

Jason Cantarella

Curriculum Vitae

Current Address

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Employment History

Associate Head, Math Department, 2016-Present.
Professor, University of Georgia, 2013-Present.
Associate Professor, University of Georgia. 2005-2013.
Assistant Professor, University of Georgia. 2002-2005.
NSF Postdoctoral Research Fellow and Assistant Professor, University of Georgia, Athens. 1999-2002.
NSF Postdoctoral Research Fellow, University of Massachusetts, Amherst. 1999-2000.

Education

Ph.D., Mathematics, University of Pennsylvania, May, 1999.
M.S., Mathematics, University of Pennsylvania, 1995.
B.A., Mathematics, Vassar College, 1993.
- Phi Beta Kappa.

Teaching

- (1) Developed “Calculus with Robotics” course using robotics problems to motivate first-semester calculus, including building a small robot which throws a ball into a cup.
See <http://www.youtube.com/watch?v=qGkNjDZgBNQ&feature=g-upl> for demonstration video.
- (2) Math Department McCay Award for contributions to research, teaching and service. 2011.
- (3) SGA Faculty recognition award, 2010. Teaching award organized by student government to recognize “favorite professor” of an undergraduate student.
- (4) Codirector of two VIGRE grants, responsible for undergraduate programs including design and construction of undergraduate study area.
- (5) Richard O. Russell Teaching Award, 2007. University-level teaching award given to 3 faculty per year in their first 10 years at UGA. First winner in mathematics department.
- (6) Developed completely new numerical analysis courses based on *Mathematica*.
See http://www.jasoncantarella.com/webpage/index.php?title=Math_4500 and http://www.jasoncantarella.com/webpage/index.php?title=Math_4510.
The new courses are based on getting students to the point where they can answer genuinely interesting real world questions such as designing their own image compression algorithms (Math 4510, numerical linear algebra) or targeting a railgun to hit a target 250 miles away with a model including air resistance, varying gravity, and the curvature of the earth (Math 4500, numerical solution of ODEs).
- (7) Math Club Faculty Advisor, 2006-2007.
- (8) Teacher Education Fellow (2003-2004) in University of Georgia mathematics department. Collaborated with Mathematics Education department to help develop effective courses for future K-12 math teachers.
- (9) Project NExT Fellow, (Gold dot), 2000-2001.
- (10) Faculty mentor for UGA VIGRE Geometry Group with a total of 30 undergraduates and 33 graduate students. The group ran from 2000-2010, including three summer undergraduate research experiences “Massively parallel computation of geometrically optimal knots”, “Mathematics and Visualization”, and “Geometric Flows for Plane Curves”. See <http://tinyurl.com/y26ukl>.
- (11) 4 Ph.D. students graduated (Michael Berglund, Matt Mastin, Chad Mullikin and Edward Ashton). Currently advising two Ph.D. students: Harrison Chapman and Tom Needham. Master’s thesis advisor for Amelia Reeves (graduated).

Conference Organization and Scientific Advising

- (1) Organizer, Simons Center for Geometry and Physics Workshop, “Symplectic and Algebraic Geometry in the Statistical Physics of Polymers”, scheduled for October 2015.
- (2) Organizer, Georgia Topology Conference, 2013.
- (3) Scientific Organizing Committee, Oberwolfach Workshop “Geometric Knot Theory”, April 28th - May 4th, 2013.
- (4) Scientific Organizing Committee, Issac Newton Institute Workshop “Topological Dynamics in the Physical and Biological Sciences”, 16 July-21 December 2012.
- (5) Scientific Organizing Committee, SouthEast Geometry Conference (various years).
- (6) Organizer, “Geometry, Topology, and Physics 2008: A Conference in Honor of the 70th Birthday of Herman Gluck”.

