

EVE ARMSTRONG

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Department of Physics, New York Institute of Technology
Department of Astrophysics, American Museum of Natural History

CURRENT APPOINTMENTS

Assistant Professor: Department of Physics, New York Institute of Technology (Sep 2019 –)
Research Associate: Department of Astrophysics, American Museum of Natural History (Sep 2019 –)

EDUCATION and POSTDOCTORAL APPOINTMENTS

Postdoctoral fellow (Nov 2017 – Aug 2019) **Computational Neuroscience Initiative
U. of Pennsylvania (UPenn)**
Mentors: Vijay Balasubramanian, Department of Physics and Astronomy; Marc Schmidt,
Department of Biology

Postdoctoral scholar (Sep 2014 – Oct 2017) **BioCircuits Inst., U. of CA, San Diego (UCSD)**
Mentor: Henry Abarbanel, Physics Department and Scripps Institution of Oceanography

Ph.D. Physics (2013) **UCSD**
Dissertation: “Probing the Nature of Cataclysmic Variables via Photometric Studies on
Multiple Timescales”
Advisors: Richard Rothschild, Center for Astrophysics and Space Sciences, UCSD;
Joseph Patterson, Department of Astronomy, Columbia University

B.A. Astrophysics (2002) **Columbia College; Columbia U.**
Mentor: David Helfand, Department of Astrophysics

RESEARCH INTERESTS

Scientific contexts:

- neutrino astrophysics, biological neuronal networks, and epidemiology
- information content of communication signals
- information flow in nonlinear systems

Approaches:

- inference methods for state and parameter estimation in nonlinear models
 - dynamical systems modeling
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CURRENT RESEARCH FOCUS

Inference frameworks to predict neutrino flavor evolution following supernova core collapse

Use inference to predict neutrino flavor evolution following cosmological events. Inference is a powerful means to augment and complement existing tools in the field of neutrino physics.

Collaborators: George Fuller (UCSD), Amol Patwardhan (Institute for Nuclear Theory, U. Washington), Eermal Rrapaj (UC Berkeley), Baha Balantekin (U. of WI, Madison), Mark Paris (Los Alamos National

Labs), Shashank Shalgar (U. of Copenhagen, Denmark), Paul Rozdeba (U. of Potsdam, Germany), Sina Fallah Ardizi (NYIT).

Inference for completing unknowns in a population model tailored to COVID-19

Identify the degree of uncertainty permitted in the measured populations of infected individuals, to estimate unknown parameters in an epidemiological model tailored to minimize strain on hospital capacity.

Collaborators: Jaline Gerardin and Manuela Runge (Department of Preventive Medicine, Northwestern University).

Inference for the classification of binary systems in large astrophysical data sets

Train a classifier to operate on data sets of time series photometry containing 10^9 objects, for the purposes of informing theory on the evolutionary history of galaxies.

Collaborators: Michael Shara (AMNH), Jax Apollon (NYIT).

OTHER ONGOING AND FUTURE PROJECTS

Inference for retrieval of exo-planet atmospheres

Estimate parameters governing the atmospheric chemical composition of exo-planets, using as Measurements directly-imaged emission spectra. Compare the advantages – including computational efficiency and degeneracy breaking – of Monte Carlo versus optimal estimation, for tackling this problem.

Collaborators: Jacqueline Faherty (AMNH), Emily Rice (AMNH), Kelle Cruz (AMNH).

A mechanistic learning model of the zebra finch song system, with capacity for “un-learning”

Expand upon current models of the avian neural song system to explain recent observations that juvenile males, when challenged to learn a new song midway through their development, will employ a range of alternate strategies in response to that challenge. This project expands upon work in my previous postdoctoral position (at UCSD), on creating a dynamical model of zebra finch song-related nucleus HVC.

Collaborators: Ofer Tchernichovski (Hunter College, CUNY), Julia Hyland Bruno (Columbia U.), Tiberiu Tesileanu (Flatiron Institute).

PAST POSITIONS and PROJECTS

Postdoctoral fellow (Nov 2017 – Aug 2019) **Computational Neuroscience Initiative, U. of PA**

Developed a dynamical systems method to analyze the acoustic structure of songs of the male cowbird, using time-delay embedding. Combining this method with an optimization procedure, generated synthetic songs for playback to female cowbirds, to assess song potency.

