

Curriculum Vitae

Theo Johnson-Freyd, <http://categorified.net/>

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Mathematical Biography

Positions

2024– Associate Professor, Department of Mathematics & Statistics, Dalhousie University

2021– Associate Faculty, Perimeter Institute for Theoretical Physics

2021–2024 Assistant Professor, Department of Mathematics & Statistics, Dalhousie University

2016–2020 Senior Postdoctoral Fellow, Perimeter Institute for Theoretical Physics
Supervisors: K. Costello and D. Gaiotto

2013–2016 NSF Postdoc and Boas Assistant Professor, Northwestern University
Supervisors: K. Costello and E. Getzler

Education

2007–13 Ph.D. in Mathematics, University of California, Berkeley
Dissertation title: *Perturbative Methods in Path Integration*
Supervisor: N. Reshetikhin

2003–07 B.Sc. in Mathematics, Stanford University, *with distinction*
Supervisor: R. Vakili

Research Interests

Quantum field theory, quantum condensed matter, category theory, moonshine, algebraic topology, deeper noncommutative algebra.

Recent awards and grants

- President's Research Excellence Award for Emerging Investigators, Dalhousie University, 2024
- Simons Collaboration for Global Categorical Symmetries, 2021-2025.
- NSERC Discovery Grant, 2021-2026.
- NSERC Accelerator Supplement, 2021-2024.
- NSERC Early Career Researcher top-up, 2021.

Publications

For abstracts of all papers, see categorified.net/publications.html.

Published and accepted for publication

1. Appendix to: Extension Theory and Fermionic Strongly Fusion 2-Categories, by Thibault Décoopet. *SIGMA*, 2024. [arXiv:2403.03211](https://arxiv.org/abs/2403.03211). DOI:10.3842/SIGMA.2024.092.

