

Simon Foucart

Curriculum Vitae

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Current and Past Positions

- 2010- Assistant Professor of Mathematics, Drexel University, Philadelphia
- 2009-10 Postdoctoral Researcher, Université Pierre et Marie Curie, Paris, France
(Laboratoire Jacques-Louis Lions; Mentor: Albert Cohen)
- 2009 Visiting Researcher (Jul-Aug), University of Bonn, Germany
(Hausdorff Center for Mathematics; Host: Holger Rauhut)
- 2006-09 Assistant Professor of Mathematics (NTT), Vanderbilt University, Nashville
(Center for Constructive Approximation; Mentor: Larry Schumaker)

Academic Training

- 2001-05 PhD in Mathematics University of Cambridge, U.K., Numerical Analysis Group
Advisor: Alexei Shadrin
- 2000-01 Part III of Math Tripos University of Cambridge, U.K.
With distinction
- 1998-01 Masters of Engineering Ecole Centrale Paris, France
- 1998-99 Licence de Mathématiques Université Pierre et Marie Curie, Paris, France

Research Interests

Compressive Sensing; Approximation Theory (especially Spline Functions and Minimal Projections); Computational Mathematics; Bioinformatics; Abstract and Classical Analysis

External Funding

‘Improving Analysis of Microbial Mixtures through Sparse Reconstruction and Statistical Inference’
PI; coPIs: Gail Rosen (Drexel Engineering) and Loni Philip Tabb (Drexel Biostatistics)
NSF grant DMS-1120622, Sep 2011-Aug 2014, \$666,322

Honors and Awards

- 2012 Recipient of the *Antelo Devereux Award for Young Faculty*, Drexel University
- 2010 *Journal of Complexity* Best Paper Award
- 2000-04 Various scholarships received at the University of Cambridge
(Dept of Applied Math and Theoretical Physics; Trinity Hall; Cambridge European Trust)
- 2001 Scholar of Trinity Hall, added to the College Register

Publications

Books

1. *A Mathematical Introduction to Compressive Sensing*.
In press, Birkhäuser, Applied and Numerical Harmonic Analysis. With H. Rauhut.

Refereed Journal Papers

15. *Quikr: a method for rapid reconstruction of bacterial communities via compressive sensing.*
Accepted, Bioinformatics. With D. Koslicki and G. Rosen.
14. *Generating dimension formulas for multivariate splines.*
Albanian Journal of Mathematics, 7/1, 24–35, 2013. With T. Sorokina.
13. *Stability and robustness of ℓ_1 -minimizations with Weibull matrices and redundant dictionaries.*
In Press, Linear Algebra and its Applications.
12. *Hard thresholding pursuit: an algorithm for Compressive Sensing.*
SIAM Journal on Numerical Analysis, 49/6, 2543–2563, 2011.
11. *The Gelfand widths of ℓ_p -balls for $0 < p \leq 1$.*
Journal of Complexity, 26/6, 629–640, 2010. With A. Pajor, H. Rauhut, T. Ullrich.
10. *Real versus complex null space properties for sparse vector recovery.*
Comptes Rendus de l'Académie des Sciences, 348, 863–865, 2010. With R. Gribonval.
9. *A note on guaranteed sparse recovery via ℓ_1 -minimization.*
Applied and Computational Harmonic Analysis, 29/1, 97–103, 2010.
8. *Sparse recovery with pre-Gaussian random matrices.*
Studia Mathematica, 200, 91–102, 2010. With M.-J. Lai.
7. *Allometry constants of finite-dimensional spaces: theory and computations.*
Numerische Mathematik, 112/4, 535–564, 2009.
6. *Sparsest solutions of underdetermined linear systems via ℓ_q -minimization for $0 < q \leq 1$.*
Applied and Computational Harmonic Analysis, 26/3, 395–407, 2009. With M.-J. Lai.
5. *Open questions around the spline orthoprojector.*
East Journal on Approximations, 14/2, 241–253, 2008.
4. *On the exact constant in Jackson–Stechkin inequality for the uniform metric.*
Constructive Approximation, 29/2, 157–179, 2009. With Yu. Kryakin, A. Shadrin.
3. *On the value of the max-norm of the orthogonal projector onto splines with multiple knots.*
Journal of Approximation Theory, 140/2, 154–177, 2006.
2. *Interlacing property for B-splines.*
Journal of Approximation Theory, 135/1, 1–21, 2005.
1. *On the best conditioned bases of quadratic polynomials.*
Journal of Approximation Theory, 130/1, 46–56, 2004.

