

CONTACT INFORMATION

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RESEARCH INTERESTS

My research is motivated by conformal field theory (CFT), and my research program seeks to build a unified mathematical framework for the study of CFT, as well as to study new mathematical connections which arise as a result. Mathematical objects which arise include operator algebras, subfactors, functorial field theories, vertex operator algebras, quantum algebra and tensor categories, vector-valued modular forms, and complex function theory.

EMPLOYMENT

The Australian National University

Lecturer (March 2019 - present)

Mathematical Sciences Institute Research Fellow (July 2018 - March 2019)

University of California, Santa Barbara

Visiting Assistant Professor (September 2015 - April 2016, September 2016 - June 2018)

Max Planck Institute for Mathematics, Bonn

Postdoctoral Researcher (August 2014 - August 2015, June 2016 - August 2016)

EDUCATION

University of California, Berkeley

PhD, Mathematics (September 2008 - May 2014)

Advisor: Vaughan F. R. Jones

Pomona College

BA, Mathematics (September 2004 - May 2008)

Magna cum laude, Phi Beta Kappa, math department award, and thesis award

VISITING POSITIONS

Research Member, MSRI Program on Quantum Symmetries (January 2020 - May 2020), support of US\$16.6k for travel and accommodation expenses provided by MSRI

EXTERNAL FUNDING

1. ARC Discovery Project DP200100067 “Physical realisation of enriched quantum symmetries,” 2020-2022, co-Chief Investigator (\$340k)
2. AMSI/AustMS Scientific Workshop Funding 2020, “The Mathematics of Conformal Field Theory II” (\$8k) + AustMS
3. AMSI/AustMS Scientific Workshop Funding 2019, “Subfactors in Sydney” (\$11k)
4. AMS-Simons Travel Grant 2017-2019 (US\$4k)
5. NSF Graduate Research Fellowship 2009-2011 (US\$75k)

PUBLISHED ARTICLES AND PREPRINTS

1. *Fusion and positivity in chiral conformal field theory*
 submitted. [arXiv:1910.08257](https://arxiv.org/abs/1910.08257).

2. *Classification of extremal vertex operator algebras with two simple modules*
submitted. [arXiv:1811.02180](#) (with J. Connor Grady)
3. *Representation theory in chiral conformal field theory: from fields to observables*
Selecta Math. (N.S.), 25:76 (2019). [arXiv:1810.08168](#)
4. *Planar algebras in braided tensor categories*
Mem. Amer. Math. Soc., to appear. [arXiv:1607.06041](#) (with André Henriques and David Penneys)
5. *Geometric realization of algebraic conformal field theories*
Adv. Math., 349 (2019), 488-563. [arXiv:1611.01176](#)
6. *Positivity and fusion of unitary modules for unitary vertex operator algebras*
RIMS Kôkyûroku (2018), no. 2086, 6-13.
7. *Singular values of weighted composition operators and second quantization*
Int. Math. Res. Not. IMRN (2018), no. 20, 6426-6441. [arXiv:1612.03970](#) (with Mihai Putinar)
8. *On classification of extremal non-holomorphic conformal field theories*
J. Phys. A: Math. Theor., 50 (2017), 115204. [arXiv:1611.04071](#) (with Zhenghan Wang)
9. *Construction of the unitary free fermion Segal CFT*
Commun. Math. Phys. 355 (2017), no. 2, 463-518. [arXiv:1608.02095](#)
10. *Internal trace for module tensor categories over braided tensor categories*
Documenta Math., 21 (2016) 1089-1149. [arXiv:1509.02937](#) (with André Henriques and David Penneys)
11. *Subfactors of index less than 5, part 4: vines*
Int. J. Math., 23 (2012), no. 3, 1250017. [arXiv:1010.3797](#) (with David Penneys)
12. *Unitary equivalence to a complex symmetric matrix: low dimensions*
Lin. Alg. Appl., 437 (2012), no. 1, 271-284. [arXiv:1104.4960](#) (with Stephan R. Garcia and Daniel Poore)
13. *Unitary equivalence of a matrix to its transpose*
J. Operator Theory, 68:1 (2012), 179-203. [arXiv:0908.2107](#) (with Stephan R. Garcia)
14. *Projections and idempotents with fixed diagonal and the homotopy problem for unit tight frames*
Oper. Matrices, 5 (2011) 139-155. [arXiv:0906.0139](#) (with J. Giol, L.V. Kovalev, D. Larson and N. Nguyen)
15. *Unitary equivalence to a complex symmetric matrix: an algorithm*
J. Math. Anal. Appl., 341 (2008) 640-648. [arXiv:0908.2201](#)

