

# Joshua Zahl

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CONTACT INFORMATION	UBC Department of Mathematics Vancouver, BC V6T 1Z2 jzahl@math.ubc.ca ORCID 0000-0001-5129-8300		
RESEARCH INTERESTS	Classical harmonic analysis, maximal functions, incidence geometry, additive combinatorics, sum-product theorems, combinatorial geometry, discrete and computational geometry.		
EDUCATION	<b>University of California, Los Angeles</b> Ph.D., Mathematics, 2013 M.A., Mathematics, 2010  <b>California Institute of Technology</b> B.S., Mathematics, 2008		
EMPLOYMENT	<b>The University of British Columbia</b> Associate professor, 2021–present Assistant professor, 2016–2021  <b>Massachusetts Institute of Technology</b> NSF/pure math instructor, 2013–2016		
HONORS AND AWARDS	PIMS/UBC Mathematical Sciences Early Career Award, 2023 National Science Foundation Mathematical Sciences Postdoctoral Research Fellowship (NSF MSPRF), 2013–2016		
GRANTS	NSERC discovery, 2017-2024.		
TEACHING	Harmonic Analysis (541)	UBC	2019, 2020, 2022, 2023
	Real Analysis (320)	UBC	2017, 2018, 2020, 2021
	Introduction to Real Analysis (319)	UBC	2021
	Discrete Mathematics (341)	UBC	2018
	Optimization in Graphs and Networks (442)	UBC	2019
	The Polynomial Method	UBC	2019
	Honours Differential Calculus (120)	UBC	2016, 2017, 2018, 2019
	Real Analysis (18.100B)	MIT	2016
STUDENTS	<ul style="list-style-type: none"><li>◦ Daniel Di Benedetto, PhD. 2017–2021</li><li>◦ Jacob Denson, M.Sc. 2017–2019</li><li>◦ Mukul Rai Choudhuri, 2019–present</li><li>◦ Kyle Chi Hoi Yip, 2019–present</li><li>◦ Kenneth Moore, 2021–present</li><li>◦ Andrew Alexander, 2023-present</li></ul>		
POSTDOCS	<ul style="list-style-type: none"><li>◦ Orit Raz, 2017–2019</li><li>◦ Itay Londner, 2018–2021</li><li>◦ Tongou Yang, 2021–2022</li></ul>		

## PREPRINTS

- On Maximal Functions Associated to Families of Curves in the Plane. *Submitted*.
- A Furstenberg-type problem for circles, and a Kaufman-type restricted projection theorem in  $\mathbb{R}^3$  (with M. Pramanik and T. Yang). *Submitted*.
- Sticky Kakeya sets, and the sticky Kakeya conjecture (with H. Wang). *Submitted*.

