

Curriculum Vitae

Theo Johnson-Freyd

May 6, 2020

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Positions

- 2016– Senior Postdoctoral Fellow, Perimeter Institute for Theoretical Physics
Supervisors: K. Costello and D. Gaiotto
- 2013–2016 NSF Postdoc and Boas Assistant Professor, Northwestern University
Supervisor: K. Costello

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. Vakil

Research Interests

Higher algebra, quantum field theory, condensed matter, topology, moonshine, noncommutative algebra, category theory, Poisson geometry, representation theory

Research publications

1. Supersymmetry and the Suzuki chain. To appear in *Tunisian Journal of Mathematics*. [arXiv:1908.11012](https://arxiv.org/abs/1908.11012).
2. Galois action on VOA gauge anomalies. To appear in *Progress in Mathematics*. [arXiv:1811.06495](https://arxiv.org/abs/1811.06495).
3. Heisenberg-picture quantum field theory. To appear in *Progress in Mathematics*. [arXiv:1508.05908](https://arxiv.org/abs/1508.05908).
4. Third homology of some sporadic finite groups. With D. Treumann. *Symmetry, Integrability and Geometry: Methods and Applications* 15 (2019), 059. [arXiv:1810.00463](https://arxiv.org/abs/1810.00463). DOI:10.3842/SIGMA.2019.059.
5. Symmetry protected topological phases and generalized cohomology. With D. Gaiotto. *Journal of High Energy Physics*. May 2019. [arXiv:1712.07950](https://arxiv.org/abs/1712.07950). DOI:10.1007/JHEP05(2019)007.
6. 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](https://arxiv.org/abs/1707.08388).

7. $H^4(\mathbf{C}o_0; \mathbf{Z}) = \mathbf{Z}/24$. With D. Treumann. *International Mathematics Research Notices*, 2018. DOI:10.1093/imrn/rny219. arXiv:1707.07587.
8. 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.
9. Spin, statistics, orientations, unitarity. *Algebraic & Geometric Topology*, Volume 17, No. 2, 2017, pp 917–956. MR3623677. DOI:10.2140/agt.2017.17.917 arXiv:1507.06297
10. (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.
11. 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.
12. 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.
13. 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.
14. 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.
15. 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.
16. 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.
17. The formal path integral and quantum mechanics. *Journal of Mathematical Physics*. 51, 122103 (2010). DOI:10.1063/1.3503472. MR2779164. arXiv:1004.4305.
18. 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 submitted for publication

1. On the classification of topological orders. arXiv:2003.06663.
2. Condensations in higher categories. With D. Gaiotto. arXiv:1905.09566.
3. Mock modularity and a secondary elliptic genus. With D. Gaiotto. arXiv:1904.05788.
4. A note on some minimally supersymmetric models in two dimensions. With D. Gaiotto and E. Witten. arXiv:1902.10249.
5. Holomorphic SCFTs with small index. With D. Gaiotto. arXiv:1811.00589.

Other mathematical publications

1. *Berkeley Lectures on Lie Groups and Quantum Groups*. With R. Borcherds, M. Haiman, N. Reshetikhin, and V. Serganova. To be published by World Scientific. 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

Teaching Activities

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

At Perimeter

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 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.

Professional Activities

- Reviewer for *Mathematical Reviews* and *zbMATH*.
- Referee for *Ann. Inst. Henri Poincaré D*, *Lett. Math. Phys.*, *Comm. Math. Phys.*, *J. Homotopy Relat. Struct.*, *Canad. J. Math.*, *J. Geom. Phys.*, *Phys. Rev. B: Cond. Mat.*, *SIGMA Symmetry Integrability Geom. Methods Appl.*, and EPSCR.
- Co-organizer (with S. Paycha, K. Rejzner, and R. Toriumi) of “Women at the intersection of mathematics and theoretical physics” conference at Perimeter Institute, November 2020.
- Co-organizer (with D. Berwick-Evans, N. Ganter, Y. Yang, and G. Zhao) of “Elliptic cohomology and physics” online workshop at Perimeter Institute, May 2020.
- Co-organizer (with D. Ayala, K. Costello, O. Gwilliam, A. Henriques, A. Mazel-Gee, and P. Teichner) of “Higher algebra and mathematical physics” conference at Perimeter Institute and Max Planck Institute, August 2018.
- Co-organizer (with R. Grady and P. Mnev) of “Quantum Field Theory on Manifolds with Boundary and the BV Formalism” workshop at Perimeter Institute, May 2017.
- Co-organizer (with K. Costello) of weekly Mathematical Physics seminar and Mathematical Physics group meeting at Perimeter Institute, 2016–17.
- Co-organizer (with T.S. Chen, X. Jin, and L. Shen) of “Representation Theory, Integrable Systems and Quantum Fields” conference at Northwestern, April 2016.
- Co-organizer (with T.S. Chen, E. Getzler, X. Jin, L. Shen, B. Tsygan, and E. Zaslow) of weekly Geometry and Physics seminar at Northwestern, 2015–16.
- Co-organizer (with D. Berwick-Evans, O. Gwilliam, N. Reshetikhin, and J. Tener) of “QF-Tahoe 2013” workshop for young researchers, March 2013.
- Co-organizer (with H. Williams) of weekly Geometry, Representations, And Some Physics (GRASP) seminar at UC Berkeley, 2010–13.
- Co-organizer (with N. Reshetikhin and H. Williams) for “Representation Theory and Geometry” workshop at UC Berkeley, September 2011.

