

Contact Information

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Research Interests

Scientific computation, numerical analysis, and applied mathematics. Recent work includes:

- Numerical methods for elliptic PDEs and integral equations; numerical linear algebra.
- Applied harmonic analysis; fast multipole methods.
- Randomized methods in linear algebra.
- Numerical homogenization; lattice equations.

Education

1998 – 2002 *Ph.D.*, University of Texas at Austin, CAM. Advisors: Ivo Babuška and Gregory Rodin.

1996 – 1998 *Licentiate*, Chalmers Univ. (Sweden), Mathematics. Advisor: Vidar Thomée.

1992 – 1995 *Civ. Ing.*, Chalmers Univ. (Sweden), Engineering Physics. John Ericsson medal awardee.

Professional Appointments

2010 – now *Associate Professor of Applied Mathematics*, University of Colorado, Boulder.

2005 – 2010 *Assistant Professor of Applied Mathematics*, University of Colorado, Boulder.

2004 – 2005 *Gibbs Assistant Professor of Mathematics*, Yale University.

2002 – 2004 *Gibbs Instructor in Mathematics*, Yale University.

1996 *Research Associate in Mathematics*, University of South Carolina.

Other activities

2012 – now *Associate Editor*, SIAM Journal on Scientific Computation.

Awards, etc

- Wenner-Gren Foundation Fellowship, Spring 2012.
- College Scholar Award. College of Arts and Sciences, Univ. of Colorado, Boulder, Fall 2011.
- NSF Career Award, 2008 – 2013.
- The Sweden-America Foundation Graduate Fellowship, 2001-2002.
- The University of Texas at Austin Graduate Fellowship, 1998-2001.
- The John Ericsson Medal, Chalmers University of Technology, 1996.
- Member, Swedish team, International Physics Olympiad, Havana, 1991.

Research Contracts

2009 – 2012 NSF #0941476 (CDI-Type I). With François Meyer (EE, CU-Boulder). \$535 784.

2008 – 2013 NSF #0748488 (CAREER award). Sole PI. \$400 000.

2006 – 2009 NSF #0610097. Sole PI. \$151 600.

Doctoral Students

- Patrick Young* Completed in Dec. 2010. (Co-advised with Kamran Mohseni.)
Adrianna Gillman Completed in Aug. 2011.
Nathan Halko Completed in Feb. 2012.
Dan Kaslovsky Expected to graduate in April 2012. (Co-advised with François Meyer.)
Sijia Hao Expected to graduate in 2012/13.

Publications

Most publications are available at: http://amath.colorado.edu/faculty/martinss/main_publications.html

Refereed journal articles:

- P. Young, S. Hao, and P.G. Martinsson, "A high-order Nystrom discretization scheme for boundary integral equations defined on rotationally symmetric surfaces" To appear in *Journal of Computational Physics*. (arXiv.org #1201.0077)
- N. Halko, P.G. Martinsson, J. Tropp, "Finding structure with randomness: Probabilistic algorithms for constructing approximate matrix decompositions." *SIAM Review*, **53**(2), pp. 217–288, 2011.
- P.G. Martinsson, "A fast randomized algorithm for computing a Hierarchically Semi-Separable representation of a matrix". *SIAM J. on Matrix Analysis and Appl.*, **32**(4), pp. 1251–1274, 2011.
- N. Halko, P.G. Martinsson, Y. Shkolnisky, M. Tygert, "An Algorithm for the Principal Component Analysis of large Data Sets". *SIAM J. on Scientific Computation*, **33**(5), pp. 2580–2594, 2011.
- A. Gillman, P. Young, and P.G. Martinsson, "A direct solver with $O(N)$ complexity for integral equations on one-dimensional domains". To appear in *Frontiers of Mathematics in China*.
- P.G. Martinsson, V. Rokhlin, and M. Tygert, "A randomized algorithm for the decomposition of matrices". *Applied and Computational Harmonic Analysis*, **30**(1), pp. 47–68, 2011.
- A. Gillman and P.G. Martinsson, "Fast and accurate numerical methods for solving elliptic difference equations defined on lattices". *Journal of Computational Physics*, **229**(24), pp. 9026–9041, 2010.
- P.G. Martinsson and G.J. Rodin, "Boundary algebraic equations for lattice problems". *Proc. R. Soc. A*, **465**(2108), pp. 2489–2503, 2009.
- L. Greengard, D. Gueyffier, P.G. Martinsson, V. Rokhlin, "Fast direct solvers for integral equations in complex three-dimensional domains". *Acta Numerica*, **18**, pp. 243–275, 2009.
- P.G. Martinsson, "A fast direct solver for a class of elliptic partial differential equations". *Journal of Scientific Computation*, pp. 316–330, **38**(3), 2009.
- E. Liberty, F. Woolfe, P.G. Martinsson, V. Rokhlin, and M. Tygert, "Randomized algorithms for the low-rank approximation of matrices". *Proc. of the National Academy of Sciences*, **104**(51), 2007.
- P.G. Martinsson and V. Rokhlin, "A fast direct solver for scattering problems involving elongated structures". *Journal of Computational Physics*, **221**, pp. 288–302, 2007.
- P.G. Martinsson and I. Babuška, "Mechanics of Materials with Periodic Truss or Frame Microstructures". *Archives of Rational Mechanics and Analysis*, **185**(2), pp. 201–234, 2007.
- P.G. Martinsson and I. Babuška, "Homogenization of materials with periodic skeletal micro-structures". *Mathematical Models and Methods in Applied Sciences*, **17**(5), pp. 805–832, 2007.

