

Alex H. Barnett Center for Computational Mathematics

Flatiron Institute

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Born: 7th Dec, 1972

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U.S. permanent resident

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RESEARCH AREAS

- Computational partial differential equations: fluid flow (Stokes), wave scattering (Helmholtz and time-domain), periodic geometries, optics, heat equation, high-frequency eigenvalue problems.
- Numerical analysis and software libraries: fast algorithms, signal/image processing, boundary integral equations, quadrature, spectral methods.
- Computational biology and inverse problems: spike sorting (neuroscience), cryo-electron microscopy.
- Mathematical physics: quantum chaos. Mathematics of music, acoustics.

EDUCATION

Harvard University. Ph. D. in Physics: *Dissipation in Deforming Chaotic Billiards* October 2000
Thesis advisor: Eric J. Heller

Cambridge University, England. B. A. (*First class*) in Theoretical Physics June 1994
Undergraduate thesis advisor: David J. C. MacKay

POSITIONS

Group Leader, Numerical Analysis. Center for Computational Mathematics, Flatiron Institute, Simons Foundation, New York, NY 2018–present

Group Leader, Numerical Algorithms. Center for Computational Biology, Flatiron Institute, Simons Foundation, New York, NY 2017–2018

Professor. 2017
Department of Mathematics, Dartmouth College, NH

Senior Research Scientist. November 2014–August 2015; January–March 2016; January–May 2017
Flatiron Institute (formerly SCDA), Simons Foundation, New York, NY

Adjunct Associate Professor. 2013–2017
Department of Physics and Astronomy, Dartmouth College, NH

Associate Professor. 2011–2017
Department of Mathematics, Dartmouth College, NH

Assistant Professor. 2005–2011
Department of Mathematics, Dartmouth College, NH

Courant Instructor / Assistant Professor. 2002–2005
Courant Institute of Mathematical Sciences, New York University, NY

Postdoctoral Research Fellow. February–August 2002
Photon Migration Imaging Laboratory, Dept. of Radiology, Harvard Medical School, Charlestown, MA

Consultant. November–December 2000
TrueWind Solutions LLC, Lowell, MA

Teaching Fellow / Head Teaching Fellow. 1995–2001
Department of Physics, Harvard University, Cambridge, MA

FELLOWSHIPS AND AWARDS

- *C. Troy Shaver 1969 Fellow*, Dartmouth College 2017
- *Office of Naval Research, N00014-17S-B001*, award amount \$10,000 2017
- Funding support for *Modern Advances in Computational and Applied Mathematics*, Yale
- *National Science Foundation, Grant DMS-1347163*, PI, award amount \$34,973 2014
- Funding support for *CBMS Conference on Fast Direct Solvers for Elliptic PDEs*
- *Neukom Institute CompX Faculty Grant*, co-PI, award amount \$25,000 2013–2014
- “Efficient numerical solution of electromagnetic scattering from periodic arrays of cylindrically symmetric objects”
- *National Science Foundation, Grant DMS-1216656*, PI, award amount \$180,000 2012–2015
- “Next-generation integral equation methods for wave scattering and propagation in periodic structures”
- *Elizabeth R. and Robert A. Jeffe 1972 Fellowship*, Dartmouth College 2011
- *Karen E. Wetterhahn Memorial Award for Distinguished Creative or Scholarly Achievement*, Dartmouth College 2011
- *Burke Initiation Award*, Dartmouth College 2011
- *National Science Foundation, Grant DMS-1005360*, co-PI, award amount \$42,355 2010
- Funding support for *International Conference on Spectral Geometry*
- *The Class of 1962 Faculty Fellowship*, Dartmouth College 2010
- *National Science Foundation, Grant DMS-0811005*, PI, award amount \$310,517 2008–2011
- “Efficient spectrally accurate global basis methods for high frequency wave scattering, eigenmodes, and photonics”
- *National Science Foundation, Grant DMS-0507614*, PI, award amount \$102,520 2005–2008
- “High frequency cavity eigenmodes: rapid computation methods, applications and asymptotics”
- *Courant Instructorship*, New York University 2002–2005
- *Harvard University Certificate of Distinction in Teaching* Fall 1997, Spring 2001 and Fall 2001
- *Harold T White Prizes*, teaching introductory physics, Harvard Physics Department 1996 and 1997
- *Kennedy Scholarship*, Kennedy Memorial Trust, London 1994
- *Hockin Prize, Duchess of Somerset Scholarships*, St John’s College, Cambridge 1993 and 1994
- *XXI International Physics Olympiad, First Prize* of 155 entrants, Groningen, The Netherlands 1990

PUBLICATIONS

Journal publications:

