Alexander (Alec) Blades Boyd

Information Physicist

Personal Information:

Date of Birth: 6/19/1989
Birthplace: Berkeley, CA
Citizenship: United States

Research Interests: information theory, statistical mechanics, entropy, complexity, nonlinear dynamics, computational mechanics, hidden Markov dynamics, Maxwell's demon, information engines, non-equilibrium thermodynamics, time's barbed arrow, natural computation, machine learning, thermal computing, physical information processing

Education:

University of California, Davis, Ph. D., Physics, December 2017 (expected)
Pomona College, B.A., Physics, May 2011

Research Experience:

June 2012-Present	Graduate Student Research Assistant, Theory of Thermodynamic Computations UC Davis, Physics Department Graduate Advisor: James Crutchfield Contributions: Developed and analyzed a variety of information engines using computational mechanics. Proved the principle of requisite complexity for information engines. Identified a thermodynamic cost of information processing beyond the Landauer bound due to modularity: the modularity dissipation.
Summer 2010	NSF REU Research Assistant, Electron Diffusion in Weakly Disordered Lattice University of Washington, Institute for Nuclear Theory Supervisor: David Thouless Contribution: Created a simulation of a disordered lattice to examine weak Anderson localization.
June 2009-May 2010	Research Assistant, Spin-Exchange Collision Calculations California State University, Physics Department Supervisor: Derek Kimball Contribution: Calculated spin-exchange collisions, incorporating the effects of anomalous spin-dependent forces.
Summer 2008	Research Assistant, Bose-Einstein Condensation Pomona College, Summer Undergraduate Research Program (SURP) Supervisor: Dwight Whitaker Contribution: Set up lasers, optical equipment, and vacuum system.

Teaching Experience:

Spring 2013	Guest lecture Natural Computation: Information Engines Instructor: James Crutchfield UC Davis, Physics Department
Jan-May 2013-2015	Teaching assistant: Natural Computation (graduate class)

	Instructor: James Crutchfield UC Davis, Physics Department
Sep 2012-Dec 2012	Teaching assistant: Python for Physicists (upper division class) Instructor: James Crutchfield UC Davis, Physics Department
Sept 2011-June 2012	Teaching assistant: Introductory Physics Instructor: Randy Harris UC Davis, Physics Department
Fall 2009	Teaching assistant: Freshmen Physics Instructor: Thomas Moore Pomona College, Physics Department
Fall 2009	Teaching assistant: Sophomore Physics Lab Instructor: Richard Mawhorter Pomona College, Physics Department
Fall 2008	Teaching assistant: Freshman Physics Lab Instructor: Alfred Kwok Pomona College, Physics Department

Volunteering:

June 2014-Present	Big Brother, Big Brothers Big Sisters of the Greater Sacramento Area

Awards & Distinctions:

Information Engines Scholarship summer 2017 (awarded to outstanding young scientists at the Information Engines workshop at the Telluride Science Research Center)
Member of Phi Beta Kappa Society since spring 2011
Nominated for Sigma Xi Scientific Research Society in spring 2009
Member of National Society of Collegiate Scholars (NCSC) since spring 2008
Tileston Physics Prize in 2008, 2009, and 2010 (awarded annually to outstanding physics students at Pomona College)

Programming Experience:

Python, LaTeX, Matlab, Mathematica, Sage

Publications:

A. B. Boyd, D. Mandal, and J. P. Crutchfield. Above and Beyond the Landauer Bound: Thermodynamics of Modularity. *arxiv.org:1708.03030 [cond-mat.stat-mech]*, (2017)

A. B. Boyd, D. Mandal, P. M. Riechers, and J. P. Crutchfield. Transient Dissipation and Structural Costs of Physical Information Transduction. *Phys. Rev. Lett.*, **118**, 220602, (2017)

A. B. Boyd, D. Mandal, and J. P. Crutchfield. Correlation-powered Information Engines and the Thermodynamics of Self-Correction. *Phys. Rev. E*, **95**, 012152, (2017)

A. B. Boyd, D. Mandal, and J. P. Crutchfield. Leveraging Environmental Correlations: The Thermodynamics of Requisite Variety. *J. Stat. Phys.* **167**, 1555 (2017)

A. B. Boyd, D. Mandal, and J. P. Crutchfield. Identifying functional thermodynamics in autonomous Maxwellian ratchets. *New J. Physics*, **18**, 023049, (2016)

A. B. Boyd and J. P. Crutchfield. Demon dynamics: Deterministic chaos, the Szilard map, and the intelligence of thermodynamic systems. *Phys. Rev. Lett.*, **116**, 190601, (2016)

D. Mandal, A. B. Boyd, and J. P. Crutchfield. Memoryless thermodynamics? A reply. *arxiv.org:1508.03311 [cond-mat.stat-mech]*, (2015)

D. F. Jackson Kimball, A. B. Boyd, and D. Budker. Constraints on anomalous spin-spin interactions from spin-exchange collisions. *Phys. Rev. A*, **82**, 062714, (2010)

Invited Talks:

Thermodynamics of Modularity: Irretrievable Dissipation of Localized Information Processing, Information Engines at the Frontiers of Nanoscale Thermodynamics Workshop, Telluride Science Research Center, Telluride, CO, August 10, 2017 (Abstract and meeting details available at https://www.telluridescience.org/reg/workshop_files/643/Info.Engines.program_2017.pdf)

Maxwell's Demon Dynamics: Trade-offs in Physical Information Processing, Earth-Life Science Institute, 2-12-1-IE-1 Ookayama, Meguro-ku, Tokyo, 152-8550, Japan, May 8, 2017