2. (3+1)D topological orders with only a \mathbb{Z}_2 -charged particle. *Commun. Contemp. Math.*, 2024. [arXiv:2011.11165](#).
3. Mock modularity and a secondary elliptic genus. With D. Gaiotto. *Journal of High Energy Physics*, 2023. [arXiv:1904.05788](#).
4. Minimal nondegenerate extensions. With D. Reutter. *Journal of the American Mathematical Society*, Volume 37, Number 1, January 2024, Pages 81–150. [arXiv:2105.15167](#). DOI:10.1090/jams/1023.
5. Ground-state degeneracy of twisted sectors of Conway Moonshine SCFT. With A. Furet. *Commun. Contemp. Math.*, 2024. [arXiv:2305.05081](#).
6. Topological Orders in (4+1)-Dimensions. With M. Yu. *SciPost Physics*, 13, 068 (2022). [arXiv:2104.04534](#). DOI:10.21468/SciPostPhys.13.3.068. MR4492330.
7. On the classification of topological orders. *Communications in Mathematical Physics*, 393, pp 989–1033 (2022). [arXiv:2003.06663](#). DOI:10.1007/s00220-022-04380-3. MR4444089.
8. Fusion 2-categories with no line operators are grouplike. With M. Yu. *Bulletin of the Australian Mathematical Society*, vol 104, issue 3, pp 434–442, December 2021. [arXiv:2010.07950](#). DOI:10.1017/S0004972721000095. MR4338473.
9. Holomorphic SCFTs with small index. With D. Gaiotto. *Canadian Journal of Mathematics*, 2021:1-29. [arXiv:1811.00589](#). DOI:10.4153/S0008414X2100002X. MR4411002.
10. Supersymmetry and the Suzuki chain. *Tunisian Journal of Mathematics*, Vol 3, No 2, pp 309–359, 2021. DOI:10.2140/tunis.2021.3.309. MR4190470. [arXiv:1908.11012](#). MR4190470.
11. A note on some minimally supersymmetric models in two dimensions. With D. Gaiotto and E. Witten. In *Integrability, Quantization, and Geometry II. Quantum Theories and Algebraic Geometry: Dedicated to the Memory of Boris Dubrovin 1950–2019*, volume 103.2 of *Proceedings of Symposia in Pure Mathematics*, pp 203–222, Amer. Math. Soc., Providence, RI, 2021. [arXiv:1902.10249](#). MR4285698. DOI:10.1090/pspum/103.2/01857.
12. Galois action on VOA gauge anomalies. *Progr. Math.*, 340, 2021, pp345–370. [arXiv:1811.06495](#). MR4391353. DOI:10.1007/978-3-030-78148-4_12.
13. Heisenberg-picture quantum field theory. *Progr. Math.*, 340, 2021, pp371–409. [arXiv:1508.05908](#). MR4391354. DOI:10.1007/978-3-030-78148-4_13.
14. Third homology of some sporadic finite groups. With D. Treumann. *Symmetry, Integrability and Geometry: Methods and Applications* 15 (2019), 059. DOI:10.3842/SIGMA.2019.059. MR3990846. [arXiv:1810.00463](#).
15. Symmetry protected topological phases and generalized cohomology. With D. Gaiotto. *Journal of High Energy Physics*. May 2019. DOI:10.1007/JHEP05(2019)007. MR3978827. [arXiv:1712.07950](#).
16. The Moonshine Anomaly. *Communications in Mathematical Physics*. February 2019, Volume 365, Issue 3, pp 943–970. DOI:10.1007/s00220-019-03300-2. MR3916985. [arXiv:1707.08388](#).
17. $H^4(\mathrm{Co}_0; \mathbf{Z}) = \mathbf{Z}/24$. With D. Treumann. *International Mathematics Research Notices*, 2020, no. 21, 7873–7907. DOI:10.1093/imrn/rny219. MR4176841. [arXiv:1707.07587](#).
18. How to derive Feynman diagrams for finite-dimensional integrals directly from the BV formalism. With O. Gwilliam. *Topology and quantum theory in interaction*, Contemp. Math., 718, Amer. Math. Soc., Providence, RI, 2018, pp 175–185. MR3869644. [arXiv:1202.1554](#).
19. Spin, statistics, orientations, unitarity. *Algebraic & Geometric Topology*, Volume 17, No. 2, 2017, pp 917–956. DOI:10.2140/agt.2017.17.917. MR3623677. [arXiv:1507.06297](#)
20. (Op)lax natural transformations, twisted quantum field theories, and “even higher” Morita categories. With C. Scheimbauer. *Advances in Mathematics*, Volume 307, 5 February 2017, pp 147–223. DOI:10.1016/j.aim.2016.11.014. MR3590516. [arXiv:1502.06526](#).
21. The quaternions and Bott periodicity are quantum Hamiltonian reductions. *Symmetry, Integrability and Geometry: Methods and Applications*, 12 (2016), 116, 6 pages. DOI:10.3842/SIGMA.2016.116. MR3581593. [arXiv:1603.06603](#).
22. Tree- versus graph-level quasilocal Poincaré duality on S^1 . *Journal of homotopy and related structures*,

- June 2016, Volume 11, Issue 2, pp 333–374. DOI:10.1007/s40062-015-0110-2. MR3511825. arXiv:1412.4664.
23. Homological perturbation theory for nonperturbative integrals. *Letters in Mathematical Physics*, November 2015, Volume 105, Issue 11, pp 1605–1632. DOI:10.1007/s11005-015-0791-9. MR3406714. arXiv:1206.5319.
 24. Reflexivity and dualizability in categorified linear algebra. With M. Brandenburg and A. Chirvasitu. *Theory and Applications of Categories*, Vol. 30, No. 23, 2015, pp. 808–835. www.tac.mta.ca/tac/volumes/30/23/30-23abs.html. MR3361309. arXiv:1409.5934.
 25. Poisson AKSZ theories and their quantizations. In *Proceedings of the conference String-Math 2013*, volume 88 of *Proceedings of Symposia in Pure Mathematics*, pp. 291–306, Providence, RI, 2014. Amer. Math. Soc. DOI:10.1090/pspum/088. MR3330296. arXiv:1307.5812.
 26. The fundamental pro-groupoid of an affine 2-scheme. With A. Chirvasitu. *Applied Categorical Structures*. Vol 21, Issue 5 (2013), pp. 469–522. DOI:10.1007/s10485-011-9275-y. MR3097055. arXiv:1105.3104.
 27. The formal path integral and quantum mechanics. *Journal of Mathematical Physics*. 51, 122103 (2010). DOI:10.1063/1.3503472. MR2779164. arXiv:1004.4305.
 28. Feynman-diagrammatic description of the asymptotics of the time evolution operator in quantum mechanics. *Letters in Mathematical Physics*. November 2010, Volume 94, Issue 2, pp 123–149. DOI:10.1007/s11005-010-0424-2. MR2733558. arXiv:1003.1156.

