BRENDAN HARRIS

PhD Candidate

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SUMMARY

PhD candidate (thesis submitted) in the Complex Systems Group at the School of Physics, The University of Sydney. Interested in understanding the dynamical mechanisms of computation and communication in the brain, especially for visual processing. Use new analytic tools, dynamical systems theory, large-scale data, and biophysical neural-circuit models for a multi-level understanding of brain function.

RESEARCH INTERESTS

Circuit- and systems-level neuroscience
Spiking neural circuits; mean-field models; hierarchical processing; oscillations and traveling waves; visual system.

Bridging statistical physics and neural dynamics
Time-series analysis; stochastic processes; criticality; cross-scale dynamics; dimensionality reduction; open software.

CONTENTS

EDUCATION

2022 — **Current Physics PhD Student** — **The University of Sydney**
Cross-scale dynamics in the working regime of the visual cortex

2021 — **Physics Honours, Class I and the University Medal** — **The University of Sydney**
Inferring parametric variation across non-stationary time series

2018 – 2020 — **Bachelor of Science/Bachelor of Advanced Studies (Dalyell Scholar)** — **The University of Sydney**
Majored in Physics and Neuroscience

PUBLICATIONS AND PREPRINTS

2026 — ***Nested spatiotemporal theta–gamma waves organize hierarchical processing across the mouse visual cortex*** — **Nature Communications** *In press*
Brendan Harris and Pulin Gong

2026 — ***Anomalous dynamics in the working regime of the visual cortex*** — **In preparation**
Brendan Harris and Pulin Gong

Jul 2025 — ***Canonical time-series features for characterizing biologically informative dynamical patterns in fMRI*** — **Aperture Neuro** **vol. 5, pp.**
Imran Alam, **Brendan Harris**, Patrick Cahill, Oliver Cliff, Marija Markicevic, Valerio Zerbi, and Ben D. Fulcher

Aug 2024 — ***Tracking the Distance to Criticality in Systems with Unknown Noise*** — **Physical Review X** **vol. 14, pp. 031021**
Brendan Harris, Leonardo L. Gollo, and Ben D. Fulcher

May 2024 — ***Distributed and dynamical communication: a mechanism for flexible cortico-cortical interactions and its functional roles in visual attention*** 
Shencong Ni, **Brendan Harris**, and Pulin Gong
Communications Biology
vol. 7, pp. 550

Jul 2021 — ***Approximate Modal Cut-Off Wavelengths and the V-Parameter for M-type Optical Fibers and Its Novel Applications***
Deepak Jain, Mark A George, **Brendan Harris**, and Simon Fleming
Journal of Lightwave Technology
vol. 39, pp. 4478–4488

CONFERENCES

Jun 2025 — **OHBM 2025** — **Poster**
Brisbane, QLD, Australia
2072: *Nested spatiotemporal dynamics organize hierarchical processing in the mouse visual cortex*
Brendan Harris and Pulin Gong

Jun 2025 — **EPC/APCV 2025** — **Talk**
The University of New South Wales
Spatiotemporal theta–gamma waves organize hierarchical processing in the mouse visual cortex
Brendan Harris and Pulin Gong

Mar 2025 — **COSYNE 2025**  — **Poster**
Montreal, QC, Canada
1–117: *Tracking the distance to criticality across the mouse visual hierarchy*
Brendan Harris, Leonardo Gollo, and Ben Fulcher

Feb 2025 — **NeuroEng 2025** — **Talk**
The University of Melbourne
Nested spatiotemporal theta–gamma waves organize hierarchical visual processing
Brendan Harris and Ben Fulcher

Jul 2024 — **2024 46th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)** — **Conference paper**
1–4: *Default Mode Network Detection using EEG in Real-time*
Navin Cooray, Chetan Gohil, **Brendan Harris**, Shaun Frost, and Cameron Higgins

Oct 2023 — **IBRO Neuroscience Reports (IBRO World Congress 2023)** — **Poster**
Granada, Spain
S783: *Nested and non-stationary oscillatory bursts underlie flexible inter-areal neural communication*
Brendan Harris and Pulin Gong

Jul 2022 — **31st Annual Computational Neuroscience Meeting: CNS*2022** — **Poster**
Melbourne, Australia
P36: *Summarizing non-stationarity in spatio-temporal neural data*
Brendan Harris and Ben Fulcher

Jun 2022 — **28th Annual Meeting of the Organization for Human Brain Mapping** — **Virtual Poster**
Summarizing non-stationarity in spatio-temporal neural data
Brendan Harris and Ben Fulcher

Sep 2020 — **Frontiers in Optics / Laser Science (2020)** — **Oral presentation**
FM4D.2: *Approximate normalized frequency (V-parameter) and modal cut-off wavelengths of M-type optical fibers*
Deepak Jain, Mark George, **Brendan Harris**, and Simon Fleming

WORKSHOPS AND TALKS

May 2025 — **Center for Neuroscience Imaging Research (CNIR), IBS, Republic of Korea** — **Talk**
Nested spatiotemporal θ–γ waves organize hierarchical visual processing
Invited to give a talk on my PhD research

Mar 2025 — **Pre-Cosyne BrainHack 2025** — **Workshop attendee**
Montreal, QC, Canada
Workshop on open science and open-source tools for computational and systems neuroscience.

