

# Matthew J. Hirn

## Curriculum Vitae

Michigan State University  
Department of Computational Mathematics, Science and Engineering  
Department of Mathematics

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### CURRENT POSITION

2015-Present *Assistant Professor*, Michigan State University  
Department of Computational Mathematics, Science, and Engineering  
Department of Mathematics

### RESEARCH INTERESTS

Applied mathematics and data analysis, with particular emphasis on:

- Pure, applied and computational harmonic analysis
- Manifold learning and its extensions
- Smooth extensions and interpolations
- Wavelet theory
- Machine learning
- Deep learning
- Quantum chemistry and materials science
- Applications: image analysis, hyperspectral image analysis, flow cytometry, dynamical systems, fluid mechanics

### APPOINTMENTS HELD

2013-2015 *Postdoctoral Researcher*, École normale supérieure, Département d'Informatique  
Member of the Data team, headed by Stéphane Mallat

Jun-Aug, 2013 *Visiting Assistant Professor*, Cornell University, Department of Mathematics  
Directed an NSF REU on high dimensional data analysis

2009-2013 *Postdoctoral Associate*, Yale University, Department of Mathematics  
Mentor: Ronald R. Coifman

EDUCATION

- 2004-2009 PhD in Mathematics, University of Maryland  
Thesis: Enumeration of harmonic frames and frame based dimension reduction  
Advisors: John J. Benedetto and Kasso Okoudjou
- 2000-2004 BA in Mathematics, Cornell University  
Senior Thesis: The refinability of step functions  
Advisor: Robert R. Strichartz

AWARDS, FELLOWSHIPS & GRANTS

- 2016-2018 Alfred P. Sloan Research Fellowship (\$55,000)
- 2013 SIAM Early Career Travel Award (declined)
- 2012-2014 AMS-Simons Travel Grant (\$4000)
- 2009 Ann G. Wylie Dissertation Fellowship, University of Maryland
- 2009 VIGRE Dissertation Fellowship, University of Maryland (declined)

INVITED VISITS

- 2016 Senior Fellow, Institute for Pure and Applied Mathematics (3 months).  
For the program on “Understanding Many-Particle Systems with Machine Learning.”
- 2015 Centre International de Rencontres Mathématiques (1 week).  
For the “8<sup>th</sup> Whitney Problems Workshop.”
- 2012 Scientific Researcher, Fields Institute (2 weeks).  
For the “Focus Program on Whitney Problems.”
- 2011 Visiting Researcher, Institute of Research of Mathematics of Rennes (3 weeks).
- 2010 American Institute of Mathematics (1 week).  
For the workshop on “Differentiable structures on finite sets.”
- 2010 United States Army Research Laboratory (1 week).

PAPERS

## PREPRINT / IN PREPARATION

- 2016 Adam Gustafson, Matthew Hirn, Ibraheem Mohammed, Hariharan Narayanan, and Jason Xu.  
The Sample Complexity of  $C^{1,1}(\mathbb{R}^d)$  Function Approximation.  
In preparation.
- 2016 Matthew J. Hirn, Stéphane Mallat, and Nicolas Poilvert.  
Wavelet scattering regression of quantum chemical energies.  
In preparation.

- 2016 Matthew J. Hirn and Nicholas Marshall.  
Time-coupled diffusion maps.  
In preparation.
- 2015 Ariel Herbert-Voss, Matthew J. Hirn, and Frederick McCollum.  
Computing minimal interpolants in  $C^{1,1}(\mathbb{R}^d)$ .  
Submitted to *Revista Matemática Iberoamericana*. arXiv:1411.5668.

## JOURNAL

- 2014 Matthew J. Hirn and Erwan Le Gruyer.  
A general theorem of existence of quasi absolutely minimal Lipschitz extensions.  
*Mathematische Annalen*, volume 359, number 3-4, pages 595-628, 2014. arXiv:1211.5700.
- 2014 Ronald R. Coifman and Matthew J. Hirn.  
Diffusion maps for changing data.  
*Applied and Computational Harmonic Analysis*, volume 36, number 1, pages 79-107, 2014. arXiv:1209.0245.
- 2013 Ronald R. Coifman and Matthew J. Hirn.  
Bi-stochastic kernels via asymmetric affinity functions.  
*Applied and Computational Harmonic Analysis*, volume 35, number 1, pages 177-180, 2013. arXiv:1209.0237.
- 2010 Matthew J. Hirn.  
The number of harmonic frames of prime order.  
*Linear Algebra and Its Applications*, volume 432, number 5, pages 1105-1125, 2010. arXiv:1209.0153.
- 2008 Matthew J. Hirn.  
The refinability of step functions.  
*Proceedings of the American Mathematical Society*, volume 136, number 3, pages 899-908, 2008.

