

# DAVID L. DUNCAN

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James Madison University  
Department of Mathematics and Statistics  
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Harrisonburg, VA 22807

## Employment

- **Associate Professor**—James Madison University  
*August 2023–Present*
- **Assistant Professor**—James Madison University  
*August 2018–July 2023*
- **Postdoctoral Fellow**—McMaster University  
*September 2015–August 2018*
- **Visiting Assistant Professor**—Michigan State University  
*August 2013–August 2015*

## Education

- **Ph.D. Mathematics**—Rutgers University  
*Degree Received: May 2013*
  - Advisor: Chris Woodward
  - Dissertation Title: *Compactness Results for the Quilted Atiyah–Floer Conjecture*
- **B.S. Mathematics**—University of Washington  
*Degree Received: August 2006*
  - Distinction in Mathematics
  - Comprehensive Option
  - Minor in Physics

## Research Interests

- Gauge Theory
- Low-Dimensional Topology

## Publications and Preprints

D.L. Duncan, I. Hambleton. Existence of  $mASD$  connections on 4-manifolds with cylindrical ends. *Communications in Analysis and Geometry* (Accepted March 2023)  
<https://arxiv.org/abs/2007.13822>

D.L. Duncan. Triangles & princesses & bears, oh my! A journey from a puzzle to the Schrödinger equation. *The Mathematical Intelligencer* (2022). DOI: 10.1007/s00283-022-10219-5

D.L. Duncan, W.J. Engelbrecht. Characterizing immutable sandpiles: A first look. *Discrete Math.*, Vol. 345, Issue 1, 2022. <https://arxiv.org/abs/2006.00041>

J.E. Ducey, D.L. Duncan, W.J. Engelbrecht, J.V. Madan, E. Piato, C.S. Shatford, A. Vichitbandha. Critical group structure from the parameters of a strongly regular graph. *J. of Comb. Theory, Series A*, Vol. 180, 105424, 2021.

D.L. Duncan. The Yang–Mills flow for cylindrical end 4-manifolds. *Indiana Univ. Math. J.*, Vol. 69, Issue 3, pp. 1007–1071, 2020.

D.L. Duncan. The Chern–Simons invariants for doubles of compression bodies. *Pac. J. Math.* **280**, 17–39, 2016.

D.L. Duncan. Compactness results for neck stretching limits of instantons. 77 pages. <https://arxiv.org/abs/1212.1547>

D.L. Duncan. On the components of the gauge group for  $PU(r)$ -bundles. 18 pages. <https://arxiv.org/abs/1311.5611>

D.L. Duncan. An index relation for the quilted Atiyah–Floer conjecture. 33 pages. <https://arxiv.org/abs/1311.4004>

D.L. Duncan. Higher-rank instanton cohomology and the quilted Atiyah–Floer conjecture. 51 pages. <https://arxiv.org/abs/1311.5609>

## Invited Talks

- "Gluing mASD connections on cylindrical end 4-manifolds". Gauge Theory Virtual Seminar. April 2021.
- "Gluing mASD connections on cylindrical end 4-manifolds". Gauge Theory, Geometry, and Low-Dimensional Topology special session. AMS Spring Virtual Meeting. March 2021.
- "Triangles and princesses and bears. Oh my!". Cleveland State University Colloquium. January 2021.
- "Bundle splittings on boundary-punctured disks". Brandeis Topology Seminar. October 2020.
- "The Chern–Simons invariants for general compact Lie groups". Duke Geometry and Topology Seminar, NC. November 2018.
- "Triangles and princesses and bears. Oh my!". Hillsdale College Colloquium, MI. February 2018.
- "Gauge Theory: Using PDEs to study manifolds". University of Nebraska at Omaha Colloquium, NE. February 2018.
- "Triangles and princesses and bears. Oh my!". University of Nebraska at Omaha Undergraduate Colloquium, NE. February 2018.
- "Gauge Theory: Using PDEs to study manifolds". James Madison University Colloquium, VA. January 2018.