- [53] “Spectrally accurate electromagnetic scattering from doubly-periodic gratings of axisymmetric objects,” Y. Liu and A. H. Barnett. *in preparation*
- [52] “Recovering missing data in coherent diffraction imaging,” D. Barmherzig, Alex H. Barnett, C. L. Epstein, L. F. Greengard, J. F. Magland, and M. Rachh, (18 pages) 2020. [arxiv:2002.02874](https://arxiv.org/abs/2002.02874)
- [51] “Aliasing error of the $\exp(\beta\sqrt{1-z^2})$ kernel in the nonuniform fast Fourier transform,” A. H. Barnett, *submitted, Appl. Comput. Harmon. Anal.* (18 pages) 2020. [arxiv:2001.09405](https://arxiv.org/abs/2001.09405)
- [50] “A high-order integral equation-based solver for the time-dependent Schrödinger equation,” J. Kaye, A. H. Barnett, and L. Greengard, *submitted, Comm. Pure Appl. Math.* (38 pages), 2020. [arxiv:2001.06113](https://arxiv.org/abs/2001.06113)
- [49] “SpikeForest: reproducible web-facing ground-truth validation of automated neural spike sorters,” J. F. Magland, J. J. Jun, E. Lovero, A. J. Morley, C. L. Hurwitz, A. P. Buccino, S. Garcia, and A. H. Barnett, *submitted, eLife*, (18 pages) 2020. [bioRxiv. https://doi.org/10.1101/2020.01.14.900688](https://doi.org/10.1101/2020.01.14.900688)
- [48] “An integral equation method for the simulation of doubly-periodic suspensions of rigid bodies in a shearing viscous flow,” J. Wang, E. Nazockdast, and A. H. Barnett, *submitted, J. Comput. Phys.* (39 pages) 2019. [arxiv:1912.04501](https://arxiv.org/abs/1912.04501)
- [47] “Accurate quadrature of nearly singular line integrals in two and three dimensions by singularity swapping,” L. af Klinteberg and A. H. Barnett, *submitted, BIT Numer. Math.* (30 pages) 2019. [arxiv:1910.09899](https://arxiv.org/abs/1910.09899)

- [46] “Solution of Stokes flow in complex nonsmooth 2D geometries via a linear-scaling high-order adaptive integral equation scheme,” B. Wu, H. Zhu, A. H. Barnett, and S. Veerapaneni, *submitted*, *J. Comput. Phys.* (24 pages) 2019. [arxiv:1909.00049](#)
- [45] “Factorization of the translation kernel for fast rigid image alignment,” A. Rangan, M. Spivak, J. Andén, and A. H. Barnett. *Inverse Problems* **36** (2), 024001 (2020). 30 pages.[arxiv:1905.12317](#)
- [44] “High-order discretization of a stable time-domain integral equation for 3D acoustic scattering,” A. H. Barnett, L. Greengard, and T. Hagstrom, *J. Comput. Phys.* **402**, 109047 (2020). 24 pages. [arxiv:1904.00076](#)
- [43] “Explicit unconditionally stable methods for the heat equation via potential theory,” A. H. Barnett, C. L. Epstein, L. Greengard, S. Jiang, and J. Wang, *Pure Appl. Anal.* **1**(4), 709–742, (2019).
- [42] “Geometry of the phase retrieval problem,” A. H. Barnett, C. L. Epstein, L. F. Greengard, J. Magland, *preprint*, 25 pages (2018). [arxiv:1808.10747](#)
- [41] “A parallel non-uniform fast Fourier transform library based on an ‘exponential of semicircle’ kernel,” A. H. Barnett, J. Magland, and L. af Klinteberg. *SIAM J. Sci. Comput.* **41**(5), C479–C504 (2019).
- [40] “High-density, long-lasting, and multi-region electrophysiological recordings using polymer electrode arrays,” J. E. Chung, H. R. Joo, J. L. Fan, D. F. Liu, A. H. Barnett, S. Chen, S. Geaghan-Breiner, M. P. Karlsson, M. Karlsson, K. Y. Lee, H. Liang, J. F. Magland, A. C. Tooker, L. F. Greengard, V. M. Tolosa, L. M. Frank. *NEURON* **101**(1), 21-31.e5 (2019).
- [39] “A fully automated approach to spike sorting,” J. E. Chung, J. F. Magland, A. H. Barnett, V. M. Tolosa, A. C. Tooker, K. Y. Lee, K. G. Shah, S. H. Felix, L. M. Frank, L. F. Greengard. *NEURON* **95**(6) 1381–1394 (2017).
- [38] “A unified integral equation scheme for doubly-periodic Laplace and Stokes boundary value problems in two dimensions,” A. H. Barnett, G. Marple, S. Veerapaneni, and L. Zhao. *Comm. Pure Appl. Math.*, **71**(11), 2334–2380 (2018).
- [37] “Ubiquitous evaluation of layer potentials using quadrature by kernel-independent expansion,” A. Rahimian, A. H. Barnett, and D. Zorin. *BIT Numer. Math.*, **58**(2), 423–456 (2018).
- [36] “Rapid solution of the cryo-EM reconstruction problem by frequency marching,” A. H. Barnett, L. Greengard, A. Pataki, and M. Spivak. *SIAM J. Imaging Sci.*, **10**(3), 1170–1195 (2017).
- [35] “Comparable upper and lower bounds for boundary values of Neumann eigenfunctions and tight inclusion of eigenvalues,” A. H. Barnett, A. Hassell, and M. Tacy, *Duke Math. J.*, **167**(16), 3059–3114 (2018).
- [34] “Unimodal clustering using isotonic regression: ISO-SPLIT,” J. F. Magland and A. H. Barnett, 23 pages (2015). [stat.ME/1508.04841v2](#)
- [33] “A fast algorithm for simulating multiphase flows through periodic geometries of arbitrary shape,” G. Marple, A. H. Barnett, A. Gillman, and S. Veerapaneni, *SIAM J. Sci. Comput.*, **38**(5), B740–B772 (2016).
- [32] “Efficient numerical solution of acoustic scattering from doubly-periodic arrays of axisymmetric objects,” Y. Liu and A. H. Barnett, *J. Comput. Phys.*, **324**, 226-245 (2016).
- [31] “Validation of neural spike sorting algorithms without ground-truth information,” A. H. Barnett, J. F. Magland, and L. Greengard, *J. Neurosci. Meth.*, **264**, 65–77 (2016)
- [30] “A fast and robust solver for the scattering from a layered periodic structure containing multi-particle inclusions,” J. Lai, M. Kobayashi, and A. H. Barnett, *J. Comput. Phys.* **298**, 194–208 (2015)
- [29] “Spectrally-accurate quadratures for evaluation of layer potentials close to the boundary for the 2D Stokes and Laplace equations,” A. H. Barnett, B. Wu, and S. Veerapaneni, *SIAM J. Sci. Comput.* **37**(4), B519–B542 (2015)