- P.G. Martinsson and V. Rokhlin, “An Accelerated Kernel-Independent Fast Multipole Method in One Dimension”, *SIAM J. of Scientific Computing*, **29**(3), 2007.
- P.G. Martinsson, “Rapid evaluation of electro-static interactions in two-phase dielectric media”. *Journal of Computational Physics*, **211**(1), pp. 289–299, 2006.
- P.G. Martinsson, V. Rokhlin, and M. Tygert, “On Interpolation and Integration in Finite-Dimensional Spaces of Bounded Functions”. *Comm. in Applied Mathematics and Comp. Science*, 1, Jan. 2006.
- P.G. Martinsson and V. Rokhlin, “A fast direct solver for boundary integral equations in two dimensions”. *Journal of Computational Physics*, **205**(1), pp. 1 – 23, 2005.
- P.G. Martinsson, M. Tygert and V. Rokhlin, “An $O(N \log^2 N)$ algorithm for the inversion of general Toeplitz matrices”. *Computers & Mathematics with Applications*, **50**, pp. 741 – 752, 2005.
- H. Cheng, Z. Gimbutas, P.G. Martinsson, V. Rokhlin, “On the compression of low rank matrices”. *SIAM Journal of Scientific Computing*, **26**(4), pp. 1389-1404, 2005.
- P.G. Martinsson and A.B. Movchan, “Vibrations of Lattice Structures and Phononic Bandgaps”. *The Quarterly Journal of Mechanics and Applied Mathematics*, **56**, pp. 45-64, 2003.
- P.G. Martinsson and G.J. Rodin, “Asymptotic Expansions of Lattice Green’s Functions”. *Proceedings of the Royal Society A*, **458**, pp. 2609–2622, 2002.
- E. Cornea, R. Howard and P.G. Martinsson, “Solutions near Singular Points to the Eikonal and Related First-Order Nonlinear Partial Differential Equations in Two Dimensions”. *Differential and Integral Equations*, **14**, pp. 1441-1468, 2001.

Refereed conference proceedings:

- A. Gillman, P. Young, P.G. Martinsson “Numerical homogenization via approximation of the solution operator”. In B. Engquist, O. Runborg, R. Tsai, editors, *Numerical Analysis of Multiscale Computations*, volume 82 of Lecture Notes in Computational Science and Engineering, Heidelberg, 2011. Springer Verlag.
- A. Szlam, P.G. Martinsson, and M. Tygert. “Normalized power iterations for the computation of SVD.” NIPS workshop on low-rank methods for large-scale machine learning, Vancouver, 2010.
- P.G. Martinsson and G.J. Rodin, “Boundary Algebraic Equations for Lattice Problems”. *IUTAM proceedings, Liverpool, 2002*

Journal articles in review:

- P.G. Martinsson, “A high-order accurate discretization scheme for variable coefficient elliptic PDEs in the plane with smooth solutions.”
- A. Gillman and P.G. Martinsson, “A fast solver for Poisson problems on infinite regular lattices.” (arXiv.org report #1105.3505).
- S. Hao, P.G. Martinsson, and P. Young, “High-order accurate Nystrom discretization of integral equations with weakly singular kernels on smooth curves in the plane” (arXiv.org report #1112.6262).
- A. Gillman and P.G. Martinsson, “An $O(N)$ algorithm for constructing the solution operator to elliptic boundary value problems in the absence of body loads”

Theses:

- P.G. Martinsson, "Fast Multiscale Methods for Lattice Equations". Doctoral Thesis, TICAM, University of Texas at Austin, 2002.
- P.G. Martinsson, "Discretisation of Certain Evolution Equations with Memory using Convolution Quadrature". Licentiate Thesis, Dept. of Mathematics, Chalmers University of Technology, 1998.
- P.G. Martinsson, "Separation of Variables Techniques in Particle Simulations and Integral Equations". Honours Thesis, Dept. of Mathematics, University of New South Wales, 1995.

