

DAVID AYALA
DAVID.AYALA@MONTANA.EDU

Education.

- **Stanford University.** Ph.D. Mathematics (2009).
Dissertation title: *Geometric cobordism categories*
Advisor: Ralph L. Cohen
- **University of Utah.** M.S. Mathematics (2004).
- **University of Utah.** B.S Physics (2004).
- **University of Utah.** B.S Mathematics (2002).

Employment.

- **Montana State University.** Associate Professor of Mathematics (2020–present).
- **Mathematical Sciences Research Institute.** Research Professor (2020).
- **Montana State University.** Assistant Professor of Mathematics (2014–2020).
- **University of California, Berkeley.** Mathematical Sciences Research Institute, Postdoctoral Fellow (2014).
- **University of Southern California.** NSF Postdoctoral Fellow (2013–2014).
- **Harvard University.** NSF Postdoctoral Fellow (2009, 2011–2013).
- **University of Copenhagen.** ERC Postdoctoral Fellow (2009–2010).

Grants.

- **Career Grant: Factorization Homology and Quantum Topology.** National Science Foundation, division of mathematical sciences. Award 1945639 (2019).
- **Workshops: Homotopy Harnessing Higher Structures.** National Science Foundation, division of mathematical sciences. Award 1833295 (2018).
- **Factorization Homology, Deformation Theory, and Duality.** National Science Foundation, division of mathematical sciences: topology. Award 1812055 (2018–2021).
- **Faculty Excellence Grant.** Montana State University (2015, 2016, 2017).
- **Factorization Homology and the Cobordism Hypothesis.** National Science Foundation, division of mathematical sciences: topology. Award 1507704 (2015–2018).

- **Scanning Methods in Algebraic Topology.** National Science Foundation, division of mathematical sciences: postdoctoral fellowship. Award 0902639 (2009–2013).

Awards.

- **Meritorious Research and Creativity Award**, offered by the the College of Letters and Science at Montana State University (2019).
- **Stannard Teaching Award**, for upper-division instruction and mentorship in the Mathematical Sciences department at Montana State University (2018).
- **ARCS.** Achievement Rewards for College Scientists: graduate student fellowship (2007–2008).
- **VIGRE.** National Science Foundation, division of mathematical sciences: graduate fellowship (2003–2004).

Research papers.

Published or accepted (refereed).

- (1) **Natural symmetries of secondary Hochschild homology.** Joint with John Francis and Adam Howard. To appear in Algebraic and Geometric Topology. arXiv:2111.08798
- (2) **Stratified non-commutative stacks.** Joint with Aaron Mazel-Gee and Nick Rozenblyum. To appear in Memoirs of the AMS. arXiv:1910.14602
- (3) **Flagged higher categories.** Joint with John Francis. Topology and quantum theory in interaction, 137–173, Contemporary Mathematics, 718, Amer. Math. Soc., Providence, RI, 2018.
- (4) **Fibrations of ∞ -categories.** Joint with John Francis. To appear in Higher Structures. arXiv:1702.02681.
- (5) **Factorization homology I: higher categories.** Joint with John Francis and Nick Rozenblyum. Advances in Mathematics 333 (2018), 1042–1177.
- (6) **A stratified homotopy hypothesis.** Joint with John Francis and Nick Rozenblyum. Accepted, Journal of the European Mathematical Society. arXiv:1409.2857.
- (7) **Poincaré/Koszul duality.** Joint with John Francis. Comm. Math. Phys. 365 (2019), no. 3, 847–933.
- (8) **Zero-pointed manifolds.** Joint with John Francis. To appear in Journal of the Institute of Mathematics of Jussieu arXiv:1409.2857.
- (9) **Factorization homology of stratified spaces.** Joint with John Francis and Hiro Lee Tanaka. Selecta Mathematica (N.S.) 23 (2017), no. 1, 293–362.

- (10) **Local structures on stratified spaces.** Joint with John Francis and Hiro Lee Tanaka. *Advances in Mathematics* 307 (2017), 903–1028.
- (11) **Factorization homology of topological manifolds.** Joint with John Francis. *Journal of Topology* 8 (2015), no. 4, 1045–1084.
- (12) **Configuration spaces and Θ_n .** Joint with Richard Hepworth. *Proceedings in the American Mathematical Society* 142 (2014), no. 7, 2243–2254.
- (13) **Counting bitangents with stable maps.** Joint with Renzo Cavalieri. *Expositiones Mathematicae* 24 (2006), no. 4, 307–335.

