Curriculum Vitae

Michael J. Catanzaro

Department of Mathematics
Iowa State University
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Employment

- Assistant Professor, Iowa State University, August 2018 - present.
- Postdoctoral research associate, University of Florida, August 2016 - July 2018.
  Mentor: Peter Bubenik.

Education

- Ph.D. Mathematics, Wayne State University, March 2016.
  Advisors: Dr. John R. Klein, Department of Mathematics, and
  Dr. Vladimir Y. Chernyak, Department of Chemistry.
- M.A. Mathematics, Wayne State University, December 2011.
  Advisor: Dr. Robert R. Bruner, Department of Mathematics.
- B.S. Physics, Wayne State University, December 2010.
- B.S. Mathematics, Wayne State University, December 2010.

Research Interests

- Topological data analysis, multiparameter persistence, multiparameter persistence modules.
- Stochastic currents, random walks, stochastic calculus on manifolds, higher Reidemeister torsion, combinatorial Hodge theory, Cerf theory.

Publications

Peer-reviewed articles

10. Catanzaro, Michael J.; Curry, Justin; Fasy, Brittany Terese; Lazovskis, Janis; Malen, Greg; Riess, Hans; Wang, Bei; Zabka, Matthew. *Moduli Spaces of Morse Functions for Persistence*. Journal of Applied and Computational Topology (2020). doi.org/10.1007/s41468-020-00055-x arxiv:1909.10623
9. Catanzaro, Michael J.; Chernyak, Vladimir Y.; Klein, John R. *Exciton Scattering via Algebraic Topology*. Journal of Topology and Analysis **11** (2019), 251–272. doi:10.1142/S1793525319500110 arXiv:1505.02365.
8. Catanzaro, Michael J.; Chernyak, Vladimir Y.; Klein, John R. *A higher Boltzmann Distribution*. Journal of Applied and Computational Topology **1** (2017), 215–240. doi:10.1007/s41468-017-0006-9 arXiv:1506.06775

7. Catanzaro, Michael J.; Chernyak, Vladimir Y.; Klein, John R. *Stochastic Dynamics of Extended Objects in Driven Systems: I. Higher-Dimensional Currents in the Continuous Setting*, Chemical Physics **481** (2016), 5–18. doi:10.1016/j.chemphys.2016.08.021 arxiv:1609.00336

6. Catanzaro, Michael J.; Chernyak, Vladimir Y.; Klein, John R. *Stochastic Dynamics of Extended Objects in Driven Systems II: Current Quantization in the Low-Temperature Limit*, Chemical Physics **481** (2016), 19–27. doi:10.1016/j.chemphys.2016.08.020 arxiv:1609.00334

5. Catanzaro, Michael J.; Shi, Tian; Tretiak, Sergei; Chernyak, Vladimir Y. *Counting the number of excited states in organic semiconductors systems using topology*, J. Chem. Phys **142** 084113 (2015), 1–12. doi:10.1063/1.4908560 arxiv:1612.03434

4. Catanzaro, Michael J.; Chernyak, Vladimir Y.; Klein, John R. *Kirchhoff's theorems in higher dimensions and Reidemeister torsion*, Homology, Homotopy, and Applications **17** (2015), 165–189. doi:10.4310/HHA.2015.v17.n1.a8 arxiv:1206.6783

3. Li, Hao; Catanzaro, Michael J.; Tretiak, Sergei; Chernyak, Vladimir. *Excited-state structure modifications due to molecular substituents and exciton scattering in conjugated molecules*, Journal of Physical Chemistry Letters **5** (2014), 641–647. doi:10.1021/jz4027198 arxiv:1612.03523

2. Catanzaro, Michael J.; Chernyak, Vladimir Y.; and Klein, John R. *On Kirchhoff's theorems with coefficients in a line bundle*, Homology, Homotopy, and Applications **15** (2013), 267–280. doi:10.4310/HHA.2013.v15.n2.a16 arxiv:1207.2822

1. Catanzaro, Michael J. *Generalized Tonnetze*, J. Math. Music **5** (2011), 117–139. doi:10.1080/17459737.2011.614448 arxiv:1612.03519

Submitted articles

(d) Salch, Andrew; Abdallah, Hassan; Regalski, Adam; Suryadevara, Raviteja; Catanzaro, Michael J.; Diwadkar, Vaibhav A. *Why Topological Data Analyses (TDA) should be used for functional discovery in fMRI data*. Submitted to PLOS Computational Biology.

