

Contact information

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Research interests

Numerical analysis, scientific computing, and applied mathematics. Recent work includes:

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

Professional appointments

2017 – *Professor of Mathematics*, University of Oxford.

2017 – *Official Student (i.e. tutorial fellow)*, Christ Church, Oxford.

2017 – *Visiting Professor of Applied Mathematics*, University of Colorado, Boulder.

2017 – *Affiliated Professor of Mathematics*, Royal Inst. of Technology (KTH), Stockholm.

2015 – 2017 *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

2017 – *Chair of Scientific Steering Committee*, DataLab, Royal Inst. of Techn. (KTH), Stockholm.

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

2012 – *Associate Editor*, Advances in Computational Mathematics.

2012 – 2017 *Director of Graduate Studies*, Dept. of Applied Math., Univ. of Colorado-Boulder.

Awards, etc

- SIAM Germund Dahlquist Prize, 2017.
- 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

2016 – 2019 NSF DMS-1620472. Sole PI. \$250 000.
2014 – 2018 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

Nathan Heavner Expected to graduate in Fall 2018.
Tracy Babb Expected to graduate in Spring 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://people.maths.ox.ac.uk/martinsson/main_publications.html

Refereed journal articles:

- P.G. Martinsson, G. Quintana-Ortí, N. Heavner, and R. van de Geijn, “Householder QR Factorization With Randomization for Column Pivoting (HQRRP).” *SIAM J. on Scientific Comp.*, **39**(2) (2017), pp. C96-C115. Arxiv.org report #1505.08115.
- P.G. Martinsson, “Compressing rank-structured matrices via randomized sampling.” *SIAM J. on Scientific Comp.*, **38**(4), pp. A1959–A1986, 2016. Arxiv.org report #1503.07152.
- M.A. Echeverri Bautista, M.A. Francavilla, P.G. Martinsson, F. Vipiana, “ $O(N)$ Nested Skeletonization Scheme for the Analysis of Multiscale Structures Using the Method of Moments,” *IEEE Journal on Multiscale and Multiphysics Computational Techniques*, **1**, pp. 139–150, 2016.
- P.G. Martinsson and S. Voronin, “A randomized blocked algorithm for efficiently computing rank-revealing factorizations of matrices.” *SIAM J. on Scientific Comp.*, **38**(5), S485 – S507, 2016.
- P.G. Martinsson and S. Voronin, “A CUR Factorization Algorithm based on the Interpolative Decomposition .” To appear in *Advances in Comp. Mathematics*. DOI: 10.1007/s10444-016-9494-8
- S. Hao and P.G. Martinsson, “A direct solver for elliptic PDEs in three dimensions based on hierarchical merging of Poincaré-Steklov operators.” *Journal of Computational and Applied Mathematics*, **308**, pp. 419 – 434, 2016.
- 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.” *IMA Journal of Numerical Analysis*. **36**(2), pp. 688 – 716, 2016.
- 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:

- M. A. Echeverri Bautista, M. A. Francavilla, P. G. Martinsson, F. Vipiana, “A Nested Compressive Solver for MoM Matrices,” Proc. IEEE International Symposium on Antennas and Propagation, Puerto Rico, 2016.
- P.G. Martinsson, “Fast Multipole Methods,” 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, G. Quintana-Ortí, N. Heavner, “randUTV: A blocked randomized algorithm for computing a rank-revealing UTV factorization.” arxiv.org #1703.00998, 2017.
- T. Babb, A. Gillman, S. Hao, P.G. Martinsson, “An accelerated Poisson solver based on a multidomain spectral discretization.” arxiv.org #1612.02736, 2016.
- S. Voronin, P.G. Martinsson, “RSVDPACK: An implementation of randomized algorithms for computing the singular value, interpolative, and CUR decompositions of matrices on multi-core and GPU architectures.” arxiv.org #1502.05366.

Presentations

Selected conference presentations and tutorials:

- 2018 • Invited plenary talk, SIAM UKIE Annual Meeting, Southampton, Jan. 2018.
- 2017 • SIAM Germund Dahlquist Prize lecture, SciCADE, Bath, UK, September 2017.
- 2016 • Invited plenary talk, Workshop on Fast Direct Solvers. Purdue Center for Computational & Applied Mathematics, November, 2016.
 - Summer school lecturer (“Applied Mathematics of Data”), Park City Mathematics Institute. Park City, UT, June 27 – July 3, 2016.
 - Invited plenary talk, SHAXC, Kaust, Saudi Arabia, May 2016.
- 2015 • Invited plenary talk at MMMA-2015 conference in Moscow, Russia, Aug. 2015.
 - Invited plenary talk at “Sparse Days III” conference in St. Girons, 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:

- 2017 • Computational Mathematics and Applications Seminar, Oxford, May 2017.
- 2016 • Applied mathematics seminar, University of Texas at Austin, Sep. 2016.
 - ICES seminar, University of Texas at Austin, March 2016.

- 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 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.
- 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 referee; Theo Mary; Université de Toulouse; Nov. 2017.
- 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:

- Chenhan Yu, Computer Science, University of Texas at Austin, in progress.
- Hilary Fairbanks, Applied Mathematics, University of Colorado at Boulder, in progress.
- Dimitri Krattiger, Aerospace Engineering, University of Colorado at Boulder, in progress.
- Benjamin Sturdevant, Applied Mathematics, University of Colorado at Boulder, 2016.
- Bradley Martin, Applied Mathematics, University of Colorado at Boulder, 2016.
- 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:

- Chair of tenured associate professor search committee 2016/2017.
- Director of graduate studies in Applied Mathematics, 2012–2017.
- Assistant professor search committee 2015/2016.
- Dean's committee on graduate education in College of Arts & Sciences, 2014 – 2015.
- Department executive committee, 2012–2017.
- 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.