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Ph.D. Dissertation

Loop Spaces and Higher-Dimensional Iterated Enrichment, Virginia Tech, May 2004.
Directed by Frank Quinn.

Academic Appointments

- Associate Professor, University of Akron, 2014-current.
- Assistant Professor, University of Akron, 2010-2014.
- Assistant Professor, Tennessee State University, 2005-2010.
- Graduate Research Assistant, Virginia Tech, 2000-2004.
- Graduate Teaching Assistant, Virginia Tech, 1997-2002.

Nonacademic Employment

- Framatome Technologies (Areva), Virginia, Jan. 1996 - Aug. 1997, Summer and Fall 1998.

Education

- Ph.D. in Mathematics, from Virginia Tech
Center for Statistical Mechanics and Mathematical Physics, May 2004.
- M.S. in Mathematics from Virginia Tech, December 2002.
- B.S. in Mathematics with Computer Science concentration, summa cum laude
from Liberty University, May 1997.

Grants Won

- Combinatorial Geometry of Phylogenetic Trees
Faculty Research Committee Summer Fellowship, 2016
- *Algebraic Combinatorics and Convex Geometry*
NSA-AMS Mathematical Sciences Program Young Researcher Grant, 2014-2015.
- *The geometry of organic chemistry: Student research opportunities*
Faculty Research Award, Tennessee State University, Summer 2008.

Research Interests

- Algebraic and geometric combinatorics, phylogenetics:
Species and convex polytope sequences such as the permutohedra, associahedra
and multiplihedra; their quotients and generalizations, and their Hopf algebras.
Polytopes from phylogenetic trees and networks, applications to linear programming.
- Categorical homotopy theory and operad theory:
Braided and iterated monoidal categories, enriched categories and n -categories;
Loop spaces and A_n -spaces.
- Low dimensional topology:
Braid groups, knot concordance, and topological quantum field theory.

Research Publications

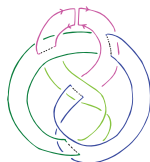
23. Split Network Polytopes and Network Spaces. (with S. Devadoss, C. Durell)
to appear: *DMTCS Proceedings*, FPSAC 31, 2019.

Research Publications, cont.

22. Species substitution, graph suspension, and graded Hopf algebras of painted tree polytopes. (with L. Berry, M. Ronco, P. Showers)
Algebraic and Geometric Topology, 19 (2), pp 1019-1078, 2019.
21. Optimization problems in phylogenetics: Polytopes, programming and interpretation. (with G. Hamerlinck, W. Sands)
Algebraic and Combinatorial Computational Biology
eds. R. Robeva, M. Macauley, pp 319-350, 2018.
20. Split-facets for Balanced Minimal Evolution Polytopes and the Permutoassociahedron. (with L. Keefe, W. Sands)
Bulletin of Mathematical Biology, 79(5), pp 975-994, 2017.
19. Facets of the Balanced Minimal Evolution Polytope. (with L. Keefe, W. Sands)
Journal of Mathematical Biology, 73(2), pp 447-468, 2016.
18. Stochastic safety radius on Neighbor-Joining method and Balanced Minimal Evolution on small trees (with J. Xi, J. Xie, and R. Yoshida).
emphProceedings of the 10th Workshop on Uncertainty Processing., pp 217-230, 2015.
17. Convex Polytopes from Nested Posets. (with S. L. Devadoss, S. Reisdorf, P. Showers)
European Journal of Combinatorics 43, pp 229248, 2015.
16. Recursive bijections for Catalan objects. (with M. Kafashan, M. Maleki and M. Strayer)
Journal of Integer Sequences, 16, Article 13.5.3, pp 1-20, 2013.
15. Cofree compositions of coalgebras. (with A. Lauve, F. Sottile)
Annals of Combinatorics, 17(1), pp 105-130, 2013.
14. When does compromise prevent more pollution?
(with C. Clemons, J. Cossey, M. Ferrara, T. Norfolk, G. Obeng, D. Ricciardi, G. Young)
Notices of the A.M.S., 59(9), 1223-1234, 2012.
13. Extending the Tamari lattice to some compositions of species. *Associahedra, Tamari Lattices and Related Structures: Tamari Memorial Festschrift*.
Progress in Mathematics, Vol. 299, pp 187-210,
F. Müller-Hoissen, J. Pallo, J. Marcel, J. Stasheff (Eds.), 2012.
12. Pseudograph associahedra. (with M. Carr, S. Devadoss)
Journal of Combinatorial Theory, Series A, 118(7), 2035-2055, 2011.
11. Cofree compositions of coalgebras (extended abstract). (with A. Lauve, F. Sottile)
DMTCS Proceedings, FPSAC 23 (Reykjavik, Iceland), 363-374, June 2011.
10. Hopf structures on the multiplihedra. (with A. Lauve, F. Sottile)
SIAM Journal on Discrete Mathematics, 24(4) 1250-1271, 2010.
9. Geometric combinatorial algebras: cyclohedron and simplex. (with D. Springfield)
Journal of Algebraic Combinatorics, 32 597-627, 2010.
8. New Hopf structures on binary trees. (with A. Lauve & F. Sottile)
DMTCS Proceedings, FPSAC 21 (Hagenberg, Austria), 411-420, 2009.
7. Marked tubes and the graph multiplihedron. (with S.L. Devadoss)
Algebraic and Geometric Topology, 8(4) 2081-2108, 2008.
6. Quotients of the multiplihedron as categorified associahedra.
Homotopy, Homology and Applications, vol. 10(2), 227-256, 2008.
5. Convex Hull Realizations of the Multiplihedra
Topology and its Applications, 156, 326-347, 2008.
4. Operads in iterated monoidal categories (with J. Siehler, E. Seth Sowers)
Journal of Homotopy and Related Structures 2, 1-43, 2007.
3. Classification of braids which give rise to interchange (with F. Humes)
Algebraic and Geometric Topology 7, 1233-1274, 2007.
2. Enrichment over iterated monoidal categories
Algebraic and Geometric Topology 4, 95-119, 2004.
1. Vertically iterated classical enrichment
Theory and Applications of Categories 12, 299-325, 2004.