- "A short tour from manifolds to gauge theory (and back?)". McMaster Threads Colloquium, ON. January 2018.
- "Some open problems in gauge theory, symplectic geometry, and low-dimensional topology". McMaster Geometry & Topology Seminar - Postdoctoral Seminar, ON. November 2017.
- "Boundary-singular holomorphic curves from instantons". Fields Institute Thematic Program on Geometric Analysis, ON. September 2017.
- "From instantons to holomorphic curves". Simons Center Workshop on Gauge Theory and Low Dimensional Topology, NY. April 2017.
- "Identifying instantons with holomorphic curves". Waterloo Geometry & Topology Seminar, ON. March 2017.
- "Triangles and princesses and bears. Oh my!". Hamilton College Mathematics Colloquium, NY. January 2017.
- "Heat flows for cylindrical end manifolds". CMS Winter Meeting in Niagara, ON. December 2016.
- "A new proof of a theorem of Dostoglou and Salamon". BIRS Conference on Interactions of Gauge Theory with Contact and Symplectic Topology in Dimensions 3 and 4 in Banff, AB. April 2016.
- "A new proof of a theorem of Dostoglou and Salamon". Rutgers Geometry, Physics, and Mirror Symmetry Seminar in Piscataway, NJ. March 2016.
- "Holonomy perturbations for ASD connections". Fields Gauge Theory Seminar in Toronto, ON. February 2016.
- "The quilted Atiyah–Floer conjecture and the Yang–Mills heat flow". SIAM Conference on Analysis in Partial Differential Equations in Scottsdale, AZ. December 2015.
- "Gauge theoretic invariants of surface products". CMS Winter Meeting in Montréal, QC. December 2015.
- "Uhlenbeck compactness". Fields Gauge Theory Seminar in Toronto, ON. October 2015.
- "Instanton and symplectic invariants for surface products". Fields geometric structures laboratory in Toronto, ON. October 2015.
- "On the critical values of the Chern–Simons functional". McMaster Geometry and Topology Seminar in Hamilton, ON. October 2015.
- "Gauge theory and 4-manifolds". Fields Gauge Theory Seminar in Toronto, ON. September 2015.
- "The quilted Atiyah–Floer conjecture and the Yang–Mills heat flow". AMS Spring Meeting in Washington DC. March 2015.
- "From instantons to quilts with boundary degenerations". CMS Winter Meeting in Hamilton, ON. December 2014.
- "Morse theory: Using functions to ‘see’ in higher dimensions". MSU Topical Seminar for Undergraduate Mathematicians. December 2014.
- "Chern–Simons invariants at the ends of 4-manifolds - Part 2". MSU Gauge Theory Seminar. October 2014.

- "Chern-Simons invariants at the ends of 4-manifolds - Part 1". MSU Gauge Theory Seminar. September 2014.
- "Instanton Floer homology and symplectic geometry". Rutgers Geometry Seminar. April 2014.
- "Yang–Mills connections for degenerating metrics". McMaster Geometry and Topology Seminar. April 2014.
- "On the critical values of the Chern–Simons functional". Purdue Geometry Seminar. March 2014.
- "An introduction to low-dimensional topology". Math department presentation for the MSU Alumni Distinguished Scholarship. February 2014.
- "An introduction to the quilted Atiyah–Floer conjecture". MSU Geometry and Topology Seminar. September 2013.
- "A compactness result for the quilted Atiyah–Floer conjecture". McMaster Geometry and Topology Seminar. February 2013.
- "A compactness result for the quilted Atiyah–Floer conjecture". University of Toronto Symplectic Geometry Seminar. January 2013.
- "Compactness results for the Atiyah–Floer conjecture for broken circle fibrations". Rutgers Geometry, Physics and Mirror Symmetry Seminar. November 2012.
- "Loewner’s Differential Equation and SLE". Rutgers Graduate Student Seminar. September 2008.

