

Contact information

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Research interests

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

- Randomized methods in numerical linear algebra.
- Numerical methods for scattering problems, computational fluid dynamics, acoustics, etc.
- Fast solvers for elliptic PDEs. $O(N)$ direct solvers. Structured matrix computations.
- Applied harmonic analysis; fast multipole methods; boundary integral equation methods.
- Modeling of heterogeneous materials; bandgap phenomena; lattice equations.

Professional appointments

2015 – now *Professor of Applied Mathematics*, University of Colorado, Boulder.
2010 – 2015 *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.

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.

Other activities

2012 – now *Associate Editor*, SIAM Journal on Scientific Computation.
2012 – now *Associate Editor*, Advances in Computational Mathematics.
2012 – now *Director of Graduate Studies*, Dept. of Applied Math., Univ. of Colorado-Boulder.

Awards, etc

- Principal lecturer, CBMS/NSF conference on Fast Direct Solvers at Dartmouth College, June 2014.
- NSF Career Award, 2008 – 2014.
- Wenner-Gren Foundation Fellowship, Spring 2012.
- College Scholar Award. College of Arts and Sciences, Univ. of Colorado, Boulder, Fall 2011.
- 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 grants

2014 – 2017 NSF DMS-1407340. Co-PI. "Big Data" in undergraduate education. \$590,300.
2013 – 2015 DARPA N66001-13-1-4050. Sole PI. \$188 916.
2013 – 2016 NSF DMS-1320652. With Denis Zorin (NYU). U. Colorado component \$219 187.
2012 – 2013 ONR K00177 IRES 12-004454. Multi-PI conference proposal. \$44 700.
2012 – 2013 NSF DMS-1207829. Multi-PI conference proposal. \$50 000.
2009 – 2013 NSF DMS-0941476 (CDI-Type I). With François Meyer (EE, CU-Boulder). \$535 784.
2008 – 2013 NSF DMS-0748488 (CAREER award). Sole PI. \$400 000.
2006 – 2009 NSF DMS-0610097. Sole PI. \$151 600.

Postdoctoral scholars

Sergey Voronin 2014 – 2016.

Doctoral students

Tracy Babb	Expected to graduate in 2016.
Anna Broido	Expected to graduate in 2017. (Co-advised with Mark Hoefer.)
Nathan Heavner	Expected to graduate in 2018.
Sijia Hao	Completed in May 2015.
Dan Kaslovsky	Completed in May 2012. (Co-advised with François Meyer.)
Nathan Halko	Completed in Feb. 2012.
Adrianna Gillman	Completed in Aug. 2011. (Currently tenure-track assistant prof. at Rice University.)
Patrick Young	Completed in Dec. 2010. (Co-advised with Kamran Mohseni.)

Publications

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

Refereed journal articles:

