

# Curriculum Vitae

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## Education

- Ph.D., New York University, 2004.
- M.S., New York University, 2000.
- B.S., Shanghai Jiao Tong University, 1998.

## Professional Appointments

- Professor of Mathematics, The University of Texas at Austin, 2012-
- Associate Professor of Mathematics, The University of Texas at Austin, 2010-2012.
- Assistant Professor of Mathematics, The University of Texas at Austin, 2006-2010.
- Postdoctoral Scholar, California Institute of Technology, 2004-2006.

## Awards and Honors

- Feng Kang Prize of Scientific Computing, Chinese Academy of Sciences, 2011.
- Best Poster Paper Award of SEG Annual Meeting, 2010.
- National Science Foundation CAREER Award, 2009.
- President's Associates Centennial Teaching Fellowship, UT Austin, 2009-2011.
- College of Natural Sciences Teaching Excellence Award, UT Austin, 2009.
- Alfred P. Sloan Research Fellowship, 2007.
- Janet Fabri Prize for the PhD dissertation, Courant Institute, NYU, 2005.
- Dean's Dissertation Fellowship of Graduate School of Arts and Sciences, NYU, 2003.
- Best Student Paper Award, the ACM/IEEE conference on Supercomputing, 2003.

## Research Grants

- KAUST Global Collaborative Research Grant, co-PI, 2011-2014 (PI: Sergey Fomel).
- NSF DMS Grant 1016577, co-PI, 2010-2013 (PI: Bjorn Engquist).
- KAUST Global Collaborative Research Grant, co-PI, 2010-2011 (PI: Sergey Fomel).
- NSF CDI Grant 1027952, PI, 2010-2013.
- NSF CAREER Grant 0846501, PI, 2009-2014.
- Alfred P. Sloan Research Fellowship, 2007-2011.
- NSF DMS Grant 0708014, PI, 2007-2011.

## Publications

### Preprints

1. J. Poulson, B. Engquist, S. Fomel, S. Li and L. Ying, A parallel sweeping preconditioner for high frequency heterogeneous 3D Helmholtz equations. Submitted.
2. L. Lin and L. Ying, Element orbitals for Kohn-Sham density functional theory. Submitted.
3. X. Song, S. Fomel, and L. Ying, Lowrank finite-differences and lowrank Fourier finite-differences for seismic wave extrapolation. Submitted.
4. H. Zhang, G. Bao, J. Qian, and L. Ying, A convergent multiscale Gaussian-beam parametrix for wave equations. Submitted.
5. P. Schmitz and L. Ying, A fast direct solver for elliptic problems on Cartesian meshes in 3D. Submitted.

### Refereed journal papers

1. S. Fomel, L. Ying, and X. Song, Seismic wave extrapolation using lowrank symbol approximation. To appear in Geophysical Prospecting.
2. I. Lashuk, A. Chandramowlishwaran, H. Langston, T. Nguyen, R. Sampath, A. Shringarpure, R. Vuduc, L. Ying, D. Zorin, and G. Biros, A massively parallel adaptive fast multipole method on heterogeneous architectures. Communications of the ACM 55 (2012).
3. L. Lin, J. Lu, L. Ying, and W. E, Optimized local basis set for Kohn-Sham density functional theory. Journal of Computational Physics 231 (2012).
4. H. Yang and L. Ying, A fast algorithm for multilinear operators. Applied and Computational Harmonic Analysis 33 (2012).
5. L. Ying, A pedestrian introduction to fast multipole methods. Science China Mathematics 55 (2012).
6. L. Demanet and L. Ying. Fast wave computation via Fourier integral operators. Mathematics of Computation 81 (2012).
7. P. Tsuji, B. Engquist, and L. Ying, A sweeping preconditioner for time-harmonic Maxwell's equations with finite elements. Journal of Computational Physics 231 (2012).
8. P. Tsuji and L. Ying. A sweeping preconditioner for Yees finite difference approximation of time-harmonic Maxwell's equations. Frontiers of Mathematics in China 7 (2012).
9. L. Lin, J. Lu, L. Ying, and W. E, Adaptive local basis set for Kohn-Sham density functional theory in a discontinuous Galerkin framework I: Total energy calculation. Journal of Computational Physics 231 (2012).
10. L. Demanet, M. Ferrara, N. Maxwell, J. Poulson, and L. Ying. A butterfly algorithm for synthetic aperture radar imaging. SIAM Journal on Imaging Sciences 5 (2012).
11. J. Hu and L. Ying, A fast spectral algorithm for the quantum Boltzmann collision operator. Commun. Math. Sci 10 (2012).
12. P. Schmitz and L. Ying, A fast direct solver for elliptic problems on general meshes in 2D. Journal of Computational Physics 231 (2012).
13. S. Jiang, B. Ren, P. Tsuji, and L. Ying. Second kind integral equations for the first kind Dirichlet problem of the biharmonic equation in three dimensions. Journal of Computational Physics 230 (2011).
14. B. Engquist and L. Ying. Sweeping preconditioner for the Helmholtz equation: Moving perfectly matched layers. Multiscale Modeling and Simulation 9 (2011).
15. L. Lin, C. Yang, J. Lu, L. Ying, and W. E. A fast parallel algorithm for selected inversion of structured sparse matrices with application to 2D electronic structure calculations. SIAM Journal on Scientific Computing 33 (2011).
16. L. Lin, J. Lu, and L. Ying. Fast construction of hierarchical matrix representation from matrix-vector multiplication. Journal of Computational Physics 230 (2011).

