

Bryan C. Daniels

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Research Vision

I investigate collective behavior in living systems by integrating empirical data with concepts and methods from statistical physics, dynamical systems, and model selection. Working closely with broad-minded collaborators — willing and excited by the prospect of exploring new ideas and solving hard problems — I seek to discover the computational logic of adaptive collective systems.

Education

2005–2010 **Cornell University** *Ph.D., Theoretical Physics*

Dissertation: *Robustness and Evolvability in Systems Biology and Plectoneme Formation in DNA Supercoiling.*

2001–2005 **Ohio Wesleyan University** *B.A., Physics, Summa cum laude*

Academic Positions & Fellowships

2023–present **School of Complex Adaptive Systems**

Assistant Professor, College of Global Futures, Arizona State University

2021–present **Julie Ann Wrigley Global Futures Laboratory**

Senior Global Futures Scientist, Arizona State University

2015–present **ASU–SFI Center for Biosocial Complex Systems**

Assistant Professor (2023), Assistant Research Prof. (2017), Postdoctoral Fellow (2015), Arizona State University and Santa Fe Institute

2019–2020 **Berlin Institute for Advanced Study**

Fellow, College for Life Sciences

2012–2015 **Center for Complexity and Collective Computation**

Postdoctoral Fellow, University of Wisconsin–Madison

Mentors: Jessica Flack and David Krakauer

2010–2012 **Santa Fe Institute**

Postdoctoral Fellow

Mentors: Jessica Flack and David Krakauer

2005–2010 **Cornell University**

Graduate student, Laboratory of Atomic and Solid State Physics (*Advisor: James Sethna*)

2009 **Los Alamos National Laboratory**

Graduate Research Intern, Center for Nonlinear Studies (*Mentor: Ilya Nemenman*)

2006 **Indiana University**

IGERT Fellow, Cognitive Science Department (*Mentor: Randall Beer*)

Honors & Awards

- 2019 Fellowship in College for Life Sciences, Berlin Institute for Advanced Study
- 2016 Travel Award, q-bio Program Committee, sponsored by NSF
- 2016 Shirley Chan Travel Award, Div. Biological Physics, American Physical Society
- 2014 Finalist, Burroughs Wellcome Fund Career Awards at the Scientific Interface
- 2005–2007 IGERT Fellowship in Nonlinear Systems
- 2005 Phi Beta Kappa
- 2005 Rusk Prize in Physics
- 2005 Sigma Xi Research Award

Publications

- *Identifying a developmental transition in honey bees using gene expression data.*
Bryan C. Daniels, Ying Wang, Robert E. Page, Jr, and Gro V. Amdam.
PLOS Computational Biology **19** (9), e1010704 (2023).
- *Subcritical escape waves in schooling fish.*
Winnie Poel, Bryan C. Daniels, Matthew M. G. Sosna, Colin R. Twomey, Simon P. Leblanc, Iain D. Couzin, and Pawel Romanczuk.
Science Advances **8**, eabm6385 (2022).
- *Discovering sparse control strategies in neural activity.*
Edward D. Lee, Xiaowen Chen, and Bryan C. Daniels.
PLOS Computational Biology **18** (5), e1010072 (2022).
- *The basis of easy controllability in Boolean networks.*
Enrico Borriello and Bryan C. Daniels.
Nature Communications **12**, 5227 (2021).
- *Innovations are disproportionately likely in the periphery of a scientific network.*
Deryc Painter, Bryan C. Daniels, and Manfred Laubichler.
Theory in Biosciences **140**, 391 (2021).
- *Quantifying the impact of network structure on speed and accuracy in collective decision-making.*
Bryan C. Daniels and Pawel Romanczuk.
Theory in Biosciences **140**, 379 (2021).
- *Quantifying dynamical high-order interdependencies from the O-information: An application to neural spiking dynamics.*
Sebastiano Stramaglia, Tomas Scagliarini, Bryan C. Daniels, and Daniele Marinazzo.
Frontiers in Physiology **11**, 595736 (2021).
- *Scaling theory of armed conflict avalanches.*
Edward D. Lee, Bryan C. Daniels, Christopher R. Myers, David C. Krakauer, and Jessica C. Flack.
Phys. Rev. E **102**, 042312 (2020).
- *Tyramine and its receptor TYR1 linked behavior QTL to reproductive physiology in honey bee workers (Apis mellifera).*
Ying Wang, Gro V. Amdam, Bryan C. Daniels, and Robert E. Page, Jr.
Journal of Insect Physiology **126**, 104093 (2020).