Publications

- (1) Knot Probabilities in Random Diagrams.
with H. Chapman, M. Mastin. arXiv:1512.05749.
- (2) A Fast Direct Sampling Algorithm for Equilateral Closed Polygons.
with B. Duplantier, C. Shonkwiler, and E. Uehara. *J. Phys. A: Math. Theor.* 49 (2016), p. 275205.
- (3) Rigid Origami Vertices: Conditions and Forcing Sets.
with Z. Abel, E. Demaine, D. Eppstein, T. Hull, J. Ku, R. Lang, and T. Tachi.
Journal of Computational Geometry 7 (2016), p. 171-184.
- (4) Transversality for Configuration Spaces and the “Square-Peg” Theorem.
with E. Denne, J. McCleary. arXiv:1402.6174.
- (5) The Symplectic Geometry of Closed Equilateral Random Walks in 3-space.
with C. Shonkwiler. *Annals of Applied Probability* 26 (2016) no. 1, p. 549-596.
- (6) The Expected Total Curvature of Random Polygons.
with A. Grosberg, R. Kusner, C. Shonkwiler. *American Journal of Mathematics* 137 (2015) no. 2, p. 411-438.
- (7) The tight knot spectrum in QCD.
with R. Buniy, T. Kephart, E. Rawdon. *Physical Review D* 89 (2014), no. 5, p. 054513.
- (8) Symmetric Criticality for Tight Knots.
with J. Ellis, J. Fu, M. Mastin. *Journal of Knot Theory and its Ramifications* 23 (2014) no. 2, p. 1450008-1–17.
- (9) Probability Theory of Random Polygons from the Quaternionic Viewpoint.
with T. Deguchi, C. Shonkwiler. *Comm. Pure and Applied Mathematics* 67 (2014) no. 10, p. 1658–1699.
- (10) Ropelength Criticality.
with J. Fu, R. Kusner, J. Sullivan. *Geometry and Topology* 18 (2014) no. 4, p. 1973-2043.
- (11) The Shapes of Tight Composite Knots.
with A. LaPointe, E. Rawdon. *J. Phys. A: Math. Theor.* 45 (2012), p. 1-19.
- (12) The 27 Possible Intrinsic Symmetry Groups of Two-Component Links.
with J. Cornish, M. Mastin, J. Parsley. *Symmetry* 4 (2012) no. 1, p. 129-142.
- (13) Intrinsic symmetry groups of links with 8 and fewer crossings.
with M. Berglund, M. Casey, E. Dannenberg, W. George, A. Johnson, A. Kelly, A. LaPointe, M. Mastin, J. Parsley, J. Rooney, R. Whitaker. *Symmetry* 4 (2012) no. 1, p. 143–207.
- (14) Tightening Knots with Constrained Gradient Descent.
with T. Ashton, M. Piatek, E. Rawdon. *Experimental Mathematics* 20 (2011) no. 1, p. 57–90.
- (15) A new cohomological formula for helicity in \mathbf{R}^{2k+1} reveals the effect of a diffeomorphism on helicity.
with J. Parsley. *Journal of Geometry and Physics* 60 (2010), p. 1127-1155.
- (16) Criticality for the Gehring Link Problem.
with J. Fu, R. Kusner, J. Sullivan, and N. Wrinkle. *Geometry and Topology* 10 (2006), p. 2055-2115.
- (17) Visualizing the tightening of knots.
with M. Piatek and E. Rawdon.
VIS '05: Proceedings of the conference on Visualization '05, 575-582, IEEE Computer Society, 2005.
- (18) A Fast Octree-Based Algorithm for Computing Ropelength.
with T. Ashton. arXiv: math.DG/0409416. *Physical and Numerical Models in Knot Theory*, Series on Knots and Everything Vol. 36. World Scientific Press (2005), p. 323–341.
- (19) On Comparing the Writhe of a Smooth Curve to the Writhe of an Inscribed Polygon.
SIAM Journal of Numerical Analysis 42 (2005) no. 5, p. 1846–1861.

