Patrick Orson

Curriculum Vitae

California Polytechnic State University
San Luis Obispo, CA USA
porson@calpoly.edu
www.patrickorson.com

Research interests

Low-dimensional geometric topology. Topological 4-manifolds. Mapping class groups of 4-manifolds. Embedded surfaces in 4-manifolds. Stable homotopy invariants of knots.

Academic appointments

Sep 2022 – present **Assistant Professor**, *California Polytechnic State University*, San Luis Obispo, CA USA.
Research and teaching tenure-track position.

Sep 2021 – Aug 2022 **Visiting Scientist**, *Max Planck Institute for Mathematics*, Bonn, Germany.
Research position.

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

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

Jan 2017 – Aug 2017 **Postdoctoral Research Associate**, *UQÀM*, Montreal, Canada.
Research position at the Université du Québec à Montréal. Teaching at McGill University.

Jan 2015 – Oct 2016 **Postdoctoral Research Associate**, *Durham University*, Durham, UK.
Research position.

Publications and accepted preprints

- **Mapping class groups of simply connected 4-manifolds with boundary**
  with M. Powell.
  J. Differential Geom. (to appear) Link: `arXiv:2207.05986`
- **Unknotting nonorientable surfaces**
  with A. Conway and M. Powell.
  J. Eur. Math. Soc. (to appear) Link: `arXiv:2306.12305`
- **Locally flat simple spheres in $\mathbb{C}P^2$**
  with A. Conway.
  Bull. London Math. Soc. (to appear) Link: `arXiv:2312.10546`
- **A survey of the foundations of four-manifold theory in the topological category**
  with S. Friedl, M. Nagel, and M. Powell. (∼150 page monograph)
  NYJM Mongr. (to appear) Link: `arXiv:1910.07372`
- **Simple spines of homotopy 2-spheres are unique**
  with M. Powell.
  Proc. Lond. Math. Soc. (3) 128 (2024), no. 2, Paper No. e12583, 25 pp. Link: `arXiv:2208.04207`

- **Null, recursively starlike-equivalent decompositions shrink**
  with J. Meier and A. Ray.
  Glasg. Math. J. 65 (2023), no. 2, 328–336. Link: arXiv:1909.06165
- **Doubly slice knots and metabelian obstructions**
  with M. Powell.
  J. Topol. Anal. 14 (2022), no. 4, 847–873. Link: arXiv:1909.08127
- **A calculus for flow categories**
  with A. Lobb and D. Schütz.
  Adv. Math. 409 (2022), Paper No. 108665, 58 pp. Link: arXiv:1710.01798
- **Abelian invariants of doubly slice links**
  with A. Conway.
  Enseign. Math. 68 (2022), no. 3-4, 243–290. Link: arXiv:2101.09121
- **The relative Whitney trick and its applications**
  with C. W. Davis and J. Park.
  Selecta Math. (N.S.) 28 (2022), no. 2, Paper No. 27, 34 pp. Link: arXiv:2104.06449
- **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. Link: arXiv:2004.04204
- **A lower bound for the doubly slice genus from signatures**
  with M. Powell.
  New York J. Math. 27 (2021), 379–392. Link: arXiv:2008.04138
- **Triple linking numbers and surface systems**
  with C. W. Davis, M. Nagel and M. Powell.
  Indiana Univ. Math. J. 69 (2020), 2505-2547 Link: arXiv:1709.08478
- **Khovanov homotopy calculations using flow category calculus**
  with A. Lobb and D. Schütz.
  Exp. Math. 29 (2020), no. 4, 475–500. Link: arXiv:1710.01857
- **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. Link: arXiv:1611.09114
- **Smooth and topological almost concordance**
  with M. Nagel, J. Park and M. Powell.
  Int. Math. Res. Not. IMRN 2019, no. 23, 7324–7355. Link: arXiv:1707.01147
- **Framed cobordism and flow category moves**
  with A. Lobb and D. Schütz.
  Algebr. Geom. Topol. 18 (2018), no. 5 2821-2858. Link: arXiv:1605.02003
- **The Khovanov stable homotopy type of colored links**
  with A. Lobb and D. Schütz.
  Algebr. Geom. Topol. 17 (2017), no. 2 1261-1281. Link: arXiv:1602.01386
- **Double L–groups and doubly-slice knots**
  Algebr. Geom. Topol. 17 (2017), no. 1, 273-329. Link: arXiv:1508.01048

- **Twist spinning of knots and metabolizers of Blanchfield pairings**
  with S. Friedl.
  Annales de Toulouse, Volume 2, number 5 (2015). Link: `arXiv:1312.1934`

Textbook chapters authored

The Disc Embedding Theorem (based on lectures by Michael Freedman)
Edited by Behrens, Kalmár, Kim, Powell, and Ray. *Oxford University Press*

Chapters authored:

- **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.

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.
- Advisor: Andrew Ranicki.

2012 **MA Mathematics (Cantab)**, *University of Cambridge*, Cambridge, UK.

2009 **MMath (Part III), Merit**, *University of Cambridge*, Cambridge, UK.
- Part III Essay: *Small 4-manifolds* A review of exotic smooth structures on $\mathbb{C}P^2\#m\overline{\mathbb{C}P^2}$.
- Advisor: Ivan Smith.

2008 **BA Mathematics (Cantab), First Class**, *University of Cambridge*, Cambridge, UK.