- *Individual and collective encoding of risk in animal groups.*
Matthew M. G. Sosna, Colin R. Twomey, Joseph Bak-Coleman, Winnie Poel, Bryan C. Daniels, Pawel Romanczuk, and Iain D. Couzin.
Proc. Natl. Acad. Sci. USA **116**, 20556 (2019).
- *Automated, predictive, and interpretable inference of Caenorhabditis elegans escape dynamics.*
Bryan C. Daniels, William S. Ryu, and Ilya Nemenman.
Proc. Natl. Acad. Sci. USA **116**, 7226 (2019).
- *Convenient Interface to Inverse Ising (ConIII): A Python 3 package for solving Ising-type maximum entropy models.*
Edward D. Lee and Bryan C. Daniels.
Journal of Open Research Software **7**, 3 (2019).
- *Network Analysis for the Digital Humanities: Principles, Problems, Extensions.*
Deryc T. Painter, Bryan C. Daniels, and Jürgen Jost.
Isis **110**, 538-554 (2019).
- *Criticality distinguishes the ensemble of biological regulatory networks.*
Bryan C. Daniels, Hyunju Kim, Douglas Moore, Siyu Zhou, Harrison Smith, Bradley Karas, Stuart A. Kauffman, and Sara I. Walker.
Phys. Rev. Lett. **121**, 138102 (2018).
- *Locating decision-making circuits in a heterogeneous neural network.*
Emerson Arehart, Tangxin Jin, and Bryan C. Daniels.
Frontiers in Applied Mathematics and Statistics **4**, 11 (2018).
- *Collective memory in macaque conflict implied by temporal scaling collapse.*
Edward D. Lee, Bryan C. Daniels, David C. Krakauer, and Jessica C. Flack.
J. Royal Society Interface **14**, 20170223 (2017).
- *Dual coding theory explains biphasic collective computation in neural decision-making.*
Bryan C. Daniels, Jessica C. Flack, and David C. Krakauer.
Frontiers in Neuroscience **11**, 313 (2017).
- *Control of finite critical behaviour in a small-scale social system.*
Bryan C. Daniels, David C. Krakauer, and Jessica C. Flack.
Nature Communications **8**, 14301 (2017).
- *Quantifying collectivity.*
Bryan C. Daniels, Christopher J. Ellison, David C. Krakauer, and Jessica C. Flack.
Current Opinion in Neurobiology **37**, 106 (2016).
- *Automated adaptive inference of dynamical phenomenological models.*
Bryan C. Daniels and Ilya Nemenman.
Nature Communications **6**, 8133 (2015).
- *Sloppiness and emergent theories in physics, biology, and beyond.*
Mark K. Transtrum, Benjamin Machta, Kevin Brown, Bryan C. Daniels, Christopher R. Myers, James P. Sethna.
J. Chem. Phys. **143**, 010901 (2015).
- *Efficient inference of parsimonious phenomenological models of cellular dynamics using S-systems and alternating regression.*
Bryan C. Daniels and Ilya Nemenman.
PLOS ONE **10**, e0119821 (2015).