Postdoctoral scholar (Sep 2014 – Oct 2017) **BioCircuits Inst., UCSD**

Created a functional dynamical model of the avian neuronal circuit associated with song generation. Use optimization to estimate parameters governing the dynamics, using whole-cell recordings of HVC neurons obtained by collaborators at the University of Chicago.

Volunteer researcher (2013 – 2014) **Weill Cornell Medical Center / NY Presbyterian Hospital**

Principal Investigator: Kevin Brown, M.D., Ph.D.; Department of Otolaryngology

Co-investigator: Kaleb Yohay, M.D.; Neurofibromatosis II (NF II) Clinic

Retrospective study of Neurofibromatosis II (NF II) patients to identify predictors of vestibular

schwannoma (VS) progression, for clinical use. (NFII is a degenerative disease of high morbidity, characterized by the growth of multiple tumors, particularly VS).

Graduate researcher (2011-2013) **UCSD, Columbia U.**
Thesis: optical time series photometry of double-degenerate binary stars with white dwarf accretors. *Aim:* Understand post-main-sequence evolution and conditions for core electron degeneracy.

Observer (2001-2013) **Columbia U.**
Time series CCD photometry at Kitt Peak National Observatory (KPNO) and the Cerro Tololo Inter-American Observatory, Chile. Training of new students.

SCIENTIFIC TALKS

SIAM Conference on Dynamical Systems (May 2021)
Host of mini-symposium: Inference as a Feedback Loop across Astrophysics, Biology, & Epidemiology
Talk: “Identifying the Measurements Required to Estimate Rates of Covid-19 Transmission, Infection, and Detection, using Variational Data Assimilation”

SIAM Conference on Comp. Sci. & Engineering (Mar 2021)
“Inference Offers a Metric to Constrain Dynamical Models of Neutrino Flavor Transformation”

Mini-Conference on Neutrino Theory (Sep 2020) **Division of Particles & Fields
American Physical Society**
“Inference constrains dynamical models of neutrino flavor transformation”

Institute for Nuclear Theory (June 2020) **U. of Washington**
“Inference offers a metric to constrain dynamical models of neutrino flavor transformation”

Dept of Engineering Sciences & Applied Math (June 2020) **Northwestern U.**
“Identifying the measurements required to estimate rates of COVID-19 transmission, infection, and detection, using variational data assimilation”

CANCELED DUE TO COVID-19: SIAM Conference on the Life Sciences (June 2020)
Host of mini-symposium: Dynamical modeling approaches to the study of birdsong

GothamFest, a conference for astrophysicists in NYC (Sep 2019) **Columbia, NYU, CUNY, AMNH**
“Can a weather-forecasting tool predict neutrino flavor evolution in supernovae?”

SIAM Conference on Dynamical Systems (May 2019) **Snowbird, UT**
Host of mini-symposium: Got rhythm? - a dynamical systems survival guide for biology
“A geometric spatial reconstruction for analyzing the information content of song”

American Physical Society annual meeting (March 2019) **Boston, MA**
“Can vocalizations predict mating pairs in a society of songbirds? A maximum-entropy Ising model approach”

- Int'l Symposium on Data Assimilation** (Jan 2019) **RIKEN Center for Computational Science**
Kobe, Japan
“From synaptic connections among neurons to energy-changing collisions among neutrinos: using inference to map information flow”.
- The Physics of Behavior workshop** (May – Jun 2018) **Aspen Center for Physics; Aspen, CO**
“Using nonlinear dynamics to unfold the geometry of birdsong”
- Nuclear Physics and Cosmology Workshop** (July 2018) **Los Alamos National Laboratories**
“Optimization predicts neutrino flavor evolution following SNe core collapse”
- Dept. of Physics** (Jun 2019) **U. of WI, Madison**
“Optimization predicts neutrino flavor evolution following SNe core collapse”
- Neutrinos, Nuclear Astrophysics, and Symmetries Conference** (Jan 2018) **UCSD**
“An optimization approach to inferring neutrino astrophysics”
- Dept. of Mathematical Biology** (Dec 2017) **New Jersey Inst. of Technology**
“Crafting functional architectures for pattern-generating networks”
- SIAM annual meeting** (July 2017) **Pittsburgh, PA**
“Data assimilation for the testing of stochastic models in mathematical biology”
- SIAM Conference on Dynamical Systems** (May 2017) **Snowbird, UT**
“A path-integral approach to data assimilation for mapping small neuronal networks”
- MURI Winter School** (Jan 2017) **BioCircuits Institute, UCSD**
“Building models of small neuronal networks and model-testing via data assimilation”
- Dynamical systems and Data Analysis in Neuroscience Workshop** (Oct 2016) **Mathematical Biosciences Inst. Ohio State U.**
Poster: “Model of the avian nucleus HVC as a network of central pattern generators”
- SIAM Conference on the Life Sciences** (July 2016) **Boston, MA**
Host of mini-symposium: Experiment and theory combined: an ideal vantage point upon neurodynamics
“Model of the songbird nucleus HVC as a network of central pattern generators”
- Dynamics Days U.S.** (Jan 2016) **Durham, NC**
“From the nonlinear behavior of a single neuron to the robust pattern of a network”
- Janelia Theoretical Neuroscience Workshop** (Nov 2015) **Janelia Research Campus Howard Hughes Medical Institute; Ashburn, VA**
“Methods of statistical nonlinear data assimilation, and what they can reveal about connectivity in small neural networks”
- Dynamics Days Europe** (Sep 2015) **Centre for Systems, Dynamics, and Control U. of Exeter, UK**
“From the nonlinear behavior of a single neuron to the robust pattern of a network”

