Joshua Zahl

CONTACT INFORMATION

Chern Institute of Mathematics
Nankai University
Tianjin, China
jzahl@nankai.edu.cn
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

University of California, Los Angeles

Ph.D., Mathematics, 2013
M.A., Mathematics, 2010

California Institute of Technology

B.S., Mathematics, 2008

EMPLOYMENT

Chern Institute of Mathematics, Nankai University

Chair professor, 2025–present

The University of British Columbia

Associate professor, 2021–2025
Assistant professor, 2016–2021

Massachusetts Institute of Technology

NSF/pure math instructor, 2013–2016

HONORS AND AWARDS

ICBS Frontiers of Science Award in Mathematics, 2024
PIMS/UBC Mathematical Sciences Early Career Award, 2023
NSF Mathematical Sciences Postdoctoral Research Fellowship (MSPRF), 2013–2016

GRANTS

NSERC Discovery		$220,000 CAD	2024-2029
NSERC Alliance	(w/ P. Shmerkin)	$300,000 CAD	2024-2027
NSERC Discovery		$175,000 CAD	2017-2024

STUDENTS

- Daniel Di Benedetto, PhD. 2017–2021
- Jacob Denson, M.Sc. 2017–2019
- Kyle Chi Hoi Yip, MSc, PhD. 2019–2024
- Mukul Rai Choudhuri, MSc, PhD. 2019–2025
- Kenneth Moore, PhD. 2021–2025
- Andrew Alexander, MSc, PhD. 2023-present
- Paige Bright, MSc. 2024–2025
- Chenjian Wang, PhD. 2025–present

POSTDOCS

- Orit Raz, 2017–2019
- Itay Londner, 2018–2021
- Tongou Yang, 2021–2022
- William O'Regan, 2024–present

Teaching

Mathematical Proof (220)	UBC	2024, 2024
Harmonic Analysis (541)	UBC	2019, 2020, 2022, 2023
Real Variables II (321)	UBC	2023
Decoupling & Restriction (610D)	UBC	2023
Real Variables I (320)	UBC	2017, 2018, 2020, 2021
Introduction to Real Analysis (319)	UBC	2021
Optimization in Graphs and Networks (442)	UBC	2018
The Polynomial Method (616A)	UBC	2018
Discrete Mathematics (341)	UBC	2017, 2024
Honours Differential Calculus (120)	UBC	2016, 2017, 2018, 2019
Real Analysis (18.100B)	MIT	2015

Preprints

- Volume estimates for unions of convex sets, and the Kakeya set conjecture in three dimensions (with H. Wang). *Submitted*
- Sticky Kakeya sets, and the sticky Kakeya conjecture (with H. Wang). *Submitted*.

Publications

- Improved L^p bounds for the strong spherical maximal operator (with J. Hickman). To appear, *Israel J. Math.*
- The Assouad dimension of Kakeya sets in $\mathbb{R}^3$ (with H. Wang). *Invent. Math.* 241: 153–206, 2025.
- On Maximal Functions Associated to Families of Curves in the Plane. To appear, *Duke Math. J.*
- 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). *Geom. Funct. Anal.* 34: 209–262, 2024.
- Unions of lines in $\mathbb{R}^n$. *Mathematika.* 69(2): 473–481, 2023 .
- A Furstenberg-type problem for circles, and a Kaufman-type restricted projection theorem in $\mathbb{R}^3$ (with M. Pramanik and T. Yang). To appear, *Am. J. Math.*
- A note on Fourier restriction and nested Polynomial Wolff axioms (with J. Hickman). *J. Anal. Math.* 152: 19–52, 2024.
- 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 Szemeredi-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

Upcoming

- Real Analysis, Harmonic Analysis, and Applications, Oberwolfach DEU
- Colloquium, University of Toronto, Toronto ON CA
- Nirenberg lectures in Geometric Analysis, CRM, Montreal QC CA
- Minerva Lectures, Princeton, Princeton NJ USA
- Distinguished Lecture Series, Indiana University, Bloomington IN USA
- ICM, Philadelphia, PA, USA

2025

- Colloquium, Stanford, Palo Alto CA USA
- Colloquium, Caltech, Pasadena CA USA
- Seminar, MIT, Cambridge MA USA
- Yip Lectures, Tsingua University, Beijing CHN
- Colloquium, Reed College, Portland OR USA
- MSRI / SLMath: Algebraic and Analytic Methods in Combinatorics, Berkeley CA USA
- MSRI / SLMath: Interactions between Harmonic Analysis, Homogeneous Dynamics, and Number Theory, Berkeley CA USA

2024

- CMS winter meeting, Special session on Geometric Analysis & PDE, Vancouver BC
- CMS winter meeting, Harmonic Analysis and Geometric Measure Theory, Vancouver BC
- Colloquium, University of Alberta, Edmonton AB
- Seminar, Montana State University, Bozeman MT USA
- On the Interface of Geometric Measure Theory and Harmonic Analysis Workshop, Banff international research station, Banff AB.
- Madison Lectures in Fourier Analysis, UW-Madison, Madison WA USA

2023

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

2022

- Extremal Combinatorics and Geometry workshop, Banff international research station, Banff AB
- Real Analysis, Harmonic Analysis, and Applications. Oberwolfach DEU
- Fourier analysis @200, ICMS, Edinburgh, GBR
- Plenary speaker, İzmir Mathematics Days - IV, İzmir, TUR / online.
- 11th lnternational Conference on Harmonic Analysis and PDE, El Escorial ESP
- Interactions between Geometric measure theory, Singular integrals, and PDE, Bonn, DEU
- AMS Joint Mathematics Meetings, special session on Geometric Measure Theory, Seattle WA USA / online
- Caltech/UCLA/USC joint analysis seminar, Pasadena, CA USA

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, Edinburgh GBR / online
- Restriction theory workshop, University of Bristol, Bristol GBR / online

Professional service

- Organizer, Isaac Newton Institute Program on Frontiers in harmonic analysis, elliptic and parabolic PDEs, and GMT, 2027.
- Editor, *Contributions to Discrete Mathematics*, 2020–present.
- Scientific Committee, Canadian Mathematics Society winter meeting, 2024, Richmond BC.
- Session organizer, Canadian Mathematics Society winter meeting, 2020, Montreal QC CA.
- Session organizer, 8th Pacific Rim Conference in Mathematics. 2020, Berkeley CA USA.
- Organizer, Banff workshop on Restriction, Kakeya, and Carleson-Type Problems. 2020,

Banff AB CA [Canceled]
- Organizer, MSRI Summer Graduate School on The Polynomial Method. 2019, Berkeley CA USA.

Last Updated July 3, 2025.