## Teaching Talks

- "Connecting learning goals and exams in STEM classes". Rutgers TA Project Graduate Student Workshop. February 2013.
- "Assessment—How to tell if students have learned what you want them to learn and giving feedback on assignments". Rutgers College Teaching II. November 2012, November 2011.
- Invited Panelist. Rutgers TA Training for Graduate Students in Mathematics. March 2012.
- "Dealing with different levels of academic preparation". Rutgers TA Project Graduate Student Workshop. October 2012.
- "Understanding your undergraduates: your students and their world". Rutgers TA Project Graduate Student Workshop. February 2012, September 2010.
- "Helping struggling students". Rutgers TA Project Graduate Student Workshop. October 2011.
- "Creative teaching in the STEM disciplines". Rutgers TA Project Graduate Student Workshop. April 2011.
- Invited Speaker. Rutgers TA Training for Graduate Students in Mathematics. March 2011.
- Invited Panelist. Rutgers TA Project Teaching Assistant Orientation. August 2010.
- Invited Panelist. Rutgers Innovation Through Institutional Integration Mentoring Skills Workshop. May 2010.

## Fellowships, Awards, etc.

- Project NExT Fellow. Summer 2019–Summer 2020.
- Section NExT Fellow (MD-DC-VA section). Fall 2018–Spring 2020.
- McMaster University Britton Postdoctoral Fellowship. Fall 2015–Spring 2017.
- Michigan State University RTG Grant. Spring 2014. NSF Award Number DMS 0739208.
- Research Assistantship. Rutgers University. Fall 2010, Fall 2011, Fall 2012.
- Rutgers Academy for the Scholarship of Teaching and Learning (RASTL) Fellowship. 2010–2011, 2011–2012, 2012–2013.
- TA Excellence Award. Spring 2010.
- Graduate Assistance in Areas of National Need (GAANN) Fellowship. 2007–2008.

## Conferences and Seminars Organized

- *Math & Stats Colloquium at James Madison University*. Organizer (with Chris Willingham, Prabhashi Withana Gamage, and Jim Sochacki). Fall 2019–Fall 2021.
- *Mastery-Based Grading. What is it? How can I get started?*. Project NExT 2020 Summer Virtual Meeting (in lieu of 2020 MathFest). Organizer (with Francesca Gandini and Whitney Liske). Summer 2020.
- *Ideas for success in undergraduate research*. MAA MD-DC-VA 2019 Fall Section Meeting. Organizer (with Jeff Ledford). Fall 2019.
- *Geometry and Topology Seminar*. McMaster University. Organizer. Winter 2017, Fall 2016.
- *Fields Gauge Theory Seminar*. Fields Institute. Organizer (with I. Hambleton). Fall 2015.
- *Special Session on Floer Homology, Gauge Theory, and Symplectic Geometry*. AMS Spring Meeting in East Lansing. Organizer (with M. Hedden and T. Parker). March 2015.
- *Graduate Student Geometry Seminar*. Rutgers University. Organizer (with A. Maalaoui). 2010–2012

## Teaching Experience

### • James Madison University

- Math 205: Introductory Calculus I. Su '22, Sp '22 (two sections), F '21 (two sections), Su '21, Sp '21 (two sections), Sp '20 (two sections), F '20.
- Math 235: Calculus I. F '22 (two sections), F '19 (two sections), F '18 (two sections).
- Math 236: Calculus II. Sp '23 (two sections).
- Math 237: Calculus III. F '23.
- Math 245: Discrete Mathematics. F '23 (two sections), Sp '22.
- Math 297: Undergraduate Research. Sp '22.
- Math 300: Linear Algebra. F '21 (two sections).
- Math 337: Advanced Calculus. Sp '23.
- Math 410: Real Analysis I. F '20 (two sections), Sp '20.

- Math 411: Real Analysis II. Sp '21.
- Math 485: Mathematical Physics. F '22
- Math 485: Differential Geometry. F '18.
- Math 486: Functional Analysis. F '22.
- Math 486: Differential Geometry. Sp '22.
- Math 486: Algebraic Topology. Sp '20.
- Math 486: Lie Groups. F '19.
- Math 497: Undergraduate Research. F '21, F '20, F '19.
- Math 499A–C: Honors Thesis. Sp '20–Sp '21.