## CONFERENCE AND WORKSHOP

- 2016 Tobias Welp, Guy Wolf, Matthew Hirn and Smita Krishnaswamy.  
A Diffusion-based Condensation Process for Multiscale Analysis of Single Cell Data.  
In *ICML Workshop Computational Biology*, New York, June 24, 2016. 5 pages.
- 2012 Martin Ehler and Matthew J. Hirn.  
Sparse endmember extraction and demixing.  
In *Proceedings of the IEEE 2012 International Geoscience and Remote Sensing Symposium*, pages 1385-1388, Munich, Germany, July 22-27, 2012.
- 2010 John J. Benedetto, Wojciech Czaja, Martin Ehler, Justin C. Flake, and Matthew J. Hirn.  
Wavelet packets for multi and hyperspectral imagery.  
In *Proceedings of IS&T/SPIE Electronic Imaging 2010, Wavelet Applications in Industrial Processing VII*, San Jose, California, January 2010.
- 2009 John J. Benedetto, Wojciech Czaja, Justin C. Flake, and Matthew J. Hirn.  
Frame based kernel methods for automatic classification in hyperspectral data.  
In *Proceedings of the IEEE 2009 International Geoscience and Remote Sensing Symposium*, volume 4, pages 697-700, Cape Town, South Africa, July 12-17, 2009.

## EXPOSITORY

- 2013 Matthew J. Hirn.  
Distinguished lecture series: Assaf Naor on the Lipschitz extension problem.  
*Fields Notes*, volume 12, number 3, page 14, Winter 2013.

## UNPUBLISHED

- 2015 Matthew J. Hirn, Nicolas Poilvert, and Stéphane Mallat.  
Quantum Energy Regression using Scattering Transforms.  
2015. arXiv:1502.02077.
- 2013 Matthew J. Hirn.  
Algorithms for computing the optimal Lipschitz constant of interpolants with Lipschitz derivative.  
2013. arXiv:1307.3292.
- 2007 Matthew J. Hirn and David Widemann.  
Frames for subspaces of  $\mathbb{C}^n$ .  
2007. arXiv:1410.5206.

TALKS

## CONFERENCE

- Mar 15, 2016 American Physical Society March Meeting 2016. Baltimore, Maryland.  
Session on Predicting and Classifying Materials via High-Throughput Databases and Machine Learning.  
*Deep Wavelet Scattering for Quantum Energy Regression*.  
Invited.
- Oct 22, 2015 8<sup>th</sup> Whitney Problems Workshop. CIRM, Luminy, France.  
*Computing Minimal Interpolants in  $C^{1,1}(\mathbb{R}^d)$*  (with A. Herbert-Voss and F. McCollum).  
Invited.
- Jun 1, 2015 PASC15 Conference. ETH Zürich.  
Minisymposium on Big Data Analytics for Novel Materials Discovery.  
*Quantum Energy Regression by Scattering Transforms*.  
Invited.
- Jan 11, 2015 Joint Mathematics Meetings. San Antonio, Texas.  
AMS Session on Numerical Analysis and Computer Science.  
*High dimensional learning rather than computing in quantum chemistry*.  
Contributed.
- Dec 12, 2014 Foundations of Computational Mathematics Conference 2014. Universidad de la República.  
Workshop A2: Computational Harmonic Analysis, Image and Signal Processing.  
*High dimensional learning rather than computing in quantum chemistry*.  
Invited.
- May 23, 2014 5<sup>th</sup> International Conference on Computational Harmonic Analysis. Vanderbilt University.

*Minimal  $C^{1,1}$  extensions.*

Invited.

- Sep 3, 2013 Statistics, Mathematics, and Applications Conference. Fréjus, France.  
*Diffusion maps for changing data.*  
Invited.
- Aug 28, 2012 Workshop on Whitney type extension and trace problems. The Fields Institute.  
*A general theorem of existence of quasi absolutely minimal Lipschitz extensions.*  
Invited.
- Jul 21, 2012 Operator Algebras, Frames, and Undergraduate Research: A Conference in Honor of the 70<sup>th</sup> Birthday of David R. Larson. Texas A&M University.  
*Diffusion maps for changing data.*  
Invited.
- Aug 4, 2011 Fourth Whitney Problems Workshop. College of William and Mary.  
*Wells' construction of interpolants in  $C^{1,1}(\mathbb{R}^n)$ .*  
Invited.
- Aug 21, 2009 Mini-Conference in Harmonic Analysis on the Occasion of John Benedetto's 70<sup>th</sup> Birthday. University of Maryland.  
*Harmonic frames of prime order.*  
Invited.
- May 9, 2009 Recent Advances in Harmonic Analysis and Elliptic Partial Differential Equations. University of Virginia.  
*Frame based kernel methods for hyperspectral imagery data.*  
Invited.
- May 1, 2009 Graduation Conference 2009, University of Maryland.  
*Frame based kernel methods for hyperspectral imagery data.*  
Invited.
- Aug 2, 2002 Mathematical Association of America Mathfest. Burlington, Vermont.  
*Mock Fourier series for the standard Cantor measure.*  
Contributed.