Working Papers

3. *Symbolic spline computations.*
Submitted. With P. Clarke.
2. *Hard thresholding pursuit and variations: number of iterations.*
Submitted. With J.-L. Bouchot.
1. *On the Hermite spline conjecture and its connection to k -monotone densities.*
With F. Balabdaoui and J. Wellner.

Refereed Proceeding Papers

5. *Stability and robustness of weak orthogonal matching pursuits.*
In: Recent Advances in Harmonic Analysis and Applications, Springer Proceedings in Mathematics & Statistics, vol 25, 395–405.
4. *Recovering jointly sparse vectors via hard thresholding pursuit.*
Proceedings of SampTA 2011, Singapore.

3. *Recovery of functions of many variables via compressive sensing*. Proceedings of SampTA 2011, Singapore. With A. Cohen, R. DeVore, H. Rauhut.
2. *Sparse recovery algorithms: sufficient conditions in terms of restricted isometry constants*. In: Approximation Theory XIII: San Antonio 2010, Springer Proceedings in Mathematics, vol 13, 65–77.
1. *Some comments on the comparison between condition numbers and projection constants*. In: Approximation Theory XII: San Antonio 2007, Nashboro Press, 143–156.

Theses

- PhD Dissertation *Small-normed projections onto polynomial and spline spaces*.
 Part III Essay *On definitions of discrete topological chaos and their relations on intervals*.

Oral Presentations

Colloquia

- *Sparse recovery: an overview leading to ℓ_1 -minimizations from Weibull measurements* (job talk), University of Georgia, 10 Dec 2012.
- *Compressive Sensing and Banach Space Geometry*, Drexel University, 26 May 2011.
- *Compressive Sensing and the Hard Thresholding Pursuit algorithm*, Towson University, 22 Apr 2011.
- *Recovery Algorithms in Compressive Sensing*, University of South Florida, 10 Dec 2010.
- *Compressive Sensing: the Optimization Approach* (job talk), Drexel University, 23 Apr 2009.
- *From Approximation Theory to Compressive Sampling via Banach Space Geometry—a Computational Tour* (job talk), University of Georgia, 5 Feb 2008, University of South Florida, 15 Feb 2008.

Short Courses

- *A tutorial on Compressive Sensing*, CIMPA school on ‘New Trends in Applied Harmonic Analysis: Sparse Representations, Compressed Sensing, and Multifractal Analysis’, Mar del Plata, Argentina, 5-16 Aug 2013.
- *Les mathématiques du Compressive Sensing — une introduction*, Labotatoire Paul Painlevé, Université des Sciences et Technologies de Lille, France, 20-22 Mar 2013.

Invited Workshop and Conference Presentations

- *Computing dimension formulas for multivariate spline spaces*. Minisymposium ‘Multivariate Splines’, 14th International Conference on Approximation Theory, San Antonio, 7-10 Apr 2013.
- *Stability and robustness of weak orthogonal matching pursuits*. Special session ‘Models and Applications in Compressive Imaging’, SIAM conference on Imaging Science, Philadelphia, 20-22 May 2012.
- *Stability and robustness of ℓ_1 -minimizations with Weibull matrices and redundant dictionaries*. Workshop on ‘Probabilistic Techniques and Algorithms’, University of Texas, 6-8 Apr 2012.
- *Hard thresholding pursuit: an algorithm for Compressive Sensing and The dimension of trivariate spline spaces on Alfeld splits*. Special sessions ‘Compressed Sensing’ and ‘Multivariate Splines’, International Symposium in Approximation Theory, Nashville, 17-21 May 2011.
- *Recovering jointly sparse vectors via Hard Thresholding Pursuit*. Special session ‘Sparse Approximation’, 9th International Conference on Sampling Theory and Applications, Singapore, 2-6 May 2011.
- *Hard Thresholding Pursuit for Sparse Reconstruction*. Special session ‘Sparse Data Representations and Applications’, AMS Southeastern Meeting, Statesboro, 12-13 Mar 2011.
- *Compressive Sensing insight into the geometry of quasi-Banach spaces*. Workshop on ‘Sparse and Low Rank Approximation’, Banff, Canada, 6-11 Mar 2011.
- *Hard Thresholding Pursuit: an algorithm for Compressive Sensing*. Workshop on ‘Wavelet and Multiscale Methods’, Oberwolfach, Germany, 1-6 Aug 2010.