Aug 2024 — **Strong Compute Chess AI Hackathon** — **Workshop attendee**
Sydney, NSW, Australia
Hackathon on transformer models and distributed GPU training for chess

Aug 2024 — **Emerging Aspirations in Complex Systems** — **Workshop talk**
The University of Sydney
Spatiotemporal θ–γ waves in the mouse visual cortex
Centre for Complex Systems, The University of Sydney

May 2024 — **School of Physics HDR symposium** — **Workshop talk**
The University of Sydney
Spatiotemporal θ–γ waves in the mouse visual cortex
School of Physics, The University of Sydney

Oct 2023 — **MIP:Lab, Geneva Biotech Campus** — **Talk**
Geneva, Switzerland
Burst-based inter-areal neural communication
Presented my PhD work to the MIP:Lab, hosted by Dr. Enrico Amico.

Jul 2023 — **Cognitive Neuroscience Hub, The University of Melbourne** — **Talk**
Melbourne University
Burst-based inter-areal neural communication
Presented my PhD work, hosted by Dr. Jacob Paul.

Jul 2023 — **tLab** — **Talk**
Monash University
Burst-based inter-areal neural communication
Presented my PhD work to the lab of Professor Nao Tsuchiya.

Jan 2023 — **Complexity, Criticality and Computation Symposium: C3-2023** — **Workshop talk**
Heron Island
Burst-based inter-areal neural communication
Symposium held by the Centre for Complex Systems (The University of Sydney).

Nov 2022 — **BrainHack Australia 2022** — **Workshop attendee**
The University of Sydney
Brainharmonic
Contributed to a project aiming to synthesize music from neural signals using deep neural networks.

Oct 2022 — **OpenScope NeuroDataReHack Hackathon** — **Workshop attendee**
Seattle, WA, USA
Workshop on re-analyzing open-source neural data, hosted by the Allen Institute

Oct 2022 — **Yale Medical School** — **Talk**
Feature-based analysis of neural time series
Invited by Dr. Evelyn Lake to present the results of my projects involving time-series features to a journal club.

Aug 2022 **Emerging Aspirations in Complex Systems** **Workshop talk**
The University of Sydney
Inferring parametric variation across non-stationary neural time series

Jul 2022 **31st Annual Computational Neuroscience Meeting: CNS*2022** **Workshop talk**
Melbourne, Australia
Inferring parametric variation across non-stationary neural time series
In workshop 'Highly comparative analysis of neural dynamics'.

Dec 2021 **Neuromatch 4.0** **Flash talk**
Summarizing non-stationarity in spatio-temporal neural data

RESEARCH EXPERIENCE

2022 **Cross-scale dynamics in the working regime of the visual cortex** **PhD research**
Dr. Pulin Gong, Complex Systems Group, The University of Sydney
In my PhD work, I aim to understand the principles of computation in spatiotemporal neural systems and their role in transforming complex stimuli into flexible behavior. Specifically, I focus on analyzing spatiotemporal patterns, criticality, cross-scale dynamics, and nonlocal diffusion in mouse electrophysiology data, spiking neural circuits and their mein-field reductions, as well gaze trajectories.

Mar – Nov 2021 **Inferring parametric variation across non-stationary time series** **Honours research**
Dr. Ben Fulcher, Complex Systems Group, The University of Sydney
Developed a method to summarize non-stationary dynamics using time-series features and dimensionality reduction, along with a new approach to dimensionality reduction that uses baseline datasets to account for redundant measurements. I applied this method to both simulated data and mouse electrophysiology recordings.

Aug – Nov 2020 **Relating BOLD dynamics, interneuron densities, and DREADD activation** **Dalyell project**
Dr. Ben Fulcher, Complex Systems Group, The University of Sydney
Explored links between BOLD dynamics, neuronal excitability, and cell densities by combining fMRI, DREADD activation, and neuron-count data with time-series features (*hctsa*) and machine-learning classifiers.