- [28] “High-order boundary integral equation solution of high frequency wave scattering from obstacles in an unbounded linearly stratified medium,” A. H. Barnett, B. J. Nelson, and J. M. Mahoney, *J. Comput. Phys.* **297**, 407–426 (2015)
- [27] “Robust and efficient solution of the drum problem via Nyström approximation of the Fredholm determinant,” L. Zhao and A. H. Barnett, *SIAM J. Numer. Anal.* **53** (4), 1984–2007 (2015)
- [26] “Robust fast direct integral equation solver for quasi-periodic scattering problems with a large number of layers,” M. H. Cho and A. H. Barnett, *Optics Express* **23**(2), 1775–1799 (2015)
- [25] “A spectrally accurate direct solution technique for frequency-domain scattering problems with variable media,” A. Gillman, A. H. Barnett, and P.G. Martinsson, *BIT Numer. Math.* **55**(1), 141–170 (2015)
- [24] “Evaluation of layer potentials close to the boundary for Laplace and Helmholtz problems on analytic planar domains,” A. H. Barnett, 22 pages, *SIAM J. Sci. Comput.* **36**(2), A427–A451 (2014)
- [23] “High-order accurate Nyström discretization of integral equations with weakly singular kernels on smooth curves in the plane,” S. Hao, A. H. Barnett, P. G. Martinsson, and P. Young, *Adv. Comput. Math.* **40** (1) 245–272 (2014)
- [22] “Fast computation of high frequency Dirichlet eigenmodes via the spectral flow of the interior Neumann-to-Dirichlet map,” A. H. Barnett and A. Hassell, *Comm. Pure Appl. Math.* **67**(3), 351–407 (2014)
- [21] “A fast direct solver for quasiperiodic scattering problems,” A. Gillman and A. H. Barnett, *J. Comput. Phys.* **248**, 309–322 (2013)
- [20] “Quadrature by expansion: a new method for the evaluation of layer potentials,” A. Klöckner, A. H. Barnett, L. Greengard, and M. O’Neil, *J. Comput. Phys.* **252**, 332–349 (2013)
- [19] “Boundary quasi-orthogonality and sharp inclusion bounds for large Dirichlet eigenvalues,” A. H. Barnett and A. Hassell, *SIAM J. Numer. Anal.* **49**, 1046–1063 (2011)
- [18] “A new integral representation for quasi-periodic scattering problems in two dimensions,” A. H. Barnett and L. Greengard, *BIT Numer. Math.* **51**, 67–90 (2011)
- [17] “A few more words about James Tenney: dissonant counterpoint and statistical feedback,” L. Polansky, A. H. Barnett, and M. Winter, *J. Math. Music*, **5** (2), 63–82 (2011)
- [16] “A new integral representation for quasi-periodic fields and its application to two-dimensional band structure calculations,” A. H. Barnett and L. Greengard, *J. Comput. Phys.*, **229** (19), 6898–6914 (2010)
- [15] “An exponentially convergent nonpolynomial finite element method for time-harmonic scattering from polygons,” A. H. Barnett and T. Betcke, *SIAM J. Sci. Comput.* **32** (3), 1417–1441 (2010)
- [14] “Perturbative analysis of the Method of Particular Solutions for improved inclusion of high-lying Dirichlet eigenvalues,” A. H. Barnett, *SIAM J. Numer. Anal.* **47**, 1952–1970 (2009)
- [13] “Stability and convergence of the Method of Fundamental Solutions for Helmholtz problems on analytic domains,” A. H. Barnett and T. Betcke, *J. Comput. Phys.* **227** (14), 7003–7026 (2008)
- [12] “Analytic steady-state space use patterns and rapid computations in mechanistic home range analysis,” A. H. Barnett and P. R. Moorcroft, *J. Math. Biol.* **57** (1), 139–159 (2008)
- [11] “Quantum mushroom billiards,” A. H. Barnett and T. Betcke, *CHAOS* **17**, 043125, 13 pages (2007)
- [10] “Mechanistic home range models and resource selection analysis: a reconciliation and unification,” P. R. Moorcroft and A. H. Barnett, *Ecology* **89** (4), 1112–1119 (2008)
- [9] “Asymptotic rate of quantum ergodicity in chaotic Euclidean billiards,” A. H. Barnett, *Comm. Pure Appl. Math.* **59**, 1457–1488 (2006)

