. A.M.S.* **371** (2019), 2043-2072.
6. with L. Spolaor and B. Velichkov. "(Log-)Epiperimetric Inequality and Regularity over Smooth Cones For Almost Area-Minimizing Currents" *Geometry & Topology* **23** (2019), 513-540.
7. with G. David and T. Toro. "Free Boundary Regularity for Almost-Minimizers." *Adv. Math.*, **350**, (2019), 1109-1192.

8. with M. Badger and T. Toro. "Regularity for the Singular Set in a Two-Phase Problem for Harmonic Measure with Hölder Data." *Rev. Mat.*, **36**, (2020), 1375-1408.
9. with L. Spolaor and B. Velichkov. "Uniqueness of the blow-up at isolated singularities for the Alt-Caffarelli Functional." *Duke Math J*, **169** (2020), 1541-1601.
10. with A. Kauranen, M. Prats, G. Sakellaris and Y. Sire. "Minimizers for the thin one-phase free boundary problem." *CPAM Vol 74* (2021), 1801-2022.
11. with G. David and S. Mayboroda. "Square Functions, Non-Tagential Limits and Harmonic Measure in Co-Dimensions Larger than One" *Duke Math J*. **170** (2021), 455-501.
12. with S. Bortz, M. Goering, T. Toro and Z. Zhao, "Two Phase Free Boundary Problem for Poisson Kernels." *Indiana U. Math. J. to appear*. ArXiv:1908.03033. ¹
13. with G. David, M. Smit Vega Garcia and T. Toro, "Regularity for almost-minimizers of variable coefficient Bernoulli-type functionals." *Math Z. to appear* ArXiv: 1909.05043.
14. with O. Chodosh and L. Spolaor "The Riemannian Quantitative Isoperimetric Inequality." *JEMS to appear*. ArXiv:1908.00677.

Preprints

15. with D. Mendelson, "Non-uniqueness of bubbling for wave maps." *Submitted* ArXiv: 2005.14128.
16. with R. Neumayer and L. Spolaor "Quantitative Stability for Minimizing Yamabe Metrics." *Submitted*. ArXiv:2009.14362.
17. with G. De Philippis, L. Spolaor and B. Velichkov, "Rectifiability and Almost Everywhere Uniqueness of the Blow-Up for the Vectorial Bernoulli Free Boundaries." *Submitted to Nonlinear Analysis for their Special Issue on Free Boundary Problems*. ArXiv:2107.12485.

Pre-Graduate School Publications

"The Least-Perimeter Partition of a Sphere into Four Equal Areas." *Discrete Comput. Geom.* **Vol 44** (2010), pp 645-653.

with Maurmann et. al. "Asymptotics of Perimeter-Minimizing Partitions." *Can. Math. Bull.* **Vol 53**(2010), pp 516-525.

with Maurmann et. al. "Isoperimetric problems on the sphere and on surfaces with density." *N.Y.J.M.* **Vol 15**(2009), pp 97-123.

Awards/Grants

NSF Analysis Grant, DMS-2000288, 2020-2023.

NSF Postdoctoral Fellowship, DMS-1703306, 2017-2020.

Wirszup Research Award, University of Chicago Math Department (awarded to an excellent finishing graduate student). Winter 2016.

NSF Graduate Research Fellowship, 2010-2015.

DoD National Defense Science and Engineering Graduate Fellowship, 2010-2013.

McCormick Fellowship, University of Chicago Mathematics Department, 2010-2012.

DeForest Senior, Benjamin Barge, George Beckwith, Anthony Stanley Departmental Prizes, Yale Mathematics Department, 2007, 2008, 2009, 2010.

¹This paper is an improved version of "Reifenberg flatness and the Oscillation of the Unit Normal Vector" with S. Bortz ArXiv:1708.05331, which we do not intend to submit for publication.

Talks and Presentations

Invited Mini-Courses

Compactness Methods and Blowups in Harmonic Analysis and Geometric Measure Theory. Three lectures, 3 hours as part of the conference "Geometric and Harmonic Analysis" in Storrs Connecticut, March 2019.

Invited Talks at Conferences and Programs

FRG conference on PDE and Geometric Measure Theory, Seattle, Date TBD (rescheduled due to COVID-19).

CBMS Conference: Analysis, Geometry, and PDEs in a Lower-Dimensional World, Tallahassee, December 2021 (rescheduled due to COVID-19).