SELECTED RECENT INTERNATIONAL CONFERENCE PRESENTATIONS (SINCE JUNE 2016)
(Almost all talks include funding for travel and/or accommodation)

1. Seminal Interactions between Mathematics and Physics II
Italian National Academy, July 2020 (plenary speaker; declined due to conflict)
2. MSRI Introductory Workshop: Quantum Symmetries
Mathematical Sciences Research Institute, Berkeley, USA, January 2020
3. Workshop on Subfactors and Applications
Mathematisches Forschungsinstitut Oberwolfach, October 2019
4. Workshop on Operator Algebras and Quantum Physics
Simons Center for Geometry and Physics, June 2019

5. NCGOA/Shanks conference on Algebra and Geometry Quantized and Quantified
Vanderbilt University, May 2019
6. Workshop on Subfactors and Fusion Categories
Banff International Research Station, October 2018
7. Workshop on Geometric and Categorical Aspects of CFTs
Casa Matemática Oaxaca, September 2018
8. Algebraic Methods in Mathematical Physics
CRM Montreal, July 2018
9. (Sub)Factors in Maui, May 2018
10. Workshop on algebraic combinatorics and representation theory of finite groups and
vertex operator algebras
Kyoto RIMS, December 2017
11. Shanks workshop on subfactors and applications
Vanderbilt University, October 2017
12. Workshop on Subfactors, higher geometry, higher twists and almost Calabi-Yau alge-
bras
Isaac Newton Institute for Mathematical Sciences, Cambridge, March 2017
13. Southeastern Analysis Meeting 2017
UT Knoxville, March 2017
14. Berkeley-Tokyo Autumn School on Quantum Field Theory and Subfactors
UC Berkeley, November 2016
15. Modular Categories—Their Representations, Classification, and Applications
Casa Matemática Oaxaca, August 2016
16. Workshop on Von Neumann Algebras
Hausdorff Institute for Mathematics, Bonn, July 2016
17. Mathematics and Physics at the Crossroads trimester program seminar
National Institute for Nuclear Physics, Frascati, June 2016

RECENT INVITED SEMINAR AND COLLOQUIUM TALKS (SINCE APRIL 2017)

(All talks include funding for travel and/or accommodation)

1. UC Davis Seminar on Quantum Mathematics & Physics, February 2020
2. University of Rome Tor Vergata Operator Algebras Seminar, July 2019
3. University of Melbourne Pure Mathematics Seminar, March 2019
4. Perimeter Institute for Theoretical Physics, April 2018
5. University of Arizona Mathematics Colloquium, February 2018
6. UC Davis Seminar on Algebra & Discrete Mathematics, November 2017
7. OSU Seminar on Quantum Algebra & Quantum Topology, September 2017
8. OSU Seminar on Non-commutative Geometry & Operator Algebras, September 2017
9. Claremont Colleges Mathematics Colloquium, April 2017

RESEARCH SUPERVISION

- I am a supervisory panel member for PhD students Amelia Han and ????
- FRT Scholar ???
- Honours student ???
- DP20 postdoc ???
- I supervised the undergraduate honors thesis of J. Connor Grady (UCSB '18) entitled *The Classification of Extremal Vertex Operator Algebras of Rank 2*). He is now a PhD student at the University of Illinois.