SPOOF/HUMOROUS SCIENTIFIC TALKS

Dept. of Physics & Astronomy (May 2021)

U. of British Columbia

“Optimization predicts neutrino flavor evolution, a junior prom date, and how to escape from an awkward party”

OUTREACH and SERVICE

Public talk (Feb 2021)

River Arts Salon; Chestertown, MD

“Pattern formation across neuroscience and astrophysics”

Public talk (Dec 2020)

American Museum of Natural History, NY

“Creative patterns in nature”

Reviewer (Fall 2019 –)

Bellevue Literary Review

Review nonfiction articles submitted for publication in the Bellevue Literary Review, a journal of fiction, nonfiction, and poetry about health, illness, and healing.

Volunteer (March 2014)

Weill Cornell Medical Center neurotrauma course: Tanzania, Africa

Accompanied a neuro-trauma team to host a course at the Muhimbili Orthopedic and Neurological Institute in Dar Es Salaam, Tanzania, on modern methods of neurological surgery. Recorded surgeries; wrote report for distribution to affiliates and donors.

Volunteer (2009-2014)

Weill Cornell Medical Center: Department of Neurological Surgery, NY

Accompanied neurological patients to surgery, with follow-up visits in recovery. Served as liaison between nursing staff and families. Shadowed a neurosurgery physician’s assistant.

Volunteer (2004-6; 2011-13)

Center for Astrophysics and Space Sciences, UCSD

Co-hosted free outreach events throughout San Diego. Mentored students visiting from schools with little access to extracurricular activities and quality science programs.

Co-founder, co-artistic director (2007-2011)

Reality Aside Theatre, Inc., NY

Produced dark comedic and interactive theatre in Midtown Manhattan, including the science-themed sketch comedy show “Spin-1/2”.

Guest lecturer (2007-8)

American Museum of Natural History: Haydn Planetarium, NY

Volunteer (June 2002)

African Israelites Community Orphanage: Ghana, West Africa

Taught English and math; helped orphanage founders plan a viable future for their organization.

NEWS & MEDIA

@RetractionWatch. “My cat Chester’s dynamical systems analysyyy7777777777777777y7is of the laser pointer and the red dot on the wall: correlation, causation, or SARS-Cov-2 hallucination? ...

<https://arxiv.org/abs/2103.17058>.” Twitter, Apr 1, 2021.

<https://twitter.com/retractionwatch/status/1379086695551864832?lang=en>

SIAM News Blog. “Empirical model aims to predict female cowbird responses to mating calls.” Sorg, Lina. May 20, 2019. <https://sinews.siam.org/Details-Page/empirical-model-aims-to-predict-female-cowbird-responses-to-mating-calls>

Retraction Watch. “Clue fans, here’s scientific proof that it was Colonel Mustard with the Candlestick.” Oransky, Ivan. Apr 1, 2018. <https://retractionwatch.com/2018/04/01/clue-fans-heres-scientific-proof-that-it-was-colonel-mustard-with-a-candlestick/>

Retraction Watch. “A scientist models a potential prom date.” Oransky, Ivan. Apr 1, 2017. <https://retractionwatch.com/2017/04/01/publications-questionable-scientific-value-scientist-models-potential-prom-date/>

Vice. “This is the only good April Fool’s joke so everybody else can shut up.” Pearson, Jordan. Apr 1, 2017. https://www.vice.com/en_us/article/yp9kyx/this-is-the-only-good-april-fools-joke-so-everybody-else-can-shut-up

