

## Michael Robinson

61-10 Drexelbrook Drive  
Drexel Hill, PA 19026  
(215)898-6285  
robim@math.upenn.edu  
<http://www.math.upenn.edu/~robim/>



### Education:

- Doctor of Philosophy in Applied Mathematics, 2008 Cornell University, Ithaca, NY. Dissertation: *Eternal solutions and heteroclinic orbits of a semilinear parabolic equation*
- Master of Science in Mathematics, 2003 Rensselaer Polytechnic Institute, Troy NY, Funded as an NSF VIGRE Fellow
- Bachelor of Science, *Summa cum Laude*, in Electrical Engineering, 2002 Rensselaer Polytechnic Institute, Troy NY

### Overview:

I am developing theoretical and practical tools for advanced signal processing techniques. I am especially interested in the emerging field of topological methods for signal processing and systems analysis.

### Work Experience:

- Assistant professor of mathematics at American University, Washington DC (to begin July 2012).
- Postdoctoral researcher at University of Pennsylvania, PA (July 2008-present).
  - Executing projects in three focus areas
    1. Topological extension to remote sensing, imaging, localization, and mapping
    2. Sheaf-theoretic methods to provide invariants for asynchronous logic circuits
    3. Integral transforms for the Euler calculus
  - Authored an independent proposal (currently under review by AFOSR) for asynchronous logic analysis and sheaf theory
  - Assisted in the authoring of several successful proposal efforts:
    - \* ONR: Algebraic topological structures for hidden modes
    - \* DARPA: Discrete topological imaging in multibounce environments
    - \* DARPA: Sensor Topology and Minimal Planning, Phase III
    - \* AFOSR MURI: Information dynamics as a foundation for network management
- SRC, Inc. (formerly Syracuse Research Corporation), Syracuse, NY (June 2003-present). Worked on a variety of engineering projects, including
  - Over-land and urban radio propagation modeling
  - Frequency allocation, radio network planning and validation
  - GPS and low-profile antenna design

- Phased array antenna element measurement and calibration
  - Synthetic aperture radar (SAR) imaging
    - \* SAR image formation
    - \* SAR spread-spectrum tag simulation, geolocation, and decoding
    - \* SAR image exploitation, involving coherent change detection, maritime domain awareness, and other intelligence-rich scenes
    - \* Atmospheric and weather effects on SAR image quality
  - Extremely active in business development and proposal writing efforts for numerous defense and intelligence projects (last calendar year, **wrote 8 proposals**)
  - Received Employee Excellence Award for above efforts, December 2010
- Cornell University Center for Applied Mathematics, Ithaca, NY (Fall 2006-May 2008). Worked as Red Hat Enterprise Linux system administrator, managed private network of 25 computers for department users.
  - Mindstream Computing, Nashua, NH (May 2001-August 2001). Developed rigorous tests and testing methods for their PCI-RapidIO bridge chip. Also wrote a CompactPCI Hot Swap controller for it. Tests checked PCI and RapidIO protocol and data integrity under a many system settings and stress levels. Tests and design were written in Verilog and C++.
  - Flow Parametrics, LLC (Fall 2000 - 2003). Worked on utilities to link a CAD system (CADKEY) to finite-element meshing tools. Work involved providing a CADKEY user interface to existing NASA-developed surface mesher and a United Technologies Research Center-developed volume mesher. Work was done in C, C++, and Fortran.
  - Pratt and Whitney, East Hartford, CT (summer internship 2000). Wrote state-of-the-art CAD utilities for use in the Computational Fluid Dynamics Department. The utilities were used for the design and analysis of jet engines. The utilities automatically corrected defects in CAD geometry, and facilitated the generation of solid bodies from wireframe meshes. Utilities were written in C and C++.
  - CNC Software, Tolland, CT (summer internship 1999). Worked on an independent project to create a translation program, which allowed the Mastercam product to read STEP files. Worked with CNC director of software to define interface and processing requirements. Program was written in C and C++ and was implemented as a plug-in module for Mastercam.
  - Pratt and Whitney, East Hartford, CT (summer internship 1998). Evaluated several STEP conversion programs being considered for use in transferring CAD data between aircraft manufacturers. Ran through numerous test cases, documented deficiencies and worked with CAD support programmers to correct geometric problems. The STEP standard allows platform-neutral exchanges of product data between CAD systems.
  - Pratt and Whitney, East Hartford, CT (summer internship 1997). Created a knowledge base for the Pratt and Whitney help desk, centralizing information concerning the repair of computer equipment. This information was applied to CasePoint, a software package that the help desk agents would use to diagnose problems.

- CNC Software, Tolland CT (via 8th grade school enrichment program, 1994). Wrote a utility to delete objects within a polygonal region for their CAD/CAM product, Mastercam. Utility was written in C.