(c) Catanzaro, Michael J.; Wang, Bei; Zabka, Matthew; Zhou, Youjia. *MVF Designer: Design and Visualization of Morse Vector Fields*. Submitted to Eurographics Conference on Visualization. arxiv.org/abs/1909.10623

(b) Catanzaro, Michael J.; Chernyak, Vladimir Y.; Klein, John R. *On fluctuations of cycles in a finite CW complex*. Submitted to Homotopy, Homology, and its Applications. arxiv.org/abs/1710.07995

(a) Catanzaro, Michael J.; Zabka, Matthew J. *A Model for Random Chain Complexes*. Submitted to Topology and It's Applications. arxiv.org/abs/1901.00964

Books, In progress

1. Bruner, Robert R.; Catanzaro, Michael J.; May, J. Peter. *Characteristic Classes*. pp 97. Draft available at math.uchicago.edu/∼may/CHAR/charclasses.pdf.

Other publications

3. Catanzaro, Michael J. *A Topological Study of Stochastic Dynamics on CW Complexes.* Wayne State University Dissertations **1433** (2016). Available at digitalcommons.wayne.edu/oa_dissertations/1433/.

2. Catanzaro, Michael J. *Finitely Presented Modules over the Steenrod Algebra in Sage.* Master's thesis, Wayne State University, December 2011. Available at people.clas.ufl.edu/catanzaro/files/Essayfinal.pdf

1. Catanzaro, Michael J. *A user's guide: Dynamics and fluctuations of cellular cycles on CW complexes*, available at mathusersguides.com/enchiridion-vol-2-2016-mike-catanzaro/

Presentations

Invited Presentations

22. *Geometric perspectives on multiparameter persistence*, 6th CIMAT TDA workshop and winter school. Guanajuato, Mexico, January 2020.

21. *Multiparameter Persistence via Geometric Topology*, SIAM Conference on Applied Algebraic Geometry. Bern, Switzerland, July 2019.

20. *Stochastic Dynamics of Cellular Cycles*, Probability, Analysis, and Data Science Seminar. Iowa State University, October 2019.

19. *Topological Data Analysis*, Midwest Big Data Summer School. Ames, Iowa, May 2019.

18. *Geometric multiparameter persistence*, Computational and Applied Math Seminar, Iowa State University, April 2019.

17. *An Introduction to Topological Data Analysis*, Mathematical Association of America, Northwest Sectional Meeting. Southwest Minnesota State University, October 2018.

16. *Combining sub-level and let set persistence*, Multiparameter Persistent Homology, CMO, Oaxaca, Mexico, August 2018.

15. *Multiparameter persistence via geometric topology*, Algebraic Topology: Methods, Computation and Science 8, IST Austria, June 2018.

14. *Multiparameter persistence via geometric topology*, Bridging Statistics and Sheaves, Institute for Mathematics and its Applications, May 2018.

13. *Geometric multiparameter persistence*, Topology and Dynamics Seminar, University of Florida, December 2017.

12. *Stochastic Dynamics on CW complexes*, Applied Math and Analysis Seminar, Duke University, November 2017.

11. *Stochastic Dynamics of Cellular Cycles*, Geometry, Topology, and Data Seminar, The Ohio State University, September 2017.

10. *Exciton Scattering for Topologists*, Topology and Dynamics Seminar, University of Florida, March 2017.

9. *Stochastic Dynamics on CW Complexes*, two presentations given in Topology and Dynamics Seminar, University of Florida, October 2016.

8. *The Topology of Higher-Dimensional Currents and Langevin Processes*, Non-Equilibrium Statistical Physics, Telluride, CO, July 2016.

7. *Kirchhoff's laws in higher dimensions and Reidemeister torsion*, Topology Seminar, Brandeis University, November 2015.

6. *Counting Electronic Excitations In Organic Systems Using Algebraic Topology*, Topology Seminar, Johns Hopkins University, April 2014.

5. *Counting Electronic Excitations In Organic Systems Using Algebraic Topology*, Topology Seminar, Wayne State University, February 2014.

4. *Counting The Number Of Electronic Excitations In Branched Conjugated Molecules Using Algebraic Topology*, Physical Chemistry Seminar, Wayne State University, November 2013.

3. *Kirchhoff's theorems in higher dimensions and Reidemeister Torsion*, Topology Seminar, Wayne State University, October 2013.

2. *Counting Electronic Excitations using Cohomology*, Graduate Student Geometry and Topology seminar, University of Illinois Urbana-Champaign, May 2013.

1. *The Topology of Spaces of Triads*, The Undergraduate Mathematics Seminar, University of Michigan Dearborn, March 2010.