Preprints intended for publication

1. The classification of fusion 2-categories. With T. Décoppe, P. Huston, D. Nikshych, D. Penneys, J. Plavnik, D. Reutter, and M. Yu. arXiv:2411.05907.
2. On the 576-fold periodicity of the spectrum SQFT: The proof of the lower bound via the Anderson duality pairing. With M. Yamashita. arXiv:2404.06333.
3. Dagger n -categories. With G. Ferrer, B. Hungar, C. Krulewski, L. Müller, Nivedita, D. Penneys, D. Reutter, C. Scheimbauer, L. Stehouwer, and C. Vuppulury. arXiv:2403.01651.
4. Topological Mathieu Moonshine. arXiv:2006.02922.
5. Condensations in higher categories. With D. Gaiotto. arXiv:1905.09566.
6. Appendix to: Coulomb branches of noncotangent type. Alexander Braverman, Gurbir Dhillon, Michael Finkelberg, Sam Raskin, and Roman Travkin. arXiv:2201.09475.

Other mathematical writings

1. *Berkeley Lectures on Lie Groups and Quantum Groups*. With R. Borcherds, M. Haiman, N. Reshetikhin, and V. Serganova. categorified.net/LieQuantumGroups.pdf.
2. An approach to less climate-impactful conferences. With David Ayala, Lukas Brantner, André Henriques, and Aaron Mazel-Gee. *Newsletter of the LMS*, Issue 480, January 2019, pp32–33. www.lms.ac.uk/sites/lms.ac.uk/files/files/NLMS_480.pdf

Supervision

Graduate Students

1. Jessica Weitbrecht, Perimeter Institute, MSc 2018.
Thesis title: *An Introduction to Lattice Vertex Operator Algebras, and their Topological Twist*
2. Alissa Furet, Dalhousie, MSc 2022.
Thesis title: *Ground-state Degeneracy of Twisted Sectors of Conway Moonshine SCFT*
3. Matthew Yu, Perimeter Institute, PhD 2023.
Thesis title: *(Non)-Invertible Topology in Quantum Field Theory*

4. Ruizhi Liu, Dalhousie, MSc 2024.
Thesis title: *Symmetries and Anomalies: with Applications to Condensed Matter and String Theory*
5. Tian Dong, Perimeter Institute, MSc 2025 (expected).
6. Nian Ibne Nazrul, Perimeter Institute, MSc 2025 (expected).
7. Adrien DeLazzer Meunier, Dalhousie, PhD 2026 (expected).
8. Daniel Teixeira, Dalhousie, PhD 2026 (expected).
9. Ruizhi Liu, Perimeter Institute, PhD 2028 (expected).

Undergraduate Students

1. James Munday, Dalhousie, Summer 2022.
Project title: *The WKB Method in Homological Perturbation Theory*
2. Eleanor Friddel, Dalhousie, BSc with honours 2025 (expected).
Project title: *Visualizing the finite simple groups*

Postdoctoral Scholars

1. Lukas Müller, Perimeter Institute (SCGCS), 2022–present.
2. Luuk Stehouwer, Dalhousie (AARMS), 2024–present.

Professional Activities

Reviewing

- Reviewer for *Mathematical Reviews* and *zbMATH*.
- Referee for *Adv. Theor. Math. Phys*, *Ann. Inst. Henri Poincaré D*, *Canad. J. Math.*, *Comm. Amer. Math. Soc.*, *Comm. Math. Phys.*, *Contemp. Math.*, *Compositionality*, *Grad. Studies Math.*, *Invent. Math.*, *J. High Energy Phys.*, *J. Homotopy Relat. Struct.*, *J. Geom. Phys.*, *Lett. Math. Phys.*, *Phys. Rev. B: Cond. Mat.*, *Proc. Symp. Pure. Math.*, *Quant. Top.*, *SciPost*, *Selecta*, and *SIGMA*.
- Referee for EPSCR, FRQNT, ICMS, and Isaac Newton Inst.