The New Stack. “Wistful researcher applies a neural network to questions about her 1997 junior prom.” Cassel, David. Apr 9, 2017. <https://thenewstack.io/wistful-researcher-applies-neural-network-questions-1997-junior-prom/>

TEACHING

Assistant Professor for physics courses (2019 - present)

NYIT

Adjunct Professor: physics (2010-13)

Cooper Union for the Advancement of Science and Art, NY

Adjunct Professor: astronomy (2011)

Lehman College, City University of NY

Adjunct Instructor: astronomy (2009)

College of Staten Island, City University of NY

MEMBERSHIPS

American Physical Society – APS (2016 – present)

Society for Industrial and Applied Mathematics – SIAM (2016 – present)

National Association of Science Writers (2003 – present)

PUBLICATIONS

Articles in preparation

1. **Armstrong, E.**, Shalgar, Shashank. Defining a ‘steady state’ in hydrodynamic simulations of neutrino flavor conversion.
2. **Armstrong, E.**, Zeng, A., Perkes, A., Andersen, L., Balasubramanian, V., Schmidt, M. An attractor representation of birdsong, together with inference, predicts song preferences in female cowbirds.
3. Hyland Bruno, J., Tchernichovski, O., **Armstrong, E.**, Tesileanu, T. Songbirds learn vocal sequences within a rhythmic framework.

Articles published

1. Rrapaj, E., Patwardhan, A., **Armstrong, E.**, Fuller, G. Inference of neutrino flavor evolution through data assimilation and neural differential equations. *Physical Review D* 103.4 (2021): 043006
2. **Armstrong, E.**, Runge, M., Gerardin, J. Identifying the measurements required to estimate rates of COVID-19 transmission, infection, and detection, using variational data assimilation.

Infectious Disease Modelling 6 (2021): 133-147.

3. **Armstrong, E.**, Patwardhan, A., Rrapaj, E., Fallah Ardizi, S., Fuller, G.M. Inference offers a metric to constrain dynamical models of neutrino flavor transformation. *Physical Review D* 102.4 (2020): 043013
4. **Armstrong, E.** Statistical data assimilation for estimating electrophysiology simultaneously with connectivity within a biological neuronal network. *Physical Review E* 101, 012415, 2020
5. **Armstrong, E.**, Patwardhan, A.V., Johns, L., Kishimoto, C.T., Abarbanel, H.D.I., Fuller, G.M. A Path-integral-based Approach to Neutrino Flavor Evolution. *Physical Review D* 96(8): 083008, 2017
6. Abarbanel, H.D.I., Shirman, S., Breen, D., Kadakia, N., Rey, D., **Armstrong, E.**, Margoliash, D. A Unifying View of Synchronization for Data Assimilation in Complex Nonlinear Networks. *Chaos: An Interdisciplinary Journal of Nonlinear Science*, 27(12): 126802, 2017
7. **Armstrong, E.**, Abarbanel, H.D.I. Model of the songbird nucleus HVC as a network of central pattern generators, *J. Neurophysiol.* 116(5): 2405-2419, 2016
8. Kadakia, N., **Armstrong, E.**, Breen, D., Morone, U., Daou, A., Margoliash, D., Abarbanel, H. D.I., Nonlinear Statistical Data Assimilation for HVC_{RA} Neurons in the Avian Song System. *Biological Cybernetics* 110.6:417-434, 2016
9. Breen, D., Shirman, S., **Armstrong, E.**, Daou, A., Margoliash, D., Abarbanel, H.D.I. HVC Interneuron Properties from Statistical Data Assimilation. *arXiv preprint arXiv: 1608:04433*, 2016
10. **Armstrong, E.**, Patterson, J., Michelsen, E., Thorstensen, J., Uthas, H., Vanmunster, T., Hamsch, F.-J., Roberts, G., Dvorak, S., Orbital, Superhump, and Superorbital Periods in the Cataclysmic Variables AQ Mensae and IM Eridani. *Monthly Notices of the Royal Astronomical Society (MNRAS)* 435, 707, 2013
11. **Armstrong, E.**, Patterson, J., Kemp, J. Two Photometric Periods in the AM CVn System CP Eridani. *MNRAS* 421, 2310, 2012
12. Skinner, J., Thorstensen, J., **Armstrong, E.**, Brady, S. The New Eclipsing Cataclysmic Variable SDSS 154453+255. *Publications of the Astron. Soc. of the Pacific (PASP)* 123, 901, 2011
13. Copperwheat, C.M., Marsh, T., Dhillon, V., Littlefair, S., Woudt, A., Warner, B., Patterson, J., Steeghs, D., Kemp, J., **Armstrong, E.**, Rea, R. The Photometric Period in ES Ceti. *MNRAS* 413, 3068, 2011
14. Dai, X, Halpern, J., Morgan, N., **Armstrong, E.**, Mirabal, N., Haislip, J., Reichart, D., Stanek, K., Optical and X-Ray Observations of GRB 060526: A Complex Afterglow Consistent with an Achromatic Jet Break. *Astrophysical Journal (Ap J)* 658, 509, 2007
15. **Armstrong, E.** et. al. GRB 060102: MDM Observation, *GRB Coordinates Network, Circular Service* 4427, 1, 2006
16. Thorstensen, J., **Armstrong, E.** Is FIRST J102347.6+003841 Really a Cataclysmic Binary? *Astronomical Journal (AJ)* 130, 759, 2005
17. Patterson, J., Thorstensen, J., **Armstrong, E.** The Dwarf Nova PQ Andromedae. *PASP* 117, 922, 2005
18. Patterson, J. **and 19 co-authors**, Superhumps in Cataclysmic Binaries. XXV. q_{crit} , $\epsilon(q)$, and Mass-Radius. *PASP* 117, 1204, 2005
19. Patterson, J., Thorstensen, J., Vanmunster, T., Fried, R., Martin, B., Campbell, T., Robertson, J., Kemp, J., Messier, D., **Armstrong, E.**, Rapid Oscillations in Cataclysmic Variables. XVI. DW Cancri. *PASP* 116, 516, 2004
20. Pretorius, M.L. Woudt, P., Warner, B., Bolt, G., Patterson, J., **Armstrong, E.**, High-speed photometry of SDSS J013701.06 - 091234.9. *MNRAS* 352, 1056, 2004
21. Mirabal, N. Halpern, J., Chornock, R., Filippenko, A., Terndrup, D., **Armstrong, E.**, Kemp, J., Thorstensen, J., Tavarez, M., Espaillat, C., GRB 021004: A Possible Shell Nebula around a Wolf-Rayet Star Gamma-Ray Burst Progenitor. *Ap J* 595, 935, 2003

