Brandon T. Shapiro

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▬ Research Interests

Combinatorial approaches to topology, geometry, K-theory, higher categories, and applied category theory.

▬ Employment

2023-Present	**Whyburn Research Associate and Lecturer**, *University of Virginia*, Charlottesville, VA.
2022-2023	**Research Associate**, *Topos Institute*, Berkeley, CA,, AFOSR grant.
2015	**Formal Methods Intern**, *Draper Laboratories*, Cambridge, MA,, DARPA grant.

▬ Education

2022	**PhD in Mathematics**, *Cornell Unversity*, Advisor: Inna Zakharevich.
	Thesis: Shape Independent Category Theory.
2019	**Master of Science in Computer Science**, *Cornell Unversity*.
2017	**Bachelor of Arts with Highest Honors in Mathematics**, *Brandeis University*.
2017	**Bachelor of Science in Computer Science**, *Brandeis University*.
2017	**Bachelor of Arts in Physics**, *Brandeis University*.
2016	**Brandeis India Science Scholars Program**, *Indian Institute of Science*.

▬ Honors and Awards

2021	**Bättig Prize for Excellence and Promise in Mathematics**, Cornell University.
2017-2021	**National Defense Science & Engineering Graduate Fellowship**, AFOSR grant.
2017	**Summa Cum Laude**, Brandeis University.
2017	**Arnold Shapiro Prize in Mathematics**, Brandeis University.
2017	**Michtom Prize in Computer Science**, Brandeis University.
2016	**Phi Beta Kappa**, Brandeis University Chapter, Junior Year Inductee.
2016	**Outstanding Presentation Award**, MAA MathFest 2016.
2013	**Presidential Merit Scholarship**, Brandeis University.
2013	**National Merit Scholarship**, Brandeis University.

▬ Papers

2025	**Categorical Tiling Theory: Constructing Directed Planar Tilings via Edge Reversal.** *Submitted for publication*. With Catherine DiLeo and Preston Sessoms. [arXiv:2509.06363]
2025	**Additivity and Fiber Sequences for Combinatorial K-Theory.** *Submitted for publication*. With Maru Sarazola. [arXiv:2107.07701]
2024	**A Combinatorial Construction of Homology via ACGW Categories.** *To appear in Contemporary Mathematics*. With Maru Sarazola and Inna Zakharevich. [arXiv:2410.00276]
2024	**All Concepts are $\mathbb{C}\mathbf{at}^{\#}$.** *Submitted for publication*. With Owen Lynch and David Spivak. [arXiv:2305.02571]

2024 **A Polynomial Construction of Nerves for Higher Categories.** *Submitted for publication*. With David Spivak. [arXiv:2405.13157]

2023 **Structures in Categories of Polynomials.** *Submitted for publication*. With David Spivak. [arXiv:2305.00167]

2023 **A Compositional Account of Motifs, Mechanisms, and Dynamics in Biochemical Regulatory Networks.** *Compositionality* 6, **2**, 2024. With Rebekah Aduddell, James Fairbanks, Amit Kumar, Pablo Ocal, and Evan Patterson. [arXiv:2301.01445]

2022 **Duoidal Structures for Compositional Dependence.** *Submitted for publication*. With David Spivak. [arXiv:2210.01962]

2022 **Dynamic Operads, Dynamic Categories: From Deep Learning to Prediction Markets.** *Electronic Proceedings in Theoretical Computer Science*, 2022. With David Spivak. [arXiv:2205.03906]

2022 **Enrichment of Algebraic Higher Categories.** *Preprint*. [arXiv:2205.12235]

2021 **Familial Monads as Higher Category Theories.** *Submitted for publication*. [arXiv:2111.14796]

2021 **Weak Cartesian Properties of Simplicial Sets.** *Journal of Homotopy and Related Structures*, 18, **477-520**, 2023. With Carmen Constantin, Tobias Fritz, and Paolo Perrone. [arXiv:2105.04775]

2020 **Partial Evaluations and the Compositional Structure of the Bar Construction.** *Theory and Applications of Categories*, Vol. 39, No. 11, **322-364**, 2023. With Carmen Constantin, Tobias Fritz, and Paolo Perrone. [arXiv:2009.07302]

2016 **Densities of Hyperbolic Cusp Invariants.** *Proceedings of the American Mathematical Society*, Volume 146, Number 9, **4073-4089**, 2018. With Colin Adams, Rose Kaplan-Kelly, Michael Moore, Shruthi Sridhar, and Josh Wakefield. [arXiv:1701.03479]

2016 **specgen: A Tool for Modeling Statecharts in CSP.** *Nasa Formal Methods* **282**, 2017. With Chris Casinghino.

2015 **Nonstandard Neutrino Interactions In Supernovae.** *Physical Review D* **94**, 093007, 2016. With C.J. Stapleford, D.J. Väänänen, J.P. Kneller, and G.C. McLaughlin. [arXiv:1605.04903]

Teaching

2025 **Differential Equations**, *University of Virginia*, Math 3250, both semesters

2024 **Algebraic Topology II**, *University of Virginia*, Math 7810

2024 **Linear Algebra**, *University of Virginia*, Math 3351

2023 **Differential Geometry**, *University of Virginia*, Math 4720

2021 **Calculus I**, *Cornell University*, Math 1110

2019 **Applied Linear Algebra (Teaching Assistant)**, *Cornell University*, Math 2310

2018 **Geometric Group Theory (Teaching Assistant)**, *Cornell University*, Math 4560

2016 **Discrete Math (Teaching Assistant)**, *Brandeis University*, COSI 29a

2015 **Java Programming (Teaching Assistant, Tutor)**, *Brandeis University*, COSI 12b