Invited Presentations

20. *Clades and tubes: facets of graph associahedra and phylogenetic polytopes.*
Geometry and combinatorics of associativity, Hamilton Mathematics Institute, Dublin 2017.
19. *Recursive Linear Programming on the Balanced Minimal Evolution Polytope.*
Polyhedral and Combinatorial Biology,
SIAM conference on Applied Algebraic Geometry, Atlanta 2017.
18. *Faces of Balanced Minimal Evolution Polytopes from Quotients of the Permutoassociahedron.*
Geometric Phylogenetics, SIAM Conference on the Life Sciences, Boston 2016.
17. *Poset polytopes and some conjectured tree polytopes.*
Enumerative Algebraic and Geometric Combinatorics,(AMS) Loyola Oct. 2015.
16. *Facets of the BME polytope.*
The Mathematics of Evolution, Loyola Oct. 2015.
15. *Seeing in 4 dimensions.* Akron Physics Club Mar. 2014
14. *Pattern.* 1st Annual Greater Akron High School Mathematics Challenge, 2013.
13. *Tubings and polytope truncations.*
Coxeter Groups meet Convex Geometry: Workshop at LACIM, Montreal, 2012.
12. *Composing species and composing coalgebras.*
AMS Eastern Sectional, Species and Hopf Algebraic Combinatorics, Cornell, Sept. 2011
11. *Polytopes, phylogenetics, puddles and fractals.* REU at Kent State University,
Applications and Ramifications of Linear Algebra, 2011.
10. *Indelible grafting: Trees and polytopes.*
AMS Spring Eastern Sectional Meeting Worcester, April 2011.
Special Session on Physically Inspired Higher Homotopy Algebra .
9. *Composing and covering of coalgebras..*
SIAM conference on Discrete Math, Austin, 2010.
8. *Positrons, polytopes and antipodes.*
AMS Spring Southeastern Section Meeting Raleigh, April 2009.
Special Session on Homotopical Algebra with Applications to Mathematical Physics.
7. *Positrons, polytopes and antipodes.*
Texas A&M Algebra and Combinatorics Seminar, September 2008.
6. *How to draw a multiplihedron.*
Williams College mathematics colloquium, March 2008.
5. *Operads in iterated monoidal categories, featuring Young diagrams.*
University of Pennsylvania Deformation Theory Seminar, September 2006.
4. *Higher categories and geometric combinatorics of free groups.*
Topology and Group Theory Seminar Vanderbilt University, September 2005.
3. *n-fold operads in iterated monoidal categories.*
Categories in algebra, geometry, and mathematical physics,
Macquarie University, July 2005.
2. *Varieties of Iterated Enrichment.*
n-categories: Foundations and Applications, IMA, Minneapolis, June 2004.
1. *Knot Cobordism Categories.*
Virginia Tech graduate issues seminar, Nov. 2003.