Articles using humor to teach science

1. **Armstrong, E.** My cat Chester’s dynamical systems analysyyyyy7777777777777777y7is of the laser pointer and the red dot on the wall: correlation, causation, or SARS-Cov-2 hallucination?” *arXiv preprint arxiv: 2103.17058* (Apr 1, 2021)
2. **Armstrong, E.** An Artificially-intelligent Means to Escape Discreetly from the Departmental Holiday Party; guide for the socially-awkward. *arXiv preprint arxiv: 2003.14169* (2020).
3. **Armstrong, E.** Forecasting Future Murders of Mr. Boddy by Numerical Weather Prediction. *arXiv preprint arxiv: 1903.12604* (Apr 1, 2019)
4. **Armstrong, E.** Colonel Mustard in the Aviary with the Candlestick: a limit cycle attractor transitions to a stable focus via supercritical Andronov-Hopf bifurcation. *arXiv preprint arxiv: 1803.11559* (Apr 1, 2018)
5. **Armstrong, E.** A Neural Networks Approach to Predicting How Things Might Have Turned Out Had I Mustered the Nerve to Ask Barry Cottonfield to the Junior Prom Back in 1997. *arXiv preprint arxiv:1703:10449* (Apr 1, 2017)
6. **Armstrong, E.** Pipe-cleaner Model of Neuronal Network Dynamics. *arXiv preprint arxiv:1603:09723* (Apr 1, 2016)
7. **Armstrong, E.** Non-detection of the Tooth Fairy at Optical Wavelengths. *arXiv preprint arxiv:1204.0492* (Apr 1, 2012); *Journal of Irreproducible Results* 52, 3: 22-25, 2014

Educational material

1. Developed a textbook for Columbia College course “Frontiers of Science” (2004), which is a core requirement for undergraduates (as of 2005). Helfand, David. *A survival guide to the misinformation age: Scientific habits of mind*. Columbia University Press, 2016
2. Developed an educational science-themed sketch comedy group “Spin ½”, a project by Reality Aside Theatre, Inc. Performed in Manhattan and surrounding areas for general and student audiences (2009-2011).

REFERENCES

Roger Yu

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