CONFERENCES CO-ORGANISED

1. The Mathematics of Conformal Field Theory II, July 2020. Funded by AMSI, AustMS, IAMP, PIMS and the MSI.
2. Subfactors in Sydney, February 2019. Funded by AMSI, AustMS, and the ARC.
3. Workshop on Quantum Symmetries, February 2019. Funded by the ARC.
4. Subfactors in Maui series, July 2019, 2017, 2013, and 2012. Funded by the NSF and DARPA.
5. Subfactor Theory in Mathematics and Physics, July 2014. Funded by DARPA.
6. QFTahoe Workshop, March 2013. Funded by the NSF.
7. Subfactors in Tahoe, February 2012. Funded by the NSF.

OUTREACH

- Hosted a group of year 12 students from Narrabundah College and consulted with them regarding a school project. October 2018.
- Co-authored a feature article for the 2018-2019 AMSI Research Report, a publication which “illustrates the cross-discipline and industry impact of the mathematical sciences.”
- Met with students as a part of ANU Open Day in 2018 and 2019.

SERVICE AND COMMUNITY

- Co-organiser for the MSI Special Year 2020 in Mathematical Physics.
- Convenor for the quantum mathematics group seminar, July 2019 to present.
- Selection committee for DP postdoc ???
- Participant in the fortnightly MSI teaching organisational meetings.
- Served as a reader for two Honours theses in 2018 and 2019.
- Participated in the Respectful Relationships Unit training at the MSI in 2019.
- Started the UC Santa Barbara seminar on quantum topology and quantum algebra, a research and learning seminar with significant interdisciplinary participation by graduate students.
- Served as a referee for 16 journals, including many leading journals such as Journal of the American Mathematical Society, Duke Mathematical Journal, Advances in Mathematics, Annales Henri Poincaré, International Mathematics Research Notices, Proceedings of the National Academy of Sciences, Proceedings of the AMS, and Transactions of the AMS.

TEACHING EXPERIENCE AND AWARDS

- I am the convenor for MATH3228/6213 Advanced Complex Analysis (2018-present). I was nominated by students for the Joint Colleges of Science Award for Teaching Excellence in 2018 (ineligible to win; the award requires at least three years of prior employment at ANU).

- I co-taught MATH3351/6211 Advanced Topics in Mathematical Physics in S1 of 2019, on the subject of Vertex Operator Algebras. I developed a curriculum and supporting lecture notes which enabled me to teach aspects of this advanced research-level topic to an audience containing undergraduate students.
- I taught MATH3349/4349 Special Topics in Mathematics in S2 of 2019, on the subject of Operator Algebras. This course also required special development supported by my research experience which enabled undergraduate students to learn such advanced material.
- At UC Santa Barbara, I was the instructor of record for 11 courses, including Calculus II (5 times), Transition to Higher Mathematics (4 times), and upper division Linear Algebra (2 times). Course sizes range from 150-350 for calculus and 35-60 for proof-based courses. On a scale of 1=excellent to 5=poor, my average course rating by students was 1.2.
- As a PhD student at UC Berkeley, I was the instructor of record for Matrix Theory and Differential Equations, and a teaching assistant for Calculus II, Precalculus, Matrix Theory, and Linear Algebra. I received an Outstanding Graduate Student Instructor award.

REFEREES

- Vaughan Jones (Vanderbilt) - Peter says yes, even though conflicted
- Yasuyuki Kawahigashi (Tokyo)
- Michael Freedman (Microsoft)?
- Arthur Jaffe (Harvard)?
- Nicolai Reshetikhin (Berkeley)?
- Roberto Longo (Rome)?
- Ingo Runkel (Hamburg)?
- Terry Gannon (Alberta)?