- [8] “Effective scattering coefficient of the cerebral spinal fluid in adult head models for Diffuse Optical Imaging”, A. Custo, W. M. Wells III, A. H. Barnett, E. M. C. Hillman, and D. A. Boas, *Applied Optics* **45**, 4747–55 (2006)
- [7] “A fast numerical method for time-resolved photon diffusion in general stratified turbid media,” A. H. Barnett, *J. Comput. Phys.* **201**, 771–797 (2004)
- [6] “Robust inference of baseline optical properties of the human head with 3D segmentation from magnetic resonance imaging,” A. H. Barnett, J. P. Culver, A. G. Sorensen, A. M. Dale, and D. A. Boas, *Applied Optics* **42**, 3095–3108 (2003)
- [5] “Parametric evolution for a deformed cavity,” D. Cohen, A. H. Barnett, and E. J. Heller, *Phys. Rev. E* **63**, 046207, 12 pages (2001)
- [4] “Mesoscopic scattering in the half-plane: squeezing conductance through a small hole,” A. H. Barnett, M. Blaauboer, A. Mody, and E. J. Heller, *Phys. Rev. B* **63**, 245312/1 (2001)
- [3] “Rate of energy absorption for a driven chaotic cavity,” A. H. Barnett, D. Cohen, and E. J. Heller, *J. Phys. A* **34**, 413–437 (2001)
- [2] “Deformations and dilations of chaotic billiards: dissipation rate, and quasi-orthogonality of the boundary wavefunctions,” A. H. Barnett, D. Cohen, and E. J. Heller, *Phys. Rev. Lett.* **85**, 1412–15 (2000)
- [1] “Substrate-based atom waveguide using guided two-color evanescent light fields,” A. H. Barnett, S. P. Smith, M. Olshanii, K. S. Johnson, A. W. Adams, M. Prentiss, *Phys. Rev. A* **61**, 023608, 11 pages (2000)

Conference proceedings, technical reports:

“Robust periodization of frequency-domain integral equation solvers,” A. H. Barnett, *Report for Oberwolfach Workshop*, 4 pages (2016)

“New tools for the high-order solution of frequency-domain wave scattering problems at high frequencies and in periodic geometries,” A. H. Barnett, *Report for Oberwolfach Workshop*, 4 pages (2013)

“Estimates on Neumann eigenfunctions at the boundary, and the ‘Method of Particular Solutions’ for computing them,” A. Hassell and A. H. Barnett, *Spectral Geometry* (P. S. P. M. proceedings of the International Conference on Spectral Geometry, July 2010, Dartmouth College), 195–210 (2012)

“Robust high-order numerical scattering from multi-layer dielectric gratings using a new integral representation for quasi-periodic fields,” A. H. Barnett and L. Greengard, *extended abstract*, WAVES2011 The 10th International Conference on Mathematical and Numerical Aspects of Wave Propagation (4 pages).

“Tensor product of kernel models,” O. de la Cruz, A. H. Barnett, H. Tang, and S. Holmes, *NIPS extended abstract*, 4 pages (2010).

“Accurate and robust computation of photonic crystal band structure using second-kind integral equations,” A. H. Barnett and L. Greengard, *extended abstract*, Proceedings of WAVES2009: The 9th International Conference on Mathematical and Numerical Aspects of Wave Propagation, 2 pages (2009).

“Quasi-orthogonality on the boundary for Euclidean Laplace eigenfunctions,” A. H. Barnett, *technical report*, `math-ph/0601006`, 21 pages (2004).

“Bayesian estimation of optical properties of the human head via 3D structural MRI,” A. H. Barnett, J. P. Culver, A. G. Sorensen, A. M. Dale, and D. A. Boas, *Proc. SPIE* **5138**, 9 pages (2003)

“Bayesian Comparison of Models for Images,” A. H. Barnett and D. J. C. MacKay, in *Maximum Entropy and Bayesian Methods*, Proceedings of MAXENT94 (Kluwer, 1996), p. 239–248

Books:

Spectral Geometry (P. S. P. M. proceedings of the International Conference on Spectral Geometry, July 2010, Dartmouth College). Editors: A. H. Barnett, C. S. Gordon, P. A. Perry, and A. Uribe. 339 pages (2012)

Software:

FINUFFT. Parallel non-uniform fast Fourier transform (2018–) <http://finufft.readthedocs.io>

SpikeForest / MountainSort. Spike-sorting software and validation website project. Co-developed with J. Magland and others (2016–). <http://spikeforest.flatironinstitute.org>

MPSpack. A MATLAB toolbox to solve Helmholtz and scattering BVPs with particular solutions and integral equations (tutorial 45 pages, manual 38 pages); downloaded at least 10^3 times (2009–2016).

<https://github.com/ahbarnett/mpspack>

Around twenty other software tools (of varying scope) at:

<https://www.simonsfoundation.org/flatiron/software/?type=40178>

<https://github.com/ahbarnett>

Outreach, education, press:

“Snapshots of modern mathematics from Oberwolfach: Fast solvers for highly oscillatory problems,” A. H. Barnett, 11 pages (2017). <https://publications.mfo.de/handle/mfo/1370>

“convolution: *son et lumière*,” A. H. Barnett, issue 01 of *Convolution. A journal for experimental criticism*, 4 pages (2011).

