Michael B. Wakin

Colorado School of Mines
Division of Engineering
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RESEARCH INTERESTS

Signal, image, and data processing using sparse, low-dimensional, and manifold-based signal models
Compressive sensing; low-rate signal sensing and acquisition; signal recovery from partial information
Multiscale geometric analysis for dimensionality reduction, compression, estimation, and computer vision
Multi-signal processing, compression, acquisition, and recovery; light field imaging; sensor networks
Approximation theory and computational harmonic analysis; wavelets, curvelets, and wedgelets

EDUCATION

2007	Ph.D., Electrical Engineering (Dr. Richard Baraniuk, advisor) Thesis: "The Geometry of Low-Dimensional Signal Models"	Rice University
2002	M.S., Electrical Engineering (Dr. Richard Baraniuk, advisor) Thesis: "Image Compression using Multiscale Geometric Edge Models"	Rice University
2000	B.S., Electrical Engineering (summa cum laude)	Rice University
2000	B.A., Mathematics (summa cum laude)	Rice University

POSITIONS

2008–present	Division of Engineering, Colorado School of Mines	Assistant Professor
2007–2008	Electrical Engineering and Computer Science, University of Michigan	Assistant Professor
2006–2007	Applied and Computational Mathematics, Caltech	NSF Postdoctoral Fellow
2000–2006	ECE Department, Rice University	Research Assistant
2004	Institute for Pure and Applied Mathematics, UCLA	Fellow
2003	National Center for Macromolecular Imaging, Baylor College of Medicine	Research Intern
2002	ECE Department, Rice University	Teaching Fellow
1998–2000	Motorola, Inc.	Summer Intern

HONORS and AWARDS

2008	Young Faculty Award	Defense Advanced Research Projects Agency (DARPA)
2007	Hershel M. Rich Invention Award	Rice University
2006	Mathematical Sciences Postdoctoral Research Fellowship	National Science Foundation
2004	Edmund M. Dupree Fellowship in Electrical Engineering	Rice University
2001	Graduate Research Fellowship	National Science Foundation
2000	Distinguished Graduate Fellowship	Texas Instruments/Nokia
2000	Senior Merit Award in Electrical Engineering	Rice Engineering Alumni
2000	Vice President's Appreciation Award	Rice University
2000	Brotzen Award for Achievement and Service	Brown College, Rice University
1998	Louis J. Walsh Scholarship in Engineering	Rice University

1997–1999	Samuel T. Sikes, Jr. Scholarship in Engineering	Rice University
1997–1999	Donald R. Baker Award for G.P.A.	Brown College, Rice University
1996–2000	President's Honor Roll	Rice University
1996	National Merit Scholarship	Arlington Lamar High School

RESEARCH SUPPORT

2009–2013 "New Theory and Algorithms for Scalable Data Fusion," AFOSR Directorate for Mathematics, Information and Life Sciences

2008–2011 "Collaborative Research: Leveraging Low-dimensional Structure for Time Series Analysis and Prediction," NSF Division of Computing and Communication Foundations (Collaborative with C. Rozell at Georgia Tech)

2008–2010 "Analog-to-Information Receiver Development," DARPA Microsystems Technology Office (Subcontracted by Northrop Grumman and Caltech)

2008–2009 "Geometric Methods for Compressive Multi-Signal Processing," DARPA Microsystems Technology Office (Young Faculty Award)

JOURNAL PUBLICATIONS

M.A. Davenport and M.B. Wakin, "Analysis of Orthogonal Matching Pursuit using the Restricted Isometry Property," submitted, 2009.

M.B. Wakin, "Manifold-Based Signal Recovery and Parameter Estimation from Compressive Measurements," submitted, 2008.

R.G. Baraniuk, V. Cevher, and M.B. Wakin, "Low-Dimensional Models for Dimensionality Reduction and Signal Recovery: A Geometric Perspective," to appear in *Proceedings of the IEEE, Special Issue on Sparse Representation and Compressive Sensing*, 2009.