Presentations

Selected conference presentations and tutorials:

- 2012 • *Randomized methods in numerical linear algebra*
Invited lecture at "Challenges in Geometry, Analysis and Computation: High Dimensional Synthesis" Yale University, June 2012.
 - Keynote speaker at an *Ercoftac* workshop on fast direct solvers for elliptic PDEs. Montestigliano, Italy, March 2012.
- 2010 • *Randomized methods for computing the SVD or PCA of very large matrices*
Workshop on Algorithms for Modern Massive Data Sets. Palo Alto, CA.
- 2009 • *Making very large-scale linear algebraic computations possible via randomization*
Tutorial lecture at NIPS 2009. Vancouver, Canada.
 - *Fast matrix computations via randomized sampling*
Special session on "Mathematics of Knowledge and Information", AMS Annual meeting 2009.
- 2006 • Three lectures on fast numerical methods in biochemical modeling.
European Center for Living Technology, Venice, Italy, Oct. 2006.

Recent department colloquia and seminars:

- 2012 • Computational mathematics seminar, Chalmers University, Jan. 2012.
- 2011 • Numerical analysis seminar, University of Texas at Austin, May 2011.
- 2010 • Computational and applied mathematics seminar, Purdue University, Nov. 2010.
 - Applied mathematics seminar, Brown University, Jan. 2010.
 - Computational mathematics seminar, CU-Denver, Feb. 2010.
- 2009 • Stanford applied mathematics seminar, June 2009.
 - Applied mathematics colloquium, Univ. of Colo. at Boulder, Oct. 2009.
 - Scientific computing seminar, Uppsala University (Sweden), May 2009.
 - Numerical analysis seminar, Royal Institute of Technology (Sweden), May 2009.
 - Applied mathematics seminar, Chalmers Institute of Technology (Sweden), May 2009.
 - Applied math seminar, Georgia Tech, April 2009.
- 2008 • Computational Science & Engineering Seminar, Georgia Tech, Dec. 2008.
 - Computer science seminar, University of Toronto, April 2008.
 - Mechanical engineering seminar, University of Pennsylvania, Jan. 2008.
 - Mathematics colloquium, University of Toronto, Jan. 2008.
- 2007 • Applied mathematics seminar, Caltech, Dec. 2007.
 - Matrix computations seminar, Berkeley, Nov. 2007.
 - Applied mathematics seminar, Stanford University, Nov. 2007.
 - Applied mathematics seminar, Duke University, Nov. 2007.
 - Numerical analysis seminar, University of Texas at Austin, March 2007.

Teaching

Courses developed:

- *Applied Analysis I and II (APPM5440 and APPM5450)*
University of Colorado at Boulder. Redeveloped curriculum in 2005. Taught multiple times.
- *Fast Methods in Scientific Computation (APPM 4720/5720)*
University of Colorado at Boulder. Newly developed 2011.

Courses taught:

- *Differential Equations with Linear Algebra (APPM2360)*
University of Colorado at Boulder. Large-section undergraduate class (140 students per section).
- *Linear Algebra with Applications (MATH222a)*
Yale University. Mid-level undergraduate class.
- *Multivariate Calculus (MATH120b)*
Yale University. Entry-level calculus class.

Service

Workshops and mini-symposia organized:

- Workshop on *Integral Equation Methods, Fast Algorithms and Applications*
Banff International Research Station, Dec. 2013. Member of the organizing committee.
- Conference *Challenges in Geometry, Analysis and Computation: High Dimensional Synthesis*
June 2012, Yale University. Member of the organizing committee.
- Minisymposium on *Fast Structured Matrix Algorithms and Their Applications*
SIAM CSE conference, Feb. 2011. Organizer.
- Workshop on *Integral Equation Methods, Fast Algorithms and Applications*
IMA (at Univ. of Minnesota), Aug. 2010. Member of organizing committee.

Ph.D. examinations:

- External reader. Andrei Osipov. Yale University, May 2011.
- External reader. Andreas Glaser, Yale University, May 2007.
- External reader. Michael O'Neil, Yale University, May 2007.
- Faculty opponent. Jonas Englund, Lund University, June 2006.

Dissertation committees:

- Rikard Ojala, Mathematics, Lund University, 2011.
- Matthew Reynolds, Applied Mathematics, University of Colorado at Boulder, 2009.
- Christopher Kurcz, Applied Mathematics, University of Colorado at Boulder, 2007.
- Jisun Lim, Applied Mathematics, University of Colorado at Boulder, 2007.

Committees at CU-Boulder:

- Program development committee for new center on Scientific Computation 2010/2011.
- Postdoctoral program committee 2010/2011.
- Assistant professor search committee 2008/2009.
- Colloquium chair 2008/2009.
- Graduate committee 2006/2007 and 2007/2008.
- Instructor search committee 2005/2006.