

Patrick Orson

Curriculum Vitae

Max Planck Institute for Mathematics
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Research interests

Low-dimensional topology and knot theory. Applications of high-dimensional manifold techniques to knot concordance and the study of topological 4-manifolds. Stable homotopy invariants refining knot homology theories.

Research and Teaching Positions

- Sep 2021 – **Postdoctoral Research Associate**, *Max Planck Institute*, Bonn, Germany.
present Currently researching at MPIM.
- Sep 2020 – **Postdoctoral Fellow**, *ETH Zürich*, Zürich, Switzerland.
Aug 2021 Research postdoctoral position and student thesis supervision.
- Sep 2017 – **Visiting Assistant Professor**, *Boston College*, Boston, USA.
Jun 2020 Researching and teaching at Boston College.
- Jan 2017 – **Postdoctoral Research Associate**, *UQÀM*, Montreal, Canada.
Aug 2017 Research associate in the Centre de Recherche en Géométrie et Topologie (CIRGET) at the Université du Québec à Montréal. Taught at McGill University.
- Jan 2015 – **Postdoctoral Research Associate**, *Durham University*, Durham, UK.
Oct 2016 Worked on the EPSRC research grant *New homotopy-type invariants of knots*. Developing new applications and directions for the Lipshitz-Sarkar stable homotopy refinement of Khovanov homology.

Education

- 2015 **PhD**, *University of Edinburgh*, Edinburgh, UK.
◦ Thesis: *Double L-Theory* A theory of algebraic ‘double-cobordism’ for chain complexes with Poincaré duality, with applications to knot theory and the algebra of Seifert forms.
◦ Supervised by Prof. Andrew Ranicki.
- 2012 **MA Mathematics (Cantab)**, *University of Cambridge*, Cambridge, UK.
- 2009 **MMath (Part III), Merit**, *University of Cambridge*, Cambridge, UK.
Focussing on geometry and topology; particularly 4-manifold topology.
◦ Part III Essay: *Small 4-manifolds* A review of exotic smooth structures on $\mathbb{C}P^2 \# m \overline{\mathbb{C}P^2}$.
◦ Supervised by Prof. Ivan Smith.
- 2008 **BA Mathematics (Cantab), First Class**, *University of Cambridge*, Cambridge, UK.

Extended research stays

- Nov 2016 – **Visitor**, *Hausdorff Institute for Mathematics*, Bonn, Germany.
Dec 2016 Participant in the Trimester Program ‘Topology’ as part of the ‘4-manifolds and Knot Concordance’ group.
Jul 2019 **Visitor**, *University of Regensburg*, Regensburg, Germany.
Extended research stay to collaborate on the manuscript ‘*A survey of the foundations of four-manifold theory in the topological category*’.

Publications and submitted preprints

1. *The relative Whitney trick and its applications*
with C. W. Davis and J. Park.
Preprint: <https://arxiv.org/abs/2104.06449>.
2. *A survey of the foundations of four-manifold theory in the topological category*
with S. Friedl, M. Nagel, and M. Powell.
Preprint: <https://arxiv.org/abs/1909.08127>.
3. *Null, recursively starlike-equivalent decompositions shrink*
with J. Meier and A. Ray.
Preprint: <https://arxiv.org/abs/1909.06165>.
4. *A calculus for flow categories*
with A. Lobb and D. Schütz.
Preprint: <http://arxiv.org/abs/1710.01798>.
5. *Abelian invariants of doubly slice links*
with A. Conway.
To appear in: *Enseign. Math.*
Preprint: <https://arxiv.org/abs/2101.09121>.
6. *Embedding spheres in knot traces*
with P. Feller, A. N. Miller, M. Nagel, M. Powell and A. Ray
To appear in: *Composit. Math.*
Preprint: <https://arxiv.org/abs/2004.04204>.
7. *A lower bound for the doubly slice genus from signatures*
with M. Powell.
New York J. Math. 27 (2021), 379–392.
<https://nyjm.albany.edu/j/2021/27-14.html>.
8. *Doubly slice knots and metabelian obstructions*
with M. Powell.
J. Topol. Anal. (6 February 2021)
<https://doi.org/10.1142/S1793525321500229>.
9. *Triple linking numbers and surface systems*
with C. W. Davis, M. Nagel and M. Powell.
Indiana Univ. Math. J. 69 (2020), 2505–2547
<https://doi.org/10.1512/iumj.2020.69.8081>.