Conferences co-organized

- “Atlantic TQFT Spring School” school at Memorial University Newfoundland, May 2024. With L. Stehouwer.
- “Subfactors and Fusion (2-)Categories” workshop at Banff Research Station, December 2023. With T. Gannon, J. Plavnik, and D. Penneys.
- “Dagger higher categories” online workshop, June 2023. With D. Penneys.
- “Atlantic TQFT Spring School” school in Wolfville, May 2023. With G. Voofs.
- “Global Categorical Symmetries” conference and school at Perimeter Institute, June 2022. With I. Bah, M. Del Zotto, J. Plavnik, and C. Teleman.
- “Women at the intersection of mathematics and theoretical physics” conference at Perimeter Institute, February 2021. With B. Dittrich, S. Paycha, K. Rejzner, A. Taormina, and R. Toriumi.
- “Elliptic cohomology and physics” online workshop at Perimeter Institute, May 2020. With D. Berwick-Evans, N. Ganter, Y. Yang, and G. Zhao.
- “Higher algebra and mathematical physics” conference at Perimeter Institute and Max Planck Institute, August 2018. With D. Ayala, K. Costello, O. Gwilliam, A. Henriques, A. Mazel-Gee, and P. Teichner.
- “Quantum Field Theory on Manifolds with Boundary and the BV Formalism” workshop at Perimeter Institute, May 2017. With R. Grady and P. Mnev.

- “Representation Theory, Integrable Systems and Quantum Fields” conference at Northwestern, April 2016. With T.S. Chen, X. Jin, and L. Shen.
- “QFTahoe 2013” workshop for young researchers, March 2013. With D. Berwick-Evans, O. Gwilliam, N. Reshetikhin, and J. Tener.
- “Representation Theory and Geometry” workshop at UC Berkeley, September 2011. With N. Reshetikhin and H. Williams.

Research seminars co-organized

- Mathematical Physics seminar, Perimeter Institute, 2016–17.
- Mathematical Physics group meeting, Perimeter Institute, 2016–17.
- Geometry and Physics seminar, Northwestern, 2015–16.
- Geometry, Representations, And Some Physics (GRASP) seminar, UC Berkeley, 2010–13.

Committee membership

- FGS Faculty Council Governance Committee, Dalhousie Mathematics, 2024–25.
- Undergraduate Curriculum Committee, Dalhousie Mathematics, 2023–24.
- Workshops & Conferences Committee, Perimeter Institute, 2022–25. As committee chair, 2022–23.
- FGS Faculty Council, Dalhousie Faculty of Graduate Studies, 2022.
- Graduate Committee, Dalhousie Mathematics, 2021–23. As committee chair and Acting Graduate Director, 2023.
- Health, Safety and Wellness Committee, Dalhousie Mathematics, 2021–22.

Teaching Activities

For course materials, see categorified.net/teaching.html.

At Dalhousie

- 2025 Winter. Instructor for “Advanced Algebra II” (Math 4055/5055)
Galois theory class for first-year graduate students.
- 2025 Winter. Instructor for “Abstract Algebra II” (Math 3032)
Ring theory class for math majors.
- 2024 Winter. Instructor for “Lie Theory” (Math 4057/5057)
Lie algebras and Lie groups class for graduate students.
- 2024 Winter. Instructor for “Advanced Algebra II” (Math 4055/5055)
Galois theory class for first-year graduate students.
- 2023 Winter. Instructor for “Abstract Algebra II” (Math 3032)
Ring theory class for math majors.
- 2023 Winter. Instructor for “Topics in Algebraic Topology” (Math 4180/5180)
Algebraic topology class for graduate students.
- 2022 Fall. Organizer for “TQFT Reading Group”
Weekly learning seminar for graduate students.
- 2022 Winter. Instructor for “Honours Linear Algebra” (Math 2135)
Proof-based linear algebra class for math majors.
- 2022 Winter. Instructor for “Advanced Algebra II” (Math 4055/5055)
Galois theory class for first-year graduate students.
- 2021 Winter. Instructor for “Abstract Algebra II” (Math 3032)