- *The Gelfand widths of ℓ_p -balls for $0 < p \leq 1$.* Minisymposium ‘Sparse approximation’, 7th International Conference on Curves and Surfaces, Avignon, France, 24-30 Jun 2010.
- *Best sufficient conditions for sparse recovery.* Minisymposium ‘Compressive Sensing’, 13th International Conference on Approximation Theory, San Antonio, 7-10 Mar 2010.
- *Reconstructions parcimonieuses: réelle contre complexe.* Journée ‘Approximation et Modélisation Géométrique’ du groupe SMAI–AFA, Paris, France, 13 Nov 2009.
- *Minimisation ℓ_1 et Compressive Sensing.* 9th Mathias Seminar, Cannes, France, 15-16 Oct 2009.
- *Sparse recovery via ℓ_q -minimization for $0 < q \leq 1$.* Special session ‘Sparse approximation and high-dimensional geometry’, 8th International Conference on Sampling Theory and Applications, Marseille, France, 18-22 May 2009.
- *Best conditioned bases in connection with minimal projections.* Minisymposium ‘Minimal projections’, 12th International Conference on Approximation Theory, San Antonio, 4-8 Mar 2007.

Contributed Conference Presentations

- *On the value of the max-norm of the orthogonal spline projection.* Constructive Theory of Functions, Varna, Bulgaria, 1-7 Jun 2005.
- *On the least condition number of a basis of quadratic polynomials.* Advances in Constructive Approximation, Nashville, 14-17 May 2003.

Seminars

- *Iterative algorithms in compressive sensing.* INRIA Rennes, France, 28 Mar 2013, University of Cambridge, U.K., 19 Mar 2013.
- *ℓ_1 -minimizations with Weibull matrices.* Wilks Seminar, Princeton Statistics Laboratory, 7 Dec 2012.
- *Schumaker’s conjecture: do Bernstein operators induce P -matrices?* Drexel University, 9 Mar 2012.
- *Orthogonal matching pursuits in Compressive Sensing.* University of Bonn, Germany, 24 Nov 2011.
- *On the dimension of multivariate spline spaces.* Drexel University, 11 Nov 2011.
- *Compressive Sensing and the Hard Thresholding Pursuit algorithm.* University of Utah, 26 Sep 2011.
- *Recovering sparse vectors via Hard Thresholding Pursuit.* Johns Hopkins University, 17 Mar 2011.
- *Geometry of ℓ_1^n via Compressive Sensing.* VIGRE Seminar, University of Georgia, 15 Feb 2011.
- *Compressive Sensing and the Hard Thresholding Pursuit algorithm.* University of Maryland, 1 Dec 2010.
- *Some open problems in Approximation Theory.* Drexel University, 29 Oct 2010.
- *Sparse recoveries via Basis Pursuit and Hard Thresholding Pursuit.* Drexel University, 8 Oct 2010.
- *Variations around the RIP.* University of Bonn, Germany, 3 Jun 2010.
- *Basis pursuit with pre-Gaussian random matrices.* Université de Franche–Comté, Besançon, France, 26 Apr 2010.
- *Gelfand widths, pre-Gaussian random matrices, joint sparsity.* Vanderbilt University, 15 Mar 2010.
- *Randomness in Compressive Sensing.* Séminaire Parisien de Statistique, Paris, France, 11 Jan 2010.
- *Un condensé de Compressive Sensing.* Journée 40 ans du Laboratoire Jacques-Louis Lions, Paris, France, 18 Dec 2009.
- *Three topics in Compressive Sensing.* University of Cambridge, U.K., 29 Oct 2009.
- *Compressive sensing via ℓ_q -minimization for $0 < q \leq 1$.* University of Edinburgh, U.K., 22 Oct 2009.
- *Reconstruction parcimonieuse par minimisation ℓ_q avec $0 < q \leq 1$.* INRIA Rennes, France, 23 Jun 2009.
- *Sparse recovery via ℓ_q -minimization for $0 < q \leq 1$.* Université Pierre et Marie Curie, Paris, France, 26 May 2009.