10. ***Khovanov homotopy calculations using flow category calculus***
with A. Lobb and D. Schütz.
Exp. Math. 29 (2020), no. 4, 475–500.
<https://doi.org/10.1080/10586458.2018.1482805>.
11. ***Satellites and concordance of knots in 3-manifolds***
with S. Friedl, M. Nagel and M. Powell.
Trans. Amer. Math. Soc. 371 (2019), no. 4, 2279–2306.
<https://doi.org/10.1090/tran/7313>.
12. ***Smooth and topological almost concordance***
with M. Nagel, J. Park and M. Powell.
Int. Math. Res. Not. IMRN 2019, no. 23, 7324–7355.
<https://doi.org/10.1093/imrn/rnx338>.
13. ***Framed cobordism and flow category moves***
with A. Lobb and D. Schütz.
Algebr. Geom. Topol. 18 (2018), no. 5 2821–2858.
<https://msp.org/agt/2018/18-5/p08.xhtml>.
14. ***The Khovanov stable homotopy type of colored links***
with A. Lobb and D. Schütz.
Algebr. Geom. Topol. 17 (2017), no. 2 1261–1281.
<https://msp.org/agt/2017/17-2/p23.xhtml>.
15. ***Double L-groups and doubly-slice knots***
Algebr. Geom. Topol. 17 (2017), no. 1, 273–329.
<https://msp.org/agt/2017/17-1/p09.xhtml>.
16. ***Twist spinning of knots and metabolizers of Blanchfield pairings***
with S. Friedl.
Annales de Toulouse, Volume 2, number 5 (2015).
<http://arxiv.org/abs/1312.1934>.

Book Chapters

Author on the following chapters of *The disc embedding theorem* (based on lectures by Michael H. Freedman), edited by Behrens, Kalmár, Kim, Powell, and Ray.
Published by Oxford University Press.

The Whitehead decomposition

with X. Cui, B. Kalmár, and N. Sunukjian.

Shrinking starlike sets

with J. Meier, and A. Ray.

Good groups

with M. H. Kim, J. Park, and A. Ray.

The s-cobordism theorem, the sphere embedding theorem and the Poincaré conjecture

with M. Powell, and A. Ray.

Surgery theory and the classification of simply connected 4-manifolds
with M. Powell, and A. Ray.

Open problems

with M. H. Kim, J. Park, and A. Ray.

Teaching and advising

ETH Zürich

Spring 2021 Advisor for Bachelor's Thesis: *Alternating knots*

Advisor for Master's Research Project: *Triple linking and surface systems*

Boston College

Spring 2020 Course instructor for Differential Topology (graduate course)

Fall 2019 Course instructor for Ideas in Mathematics (two sections)

Spring 2019 Course instructor for Introduction to Analysis

Fall 2018 Course instructor for Introduction to Abstract Mathematics (two sections)

Spring 2018 Course instructor for Calculus II (honors)

Fall 2017 Course instructor for Calculus I (two sections)

McGill University

Spring 2017 Course instructor for Calculus I.

University of Edinburgh

Fall 2014 Teaching assistant for MSc/MMath Geometry and Topology

Spring 2014 Teaching assistant for Geometry

Fall 2013 Teaching assistant for Group Theory

Spring 2013 Teaching assistant for Geometry and Convergence

Fall 2012 Teaching assistant for Fundamentals of Pure Mathematics

Spring 2012 Teaching assistant for Maths for Scientists and Engineers

Fall 2011 Teaching assistant for Proofs and Problem Solving

Spring 2011 Teaching assistant for Several Variable Calculus

Fall 2010 Teaching assistant for Linear Algebra

Spring 2010 Teaching assistant for Foundations of Calculus

Linyi University, Shandong, China

July 2009 Taught a course on Riemann Surfaces for the Linyi-Cambridge Summer School.

