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Scott Morrison - Resume

I am a mathematician interested in topological ordered systems (with applications to quantum computing), higher dimensional categories, quantum field theories, operator algebras, and interactive theorem proving. I am especially excited about exotic examples of quantum symmetries.

Employment

Future Fellow
January 2018-June 2020. Supported by the ARC grant *Quantum symmetries.*

Professor
January 2020-February 2020, in the Mathematical Sciences Institute at the Australian National University.

Associate Professor
January 2016-December 2019, MSI.

Senior Lecturer
July 2012-December 2015, MSI.

DECRA Research Fellow, the Autralian National University
July 2012-June 2015. Supported by the ARC grant *Fusion categories and topological quantum field theory.*

Miller Fellowship, UC Berkeley.
July 2009-June 2012. I was a Fellow of the interdisciplinary Miller Institute for Basic Research at UC Berkeley, hosted in the mathematics department.

Post-doctoral research, Microsoft Station Q.
April 2007-June 2009. Station Q is a multidisciplinary research group, focusing on *topological quantum computing.*

Prizes

- The Medal of the Australian Mathematical Society, 2015.
- The Christopher Heyde Medal for Research in Pure Mathematics, 2015.

Education

University of California, Berkeley, Doctor of Philosophy (Mathematics).
2001-2007. Worked with Prof. Vaughan Jones. Received the 2007 Herbert Alexander Prize for Outstanding Dissertation in Pure Mathematics and a 2004 Outstanding Graduate Student Instructor Award.

University of New South Wales, Bachelor of Science (Hons.)
1998-2001, Sydney, Australia. First class honours in Mathematics, and the University Medal.

Publications

Six highlighted publications

The following six publications highlight particularly high impact research outputs, and indicate the broad range of my research interests.

The classification of subfactors with index at most $5\frac{1}{4}$.

with Narjess Afzaly and David Penneys. In press at *Memoirs of the American Mathematical Society*, accepted Feb 2018. arXiv:*1509.00038*.

This represents the state of the art in a major project I've lead over the last decade, on the classification of subfactors, building on a sequence of six earlier papers with a total of eight coauthors in the USA, Australia, and Japan.

Modular data for the extended Haagerup subfactor.

with Terry Gannon. *Communications in Mathematical Physics* vol. 356, issue 3, pp. 981-1015 (2017). arXiv:*1606.07165*.

We describe the Drinfeld centre and modular data of the most exotic known example of a fusion category, indicating connections to conformal field theory, revealing unexpected and intricate relationships with certain quantum group representation categories.

Webs and quantum skew Howe duality

with Sabin Cautis and Joel Kamnitzer. *Math. Ann.*, vol. 360 (2014) pp. 351-390. arXiv:*1210.6437*.

This paper solved a longstanding problem, providing a diagrammatic presentation of the representation theory of quantum $\mathfrak{sl}_n$. It introduces an unexpected new technique in skew Howe duality, and others authors have since applied these ideas in other settings.

Constructing the extended Haagerup planar algebra

with Stephen Bigelow, Emily Peters and Noah Snyder. *Acta Mathematica*, vol. 209 (2012) pp. 29–82. arXiv:*0909.4099*.

We construct the long sought after 'extended Haagerup subfactor', completing the classification of subfactors up to index $3 + \sqrt{3}$.

Higher categories, colimits and the blob complex

with Kevin Walker. *Proceedings of the National Academy of Sciences* May 17, 2011 vol. 108 no. 20 pp. 8139–8145. arXiv:*1108.5386*.

This survey paper on the 'blob complex' introduces the main construction and sketches applications. It is extremely unusual for pure mathematics papers to be published in PNAS, and I consider this paper an important accomplishment.

Man and machine thinking about the smooth 4-dimensional Poincaré conjecture

with Michael Freedman, Robert Gompf and Kevin Walker. *Quantum Topology*, vol. 1, issue 2 (2010), pp. 171–208. arXiv:*0906.5177*.