Computed eigenmodes for integrable and chaotic billiards, appearing in: P. Sarnak, “Recent progress on QUE” (2009); D. Mackenzie, *What’s Happening in the Mathematical Sciences, Volume 8* (AMS, 2011); S.-Y. Koyama, *From primes and zetas to arithmetic quantum chaos* (Nihon Hyoronsha, 2010); and S.-Y. Koyama, “Arithmetic quantum chaos and zeta functions”, *Suurikagaku*, **571** (2011)

Cover of *Notices of the American Mathematical Society*, January 2008. I created all images (modes 1, 10, 10^2 , 10^3 , 10^4 , 10^5 of a planar chaotic cavity), and eigenvalue data for article “Quantum Chaos” by Z. Rudnick.

Quantum chaos research featured in “A Decade of Science at Dartmouth”, W. Schpero and C. Chiang, *Dartmouth Undergraduate Journal of Science*, Spring 2008.

INVITED RESEARCH TALKS

Challenges in Computational Methods for Integral Equations, Casa Matemática Oaxaca, Mexico June 2020

PACM Colloquium, Princeton Spring 2020

Workshop on Machine Learning of Organic Force Fields, Flatiron Institute, NY December 2019

UC Berkeley/LBL Applied Mathematics Seminar November 2019

Flatiron-Wide Algorithms and Mathematics, Flatiron Institute, NY October 2019

Widely Applied Mathematics seminar, SEAS, Harvard October 2019

Mathematical Fluids, Materials and Biology, U. Michigan June 2019

High-Order Discretizations and Quadrature for Integral Equation Methods, SIAM CSE, Spokane, WA February 2019

Frontiers in Computational and Applied Mathematics, NJIT, Newark, NJ August 2018

ICOSAHOM (two invited minisymposium talks), Imperial College, London, UK July 2018

Flatiron Friday Seminar, Simons Foundation, NY June 2018

Applied Mathematics Seminar, Yale April 2018

Aerospace & Mechanical Engineering Seminar, USC April 2018

Fast Algs. for Generating Static and Dynamically Changing Point Configs., ICERM, Brown March 2018

Scientific Computing and Numerical Analysis (SCAN) seminar, Cornell February 2018

Flatiron Institute Board Meeting, Simons Foundation January 2018

Workshop on *Random geometries / Random topologies*, ETH Zurich December 2017

Scientific Computing Colloquium, FSU, Tallahassee November 2017

Flatiron Institute Lunch & Learn Seminar, NYC	November 2017
SIAM Conference on Computational Science and Engineering, Atlanta	March 2017
IMA workshop, <i>Mathematical and Numerical Modeling in Optics</i> , U. Minnesota	December 2016
Math/ICES numerical analysis seminar, UT Austin	December 2016
Oberwolfach Workshop on Fast Solvers for Highly Oscillatory Problems. MFO, Germany	November 2016
SIAM Annual meeting, Boston	July 2016
SIAM Conference on Computational Science and Engineering, Salt Lake City	March 2015
PACM Colloquium, Princeton	February 2015
SCDA Journal Club, Simons Foundation	November 2014
CBMS-NSF Conference on Fast Direct Solvers for Elliptic PDE, Dartmouth College	June 2014
Numerical Analysis and Scientific Computing Seminar, Courant Institute, NYU	March 2014
<i>Integral Equations Methods: Fast Algorithms and Applications</i> , BIRS, Banff	December 2013
Numerical analysis and PDE seminar, U. of Delaware	November 2013
Colloquium, U. of Arizona, Tuscon, AZ	November 2013
Colloquium, Mathematics Dept, Tufts University	September 2013
Physics Colloquium, UMass Boston	April 2013
Middlebury College, VT	April 2013
Applied Mathematics Seminar, NJIT, Newark, NJ	March 2013
SIAM Conference on Computational Science and Engineering, Boston	February 2013
Numerical Analysis and Scientific Computing Seminar, Courant Institute, NYU	February 2013
Widely Applied Math Seminar, DEAS, Harvard	January 2013
Oberwolfach Workshop on Computational Electromagnetism and Acoustics. MFO, Germany	January 2013
Applied Math Colloquium, U. Michigan	November 2012
Integrated Applied Mathematics Seminar, UNH.	November 2012
<i>Applications of Integral Equation Methods</i> , minisymposium, SIAM Annual Meeting, Minneapolis	July 2012
Workshop on <i>Geometry of eigenvalues and eigenfunctions</i> , CRM, Univ. de Montréal	June 2012
<i>Challenges in Geometry, Analysis, and Computation</i> , Yale University (poster)	June 2012
Frontiers in Computational and Applied Mathematics, NJIT, Newark, NJ	May 2012
Analysis/PDE Seminar, UNC Chapel Hill	April 2012
Mathematical Physics and Harmonic Analysis Seminar, Texas A&M University	February 2012
<i>Modern Numerical Methods for Waves: Periodic Geometries</i> , ICIAM, Vancouver	July 2011
WAVES2011, Vancouver (contributed talk)	July 2011
Applied and Computational Mathematics Seminar, Dartmouth	May 2011; January 2012; February 2012
New England Numerical Analysis Day, UMass Dartmouth	April 2011
CSC Seminar, Simon Fraser University, Vancouver, BC	March 2011
Numerical Analysis and Scientific Computing Seminar, Courant Institute, NYU	January 2011
Applied Mathematics and Computational Science Colloquium, U. Penn	January 2011
Conference in honor of 65th birthday of Eric Heller, ITAMP, Harvard	October 2010
<i>Integral Equation Methods, Fast Algorithms and Applications</i> , IMA workshop, Minnesota	August 2010

