Curriculum Vitae

Theo Johnson-Freyd

Last updated October 6, 2017

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CANADA

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Positions

2016– Postdoctoral Fellow, Perimeter Institute for Theoretical Physics
Supervisor: K. Costello

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.S. in Mathematics**, Stanford University, *with distinction*
Supervisor: R. Vakil

Selected Honors and Grants

2013–16. Mathematical Sciences Postdoctoral Research Fellowship, National Science Foundation

2010. Graduate Division Summer Grant, UC Berkeley

2009. Honorable Mention, Ford Foundation Predoctoral Fellowship

2007–09. Honorable Mention, NSF Graduate Research Fellowship Program

Research Interests

Quantum field theory, condensed matter, topology, moonshine, Poisson geometry, category theory, representation theory

Research publications

1. Spin, statistics, orientations, unitarity. *Algebraic & Geometric Topology*, Volume 17, No. 2, 2017, pp 917–956. MR3623677. arXiv:1507.06297
2. (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.
3. 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.

4. 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.
5. 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.
6. 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. http://www.tac.mta.ca/tac/volumes/30/23/30-23abs.html. MR3361309. arXiv:1409.5934.
7. 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.
8. 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. DOI:10.1007/s10485-011-9275-y. MR3097055. arXiv:1105.3104.
9. The formal path integral and quantum mechanics. *Journal of Mathematical Physics*. 51, 122103 (2010). DOI:10.1063/1.3503472. MR2779164. arXiv:1004.4305.
10. 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.

Textbook accepted for publication

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. Draft of Part I available at pitp.ca/personal/tjohnsonfreyd/LieQuantumGroups.pdf.

Submitted for publication

1. $\mathrm{H}^4(\mathrm{Co}_0;\mathbf{Z}) = \mathbf{Z}/24$. With D. Treumann. 2017. arXiv:1707.07587.
2. The Moonshine Anomaly. 2017. arXiv:1707.08388.
3. Exact triangles, Koszul duality, and coisotopic boundary conditions. 2016. arXiv:1608.08598.

Other preprints

1. Heisenberg-picture quantum field theory. 2015. arXiv:1508.05908.
2. Chains($\mathbb{R}$) does not admit a geometrically meaningful properadic homotopy Frobenius algebra structure. 2013. arXiv:1308.3423.
3. Peturbative methods in path integration. Ph.D. Thesis. 2013. perimeterinstitute.ca/personal/tjohnsonfreyd/JohnsonFreyd-thesis.pdf.
4. How to derive Feynman diagrams for finite-dimensional integrals directly from the BV formalism. With O. Gwilliam. 2011. arXiv:1202.1554.
5. On the coordinate (in)dependence of the formal path integral. 2010. arXiv:1003.5730.

In preparation

1. Symmetry protected topological phases and generalized cohomology. With D. Gaiotto.
2. Condensable n-algebras and the cobordism hypothesis in condensed matter. With D. Gaiotto.

Research Lectures

2017 Emory (Algebra): 576 Fermions

Boston College (NT&AG): Bott periodicity from Hamiltonian reduction

Northeastern (Research Seminar): Exceptional structures, fermions, anomalies, and Hamiltonian reduction

Institute Superior Técnico (Higher Structures Lisbon): The Moonshine Anomaly

Edinburgh (Maximals): The Moonshine Anomaly

Berkeley (RTGC): Orbifolds of conformal field theories and cohomology of sporadic groups

Fields (Geometric Structures): Advanced integration by parts: the BV formalism

Boston University (Geometry and Physics): Fermionic hamiltonian reduction and periodicity

Berkeley (RTGC): Ideals in derived algebra and boundary conditions in AKSZ-type field theories

2016 Stanford (Kachru group): 576 fermions, the Conway group, and tmf

Perimeter (Mathematical Physics): Moonshine, topological modular forms, and 576 fermions

Berkeley (RTGC): Bott periodicity via quantum Hamiltonian reduction

Oberwolfach (Factorization algebras and functorial field theories): Bott periodicity via quantum Hamiltonian reduction

Berkeley (RTGC): "Spin-statistics" is a categorification of "Hermitian"

2015 UIC (Geometry, topology, and dynamics): Where does the spin-statistics theorem come from?

Perimeter (Condensed Matter and TFTs): Spin–Statistics and categorified Galois groups

UIUC (Topology): A higher category theorist's take on the spin–statistics theorem

Berkeley (Representation Theory): Some non-dualizable categories

IBS-CGP, Korea (Colloquium): Local Poincare duality & deformation quantization

MPIM, Bonn (Higher geometry): Some comments on Heisenberg-picture qft

Notre Dame (Topology): Twisted field theories and higher-categorical (op)lax transfors