We describe two potential attacks on the most important open problem in geometric topology, the smooth 4-dimensional Poincaré conjecture. This paper initiated a new surge of interest in Cappell-Shaneson spheres and other potential counterexamples.

Other publications

Rank-finiteness for G-crossed braided fusion categories.

with Corey Jones, Dmitri Nikshych, and Eric Rowell, to appear *Transformation Groups*. arXiv:*1902.06165*

Computing modular data for pointed fusion categories.

with Angus Gruen, to appear *Indiana University Mathematics Journal*. arXiv:*1808.05060*

Monoidal categories enriched in braided monoidal categories.
with David Penneys. *International Mathematics Research Notices*, issue 11, pp. 3527-3579 (2019).
DOI:10.1093/imrn/rnx217 arXiv:*1701.00567*

Lifting shadings on symmetrically self-dual subfactor planar algebras.
with Zhengwei Liu and David Penneys. in press *Contemporary Mathematics*, accepted Feb 2018.
arXiv:*1709.05023*

The centre of the extended Haagerup subfactor has 22 simple objects.
with Kevin Walker. *International Journal of Mathematics* 2017. DOI:10.1142/S0129167X17500094
arXiv:*1404.3955*.

Categories generated by a trivalent vertex.
with Emily Peters and Noah Snyder. *Selecta Mathematica* 2016. DOI:10.1007/s00029-016-0240-3
arXiv:*1501.06869*.

2-supertransitive subfactors at index $3 + \sqrt{5}$.
with David Penneys. *Journal of Functional Analysis*, 269 (2015), pp. 2845-2870. DOI:10.1016/j.jfa.2015.06.023
arXiv:*1406.3401*.

Quotients of $A_2 * T_2$
with Masaki Izumi and David Penneys. *Canadian Journal of Mathematics* 2016. DOI:10.4153/CJM-2015-017-4
arXiv:*1308.5723*.

Subfactors of index exactly 5.
with Masaki Izumi, David Penneys, Emily Peters, and Noah Snyder. *Bulletin of the London Mathematics Society*, (2015) 47 (2), pp. 257-269. DOI:10.1112/blms/bdu113 arXiv:*1406.2389*.

Constructing spoke subfactors using the jellyfish algorithm
with David Penneys, *Transactions of the American Mathematical Society*, vol. 367, no. 5 (2015).
DOI:10.1090/S0002-9947-2014-06109-6 arXiv:*1208.3637*

1-supertransitive subfactors with index at most $6\frac{1}{5}$
with Zhengwei Liu and David Penneys. *Communications in Mathematical Physics*, vol. 334, issue 2 (2015), pp 889-922. DOI:10.1007/s00220-014-2160-4 arXiv:*1310.8566*.

An obstruction to subfactor principal graphs from the graph planar algebra embedding theorem. *Bulletin of the London Mathematical Society*, vol. 46 (2014). DOI:10.1112/blms/bdu009
arXiv:*1302.5148*.

The little desert? Some subfactors with index in the interval $(5, 3 + \sqrt{5})$
with Emily Peters, *International Journal of Mathematics*, vol. 25, issue 8 (2014). arXiv:*1205.2742*
DOI:10.1142/S0129167X14500803.

The classification of subfactors of index at most 5
with Vaughan F.R. Jones and Noah Snyder. *Bulletin of the American Mathematical Society* **51** (2014), no. 2, 277–327. arXiv:*1304.6141*.

Subfactors of index less than 5, part 3: quadruple points
with Masaki Izumi, Vaughan F.R. Jones and Noah Snyder. *Communications in Mathematical Physics*, vol. 316, issue 2 (2012). DOI:10.1007/s00220-012-1472-5 arXiv:*1109.3190*.

The blob complex
with Kevin Walker. *Geometry & Topology* 16 (2012) 1481–1607. DOI:10.2140/gt.2012.16.1481
arXiv:*1009.5025*.

Subfactors of index less than 5, part 2: triple points
with David Penneys, Emily Peters and Noah Snyder. *International Journal of Mathematics* vol. 23, no. 3 (2012) 1250016 (33 pages). DOI:10.1142/S0129167X11007586 arXiv:*1007.2240*.

