Mariel Pettee

Physicist, AI researcher, and artist
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Education

2021 — Yale University, New Haven, CT — PhD in Physics

2015 — University of Cambridge, Trinity College, Cambridge, UK — MASt in Physics
Lt. Charles H. Fiske III Harvard-Cambridge Scholar
Commendable Performance

2014 — Harvard University, Cambridge, MA — AB in Physics & Mathematics
Cum Laude, High Honors in Field
Secondary in Dramatic Arts

Research Experience

2022 - Now — Guest Researcher • *Flatiron Institute & Polymathic AI*

As a founding member of the Polymathic AI collaboration, I am working to build the first foundation models for science. My focus areas include numerical embeddings in language models, understanding interdisciplinary domain transfer, and interpretability.
Supervisor: Prof. Shirley Ho

2021 - Now — Chamberlain Postdoctoral Fellow • *Lawrence Berkeley National Lab*

My postdoctoral work is grounded in radical applications of AI for fundamental physics. Highlights include the first unbinned measurement at the LHC, finding stellar streams in the Milky Way with weakly-supervised anomaly detection, improving pion reconstruction with GNNs, and exploring best practices for learning likelihood ratios.
Supervisor: Dr. Benjamin Nachman

2020 — AI Intern • *Intel AI Lab*

As a summer intern with the AI Lab at Intel, I developed a recurrent VAE architecture to learn latent graph representations of the human body in motion.
Supervisor: Dr. Hanlin Tang

2016 - 2021 — Graduate Researcher • *Yale University & the ATLAS Experiment at CERN*

The highlight of my PhD thesis was finding the first evidence of a Higgs boson produced in association with a leptonically-decaying W or Z boson and decaying into a pair of tau leptons. I also implemented RNN-based tau triggers in ATLAS and performed trigger and data acquisition optimization studies at the Mu2e Experiment at Fermilab.
Supervisor: Prof. Sarah Demers

2014 - 2015 — Graduate Researcher • *University of Cambridge*

While pursuing my Master's degree at the University of Cambridge, I constructed and tested nanoscale battery prototypes made of DNA-functionalized gold nanocolloids.
Supervisor: Prof. Erika Eiser

Selected Publications

Full list of papers with the ATLAS Collaboration. (**Note:** ▷ *indicates alphabetical author ordering.*)

2024 ATLAS Collaboration (**Contact Editor**). A Simultaneous Unbinned Differential Cross Section Measurement of 24 Z+jets Kinematic Observables with the ATLAS Detector. *Phys. Rev. L.* [CERN-EP-2024-132] [arXiv:2405.20041] [hep-ex].

ATLAS Collaboration (**Contact Editor**). Evidence of the VH, H⟶ττ process with the ATLAS detector in Run 2. *Phys. Rev. B.* [CERN-EP-2023-272] [arXiv:2312.02394] [hep-ex].

2023 S. Golkar, **M. Pettee**, M. Eickenberg, A. Bietti, M. Cranmer, G. Krawezik, F. Lanusse, M. McCabe, R. Ohana, L. Parker, B. Régalo-Saint Blancard, T. Tesileanu, K. Cho, S. Ho. xVal: A Continuous Number Encoding for Large Language Models. *NeurIPS AI for Science Workshop.* [arXiv:2310.02989] [stat.ML].

M. Pettee, S. Thanvantri, B. Nachman, D. Shih, M. R. Buckley, J. H. Collins. Weakly-Supervised Anomaly Detection in the Milky Way. *MNRAS.* [arXiv:2305.03761] [astro-ph.GA].

S. Rizvi, **M. Pettee**, B. Nachman. Learning Likelihood Ratios with Neural Network Classifiers. *JHEP.* [arXiv:2305.10500] [hep-ph].

V. Mikuni, **M. Pettee**, B. Nachman. Fast Point Cloud Generation with Diffusion Models in High Energy Physics. *Phys. Rev. D.* [arXiv:2304.01266] [hep-ph].

▷ A. Huang, X. Ju, J. Lyons, D. Murnane, **M. Pettee**, L. Reed. Heterogeneous Graph Neural Network for Identifying Hadronically Decayed Tau Leptons at the High Luminosity LHC. *JINST.* [arXiv:2301.00501] [physics.ins-det].

