

Alexander B. Watson

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EDUCATION Columbia University; New York, NY 2012-2017
PhD in Applied Mathematics; Supervisor: Michael I. Weinstein
Thesis: Wave dynamics in locally periodic structures by multiscale analysis

St. Peter's College, Oxford University; Oxford, U.K. 2007-2011
BSc and MMath in Pure and Applied Mathematics (1st class honors)

POSITIONS University of Minnesota Twin Cities; Minneapolis, MN 2020-
Postdoctoral Associate
Mathematics Department; Post-doc mentor: Mitchell Luskin

Duke University; Durham, NC 2017-2020
William E. Elliott Assistant Research Professor (non-tenure track)
Mathematics Department; Post-doc mentor: Jianfeng Lu

AWARDS AMS Simons travel grant (2020)

RESEARCH Interests: Partial differential equations, mathematical physics, numerical analysis, computational physics, data science. Interdisciplinary research at the interface of mathematics with condensed matter physics and photonics. Recent foci include: 2D materials, graphene, topological insulators/edge states, Wannier functions, twisted bilayer graphene.

Publications and pre-prints:

1. Wavepackets in inhomogeneous periodic media: Effective particle-field dynamics and Berry curvature (with J. Lu, M. I. Weinstein); *Journal of Mathematical Physics* **58** 021503 (2017)
2. Wavepackets in inhomogeneous periodic media: Propagation through a one-dimensional band crossing (with M. I. Weinstein); *Communications in Mathematical Physics* **363** 655-698 (2018)
3. Dirac operators and domain walls (with J. Lu, M. I. Weinstein); *SIAM Journal on Mathematical Analysis* **52** 2 1115-1145 (2020)
4. The Iterated Projected Position Algorithm for Constructing Exponentially Localized Generalized Wannier Functions for Periodic and Non-Periodic Insulators in Two Dimensions and Higher (with K. D. Stubbs, J. Lu); *Physical Review B* **103** 075125 (2021)
5. Computing edge states without hard truncation (with K. Thicke, J. Lu); *SIAM Journal on Scientific Computing* **43** 2 B323-B353 (2021)
6. Wave-packet propagation in a finite topological insulator and the spectral localizer index (with J. Michala, A. Pierson, T. Loring); *Involve* **14** 2 209-239 (2021)
7. Existence of the first magic angle for the chiral model of bilayer graphene (with M. Luskin); *Journal of Mathematical Physics* **62** 091502 (2021)

8. Defect state resonances of truncated crystal structures (with J. Lu and J. Marzuola); *SIAM Journal on Applied Mathematics* **82** 1 (2022)
9. Existence and computation of generalized Wannier functions for non-periodic systems in two dimensions and higher (with K. D. Stubbs, J. Lu); *Archive for Rational Mechanics and Analysis* **243** 3 (2022)
10. Computing spectral properties of topological insulators without artificial truncation or supercell approximation (with M. J. Colbrook, A. Horning, K. Thicke); *IMA Journal of Applied Mathematics* (2023)
11. Edge state dynamics along curved interfaces (with G. Bal, S. Becker, A. Drouot, C. Fermanian-Kammerer, and J. Lu); *SIAM Journal on Mathematical Analysis* (2023)
12. Bistritzer-MacDonald dynamics in twisted bilayer graphene (with T. Kong, A. H. MacDonald, M. Luskin); *Journal of Mathematical Physics* (2023)
13. Locality of the windowed LDOS (with T. A. Loring, J. Lu); *submitted*, pre-print: [arXiv:2101.00272](https://arxiv.org/abs/2101.00272)
14. On the Su-Schrieffer-Heeger model of electron transport: low-temperature optical conductivity by the Mellin transform (with D. Margetis, M. Luskin); *submitted*, pre-print: [arXiv:2209.13068](https://arxiv.org/abs/2209.13068)

