

# Max Engelstein

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## Employment

C.L.E. Moore Instructor/NSF Postdoc, MIT, Fall 2016-Present.

Sponsoring Scientist: Professor David Jerison

NSF Postdoctoral Fellowship, Summer 2017-Present

Huneker 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. to appear*. ArXiv:1702.04325.
6. with L. Spolaor and B. Velichkov. "(Log-)Epiperimetric Inequality and Regularity over Smooth Cones For Almost Area-Minimizing Currents" *Geometry & Topology to appear*. ArXiv: 1802.00418.

### Preprints

7. with G. David and T. Toro. "Free Boundary Regularity for Almost-Minimizers." *Submitted*. ArXiv:1702.06580. Winter 2017.
8. with S. Bortz. "Reifenberg flatness and the Oscillation of the Unit Normal Vector." *Preprint*. ArXiv:1708.05331. Summer 2017. <sup>1</sup>

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<sup>1</sup>The geometric aspect of this paper has been improved upon by M. Goering, T. Toro and Z. Zhao. All five of us are currently writing a paper combining the two manuscripts.

9. with L. Spolaor and B. Velichkov. "Uniqueness of the blow-up at isolated singularities for the Alt-Caffarelli Functional." *Submitted*. ArXiv:1801.09276. Winter 2018.
10. with M. Badger and T. Toro. "Regularity for the Singular Set in a Two-Phase Problem for Harmonic Measure with Hölder Data." *Submitted*. ArXiv: 1807.08002. Summer 2018.
11. with G. David and S. Mayboroda. "Square Functions, Non-Tagential Limits and Harmonic Measure in Co-Dimensions Larger than One" *Submitted*. ArXiv: 1808.08882. Summer 2018.

### 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 Postdoctoral Fellowship**, 2017-2020.

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

**Graduate Student Travel Grants** from the AMS (Winter 2016) and U of C (Winter 2015).

**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.

### Talks and Presentations

#### Seminar Talks (Analysis and/or PDE Seminars unless otherwise noted)

**In 2018:** University of Missouri; SUNY Stony Brook; CalTech/UCLA; University of Chicago; Brown University; MIT (planned); Columbia University (Geometry/Analysis, planned).

**In 2017:** Princeton University (Geometric Analysis); Universitat Autònoma de Barcelona; Worcester Polytechnic Institute, MSRI Postdoc Seminar; MIT (Geometric Analysis); 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.

#### Other Invited Talks

Mini-course for "Geometric and Harmonic Analysis" at Storrs Connecticut, March 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.

### Contributed Talks/Presentations

Workshop on Harmonic Analysis and its applications to PDE and GMT. Madrid, Spain. May, 2018.

Nonsmooth Analysis Workshop. Storrs, Connecticut. November, 2017.

Geometry, Analysis and Probability. Seoul, South Korea. May, 2017. Poster Presentation.

6th Symposium on Analysis and PDEs. West Lafayette, Indiana. June 2015.

X Americas Conference on Differential Equations and Nonlinear Analysis. Buenos Aires, Argentina. February 2015.

Introductory School to the Programme "Free Boundary Problems and Related Topics." Cambridge, UK January 2014. Poster Presentation.

## Teaching

### Teaching at MIT

**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.

## Service

**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 Journal Articles for:** *Forum of Mathematics: Sigma*, *GAFA*, *Memoirs of the AMS*, *Journal of Fourier Analysis and Applications*, *Duke Math Journal*, *Annals of Math.*, *Journal of Functional Analysis*, *Complex Analysis and its Synergys*, *Crelle's Journal*.

**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

**Academic Advisor** Fall 2018-Present. 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-present. 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.