Frontiers in Computational and Applied Mathematics, NJIT, Newark, NJ	May 2010
<i>Numerical solution of the Painlevé equations</i> , ICMS, Edinburgh, UK	May 2010
Applied Analysis Seminar, Louisiana State University	March 2009
Dartmouth Mathematics Colloquium	November 2009
MIT Applied Mathematics Colloquium	November 2009
Computational Optical Sensing and Imaging Seminar, CU Boulder	September 2009
<i>Topological Complexity of Random Sets</i> , AIM workshop, Palo Alto	August 2009
WAVES2009, Pau, France (contributed talk)	June 2009
Colloquium & PDE/Analysis Seminar (two separate talks), ANU, Canberra, Australia	February 2009
<i>Laplacian Eigenvalues & Eigenfunctions: Theory, Computation, Application</i> , IPAM, UCLA	February 2009
<i>Workshop on Numerical and Analytical Methods for Wave Scattering</i> , Manchester, UK	June 2008
Workshop on quantum chaos, CRM (Univ. de Montréal)	June 2008
Frontiers in Computational and Applied Mathematics, NJIT, Newark, NJ (contributed poster)	May 2008
McGill Applied Mathematics Seminar, Montreal	March 2008
Applied Mathematics Seminar, U. Delaware	November 2007
Numerical analysis seminar, Manchester, UK	July 2007
Three separate mini-symposium talks, ICIAM, Zurich	July 2007
PDE/Analysis Seminar, ANU, Canberra, Australia	February 2007
Heller Group Seminar, Physics Department, Harvard	December 2006
Applied Mathematics Seminar, UMass Amherst, MA	November 2006
Dartmouth Physics Colloquium	October 2006
SIAM Annual Meeting, Boston (contributed talk)	July 2006
Joint MIT/Harvard Analysis Seminar	March 2006
Computations in Science Seminar, U. Chicago	November 2005
Institute of Sound and Vibration Research, Southampton University, UK	June 2005
Computational Mathematics and Applications Seminar, Computing Laboratory, Oxford, UK	June 2005
Numerical Analysis and Scientific Computing Seminar, Courant Institute, NYU	December 2004
Applied Mathematics Colloquium, Columbia University	October 2004
<i>Workshop on Semi-classical Theory of Eigenfunctions and PDEs</i> , CRM (Univ. de Montréal)	June 2004
Applied Mathematics Seminar, Yale University	March 2004
Applied Mathematics Laboratory Seminar, Courant Institute, NYU	February 2004
European Conference on Biomedical Optics, Munich, Germany (contributed talk)	June 2003
Theoretical & Computational Biology Seminar Series, Mount Sinai School of Medicine, NY	May 2003
Applied Mathematics Seminar, Courant Institute, NYU	November 2002
Photon Migration Imaging Seminar, Harvard Medical School	May 2002
Applied Mathematics Laboratory Seminar, Courant Institute, NYU	December 2001
Statistics Seminar, University of Toronto	September 2001
Pan-American Advanced Study Institute on Quantum Chaos, Ushuaia, Argentina	October 2000
<i>14th Maximum Entropy Workshop (MAXENT94)</i> , Cambridge, UK	June 1994

TEACHING

Dartmouth College *(the six new courses I created are shown by asterisks)*

- Math 5: The Mathematics of Music and Sound (non-majors)* Spring 2007, Fall 2008, 2010, 2011
- Math 11: Multivariable Calculus Fall 2010, 2015
- Math 22: Linear Algebra with Applications Summer 2006, Fall 2016, Summer 2017
- Math 23: Differential Equations Fall 2005, 2007
- Math 46: Introduction to Applied Mathematics (majors)* Spring 2007, 2008, 2009, 2011
- Math 50: Probability and Statistical Inference Winter 2006
- Math 53: Chaos! (dynamical systems, for majors)* Fall 2007, 2009, 2011, 2015
- Math 56: Computational and Experimental Mathematics (majors)* Spring 2013, 2014
- Math 116/126: Numerical PDEs & Waves* (graduate) Winter 2006, Fall 2008, Winter 2012
- Math 116: Great Papers in Numerical Computation* (graduate) Spring 2014
- Math 147: Graduate Teaching Seminar (with M. Groszek or R. Orellana) Summer 2012, 2013, 2014, 2017

New York University

- Business Calculus Fall 2004
- Mathematical Wave Dynamics (honors VIGRE course, with O. Bühler) Spring 2004
- Linear Algebra Fall 2003
- Multivariable Calculus Spring 2003
- Undergraduate Math Lab (honors VIGRE course, with P. Sarnak) Fall 2002

Harvard University

- TA / head TA, 8 semesters in physics; *Microteaching Facilitator* for Derek Bok Center 1995–2001

MENTORING

Postdoctoral advisees:

- Jason Kaye (postdoc at CCM, Flatiron Institute) October 2019–present
- James Jun (postdoc at CCM, Flatiron Institute) September 2018–present
- Jun Wang (postdoc in Numerical Algorithms, CCB, Flatiron Institute) October 2017–present
- Adrianna Gillman (JWY Instructor. Now: Tenure track at CU Boulder) July 2011–June 2014
- Min Hyung Cho (IACM Instructor. Now: Tenure track at UMass Lowell) July 2012–June 2015