Preprints.

- (1) **Symmetries of a rigid braided category.** Joint with John Francis.
arXiv:2205.04954
- (2) **Derived Mackey functors and equivariant cohomology.** Joint with Aaron Mazel-Gee and Nick Rozenblyum. Preprint.
arXiv:2105.02456 .
- (3) **Traces for factorization homology in dimension 1.** Joint with John Francis. Preprint.
arXiv:2105.01143
- (4) **The geometry of cyclotomic trace.** Joint with Aaron Mazel-Gee and Nick Rozenblyum. Preprint.
arXiv:1710.06414
- (5) **A naive approach to equivariant and cyclotomic spectra.** Joint with Aaron Mazel-Gee and Nick Rozenblyum. Preprint.
arXiv:1710.06416
- (6) **Factorization homology of enriched $(\infty, 1)$ -categories.** Joint with Aaron Mazel-Gee, John Francis, and Nick Rozenblyum. Preprint.
arXiv:1710.06409
- (7) **The cobordism hypothesis.** Joint with John Francis. Preprint.
arXiv:1705.02240

Book chapters (invited, refereed).

- (1) **A factorization homology primer.** Joint with John Francis. To appear in the *Handbook of Homotopy Theory*.
arXiv:1903.10961

Other publications (not refereed).

- **In hope of climate-aware conferencing.** Joint with Lukas Bantner, Andre Henriques, Theo Johnson-Freyd, and Aaron Mazel-Gee. To appear in the *London Mathematical Society Newsletter* 480 (2019), 32–33.

Editorial Work.

- **Topology and quantum theory in interaction.** Jointly edited with Daniel Freed and Ryan Grady. Contemporary Mathematics of the American Mathematical Society, 718 (2018).

Teaching.

- Methods of Proof. Spring 2023.
- Algebraic Topology. Spring 2023.
- Topology. Fall 2022.
- Calculus on Manifolds. Fall 2021.
- Introduction to Topology. Fall 2021.
- Algebraic Topology Spring 2021.
- Introduction to Linear Algebra. Spring 2021.
- Advanced Linear Algebra. Fall 2020.
- Calculus on Manifolds. Fall 2019.
- Introduction to Topology. Fall 2019.
- Geometric and Algebraic Topology. Spring 2019.
- Topology. Fall 2018.
- Advanced Linear Algebra. Fall 2018.
- Introduction to Abstract Algebra. Spring 2018.
- Calculus on Manifolds. Fall 2017.
- Advanced Linear Algebra. Fall 2017.
- Abstract Algebra. Spring 2017.
- Introduction to Linear Algebra (course supervisor). Spring 2017.
- Advanced Linear Algebra. Fall 2016.
- Introduction to Linear Algebra. Fall 2016.
- Riemannian Geometry. Spring 2016.
- Abstract Algebra. Spring 2016.
- Topology. Fall 2015.
- Geometric and Algebraic Topology. Spring 2015.
- Topology. Fall 2014.
- Honors Vector Calculus. Fall 2014.

Students.

- **Graduate.**
 - Zachary Jandrasi. PhD, Montana State University (2027, expected)
 - Garrett Figueroa. PhD, Montana State University (2026, expected)
 - Alexandra Ballow. PhD, Montana State University (2026, expected)
 - Samuel McCrosson. PhD, Montana State University (2026, expected)

- Benjamin Moldstad. PhD, Montana State University (2024, expected)
- Adam Howard. PhD, Montana State University (2021).
- Eric Berry. PhD, Montana State University (2021).
- Scotty Tilton. Masters project, Montana State University (2019).
- Anna Cepek. PhD, Montana State University (2019).
- Daniel Perry. PhD, Montana State University (2019).
- Emanuele Dotto. Masters project, University of Copenhagen (2010).
- Casper Guldberg. Masters project, University of Copenhagen (2010).
- **Undergraduate.**
 - Mark Poston & Scotty Tilton. Bachelors project, Montana State University (2019).

Graduate Committees.

