

Damian Sowinski, Ph.D.

Theoretical Physicist | Complex Systems, Information Theory & Artificial Intelligence

Contact

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Webpage

DamianSowinski.com

Languages

English *native*

Polish *fluent*

Programming

MATLAB, Python

Mathematica,

Fortran

C, C++

External Links

arXiv

ORCID

Lectures

Wordpress

Visualizations

Google Scholar

Summary

Theoretical and computational physicist working at the intersection of complex systems, information theory, and artificial intelligence. My research develops physics-based frameworks to study fundamental questions about agency, collective behavior, and the emergence of life — drawing on tools ranging from neuroevolution and machine learning to stochastic simulation and continuum mechanics. I maintain an active publication record in journals including Physical Review, Nature Communications Physics, and PRX Life, and hold active collaborations with groups at Rochester, Delaware, Sherbrooke, and VUB in Brussels, with grant proposals pending at Templeton, Sloan, and NASA. My work is inherently cross-disciplinary, and I have a strong record of building collaborative research programs and mentoring students at multiple levels.

Education

Doctor of Philosophy, *Physics*

Dartmouth College, New Hampshire

Bachelor of the Arts, *Physics*

University of California, Berkeley

Research

**Department of Physics and Astronomy,
University of Rochester**

Rochester, New York **2023-Present**

Research Scientist

- ▶ Collaborate with A. Frank & G. Ghoshal on semantic information theory in biological, ecological, and societal systems (Templeton Foundation Grant, with A. Kolchinsky & J. Piñero, Pompeu Fabra).
- ▶ Collaborate with A. Quillen on the classical to quantum chaos transition, and sampling algorithms for use in quantum computing
- ▶ Work with D. Biro & T. Sasaki on mapping the information architecture of *Solenopsis invicta* during foraging; developed the LEAFS framework for modeling emergence of collective problem-solving.
- ▶ Collaborate with S. Bartlett, S. Holler, M. Wong et al. on applying computational mechanics to exoplanet spectra and pyrolysis data, and on the emergence of phenotypes through neuroevolution of RNNs.
- ▶ Co-authoring a comprehensive review of the history, science, and speculation on and around technosignatures with C. Vidal's SETI collaboration.

**Thayer School of Engineering,
Dartmouth College**

Hanover, New Hampshire **2019-2022**

Research Scientist I-III

- ▶ Collaborate with M. McGarry & E. Van Houten on a parallel finite element suite for forward and inverse simulations of poroelastic and anisotropic Neo-Hookean continuum models, with applications to tissue property imaging.
- ▶ Assist with curriculum development for K. Paulsen's Finite Element course; train at the Center for Surgical Imaging at Dartmouth-Hitchcock to run MRI sequences on phantoms; contribute to grant writing for diabetic foot studies.
- ▶ Collaborate with R. Granger & E. Bowen on a Riemannian metric inspired by retinal cellular architecture for image similarity judgments, and differential geometry approaches to the Weber-Fechner law.
- ▶ Work with D. Reeves (Fred Hutchinson Cancer Research Center) on a field theory analogue of ecological models for interacting heterotroph-autotroph systems.
- ▶ Collaborate with M. Gleiser, J. DeSilva, J. Carroll-Nellenback et al. on modeling information dynamics in groups of epistemic agents.

Research (Continued...)

Institute for Cross-Disciplinary Engagement, Dartmouth College

Hanover, New Hampshire **2017-2019**

Postdoctoral Scholar

- ▶ Build the theoretical foundation of Configurational Information Measures (CIM) and develop pyCE, a Python library for simulation and analysis of astrophysical and cosmological phenomena, with M. Gleiser.
- ▶ Mentor graduate students M. Stephens and M. Krakow on continuity of pyCE codebase and analysis techniques; gave public lecture series on epistemology, information, and physics.
- ▶ Collaborate with S. Frey (UC Davis) on MaxEnt. analysis of NBA video data

WisPIC, University of Wisconsin

Madison, Wisconsin **2016-2017**

Postdoctoral Researcher

- ▶ Analyze information measures applied to Ising, Potts, and Heisenberg models on lattices and Erdős–Rényi graphs representing distinct neurotopologies; maintain a statistical mechanics pipeline for data generation and analysis.
- ▶ Collaborate with S. Streipert, applying Integrated Information Theory to split-brain phenomenon using deterministic and stochastic networks; work with L. Barbossa on spin glass systems for complex network dynamics.