### **Publications:**

1. (with Robert Ghrist) "Topological localization via signals of opportunity," *IEEE Trans. Sig. Proc.*, Vol. 60, No. 5, May 2012.
2. (with Robert Ghrist) "Euler-Bessel and Euler-Fourier transforms," *Inverse Problems*, Vol. 27, No. 12, 2011.
3. "Classification of connecting solutions of semilinear parabolic equations," *Electron. J. Diff. Eqns.*, Vol. 2011(2011), No. 61, pp. 1-10.
4. "A cell complex structure for the space of heteroclines for a semilinear parabolic equation," *Electron. J. Diff. Eqns.*, Vol. 2009(2009), No. 16, pp. 1-17.
5. "An asymptotic-numerical approach for examining global solutions to an ordinary differential equation," *Ergodic Theory and Dynamical Systems*, Vol. 29, (2009), pp. 223-253.
6. "Construction of eternal solutions for a semilinear parabolic equation," *Electron. J. Diff. Eqns.*, Vol. 2008(2008), No. 139, pp. 1-8.
7. "IMEX method convergence for a semilinear parabolic equation," *J. Differential Equations*, vol. 241, no. 2, October 2007, pp 225-236; doi:10.1016/j.jde.2007.07.001.
8. "A wavefront launching model for predicting channel impulse response," *ACES Journal*, vol. 22, no. 2, July 2007, pp 302-305.
9. "Polarizing frequency of a fluid plasma antenna element," *IEEE Antennas and Propagation Society Symposium*, 2004.

### **Patents:**

- (with Andy Davis, Harvey Schuman, Don McPherson, John Wiley, David Hagenmayer) "Bench-Top Measurement Method, Apparatus and System for Phased Array Radar Apparatus Calibration," accepted for filing by the USPTO on February 11, 2011 under Application No. 13/025652.

### **Preprints:**

- "Multipath-dominant, pulsed doppler analysis of rotating blades," [arXiv:1204.4366](#) submitted.
- "Knowledge-based antenna pattern extrapolation," [arXiv:1203.2528](#), submitted.
- (with Robert Ghrist and Justin Curry) "Euler calculus and its applications to signals and sensing," submitted.
- "Inverse problems in geometric graphs using internal measurements," [arXiv:1008.2933](#), which discusses algorithms and underlying theory for solving imaging problems in multipath-dominant, opportunistically illuminated environments.

- (with Robert Ghrist and Hank Owen) “DTIME: Discrete Topological Imaging for Multipath Environments,” University of Pennsylvania ESE Technical Report, [http://repository.upenn.edu/eese\\_reports/6](http://repository.upenn.edu/eese_reports/6).
- “Asynchronous logic circuits and sheaf obstructions,” [arXiv:1008.2729](https://arxiv.org/abs/1008.2729), which describes a new constructible sheaf framework for analyzing the temporal behavior of logic circuitry.
- “Instability of a parabolic equation with a quadratic nonlinearity,” [arXiv:0704.3989](https://arxiv.org/abs/0704.3989), which gives an explicit construction showing that a certain critical point whose linearization is stable is in fact unstable. This is not a new result, but the proof is a good example of the blow-up method of H. Fujita.

### **Selected Talks:**

- “Euler integral transforms and applications.” Workshop on Computational Topology. Fields Institute. November 8, 2011.
- “Topology and geometry of graphs by distributed sensing.” Applied Topology Workshop, Hakata, Japan September 2, 2011.
- “Sounding your surroundings.” IMA Summer School on Topological Analysis, University of Pennsylvania, week of 25 July 2011.
- (poster) “Sheaf theoretic invariants for computational networks.” NMMC 2011, May 16, 2011. Also at NOLTA 2011, Kobe, Japan, September 5, 2011.
- “Measuring topology and geometry by distributed sensing.” NRO Technical Seminar (July 11, 2011). Also at Drexel University (April 14, 2011), Complex Networks MURI meeting (May 15, 2011). Demonstrated acoustic sounding equipment to supply opportunistic localization data.
- “Logic circuits as sheaves.” NSA Mathematics Colloquium. March 4, 2011. Also at Tulane University, March 25, 2011.
- (poster) “Euler characteristic integrals in signal processing.” FFT 2011. February 17, 2011.
- “Measuring the geometry of metric graphs by distributed sensing.” Lehigh University. October 13, 2010. Also at Tulane University, October 28, 2010.
- “Forays into signal processing using the Euler characteristic integral.” Princeton University, February 12, 2010.
- “Constructible sheaves and their cohomology for asynchronous logic and computation.” GETCO 2010, Aalborg, Denmark. January 14, 2010. Also at STOMP group meeting, February 18, 2010.
- “Localization of Mobile Receivers using Opportunistic Signals.” PASSHEMA Conference, Mansfield University. March 21, 2009.
- “Frequency assignment in land mobile radio systems.” Applied Mathematics and Computational Science Seminar, University of Pennsylvania. October 10, 2008.
- “Some finite dimensionality results for the space of heteroclinic orbits of a semilinear parabolic equation.” Dynamics Seminar, Cornell University. February 1, 2008.