M.A. Davenport, P.T. Boufounos, M.B. Wakin, and R. G. Baraniuk, "Signal Processing with Compressive Measurements," to appear in *IEEE Journal of Selected Topics in Signal Processing, Special Issue on Compressive Sensing*, 2009.

R.A. Frazin, M. Jacob, W.B. Manchester, H. Morgan, and M.B. Wakin, "Toward Reconstruction of Coronal Mass Ejection Density from Only Three Points of View," *Astrophysical Journal*, vol. 695, no. 1, pp. 636–641, April 2009.

R.G. Baraniuk and M.B. Wakin, "Random Projections of Smooth Manifolds," *Foundations of Computational Mathematics*, vol. 9, no. 1, pp. 51–77, February 2009.

V. Chandrasekaran, M.B. Wakin, D. Baron, and R.G. Baraniuk, "Representation and Compression of Multi-Dimensional Piecewise Functions Using *Surflets*," *IEEE Transactions on Information Theory*, vol. 55, no. 1, pp. 374-400, January 2009.

R. Baraniuk, M. Davenport, R. DeVore, and M. Wakin, "A Simple Proof of the Restricted Isometry Property for Random Matrices," *Constructive Approximation*, vol. 28, no. 3, pp. 253–263, December 2008.

E.J. Candès, M.B. Wakin, and S.P. Boyd, "Enhancing Sparsity by Reweighted L_1 Minimization," *Journal of Fourier Analysis and Applications*, vol. 14, no. 5, pp. 877–905, December 2008.

E.J. Candès and M.B. Wakin, "An Introduction to Compressive Sampling," *IEEE Signal Processing Magazine*, vol. 25, no. 2, pp. 21–30, March 2008.

M.B. Wakin, J.K. Romberg, H. Choi, and R.G. Baraniuk, "Wavelet-domain Approximation and Compression of Piecewise Smooth Images," *IEEE Transactions on Image Processing*, vol. 15, no. 5, pp. 1071–1087, May 2006.

D. Baron, M.B. Wakin, M.F. Duarte, S. Sarvotham, and R.G. Baraniuk, "Distributed Compressed Sensing," submitted to *IEEE Transactions on Information Theory*, 2005.

J.K. Romberg, M.B. Wakin, and R.G. Baraniuk, "Wedgelet Models and Algorithms for Image Processing," in preparation.

CONFERENCE PUBLICATIONS

M.B. Wakin, "A Manifold Lifting Algorithm for Multi-View Compressive Imaging," in *Picture Coding Symposium – PCS 2009*, Chicago, Illinois, May 2009.

J.Y. Park and M.B. Wakin, "A Multiscale Framework for Compressive Sensing of Video," in *Picture Coding Symposium – PCS 2009*, Chicago, Illinois, May 2009.

M.F. Duarte, S. Sarvotham, D. Baron, M.B. Wakin, and R.G. Baraniuk, "Performace Limits for Jointly Sparse Signals via Graphical Models," *Sensor, Signal and Information Processing Workshop – SenSIP,* Sedona, AZ, May 2008.

M.F. Duarte, M.B. Wakin, and R.G. Baraniuk, "Wavelet-domain Compressive Signal reconstruction using a Hidden Markov Tree Model," *IEEE 2008 International Conference on Acoustics, Speech, and Signal Processing – ICASSP 2008,* Las Vegas, Nevada, March 2008.

C. Hegde, M. Wakin, and R. Baraniuk, "Random Projections for Manifold Learning," in *Neural Information Processing Systems – NIPS,* Vancouver, Canada, December 2007.

M.F. Duarte, M.A. Davenport, M.B. Wakin, J.N. Laska, D. Takhar, K.F. Kelly and R.G. Baraniuk, "Multiscale Random Projections for Compressive Classification," *IEEE 2007 International Conference on Image Processing – ICIP-2007,* San Antonio, Texas, September 2007.

E. Candès, N. Braun, and M. Wakin, "Sparse Signal and Image Recovery from Compressive Samples," invited to special session on Model-Based Imaging, *IEEE International Symposium on Biomedical Imaging*, Washington, D.C., April 2007.

