Patrick Orson

Curriculum Vitae

California Polytechnic State University
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Research interests

Low-dimensional geometric topology. 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 2022 – present **Assistant Professor**, *Cal Poly*, San Luis Obispo, CA USA.
Research and teaching at California Polytechnic State University.

Sep 2021 – Aug 2022 **Visiting Scientist**, *Max Planck Institute*, Bonn, Germany.
Currently researching at MPIM.

Sep 2020 – Aug 2021 **Postdoctoral Fellow**, *ETH Zürich*, Zürich, Switzerland.
Research postdoctoral position and student thesis supervision.

Sep 2017 – Jun 2020 **Visiting Assistant Professor**, *Boston College*, Boston, USA.
Researching and teaching at Boston College.

Jan 2017 – Aug 2017 **Postdoctoral Research Associate**, *UQÀM*, Montreal, Canada.
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 – Oct 2016 **Postdoctoral Research Associate**, *Durham University*, Durham, UK.
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 – Dec 2016 **Visitor**, *Hausdorff Institute for Mathematics*, Bonn, Germany.
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. ***Simple spines of homotopy 2-spheres are unique***
with M. Powell.
Preprint: `https://arxiv.org/abs/2208.04207`.

2. ***Mapping class groups of simply connected 4-manifolds with boundary***
with M. Powell.
Preprint: `https://arxiv.org/abs/2207.05986`.

3. ***A survey of the foundations of four-manifold theory in the topological category***
with S. Friedl, M. Nagel, and M. Powell. (∼100 page monograph)
Preprint: `https://arxiv.org/abs/1909.08127`.

4. ***Null, recursively starlike-equivalent decompositions shrink***
with J. Meier and A. Ray.
Preprint: `https://arxiv.org/abs/1909.06165`.

5. ***A calculus for flow categories***
with A. Lobb and D. Schütz.
To appear in: Adv. Math.
Preprint: `http://arxiv.org/abs/1710.01798`.

6. ***Abelian invariants of doubly slice links***
with A. Conway.
To appear in: Enseign. Math.
Preprint: `https://arxiv.org/abs/2101.09121`.

7. ***The relative Whitney trick and its applications***
with C. W. Davis and J. Park.
Selecta Math. (30 December 2021)
`https://doi.org/10.1007/s00029-021-00738-y`.

8. ***Embedding spheres in knot traces***
with P. Feller, A. N. Miller, M. Nagel, M. Powell and A. Ray
Compos. Math. 157(10):2242–2279, 2021.
`https://www.doi.org/10.1112/S0010437X21007508`.

9. ***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`.

10. ***Doubly slice knots and metabelian obstructions***
with M. Powell.
J. Topol. Anal (6 February 2021)
https://doi.org/10.1142/S1793525321500229.

11. ***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.

12. ***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.

13. ***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.

14. ***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.

15. ***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.

16. ***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.

17. ***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.

18. ***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 peer reviewed journals.
- Quick opinions for peer reviewed journals.
- Reviewer for: *Mathematical Reviews* and *Zentralblatt MATH*.

Selected Meeting and Conference Talks

Apr 2022 **Joint Mathematical Meetings**, *Seattle*.
Nov 2021 **Topology Seminar**, *University of Notre Dame*.
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 2016 **Surgery Theory and Homology Surgery**, *HIM*.
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.

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 2011 **Index Theory Seminar Series**, *University of Edinburgh*.
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/`