- (20) An Energy-Driven Approach to Linkage Unfolding.
with E. Demaine, H. Iben, and J. O'Brien.
SCG '04: Proceedings of the twentieth annual symposium on Computational Geometry
ACM Press, 2004. p. 134–143.
- (21) Upper Bounds for Ropelength as a function of Crossing Number.
with X.W. Faber, C. Mullikin. *Topology and its Applications* 135 (2003) no. 1-3, p. 253-264.
- (22) The Second Hull of a Knotted Curve.
with G. Kuperberg, R. Kusner, J. Sullivan. *American Journal of Mathematics* 125 (2003) no. 6, p. 1335-1348.
- (23) Vector Calculus and the Topology of Domains in 3-Space.
with D. DeTurck and H. Gluck. *American Mathematical Monthly* 109 (2002) no. 5.
- (24) Circles Minimize Most Knot Energies.
with A. Abrams, J. Fu, M. Ghomi, R. Howard. *Topology* 42 (2002) no. 2, p. 381–394.
- (25) On the Minimum Ropelength of Knots and Links.
with R. Kusner, J. Sullivan. *Inventiones Mathematicae* 150 (2002) no. 2, p. 257–286.
- (26) Upper Bounds for Writhe and Helicity.
with D. DeTurck and H. Gluck. *Proceedings of the Conference in Honor of the 70th Birthday of Joan Birman, Jane Gilman, Xiao-Song Lin, William Menasco, eds., International Press, AMS/IP Series on Advanced Mathematics* (2002).
- (27) The Biot-Savart Operator for Application to Knot Theory, Fluid Dynamics, and Plasma Physics.
with D. DeTurck and H. Gluck. *Journal of Mathematical Physics* 42 (2001), no. 2, p. 876–905.
- (28) A General Mutual Helicity Formula.
Proceedings of the Royal Society: A 456 (2000), no. 2003, p. 2771–2779.
- (29) Isoperimetric Problems for the Helicity of Vector Fields and the Biot-Savart and Curl Operators.
with D. DeTurck, H. Gluck, and M. Teytel. *Journal of Mathematical Physics* 41 (2000), no. 8, p. 5614-5641.
- (30) Eigenvalues and Eigenfields of the Biot-Savart and Curl Operators on Spherically Symmetric Domains.
with D. DeTurck, H. Gluck, and M. Teytel. *Physics of Plasmas* 7 (2000), no. 7, p. 2766-2775.
- (31) The Influence of Geometry and Topology on Helicity.
with D. DeTurck, H. Gluck, and M. Teytel. In *Magnetic Helicity in Space and Laboratory Plasmas*, American Geophysical Union, Geophysical Monograph Series 111, ed. Pevtsov, Canfield, & Brown. 1999.
- (32) Nontrivial Embeddings of Polygonal Intervals and Unknots in 3-Space.
with H. Johnston, *Journal of Knot Theory and its Ramifications* 7 (1998), no. 8, p. 1027-1039.
- (33) Tight Knot Values Deviate From Linear Relation.
with R. Kusner and J. Sullivan, *Nature* 392 (1998), p. 237.

Released Software

- (1) `ridgerunner 2.0.0` with Eric Rawdon, Michael Piatek, last release July 2012.
- `ridgerunner` is a fast code for finding approximately tight configurations of knotted curves in space using the method of constrained gradient descent. Several papers have been published using `ridgerunner` data, and the images and movies generated have been published in the art magazine *Cabinet*, and showed in several gallery shows of mathematical art.
- (2) `plCurve 7.4.1` with Ted Ashton and Harrison Chapman, GPL, last release March 2016.
- `plCurve` is a fast code for handling polygonal curves in space, including computing their HOMFLY polynomials, as well as different kinds of geometric data, and generating random polygons.
- (3) `liboctrope 2.0.0` with Ted Ashton, GPL, last release July 2012.
- A fast code for computing the self-contacts of tubes around space polygons.
- (4) `tsnnls 2.3.3` with Michael Piatek and Eric Rawdon, LGPL, last release July 2012.
- `Tsnnls` is a linear algebra solver for the sparse non-negative least squares problem. It is used in fields from CAD to geology, including firmware for biology lab equipment, finite-element analysis (Tsplines, Inc.) and the construction of a fish-finding sonar (Atlantide Consulting).
- (5) `vecttools 1.2.2`, GPL, last release July 2012.
- A collection of utility codes for various curve theory tasks, including generating seamless triangulated tubes around closed or open space polygons, reconstructing curves from curvature and torsion, splining polygonal curves, and computing writhe.
- (6) Perl Encyclopedia of Triangle Centers, no license.

- The Perl ETC is used to compute triangle centers in the popular *GeoGebra* system.

Grants and Funding

NSF TUES-1 Grant, DUE-12-45540. 2013-2016.
Simons Collaboration Grant, #284066. 2013.
University of Georgia STEM Education Minigrant, 2012-2013.
University of Georgia Faculty Summer Research Grant, 2012.
University of Georgia ICE Development Grant, 2010.
Conference on Applications of Geometry to Topology and Physics, DMS-08-16502.
University of Georgia VIGRE grant, (co-PI) DMS-07-38586. 2008-2013.
NSF REU Site Grant, (co-PI) DMS-06-49242. 2007-2010.
University of Georgia ICE Project Grant, 2006.
University of Georgia VIGRE Grant, (co-PI) DMS-00-89927. 2000-2005.
Pittsburgh Supercomputing Center Grant, (with Eric Rawdon) DMS-03-0005P. 2003-2004.
NSF Individual Investigator Grant, (with Joseph H.G. Fu) DMS-02-04862. 2002-2005.
University of Georgia Research Foundation, Faculty Research Grant. 2002-2003.
NSF Postdoctoral Research Fellowship, DMS-99-02397. 1999-2002.