2022 ▷ A. Bogatskiy, S. Ganguly, T. Kipf, R. Kondor, D. W. Miller, D. Murnane, J. T. Offermann, **M. Pettee (co-editor)**, P. Shanahan, C. Shimmin, and S. Thais. Symmetry Group Equivariant Architectures for Physics. *Snowmass 2021 White Paper.* [arXiv:2203.06153] [cs.LG].

ATLAS Collaboration (**co-editor**). Point Cloud Deep Learning Methods for Pion Reconstruction in the ATLAS Experiment. [ATL-PHYS-PUB-2022-040].

M. Papillon, **M. Pettee**, N. Miolane. PirouNet: Creating Dance through Artist-Centric Deep Learning. *EAI ArtsIT 2022 (Best Paper Award).* [arXiv:2207.12126] [cs.LG].

M. Papillon, **M. Pettee**, N. Miolane. Intentional Choreography with Semi-Supervised Recurrent VAEs. *NeurIPS 2022 Workshop on ML for Creativity and Design.* [arXiv:2209.10010] [cs.LG].

▷ G. Kasieczka, R. Mastandrea, V. Mikuni, B. Nachman, **M. Pettee**, D. Shih. Anomaly Detection Under Coordinate Transformations. [arXiv:2209.06225] [hep-ph].

2021 **M. Pettee**. Interdisciplinary Machine Learning for Particle Physics. *PhD Thesis, Yale University.*

2020 **M. Pettee**, S. Miret, S. Majumdar, and M. Nassar. Choreo-Graph: Learning Latent Graph Representations of the Dancing Body. *NeurIPS 2020 Workshop on ML for Creativity and Design.*

2019 **M. Pettee**, C. Shimmin, D. Duhaime, and I. Vidrin. Beyond Imitation: Generative and Variational Choreography via Machine Learning. *Proceedings of the 10th International Conference on Computational Creativity.* [arXiv:1907.05297] [cs.LG].

The ATLAS Collaboration (**co-editor**). Expected Performance of the ATLAS Detector at the High-Luminosity LHC. [ATL-PHYS-PUB-2019-005].

Invited Talks

Invisible Cities: Towards a multi-modal era of fundamental physics research

2024	LBNL, *Berkeley, CA*	Berkeley Lab AI for Science Summit
	CERN, *Geneva, Switzerland*	Foundation Models for Science Mini-Workshop
	Argonne National Laboratory	HEP Theory Seminar

A Simultaneous Unbinned Differential Cross-Section Measurement of 24 Z+jets Observables

2024	*Ljubljana, Slovenia*	ATLAS Standard Model Workshop

Towards Foundation Models for Fundamental Physics

2024	NASA, *Huntsville, AL*	Science Mission Directorate AI Workshop
	DESY, *Hamburg, Germany*	1st Large Language Models in Physics Symposium
	LBNL, *Berkeley, CA*	Physics Division Research Progress Meeting
	U. of Tokyo, *Tokyo, Japan*	AI-Driven Discovery in Physics & Astrophysics
	KEK, *Tsukuba, Japan*	ML for HEP Workshop

What Do Language Models Have to Say About Fundamental Physics?

2024	MIT, *Cambridge, MA*	IAIFI Summer Workshop
	UC Berkeley, *Berkeley, CA*	Bakar Inst. of Digital Materials for the Planet Seminar
	SLAC, *Menlo Park, CA*	SLAC AI Seminar
2023	IBM, *Zurich, Switzerland*	IBM Research Seminar

Dancing With Myself: AI and Choreography

2024	Pratt Institute, *Brooklyn, NY*	AI in the Humanities Symposium
	Foothill College, *Los Altos Hills, CA*	Creativity in the Age of AI Symposium
2023	Mills College, *Oakland, CA*	DanceHack Workshop
2022	U. of Alabama, *Tuscaloosa, AL*	Theatre & Dance Department Colloquium
	Amherst College, *Amherst, MA*	AI in the Liberal Arts Seminar
	Ballet Des Moines, *Des Moines, IA*	Panel Discussion: Creativity, Science, and Ethics
	Kinetech Arts, *San Francisco, CA*	Y-Exchange Featured Artist
2020	Kinetech Arts, *San Francisco, CA*	Kinetech Open Lab Talk
	Brown U., *Providence, RI*	Conference for Research on Choreographic Interfaces