17. P. Tsuji and L. Ying. A fast directional algorithm for high-frequency electromagnetic scattering. *Journal of Computational Physics* 230 (2011).
18. B. Engquist and L. Ying. Sweeping preconditioner for the Helmholtz equation: Hierarchical matrix representation. *Communications in Pure and Applied Mathematics* 64 (2011).
19. L. Lin, C. Yang, J. Meza, J. Lu, L. Ying, and W. E. SelInv—an algorithm for selected inversion of a sparse symmetric matrix. *ACM Trans. Math. Software* 37 (2011).
20. P. Tsuji, D. Xiu, and L. Ying. A fast method for high-frequency acoustic scattering from random scatterers. *International Journal on Uncertainty Quantification* 1 (2011).
21. L. Demanet and L. Ying. Discrete symbol calculus. *SIAM Rev.* 53 (2011).
22. J. Qian and L. Ying. Fast multiscale Gaussian wavepacket transforms and multiscale Gaussian beams for the wave equation. *SIAM MMS* 8 (2010).
23. J. Qian and L. Ying. Fast Gaussian wavepacket transforms and Gaussian beams for the Schrodinger equation. *J. Computational Physics* 229 (2010).
24. L. Demanet and L. Ying. Scattering in flatland: efficient representations via wave atoms. *Found. of Comput. Math.* 10 (2010).
25. B. Engquist and L. Ying. Fast directional algorithms for the Helmholtz kernel. *Journal of Computational and Applied Mathematics* 234 (2010).
26. L. Lin, J. Lu, L. Ying, and W. E. Pole-based approximation of the Fermi-Dirac function. *Chinese Annals of Mathematics - Series B* 30 (2009).
27. L. Ying and S. Fomel. Fast computation of partial Fourier transforms. *Multiscale Model. Simul* 8 (2009).
28. L. Lin, J. Lu, L. Ying, R. Car, and W. E. Fast algorithm for extracting the diagonal of the inverse matrix with application to the electronic structure analysis of metallic systems. *Commun. Math. Sci.* 7 (2009).
29. E. Candès, L. Demanet and L. Ying. A fast butterfly algorithm for the computation of Fourier integral operators. *Multiscale Modeling and Simulation* 7 (2009).
30. B. Engquist and L. Ying. A fast directional algorithm for high frequency acoustic scattering in two dimensions. *Communications in Mathematical Sciences* 7 (2009).
31. L. Demanet and L. Ying. Wave atoms and time upscaling of wave equations. *Numerische Mathematik* 113 (2009).
32. L. Ying. Sparse Fourier transform via butterfly algorithm. *SIAM Journal on Scientific Computing* 31 (2009).
33. L. Demanet, L. Ying. Wave atoms and sparsity of oscillatory patterns. *Applied and Computational Harmonic Analysis* 23 (2007).
34. E. Candès, L. Demanet and L. Ying. Fast computation of Fourier integral operators. *SIAM Journal on Scientific Computing* 29 (2007).
35. B. Engquist and L. Ying. Fast directional multilevel algorithms for oscillatory kernels. *SIAM Journal on Scientific Computing* 29 (2007).
36. L. Ying, E. Candès. The phase flow method. *Journal of Computational Physics* 220 (2006).
37. L. Ying, E. Candès. Fast geodesics computation with the phase flow method. *Journal of Computational Physics* 220 (2006).
38. L. Ying, G. Biros, D. Zorin. A high-order 3D boundary integral equation solver for elliptic PDEs in smooth domains. *Journal of Computational Physics* 219 (2006).
39. E. Candès, L. Demanet, D. Donoho, L. Ying. Fast discrete curvelet transforms. *SIAM Journal on Multiscale Modeling and Simulation* 5 (2006).
40. L. Ying. A kernel independent fast multipole algorithm for radial basis functions. *Journal of Computational Physics* 213 (2006).