Subfactors of index less than 5, part 1: the principal graph odometer
with Noah Snyder. *Communications in Mathematical Physics*, vol. 312, issue 1 (2012), pp. 1–35.

DOI:10.1007/s00220-012-1426-y arXiv:*1007.1730*.

Non-cyclotomic fusion categories

with Noah Snyder, *Transactions of the American Mathematical Society*, vol. 364 (2012), no. 9, pp. 4713–4733. arXiv:*1002.0168*.

Cyclotomic integers, fusion categories, and subfactors

with Frank Calegari and Noah Snyder, with an appendix by Victor Ostrik, *Communications in Mathematical Physics* vol. 303, issue 3 (2011), pp. 845–896. DOI:10.1007/s00220-010-1136-2 arXiv:*1004.0665*.

Knot polynomial identities and quantum group coincidences

with Emily Peters and Noah Snyder, *Quantum Topology* vol. 2 (2011) pp. 101–156. DOI:10.4171/QT/16 arXiv:*1003.0022*.

The braid group surjects onto G_2 tensor space

Pacific Journal of Mathematics, vol. 249 (2011), no. 1, pp. 189–198. DOI:10.2140/pjm.2011.249.189 arXiv:*0907.0256*.

Skein theory for the D_{2n} planar algebras

with Emily Peters and Noah Snyder, *Journal of Pure and Applied Algebra* vol. 214, no. 2 (2010) pp. 117–139. DOI:10.1016/j.jpaa.2009.04.010 arXiv:*0808.0764*.

A Diagrammatic Category for the Representation Theory of $U_q\left(\mathfrak{sl}_n\right)$

Ph.D. thesis. arXiv:*0704.1503*.

Fixing the functoriality of Khovanov homology

with David Clark and Kevin Walker, *Geometry and Topology* vol. 13 (2009) pp. 1499–1582. DOI:10.2140/gt.2009 arXiv:*math.GT/0701339*.

On Khovanov's cobordism theory for $\mathfrak{su}_3$ knot homology

with Ari Nieh, *Journal of Knot Theory and its Ramifications* vol. 17, no. 9 (2008). arXiv:*math.GT/0612754* DOI:10.1142/S0218216508006555.

The Karoubi Envelope and Lee's Degeneration of Khovanov Homology

with Dror Bar-Natan, *Algebraic & Geometric Topology* vol. 6 (2006) pp. 1459–1469. arXiv:*math.GT/0606542* DOI:10.2140/agt.2006.6.1459.

Preprints in peer review

Extension theory for braided-enriched fusion categories.

with Corey Jones, David Penneys, and Julia Plavnik. arXiv:*1910.03178*

Invariants of 4-manifolds from Khovanov-Rozansky link homology.

with Kevin Walker and Paul Wedrich. arXiv:*1907.12194*

The Extended Haagerup fusion categories.

with Pinhas Grossman, David Penneys, Emily Peters, and Noah Snyder. arXiv:*1810.06076*

Completion for braided enriched monoidal categories.

with David Penneys, and Julia Plavnik. arXiv:*1809.09782*

A field guide to categories with A_n fusion rules.

with Cain Edie-Michell. arXiv:*1710.07362*

Computing annular Khovanov homology.

with Hilary Hunt, Hannah Keese, and Anthony Licata. arXiv:*1505.04484*.

Outreach

I am a co-founder and moderator of MathOverflow, a website for mathematicians to ask and answer *research-level questions.* MathOverflow has had a profound effect on the fundamental processes of mathematical research. MathOverflow was established in 2009 and by its 10th anniversary over 100,000 questions have been asked. MathOverflow receives approximately 18,000 visits, and about 45 new questions each day. With Anton Geraschenko and Ravi Vakil, I wrote an opinion piece about MathOverflow for the June 2010 issue of the *Notices of the AMS.*

The visibility of MathOverflow makes the processes of mathematical research more accessible to the public. It is a fantastic tool for finding the relevant mathematical experts for deep technical questions. It is completely international, with active participants ranging from Fields Medallists to precocious undergraduates in countries without strong mathematical traditions. *MathOverflow* has helped create many new collaborations. There are over 1700 pre-prints posted on the `arXiv` which cite or acknowledge MathOverflow.