Interdisciplinary AI for Fundamental Physics

2023	*Ascona, Switzerland*	Hammers & Nails (Swiss Edition)
	Flatiron CCA, *New York, NY*	KITP Workshop on Data-Driven Galaxy Evolution
2022	Univ. of Alabama, *Tuscaloosa, AL*	Physics Department Colloquium
	SLAC, *Menlo Park, CA*	SLAC AI Seminar
	UC Irvine, *Irvine, CA*	Physics & Astronomy Machine Learning Seminar Series
	Imperial College, *London, UK*	Data Learning Working Group Seminar
	Amherst College, *Amherst, MA*	Artificial Intelligence in the Liberal Arts Seminar Series
	Cornell U., *Ithaca, NY*	Laboratory for Elementary Particle Physics Journal Club
2021	UC Berkeley, *Berkeley, CA*	Berkeley Institute for Data Science ML + Science Forum
	Seattle U., *Seattle, WA*	Physics Department Colloquium
	U. of Tennessee, *Knoxville, TN*	HEP Seminar
	Flatiron Institute, *New York, NY*	Center for Computational Astrophysics ML Forum

Weakly-Supervised Anomaly Detection in the Milky Way

2023	UChicago, *Chicago, IL*	Data Science Institute & James Franck Institute Seminar
	Rutgers U., *New Brunswick, NJ*	High-Energy Physics Theory Seminar

Equivariance Meets Invariance: Physics-Informed Machine Learning

2023	*Minneapolis, MN*	American Physical Society (APS) April Meeting

Contributed Talks

A Simultaneous Unbinned Differential Cross-Section Measurement of 24 Z+jets Observables

2024	Sorbonne Université, *Paris, France*	France-Berkeley PHYSTAT Conference on Unfolding

Using Classifiers for Unbinned Unfolding

2024	Sorbonne Université, *Paris, France*	France-Berkeley PHYSTAT Conference on Unfolding

Weakly-Supervised Anomaly Detection in the Milky Way

2023	Flatiron Institute, *New York, NY*	Flatiron-Wide Machine Learning Meeting

Point Cloud Methods for Pion Reconstruction in the ATLAS Detector

2022	CERN, *Geneva, Switzerland*	Inter-experiment Machine Learning Workshop
	New York, NY	APS April Meeting

Dancing with Myself: AI and Choreography

2021	*St. Louis, MO*	Strange Loop Conference

Choreo-Graph: Learning Latent Graph Representations of the Dancing Body

2020	NeurIPS, *Vancouver, Canada*	Workshop on ML for Creativity and Design

Run 3 Triggers for HLeptons Analyses

2020	*Online*	ATLAS Tau & HLeptons Workshop

Expected ATLAS Performance at the HL-LHC

2019	UMass Amherst, *Amherst, MA*	US ATLAS Workshop

Overview of Tau vs. Jet Identification

2019	*Prague, Czech Republic*	ATLAS Tau & HLeptons Workshop

Beyond Imitation: Generative Choreography via Machine Learning

2019	UNC Charlotte, *Charlotte, NC*	International Conference on Computational Creativity

RNN Tau Identification in the ATLAS HLT

2018	Fermilab, *Batavia, IL*	US LHC Users Association Meeting
	CERN, *Geneva, Switzerland*	ATLAS Machine Learning Workshop