Contributed Presentations

9. *Morse theory and persistence*. Algebra and Geometry seminar, Iowa State University, September 2019.

8. *An Introduction to Topological Data Analysis*. Theoretical and Applied Data Science Seminar, Iowa State University, January 2019.

7. *Stochastic Dynamics on CW Complexes*, Applied Topology in Bedlewo 2017, Bedlewo, Poland, June 2017.

6. *On the Boltzmann distribution and Hodge theory*, Young Topologists' Meeting, EPFL, July 2015.

5. *A generalization of the Boltzmann distribution & Hodge theory*, Graduate Student Topology and Geometry Conference, University of Illinois, March 2015.

4. *Constructions in ∞-categories*, Talbot Workshop, 2014.

3. *Jet and Minijet Contributions to Transverse Momentum Correlations in High Energy Collisions*, The Undergraduate Physics Research Conference, Wayne State University, November 2009.

2. *The Topology of Spaces of Triads and Generalized Tonnetze*, The Undergraduate Research Conference, Wayne State University, November 2009.

1. *The Topology of Spaces of Triads*, The Young Mathematicians Conference, The Ohio State University, August 2009.

Conference Organization

- Local organizer for the Underrepresented Students in Algebra and Topology Research Symposium (USTARS) at Iowa State University, April 2019.

Undergraduate Research

- Iowa State University, Aug. 2019 - present: Mentoring Brantley Vose on computing harmonic chain representatives of persistent homology classes, including coding and developing a visualization package.
- Iowa State University, May 2019 - present: Mentoring Kate Lyon on the use of Mapper to study world happiness and greenhouse gas emissions from developed countries.
- University of Florida, Jan. 2017 - April 2018: Mentored Samuel Rizzo on applying Persistence Landscapes to study task modulation with fMRI data.
- University of Florida, Jan. 2017 - April 2017: Mentored Samuel Swanson on computing Hodge decompositions for persistent homology classes.
- Wayne State University, Nov. 2015 - Dec. 2016: Mentored Raviteja Suryadevara on an application of persistent homology to an fMRI study.

Teaching Experience

As the primary instructor, I developed syllabi, quizzes, and tests for the following courses.

- Advanced Abstract Algebra II (505): Spring 2020.
- Advanced Abstract Algebra (504): Fall 2019.
- Directed study on Algebraic Topology (5000): Fall 2019.
- Advanced Topics in Topology: Differential Topology, Vector Bundles, and Characteristic Classes (7396): Fall 2017.
- Advanced Calculus for Engineers and Physical Scientists I (4102/5104): Winter 2017.
- Topology (502): Spring 2019.
- Mathematics in Today's World (1000): Summer 2013.
- Elementary Statistics (1020): Summer 2014.
- Algebra with Trigonometry (1050): Summer 2011, Fall 2011, Fall 2014, and Winter 2015.
- Pre-Calculus (1800): Winter 2011.
- Linear Algebra (2250): Summer 2015.

As the primary lecturer, I taught the following courses.

- Calculus 1 (165): Fall 2019.
- Calculus 3 (2313): Fall 2016 and Fall 2018.

Technical skills

- Proficient in C/C++, Python, R, and Bash scripting.
- Written code for Sage, Pythia, Hijing, and Root.

Awards

- *Anderson Scholar Faculty Honoree*, University of Florida, College of Liberal Arts and Sciences, December 2017.
- *Bertram Eisenstadt Award for Outstanding Achievement in PhD Program*, Wayne State University, Department of Mathematics, May 2016.
- *Robert Irvan Endowed Mathematics Scholarship*, Wayne State University, Department of Mathematics, May 2015.
- *M.F. Janowitz Endowed Mathematics Scholarship*, Wayne State University, May 2014.
- *Maurice Zelonka Endowed Scholarship*, Wayne State University, Department of Mathematics, May 2013.
- *Outstanding Teaching Service*, Wayne State University, Department of Mathematics, May 2012.
- *Outstanding Undergraduate Award*, Wayne State University, Department of Mathematics, May 2010.
- *M.F. Janowitz Endowed Mathematics Scholarship*, Wayne State University, May 2010.
- *George B. Beard Student Prize for Excellent Presentation of Research*, Wayne State University, Department of Physics, November 2009.
- *Robert Irvan Endowed Mathematics Scholarship*, Wayne State University, Department of Mathematics, May 2009.
- *Vaden W. Miles Outstanding Undergraduate Award*, Wayne State University, Department of Physics, March 2009.
- *Undergraduate Scholarship*, Wayne State University, Department of Mathematics, May 2008.
- *Presidential Scholarship*, Wayne State University, June 2005.