Recent Research Lectures

For talks given in 2016 and earlier, see categorified.net/talks.html.

2020 MSRI (Tensor Categories and TQFTs): Gapped condensation in higher categories

Rutgers (NHETCS): A deformation invariant of 2D SQFTs

Santa Barbara (Geo. Top. Phys.): A deformation invariant of 2D SQFTs

Perimeter (QFT): A deformation invariant of 1+1D SQFTs

2019 IAS (Hep Thy): TMF and SQFT.

Dalhousie (Colloquium): Bott periodicity from quantum Hamiltonian reduction.

Dalhousie (ATCAT): Condensation and idempotent completion.

McGill (Geometry): Bott periodicity from quantum Hamiltonian reduction.

Aspen Center for Physics (Gen'd Syms, Anoms and Obs): Phases of 2d SQFTs.

Lewis & Clark (Mathcamp Colloquium): Exceptional Mathematics: from Egyptian fractions to heterotic strings

- Oxford (Topology): Secondary invariants and mock modularity
- Aspen Center for Physics (Higher Symmetries): The Galois action on VOA anomalies
- Simons, NYC (NT, Geom., Moonshine & Strings): Galois actions on VOA gauge anomalies
- Stanford (Analysis & PDE): Bott periodicity from quantum Hamiltonian reduction
- UC Santa Cruz (Alg No Th): Galois actions on VOA gauge anomalies
- UC Santa Cruz (Colloquium): Bott periodicity from quantum Hamiltonian reduction
- 2018 Perimeter (Koszul Duality): Poisson and coisotropic
- Ohio State (QAQT): Holomorphic SCFTs of small index
- UIUC (Math. Phys.): Holomorphic SCFTs of small index.
- BIRS, Banff (Fusion Categories and Subfactors): Galois action on gauge anomalies
- CIRM, Luminy (Rep. Thy., Math. Phys., and Int. Sys.): T-duality for finite groups
- Yale (Geom., Sym., Phys.): The fourth cohomology of some sporadic groups
- SUNY Buffalo (Algebra): Moonshine anomalies
- Washington (Noncom. alg.): Infinitely-categorified commutative algebra
- UC Davis (QMAP): Moonshine anomalies
- Northeastern: Higher algebraic closures and phases of matter
- UT Austin (Geometry): Moonshine anomalies
- 2017 UC Berkeley (RTMP): Higher categories, generalized cohomology, and condensed matter
- Emory (Algebra): 576 Fermions
- Boston College (NT&AG): Bott periodicity from Hamiltonian reduction
- Northeastern (Research Seminar): Exceptional structures, fermions, anomalies, and Hamiltonian reduction
- Instituto Superior Técnico, Lisbon (Higher Structures): The Moonshine Anomaly
- Edinburgh (Maximals): The Moonshine Anomaly
- UC Berkeley (RTGC): Orbifolds of conformal field theories and cohomology of sporadic groups
- Fields Institute (Geometric Structures): Advanced integration by parts: the BV formalism
- Boston University (Geometry and Physics): Fermionic hamiltonian reduction and periodicity
- UC Berkeley (RTGC): Ideals in derived algebra and boundary conditions in AKSZ-type field theories

References

- K. Costello. kcostello@perimeterinstitute.ca
- D. Freed. dafr@math.utexas.edu
- D. Gaiotto. dgaiotto@perimeterinstitute.ca
- G. Moore. gwmooore@physics.rutgers.edu
- N. Reshetikhin. reshetik@math.berkeley.edu
- P. Teichner. teichner@mpim-bonn.mpg.de
- E. Witten. witten@ias.edu
- J. Wunsch (concerning teaching). jwunsch@math.northwestern.edu