Leveraging Environmental Correlations: The Thermodynamics of Requisite Variety, Nanyang Technological University, 50 Nanyang Ave, Singapore, April 27, 2017

Leveraging Environmental Correlations: The Thermodynamics of Requisite Variety, Aberdeen Proving Ground, MD, February 15, 2017

Biology's Demons, Physics of Living Matter Workshop, 660 East Fifth Street, Tempe, AZ, February 2, 2017

Leveraging Environmental Correlations: The Thermodynamics of Requisite Variety, University of Maryland, College Park, MD, January 9, 2017

Thermodynamics of Memory in Autonomous Maxwellian Demons, MURI Review Meeting, Telluride Science Research Center, Telluride, CO, June 30, 2016 (Meeting details available at http://csc.ucdavis.edu/~chaos/share/MURIReview2016.pdf)

Thermodynamics of Memory in Autonomous Maxwellian Demons, Information Engines at the Frontiers of Nanoscale Thermodynamics Workshop, Telluride Science Research Center, Telluride ,CO, June 23, 2016 (Abstract and meeting details available at https://www.telluridescience.org/reg/workshop_files/611/program_2016.pdf)

Maxwellian Demons: The Role of Deterministic Chaos in Physical Information Processing, Student Run Math/Applied Math Seminar, University of California, Davis, CA, April 22, 2016 (Abstract available at https://www.math.ucdavis.edu/research/seminars/?talk_id=4616)

Memory & Correlation in the Thermodynamics of Maxwellian Demons, Berkeley workgroup on Learning, Information Theory, & Nonequilbrium Thermodynamics, Redwood Center, University of California, Berkeley, CA, December 11, 2015 (Abstract available at http://csc.ucdavis.edu/~chaos/share/infoeng/InfoEng/Info_Ratchets.html)

Maxwellian Demons: The Role of Deterministic Chaos in Physical Information Processing, Pomona College Physics Department Colloquium 2015, Claremont, CA, October 29, 2015

Information engines: history and future prospects, Conference on Complex Systems '15 Satellite Session: The Industrial Age and Thermodynamics; the Information Age and … What?, Tempe, AZ, September 30, 2015 (Abstract available at http://csc.ucdavis.edu/~chaos/share/SatSessCCS15WhatInfoAgeTalkAbstracts.pdf)

Exact Information Thermodynamics of an Autonomous Maxwellian Ratchet, Thermodynamics and Nonlinear Dynamics in the Information Age Workshop, Telluride Science Research Center, Telluride, CO, July 13, 2015 (Abstract and meeting schedule available at https://www.telluridescience.org/reg/workshop_files/548/program_final.pdf)

Beyond Landauer, MURI Review Meetings, Santa Fe Institute, Santa Fe, NM, June 24, 2015 (Meeting schedule available at http://csc.ucdavis.edu/~chaos/share/MURIReview2015SFI.pdf)

Information Engines, MURIs Mini-Summit, Kavli Nanoscience Institute, Caltech, Pasadena, CA, October 9, 2014 (Meeting schedule available at http://csc.ucdavis.edu/~chaos/share/NEMSInfoEngNetOctober2014Schedule.pdf)

Demon Design: Circumventing Landauer's Limit, 2014 SIAM Annual Meeting, The Palmer House, Chicago, IL, July 7, 2014. (Abstract available at http://www.siam.org/meetings/an14/an14_abstractbook.pdf)

Contributed Talks:

Leveraging Environmental Correlations: The Thermodynamics of Requisite Variety, Cancun International Conference Center, Boulevard Kukulcan KM. 9 1 er Piso, Zona Hotelera, 77500 Cancun, Q. Roo, Mexico, September 18 and 20, 2017 (Abstract and meeting schedule available at http://easychair.org/smart-program/CCS'17/index.html)

Leveraging Environmental Correlations: The Thermodynamics of Requisite Variety, Dynamics Days 2017, Sheraton Silver Spring Hotel, 8777 Georgia Avenue, Silver Spring, MD, January 5, 2017 (Abstract and meeting schedule available at https://ireap.umd.edu/sites/default/files/documents/DDays2017/DDays2017_schedule_FINAL.pdf)

Maxwell's Demon Dynamics: Deterministic Chaos, the Szilard Map, and the Intelligence of Thermodynamic Systems, 2016 Annual Meeting of the Far West Section of the APS, University of California, Davis, CA, October 29, 2016 (Abstract and meeting schedule available at http://meetings.aps.org/Meeting/FWS16/Session/S4)

Demon Dynamics: Deterministic Chaos, the Szilard Map, and the Intelligence of Thermodynamic Systems, 2015 Annual Meeting of the Far West Section of the APS, California State University, Long Beach, CA, October 31, 2015 (Abstract and meeting schedule available at http://meetings.aps.org/Meeting/FWS15/Session/S2)

Limits on anomalous short-range spin-dependent interactions from spin-exchange collisions, 2010 annual meeting of the American Physical Society Division of Atomic Nuclear and Optical Physics, Hyatt Regency Hotel Houston, Houston, TX, May 27, 2010. (Abstract available at http://meetings.aps.org/Meeting/DAMOP10/sessionindex2/?SessionEventID=127237)

Posters:

Maxwellian demon dynamics: Deterministic chaos in physical information processing, Berkeley Mini Statistical Mechanics Meeting Poster Session I, University of California, Berkeley CA, January 8, 2016 (Poster list available at http://gold.cchem.berkeley.edu/statmech/poster_sessions_i_ii.pdf)

Demon Design: Circumventing Landauer's Limit, Dynamics Days 2014, Clough Undergraduate Learning Commons, Georgia Tech, Atlanta GA, January 3, 2014. (Abstract available at http://www.ddays2014.gatech.edu/booklet.pdf)