Ring theory class for math majors.

At Perimeter Institute

2020 Winter. Mentor for “PSI Winter School”

Supervised a graduate-student research project.

2019 Fall. Instructor for “Graduate Seminar: Cohomology of Groups”

Weekly lecture series for Ph.D. students in math, condensed matter, and quantum field theory.

At Northwestern

2016 Winter. Instructor for “Graduate Seminar: Topology and Geometry” (Math 448)

Quantum topology class centred on student presentations.

2015 Fall. Instructor for “First-year Seminar: Theories of Mind and Mathematics” (Math 105)

Seminar-based class combining mathematics, philosophy, and writing.

2015 Fall. First-year academic adviser

Fifteen advisees. Individual and group meetings to discuss course schedules, requirements, and the transition from high school to university.

2014 Spring. Instructor for “Freshman Seminar: Theories of Mind and Mathematics” (Math 105)

Seminar-based class combining mathematics, philosophy, and writing.

2013 Fall. Instructor for “Foundations of Higher Mathematics” (Math 300)

Set theory class centred on student presentations.

At summer schools for graduate students

2024 Fall. Co-mentor (with D. Reutter) for “Scottish Talbot On Algebra and Topology: Higher tensor categories and their extensions” at Cairngorm Lodge, Glenmore, Scotland.

Week-long school for graduate students featuring three lectures per day by student participants, plus one lecture each evening by the mentors, based on my paper “Minimal Nondegenerate Extensions” joint with D. Reutter.

2024 Spring. Organizer for “TQFT Spring School” at Memorial University Newfoundland.

Week-long school for graduate students featuring three pedagogical lecture series.

2023 Summer. Lecturer for “Topological Moonshine” at UIUC.

Week-long school for graduate students featuring four research-level lecture series.

2023 Spring. Organizer for “TQFT Spring School” in Wolfville, NS.

Week-long school for graduate students featuring three pedagogical lecture series.

2022 Summer. Organizer for “Global Categorical Symmetries” at Perimeter Institute.

Week-long school for graduate students featuring four pedagogical lecture series.

2019 Summer. Lecturer for “Sporadic Groups and where to find them” at Canada/USA Mathcamp.

Five-week summer camp for high school students.

2019 Summer. TA for “QFT for Mathematicians” at Perimeter Institute.

Week-long school for graduate students featuring four pedagogical lecture series.

2014 Summer. TA for “String Math Summer School” at Pacific Institute for the Mathematical Sciences.

Week-long school for graduate students featuring five research-level lecture series.

At Berkeley

2009 Summer. Instructor for Second-semester Calculus (Math 1B)

Lectured, prepared homework and exams, etc.

2009 Spring. Teaching assistant for First-semester Calculus (Math 1A) with Z. Stankova

Taught section 6 hours a week, held office hours, graded exams.

2008 Fall. Teaching assistant for Precalculus (Math 32) with C. Mitchell

- Taught section 6 hours a week, held office hours, graded exams.
- 2008 Summer. Instructor for Second-semester Calculus (Math 1B)
Lectured, prepared homework and exams, etc.
- 2008 Spring. Teaching assistant for Multivariable Calculus (Math 53) with J. Neu
Taught section 6 hours a week, held office hours, graded exams.
- 2007 Fall. Teaching assistant for Second-semester Calculus (Math 1B) with N. Reshetikhin
Taught section 6 hours a week, held office hours, graded exams.
- 2007 Fall. Participated in Berkeley Mathematics Department training course for graduate student instructors and the UC Berkeley Teaching Conference.