- **McMaster University**

- Math 1A03: Calculus I. F '15.
- Math 1C03: Introduction to Mathematical Reasoning. F '16.
- Math 3A03: Analysis. F '17.
- Math 3T03: Topology. Winter 2018, Sp '16.
- Math 4W03: Differential Topology (Reading Course). W '18.
- Math 762: Differential Geometry (Graduate Course). W '17.

- **Michigan State University**

- Math 153H: Calculus II (Honors). F '14.
- Math 299: Transitions to Formal Mathematics. F '14, Sp '14, F '13 (two sections).
- Math 330: Higher Geometry. Su '15.
- Math 396: Capstone in Mathematics for Secondary Education. Sp '15.

- **Rutgers University**

- Math 135: Calculus I. Recitation Instructor. F '08.
- Math 151: Calculus I for Mathematical and Physical Sciences. Lecturer and Workshop Instructor. Sp '11, F '09, Sp '09 (Workshop Instructor Only).
- Math 152: Calculus II for Mathematical and Physical Sciences. Lecturer and Workshop Instructor. Sp '12, Sp '10.
- Math 421: Advanced Calculus for Engineering. Lecturer. Su '11.
- Head Teaching Assistant. Su '12, Su '11.

- **Kelsey Creek Alternative School (K–12 Teaching)**

- Geometry. Instructor. F '06, '05–'06, '04–'05, Sp '04.
- Physics. Instructor. F '06.
- Math Enrichment. Instructor. F '06.
- Science Enrichment. Instructor. F '06.
- Logic. Instructor. '05–'06.
- Math Analysis. Instructor. '05–'06.
- Calculus. Instructor. '04–'05.

- **Prime Learning Center (K–12 Supplemental Learning)**

- Geometry I A. Instructor. 3 sessions. '05–'06.
- Geometry I B. Instructor. 2 sessions. '05–'06.
- Pre-Algebra I A. Instructor. 1 session. '06.
- Algebra I A. Instructor. 1 session. '05.

## Mentoring Experience

- **Research Supervisor—REU—James Madison University**

- Students: Michael Glover, Lydia Hill. Project: *Geodesic Flows of Fixed-Area Polygons*. Summer 2023. Supported by the Jeffrey E. Tickle '90 Family Endowment.

- **Research Supervisor—REU—James Madison University**

- Students: Andre Mas, William Nettles, Noah Pope. Project: *Gradient Flows—Approximation Schemes and General Properties*. Summer 2022. Supported by the Jeffrey E. Tickle '90 Family Endowment.

- **Research Supervisor—Undergraduate Research—James Madison University**

- Student: Ashray Shah. Project: *The Critical Group*. Spring 2022.

- **Research Supervisor—Undergraduate Research—James Madison University**

- Student: William Nettles. Project: *Geodesics & the Schrödinger Equation*. Fall 2022.

- **Research Supervisor—REU—James Madison University**

- Students: Andre Mas and Shane Daveler. Project: *Representation Varieties*. Summer 2021. Supported by the Jeffrey E. Tickle '90 Family Endowment.

- **Thesis Supervisor—Undergraduate Honors Thesis—James Madison University**

- Student: Shane Daveler. Project: *Representation Varieties and Fixed Points*. Spring 2020–Spring 2021.

- **Supervisor—Undergraduate Reading Course/Research—James Madison University**

- Student: Jacob Crim. Project: *The Volume Conjecture*. Fall 2020–Spring 2021.

- **Research Supervisor—REU—James Madison University**

- Students: Jacob Crim and Shane Daveler. Project: *Critical Groups*. Summer 2020. Supported by the Jeffrey E. Tickle '90 Family Endowment.