UBC (Geometry and Physics): Functorial axioms for Heisenberg-picture quantum field theory

2014 IBS-CGP, Korea (Quantum Mondays Seminar): Heisenberg-picture quantum field theory

Northwestern (CFT Seminar): The CS-WZW correspondence

SCGP, Stony Brook (Homological Methods in Quantum Field Theory Workshop): Poisson AKSZ theories

Northwestern (Associators and Formality Seminar): Lie bialgebra quantization in 2- and 3-dimensional field theory

Berkeley (Representation Theory): Heisenberg-picture TQFTs

Erwin Schrödinger Institute (Modern Trends in TQFT): Poisson AKSZ theory and homotopy actions of properads

UC Berkeley (Topology): Up-to-homotopy Frobenius structures on manifolds, and how they

relate to perturbative QFT

2013 UT Austin (Geometry): Poisson AKSZ theories and quantization

Temple (AMS Sectional Meeting): Poisson AKSZ theories and quantization

Northwestern (Geometry and Physics): Poisson AKSZ theory, properads, and quantization

Northwestern (Geometry and Physics): A properad action on homology that fails to lift to the chain level

Loyola (Algebra and Combinatorics): A properadic approach to the deformation quantization

Northeastern (Research Seminar): A salad of BV integrals and AKSZ field theories

Stony Brook (String-Math 2013): Star quantization via lattice topological field theory

AIM (Geometric perspectives in QFT): Lattice topological field theory

Tahoe (QFT): Lattice Poisson AKSZ BV

UBC (Algebraic geometry): Lattice Poisson AKSZ Theory

2012 Hamburg (TFT2012): Nonperturbative integrals, imaginary critical points, and homological perturbation theory

Aarhus (QGM): Nonperturbative integrals, imaginary critical points, and homological perturbation theory

Northeastern (Representation Theory): Wick-type theorems beyond the Gaussian

2011 Zürich (Talks in Mathematical Physics): Gauge-fixed integrals for Lie algebroids

Zürich (Classical and quantum geometry): Introduction to BV integrals

Berkeley (GRASP): Asymptotics of oscillating integrals via homological perturbation theory

Northwestern (Geometry and Physics): Homological perturbation and factorization algebras

Northwestern (NUMS): On Atoms, Mountains, and Rain

UT Austin (GADGET): Feynman Diagrams for Schrodinger's Equation

2010 UC Berkeley (GRASP): Formal calculus, with applications to quantum mechanics

UC Berkeley (Subfactors): The formal path integral in quantum mechanics

2009 Aarhus Universitet (Ph.d. seminar): What the hell is a Feynman diagram?

Professional Activities

- Reviewer for *Mathematical Reviews* and *zbMATH*.
- Referee for *Lett. Math. Phys.*, *Comm. Math. Phys.*, *J. Homotopy Relat. Struct.*, *Canad. J. Math.*, and EPSCR.
- 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 A. Weekes and K. Costello) of weekly Mathematical Physics seminar at Perimeter Institute, 2016–present.
- 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.

Teaching Activities

At Northwestern

2016 Winter. Instructor for Graduate Seminar: Topology and Geometry (Math 448)
Quantum topology class centered 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. `math.northwestern.edu/~theojf/Seminar2015/`

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. `math.northwestern.edu/~theojf/FreshmanSeminar2014/`

2013 Fall. Instructor for Foundations of Higher Mathematics (Math 300)
Set theory class centered on student presentations. `math.northwestern.edu/~theojf/Math300-syllabus`

At Berkeley

2011 Fall. Guest lecturer for Calculus (Math 1B) with N. Reshetikhin
Three lectures for 300 students.

2010 Spring. Guest lecturer for Precalculus (Math 32) with R. Bayer
Three lectures for 80 students.

2009 Summer. Guest lecturer for Complex Analysis (Math 185) with N. Reshetikhin
Five lectures for 30 students.

2009 Summer. Instructor for Second-semester Calculus (Math 1B)
Lectured, prepared homework and exams, etc. `math.berkeley.edu/~theojf/09Summer1B/`

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. `math.berkeley.edu/~theojf/08Summer1B/`

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.

At Stanford

2007 Winter. Grader for Set Theory (Math 161) with M. Young
Held office hours, graded homework.

2006–2007 . Tutoring Coordinator, Stanford Undergrad Mathematics Organization
Free drop-in tutoring center.

2006 Winter. Grader for Linear Algebra and Matrix Theory (Math 113) with R. Vakil
Held office hours, graded homework.

2004–2007. Tutor, Stanford Undergrad Mathematics Organization
Free drop-in tutoring center.