41. L. Ying, D. Zorin. A simple manifold-based construction of surfaces of arbitrary smoothness. *ACM Transactions on Graphics* 23 (2004) (SIGGRAPH 2004).
42. L. Ying, G. Biros, D. Zorin. A kernel-independent adaptive fast multipole method in two and three dimensions. *Journal of Computational Physics* 196 (2004).
43. G. Biros, L. Ying, D. Zorin. A fast solver for the Stokes equations with distributed forces in complex geometries. *Journal of Computational Physics* 194 (2004).
44. L. Velho, K. Perlin, L. Ying, H. Biermann. Algorithmic shape modeling with subdivision surfaces. *Computers and Graphics* 26 (2002).

#### Book chapters

1. B. Engquist and L. Ying, Fast algorithms for high frequency wave propagation. To appear in *Numerical Analysis of Multiscale Problems*, I. Graham, T. Hou, O. Lakkis and R. Scheichl (editors), *Lecture Notes in Computational Science and Engineering*, Springer.
2. L. Ying. Fast algorithms for boundary integral equations. In *Multiscale Modeling and Simulation in Science*, B. Engquist, O. Runborg, P. Lötstedt (editors), *Lecture Notes in Computational Science and Engineering*, Vol. 66, 2009, Springer.

#### Refereed proceeding papers

1. J. Hu, S. Fomel, L. Demanet, and L. Ying, A fast butterfly algorithm for the hyperbolic Radon transform. Submitted to the 2012 SEG Annual Meeting.
2. J. Poulson, B. Engquist, S. Li, and L. Ying, A parallel sweeping preconditioner for frequency-domain seismic wave propagation. Submitted to the 2012 SEG Annual Meeting.
3. X. Song, S. Fomel, L. Ying, and T. Ding, Lowrank finite-difference for wave extrapolation. *Proceedings of the 2011 SEG Annual Meeting*.
4. B. Engquist, J. Poulson, and L. Ying, Sweeping preconditioner for the 3D Helmholtz equation. *Proceedings of the 2011 SEG Annual Meeting*.
5. S. Fomel, L. Ying, and X. Song, Seismic wave extrapolation using lowrank symbol approximation. *Proceedings of the 2010 SEG Annual Meeting*.
6. I. Lashuk, A. Chandramowlishwaran, H. Langston, T. Nguyen, R. Sampath, A. Shringarpure, R. Vuduc, L. Ying, D. Zorin, and G. Biros. A massively parallel adaptive fast multipole method on heterogeneous architectures. *Proceedings of the 2009 ACM/IEEE Conference on Supercomputing*.
7. B. Engquist, K. Tran, and L. Ying. Fast hybrid algorithms for high frequency scattering Engquist. *The 3rd Conference on Mathematical Modeling of Wave Phenomena and the 20th Nordic Conference on Radio Science and Communications*. AIP Conference Proceedings 1106, 2009.
8. L. Demanet and L. Ying. Curvelets and wave atoms for mirror-extended images. *Proceedings of SPIE Wavelets XII Conference 2007 (Invited Paper)*.
9. L. Ying, L. Demanet, E. Candès. 3D discrete curvelet transform. *Proceedings of SPIE Wavelets XI Conference 2005 (Invited Paper)*.
10. L. Ying, G. Biros, D. Zorin, H. Langston. A new parallel kernel-independent fast multipole method. *Proceedings of the 2003 ACM/IEEE Conference on Supercomputing*.
11. G. Biros, L. Ying, D. Zorin. The embedded boundary integral equation solver for the incompressible Navier-Stokes equations. *International Association for Boundary Element Methods Symposium 2002*.
12. L. Ying, D. Zorin. Nonmanifold subdivision. *The 12th IEEE Visualization Conference 2001*.
13. L. Ying, A. Hertzmann, H. Biermann, D. Zorin. Texture and shape synthesis on surfaces. *The 12th Eurographics Workshop on Rendering 2001*.