- **PhD.**
 - **Past.** Adam Howard (chair), 2021; Eric Berry (chair), 2021; Eric Fink, 2020; Matthew Raymond, 2019; Daniel Perry (chair), 2019; Anna Cepek (chair), 2019; Hannah Bergren, 2016; Joseph Manlove, 2015.
 - **Present.** Benjamin Moldstad (chair); Christopher McKay; Samuel McCrosson (chair); Alexandra Ballow (chair); Garrett Figueroa (chair); Fredrick Fox (chair); Christopher Boehlert;
- **Masters.**
 - **Past.** Quinn Anderson, 2019; Adam Howard, 2018; Holt Bodish (chair), 2018; Micah Thorpe-Kramp, 2018; Stephen Gormley, 2018; Dustin Roose, 2018; Kai Jensen, 2018; Tyler Reckner, 2017; Derek Conder, 2016;
 - **Present.** James Powell (chair), 2023; Zoya Batool (chair), 2023;

University service.

- 2022/23: Graduate curriculum reform committee, Graduate program committee, Hiring committee, DEI task-force member, Colloquium committee, Topology comprehensive exam.
- 2021/22: Graduate program committee, DEI task-force member, Colloquium committee, Retention-Promotion-Tenure committee, Topology comprehensive exam.
- 2020/21: Graduate program committee, Math seminar organizer, Colloquium committee, Algebra comprehensive exam.
- 2019/20: Math seminar organizer, Hiring committee, Colloquium committee.

- 2018/19: Math seminar organizer, Hiring committee, Colloquium committee.
- 2017/18: Awards committee, Algebra comprehensive exam, Topology comprehensive exam.
- 2016/17: Algebra comprehensive exam, Topology comprehensive exam.
- 2015/16: Topology comprehensive exam.
- 2014/15: Hiring committee, Topology comprehensive exam.

Program organization.

- (1) **Stable categories in Paradise Valley.** MSU (2023). Week-long workshop.
- (2) **Higher category theory and categorification.** Instituto de Matematicas, Universidad Nacional Autonoma de Mexico (2022). Month-long program.
- (3) **Higher category theory and categorification.** Mathematical Sciences Research Institute (2020). Semester-long program.
- (4) **Higher category theory: introductory workshop.** Mathematical Sciences Research Institute (2020). Week-long workshop.
- (5) **Homotopy harnessing higher structures: manifolds.** Isaac Newton Institute (2018). Week-long conference.
- (6) **Higher algebra and mathematical physics.** Perimeter Institute (2018). Week-long double-conference.
- (7) **NSF-CBMS: geometric and topological methods in quantum field theory.** Montana State University (2017). Week-long conference.
- (8) **Factorizable structures in topology and algebraic geometry.** Banff International Research Station (2015). Week-long workshop.
- (9) **West coast algebraic topology summer school: topological quantum field theory.** University of British Columbia (2014). Week-long summer school.
- (10) **West coast algebraic topology summer school: homotopy theory, manifolds, and topological field theories.** University of Oregon (2010). Week-long summer school.

Peer review.

- **Journal referee.** Annals of Mathematics; Inventiones Mathematicae; Journal of the American Mathematical Society; Geometry and Topology; Algebraic and Geometric Topology; Journal of Topology; Advances in Mathematics; Proceedings of the American Mathematical Society; Transactions of the American

Mathematical Society; Mathematics Annalen; London Mathematical Society; Israel Journal of Mathematics; Homology, Homotopy, and Application; Royal Society of Edinburgh: Proceedings A.

- **NSF panelist.** Topology grants.

Invited conference presentations (selected).

- **Global categorical symmetries.** Derived Skein modules. Switzerland (2023).
- **Stratifications in algebra and topology.** Homotopy theory with applications to arithmetic and geometry. Fields Institute (2022).
- **Traces via factorization homology.** Getzler's Birthday conference. Northwestern (2022).
- **Factorization homology for tangles.** Homotopical methods in geometry and physics; 6-part lecture series. Northwestern (2022).
- **The 1-dimensional tangle hypothesis.** Tensor categories and topological quantum field theories. MSRI (2020).
Video: <https://www.msri.org/workshops/917/schedules/28198>
- **Factorization homology.** Higher structures in holomorphic and topological field theory. IHES (2019).
Video: <https://www.imclips.net/video/UENa1-ZehG4.html>
- **Geometry of the cyclotomic trace.** NRW Topology Meeting. University of Muenster (2018).
- **Geometry of the cyclotomic trace.** Conference on Trace Methods. Northwestern University (2018).
- **Factorization homology.** Conference on Factorization Homology; 8-part lecture series. Haifa University (2018).
- **Adjoint and orthogonal groups.** Workshop on Higher Operads. BIRS, Oaxaca (2018).
Video: www.birs.ca/events/2018/5-day-workshops/18w5147/videos/watch/201805091000-Ayala.html
- **Geometry of the cyclotomic trace.** AMS special session, Portland State University (2018).
- **Factorization homology and the cobordism hypothesis.** Workshop on Factorization Algebras and Configuration Spaces; 2-part lecture series. University of Nice (2018).
- **Factorization homology.** Conference on Floer Homology and Homotopy Theory. University of California at Los Angeles (2017).
- **Factorization homology and TQFT.** Topology Festival. Cornell University (2017).