- P.G. Martinsson and S. Voronin, “A randomized blocked algorithm for efficiently computing rank-revealing factorizations of matrices.” To appear in *SIAM Journal on Scientific Computation*.
- T. Haut, T. Babb, P.G. Martinsson, B. Wingate, “A high-order scheme for solving wave propagation problems via the direct construction of an approximate time-evolution operator.” To appear in *IMA Journal of Numerical Analysis*. (arXiv.org report #1402.5168)
- J. Bremer, A. Gillman, P.G. Martinsson, “A high-order accurate accelerated direct solver for acoustic scattering from surfaces.” *BIT Numerical Math.* **55**(2), pp. 367 – 397, 2015.
- S. Hao, P.G. Martinsson, P. Young, “An efficient and highly accurate solver for multi-body acoustic scattering problems involving rotationally symmetric scatterers.” *CAMWA (Computers and Mathematics with Applications)*. **69**(4), pp. 304-318, 2015.
- E. Corona, P.G. Martinsson, D. Zorin “An $O(N)$ Direct Solver for Integral Equations in the Plane”. *Advances in Computational and Harmonic Analysis*, **38**(2), pp. 284-317, 2015.
- A. Gillman, A. Barnett, P.G. Martinsson “A spectrally accurate direct solution technique for frequency-domain scattering problems with variable media”. *BIT Numerical Mathematics*, **55**(1), pp. 141-170, 2015. (arXiv.org report #1308.5998).
- A. Gillman and P.G. Martinsson “A direct solver with $O(N)$ complexity for variable coefficient elliptic PDEs discretized via a high-order composite spectral collocation method.” *SIAM J. on Scientific Computation*, **36**(4), pp. A2023-A2046, 2014.
- 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.” *Advances in Computational Mathematics*, **40**(4), pp. 773–796, 2014.
- A. Gillman and P.G. Martinsson, “A fast solver for Poisson problems on infinite regular lattices.” *Journal of Computational and Applied Mathematics*, **258**(1), pp. 42–56, 2014.
- A. Gillman, S. Hao, and P.G. Martinsson, “A simplified technique for the efficient and highly accurate discretization of boundary integral equations in 2D on domains with corners.” *Journal of Computational Physics*, **256**(1), pp. 214–219, 2014.
- S. Hao, A. Barnett, P.G. Martinsson, and P. Young, “High-order accurate Nyström discretization of integral equations with weakly singular kernels on smooth curves in the plane” *Advances in Computational Mathematics*, **40**(1), pp. 245–272, 2014.
- P.G. Martinsson, “A direct solver for variable coefficient elliptic PDEs discretized via a composite spectral collocation method.” *Journal of Computational Physics*, **242**(1), pp. 460–479, 2013.

- P. Young, S. Hao, and P.G. Martinsson, “A high-order Nyström discretization scheme for boundary integral equations defined on rotationally symmetric surfaces” *Journal of Computational Physics*, **231**(11), pp. 4142–4159, 2012.
- A. Gillman, P. Young, and P.G. Martinsson, “A direct solver with $O(N)$ complexity for integral equations on one-dimensional domains”. *Frontiers of Math. in China*, **7**(2), pp. 217–247, 2012.
- 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.
- 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, encyclopedia articles, etc:

- P.G. Martinsson, "Fast Multipole Methods," To appear in *Encyclopedia of Applied and Computational Mathematics* by Springer, edited by Björn Engquist.
- F. Cajko, E. Michielssen, L. Gomez, P.G. Martinsson, L. Hernandez-Garcia. "A Fast Direct Solver for TMS Analysis and Design in 3D." 2011 IEEE International Symp. on Antennas and Propagation.
- 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, pp. 187–216. 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, Gregorio Quintana-Ortí, Nathan Heaver, and R. van de Geijn, "Householder QR Factorization With Randomization for Column Pivoting." Based on Arxiv.org report #1505.08115.
- P.G. Martinsson, "Compressing rank-structured matrices via randomized sampling." Arxiv.org report #1503.07152.
- S. Hao and P.G. Martinsson, "A direct solver for elliptic PDEs in three dimensions based on hierarchical merging of Poincaré-Steklov operators."
- P.G. Martinsson and S. Voronin, "A CUR Factorization Algorithm based on the Interpolative Decomposition ." Arxiv.org report #1412.8447.

Presentations

Selected conference presentations and tutorials:

- 2016 • Summer school lecturer ("Applied Mathematics of Data"), Park City Mathematics Institute. Park City, UT, June 27 – July 3, 2016.
- 2015 • Invited plenary talk at MMMA-2015 conference in Moscow, Russia, Aug. 2015.
- Invited plenary talk at "Sparse Days III" conference in St. Giron, France, July 2015.
- 2014 • Invited talk at ICAM 2014, City University of Hong Kong, Dec. 2014.
- Principal lecturer for CBMS/NSF conference on *Fast Direct Solvers for Elliptic PDEs*. Dartmouth College, June 23 – 27, 2014
 - Speaker at ICERM workshop on spectral methods for graphs, Brown U., May 2014.