The 2018 ATLAS Tau Trigger & Combined Performance

2018	U. of Pittsburgh, *Pittsburgh, PA*	US ATLAS Workshop

ATLAS Tau Trigger & Combined Performance at High μ

2018 CERN, *Geneva, Switzerland* ATLAS P&P Physics Plenary

FTK & the Tau Trigger

2018 CERN, *Geneva, Switzerland* ATLAS TDAQ Week

Awards

2023 DOE Mission Science Allocation Award *NERSC*
- "Multidisciplinary AI Models for Science"

2021 Owen Chamberlain Postdoctoral Fellowship *Lawrence Berkeley National Lab*

2018 Lightning Round Talk Winner *US LHC Users Association*

Women's Faculty Forum Seed Grant *Yale University*

2016 Winner, Windy City Physics Slam *ICHEP*
- PBS Chicago Interview Clip

Distinguished Poster Award (Top 20 out of 500) *ICHEP*

2015 Leigh Page Prize *Yale University*

Honorable Mention *NSF Graduate Research Fellowship*

2014 Harvard-Cambridge Scholarship *Harvard University*
- Full tuition for a master's program at Cambridge

Julia Shaffner Memorial Prize *Harvard University*
- Outstanding woman in science

2013 President's Challenge Finalist *The Harvard Innovation Lab*

15 Most Interesting Seniors *The Harvard Crimson*

2012 Judges' Award for Acting *International Student Drama Festival*

Certificate of Distinction in Teaching *Harvard University*

Caroline Isenberg Fellowship *Harvard University*

Elizabeth Cary Agassiz Fellowship *Harvard University*

2011 Best Lead Actress in a Play *Harvard Theater Award*

Press

2024 Viewing the Standard Model with unprecedented detail through the lens of AI
Berkeley Lab Physical Sciences News

2023 ATLAS measures rare Higgs boson interaction with tau leptons, *ATLAS Briefing*

"Scientists Begin Building AI for Scientific Discovery Using Tech Behind ChatGPT"
- Simons Foundation Press Release
- Berkeley Lab Article

2022 Interviewee on the Cognicast podcast
- A wide-ranging discussion of my research trajectory across AI, physics, and art
- Episode webpage
- Listen on Apple Podcasts

2021 Mariel Pettee successfully defends PhD thesis, *Yale Physics*

2020 Advice to Women in STEM: Mariel Pettee, *Yale Scientific Magazine*

2019 Feature on Yale University's Instagram page

Featured on Women+ Art AI

2016 Scientists Battle for Physics Slam Crown, *PBS Chicago*

2013 15 Most Interesting Seniors: Mariel N. Pettee, *The Harvard Crimson*

Scientific Essays

2024 A high-dimensional jet-powered measurement of the strong force
CERN Experimental Physics Newsletter

2023 LLMs and the Language of Science
APS Topical Group on Data Science Newsletter

xVal: A Continuous Number Encoding for LLMs
Polymathic AI Collaboration Blog Post

2018 Theories of Everything
Sightline Arts

Now or Never: The Case for a Larger Hadron Collider
Yale Distilled Magazine

Teaching Experience

Graduate-level Courses on Scientific Teaching

2016	Physics 530: Theory and Practice of Scientific Teaching for Physical Scientists	*Yale*
2014	Astro 302: Scientists Teaching Science	*Harvard*

Teaching Assistant Experience

Note: ▷ *indicates courses for which I was the sole TA.*

2016 - 2018	▷	Physics 115: The Physics of Dance	*Yale University*
2018	▷	American Studies 349: Technologies for Movement Research	*Yale University*
2017		Physics 171: University Physics for the Life Sciences	*Yale University*
2016		Physics 205L: Modern Physical Measurement	*Yale University*
2015		Physics 165L: General Physics Laboratory	*Yale University*
2012 - 2013	▷	Math 121: Linear Algebra and Applications	*Harvard University*
2013		Math 110: Vector Space Methods for Differential Equations	*Harvard University*

Guest Lectures

2023	The Language of Movement	Amherst College, *Amherst, MA*
2021	Graduate-level Machine Learning for Physics	U. of Alabama, *Tuscaloosa, AL*