- *Sparse code of conflict in an animal society.*
Bryan C. Daniels, David C. Krakauer, and Jessica C. Flack.
Proc. Natl. Acad. Sci. USA **109**, 14259 (2012).
- *Nucleation at the DNA supercoiling transition.*
Bryan C. Daniels and James P. Sethna.
Phys. Rev. E **83**, 041924 (2011).
- *Saturation Probabilities of Continuous-Time Sigmoidal Networks.*
Randall D. Beer and Bryan C. Daniels.
arXiv:1010.1714 (q-bio.NC) (2010).
- *Discontinuities at the DNA supercoiling transition.*
Bryan C. Daniels, Scott Forth, Maxim Y. Sheinin, Michelle D. Wang, and James P. Sethna.
Phys. Rev. E **80**, 040901 (R) (2009).
- *Statistical properties of multistep enzyme-mediated reactions.*
Wiet H. de Ronde, Bryan C. Daniels, Andrew Mugler, Nikolai A. Sinitsyn, and Ilya Nemenman.
IET Systems Biology **3**, 429 (2009).
- *Sloppiness, robustness, and evolvability in systems biology.*
Bryan C. Daniels, Yan-Jiun Chen, James P. Sethna, Ryan N. Gutenkunst, and Christopher R. Myers.
Current Opinion in Biotechnology **19**, 389 (2008).
- *Abrupt Buckling Transition Observed during the Plectoneme Formation of Individual DNA Molecules.*
Scott Forth, Christopher Deufel, Maxim Y. Sheinin, Bryan Daniels, James P. Sethna, and Michelle D. Wang.
Phys. Rev. Lett. **100**, 148301 (2008).
- *Absence of Kondo lattice coherence effects in $Ce_{0.6}La_{0.4}Pb_3$: A magnetic-field study.*
Richard Pietri, Costel R. Rotundu, Bohdan Andraka, Bryan C. Daniels, and Kevin Ingersent.
J. Appl. Phys. **97**, 10A510 (2005).
- *Synchronization of Coupled Rotators: Josephson Junction Ladders and the Locally-Coupled Kuramoto Model.*
B. C. Daniels, S. T. M. Dissanayake, and B. R. Trees.
Phys. Rev. E **67**, 026216 (2003).

Book chapters

- *Phase Transitions and Criticality in the Collective Behavior of Animals — Self-organization and biological function.*
Pawel Romanczuk and Bryan C. Daniels.
In *Order, Disorder and Criticality. Advanced Problems of Phase Transition Theory, vol. VII*, ed. Yu. Holovatch. World Scientific Publishing, Singapore (2023).
- *Inferring the Logic of Collective Information Processors.*
Bryan C. Daniels.
In *Advances in Info-Metrics: Information and Information Processing Across Disciplines*, ed. Min Chen, J. Michael Dunn, Amos Golan, and Aman Ullah. Oxford University Press (2020).

- *Parameter Estimation, Sloppiness, and Model Identifiability*.
Bryan C. Daniels, Dirk Fey, and Maciej Dobrzyński.
In *Quantitative Biology: Theory, Computational Methods, and Models*, ed. B. Munsky, W. Hlavacek, and L. Tsimring. MIT Press (2018).

In review

- *Continuous Attractor Networks for Laplace Neural Manifolds*.
Bryan C. Daniels and Marc W. Howard.
arXiv 2406.04545.
- *Difficult control is related to instability in biologically inspired Boolean networks*.
Bryan C. Daniels and Enrico Borriello.
arXiv 2402.18757.
- *The coexistence of localized and distributed behavioral information in neural activity*.
Gaurang Yadav and Bryan C. Daniels.
bioRxiv 2023.11.17.567603.
- *Neet: Simulating and Analyzing Dynamical Network Models*.
Douglas G. Moore, Harrison B. Smith, Bryan C. Daniels, Hyunju Kim, Bradley Karas, Siyu Zhou, and Sara I. Walker.