- “Dynamics of a semilinear parabolic equation.” Joint Mathematics Meetings, San Diego, California. January 6, 2008.
- “Instability of an equilibrium of a nonlinear parabolic equation with a negative definite linearization.” Applied Mathematics Seminar, Université de Provence. March 13, 2007.
- “Towards a characterization of the dynamics of a semilinear parabolic differential equation.” Mathematical Sciences Seminar, Cornell University. November 8, 2006.
- “Tug-of-war: how nonlinearity and the Laplacian interact.” Olivetti Club, Cornell University. April 25, 2006.
- “Do electrons really spin?” Mathematical Sciences Seminar, Cornell University. February 8, 2006.
- “Studying the bifurcation behavior of a nonlinear PDE.” Mathematical Sciences Seminar, Cornell University. October 5, 2005.
- “Polarizing frequency of a fluid plasma antenna element.” Mathematical Sciences Seminar, Cornell University. November 8, 2004.

### **Teaching:**

- Currently advising Sam Krupa, and undergraduate researcher who is analyzing discretization errors in Euler characteristic integration.
- MATH 320 “Computer Methods,” University of Pennsylvania, Fall 2010. Worked as the sole instructor. The course taught solution of nonlinear equations, interpolation, and approximate methods for solving differential equations. This course was taught using a combined lecture/project format that required students to gain substantial with familiarity programming and with the course material by using data sets that I collected for them. Some students successfully learned to program during this course, having never tried it before. *See my website, under the Teaching tab for more detail.*
- MATH 104 “Calculus 2,” University of Pennsylvania, Fall 2010, Fall 2011. Worked as one instructor of a team of several instructors focusing on the basics of integration theory, differential equations and series. My particular take on this standard course encourages students to understand real-world applications of these topics.
- MATH 313/513 “Computational Linear Algebra,” University of Pennsylvania. Worked as the sole instructor: Spring 2009. This course introduced students to the topics of standard linear algebra, with a focus on numerical and automatic computation. The MATH 513 cross-listing provided an opportunity for more advanced students to explore some of the less-traditional and more technical aspects of the theory.
- MATH 114 “Calculus II,” University of Pennsylvania. Worked as a teaching assistant: Fall 2008. Duties involved issuing and grading weekly quizzes, periodic exams, holding recitations and office hours.
- MATH 293 “Differential equations for engineers,” Cornell University. Worked as a Teaching Assistant: Spring 2006, Spring 2005, Fall 2004. Duties involved grading weekly homeworks, quarterly exams, holding weekly recitations, and office hours. I was nominated for the 2006 Department of Mathematics Teaching Award for my work in this course.

- MATH 191 “Calculus For Engineers,” Cornell University. Worked as an Assistant Lecturer: Fall 2005. Duties involved lecturing three times a week, writing and grading exams, and holding weekly office hours.
- “Introduction to MATLAB MEX programming,” Syracuse Research Corporation, Summer 2005. Taught an informal in-house company training session.

**Conferences Attended:**

- NOLTA 2011, September 2011, Kobe, Japan
- IMA Summer school on Applied Topology, July 2011, Philadelphia, PA
- NMMC 2011, May 2011, Madison, WI
- FFT 2011, February 2011, College Park, MD
- ATMCS IV, June 2009, Muenster, Germany
- GETCO 2010, January 2009, Aalborg, Denmark
- PASSHEMA Conference, March 2008, Mansfield, PA
- Joint Mathematics Meetings, January 2008, San Diego, CA
- Workshop in Dynamical Systems, October 2007, Penn State University
- Workshop in Geometric Combinatorics, June 2005, MSRI, Berkeley, CA
- Antennas and Propagation Symposium, June 2004, Monterey, CA
- Applied Computational Electromagnetics Symposium (ACES), April 2004, Syracuse, NY
- AMS/MAA Joint Meetings, January 2003, Baltimore, MD
- AMS/MAA Joint Meetings, January 2002, San Diego, CA

**Miscellaneous Awards and Honors:**

- Employee Excellence Award from SRC, December 2010
- Received first place in the RPI Embedded Control Invitational competition Spring 2000
- Rensselaer Medal (awarded to the top student in mathematics and science in graduating high school class)
- National Honor Society
- Eagle Scout as of 24 April 1997
- Volunteer Computer Mentor (C programming), Grade 9-12

**Hobbies and Interests:**

Computers and electronics (see below); amateur radio (extra class), callsign KB1DDS; gardening; camping; backpacking; sailing; bookbinding; cooking

**Electronics Skills:** *(See my website for more detail)*

- Designed, built, and operates a system for collecting acoustic ranging data to drive-test topological signal processing concepts as well as traditional SONAR image formation and exploitation
- Designed and built several different simple computers from 7400-series logic gates
- Restored nonfunctional DEC minicomputers to working condition: PDP-11/45, PDP-11/03, VAX 8530
- Proficient in ANSI Standard C/C++, MATLAB, Python, Scheme, assembly (Intel, Microchip PIC, Motorola 68k, PDP-11), IEEE Verilog, L<sup>A</sup>T<sub>E</sub>X, HTML
- Familiar with Haskell, Common Lisp, Fortran, Java, DCL, Pascal

**References:** available upon request.