M. Davenport, M. Duarte, M.B. Wakin, J. Laska, D. Takhar, K. Kelly, and R. Baraniuk, "The Smashed Filter for Compressive Classification and Target Recognition," invited to *Computational Imaging V at IS&T/SPIE Electronic Imaging*, San Jose, California, January 2007.

M.B. Wakin, J.N. Laska, M.F. Duarte, D. Baron, S. Sarvotham, D. Takhar, K.F. Kelly, and R.G. Baraniuk, "An Architecture for Compressive Imaging," invited to *IEEE 2006 International Conference on Image Processing – ICIP-2006,* Atlanta, Georgia, October 2006.

S. Kirolos, J.N. Laska, M.B. Wakin, M.F. Duarte, D. Baron, T. Ragheb, Y. Massoud, and R.G. Baraniuk, "Analog-to-Information Conversion via Random Demodulation," in *IEEE Dallas Circuits and Systems Workshop (DCAS)*, Dallas, Texas, October 2006.

M.B. Wakin and R.G. Baraniuk, "Random Projections of Signal Manifolds," invited to special session on Statistical Inference on Nonlinear Manifolds, *IEEE 2006 International Conference on Acoustics, Speech, and Signal Processing – ICASSP 2006,* Toulouse, France, May 2006.

J.A. Tropp, M.B. Wakin, M.F. Duarte, D. Baron, and R.G. Baraniuk, "Random Filters for Compressive Sampling and Reconstruction," in *IEEE 2006 International Conference on Acoustics, Speech, and Signal Processing – ICASSP 2006,* Toulouse, France, May 2006.

M.F. Duarte, M.A. Davenport, M.B. Wakin, and R.G. Baraniuk, "Sparse Signal Detection from Incoherent Projections," in *IEEE 2006 International Conference on Acoustics, Speech, and Signal Processing – ICASSP 2006,* Toulouse, France, May 2006.

M.F. Duarte, M.B. Wakin, D. Baron, and R.G. Baraniuk, "Universal Distributed Sensing via Random Projections," in *International Conference on Information Processing in Sensor Networks – IPSN 2006*, Nashville, TN, April 2006.

M.B. Wakin, J.N. Laska, M.F. Duarte, D. Baron, S. Sarvotham, D. Takhar, K.F. Kelly, and R.G. Baraniuk, "Compressive Imaging for Video Representation and Coding", in *Picture Coding Symposium – PCS 2006*, Beijing, China, April 2006.

D. Takhar, J.N. Laska, M.B. Wakin, M.F. Duarte, D. Baron, S. Sarvotham, K.F. Kelly, and R.G. Baraniuk, "A New Compressive Imaging Camera Architecture using Optical-Domain Compression," invited to *Computational Imaging IV at IS&T/SPIE Electronic Imaging*, San Jose, California, January 2006.

M.B. Wakin, M.F. Duarte, S. Sarvotham, D. Baron, and R.G. Baraniuk, "Recovery of Jointly Sparse Signals from Few Random Projections," in *Neural Information Processing Systems – NIPS,* Vancouver, Canada, December 2005.

M.F. Duarte, S. Sarvotham, D. Baron, M.B. Wakin, and R.G. Baraniuk, "Distributed Compressed Sensing of Jointly Sparse Signals," invited to *39th Asilomar Conference on Signals, Systems, and Computers,* Pacific Grove, California, November 2005.

D. Baron, M.F. Duarte, S. Sarvotham, M.B. Wakin, and R.G. Baraniuk, "An Information-Theoretic Approach to Distributed Compressed Sensing," invited to *43rd Allerton Conference on Communication, Control, and Computing,* Monticello, Illinois, September 2005.

M.B. Wakin, D.L. Donoho, H. Choi, and R.G. Baraniuk, "The Multiscale Structure of Non-Differentiable Image Manifolds," invited to *Wavelets XI at SPIE Optics & Photonics,* San Diego, California, July 2005.

M.B. Wakin, D.L. Donoho, H. Choi, and R.G. Baraniuk, "High-Resolution Navigation on Non-Differentiable Image Manifolds," invited to special session on Higher-Dimensional Geometry in Signal Processing, *IEEE 2005 International Conference on Acoustics, Speech, and Signal Processing – ICASSP 2005,* Philadelphia, Pennsylvania, March 2005.