## PUBLICATIONS

- Improved Elekes-Szabó type estimates using proximity (with J. Solymosi). *J. Comb. Theory Ser. A*. 201:105813, 2024.
- Kakeya sets from lines in  $SL_2$  (with N.H. Katz and S. Wu). *Ars Inven. Anal.* Paper No. 6, 23 pp, 2023.
- On the dimension of exceptional parameters for nonlinear projections, and the discretized Elekes-Rónyai theorem (with O. Raz). Accepted, *Geom. Funct. Anal.*
- Unions of lines in  $\mathbb{R}^n$ . *Mathematika*. 69(2):473–481, 2023 .
- A note on Fourier restriction and nested Polynomial Wolff axioms (with J. Hickman). In press, *J. Anal. Math.*
- On rich lenses in planar arrangements of circles and related problems (with E. Ezra, O. Raz, M. Sharir). *SIAM J. Discrete Math.* 36(2): 958–974, 2022.
- Sphere tangencies, line incidences, and Lie’s line-sphere correspondence. *Math. Proc. Camb. Philos. Soc.* 172(2): 401–421, 2022.
- New Kakeya estimates using Gromov’s algebraic lemma. *Adv. Math* 380, 2021.
- Distinct distances in the complex plane (with A. Sheffer). *Trans. Amer. Math. Soc.* 374(9): 6691–6725, 2021.
- An efficient algorithm for generalized polynomial partitioning and its applications (with P. Agarwal, B. Aronov, and E. Ezra). *SIAM J. Comput.* 50(2):760–787, 2021.
- Constructive polynomial partitioning for algebraic curves in  $\mathbb{R}^3$  with applications (with B. Aronov and E. Ezra). *SIAM J. Comput.* 49(6):1109–1127, 2020.
- Large Sets Avoiding Rough Patterns (with J. Denson and M. Pramanik). In: Rassias M.T. (eds) *Harmonic Analysis and Applications*, pp 59–75. Springer Optimization and Its Applications, vol 168. Springer, 2021.
- A Kakeya maximal function estimate in four dimensions using planebrushes (with N.H. Katz). *Rev. Mat. Iberoam.* 37(1):317–359, 2021.
- Counting higher order tangencies for plane curves. *Combin. Probab. Comput.* 29(2):310–317, 2020.
- On the discretized sum-product problem (with L. Guth and N.H. Katz). *Int. Math. Res. Not.* Volume 2021, Issue 13: 9769–9785, 2021.
- A discretized Severi-type theorem with applications to harmonic analysis. *Geom. Funct. Anal.*, 28(4):1131–1181, 2018.
- Breaking the 3/2 barrier for unit distances in three dimensions. *Int. Math. Res. Not.*, Vol 2019, Issue 20: 6235–6284, 2019.
- An improved bound on the Hausdorff dimension of Besicovitch sets in  $\mathbb{R}^3$  (with N.H. Katz). *J. Amer. Math. Soc.* 32(1):195–259, 2019.
- Polynomial Wolff axioms and Kakeya-type estimates in  $\mathbb{R}^4$  (with L. Guth). *Proc. London Math. Soc.* 117(1): 192–220, 2018.
- Cutting algebraic curves into pseudo-segments and applications (with M. Sharir). *J. Comb. Theory Ser. A* 150:1–35, 2017.
- Curves in  $\mathbb{R}^4$  and two-rich points (with L. Guth). *Disc. Comput. Geom* 58(1): 232–253, 2017.
- New bounds on curve tangencies and orthogonalities (with J. Ellenberg and J. Solymosi). *Discrete Analysis* 18, 2016.
- Spectral gaps, additive energy, and a fractal uncertainty principle (with S. Dyatlov). *Geom. Funct. Anal.* 26(4):1011–1094, 2016.
- Algebraic curves, rich points, and doubly-ruled surfaces (with L. Guth). *Am. J. Math.*, 140(5):1187–1229, 2018.
- A note on rich lines in truly high dimensional sets. *FoM, Sigma* 4(e2):1–13, 2016.
- Point-curve incidences in the complex plane (with A. Sheffer and E. Szabó). *Combinatorica* 38(2): 487–499, 2018.
- A semi-algebraic version of Zarankiewicz’s problem (with J. Fox, J. Pach, A. Sheffer, and

- A. Suk). *J. Eur. Math. Soc.* 19(6): 1785–1810, 2017.
- Few distinct distances implies no heavy lines or circles (with A. Sheffer and F. de Zeeuw). *Combinatorica* 36(3):349–364, 2016.
- Quantitative visibility estimates for unrectifiable sets in the plane (with M. Bond and I. Łaba). *Trans. Amer. Math. Soc.* 368:5475–5513, 2016.
- Incidences between points and non-coplanar circles (with A. Sheffer and M. Sharir). *Combin. Probab. Comput.* 24(3):490–520, 2015.
- A Szemerédi-Trotter type theorem in  $\mathbb{R}^4$ . *Disc. Comput. Geom* 54(3):513–572, 2015.
- On the Wolff circular maximal function. *Illinois J. Math.* 56(4):1281–1295, 2014.
- An improved bound on the number of point-surface incidences in three dimensions. *Contrib. Discrete Math.* 8(1):100–121, 2013.
- $L^3$  estimates for an algebraic variable coefficient Wolff circular maximal function. *Revista Mat. Iber.* 28(4):1061–1090, 2012.
- On universal cycles for multisets. (with G. Hurlbert and T. Johnson). *Discrete Math.* 309(17):5321–5327, 2009.
- Bounds on degrees of  $p$ -adic separating polynomials. (with D.J. Katz). *J. Comb. Theory Ser. A* 115(7):1310–1319, 2008.