Beyond Institute, University of Arizona

Tempe, Arizona **2015**

Visiting Scholar

- ▶ Collaborate with S. I. Walker, H. Kim, & A. Adams on information processes in biological systems; develop a stochastic cellular automata model combining deterministic and Ising-like dynamics, analyze competition between deterministic and stochastic subprocesses, and apply machine learning to the yeast cell growth cycle

Department of Physics & Astronomy, Dartmouth College

Hanover, New Hampshire **2011-2016**

Graduate Student

- ▶ Develop Configurational Entropy in statistical field theory with M. Gleiser; gain expertise in computational physics, numerical methods, and optimization across multiple programming languages and simulated systems

Hayden Planetarium, American Museum of Natural History

New York, New York **2010-2011**

Research Assistant

- ▶ Work with M. Mac-Low & C. McNally on modified GADGET code in hydrodynamic simulations

Department of Astronomy, Hunter College

New York, New York **2010-2011**

Research Assistant

- ▶ Analyze M and L dwarf spectra, characterizing populations in color space for future LSST photometric surveys

Lawrence Berkeley National Laboratory

Berkeley, California **2000-2003**

Undergraduate Researcher

- ▶ Calibration of KamLAND photomultiplier tubes and z-axis arm under H. Steiner

Teaching & Advising

University of Rochester

Rochester, New York **2025-Present**

Adjunct Professor/ Document Specialist

- ▶ Physics 100 (Physics and the Natural World) for non-STEM majors, historical development of natural philosophy
- ▶ Physics 141 (Honors Mechanics) for incoming physics majors; developed curriculum around Kleppner & Kolenkow.
- ▶ Develop curriculum and documentation for all non-honors physics labs; created the .departments lab website

University of Rochester

Rochester, New York **2023-Present**

Advising/Mentoring

- ▶ Advise graduate students S. Kelty (configurational entropy and critical points in the Ising model), B. Bhatt (entropy estimation for fMRI data analysis), and B. Markwick (agent-based foraging simulations).
- ▶ Created "My Favorite Spacetimes," an advanced topics seminar for graduate and upper-level undergraduates covering the history of Special Relativity, Minkowski and Rindler spacetimes, and classical papers on GR.
- ▶ Founded the Complex Systems and Integrated Information collaboration (2023), coordinating speakers and scheduling.

Teaching & Advising (Continued...)

Thayer School of Engineering, Dartmouth College

Hanover, New Hampshire **2019**

Co-Lecturer

- ▶ Update curriculum for K. Paulsen's Engineering 105 (finite element methods), deliver lectures during his travel, and hold office hours to help graduate students troubleshoot FORTRAN code.

RIA Global Education

Online Course **2019**

Adjunct Professor

- ▶ Physics of Music course covering vibrations and waves in different media.

Department of Physics & Astronomy, Dartmouth College

Hanover, New Hampshire **2011-2016**

Graduate Student Teaching Assistant

- ▶ TA for courses spanning classical mechanics, electromagnetism, introductory astronomy, quantum mechanics (intro and advanced), special and general relativity, cosmology, and quantum field theory.
- ▶ Assist teaching Honors Introductory Physics; organize extracurricular mathematics and programming sessions for incoming undergraduates.

Hunter College

New York, New York **2010-2011**

Educational Consultant

- ▶ Develop and teach a Physics GRE prep course and an intro Python course; organize undergraduate tutoring sessions.