- *Compressed Sensing via nonconvex minimization*. Hausdorff Center, Bonn, Germany, 19 Dec 2008.
- *Condition numbers of finite-dimensional frames*. University of Georgia, 11 Oct 2007.
- *Condition numbers of finite-dimensional frames*. Vanderbilt University, 9 Oct 2007
- *The orthogonal projector onto splines—ongoing development*. Vanderbilt University, 19 Sep 2006.
- *Best conditioned bases and minimal projections*. University of Cambridge, U.K., 10 Jun 2004.
- *Some inheritance properties for Chebyshev-type spaces*. University of Cambridge, U.K., 20 Feb 2003.

Popular Talks

1. *Compressive Sensing: Making the most of few measurements*. Drexel University, Dean’s seminar, 20 Apr 2011.

Miscellaneous Conferences and Workshops

- SQuaRE project ‘Developing the theory of 1-bit compressive sensing’, AIM, Palo Alto, 18-22 Nov 2013. With R. Baraniuk, D. Needell, Y. Plan, M. Wooters.
- Annual Meeting of the Canadian Applied and Industrial Mathematics Society, Quebec City, 16-20 Jun 2013.
- Workshop on ‘Structure and Randomness in System Identification and Learning’, Institute for Pure and Applied Mathematics, University of California at Los Angeles, 15-18 Jan 2013
- DTRA/NSF/NGA Algorithm Workshop, San Diego, 26-29 Nov 2012.
- Workshop on ‘Applied Harmonic Analysis and Sparse Approximation’, Oberwolfach, Germany, 10-16 Jun 2012.
- Long Program on ‘Mathematical and Computational Approaches in High-Throughput Genomics’, Institute for Pure and Applied Mathematics, University of California at Los Angeles. Attending the workshop for the period 12 Sep-10 Oct 2011.
- Concentration week on ‘Greedy Algorithms in Banach Spaces and Compressed Sensing’, Texas A&M University, 18-22 Jul 2011.
- ‘Foundations of Computational Mathematics’ conference, Budapest, 4-14 Jul 2011.
- Trimester Program on ‘Analysis and Numerics for High Dimensional Problems’, Hausdorff Research Institute, Bonn, Germany. Attending the workshops for the period 19 Jun-2 Jul 2011.
- ‘February Fourier Talks’ conference, University of Maryland, 17-18 Feb 2011.
- Workshop on ‘High Dimensional Problems and Solutions’, Paris, France, 21-22 Jun 2010.
- Workshop on ‘Sparsity and Computation’, Bonn, Germany, 7-11 Jun 2010.
- Workshop on ‘Probability and Geometry in High Dimensions’, Marne-la-Vallée, France, 17-21 May 2010.
- Fall School on ‘Interactions between Compressed Sensing, Random Matrices, and High Dimensional Geometry’, Marne-la-Vallée, France, 16-20 Nov 2009.
- Summer School on ‘Theoretical Foundations and Numerical Methods for Sparse Recovery’, Linz, Austria, 31 Aug-4 Sep 2009.
- Workshop on ‘Nonlinear Approximation Techniques Using L_1 ’, Texas A&M University, 16-18 May 2008.
- 10th SIAM Conference on Geometric Design and Computing, San Antonio, 4-8 Nov 2007.
- 6th International Conference on Curves and Surfaces, Avignon, France, 29 Jun-5 Jul 2006.

Teaching

- **Drexel University** (2010-). *Graduate courses*: Linear Algebra and Matrix Analysis, Approximation Theory, Compressed Sensing, Mathematics of Genome Analysis. *Undergraduate courses*: Problem Solving for Math Competitions, Probability and Statistics II, Numerical Analysis II, Linear Algebra, Calculus I.
- **Vanderbilt University** (2006-09). *Graduate courses*: Compressed Sensing. *Undergraduate courses*: Introduction to Numerical Mathematics, Methods of Ordinary Differential Equations, Calculus I & III.
- **University of Cambridge**, U.K. (2003-05). Gave supervisions in Differential Equations, Probability, Numbers and Sets, Dynamics, Numerical Analysis.
- **Ecole Nationale de Commerce**, Paris, France (1999-00). Oral examiner in Mathematics, preparing students for the entrance examinations to the economic Grandes Ecoles.