## TALKS

### 2023

- Rainwater Seminar, University of Washington, Seattle WA
- Analysis seminar, Rice University, Houston TX
- Undergraduate colloquium, Rice University, Houston TX
- AiM research community, Fourier restriction conjecture and related problems, American Institute of Mathematics, Pasadena
- Harmonic Analysis and Nonlinear Partial Differential Equations, RIMS Kyoto JP
- Modern trends in harmonic analysis, ICTS Bangalore IND
- Analysis and PDE Seminar, Berkeley CA
- Harmonic Analysis and Differential Equations Seminar, Berkeley CA
- CSMQ Colloquium, Montreal QC
- AMS Joint Math Meetings, Special Session on Distance Problems in Continuous, Discrete and Finite Field Settings, Boston MA

### 2022

- Extremal Combinatorics and Geometry workshop, Banff international research station, Banff BC.
- Real Analysis, Harmonic Analysis, and Applications workshop. Oberwolfach DE.
- Fourier analysis @200 conference, ICMS, Edinburgh, UK.
- Plenary speaker, İzmir Mathematics Days - IV, İzmir, Turkey / online.
- 11th International Conference on Harmonic Analysis and PDE, El Escorial ES.
- Interactions between Geometric measure theory, Singular integrals, and PDE workshop, Bonn, DE.
- AMS Joint Mathematics Meetings, special session on Geometric Measure Theory.
- Caltech/UCLA/USC joint analysis seminar

### 2021

- CMS Winter meeting, special session on Harmonic Analysis and Fractal Geometry, online.
- Symposium on Computational Geometry (SoCG 21), online.
- CanaDAM, online.
- AMS Spring Western Sectional Meeting, Special Session on Analysis, Combinatorics, and Geometry of Fractals, online.
- Fourier restriction online, online.
- MSU Math Mathematics Seminar, Montana State University, online / Bozeman MT.
- Virtual Harmonic Analysis Seminar, UK Harmonic Analysis Group, online/ Edinburgh UK.
- Restriction theory workshop, University of Bristol, online / Bristol UK.

### 2019

- NYC Discrete Geometry Seminar, Baruch college, New York NY.

- Fejes Tóth Lecture, University of Calgary, Calgary AB.

## 2018

- Geometric Measure Theory and its Connections, Helsinki FI.
- Additive Combinatorics from a Geometric Viewpoint. USC, Columbia, SC.
- Combinatorics Seminar. UCSD, San Diego CA.
- Mini Real Algebraic Geometry Conference, Purdue, West Lafayette IN.
- Colloquium, April 19-21, 2018. Indiana University, Bloomington IN.
- Extremal Problems in Combinatorial Geometry, Banff international research station, Banff BC.

## 2017

- Algebraic Methods in Combinatorics, Center of mathematical sciences and applications, Harvard MA.
- Harmonic Analysis and Related Areas, Clay mathematics institute, Oxford UK.
- Real Analysis, Harmonic Analysis, and Applications workshop, Oberwolfach DE.
- Harmonic analysis and its interactions: in honour of Tony Carbery. ICMS, Edinburgh UK.
- Recent Developments in Harmonic Analysis, MSRI CA.
- Discrete Geometry workshop, workshop, Oberwolfach.

## PROFESSIONAL SERVICE

- Session organizer, Canadian Mathematics Society winter meeting, December 4-7, 2020, Montreal QC.
- Session organizer, 8th Pacific Rim Conference in Mathematics. August 3-7, 2020, Berkeley CA.
- Organizer, Banff workshop on Restriction, Kakeya, and Carleson-Type Problems. April 26-May 1, 2020, Banff AB [Canceled]
- Primary organizer, MSRI Summer Graduate School on The Polynomial Method. July 8-19, 2019, Berkeley CA.
- Member of NDSEG panel 2014.

## LAST UPDATED

Oct 11, 2023.