Beginning with Children Foundation

New York, New York **2008-2011**

Educational Consultant

- ▶ Develop curriculum for after-school tutoring in mathematics and test prep (SSAT, SHSAT, SAT) across multiple NYC charter schools.
- ▶ Mentor students on academic habits, oversee and help them with college applications.

Tutor Associates

New York, New York **2005-2011**

Head Physics and Mathematics Tutor

- ▶ Tutor students in AP Physics and AP Calculus and standardized test prep.
- ▶ Develop mock exams, and dynamic spreadsheets to track and analyze student performance over time.

Launch Education *STEM Tutor*

New York, New York **2008-2011**

Celia Cruz Bronx High School of Music. *Physics Teacher*

New York, New York **2005-2007**

Grace Dodge High School *Mathematics Teacher*

New York, New York **2006**

UC Tutors *Tutor*

Irvine, California **2004-2005**

SmArT Academy *Physics and Mathematics Teacher*

Cerritos, California **2003-2005**

Fullerton Community College *Head Science and Mathematics Tutor.*

Cerritos, California **2003-2005**

Cragmont Elementary School *Work Study Teacher's Assistant*

Berkeley, California **2001-2003**

Publications (click to link)

Behavioral Speciation in the Neuroevolution of Recurrent Neural Net Foragers driven by Environmental Homogeneity

Damian R. Sowinski

Submitted to *Artificial Life Conference 2026*

Causal Leverage Density: A Universal Framework for Semantic Information

Damian R. Sowinski, Silvia Holler, Mike Wong, Gary Segal, David Parkinson, Clément Vidal, James Henderson Cleaves, Pritvik Sinhadc, Anirudh Prabhu, Stuart Bartlett

Artificial Life Conference Proceedings 37. Vol. 2025. No. 1, MIT Press.

Notions of adiabatic drift in the quantized Harper model

Alice C Quillen, Nathan Skerrett, Damian R. Sowinski, Abobakar S. Miakhel

Physical Review A 112 (4), 042226

Publications [\(click to link\)](#)

Exo-Daisy World: Revisiting Gaia Theory through an Informational Architecture Perspective

Damian R Sowinski, Adam Frank, Gourab Ghoshal
The Planetary Science Journal 6.7 (2025): 176.

Information Bounds Production in Replicator Systems

Jordi Piñero, Damian R Sowinski, Gourab Ghoshal, Adam Frank, Artemy Kolchinsky
Accepted, Nature Communications Physics

Reflections of Life: Distinguishing Living from Non-living Worlds with Complexity Metrics

Stuart Bartlett, Xianlej San, Siteng Fan, Gary Segal, Damian R Sowinski, Yuk L Yung
Under Review, The Astrophysical Journal

In vivo Magnetic Resonance Imaging of the Interstitial Pressure Gradients using a Pulsatile Poroelastic Computational Model

Matthew McGarry, Damian Sowinski, Likun Tan, Elijah Van Houten, Jaco J.M. Zwanenburg, John Weaver, Keith Paulsen
Interface focus 15 (1), 20240044

Configurational Information Measures, Phase Transitions, and an upper bound on Complexity

Damian Sowinski, Sean Kealty, Adam Frank, Gourab Ghoshal
Under Review, Physical Review E

Semantic Information in a feedback-control Kuramoto Model

Damian Sowinski, Adam Frank, Gourab Ghoshal
Phys. Rev. Research 6, 043188 2024

Semantic Information in a Model of Resource Gathering Agents

Damian Sowinski, Jonathan Carroll-Nellenback, Jordi Pinero, Artemy Kolchinsky, Robert Marwick, Adam Frank, Gourab Ghoshal, Marcelo Gleiser
PRX Life 1 (2), 2024

The Consensus Problem in Politics of Agents with Dissimilar Cognitive Architectures