V. Chandrasekaran, M.B. Wakin, D. Baron, and R.G. Baraniuk, "Surflets: A Sparse Representation for Multidimensional Functions Containing Smooth Discontinuities," in *IEEE 2004 International Symposium on Information Theory – ISIT 2004*, Chicago, Illinois, June 2004.

F.C.A. Fernandes, M.B. Wakin, and R.G. Baraniuk, "Non-Redundant, Linear-Phase, Semi-Orthogonal, Directional Complex Wavelets," in *IEEE 2004 International Conference on Acoustics, Speech, and Signal Processing – ICASSP 2004,* Montreal, Quebec, Canada, May 2004.

V. Chandrasekaran, M.B. Wakin, D. Baron, and R.G. Baraniuk, "Compression of Higher Dimensional Functions Containing Smooth Discontinuities," in *38th Annual Conference on Information Sciences and Systems – CISS 2004,* Princeton, New Jersey, March 2004.

M.B. Wakin, M.T. Orchard, R.G. Baraniuk, and V. Chandrasekaran, "Phase and Magnitude Perceptual Sensitivities in Nonredundant Complex Wavelet Representations," invited to *37th Asilomar Conference on Signals, Systems, and Computers,* Pacific Grove, California, November 2003.

J.K. Romberg, M.B. Wakin, and R.G. Baraniuk, "Approximation and Compression of Piecewise Smooth Images Using a Wavelet/Wedgelet Geometric Model," invited to *IEEE 2003 International Conference on Image Processing – ICIP-2003,* Barcelona, Spain, September 2003.

M.B. Wakin, J.K. Romberg, H. Choi, and R.G. Baraniuk, "Geometric Methods for Wavelet-Based Image Compression," in *Wavelets X at SPIE International Symposium on Optical Science and Technology,* San Diego, California, August 2003.

J.K. Romberg, M.B. Wakin, H. Choi, and R.G. Baraniuk, "A Geometric Hidden Markov Tree Wavelet Model," invited to *Wavelets X at SPIE International Symposium on Optical Science and Technology,* San Diego, California, August 2003.

J.K. Romberg, M.B. Wakin, and R.G. Baraniuk, "Multiscale Geometric Image Processing," invited to *SPIE Visual Communications and Image Processing*, Lugano, Switzerland, July 2003.

M.B. Wakin, J.K. Romberg, H. Choi, and R.G. Baraniuk, "Geometric Tools for Image Compression," in *36th Asilomar Conference on Signals, Systems, and Computers,* Pacific Grove, California, November 2002.

R.M. Castro, M.B. Wakin, and M.T. Orchard, "On the Problem of Simultaneous Encoding of Magnitude and Location Information," in *36th Asilomar Conference on Signals, Systems, and Computers,* Pacific Grove, California, November 2002.

M.B. Wakin, J.K. Romberg, H. Choi, and R.G. Baraniuk, "Rate-Distortion Optimized Image Compression Using Wedgelets," in *IEEE 2002 International Conference on Image Processing – ICIP-2002,* Rochester, New York, September 2002.

J.K. Romberg, M.B. Wakin, and R.G. Baraniuk, "Multiscale Wedgelet Image Analysis: Fast Decompositions and Modeling," in *IEEE 2002 International Conference on Image Processing – ICIP-2002,* Rochester, New York, September 2002.

M.B. Wakin, J.K. Romberg, H. Choi, and R.G. Baraniuk, "Image Compression Using an Efficient Edge Cartoon + Texture Model," in *IEEE Data Compression Conference – DCC,* Snowbird, Utah, April 2002.

TECHNICAL REPORTS

M.F. Duarte, S. Sarvotham, M.B. Wakin, D. Baron, and R.G. Baraniuk, "Theoretical Performance Limits for Jointly Sparse Signals via Graphical Models," Technical Report TREE-0802, Electrical and Computer Engineering Department, Rice University, July 2008.