- **Deeply non-affine algebraic sigma-models are state sum field theories.** QFT on Manifolds with Boundary and BV. Perimeter Institute (2017).
- **Higher adjoints and the orthogonal group.** Wasatch Topology Conference. University of Utah (2016).
- **Factorization homology.** Workshop on Factorization Homology; 3-part lecture series. University of Texas at Austin (2016).
- **Factorization homology.** Summer school on factorization homology; 12-part lecture series. Instituto Nacional de Matematica Pura e Aplicada (IMPA) (2016).
Video: <https://m.youtube.com/watch?v=JL57PFiqptM>
- **Factorization homology.** Summer school: Homotopy theory, manifolds, and topological field theories; 6-part lecture series. Hausdorff Institute of Mathematics (2015).
Video: <https://m.youtube.com/watch?v=T1dhHwNmDXI>
- **Factorization homology.** Topology conference. Oberwolfach (2015).
- **Poincaré/Koszul duality.** Reimagining the Foundations of Algebraic Topology. MSRI / University of California at Berkeley (2014).
- **Poincaré/Koszul duality.** Goodwillie's birthday conference. Dubrovnik (2014).
- **Higher categories are sheaves on manifolds.** Workshop: higher categories; 3-part lecture series. University of Trondheim (2013).
- **Labeled configuration spaces.** Graduate Student Topology Conference. University of Notre Dame (2013).
- **Higher categories as sheaves on manifolds.** Conference on Topological Quantum Field Theories. University of Notre Dame (2012).
Video: <https://m.youtube.com/watch?v=8nm2ByS5NnY>
- **Factorization homology.** Cohen, Carlsson, Madsen Birthday conference, Stanford University (2012).
- **Cobordism categories with singularities.** The first Copenhagen topology conference. University of Copenhagen (2010).
- **Cobordism categories.** Conference on Topological Field Theories. Northwestern University (2009).

Invited seminar presentations (selected).

- **Derived Skein modules.** Geometry Seminar. UT Austin (2023).
- **Symmetries of a rigid braided category.** Johns Hopkins Topology Seminar. Johns Hopkins (2022).
- **Orthogonal groups and category theory.** Australian Topology Seminar. Australia (2021).

- **Adjoint and the orthogonal group.** Topology Seminar. CalTech (2021).
- **Picard groups and equivariant cohomology via stratifications.** Topology Seminar. Warwick University (2020).
- **Factorization homology.** Factorization homology seminar: 5-part lecture series. Mathematical Sciences Research Institute (2020).
- **Adjoint and the orthogonal group.** Edinburgh Topology Seminar. University of Edinburgh (2018).
- **Adjoint and the orthogonal group.** Isaac Newton Institute. Cambridge University (2018).
- **Adjoint and the orthogonal group.** Topology Seminar. University of Oxford (2018).
- **Contact geometry.** Mathematics Colloquium. Reed College (2017).
- **Bruhat stratified orthogonal group acts on higher categories.** Topology Seminar. Massachusetts Institute of Technology (2017).
- **Factorization homology.** Langlands seminar: 3-part lecture series. University of Chicago (2016).
- **Poincaré/Koszul duality.** Topology Seminar. Stanford University (2014).
- **Poincaré/Koszul duality.** Topology Seminar. Max Planck Institute for Mathematics (2013).
- **Poincaré/Koszul duality.** Topology Seminar. University of Oxford (2013).
- **Factorization homology and link invariants.** Math Colloquium. University of Melbourne (2013).
- **Higher categories are sheaves on manifolds.** Topology Seminar. Stanford University (2012).
- **Factorization homology and singular manifolds.** Topology Seminar. Johns Hopkins University (2012).
- **Configuration spaces and higher categories.** Topology Seminar. Northwestern University (2011).
- **Configuration spaces and higher categories.** Topology Seminar. University of Chicago (2011).
- **Combinatorial model for configuration spaces.** Topology Seminar. Massachusetts Institute of Technology (2010).
- **Cobordism categories with singularities.** Topology Seminar. Massachusetts Institute of Technology (2009).