Damian Sowinski, Jonathan Carroll-Nellenback, Jeremy M DeSilva, Adam Frank, Gourab Ghoshal, Marcelo Gleiser
Entropy 24 (10), 1378

Visual Stream Connectivity Predicts Assessments of Image Quality

Elijah Bowen, Antonio Rodriguez, Damian Sowinski, and Richard Granger
Journal of Vision 22 (11), 4-4

Mapping Heterogenous Anisotropic Tissue Mechanical Properties with Transverse Isotropic Nonlinear Inversion MR Elastography

Matthew McGarry, Elijah Van Houten, Damian Sowinski, Dhruvo Jyoti, Daniel Smith, Diego A Caban-Rivera, Grace McIlvain, Philip Bayly, Curtis L Johnson, John Weaver, Keith Paulsen
Magnetic Resonance in Medicine 87 (3), 1313-1328

Quantifying Stability of Parameter Estimates for In Vivo Nearly Incompressible Transversely-Isotropic Brain MR Elastography

Dhruvo Jyoti, Matthew McGarry, Elijah Van Houten, Damian Sowinski, Philip V Bayly, Curtis L Johnson, Keith Paulsen
Biomedical Physics & Engineering Express 8 (3), 035015

Poroelasticity as a Model of Soft Tissue Structure: Hydraulic Permeability Reconstruction for Magnetic Resonance Elastography In Silico

Damian Sowinski, Matthew McGarry, Scott Gordon-Wylie, Elijah Van Houten, John Weaver, and Keith Paulsen
Frontiers of Physics, Research Topic: Innovative Dev. in Multi-Modality Elastography (2020)

Correlated Noise in Brain Magnetic Resonance Elastography

Ariel J. Hannum, Grace McIlvain, Damian Sowinski, Matthew D. J. McGarry, Curtis L. Johnson
Magnetic Resonance in Medicine (2021) 00: 000– 000.

Publications [\(click to link\)](#)

Towards a Perceptual Distance Metric for Auditory Stimuli

Sarah Oh, Elijah Bowen, Antonio Rodriguez, Damian Sowinski, Eva Childers, Annemarie Brown, Laura Ray, and Richard Granger
arXiv:2011.00088

A Heterogenous, Time Harmonic, Nearly Incompressible Transverse Isotropic Finite Element Brain Simulation Platform for MR Elastography

Matthew D J McGarry, Elijah Van Houten, Charlotte Guertler, Ruth J Okamoto, Daniel R Smith, Damian R Sowinski, Curtis L Johnson, Philip Bayly, John Weaver, and Keith D Paulsen
Physics in Medicine & Biology (2020)

Configurational Information Approach to Instantons and False Vacuum Decay in D-dimensional Spacetime

Damian Sowinski, Marcelo Gleiser
Physical Review D, 98, 056026 (2018)

Configurational Entropy as a Lifetime Predictor and Pattern Discriminator for Oscillons

Marcelo Gleiser, Michelle Stephens, and Damian Sowinski
Physical Review D 97, 096007 (2018)

How We Make Sense of the World: Information, Map-Making, and the Scientific Narrative

Marcelo Gleiser, Damian Sowinski
The Map and the Territory: Exploring the Foundations of Science, Thought and Reality, ed. by S. Wuppuluri, N. da Costa, and F. A. Doria, Springer Frontiers Collection (2018)

Information Dynamics at a Phase Transition

Damian Sowinski, Marcelo Gleiser
Journal of Statistical Physics, Volume 167, Issue 5, pages 1221-1232, June 2017

Complexity and Stability for Epistemic Agents: The Foundations and Phenomenology of Configurational Entropy

Damian R. Sowinski
Dartmouth College, Department of Physics and Astronomy, Thesis (2016)

Information-Entropic Signature of the Critical Point

Marcelo Gleiser, Damian Sowinski
Physics Letters B, Volume 747, Pages 125-128, 30 July 2015