#### Technical reports

1. A. Gupta and L. Ying. A Fast Maximum-Weight-Bipartite-Matching Algorithm for Reducing Pivoting in Sparse Gaussian Elimination, Tech. Report RC 21576 (97320), IBM T. J. Watson Research Center, Yorktown Heights, NY, 1999.

## Teaching

At UT Austin

- Calculus, (Fall 2006, Spring 2008).
- Probability, (Spring 2007).
- Scientific Computing in Numerical Analysis, (Fall 2008, Fall 2009, Fall 2010, Fall 2011).
- Iterative Methods and Fast Algorithms, (Fall 2007, Spring 2009, Spring 2010, Spring 2012).

At Caltech:

- Introductory Methods of Computational Mathematics, (Spring 2006).

## Students and Postdocs Advised

Ph.D. students:

- Phillip Schmitz, UT Austin (2008-2010).
- Paul Tsuji, CAM, UT Austin (2009-present).
- Jack Poulson, CAM, UT Austin (2010-present).
- Haizhao Yang, Mathematics, UT Austin (2010-present).

Postdoctoral scholars:

- Jingwei Hu, UT Austin (2011-present).

## Services

University and departmental services

- Member, Strategic Planning Committee, Mathematics Department, UT Austin, 2011-present.
- Member, Chairs Committee, Mathematics Department, UT Austin, 2011-present.
- Member, Hiring Committee, Mathematics Department, UT Austin, 2010-2011.
- Member, Faculty Welfare Committee, UT Austin, 2010-2011.
- Member, University Faculty Council, UT Austin, 2009-2011.
- Chair, CAM Program Admission Committee, UT Austin, 2008-2009.

Professional services

- Associate editor, Communications in Mathematical Sciences (2010-present).
- Journal Referee for SIAM Review, SIAM Journal on Numerical Analysis, SIAM Journal on Scientific Computing, SIAM Journal on Imaging Sciences, Nonlinearity, Journal of Computational Physics, Communications in Mathematical Sciences, IEEE Transactions on Image Processing, IEEE Transactions on Signal Processing, Signal Image and Video Processing, Journal of the Optical Society of America A, ACM Transaction on Graphics, and etc.
- Conference referee for the IEEE Conference on Visualizations (2007), the SIGGRAPH Conferences (2005, 2006, 2008), and the ACM/IEEE Conferences on Supercomputing (2005, 2007).
- School organized: RTG summer school on multiscale analysis and modeling (Mathematics Department, UT Austin, 2008), Electronic structure analysis and computation (Shanghai Jiao Tong University, 2011).
- Workshops and minisymposiums organized: Four minisymposiums at ICIAM 2007.

## Talks

### Lecture series and minicourses

- RTG Summer School on Multiscale Modeling and Analysis, UT Austin, Aug 2008.
- Summer School on Multiscale Modeling and Simulation in Science, Sweden, Jun 2007.

### Invited talks at conferences and workshops

- Minisymposium at ICIAM 2011, Jul 2011.
- Summer School on Electronic Structure Analysis and Computation at SJTU, June 2011.
- Minisymposium at Applied Inverse Problems Conference, May 2011.
- International Congress of Chinese Mathematicians, Dec 2010.
- IMA Workshop on Integral Equation Methods, Fast Algorithms and Applications, Aug 2010.
- Minisymposium at SIAM Conference on Mathematical Aspects of Materials Science, May 2010.
- Banff Workshop on Numerical Analysis of Multiscale Computations, Dec 2009.
- Minisymposium at SIAM Conference on Applied Linear Algebra, Oct 2009.
- Minisymposium at SIAM Conference on Imaging Science, Jul 2008.
- Minisymposium at ICIAM 2007, Jul 2007.
- Minisymposium at SIAM Conference on Imaging Science, May 2006.
- IPAM Workshop on Multiscale Geometry in Scientific Computing, Oct 2004.
- Session at SIGGRAPH 2004, Los Angeles, Aug 2004.