Graduate students:

- Yuxiang (Larry) Liu (Ph.D. '16; Physics. Now: Postdoc, Applied Physics, Yale) January 2013–June 2016
The numerical solution of frequency-domain acoustic and electromagnetic periodic scattering problems
- Lin Zhao (Ph.D. '15. Now: Research associate, INTECH, Princeton) May 2012–June 2015
Boundary integral equations and their applications.
- Matt Mahoney (Ph.D. '09; advised for one year) July 2006–July 2007
Global numerical methods for eigenmodes with gravity

Interns:

- Andrea Malleo (CCM) June–August 2019
- Daniel Fortunato (CCM) June–August 2019
- Yu-Hsuan Melody Shih (Numerical Algorithms Group, CCB) June–August 2018, July 2019
- Hannah Lawrence (Numerical Algorithms Group, CCB) June–August 2017

Undergraduate students:

- Paula Chen '17 (senior thesis) Fall 2016–Spring 2017
Neural spike sorting algorithms for overlapping spikes

Luis Martinez '16 (Physics; senior thesis) Spring 2016
Bubbles in my scalar field soup: a study on oscillons in cosmology

Matthew Jin '17 (supported by \$4k from my NSF grant) June 2014–2016
Topological statistics of nodal surfaces of random waves

John Conley '15 (Presidential Scholar) September 2013–May 2014
Modeling optical waveguides and solar cells

James Brofos '15 (supported by \$4k from my NSF grant) June–August 2013
Behavior and solution of layer densities for close-to-touching curves

Ben Southworth '13 (supported by start-up; co-advisor Brenden Epps) June–July 2013
Stability of the SVD for measurement of eigenfunctions of a linear system

Bradley Nelson '13 (supported by \$4k Richter Memorial Fund; senior thesis) March 2012–May 2013
Integral equations for waves in variable-index media

Hahn Nguyen '14 (first-year WISP intern, Women in Science Program) January–June 2011
Accurate evaluation of layer potentials up to the boundary

Kyle Konrad '12 (senior thesis, Neukom Scholar) March 2011–June 2012
Nodal domain counts of chaotic eigenfunctions

Vipul Kakkad '13 (Presidential Scholar) January–March 2012
Optimization of tubular bell mode frequencies

Taylor Sipple '13 (Presidential Scholar) June–December 2011
Method of particular solutions for polygon and Dirichlet-Neumann eigenmodes

Kathleen Champion '11 (Presidential Scholar and senior thesis; co-supervisor Amy Gladfelter, Biology) January 2010–May 2011
Three-dimensional tracking of nuclear mitosis

Zoe Lawrence '10 (senior thesis, with 'high honors'; co-supervisor Dorothy Wallace) Spring 2010
The spatiotemporal dynamics of African Cassava Mosaic Disease

Emmanuel Mensah '09 (independent study) Spring 2009
The inverse source problem in medical imaging (published in DUJS, November 2009)

Yong Su '09 (senior thesis, with 'high honors'; Neukom Scholar) September 2008–March 2009
Computing the capacitance of the unit cube

Evan Tice '09 (computer science major; co-supervisor Amy Gladfelter, Biology) January 2008–June 2009
Automated image tracking of cell movement and division (awarded Kemeny Prize, 2008)

Chetan Mehta '08 (senior thesis, with 'high honors') June 2007–May 2008
Optimal optode location in Diffuse Optical Tomography

Chor Lam '08 (Presidential Scholar) January–June 2008
Chaos in billiards

Vissuta Jiwariyavej '09 (sophomore WISP intern, Women in Science Program) January–June 2007
A clap can chirp: waves and echoes in the racquetball court

William A. Webb (summer research student, Caltech; co-advisor Mason Porter) Summer 2006
A computational study of the quantization of billiards with mixed dynamics

External thesis committees:

Jason Kaye (NYU, Ph.D 2019)
Integral equation-based numerical methods for the time-dependent Schrödinger equation

Leonardo Andrés Zepeda-Núñez (MIT, Ph.D 2015)
Fast solvers for the Helmholtz equation

ACADEMIC SERVICE

Seminar organizing:

Numerical Algorithms Seminar, CCB/CCM, Flatiron Institute (≥ 50 invited talks)	2017–present
Applied and Computational Mathematics Seminar, Dartmouth College (≥ 90 invited talks)	2006–2016
Organizer (with J. Zhang), Applied Mathematics Laboratory Seminar, Courant Institute, NYU	2002–2003
Organizer, Creating Careers in Physics series, Harvard	1999–2000

Additional educational activities:

<i>Periods, Pitches and Pipes</i> : middle-school music/math module (with Megan Martinez)	June 2013
<i>The Mathematical Overtones of Music</i> , lecture, JHU Center for Talented Youth, Odyssey Series	May 2011
<i>Interactive Learning in the Sciences</i> , session given for DCAL (teaching center)	October 2007
Cross-disciplinary classroom visits by professional musicians to Math 5, 53	2007–2011
Guest lectures (1 week graduate level), Math 117, Dartmouth College	Summer 2012, 2013
Committee member, Applied Mathematics Qualifying Examination, Lin Zhao	Spring 2012
Committee member, Applied Mathematics Qualifying Examination, Katherine Kinnaird	Spring 2010