Grants

- 2020 **The Dynamics of Collective Decisions**
Awarded grant, €5 041, Otto & Marta Fischbeck Foundation
Workshop at the Wissenschaftskolleg in Berlin, Germany
- 2018 **Distributed Decision Making: Universal features of decision making via collective computation**
Awarded grant, \$23 240, ASU–SFI Center
Workshop at the Santa Fe Institute, with Jessica Flack

Professional Activities

Meeting organization

- Feb. 2020 **Workshop: The Dynamics of Collective Decisions** *Organizer, Wissenschaftskolleg zu Berlin (Berlin Institute for Advanced Study)*
- May 2018 **Working Group: Distributed Decision Making – Universal features of decision making via collective computation** *Co-organizer, Santa Fe Institute*
- Sep. 2017 **Working Group: Quantifying Collective Behavior in Living Systems II** *Co-organizer, Santa Fe Institute*
- May 2017 **Working Group: Quantifying Collective Behavior in Living Systems**
Co-organizer, Santa Fe Institute
- July 2014 **Working Group: Collective Cognition – Quantifying Distributed Inference** *Co-organizer, Santa Fe Institute, (video summary here: vimeo.com/111008805)*

Editing

- 2022–present **PLOS ONE** *Section Editor — Multidisciplinary Physics, Computational Biology, Complexity and Networks*
- 2021 **Theory in Biosciences** *Special issue on Quantifying Collectivity*

2017–2022 **PLOS ONE** *Editorial Board member*

Committee service

2023–present Committee for Justice, Equity, Diversity, and Inclusion, College of Global Futures, ASU

2022–present Ad-hoc admissions committee, School of Complex Adaptive Systems, ASU

2022–present Ad-hoc curriculum committee, School of Complex Adaptive Systems, ASU

Apr. 2014 Kohler graduate fellowship selection committee member, UW–Madison

Refereeing — Journals

- Proc. Natl. Acad. Sci. USA
- Physical Review Letters
- PNAS Nexus
- Nature Computational Science
- Proceedings B: Biological Sciences
- J. Physics A: Math. Theor.
- J. Physics: Condensed Matter
- Animal Behavior
- Frontiers in Physiology
- eLife
- Entropy
- Integrative Biology
- Trends in Cognitive Science
- Physica A: Statistical Mechanics
- Nature Communications
- PLOS Computational Biology
- J. Royal Society Interface
- Physical Review E
- Physical Biology
- Journal of Complexity
- Bioinformatics
- IEEE Mol. Bio. & Multi-Scale Comm.
- BioSystems
- J. System Science & System Eng.
- IEEE Computational Intelligence
- Theory in Biosciences
- Synthese

Refereeing — Grants

- National Science Foundation
- Human Frontier Science Program
- ANR (French National Research Agency)
- NSERC (Canada)
- Israel Science Foundation

Student supervision

2023– Diya Hamada, Barrett College Research Fellow. Arizona State University.

2023–2024 Ayomide Laguda, Barrett College Research Fellow. Arizona State University.

2023 Alessandra Alvarado Lozada, Barrett College Research Fellow. Arizona State University.

2022–2023 Sabah Ashfeen, Barrett College Research Fellow. Arizona State University.

2022 Padma Prabakaran, Barrett College Research Fellow. Arizona State University.

2020 Robin Na (Seoul National University visiting undergraduate student), summer internship. Arizona State University.

2019– Gaurang Singh (IIT Bombay Master's student, now graduate student at Indiana University), independent research project. Arizona State University.

2017–2019 Undergraduate and graduate student workers, Digital Innovation Group and Data Mining and Informatics research teams. Arizona State University.

2013 Jess Banks (Oberlin math, now graduate student at UC–Berkeley), summer internship. UW–Madison.

2011– Edward Lee (Princeton physics, graduate student at Cornell, now postdoc at Complexity Science Hub Vienna), summer internship, post-undergraduate research, postdoctoral research. SFI, UW–Madison.