My research and outreach activities have appeared in the science and general media, including

Chalk it up to experience
Sherryn Groch, front page **Canberra Times**, 3 July 2018
165-year-old math problem on verge of solution
Shubashree Desikan, **The Hindu**, 9 April 2014
Sudden Progress on Prime Number Problem Has Mathematicians Buzzing
Erica Klarreich, **Wired Magazine**, 22 November 2013
Game of proofs boosts prime pair result by millions
Jacob Aron, **New Scientist**, 5 June 2013
Cracking Open the Scientific Process
Thomas Lin, **New York Times**, 16 Jan 2012
The Global Math Commons
Erica Klarreich, **Simons Foundation newsletter**, 18 May 2011
Stanford and UC Berkeley create massively collaborative math
Lisa Krieger, **San Jose Mercury News**, 8 August 2010

Service

I am a member of the mathematics advisory board for the `arXiv` (the main preprint server for mathematics and physics), as well as a subject area moderator for quantum algebra. (Both since 2014.) I am a founding board member of MathOverflow, the premier online site for research level mathematics questions and answers. I was on the 2013-2015 Council of the Australian Mathematical Society,

Internally, I am the HDR convenor within the Mathematical Sciences Institute (since 2014), and a member of the MSI technology committee.

Grants

Physical realisation of quantum symmetries
An ARC 'Discovery Project' for 2020-2022 ($340,000), jointly held with Arnaud Brothier, Pinhas Grossman, and James Tener.

Quantum symmetries

An ARC 'Future Fellowship' for 2018-2021 ($862,000).

Low-dimensional categories

An ARC 'Discovery Project' for 2016-2018 ($455,000). (postdoc and travel funding)

Symmetries of subfactors

An ARC 'Discovery Project' for 2014-2016 ($375,000), jointly held with Pinhas Grossman and Vaughan Jones. (postdoc and travel funding)

Fusion categories and topological quantum field theory

An ARC 'Discovery Early Career Research Award' for 2012-2014 ($360,000).

Quantum symmetries

A DARPA grant for 2012-2014, jointly held with Dietmar Bisch, Vaughan Jones, and Dmitri Shlyakhtenko (USD488,058). (travel and conference funding)

MathOverflow development

A Sloan Foundation grant (USD8,000) to support setting up MathOverflow Inc., and software development for MathOverflow.

Conferences organised

MSRI (Berkeley) semester program on Quantum Symmetries

Co-organiser with Vaughan Jones, Victor Ostrik, Emily Peters, Eric Rowell, Noah Snyder, and Chelsea Walton. Spring 2020.

Subfactors in Sydney

Co-organiser with Arnaud Brothier, Pinhas Grossman, and James Tener. January 2019.

Banff workshop on Subfactors and fusion categories

Co-organiser with Terry Gannon, David Penneys, and Julia Plavnik. October 2018.

Banff workshop on Subfactors and Fusion Categories

Co-organiser with Vaughan Jones, David Penneys, Emily Peters, and Noah Snyder . April 2014.

AIM workshop on Fusion Categories

Co-organiser with Eric Rowell and Noah Snyder. March 2012.

Subfactors in Maui

Co-organiser of Subfactors in Maui 2014 (funded by the NSF), Subfactors in Maui 2011 (funded by DARPA), and Subfactors in Maui 2007.

Quantum Topology in Wellington

With David Gauld, Quantum Topology at the joint NZMS/AMS meeting in New Zealand, 2007.

For a complete list of my invited conference talks, please see my webpage.

Refereeing

I have refereed for many top mathematics journals, amongst them *Advances in Mathematics*, *Annals of Mathematics*, *Communications in Mathematical Physics*, the *Duke Mathematical Journal*, *Geometry & Topology*, the *Journal of the American Mathematical Society*, the *Journal of Functional Analysis*, and *Quantum Topology*.