Invited seminar talks

1. University of Minnesota (November 2016)
2. University of North Carolina (April 2018)
3. University of Tübingen (May 2018)
4. Institut Henri Poincaré, Paris (May 2018)
5. University of Rennes 1 (May 2018)
6. University of New Mexico (October 2018)
7. Warwick University (May 2019)
8. Bristol University (May 2019)
9. University of Illinois Chicago (October 2019)
10. University of Chicago (October 2019)
11. North Carolina State University (April 2020, postponed)
12. Columbia University (March 2021)
13. Texas A&M University (September 2022)
14. University of Minnesota (October 2022)
15. Drexel University (October 2022)
16. University of Michigan (November 2022)
17. Rice University (November 2022)
18. University of Minnesota (November 2022)
19. Rennselaer Polytechnic Institute (December 2022)
20. Ohio State University (January 2023)
21. Michigan State University (January 2023)
22. University of Utah (January 2023)

Invited conference talks

1. LMS-EPSRC Symposium on Mathematical and Computational aspects of Maxwell's equations; Durham University (July 2016)
2. SIAM Conference on Nonlinear waves; Philadelphia, PA (August 2016)
3. KI-Net Young Researcher's Workshop: Stochastic and deterministic methods in kinetic theory; Duke University (November 2016)
4. Young Researcher's Workshop at UIUC; University of Illinois at Chicago (April 2017)
5. Photonic Topological Insulators; Banff International Research Station (September 2017)
6. KI-Net Young Researcher's Workshop: Current trends in kinetic theory; University of Maryland at College Park (October 2017)
7. Young Researcher's Workshop at PKU; Peking University (December 2017)
8. SIAM Southeastern Atlantic Section Conference; University of North Carolina (March 2018)
9. SIAM Conference on Nonlinear Waves; Anaheim, CA (June 2018)
10. SIAM Conference on Mathematical Aspects of Materials Science; Portland, OR (July 2018)
11. IMACs Conference on Nonlinear Evolution Equations and Wave Phenomena; University of Georgia (April 2019)
12. SIAM Analysis of PDE; Palm Springs, CA (December 2019)
13. Theory and Computation for 2D Materials; Institute for Pure and Applied Mathematics (IPAM), UCLA (January 2020)
14. SIAM Southeastern Atlantic Section Conference; Auburn University (March 2020, postponed)
15. Metamaterials 2020; New York, NY (September 2020)
16. SIAM Texas and Louisiana Section Conference; Texas A&M (October 2020)
17. SIAM Conference on Computational Science and Engineering; Forth Worth, Texas (March 2021)
18. IMACs Conference on Nonlinear Evolution Equations and Wave Phenomena; University of Georgia (March 2022)
19. Mathematics and Physics at the Moiré scale; Institute for Pure and Applied Mathematics (IPAM), UCLA (April 2022)

SERVICE

Referee: *SIAM Multiscale Modeling and Simulation*, *SIAM Journal on Applied Mathematics*, *ESAIM: Mathematical Modeling and Numerical Analysis*, *Communications in Mathematical Sciences*, *Journal of Differential Equations*, *SIAM Journal on Scientific Computing*, *AMS Mathematical Reviews*, *Communications in Mathematical Physics*, *Journal of Computational Physics*, *SIAM Journal on Mathematical Analysis*, *MathSciNet*.

Organizer: “Quantum dynamics, multi-scale analysis, and edge states” at *SIAM Southeastern Atlantic Section 2018* (sole organizer), “Layered materials and edge states” *SIAM Analysis of PDE 2019* (sole organizer), “Waves in topological materials” *SIAM Mathematical Aspects of Materials Science 2021* (with A. Drouot and Y. Zhu).

TEACHING

Lecturer in the Mathematics Department at Duke University. Undergraduate classes: *MATH 212: Multivariable Calculus* (Fall 2017), *MATH 353: ODE and PDE* (Spring 2018, Spring 2019, Fall 2019, Spring 2020, course co-ordinator Spring 2019, Spring 2020). Graduate classes: *MATH 553: Asymptotic Analysis* (Fall 2018). Average teacher evaluation 2019-20: 4.7 out of 5. Additional to official teaching duties: introductory lectures on topological insulators to graduate students in mathematics and physics (Spring 2019 and Fall 2020).

Mentoring in the Mathematics Department at Duke University. Faculty mentor for *DOmath* program (Summers 2018 and 2019): led teams of undergraduate students on research projects. Summer 2018 project lead to publication 6 above.

Outreach Presented research and participated in panel discussion for students at North Carolina School of Science and Math (October 2019). Presented introductory lectures on graphene and condensed matter physics for gifted and talented program high school students in Minnesota (July 2022).