C. Hegde, M. Wakin, and R. Baraniuk, "Random Projections for Manifold Learning: Proofs and Analysis," Technical Report TREE0710, Electrical and Computer Engineering Department, Rice University, October 2007.

M. Davenport, M.B. Wakin, and R.G. Baraniuk, "Detection and Estimation with Compressive Measurements," Technical Report ECE06-10, Electrical and Computer Engineering Department, Rice University, November 2006.

S. Sarvotham, M.B. Wakin, D. Baron, M.F. Duarte, and R.G. Baraniuk, "Analysis of the DCS One-Stage Greedy Algorithm for Common Sparse Supports," Technical Report ECE05-03, Electrical and Computer Engineering Department, Rice University, October 2005.

V. Chandrasekaran, M. Wakin, D. Baron, and R.G. Baraniuk, "Compressing Piecewise Smooth Multidimensional Functions Using Surflets: Rate-Distortion Analysis," Technical Report, Electrical and Computer Engineering Department, Rice University, March 2004.

M. B. Wakin and C. J. Rozell, "A Markov Chain Analysis of Blackjack Strategy," 2004.

INVITED PRESENTATIONS

"Geometric Methods for Compressive Multi-Signal Processing," highlight talk at *DARPA Young Faculty Award 2007 Review and 2009 Kickoff Meeting*, Arlington, Virginia, October 2009.

"Sparse and Geometric Models for Signal Understanding from Compressive Measurements," at *Institute for Operations Research and the Management Sciences (INFORMS) Annual Meeting, Special Session on Compressed Sensing Theory and Applications*, San Diego, California, October 2009.

"Manifold-based Signal Understanding from Compressive Measurements," Electrical and Computer Engineering Department Seminar, *Duke University*, June 2009.

"Concise Models for Multi-Signal Compressive Sensing," at *8th International Conference on Sampling Theory and Applications (SampTA 2009), Special Session on Mathematical Aspects of Compressed Sensing*, Marseille, France, May 2009.

"Compressive Signal Processing using Manifold Models," Computational Analysis Seminar, *Vanderbilt University Department of Mathematics*, December 2008.

"A Geometric Introduction to Compressive Sensing," Mathematical and Computer Sciences Departmental Colloquium, *Colorado School of Mines*, September 2008.

"Manifold-based Image Understanding from Compressive Measurements," at *SIAM Conference on Imaging Science*, *Minisymposium on Applications of Compressive Imaging*, San Diego, California, July 2008.

"Manifold Models for Compressive Imaging," at *Foundations of Computational Mathematics Conference*, *Workshop on Image and Signal Processing*, Hong Kong, June 2008.

"Sparse Representations, Manifold Models, and Geometry in Compressive Sensing," at *MIT/AFOSR Workshop on Geometric Approaches in Communications and Signal Processing*, Cambridge, Massachusetts, May 2008.

"The Geometry of Compressive Sampling," *MIT Stochastic Systems Group*, May 2008.

"Geometric Models for Dimensionality Reduction in Signal and Data Processing," Electrical and Computer Engineering Department Seminar, *University of Colorado at Boulder*, April 2008.

"Geometric Models for Dimensionality Reduction in Signal and Data Processing," Division of Engineering, *Colorado School of Mines*, March 2008.

"Compressive Sensing," short course at *Information Theory and Applications Workshop*, San Diego, California, February 2008.

"Manifold Models for Compressive Imaging," at *Computational Imaging VI at IS&T/SPIE Electronic Imaging*, San Jose, California, January 2008.

"The Geometry of Compressed Sensing," Applied Mathematics Department Colloquium, *University of Colorado at Boulder*, November 2007.

"Dimensionality Reduction of Manifold-Modeled Data via Random Projections," *AMS Fall Western Section Meeting*, Special Session on Computational Methods in Harmonic Analysis and Signal Processing, Albuquerque, New Mexico, October 2007.

"Compressed Sensing: A Tutorial," *IEEE Statistical Signal Processing Workshop*, Madison, Wisconsin, August 2007.