Professional service

*Referee for Geometry and Topology, Advances in Mathematics,
Algebraic and Geometric Topology, Revista Matemática Iberoamericana,
and Topology and Its Applications*

Quick opinions for peer reviewed journals

Reviewer for Mathematical Reviews and Zentralblatt MATH

Selected Meeting and Conference Talks

- Jul 2021 **Swiss knots**, *University of Fribourg*.
- Apr 2021 **Séminaire du topologie, géométrie et algèbre**, *University of Nantes*.
- Oct 2020 **Geometry and Topology Seminar**, *Massachusetts Institute of Technology*.
- Sep 2020 **Geometry Seminar**, *ETH Zürich*.
- June 2020 **Nearly Carbon Neutral Geometric Topology Conference**, *Virtual conference*.
- Feb 2020 **Knot Theory on Okinawa**, *Okinawa Institute of Science and Technology*.
- Aug 2019 **Floer homotopy theory and low-dimensional topology**, *University of Oregon*.
- Apr 2019 **Topology Seminar**, *Georgia Tech*.
- Jan 2019 **Max Planck Topology Seminar**, *MPIM Bonn*.
- Oct 2018 **Joint Georgia Tech./UGA Topology seminar**, *University of Georgia*.
- Feb 2018 **Topology Seminar**, *Wesleyan University*.
- Oct 2017 **Geometry and Physics Seminar**, *Boston University*.
- Mar 2017 **Topology Seminar**, *Rice University*.
- Feb 2017 **CIRGET Geometry and Topology Seminar**, *UQÀM*.
- Feb 2017 **Geometry and Topology Seminar**, *Boston College*.
- Jan 2017 **Topology Seminar**, *Brandeis University*.
- Aug 2016 **British Topology Meeting**, *University of Glasgow*.
- Jun 2016 **ECSTATIC (Early Career Researchers Conference)**, *Imperial College London*.
- Nov 2015 **Topology Seminar**, *Universität Regensburg*.
- Jan 2015 **Geometry Seminar**, *Durham University, UK*.
- Jul 2014 **Transpennine Topology Triangle**, *University of Sheffield*.
- Nov 2013 **Topology Seminar**, *University of Manchester*.
- Sep 2013 **Scottish Topology Seminar**, *University of Glasgow*.
- Sep 2013 **British Topology Meeting**, *University of Aberdeen*.

Seminars Organised

- Feb – May 2021 **Current Events Seminar**, *AIM Virtual Semester Program*.
A weekly seminar of virtual research talks, organised as part of the AIM virtual semester program on 4-dimensional topology.
- Jan – Jun 2018 **Khovanov Homotopy Type**, *Boston College*.
A learning seminar about the Lipshitz-Sarkar stable homotopy refinement of Khovanov homology.
<http://patrickorson.com/khovanovhtpy/>
- Aug – Dec 2017 **Surfaces in 4-manifolds**, *Boston College*.
A learning seminar centred around Gabai's 4-Dimensional Lightbulb Theorem.
- Jan – May 2017 **Seiberg-Witten and stable homotopy**, *UQÀM*.
A learning seminar for staff and students studying the Bauer-Furuta invariants and the Manolescu refinement of the Seiberg-Witten Floer homology using stable homotopy theory.
<http://patrickorson.com/SWstable/>

- Nov – Dec **Surgery Theory and Homology Surgery**, *HIM*.
2016 A Learning Seminar as part of the Junior Trimester Program in Topology. Gave an overview of the Browder-Novikov-Sullivan-Wall surgery theory with particular emphasis on its relevance to low-dimensional topologists working on 4-manifolds and knot concordance.
- 2015 – 2016 **Chern-Simons Theory Study Group**, *Durham University*.
An interdisciplinary reading group for physicists and mathematicians to study the interactions between Witten's Chern-Simons results and knot theory.
<http://patrickorson.com/chernsimons/>
- 2013 – 2014 **Algebraic L-Theory Study Group**, *University of Edinburgh*.
A reading group for staff and students studying abstract chain-dualities on algebraic bordism categories and their interaction with sheaf theory.
- 2011 – 2012 **Surgery Theory Study Group**, *University of Edinburgh*.
A working group for staff and students studying aspects of classical algebraic and geometric surgery theory.
<http://patrickorson.com/surgerygroup/>
- 2011 – 2012 **Graduate Geometry & Topology Seminar**, *University of Edinburgh*.
Ran the graduate student geometry and topology seminar.
- Jan – May **Index Theory Seminar Series**, *University of Edinburgh*.
2011 A seminar series for staff and students to learn the heat-kernel proof of the Atiyah-Singer index theorem, using Getzler's contribution.
<http://patrickorson.com/indextheory/>