Information-Entropic Stability Bound for Compact Objects: Application to Q-Balls and the Chandrasekhar limit of Polytropes

Marcelo Gleiser, Damian Sowinski
Physics Letters B, Volume 727, Issues 1-3, Pages 272-275, 25 November 2013

Cosmic Anisotropy: A History of the Axis of Evil

Damian Sowinski
Dartmouth College, Scribd article 130092552 (2013)

From Monopoles to Textures: A Survey of Topological Defects in Cosmological Quantum Field Theory

Damian Sowinski
Dartmouth College, Scribd article 85012149 (2012)

Photometric Analysis of M&L Dwarfs with the LSST Throughput Profiles

Damian Sowinski
American Museum of Natural History, Scribd article 35701963 (2010)

Science Communications

Cosmic Strings and the CP Problem

University of Rochester, Astronomy Journal Club

Laplace's Demon and the Drunkard

Bartlett Collaboration on Complexity, Zoom Talk

Why Can't We Agree?

Biro's Animal Collective Behavior Workshop

My Favorite Spacetimes

University of Rochester, 10 week seminar

Much Ado About Nothing:

Vacuum Phase Transitions & Topological Defects

University of Rochester, Astronomy Journal Club

Consensus in Politics with Heterogeneous Cognitive Architectures is Hard

Northeast Conference on Complex Systems 2024

Naked Singularities in Critical Grav. Collapse

University of Rochester, Astronomy Journal Club

Semantic Information in the Kuramoto Model

Landi's Quantum Information Seminar

Simulating Nanoparticle Dynamics

Dartmouth College, Nanoparticle Imaging Seminar

Numerical Techniques for Stochastic DiffeQs

Dartmouth College, Nanoparticle Imaging Group Seminar

Hydraulic Permeability Reconstruction in Magnetic Resonance Elastography

American Physical Society, March Meeting, Talk

Criticality in the Presence of Physical Gradients

U of Rochester, Adam Frank's Collaboration Zoom Talk

Agent Based Predator-Prey Flocking Models

U of Rochester, Adam Frank's Collaboration Zoom Talk

Coarse Graining in Lotka-Volterra Systems

Sarbonne Universite, Ecological Dynamics Group Z Talk

Modeling Networks of Interacting Species

Sarbonne Universite, Ecological Dynamics Group Z Talk

A Survey of Biomechanical Models

Dartmouth College, MRE Zoom Seminar

Biomechanics and Arterial Modeling

Dartmouth College, MRE Zoom Seminar

2025

What is Complexity? Perspectives from Computational Mechanics

University of Rochester, Department of Physics & Astronomy, Seminar

Time Machines and Warp Drives: General Relativity and Sci-fi

McGregor's Tavern, Nerd Night Public Lecture

Top-Down Bottom-Up Causation in Collective Behavior

University of Rochester, Animal Behavior and Cognitive Science, Seminar

2024

Time Machines, Wormholes, and Warp Drives

University of Rochester, Astronomy Journal Club

Biospheres and Planets:

Semantic Information Theory & the Gaia Hypothesis

Astrobiology Science Conference

The Meaning in Life: Towards a Theory of Semantic Information

Information Driven States of Matter Workshop,

Information Sharing Politics, Cognitive Architectures, and Consensus

Complex Systems and Information Theory Meeting Seminar

Emergence of Meaning in the Sensor Evolution of Ante-organisms

American Physical Society, March Meeting

2023

Semantic Information in Agent-Based Foraging Models

Complex Systems and Information Theory Seminar

Multi-Timescale Nanoparticle Simulations

Dartmouth College, Nanoparticle Imaging Seminar

Finding Meaning in Finding Food

Northeast Conference on Complex Systems 2023

2022

Lie Algebras and Conformal Transformations in Phase Transitions

Collaboration with Zaji Daugherty at the City College, NYC

Information Transfer in Ising Models with Temperature Gradients

University of Rochester, Adam Frank's Collaboration Zoom Talk

2021

Renormalization Group Flow and the Acoustoelastic Effect in Gel Phantoms

Dartmouth College, Magnetic Resonance Elastography Zoom Seminar

Langevinference - a novel approach to property inference in MRE

Dartmouth College, Magnetic Resonance Elastography Zoom Seminar

The Acoustoelastic Effect and Hyperelasticity

Dartmouth College, Magnetic Resonance Elastography Zoom Seminar

Information Geometry and Entropic Measures in Data Analysis

Dartmouth College, Psych and Brain Science Department Talk

The Irreducible Representation Expansion of Hyperelasticity

University of Delaware, Anisotropic MRE Collaboration Zoom Talk

2020

Diabetic Foot - Biomechanical Aspects of Finite Deformations

Dartmouth College, MRE Zoom Seminar

The Continuum Mechanics of Infinitesimal and Finite Deformations

Dartmouth College, Thayer School of Engineering 2 part Lecture Series

The Foundations of an Effective Field Theory of Tissue

Dartmouth College, Thayer School of Engineering 4 part Lecture Series

Science Communications (Continued...)

Regularization Methods in MRE

BioMedical Engineering Society Annual Meeting

A Bayesian Perspective on Optimization

MRE internal annual collaboration meeting

Information Content in Natural Images

Dartmouth College, Psych & Brain Science Department Talk

Oscillons in Vacuum Phase Transitions

American Physical Society, New England Meeting

Finding Boson Stars Numerically

Dartmouth College, Physics Department Talk

An Ode to Oscillons: Criticality in QFT

McGill Northeast Cosmology Workshop, Talk

A Minimal History of Maximal Entropy

Dartmouth College, Postdoc Association Public Lecture

Ising Models in Neuroscience

WISPIC, Neuroscience Department Talk

The Epistemic Foundations and Phenomenology of Configurational Entropy

Dartmouth College, Physics Department Lecture

Information Turbulence at Criticality

Carnegie Institute of Science, Poster Session

The Cox Axioms: A Foundational Approach to Bayesian Probability Theory

Dartmouth College, 2 part Lecture Series

Cosmic Anisotropy: A History of the Axis of Evil

Dartmouth College, Physics Department Talk

The Weber-Fechner Law and Perception Metrics

Dartmouth College, Psych and Brain Science Department Talk

Information, Quantum Mechanics, and the Eyeball

Dartmouth College, Psych and Brain Science Department Talk

Logit and Probit Functions for Classification in Psychometric Analysis

Dartmouth College, Psych and Brain Science Department Talk

Vector Spaces and Mathematical Methods for Psychophysics

Dartmouth College, Psych and Brain Science 4 part Lecture Series

Do you even Latex?

Kresge Library at Dartmouth College, 4 session Workshop

The ADM Decomposition and Numerical relativity

Dartmouth College, Physics Department Talk

pyCE: A Python Library for Configurational Entropy

Dartmouth College, Physics Department Talk

Steaming Piles of Science: Dr. Sowinski on Information Theory

Interview for a popular science podcast ([link](#))

MIB Coordinates and Finite Difference Methods for QFT Simulations

Dartmouth College, 2 Part Lecture Series

Criticality and Information Dynamics in Neuroscience

WISPIC, Neuroscience Department Talk

From Epistemology to Information

Institute for Cross-Disciplinary Engagement, 3 part Lecture Series

Maximum Entropy Methods in Statistical Physics

Dartmouth College, 2 part Lecture Series

Probability, Information, and Statistical Physics

Dartmouth College, 4 part Lecture Series

Geometry, Topology, and Physics by Nakahara

Dartmouth College, Reading Course

Configurational Entropy and the Chandrasekhar Limit

American Physical Society April Meeting, Talk

A Multi-Letter Polymerization Model of Chiral Symmetry Breaking

Astrobiology Graduate Student Conference, Poster Session