#### SEMINAR

- Nov 17, 2015 Physical Chemistry Seminar, Michigan State University.  
*High Dimensional Learning Rather than Computing in Quantum Chemistry.*
- Oct 9, 2015 Computer Science and Engineering Lecture Series, Michigan State University.  
*High Dimensional Learning Rather than Computing in Quantum Chemistry.*
- Sep 11, 2015 Applied Math Seminar, Michigan State University.  
*Quantum Energy Regression by Scattering Transforms.*
- May 7, 2015 Data Team Seminar, École normale supérieure.  
*Regression of Quantum Energies by Scattering.*

- Feb 26, 2015 Colloquium, University of Minnesota.  
*Interpolation for Physical Big Data.*
- Feb 18, 2015 Colloquium, City College of New York.  
*Interpolation for Physical Big Data.*
- Feb 4, 2015 Applied Mathematics Seminar, Yale University.  
*High Dimensional Learning rather than Computing in Quantum Chemistry.*
- Jan 16, 2015 Colloquium, Michigan State University.  
*Interpolation for Physical Big Data.*
- Apr 15, 2014 Analyse non-linéaire et EDP seminar, Institut Henri Poincaré.  
*Minimal  $C^{1,1}$  Extensions.*
- Oct 23, 2013 Sierra group meeting, École normale supérieure.  
*Diffusion based manifold learning* (joint talk with Guy Wolf).
- Jul 3, 2013 REU Smorgasbord Seminar, Cornell University.  
*Diffusion geometry for high dimensional data.*
- Feb 21, 2013 Analysis Seminar, Yale University.  
*Quasi absolutely minimal Lipschitz extensions.*
- Dec 3, 2012 Analysis Seminar, Cornell University.  
*New developments in the theory of absolutely minimal Lipschitz extensions.*
- Nov 29, 2012 Colloquium, Kansas State University.  
*Diffusion maps for changing data.*
- Nov 5, 2012 Image Analysis Seminar, University of Houston.  
*Diffusion maps for changing data.*
- Oct 17, 2012 Computational Analysis Seminar, Vanderbilt University.  
*Diffusion maps for changing data.*
- Oct 2, 2012 Norbert Wiener Center Seminar, University of Maryland.  
*Diffusion maps for changing data.*
- Jul 26, 2012 Mathematics Colloquium and Informal Seminar, Bell Labs.  
*Diffusion maps for changing data.*
- Jan 23, 2012 Applied Mathematics Seminar, Duke University.  
*Diffusion maps for changing data.*
- Dec 7, 2011 Groupe de travail “applications des mathématiques,” École Normale Supérieure de Cachan, Antenne de Bretagne, France.  
*Minimal interpolants in  $C^{1,1}(\mathbb{R}^n)$ .*
- Oct 6, 2009 Applied Mathematics Seminar, Yale University.  
*Sparse endmember extraction and demixing.*
- Nov 8, 2007 Norbert Wiener Center Seminar, University of Maryland.  
*Uncertainty principles in sparse representation and compressed sensing.*

Sep 20, 2007 Norbert Wiener Center Seminar, University of Maryland.  
*Uncertainty principles for finite abelian groups.*

## TEACHING

### MICHIGAN STATE UNIVERSITY

2016, Spring NSC 204 / CMSE 201: Introduction to Computational Modeling (flipped class).  
2015, Fall Math 414: Linear Algebra II.

### YALE UNIVERSITY

2010, Fall Math/Amth 244: Discrete Mathematics.  
2009, Fall Math/Amth 244: Discrete Mathematics.

### UNIVERSITY OF MARYLAND

2007, Summer Review Course for Analysis PhD Qualifying Exam.  
2006, Spring Math III: Introduction to Probability.  
2005, Fall Math III: Introduction to Probability.

### GUEST LECTURES FOR GRADUATE COURSES

Nov 22, 2013 Manifold learning. MVA (Mathematics/Vision/Learning) masters course: Sparse Wavelet Representations and Classification, École normale supérieure de Cachan.  
Nov 18, 2008 Introduction to compressed sensing. Math 648W: Wavelet Theory and Waveform Design, University of Maryland.

## SERVICE TO THE PROFESSION

Nov 5, 2015 Panel member on “How to look for an academic job,” Michigan State University, Department of Mathematics.  
2015 Co-organizer of the 8<sup>th</sup> Whitney Problems Workshop 2015, Centre International de Rencontres Mathématiques (CIRM)  
2012-2013 Applied Mathematics Seminar co-organizer, Yale University  
2010-2015 Reference for seven undergraduate students  
2009-2014 Journal referee for:  
Applied and Computational Harmonic Analysis (“excellent reviewer”; top 10<sup>th</sup> percentile)  
IEEE Signal Processing Letters  
IEEE Transactions on Information Theory  
Linear Algebra and Its Applications  
Neural Computation  
Proceedings of the American Mathematical Society  
SIAM Journal on Applied Dynamical Systems

## Signal Processing

- 2009 Speaker at Putnam Exam review sessions, Yale University
- 2007-2008 Norbert Wiener Center Seminar co-organizer, University of Maryland