AIMS Special Sessions: Elliptic PDEs and Geometric Variational Problems & Analysis of Nonlinear PDEs and Applications, Atlanta, Date TBD (rescheduled due to COVID-19)

"Harmonic Analysis and PDE," in Seoul, South Korea, Date TBD (rescheduled due to COVID-19).

"Kansas Prairie Analysis Seminar," in Manhattan, KS, November 2019.

"Swedish Summer PDE," in Stockholm, Sweden, August 2019.

"Harmonic Analysis and PDE," in Helsinki, Finland, June 2019.

"Workshop on Spectral Properties of Disordered Systems," in Paris, France, January 2019.

Short talk at "Midwest PDE seminar", at Purdue, IN, October 2018.

40 min talk at "Calculus of Variations" workshop. Oberwolfach, July 2018.

Research Seminar at PCMI summer term in "Harmonic Analysis". July 2018.

Research Seminar at "Research Term on Real Harmonic Analysis and its Applications to Partial Differential Equations and Geometric Measure Theory." ICMAT, June 2018

AMS Special Session: Analysis at the intersection of GMT and PDE, Portland, OR. April 2018.

"Calculus of Variations and Free Boundary Problems." Université Grenoble, Alpes. June 2017.

AMS Special Session: Geometric Aspects of Harmonic Analysis, Brunswick, ME. September 2016.

AMS Special Session: Geometric Measure Theory and its Applications, Stony Brook. March 2016.

Seminar Talks (Analysis, PDE or Geometric Analysis Seminars unless otherwise noted)

In 2021: HA-GMT-PDE (Online); University of Chicago C-Z Seminar (Online)x2; University of Basque Country (Online); PDEA Webinar; Rice University (tbc); Rutgers University (Online).

In 2020: UCSD; Indiana University; IAS; PDE Zoom Seminar; Online Seminar on Geometric Analysis; Virtual Analysis and PDE Seminar

In 2019: Rutgers University; Northwestern University; University of Washington, Seattle.

In 2018: University of Missouri; SUNY Stony Brook; CalTech/UCLA; University of Chicago; Brown University; MIT; Columbia University; University of Minnesota-Twin Cities (Colloquium and PDE Seminar); UCLA; SUNY Stony Brook (Colloquium); University of Wisconsin-Madison (Colloquium).

In 2017: Princeton University; Universitat Autònoma de Barcelona; Worcester Polytechnic Institute, MSRI Postdoc Seminar; MIT; University of Chicago.

In 2016: University of Minnesota, Twin Cities; Johns Hopkins University; University of Wisconsin, Madison.

In 2014-2015: Northwestern University; University of Chicago (x2); University of Washington, Seattle; Purdue University.

Teaching

Teaching at UMN

Instructor 2373 Fall 2021. A class on linear analysis and ODEs for students in the college of science and engineering.

Instructor 8601-8602 Fall 2020-Spring 2021. First year graduate real analysis sequence, designed to prepare graduate students for their analysis prelims.

Teaching at MIT

Course Admin, 18.03 Spring 2019. In charge of supporting the lead instructor and organizing an introductory class on differential equations with > 400 students and 20 recitations.

Instructor, 18.100Q Fall 2018. Teaching a "communication intensive" introductory real analysis course. Emphasis on strengthening the students' abilities to clearly communicate and write mathematics.

Recitation Leader, 18.02 Fall 2016. Taught two sections of an introductory multivariate course.

Teaching at the University of Chicago

Co-Instructor, Calculus of Variations Summer 2016. Co-taught a two-week course at the University of Chicago summer REU (Research Experience for Undergraduates), aimed at second and third year math majors.

Instructor, Math 112: Studies in Mathematics Fall 2015. Elementary number theory for students majoring in non-quantitative fields.

Instructor, Math 196: Linear Algebra Fall 2014. Introductory linear algebra for non-majors.

College Fellow. Fall 2011-Spring 2012. Teaching assistant for introductory courses in real and complex analysis.

Students and Postdocs

At University of Minnesota

PhD Students: Cole Jeznach (joint with S. Mayboroda), Fall 2019–Present.

Thesis/Oral Committees: Ryan Matzke Thesis Committee/Reviewer (May 2021). Bruno Poggi Thesis Committee/Reviewer (May 2021). Michelle Mastrianni Oral Exam Committee (Fall 2021).

Undergraduate Honors Projects supervised: Alan Koval, Fall 2020-Spring 2021.