Mentorship

2025	**Summer Research Mentor**, *University of Virginia*, Triangle algebras
	Worked with an undergraduate on developing the theory of a 2-dimensional algebraic structure for composing grids of triangles.
2024-2025	**Peer Mentoring Initiative**, *University of Virginia*, Organizer and mentor
	Students at different career stages are paired with more experienced students or postdocs for meetups and mentorship.
2024	**REU Mentor**, *University of Virginia*, Categorical tiling theory
	Lead a group of undergraduates pursuing original research over the summer on a categorical approach to combinatorial geometry.
2023-2025	**Geometry Lab Mentor**, *University of Virginia*, Zome geometry group
	Lead groups of beginning undergraduates in semester-long exploratory projects.
2023	**Workshop on $(\infty, 2)$-Categories**, *Online*
	Mentored a student in preparation for an expository talk based on a research paper.
2020-2022	**Directed Reading Program**, *Cornell University*
	Mentored three undergraduates in projects on constructive type theory, categorical algebra, and combinatorial topology.
2020	**Julia Robinson Math Festival Volunteer**, *Cornell University*

▬▬▬ Conference Organizing

2023	**Special Session on Category Theory and Machine Learning.** CALCO, Bloomington.

▬▬▬ Conference Talks

2025	**Categorical Tiling Theory.** Category Theory OctoberFest, Online.
2025	**Directed Tilings of the Euclidean and Hyperbolic Plane.** MAA Spring 2025 DC-MD-VA Section Meeting, Fairfax.
2024	**Homotopy Theory of Double Categories for Algebraic K-Theory.** AMS Spring Southeastern Sectional Meeting, Tallahassee.
2024	**CGW Categories.** Workshop on Higher Segal Spaces and their Applications to Algebraic K-Theory, Hall Algebras, and Combinatorics, BIRS.
2023	**Finite Posets as Algebraic Expressions in Duoidal Categories.** Category Theory OctoberFest, Online.
2023	**A Dynamic Monoidal Category for Deep Learning.** CALCO, Bloomington.
2022	**Polynomial Functors for Categorical Open Dynamics.** Joint Math Meetings, Special Session on Applied Category Theory, Boston.
2022	**Double Presheaf Categories via Polynomial Functors.** Virtual Double Categories Workshop, Online.
2022	**Dynamic Operads for Evolving Organizations.** Applied Category Theory, Glasgow.
2022	**Familial Monads for Higher and Lower Category Theory.** Workshop on Polynomial Functors, Online.
2021	**Compositional Structure of Partial Evaluations.** Categories and Companions Symposium, Online.
2019	**Shape Independent Category Theory.** Category Theory OctoberFest, Baltimore.
2019	**Types as Weak ω-Groupoids.** School and Workshop on Univalent Foundations, Birmingham.

2018   **Cell Shapes for Higher Structures.** Young Topologists Meeting, Copenhagen.

2016   **The Geometry of Knots.** With Shruthi Sridhar. MAA MathFest, Columbus.

2016   **Cusp Density: Dense or Knot?** Unknot III, Columbus.

Seminar and Colloquium Talks

2025   **Chain Complexes of Finite Sets and Venn Diagrams for Homological Algebra.** Virginia Commonwealth University Analysis, Logic, and Physics Seminar.

2023   **Combinatorial Homological Algebra and K-Theory.** University of Minnesota Topology Seminar.

2023   **Higher Category Theory in $\mathbb{C}\mathrm{at}^{\#}$.** Topos Institute Colloquium, Online.

2020   **Compositional Structure of Partial Evaluations.** MIT Categories Seminar, Online.

2020   **Cubical ω-Categories and Cubical Θ.** MSRI Cubical Sets Seminar, Online.

2020   **Test Category Structure of Cubes.** MSRI Cubical Sets Seminar, Online.

2020   **Constructing Cubes from Semicubes.** MSRI Cubical Sets Seminar, Online.

Workshop Participation

2024   **Polynomial Functors at Work**, *Topos Institute*

2023   **Talbot Workshop**, *Online*, Scissors Congruence K-Theory, Presenter

2023   **Math and Metaphysics Symposium**, *Austin, TX*, Presenter

2023   **Finding the Right Abstractions for Healthy Systems**, *Bodega Bay, CA*

2021   **Equivariant Algebra Seminar**, *eCHT*, Presenter

2019   **Applied Category Theory Adjoint School & Workshop**, *University of Oxford*

2019   **School & Workshop on Univalent Foundations**, *University of Birmingham*

2018   **Homotopy Theory Summer**, *Berlin Mathematical School*

2018   **Talbot Workshop**, *Govt. Camp, OR*, Model Independent ∞-Category Theory

2016   **SMALL REU**, *Williams College*, Hyperbolic Knot Theory Group

2014   **Computational Astrophysics REU**, *North Carolina State University*

Local Seminars

2023-   **Homotopy Theory Group Meeting**, *University of Virginia*, Organizer, Presenter

2023-   **Topology Seminar**, *University of Virginia*, Organizer, Presenter

2024   **Spectra Reading Group**, *University of Virginia*, Presenter

2022-2023   **Berkeley Seminar**, *Topos Institute*, Organizer, Presenter

2018-2022   **Homotopy Group**, *Cornell University*, Organizer, Presenter

2017-2022   **Topology Seminar**, *Cornell University*, Presenter

2020   **Logic Seminar**, *Cornell University*, Presenter

2019   **"What is...?" Seminar**, *Cornell University*, Organizer

2018   **∞-Category Theory Reading Group**, *Cornell University*, Presenter

2018   **Homotopy Type Theory Group**, *Cornell University*, Organizer, Presenter

2017-2022   **Olivetti Club**, *Cornell University*, Presenter

2016-2017   **Floer Homology Group**, *Brandeis University*

2015   **Haskell and Type Theory Group**, *Brandeis University*