Teaching Experience

Graduate Teaching: courses

- Advanced Combinatorics and Graph Theory.
- Topology I, point-set topology.
- Topology II, Algebraic topology.
- Structured Categories. (individual)
- Advanced Linear Algebra.
- The Associahedron: topology, combinatorics, and applications. (individual)

Undergraduate Teaching: courses

- Ordinary Differential Equations.
- Fundamentals of Advanced Mathematics.
- Combinatorics and Graph Theory.
- Calculus I, III, and Vector Geometry.
- Linear Algebra, with Mathematica.

Selected Contributed Presentations

- (refereed) *Compositions of cofree coalgebras: Trees and polytopes.*
FPSAC (Formal Power Series and Algebraic Combinatorics), Reykjavik 2011.
- *Pattern MA Θ* Math Honor society
induction ceremony guest speaker, St. Vincent St. Mary HS, Feb. 2011.
- *2-fold operads, Young diagrams, and dendritic growth.*
University Research Symposium, Tennessee State University, April 2008.
- *Multiplihedra: polytopes, pasting, and parameterized enrichment.*
AMS Fall Southeastern Meeting Murfreesboro, November 2007.
- *Convex hull realizations of the multiplihedra.*
AMS Fall Central Section Meeting, Chicago, October 2007.
- (refereed) *N-fold operads: braids, Young diagrams, and dendritic growth.*
Seminar on Categories and Applications IV,
Universitat Autònoma de Barcelona, June 2007.
- *What is an operad and how does it act? Algebras, modules, and the multiplihedra.*
National Assoc. of Math. Faculty conference, Tennessee State University, March 2007.
- (refereed) *A categorification of the associahedra.*
International Category Theory Conference CT06, Nova Scotia, June 2006.
- *Finite type invariants, grope cobordisms, and grope constraints*
AMS Special Session on Knot Theory and Its Applications, Bowling Green, March 2005.
- *Combinatoric n-fold monoidal categories from ordered semigroups*
AMS Special Session on Semigroup Theory, Vanderbilt, Nashville, October 2004.
- *Loop spaces, enrichment, and n-categories*
Union College Mathematics Conference, Schenectady, Nov. 2003.
- *Enrichment and Delooping of Categories with Loop Space Nerves*
Workshop on Categorification and Higher-Order Geometry,
Instituto Superior Técnico, Lisbon, July 2003.
- *Braids and Enrichment*
Lehigh University Geometry and Topology Conference, June 2003.

Selected Seminar Talks

- *Split-facets of the balanced minimal evolution polytope.*
one lecture: U. Akron Algebra seminar, April 2016.
- *Can symmetries help solve genetic mysteries?*
two lectures: U. Akron Algebra seminar, November 2015.
- *Routes, schedules, and genetic histories: using polytopes to find optimal solutions.*
three lectures: U. Akron Algebra seminar, October 2014.
- *Determinants and truth values.*
two lectures: U. Akron Algebra seminar, September 2013.
- *Tubes and Trees: When is a poset a polytope?*
two lectures: U. Akron Algebra seminar, March 2013.
- *Addition and multiplication of Young diagrams.*
two lectures: U. Akron Algebra seminar, 2011.
- *Introduction to the Hopf algebra of permutations.*
two lectures: U. Akron Algebra seminar, 2010.
- *Shapes and Lattices.*
Tennessee State U. student/faculty research seminar, October 2009.
- *Positrons, polytopes, and antipodes*
Tennessee State U. student/faculty research seminar, September 2008.
- *What is an operad, and how does it describe a loop space of knots?*
Tennessee State U. student/faculty research seminar, January 2007.
- *A short introduction to Geometric Combinatorics.*
Tennessee State U. student/faculty research seminar, October 2005.
- *Twisted Ribbons and Categorical Consequences of the Yang-Baxter Equation*
Virginia Tech graduate research seminar, Sep. 2003.
- *Introduction to Topological Quantum Field Theory*
VT graduate research seminar, March 2002.
- *Train Tracks and Projective Laminations*
two lectures for VT graduate research seminar, March 2002.