- **Research Supervisor—Undergraduate Research—James Madison University**

- Student: Wesley Engelbrecht. Project: *Immutable Sandpiles*. Fall 2019–Spring 2020.

- **Research Supervisor (with J. Ducey)—REU—James Madison University**

- Students: Wesley Engelbrecht, Jawahar Madan, Eric Piato, Christina Shatford, Angela Vichitbandha. Project: *Algebraic and Geometric Invariants of Incidence Structures*. Summer 2019. Supported by NSF Grant Number 1560151 and the Jeffrey E. Tickle '90 Family Endowment.
- **Assistant Research Supervisor (with C. Woodward)—REU—Rutgers University**
  - Student: Jake McNamara. Project: *Injectivity of the Narasimhan–Seshadri map for instantons*. Summer 2014. Supported by NSF Award DMS 1207194.
- **Mentor—Graduate Reading Course—Michigan State University**
  - Student: Metin Ozsarfatı. Project: *Introduction to Morse 2-Functions*. Spring 2014.
- **Assistant Research Supervisor (with C. Woodward)—REU—Rutgers University**
  - Student: Andrew Schultz. Project: *Heegaard Splittings of Circle Fibrations*. Summer 2012. Supported by NSF Award DMS 0605097.
- **Mentor—Directed Reading Program—Rutgers University**
  - Student: Jazmin Velez. Project: *Linear Operators on Function Spaces*. Summer 2011.
- **Mentor—Directed Reading Program—Rutgers University**
  - Student: Jaxmin Velez. Project: *Complex Vector Spaces*. Spring 2011.
- **Prague Group Mentor—DIMACS REU—Charles University in Prague, Czech Republic**
  - Summer 2010.
- **Assistant Research Supervisor (with C. Woodward)—REU—Rutgers University**
  - Student: Glen Wilson. Project: *Displacing Fibers of Moment Polytopes*. Summer 2010.
- **Mentor—Directed Reading Program—Rutgers University**
  - Student: Pratik Desai. Project: *Projective Space*. Summer 2010.
- **Prague Group Mentor—DIMACS REU—Charles University in Prague, Czech Republic**
  - Summer 2009.
- **Mentor—Directed Reading Program—Rutgers University**
  - Student: Vaibhav Sharma. Project: *The Riemann Zeta Function*. Fall 2008.
- **Mentor—Directed Reading Program—Rutgers University**
  - Student: Matt Calhoun. Project: *Matrix Lie Groups*. Fall 2007.

## Service to the Profession

- **Associate Editor**
  - Mathematics Magazine. Jan. 2020–Present, Jan. 2019–Dec. 2020 (interim).



- **First Year Advisor**
  - Advisor for First Year Math & Stats Majors at JMU. May 2022–Present.
- **Referee**
  - Geometriae Dedicata
  - Mathematics Magazine
  - SIGMA
  - Transactions of the AMS

## Other Activities

- **4-VA Grant**
  - Co-PI. The Proofs Project (out of Virginia Tech). Summer 2023–Winter 2024.
- **Fields Institute—Toronto, ON**
  - Teaching Assistant (for A. Naber). Summer School on Geometric Analysis. Summer 2017.
- **Michigan State University, Department of Mathematics—East Lansing, MI**
  - Coordinator (with K. Stilson and B. Dillman). Math Summer Camp (Grades 4–6). Summer 2015.
- **DIMACS—Piscataway, NJ**
  - Graduate Coordinator (with B. Nakamura). DIMACS/Rutgers Math REU (Research Experience for Undergraduates). Summer 2009, Summer 2010.
- **Education Access Network—Seattle, WA**
  - Mathematics Curriculum Developer. Spring 2006–Fall 2006.
  - SAT/ACT Math Preparation Workshop. Instructor. Spring 2006–Summer 2006.

## Undergraduate Research

- **Besicovitch’s Approach to Kakeya’s Conjecture—Senior Thesis**
  - Advisor: Jim Morrow
- **Stochastic Loewner Evolution**
  - Advisors: Steffen Rohde, Joan Lind