Advisees

- Postdocs** Jean-Luc Bouchot (Nov 2012-)
David Koslicki (Jan-Sep 2012), now Assistant Professor at Oregon State University,
detached at the Mathematical Biosciences Institute of the Ohio State University
- PhD students** Michael Minner (Sep 2012-)

Professional Services

Reviewing

- Refereed for the journals *Foundations of Computational Mathematics* (2013), *IEEE Transactions on Information Theory* (2013; twice in 2011; 2009; 2008), *IEEE Signal Processing Letters* (2013; 2009), *Advances in Computational Mathematics* (2013), *Mathematics of Computation* (2012), *IEEE Transactions on Signal Processing* (2012), *Journal of Approximation Theory* (2012; 2007), *Linear Algebra and its Applications* (2012), *Constructive Approximation* (2012; twice in 2010), *SIAM Journal on Matrix Analysis and Applications* (2011), *International Journal of Mathematics and Mathematical Sciences* (2011), *Inverse Problems and Imaging* (2011), *Signal Processing* (2011), *EURASIP Journal on Advances in Signal Processing* (2011), *Applied and Computational Harmonic Analysis* (twice in 2010), and *IEEE Journal of Selected Topics in Signal Processing* (twice in 2009)
- Refereed for various conference proceedings (GRETSI 2013, SampTA 2013, SPARS 2013, CAM-SAP 2011, AT 2010)
- Refereed for the book series *Panoramas et Synthèses* (Société Mathématique de France, 2011)
- Refereed for the *Agence Nationale de la Recherche* (French equivalent of NSF, 2010)
- Reviewer for *Mathematical Reviews* (wrote about 30 reviews since 2005)

Organization

- 2013 Organizer of the minisymposium *Compressive Sensing*
14th International Conference on Approximation Theory, San Antonio, 7-10 Apr
- 2011- Organizer of the seminar *Compressive Sensing, Extensions, and Applications*
Drexel University
- 2010 Organizer of the minisymposium *Compressive Sensing*
13th International Conference on Approximation Theory, San Antonio, 7-10 Mar
- 2007-09 Coordinator of the *Computational Analysis Seminar*
Vanderbilt University
- 2008 Co-organizer of the Shanks Workshop *Nonlinear Models in Sampling Theory*
Vanderbilt University
- 2007 Co-organizer of the Shanks Workshop *An Advanced Tutorial in Compressed Sensing*
Vanderbilt University
- 2007 Co-organizer of the 10th SIAM Conference on Geometric Design and Computing
San Antonio, 4-8 Nov

Administrative Activities

- *Department committees*: graduate program (qualifying exam subcommittee 2010-13); tenure-track faculty hiring (2012-13); candidacy exams (three occurrences in Sept 2012); web page (2011-12); visiting faculty hiring (2010-11).
- *University committees*: Task force on the future of computing at Drexel (2013); NSF graduate research fellowship program review (2011-13); panelist at the meeting on higher education in the U.K. organized by Drexel Study Abroad (May 2012); U.K. scholarship review (Marshall and Gates–Cambridge scholarships, 2011-2012).

Membership of Associations

- Member, American Mathematical Society
- Member, Mathematical Association of America
- Member, Society for Industrial and Applied Mathematics
- Member, Société Mathématique de France
- Member, Société de Mathématiques Appliquées et Industrielles
- Member, European Mathematical Society

Additional Information

Computer Skills

MATLAB, Mathematica, Maple, R, Html, JavaScript.

Languages

French (native), German (basic), and Spanish (basic).

Miscellaneous Interests

- Team Handball: competition at pre-national and national levels in France and England.
- Gymnastics: trained at Forbach Academy (France, 1986-1990); former member of the Cambridge University Team (selected for the Varsity matches against Oxford, 2001 to 2005, winner in 2004).
- Trampolining: former member of the Cambridge University Team (selected for the Varsity matches against Oxford, 2001 and 2002).