Selected Domestic Invited Talks

Rocky Mountain Algebraic Combinatorics Seminar, June 2016.
AMS Spring Southeastern Section Meeting, March 2016.
AMS Special Session on Algebraic Structures in Knot Theory
Joint Mathematical Meetings 2015, Seattle, WA.
NSF Poster Session for Funded Education Projects.
Simons Center for Geometry and Physics, October 2015.
Symplectic and Algebraic Geometry in the Statistical Physics of Polymers Workshop
MathFest 2015, Washington DC.
Invited paper session: What can a mathematician do with a 3d printer?
FRAGMENT seminar, Colorado State University, March 2015.
University of Tennessee, Geometry/Topology Seminar, January 2015.
Washington and Lee University, Colloquium, November 2014.
AMS Southeastern Sectional Meeting, November 2014.
AMS Special Session on Knot Theory and Its Applications
Mills College, Colloquium, October 2014.
Holy Names University, Colloquium, October 2014.
AMS Western Sectional Meeting, October 2014.
AMS Special Session on Applications of Knot Theory to the Entanglement of Biopolymers
Vassar College, Colloquium, October 2014.
University of New Mexico MCTP Colloquium, April 2014.
AMS Western Sectional Meeting, April 2014.
AMS Special Session on Physical Knots, Honoring the Retirement of Jon K. Simon
Stony Brook University, April 2014.
AMS Joint Meetings, Baltimore, January 2014.
MAA Special Session: Teaching with Technology, Impact, Evaluation, Reflections
George Mason University, Colloquium, November 2013.
Georgia Topology Conference, July 2013.
Honors Day Colloquium Speaker, Mercer University, March 2013.
Mathematical Biosciences Institute Workshop, Mathematical Challenges in Biomedical Visualization, February 2013.
Emory University, Geometry and Analysis Seminar, January 2013.
Society for Mathematical Biology Annual Meeting, July 2012.
Modeling and Computation of Macromolecular Structures and Interactions.
UnKnot Conference, July 2012.
Southeast Geometry Seminar, April 2012.
SouthEast Geometry Conference, March 2012.

AMS Joint Meetings, Boston, January 2012.
 MAA Special Session: Knot Theory Untangled.
 AMS Fall Southeastern Section Meeting, Durham, September 2011.
 Special Session on Geometric Knot Theory and its Applications
 AMS Joint Meetings, New Orleans, LA. January 2011.
 Special Session on Measures of Entanglement of Macromolecules and Their Applications.
 Special Session on Knots, Links, 3-Manifolds, and Physics.
 Bryn Mawr-Haverford College Colloquium, September 2010.
 AMS Spring Central Section Meeting, St. Paul, April 2010.
 Tulane University, Colloquium speaker, February 2010.
 unKnot conference speaker, Dennison University, July 2009.
 University of Rochester, Geometry Seminar, Topology Seminar, and Math Club Seminar, February 2009.
 SouthEast Geometry Seminar, Georgia Tech, December 2008.
 Applications of Geometry to Topology and Physics, Rutgers-Newark, November 2008.
 University of Pennsylvania Geometry/Topology Seminar, January 2008.
 Smith College "Pizza Colloquium", October 2007.
 Valley Geometry Seminar, Univ. of Massachusetts, October 2007.
 AMS Fall Southwestern Section Meeting, Albuquerque, November 2007.
 Special Session on Topology and Physics
 AMS Fall Southeastern Section Meeting, Murfreesboro, November 2007.
 Special Session on Physical Knotting and Linking.
 University of Pennsylvania, Geometry and Analysis Seminars, May 2007.
 St. Thomas University, CAMS Colloquium, March 2007.
 Tulane University, Colloquium, November 2006.
 AMS Fall Central Section Meeting, Cincinnati, October 2006.
 Special Session on Physical Knotting and Linking.
 Vanderbilt University, Topology Seminar, January 2005.
 Tennessee State University, Colloquium, January 2005.
 Southeast Geometry Seminar, Georgia Tech, December 2005.
 University of Georgia Ideas for Creative Exploration (ICE) open house, September 2005. Harvard University, Topology Seminar, March 2005.
 Lehigh University Geometry and Topology Conference, June 2004.
 Pennsylvania State University, Geometry and Dynamics Seminar, December 2003.
 University of Pennsylvania Geometry Seminar, September 2003.
 AMS Spring Western Section Meeting, San Francisco, May 2003.
 Special Session on Numerical Methods, Calculations and Simulations in Knot Theory and its Applications.
 Emory University, Topology Seminar, April 2003.
 Southeast Geometry Seminar, Georgia Tech, November 2002.
 Georgia Tech, Geometry Seminar, August 2002.
 Discrete and Combinatorial Geometry Seminar, Cornell University, May 2002.
 University of Illinois, Champaign-Urbana, Geometry Seminar, February 2002.
 SIAM Geometric Design Minisymposium, Sacramento, November 2001.
 University of California, San Diego Topology Seminar, October 2001.
 Contributed talk, Georgia International Topology Conference, May 2001.
 Stanford/AIM Contact Geometry Conference, Stanford University, December 2000.
 Dartmouth College Colloquium, February 2000.
 Barnard College/Columbia University, Knot Theory Seminar, December 1999.
 Dartmouth College Colloquium, November 1999.
 Rutgers University, Topology/Geometry Seminar, April 1999.
 Princeton University, Geometry Seminar, April 1999.