"Sparse Representations and Low-Dimensional Geometry in Image Recovery," *Conference on Applied Inverse Problems*, Vancouver, Canada, June 2007.

"Geometric Models for Dimensionality Reduction in Signal and Data Processing," Department of Electrical Engineering and Computer Science, *University of Michigan*, March 2007.

"Geometric Models for Dimensionality Reduction in Signal and Data Processing," *Caltech Mathematics of Information Seminar*, January 2007.

"Compressive Sensing, Sparsity, and Manifolds," *ExxonMobil Upstream Research Company*, July 2006.

"Manifold-based Models for Image Processing," *Los Alamos National Laboratory Speaker Series in Data Driven Modeling & Analysis*, June 2006.

"The Multiscale Structure of Non-Differentiable Image Manifolds," *Texas Instruments DSP Leadership Meeting*, Dallas, Texas, October 2005.

"Multiscale Geometric Analysis for Image Compression," *Rice University ECE Affiliates Meeting*, September 2005.

"Wedgelets: A Multiscale Geometric Representation for Images," *UCLA IPAM Tutorials on Multiscale Geometry and Analysis in High Dimensions,* Los Angeles, California, September 2004.

"Approximation and Compression of Piecewise Smooth Multidimensional Functions," *2nd International Conference on Computational Harmonic Analysis,* Vanderbilt University, Nashville, Tennessee, May 2004.

"Approximation and Compression of Piecewise Smooth Images using Wedgeprints," *6th International Joint Meeting of the AMS and the Sociedad Matemática Mexicana*, Houston, Texas, May 2004.

PATENTS

R. G. Baraniuk, D. Z. Baron, M. F. Duarte, S. Sarvotham, M. B. Wakin, and M. A. Davenport, "Method and Apparatus for Distributed Compressed Sensing," US Patent 7,271,747, issued September 18, 2007 and US Patent 7,511,643 issued March 31, 2009.

OPINION PIECES and EDITORIALS

M. Davenport, J. Laska, C. Rozell, and M. Wakin, "The Way I See It: The Lessons of Rejection Shouldn't be Overlooked," Rice University News, July 15, 2009.

PROFESSIONAL ACTIVITIES

Member: Phi Beta Kappa, Tau Beta Pi, Eta Kappa Nu, IEEE, SIAM

Reviewer: *IEEE Transactions on Signal Processing*
IEEE Transactions on Image Processing
IEEE Transactions on Information Theory
IEEE Journal of Selected Topics in Signal Processing
Proceedings of the IEEE
SIAM Journal on Numerical Analysis
SIAM Journal on Multiscale Modeling and Simulation

Applied and Computational Harmonic Analysis
EURASIP Journal on Applied Signal Processing
Image and Vision Computing Journal
Journal of Fourier Analysis and Applications
Journal of Machine Learning Research
Mathematical Reports of the Academy of Science, Royal Society of Canada
IEEE International Symposium on Information Theory
IEEE International Symposium on Circuits and Systems
International Conference on Sampling Theory and Applications
Proposal Reviewer, DOE Office of Advanced Scientific Computing Research

Co-Organizer: *NIPS Workshop on Manifolds, Sparsity, and Structured Models*, December 2009

TEACHING EXPERIENCE

Professor (Mines):	EGGN 515	Mathematical Methods for Signals and Systems	(F'09, F'08)
	EGGN 483	Analog and Digital Communication Systems	(S'09)
Professor (Michigan):	EECS 556	Image Processing	(W'08)
	EECS 451	Digital Signal Processing and Analysis	(F'07)
Teaching Fellow (Rice):	ELEC 301	Signal and Systems	(F'02)

UNIVERSITY SERVICE

2008–present	Engineering Graduate Admissions and Recruiting Committee, Colorado School of Mines
2009	Applied Statistics Faculty Search Committee, Colorado School of Mines
2008	ECE Systems Graduate Admissions Committee, University of Michigan
2004	Accounts Manager, Duncan Hall Fridge Co-Op
2003–2004	Community Associate (Brown College)
2001–2002	Graduate Student Council (ECE Department)
2001–2002	Student Representative to ECE Graduate Committee