Nonmathematical teaching experience

- 2006-07. Choreographer, Stanford Viennese Ball Opening Committee.
- 2006-07. Kitchen Manager, Columbae Cooperative House.
- 2006 Summer. Residential Counselor, Stanford Dancecamp.
- 2005 Summer. Residential Counselor, Canada/USA Mathcamp.

Recent research lectures

For abstracts, slides, and videos, and for talks given in ≤ 2020 , see categorified.net/talks.html.

2024

- NYU (GCS annual pre-meeting): The unitary cobordism hypothesis
- Fields (Geo. and Phys.): The unitary cobordism hypothesis
- Boston U (Geo. and Phys.): Exact sequences of Hopf algebra
- Berkeley (Rep. Thy. and Tens. Cat.): The homotopy groups of a TQFT
- SCGP (Appl. of Gen. Sym. and Top. Def. to Quant. Mat.): Wormholes and an exact sequence
- Edinburgh ICMS (Cat. Sym. in QFT): Quantum homotopy groups
- Notre Dame (Field Thy. and Top.): Quantum homotopy groups
- Harvard CMSA (Symmetries Public Lecture): The universal target category
- JHU (Topology): The universal target category
- Perimeter (Higher Cat. Tools for Quant. Phases of Mat.): Quantum homotopy groups
- SCGCS (Internal): Recent progress on the classification of fusion higher categories

2023

- SCGCS (General Assembly): Dagger Categories
- NYU Abu Dhabi (GT&P): Higher Dagger Categories
- Perimeter (Math. Phys.): Deeper Kummer theory
- Perimeter (Researcher Presentations): Quantum Homotopy Types
- Hamburg (TQFT Sem.): SVOAs and some exceptional groups
- Regensburg (Higher Str in TFT): Super duper vector spaces II: The higher-categorical Galois group
- UIUC (Top. Moonshine): Topological Umbral Moonshine
- Oxford (OWSM): Higher algebraic closure
- OSU (Colloquium): Higher algebraic closure
- Feza Gürsey Institute (Higher Str. Sem.): Higher algebraic closure

2022

Simons Foundation (GCS annual meeting): Homotopy Quantum Groups
CRM (Quantum Symmetries): SVOAs and some exceptional groups
Perimeter (Math Phys.): Hypergroups and fusion higher categories
Oxford (Sym. Sem.): A 4D TQFT which is not (quite) a gauge theory
AIM (Higher cat. and top. order): Hypergroups and fusion higher categories
Perimeter (PSI): Global categorical symmetry and higher fusion categories
ACP (Higher sym. and QFT): What is a fusion higher category?
MPIM (Math QFT): Classification of (semisimple) TQFTs
Oxford (ST. Sem): Why the spaces of $N=(0,1)$ susy QFTs form a spectrum?
Dalhousie (ATCAT): Categorified algebraic closure

2021

Haifa (G&T): Algebraically closed higher categories
Perimeter (Math Phys): Algebraically closed higher categories
QMUL (CTP): Classification of topological quantum field theories
ICTP (Generalized Coh. and Physics): TMF and SQFT: questions and conjectures
Kavli IPMU (NAAP): A menagerie of $N=1$ SVOAs
WHGCP: Semisimple higher categories
KIAS (AGQFT): Operators and (higher) categories in quantum field theory
Inst. Sup. T ec. (TQFT Club): Higher S-matrices
AIM (Fusion Fridays): Minimal nondegenerate extensions
Harvard (Quantum Matter): Minimal nondegenerate extensions and an anomaly indicator
CMS 75+1 (Quantum Math): Classification of topological orders
UniVie (Higher Structures): Higher S-matrices
Ohio State (Colloquium): The classification of topological orders
AIM (Fusion categories and tensor networks): Fusion n-category Q&A
IAS (Moonshine): Orbifolds
Warwick (AGQFT): Higher Galois closures
Amherst (Rep Thy): Strongly-fusion 2-categories are grouplike
NCSU (UQSL): Condensations and components