Outreach:

Research talk for Simons Foundation New Hire Workshop	November 2019
Research talk for Simons Foundation Staff Meeting	February 2019
Research talk for Flatiron Institute Board Meeting	January 2018
Guest lecture, Mathematics and Music, Hanover High School	May 2016
Two-hour workshops on <i>Math and Music</i> for high-school teachers, Math for America	January, March 2016
Co-supervisor, <i>Exploring Mathematics</i> , 2-week “camps” ages 11-17, Dartmouth	Summer 2012–2014, 2017
Faculty Advisor, Dartmouth SIAM Student Chapter	March 2012–Nov 2015
Faculty Advisory Board, Dartmouth Undergraduate Journal of Science (DUJS)	Fall 2007–2017
Affiliated faculty, Electro-Acoustic Music Program, Dartmouth	2007–2017
Research talks for Dartmouth Graduate Recruiting Open House	2006, 2007, 2009, 2011, 2013
Research talks for Dartmouth Mathematics Society	2006, 2008, 2009, 2010, 2011
Judge, DMAX Makeathon	May 2014
Research talk at Thugz Institute of Science, Dartmouth	April 2014
Mathematical model building, Dartmouth Mathematics Society	October 2006
Guest lecture, Music 3 (Music and Technology), Dartmouth	November 2006
First-year advising	Fall 2007, 2008, 2010, 2011

University committees (Dartmouth College):

Chair, Committee on Organization and Policy (elected position)	Fall 2015
Committee on Organization and Policy (elected position)	2013–2016
Committee on Student Life	2011–2013
Advisory Committee, Leslie Center for the Humanities	Winter 2011–Spring 2013

Department committees & duties (Dartmouth College):

Teaching Assistant Discussion Group	Fall 2017
Advisor to Graduate Students	2011–2013
Graduate Program Committee	2006–2007, 2012–2014, 2015–2017
Graduate Admissions Committee	2005, 2006, 2011
Undergraduate Program Committee	2005, 2008–2010
Recruiting Committee	2007–2008, 2010–2011, 2012–2013
Computing Committee	2005–2006, 2015–2016
Equipment Committee	2007–2008
Mirkil Book Committee	2006–2007

OTHER PROFESSIONAL ACTIVITIES

Conference organizing:

Chair of committee, <i>Flatiron-Wide Algorithms and Mathematics</i> , Flatiron Institute, NY	October 2019
Organizing committee, <i>Frontiers in Applied and Computational Mathematics</i> , NJIT	August 2018
Organizer (with 3 others), <i>Modern Advances in Computational and Applied Mathematics</i> , Yale	June 2017
Organizer (with L. Zepeda-Núñez), two minisymposia on the high-frequency Helmholtz equation, SIAM	

Annual Meeting, Boston July 2016
 Organizer (with 3 others), *CBMS-NSF Conference on Fast Direct Solvers for Elliptic PDE*, Dartmouth College June 2014
 Organizer (with 4 others), *Integral Equations Methods: Fast Algorithms and Applications*, BIRS December 2013
 Organizer (with L. Demanet), minisymposium on the high-frequency Helmholtz equation, SIAM CSE, Boston February 2013
 Organizer (with L. Demanet), two minisymposia on numerical waves, ICIAM, Vancouver, BC July 2011
 Organizer (with 3 others), *International Conference on Spectral Geometry*, Dartmouth College July 2010
 Organizer (with 3 others), Boston Area Undergraduate Physics Competition 1998–2001

Journals:

Co-Editor in Chief, *Advances in Computational Mathematics (ACOM)* 2017–present
 Guest editorial board, Special Issue on *Advances in Computational Integral Equations*, ACOM 2020
 Editorial board, *Advances in Computational Mathematics* 2012–2017

Referee service:

SIAM Journal on Scientific Computing, SIAM Journal on Applied Mathematics, SIAM Journal on Numerical Analysis, Journal of Computational Physics, *Advances in Computational Mathematics*, *Notices of the AMS*, Journal of the AMS, *Communications in Mathematical Physics*, *Mathematics of Computation*, Journal of Mathematical Analysis and Applications, Journal of Differential Equations, *Inverse Problems*, *Proceedings of the Royal Society of London A*, Journal of Physics A, *Engineering Analysis with Boundary Elements*, *Numerical Functional Analysis and Optimization*, *Experimental Mathematics*, *Constructive Approximation*, *Applied Optics*, *Waves in Random and Complex Media*, *Wave Motion*, *NeuroImage*, Journal of Electronic Imaging, *Physics in Medicine and Biology*, *Transactions on Medical Imaging*, Journal of the Optical Society of America A, *Nonlinear Dynamics*, *Canadian Journal of Physics*, *New Journal of Physics*, *AMS Mathematical Reviews*, Johns Hopkins Press, NSERC (Canada), Israel Science Foundation.

Review panels:

National Science Foundation
 Scientific Committee, *International Conference on Mathematical and Numerical Aspects of Wave Propagation (WAVES)* 2011, 2013, 2015, 2017, 2019
 Scientific Committee, *International Association for Boundary Element Methods (IABEM)* 2018

Member:

Society for Industrial and Applied Mathematics
 Optical Society of America
