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Scott Morrison - Resume

I am a mathematician interested in higher dimensional categories, topological field theories, operator algebras (particularly subfactors), and connections with topological quantum computing. I am especially excited about exotic examples of higher categorical structures.

Employment

Senior Lecturer, the Australian National University

July 2012-present. I am a Senior Lecturer in the Mathematical Sciences Institute at the Australian National University.

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*. The research interests of the group cover *condensed matter physics*, especially topological phases and the fractional quantum hall effect, and *quantum topology*, a field of mathematics describing topological quantum field theories (TQFTs) and their applications. During my stay at Station Q, my research was primarily on *extensions of TQFT* which introduce ideas from homological algebra, and on *the classification of TQFTs* related to von Neumann algebras and quantum groups.

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 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*.

This survey article summarises the output of a major project I've lead on the classification of subfactors. The full proof is spread over six papers and involved seven coauthors.

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.

Non-cyclotomic fusion categories

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

This article answers in the negative a question from the beginnings of fusion categories: can they all be defined over cyclotomic fields? This result demonstrates that the fusion categories coming from subfactors are significantly different from the 'classical examples' from groups and quantum groups.

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.

Published

2-supertransitive subfactors at index $3 + \sqrt{5}$.

with David Penneys. In press at *Journal of Functional Analysis*, accepted June 27 2015. arXiv:*1406.3401*.

Quotients of $A_2 * T_2$

with Masaki Izumi and David Penneys. In press at *Canadian Journal of Mathematics*, accepted March 19 2015. 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). 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.

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*.

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*.

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

Computing annular Khovanov homology.
with Hilary Hunt, Hannah Keese, and Anthony Licata. arXiv:*1505.04484*.

Categories generated by a trivalent vertex.
with Emily Peters and Noah Snyder. arXiv:*1501.06869*.

The centre of the extended Haagerup subfactor has 22 simple objects.
with Kevin Walker. arXiv:*1404.3955*.

Outreach

I am a co-founder and moderator of MathOverflow, a website for mathematicians to ask and answer research-level questions. MathOverflow was established in 2009 and over 16,000 people have now asked a question. MathOverflow receives approximately 10,000 visits, and about 30 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 600 pre-prints posted on the `arXiv` which cite or acknowledge MathOverflow.

I am a member of the group blog the *Secret Blogging Seminar*: a group of Berkeley Ph. D. graduates discuss research mathematics and events important to mathematicians. As an example, my post there germinated the massively collaborative 'Polymath 8' project, improving the bounds on gaps between prime numbers.

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

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 on the 2014/2015 Council of the Australian Mathematical Society, and also the mathematics advisory board for the `arXiv` (the main preprint server for mathematics and physics).

I am a founding board member of the MathOverflow legal entity; we have signed a contract with Stack Exchange to migrate our site into their network, providing us with extensive support

and free development work, we have successfully applied for grant funding for MathOverflow from the Sloan foundation, and we have planned for progressive changes in the moderation team.

Internally, I am the HDR convenor within the Mathematical Sciences Institute, and a member of the MSI IT committee.

Grants

The research page of my website contains more details on these grants, including application materials and assessments.

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.

I am currently applying for a 2016 ARC Discovery Project grant.

Software development

I am the principal developer of several open source packages for mathematical computation. The FusionAtlas and KnotTheory packages in particular are widely used and have been cited many times in the mathematical literature.

FusionAtlas
A freely available Mathematica package for analysing subfactors and fusion categories, with contributions by David Penneys, Emily Peters, Noah Snyder and James Tener.

QuantumGroups
A Mathematica package for the representation theory of quantum groups, including quantum knot invariants. Available online with a brief tutorial in arXiv:*1003.0022*.

KnotTheory and the Knot Atlas
The Knot Atlas is an online editable encyclopedia and database of knot theory and knot invariants. KnotTheory is an associated Mathematica package. I co-maintain both with Dror Bar-Natan, with contributions from many people.

Conferences organized

Banff workshop on Subfactors and Fusion Categories
Co-organizer with Vaughan Jones, David Penneys, Emily Peters, and Noah Snyder. April 2014

AIM workshop on Fusion Categories
Co-organizer with Eric Rowell and Noah Snyder. March 2012.

Subfactors in Maui

Co-organizer 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, including *Algebraic and Geometric Topology*, *Communications in Mathematical Physics*, the *Duke Mathematical Journal*, *Geometry & Topology*, *International Mathematics Research Notices*, the *Journal of Functional Analysis*, the *Proceedings of the American Mathematical Society*, and *Quantum Topology*.

Teaching

In Semester 2 2015, I am teaching the linear algebra component of the largest first year course at the MSI, MATH 1014.

During the course of my research-only position funded by the Discovery Early Career Researcher Award, I volunteered to teach the following courses.

2014 S2 — Analysis 3: Hilbert Spaces, Measure Theory, and Spectral Theory

Course notes available at my webpage.

2014 S2 — Honours special topics: Link homology

2014 S2 — Advanced Studies Extensions: category theory

2013 S2 — Analysis 3: Hilbert Spaces, Measure Theory, and Spectral Theory

I would like to *highlight two aspects* of my recent teaching work: being asked by students to run both special topics courses and ASE/reading courses, and volunteering to teach Analysis 3 while in a research only position (with increased enrollment from 2013 to 2014).

My honours students Joshua Chen and Hilary Hunt have recently graduated with first class honours. Joshua's thesis was on Temperley-Lieb categories and their Turaev-Viro invariants. He is now continuing his studies with a Masters degree in mathematics at Bonn. Hilary studied algorithms in low dimensional topology and knot theory, and in particular computing the Khovanov homology of braid closures. She is now working as a research assistant with me, on the isotopy representation on Khovanov homology. I am also working with (and on the thesis committee) Narjess Afzaly, a Ph.D. student in computer science, on new algorithms for enumerating principal graphs of subfactors.

University of California, Berkeley

Outstanding Graduate Student Instructor Award, 2004. Teaching Assistant for 9 semesters, for MATH 1B (Introductory Calculus), 53 (Multivariable Calculus), 54 (Linear Algebra), 53H (Honors Multivariable Calculus), 54H (Honors Linear Algebra), 110 (Linear Algebra), and 121A (Mathematical Methods for the Physical Sciences).