Selected Refereeing

- Referee for *Journal of Combinatorial Theory, Series A*, 2013, 2016.
- Referee for *Selecta Mathematica*, 2012.
- Referee for *SIAM Journal on Discrete Mathematics*, 2011.
- Referee for *Mathematical Structures in Computer Science*, 2010.
- Grant proposal review for *Fonds quebécois de la recherche sur la nature et les technologies*, 2010.
- Referee for *Journal of Homotopy and Related Structures*, 2008.
- Referee for *Theory and Applications of Categories*, 2007.

Activities

- Co-Organizer of Special Session on Graphs and Polytopes in Algebraic Combinatorics, Fall Central Sectional AMS Meeting October 20-21, 2012.
- Organizer of Physics and Mathematics Faculty Research Seminar, Tennessee State University, 2005-2010.
- Founder and organizer of Mathematics Graduate Student Research Seminar, Virginia Tech, 2003-2004.
- “Teaching to Promote Students Intellectual Development”
workshop by Marcia Baxter Magolda
VT Center for Excellence in Undergraduate Teaching, May 2001.

Advising: Thesis and Undergraduate Research

24. William Sands, MS, U. Akron
Phylogenetic Inference Using a Discrete-Integer Linear Programming Model, 2017.
23. Logan Keefe, MS, U. Akron
New Facets of the Balanced Minimal Evolution Polytope, 2016.
22. Matthew Hughes, MS, U. Akron
Price Signaling in a Two-Market Duopoly, 2016.
21. Joseph Johnson, MS, U. Akron
Modeling Monitoring of An Industry In A Game-Theoretic Framework With Imperfect Information, 2015.
20. Anthony Zunis, MS, U. Akron
A Game Theoretic Analysis and Simulation of Non-Incumbent Elections, 2014.
19. Patrick Showers, Master's Thesis, U. Akron
Abstract Polytopes from Nested Posets, 2013.
18. Lisa Berry, Master's Thesis, U. Akron
Painted trees and pterahedra, 2013.
17. Dan Crawford, Master's Thesis, U. Akron
Minimizing pollution through semi-antagonistic equilibrium points, 2013.
16. Bethany Baranyk, Master's Thesis, U. Akron
A Model for choosing a four-year university or a two-year community college with the presence of a government subsidy, 2012.
15. Stephen Reisdorf, Master's Thesis, U. Akron
Cellohedra, 2012.
14. George Obeng, Master's Thesis, U. Akron
A game theoretical model for prevention of meat contamination, 2011.
13. Michael Knap, Research Symposium Graduate Presentation 1st place winner, TSU
Simple statistical results of four network topologies in the discovery problem, 2010.
12. Kelly Jerik, Senior project, TSU
Finding a polytope which models the connectedness of a CW-complex, 2010.
11. Chris White, Senior project, TSU
An Analysis of the Programming for Chess Computers, 2010.
10. Fon Hunter, Senior project, TSU
Graded Algebra based on Polytope Faces, 2010.
9. Shaine Walker, Senior project, TSU
Associahedra: Polytopes and Lattices, 2009.
8. Derriell Springfield, Master's Thesis, TSU
Algebras based upon the cyclohedron, 2009.
7. K. Walker Kelly, Master's Thesis, TSU
Log Jams: Napier's logarithm and its morphs, 2008.
6. Govina M. Eyum, Master's Thesis, TSU
Products of Young diagrams in a 2-fold monoidal category, 2007.
5. E. Seth Sowers, Master's Thesis, TSU
Operads in 2-fold monoidal categories, 2006.
4. Felita N.C. Humes, Master's Thesis, TSU
Iterated monoidal categories based on a braiding, 2006.
3. Ahmad Kheder, Senior project, TSU
Investigating minimal recursive growth., 2007.
2. Lauren Murphy, Senior project, TSU
Seifert surfaces, knots and braids, 2006.
1. Jerome Lecointre, Senior project, TSU
Polytope structure of the composihedra, 2006.