Invited Talks

- Aug. 2024 Aspen Center for Physics. Workshop: Physics of Biological Data Analysis.
- Oct. 2023 Complexity Science Hub Vienna, Obergurgl, Austria. Workshop: Computation in Dynamical Systems.
- July 2023 Santa Fe Institute. Workshop: Sensory Prediction, Engineered and Evolved.
- June 2022 Aspen Center for Physics. Workshop: Learning Dynamical Models from Biophysical Data.
- Apr. 2022 Joint Mathematics Meetings. Session on “Complex Adaptive Systems and Evolutionary Models in Biology and Psychology.”
- May 2020 Emory University. Theory and Modeling of Living Systems. Virtual workshop: “Can machine learning learn new physics, or do we need to put it in by hand?”
- Jan. 2020 University of Muenster. Muenster Graduate School of Evolution. Lecture series: “The Growth of the Evolutionary Thought.”
- Jan. 2020 Max Planck Research Group Leader Symposium, Berlin.
- June 2019 Santa Fe Institute. CollectiveCrypto workshop: Exploring the Role of Collective Effects in Cryptonetwork & Token Design.
- Mar. 2019 Santa Fe Institute. SFI Studio event on Complexity for Intelligence Science.
- June 2018 Santa Fe Institute. Workshop on Limits of Human Performance: The Role of Collective Effects in Individual and Team Performance.
- Feb. 2018 University of Arizona. Applied Mathematics Colloquium.
- Mar. 2017 APS March Meeting. Invited session: Robot scientists and machine learning for automated modeling and control of complex systems (DBIO/GSNP).
- Dec. 2016 Los Alamos National Laboratory. Center for Nonlinear Studies.
- July 2016 Vanderbilt University. Selected for contributed talk at q-bio conference.
- Oct. 2015 Santa Fe Institute. Working group on Information Theory, Ecosystems, and Schrödinger’s Paradox.
- June 2015 Champalimaud Neuroscience Programme, Lisbon, Portugal. Polavieja lab.
- Nov. 2014 University of Michigan. Center for the Study of Complex Systems Seminar.
- Oct. 2014 American University. Recent Innovations in Info-Metrics.
- May 2014 Santa Fe Institute. Workshop on Statistical Mechanics.
- Apr. 2014 University of Wisconsin–Madison. Chaos and Complex Systems Seminar.
- Jan. 2014 Georgia Tech. Selected for contributed talk at Dynamics Days conference.
- Dec. 2013 University of Wisconsin–Madison. SILO (Systems, Information, Learning, and Optimization) lecture.
- Oct. 2013 University of Wisconsin–Madison. SoundWaves public lecture.

Teaching

- 2022–present **Complex Adaptive Systems 523: Statistics and Dimensionality Reduction**, Arizona State University
Online course covering data analysis methods applied to complex systems.
- 2021–present **Complex Adaptive Systems 503: Collectives**, Arizona State University
Online course covering examples of real-world collectives and the theory to describe their behavior.
- 2016–2018, 2020–present **Anthropology/Biology/Sustainability 570: Fundamentals of Complex Adaptive System Science**, Arizona State University
Co-taught with Manfred Laubichler, Michael Barton, and Enrico Borriello
- 2013–2014 **Genetics 677: Evolutionary Systems Biology**, University of Wisconsin–Madison
Co-taught with evolutionary biologist Laurence Loewe
- 2014 **Biochemistry 609: Mathematical Methods for Systems Biology** *Guest lecturer*, University of Wisconsin–Madison
- 2013 **Humanities Hackathon short course**, University of Wisconsin–Madison
Course development, workshop organization, and lectures on computational analysis techniques for a professional humanities audience.
- 2007–2009 **Physics Teaching assistant**, Cornell University
- Physics 218: Waves and Thermodynamics
 - Physics 317: Applications of Quantum Mechanics
 - Physics 2206: Weapons of Mass Destruction
 - Physics 1101: General Physics Autotutorial

Community Outreach

- 2021 **ASU Homecoming Block Party**
“Ask an Expert” public outreach for College of Global Futures
- 2020–present **Neuromatch Academy**
Faculty mentor for online summer school in computational neuroscience
- 2009–present **Adopt-a-Physicist volunteer**
Online interaction with high school physics students
- 2014–2015 **High school field trip outreach events, Wisconsin Institute for Discovery**
Led a group of postdocs and graduate and undergraduate students to develop activities that demonstrate computational reasoning, complex systems research, and interdisciplinary science for a high school audience
- 2010–2011 **Service Learning Mentor, The Masters Program**
One-on-one and group mentorship with high school students
- 2008–2010 **Expanding Your Horizons volunteer**
Physics demonstrations for middle school girls