Undergraduate Thesis Reviewed: Thomas Winckleman Spring 2021, Cameron Vogt Spring 2021.

Undergraduate Research Supervised: Nathan Essner Fall 2021–Present

Summer REUs

Sole project leader of the MathILy-EST REU, supervising 6 first and second year undergraduate students researching discrete free boundary problems. Summer 2021.

Service

Minnesota Committees Dunham Jackson Postdoc (2019-2021), Riviere Fabes Organization (2019-), Climate Committee (2020-), Special Task force on Term Faculty (2021-), Faculty Recruitment Committee (2021-)

Outside Grant Reviewer at Polish National Science Center. Served as an expert reviewer for an early career grant proposal (Spring 2020).

Outside Thesis Reader at Universitat Autònoma Barcelona. Carmelo Puliatti's Thesis (Fall 2019).

Co-Organizer of AMS Special Session on "Interactions between Geometric Measure Theory, PDE, and Harmonic Analysis" (w/M. Allen, S. Becker-Kahn and M. Smit Vega Garcia) Spring Western/Central Sectional meeting at University of Hawaii Manoa. March 2019.

Co-leader of Working Seminar on "Center Manifolds" (w/ G. Rey). PCMI, Summer 2018.

Co-Organizer of AMS Special Session on "Regularity of PDEs in Rough Domains" (w./M. Akman) Spring Eastern Sectional at Northeastern. April 2018.

MathSciNet Reviewer. Spring 2017-Present

Organizer of MSRI's Harmonic Analysis Postdoc Seminar Spring 2017.

Selection Panelist for DoD's NDSEG Fellowship 2017, 2018.

Refereed/Gave Short Opinions for: *Acta Math.*, *Advances in Math.*, *Analysis & PDE*, *Calc. Var. PDE.*, *CPDE*, *Complex Analysis and its Synergys*, *Crelle's Journal*, *Duke Math Journal*, *Forum of Mathematics: Sigma*, *GAEA*, *IMRN*, *Journal of Differential Equations*, *Journal of Fourier Analysis and Applications*, *Journal of Functional Analysis*, *Memoirs of the AMS*, *Potential Analysis*, *Transactions of the AMS*

WOMP Co-organizer Fall 2012. Co-organized and co-led the University of Chicago orientation for incoming graduate students.

UChicago REU Co-organizer Summer 2012, 2016. Helped organize the summer research experience for undergraduates at the University of Chicago (over fifty students participated).

Outreach and Mentoring

Research Director, MathILy-EST REU Summer 2021—leading six undergraduates in researching discrete free boundary problems.

Faculty Mentor Mathematics Project in Minnesota Summer 2021-present

Faculty Speaker Mathematics Project in Minnesota Winter 2021.

Lead Instructor, MathILy Summers 2019, 2020. MathILy is a summer program for mathematically gifted high school students which mainly utilizes discovery based learning.

Academic Advisor Fall 2018-Spring 2019. Help MIT undergraduates navigate the mathematics major. Advise them on coursework and help them prepare for their long-term plans.

Mentor, MIT Undergraduate Reading Project Fall 2017-Fall 2018. Supervised two Undergraduate Research Projects (UROP). One in the Academic Year 2017-2018 on the interaction between singular integrals and the geometry of rough sets. The second in the Fall of 2018 on least perimeter partitions of irregular sets.

Mentor Summer 2018. Supervising a high-school student as they read Falconer's "Fractal Geometry" and study properties of regularized distances.

Mentor Summer 2018. Supervising an MIT undergraduate as they read through Mattila's "Geometry of Sets and Measures."

Mentor, University of Chicago Directed Reading Program. Fall 2012, Fall 2015, Winter 2016, Spring 2016. Supervised undergraduates in independent reading courses on measure theory, functional analysis and elliptic PDE.

Assistant Instructor, MathILy Summers 2013, 2015. MathILy is a summer program for mathematically gifted high school students which mainly utilizes discovery based learning.

Mathematics Tutor, "Upward Bound" Fall 2013-Winter 2015. "Upward Bound" is run by the University of Chicago to help local, disadvantaged high school students prepare for college.

TA, Adventures in Analysis Summer 2014. "Adventures in Analysis", is a program for underrepresented minority students who are about to begin graduate school in mathematics and statistics.

Mentor, University of Chicago REU. Summers 2011, 2012, 2016. Supervised ten expository mathematics papers over three years, including four selected as among the best in the program.