Jan – Mar 2020 **Quantum Control Laboratory** **Denison project**
Dr. Cornelius Hempel, School of Physics, The University of Sydney
Completed lab projects in optics, instrumentation, and Python/Julia/C++ programming, including building an interferometer for ion trap vibration measurements, testing signal generator stability, and developing Arduino-based sensors.

Aug – Nov 2019 **Classifying the stability of near-critical systems** **Undergraduate project**
Dr. Ben Fulcher, Complex Systems Group, The University of Sydney
Used machine-learning algorithms and time-series features to classify time series from monostable and bistable regions of dynamical systems.

Jul – Aug 2019 **Interneuron densities and intrinsic timescales in the mouse brain** **Casual lab assistant**
Dr. Ben Fulcher, Complex Systems Group, The University of Sydney
Investigated the relationship between interneuron subtypes and brain dynamics by analysing fMRI time-series features (*hctsa*) and interneuron density datasets in Matlab and Python.

Mar – Jun 2019 **Numerical analysis of M-type optical fibers** **Undergraduate project**
Dr. Deepak Jain, School of Physics, The University of Sydney
Modelled M-type optical fibres in COMSOL and formulated expressions describing their unique properties, cut-off wavelengths, anticrossings, and mode profiles.

Aug 2018 – Aug 2021 **Tracking the distance to criticality in systems with unknown noise** **Undergraduate project**
Dr. Ben Fulcher, Complex Systems Group, The University of Sydney
Searched for time-series features that best predict the distance to criticality in noisy dynamical systems; this involved numerical simulation and time-series analysis (hctsa) in Matlab and with the School of Physics HPC cluster.

SUPERVISION

Mar – Nov 2025 **Aiden Sloots** **Secondary**
The University of Sydney
Physics Honours student

TEACHING

Jul – Nov 2024 **Computational optics** **Tutor**
The University of Sydney
Tutored a computational optics lab

Feb – Mar 2023 **3rd-year Statistical Mechanics** **Tutor**
The University of Sydney
Tutored a combined lecture and tutorial class on statistical mechanics, covering topics such as the Einstein solids, the Ising model, Peierls argument, Monte-Carlo sampling, phase transitions, criticality, and the renormalization group.

Aug 2022 – Mar 2023 **3rd-year Interdisciplinary Physics computational lab** **Tutor**
The University of Sydney
Tutored the Matlab computational labs of PHYS3888, a course on the physics of complex systems that introduces third year physics students to networks, linear and nonlinear dynamical systems, criticality, and machine learning/neural networks.

Mar – Nov 2022 **Second-year physics Matlab course** **Tutor**
The University of Sydney

Aug – Nov 2018 **Science Dalyell Showcase** **Mentor**
The University of Sydney

INDUSTRY

Mar – Dec 2023 **Resonait Medical Technologies** **Software developer**
Dr. Cameron Higgins
Worked on a casual basis writing Matlab code to interface with EEG headsets, infer the activation of brain networks, and implement neurofeedback for the monitoring and treatment of depression

AWARDS

2025 **Postgraduate Research Support Scheme** — **Scholarship**
The University of Sydney
To fund travel and accommodation for the COSYNE 2025 conference (Montreal, Canada)

2025 **Cosyne Presenters Travel Grant** — **Scholarship**
COSYNE
To fund travel and accommodation for the COSYNE 2025 conference (Montreal, Canada)

2023 **Postgraduate Research Support Scheme** — **Scholarship**
The University of Sydney
To fund travel and accommodation for the IBRO2023 conference (Granada, Spain)

2022 **Dean's List of Excellence in Academic Performance** — **Recognition**
The University of Sydney
For academic performance during my Honours year

2022 **Honours Class I and the University Medal** — **Recognition**
The University of Sydney
For academic and research performance during my Honours year

2022 **Research Training Program (fee offset and stipend)** — **Scholarship**
The University of Sydney
To fund my PhD studies

2022 **Emerging Aspirations in Complex Systems Award** — **Scholarship**
The University of Sydney
To fund accommodation for the C3 symposium

2021 **The University of Sydney Physics Foundation Scholarship No III** — **Scholarship**
The University of Sydney
For academic performance in 3rd year undergraduate Physics

2021 **University of Sydney Academic Merit Prize** — **Scholarship**
The University of Sydney
For academic performance during my Honours year

2019 **Denison Research Scholarship and Denison Relocation Scholarship** — **Scholarship**
The University of Sydney
To fund a 6-week summer research project with the Quantum Control Laboratory

2018 **Dean's List of Excellence in Academic Performance** — **Recognition**
The University of Sydney
For academic performance in my 1st year of undergraduate study

2017 **Sydney Scholars Award** **Scholarship**
The University of Sydney
For academic results in the higher school certificate

REFEREES

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