### Colloquia and seminars

- Math Department Colloquium, Iowa State University, Apr 2012.
- Computational and Applied Mathematics Seminar, Iowa State University, Apr 2012.
- Math Department Colloquium, Stanford University, Jan 2012.
- Seminar at Department of Mathematics, Fudan University, Jun 2011.
- ICME Colloquium, Stanford University, Feb 2011.
- Applied and Computational Mathematics Colloquium, Caltech, Feb 2011.
- ICES Seminar, UT Austin, Feb 2011.
- ICMSEC and LSEC, Chinese Academy of Science, Dec 2010.
- School of Mathematics, Peking University, Dec 2010.
- Numerical Analysis and Scientific Computing Seminar, New York University, Oct 2010.
- Applied and Computational Mathematics Colloquium, Caltech, Oct 2010.
- Computational and Applied Mathematics Seminar, Purdue University, Sep 2010.
- Scientific Computing and Numerics Seminar, Cornell University, Sep 2010.
- ICES Seminar, UT Austin, Sep 2010.
- Applied Mathematics Seminar, Stanford University, May 2010.
- Math Department Colloquium, UT Austin, Mar 2009.
- Applied Mathematics Colloquium, Southern Methodist University, Jan 2010.
- Applied Mathematics Seminar, University of Wisconsin-Madison, Oct 2009.
- CAAM Colloquium, Rice University, Sep 2009.
- Applied Mathematics Seminar, Michigan State University, Apr 2009.
- RTG Seminar, UT Austin, Mar 2009.
- Applied Mathematics Colloquium, Illinois Institute of Technology, Mar 2009.

- Applied Mathematics Seminar, Princeton University, Feb 2009.
- Numerical Analysis Seminar, UT Austin, Dec 2008.
- Scientific Computing Seminar, UC Berkeley, Nov 2008.
- ICME Colloquium, Stanford University, Nov 2008.
- Applied Mathematics Seminar, Stanford University, Mar 2008.
- Applied Mathematics Seminar, University of North Carolina at Charlotte, Nov 2007.
- Applied and Computational Mathematics Colloquium, Caltech, Nov 2007.
- Mathematical Physics Seminar, UT Austin, Sep 2006.
- Applied Mathematics Seminar, University of Waterloo, Feb 2006.
- Applied Mathematics Seminar, University of Minnesota, Feb 2006.
- Computational and Applied Mathematics Seminar, UC Irvine, Feb 2006.
- Applied Mathematics Seminar, University of Texas at Austin, Feb 2006.
- Applied and Computational Mathematics Colloquium, Caltech, Jan 2006.
- Applied Mathematics Seminar, University of Tennessee, Jan 2006.
- Computer Science and Mathematics Division Seminar, Oak Ridge National Lab, Jan 2006.
- Computational and Applied Mathematics Seminar, Purdue University, Jan 2006.
- CAMP/Nonlinear PDE's Seminar, University of Chicago, Jan 2006.
- Applied Mathematics Seminar, UCLA, Sep 2005.
- Computational Biology Seminar, IBM T.J.Watson Research Lab, Feb 2004.

## Software Packages

- CurveLab. This package implements the curvelet transform in 2D and 3D. It can be downloaded from <http://www.curvelet.org/>. Curvelab is now a central imaging tool used in several academic and industrial research laboratories. It is also used in the scope of several class projects.
- Wave Atoms. This package implements the wave atom transform in 1D, 2D and 3D. It can be downloaded from <http://www.waveatom.org/>. It has been used in seismic data processing and fingerprint analysis.
- Kernel Independent Fast Multipole Method. This package implements the kernel independent fast multipole method in 2D and 3D for Laplace, Stokes and Navier kernels. It can be downloaded from <http://www.math.utexas.edu/~lexing/codes/index.html>. It has been tested in several academic, government and industrial laboratories such as IBM T.J. Watson Research Lab and Oak Ridge National Lab.