- 2012 • *Randomized methods in numerical linear algebra*
Plenary lecture at “Challenges in Geometry, Analysis and Computation: High Dimensional Synthesis”
Yale University, June 2012.
- *Fast Methods in Scientific Computing*
Keynote speaker at E-CAero Spring School. Montestigliano, Italy, March 2012.
- 2011 • *Randomized Methods for Very Large-Scale Linear Algebra*
Random Matrix Theory workshop at FoCM'11, Budapest, Hungary, July 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.

Selected department colloquia and seminars:

- 2015 • CAAM Colloquium, Rice University, November 2015.
- Mathematics Colloquium, New York University, May 2015.
- Scientific and Statistical Computing Seminar, Univ. of Chicago, Feb. 2015.
- 2014 • Mathematics colloquium, Rensselaer Polytechnic Institute, March 2014.
- PACM colloquium, Princeton, Feb. 2014.
- AMCS colloquium, University of Pennsylvania, Feb. 2014.
- Mathematics colloquium, Colorado School of Mines, Feb. 2014.
- 2013 • Matrix computations seminar, Berkeley, Nov. 2013.
- 2012 • ICES seminar, Univ. of Texas at Austin, Dec. 2012
- ACM seminar, Univ. of Michigan, Nov. 2012
- ACM colloquium, Caltech, Nov. 2012.
- Computational mathematics seminar, UC-Davis, Oct. 2012.
- Numerical analysis seminar, Royal Institute of Technology (Sweden), May 2012.
- Computational mathematics seminar, Chalmers University (Sweden), 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 colloquium, University of Colorado at Boulder, Sep. 2010.
- Computational mathematics seminar, CU-Denver, Feb. 2010.
- Applied mathematics seminar, Brown University, Jan. 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.

Teaching

Courses developed:

- *Fast Algorithms for Big Data (APPM5720)*
University of Colorado at Boulder. Newly developed curriculum to be taught in Spring 2016.
- *Applied Analysis I and II (APPM5440 and APPM5450)*
University of Colorado at Boulder. Redeveloped curriculum in 2005. Taught multiple times.
- *Summer school on "Fast Direct Solvers"*
10-lecture intensive course developed for CBMS conference at Dartmouth College, 2015.
Course is now available online — slides, videos of lectures, tutorial codes, etc.
- *Fast Methods in Scientific Computation (APPM 4720/5720)*
University of Colorado at Boulder. Newly developed 2011.
- *Spring school on "Fast Methods in Scientific Computing"*
Montestigliano, Italy, March 2012. For advanced graduate students.

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

Conferences and workshops organized:

- Oberwolfach mini-workshop *Fast Solvers for Highly Oscillatory Problems*, Oct. 30 – Nov. 5, 2016.
Member of the organizing committee.
- Conference *International Association for Boundary Element Methods (IABEM)*, August 2016, Golden, CO. Member of the organizing committee.
- Workshop on *Eigenvectors in graph theory and related problems in numerical linear algebra*
ICERM, Brown University, May 5–9, 2014. Chair of the organizing committee.
- 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, and co-PI of NSF grant #1207829.
- 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. Daniel Beylkin. Yale University, May 2015.
- 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:

- Dimitri Krattiger, Aerospace Engineering, University of Colorado at Boulder, in progress.
- David Appelhans, Applied Mathematics, University of Colorado at Boulder, 2014.
- Jon Häggblad, Numerical Analysis, KTH (Royal Inst. of Technology), Stockholm, 2012
- Matthew Reynolds, Applied Mathematics, University of Colorado at Boulder, 2012.
- David Biaggioni, Applied Mathematics, University of Colorado at Boulder, 2012.
- Rikard Ojala, Mathematics, Lund University, 2011.

- Christopher Kurcz, Applied Mathematics, University of Colorado at Boulder, 2007.
- Jisun Lim, Applied Mathematics, University of Colorado at Boulder, 2007.

Service and committees at the University of Colorado:

- Director of graduate studies in Applied Mathematics, 2012–.
- Assistant professor search committee 2015/2016.
- Dean's committee on graduate education in College of Arts & Sciences, 2014 – 2015.
- Department executive committee, 2012–.
- Assistant professor search committee 2013/2014.
- Mathematics / applied mathematics coordination committee, 2012/13.
- 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.