Grants and awards

2024-2026 **Frost Postdoctoral Fellowship Mentor, Cal Poly**.
The Mathematics Department at Cal Poly was able to hire its first ever postdoc in Pure Mathematics after I won a competitive internal application process, throughout the College of Science and Mathematics at Cal Poly. I am the teaching and research mentor for this postdoctoral fellow.

2023-2026 **AMS-Simons Research Enhancement Grant**,
for Primarily Undergraduate Institution (PUI) Faculty.

2008-2009 **Scholar of Emmanuel College, Cambridge**.

Extended research stays

July 2019 **Visitor**, *University of Regensburg*, Regensburg, Germany.

Fall 2016 **Visitor**, *Hausdorff Institute for Mathematics*, Bonn, Germany.
Trimester Program "Topology". Part of the "4-manifolds and Knot Concordance" group.

Teaching experience

California Polytechnic State University

Spring 2025 Topology II (graduate course)
Winter 2025 Topology I
Winter 2025 Calculus IV
Fall 2024 Methods of Proof in Mathematics
Spring 2024 Calculus IV (hons.)
Winter 2024 Calculus III (hons.)
Fall 2023 Calculus II (hons.)
Spring 2023 Calculus III
Winter 2023 Methods of Proof in Mathematics
Fall 2022 Calculus I

Boston College

Spring 2020 Differential Topology (graduate course)
Fall 2019 Ideas in Mathematics (math for the liberal arts)
Spring 2019 Introduction to Analysis
Fall 2018 Introduction to Abstract Mathematics
Spring 2018 Calculus II (hons.)
Fall 2017 Calculus I

McGill University

Spring 2017 Calculus I.

University of Edinburgh

Fall 2014 MSc/MMath Geometry and Topology (TA)
Spring 2014 Geometry (TA)
Fall 2013 Group Theory (TA)
Spring 2013 Geometry and Convergence (TA)
Fall 2012 Fundamentals of Pure Mathematics (TA)
Spring 2012 Maths for Scientists and Engineers (TA)
Fall 2011 Proofs and Problem Solving (TA)
Spring 2011 Several Variable Calculus (TA)
Fall 2010 Linear Algebra (TA)
Spring 2010 Foundations of Calculus (TA)

Advising and Mentoring

POSTDOCTORAL

2024-2026 **Terrin Warrin**, *California Polytechnic State University*.
Frost Postdoctoral Fellow

GRADUATE

2024-2025 **Madeleine Goertz**, *California Polytechnic State University*.
Master's thesis: *The Smale Conjecture*

2024-2025 **Hai Tri Tran**, *California Polytechnic State University*.
Master's thesis: *Mapping class groups of surfaces*

2022-2023 **Shiaohan Liu**, *California Polytechnic State University*.
Master's thesis: *The Construction of Khovanov Homology*

Spring 2021 **Sascha Bär**, *ETH Zürich*.
Master's project: *Triple linking and surface systems*

UNDERGRADUATE

2022-2023 **Lindsey McMahon**, *California Polytechnic State University*.
Senior project: *Minimal Crosscap Nonorientable Surfaces Bounded by Low Crossing Number Knots*

Spring 2021 **Wiona Glänzer**, *ETH Zürich*.
Bachelor's thesis: *Alternating knots*

Selected Meeting and Conference Talks

Jan 2025 **Joint Mathematical Meetings**, *Seattle*.
Aug 2024 **British Topology Meeting**, *University of Aberdeen*.
May 2024 **UGA International Topology Conference**, *University of Georgia*.
May 2024 **Colloquium**, *California Polytechnic State University*.
April 2024 **Topology Seminar**, *Columbia University*.
April 2024 **Topology Seminar**, *Stanford University*.
October 2023 **Geometry and Topology Seminar**, *Boston College*.
August 2023 **Max Planck Topology Seminar**, *MPIM Bonn*.
June 2023 **Algebraic Methods in Manifold Topology**, *University of Glasgow*.
May 2022 **Geometry and Topology Seminar**, *University of Cambridge*.
Apr 2022 **Joint Mathematical Meetings**, *Seattle*.
Jan 2022 **Colloquium**, *North Dakota State University*.
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*.

Professional service

- **Referee:** for peer reviewed journals.
- **Reviewer:** *Mathematical Reviews*, *Zentralblatt MATH*.

Departmental service

2022 – present **Topology course coordinator**.
California Polytechnic State University

2022 – 2023 **Geometry and Topology semester conversion committee**.
California Polytechnic State University

Conferences and Seminars Organised

July 2025 **Topological Manifolds Conference**, *UQÀM*.
Part of the Thematic Semester on Low Dimensional Topology.

July 2025 **Topological Manifolds Summer School**, *UQÀM*.
Part of the Thematic Semester on Low Dimensional Topology.

May 2025 **Knotted Surfaces and 4-manifolds**, *Cal Poly*.
AMS Western Sectional Meeting: Special Session

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 faculty 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 faculty and students studying chain-dualities on algebraic bordism categories.

2011 – 2012 **Surgery Theory Study Group**, *University of Edinburgh*.
Working group for faculty and students studying aspects of 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 faculty and students to learn the heat-kernel proof of the Atiyah-Singer index theorem, using Getzler's contribution.
`http://patrickorson.com/indextheory/`