Selected International Invited Talks

GELATO '15 Workshop, University of Basel, Switzerland, August 2015.

CanaDAM '15, University of Saskatchewan, June 2015.
 BIRS Workshop, "Entanglement in Biology", November 2013.
 Oberwolfach Workshop, Geometric Knot Theory, May 2013.
 BMS Fridays Colloquium, Berlin Mathematical School, Berlin, Germany, December 2012.
 Workshop "Quantized Flux in Tightly Knotted and Linked Systems",
 Issac Newton Institute, Cambridge, United Kingdom, December 2012.
 Geometric Analysis Seminar, Imperial College, London, United Kingdom, November 2012.
 Workshop "Geometric Structures in PDE", ICMat, Madrid, Spain, November 2012.
 Conference "Tangled Magnetic Fields in Astro- and Plasma Physics", Edinburgh, United Kingdom, October 2012.
 Durham University, Numerical Analysis Seminar, Durham, United Kingdom, September 2012.
 Issac Newton Institute, Topological Dynamics Seminar, Cambridge, United Kingdom, September 2012.
 ESF-EMS-CRM-Pi Conference on "Knots and Links: From Form to Function", Pisa, Italy, July 2011.
 CDG Workshop "Differential Geometry and Parametrization of 3D Knots", Centro Di Giorgi, Pisa, Italy, June 2011.
 BIRS Workshop, "Volume Inequalities", Banff, Canada, March 2010.
 BIRS Workshop, "Mathematics and physics of polymer entanglement", Banff, Canada, January 2010.
 ICTP Summer School on Knot Theory minicourse, Trieste, Italy, May 2009.
 Workshop on "Knots and Soft-Matter Physics", Kyoto, Japan, August 2008.
 BIRS Workshop "The Mathematics of Knotting and Linking in Polymer Physics and Molecular Biology",
 Banff, Canada, May 2008.
 Topology and Physics Conference, Chinese Academy of Sciences, Beijing, China, August 2007.
 Conference in Memory of X.S. Lin, Chern Institute of Mathematics, Tianjin, China, August 2007.
 BIRS Workshop "Mathematics of Knotting and Linking in Polymer Physics and Molecular Biology",
 Banff, Canada, May 2007.
 Cranfield University/RMCS, Department of Aerospace, Power, and Sensors Seminar,
 Swindon, United Kingdom, May 2005.
 Denmark Technical University Colloquium, Lyngby, Denmark, April 2005.
 Conference "Knots and Polymers: random knots, physical knots, and DNA knots,"
 Ochanomizu University, Tokyo, Japan. February 2005.
 Centrum voor Wiskunde en Informatica (CWI) seminar, Amsterdam, Netherlands. March 2004.
 Universität Bonn, Sfb 644 Seminar, Bonn, Germany, November 2003.

Outreach Activities

Taught two classes at Native American Community Academy (NACA) high school, Albuquerque, NM, in April 2014 on "robot calculus" problem.

Mathematical Visualization Activities

Continuing interest in the arts and visualization, reflected in exhibition of artworks and visualizations:

The Flocktree, sculpture/installation,

installed in courtyard at 159 Oneta Street, Athens, GA, Fall 2006, with support from UGA ICE program.

Everything in its right place III, digital media, *Contemporary Mathematical Photography and New Media*,
 New Image Gallery, James Madison University, Fall 2006.

Tight knot visualizations, digital rendering, *Cabinet* magazine, 2005.

Everything in its right place II, sculpture/installation,

AMS-MAA Joint Mathematics Meeting Mathematical Art Exhibit, January 2005.

Everything in its right place, installation, Main Gallery, Lamar Dodd School of Art, September 2004.