Student Mentorship

Fall 2024	Malika Golshan, post-grad in Physics at UC Berkeley *Weakly Supervised vs. Fully Supervised Learning*
Summer 2024	Abhipsha Das, grad student in Computer Science at NYU Courant Institute *Mapping the Landscape of Scientific Literature with LLMs*
Summer 2024	Luis Zerkowski, grad student in Artificial Intelligence at University of Amsterdam *Analyzing Choreographic Duets with Graph-Based Autoencoders*
Summer 2024	Zixuan Wang, grad student in Computer Science at Georgia Institute of Technology *Generating Choreographic Duets with Transformers*
2022 - 2024	Shahzar Rizvi, undergrad & then graduate student in Statistics at UC Berkeley *Learning Likelihood Ratios with Neural Network Classifiers* (published in JHEP) **Next position:** graduate student at MIT
2022 - 2024	Sowmya Thanvantri, undergrad in Physics at UC Berkeley *Weakly-Supervised Anomaly Detection in the Milky Way* (published in MNRAS) **Next position:** graduate student at Princeton
2022	Jason Wong, undergrad in Physics at UC Berkeley *Optimization Studies for the ATLAS OmniFold Measurement* (ATLAS preprint) **Next position:** graduate student at UC Berkeley

Leadership & Service

2024	Google Summer of Code Mentor • Directly supervised two open-source 12-week research projects with students
	Organizer for NeurIPS Physical Sciences Workshop
	Co-Coordinator of Polymathic AI's future research & development cohort
2019 - 2024	Reviewer for NeurIPS Physical Sciences Workshop
2017 - 2021	HLeptons Trigger Liaison: Trigger Studies for the ATLAS $H \to \tau\tau$ Analysis Group
2020	Session Co-Convener, PyHEP 2020 (Conference for Python in High-Energy Physics)
2019	Reviewer for Women in Machine Learning (WiML) Workshop
2014	President, *The Signet Society of Arts & Letters*, Harvard University

Inclusion & Outreach

2022 - 2024	QuarkNet Speaker • Presented a talk on physics, art, and ML to high school students • Answered their questions in a separate hour-long interview
2020	Member of the American Physical Society's Inclusion, Diversity, and Equity Alliance

2019 - 2021 Member of the Yale Physics Climate & Diversity Committee
- Advocated for a department-wide discussion of discrimination in our community
- Contributed to the design of our department's Code of Conduct

2018 - 2020 US LHC Users Association advocacy trip to Capitol Hill
- Met with the offices of around 15 representatives from Congress each year
- Garnered support for high-energy physics research through DOE & NSF

2017 - 2018 Speaker, *Science in the News*, delivering scientific talks to the New Haven public

Girls' Science Investigations at Yale
- Volunteer & "ask-a-scientist" Q&A speaker

2016 Winner, Windy City Physics Slam at ICHEP

Choreographer of *Form Factors*, a dance intervention with physicists at ICHEP

2015 - 2020 Yale Women in Physics Mentor

Posters

2022 Point Cloud Methods for Pion Reconstruction in the ATLAS Detector
Large Hadron Collider Physics Conference, *Online*

2020 Choreo-Graph: Learning Latent Graph Representations of the Dancing Body
Women in Machine Learning (WiML) Workshop at NeurIPS, *Online*

RNN Tau Identification in the ATLAS High-Level Trigger
ATLAS Trigger & Data Acquisition Week at CERN, *Geneva, Switzerland*

2019 Generative & Variational Choreography via Machine Learning
Women in Machine Learning (WiML) Workshop at NeurIPS, *Vancouver, Canada*

Machine Woman: Preservation, Memory, Forgetting, and AI
Women's Faculty Forum, Yale University, *New Haven, CT*

2017 Performance of the ATLAS Tau Trigger in Run 2
Advanced Computing & Analysis Techniques in Physics Research (ACAT), *Seattle, WA*

2016 Trigger Studies for the Mu2e Experiment (**Poster Award**: top 20 out of 500)
International Conference on High Energy Physics (ICHEP), *Chicago, IL*

Arts

AI & Art

2023 *mememormee*: an evening-length work featuring AI-generated choreography set on six dancers, following a residency at Amherst College
- Spotlight Presentation at the 2023 NeurIPS Workshop on ML for Creativity & Design

2021 Untitled Bird Project: a 1 hour pop-up exhibit featuring AI-generated bird calls situated in nature

2020 Mirror Exercise: an AI-generated duet with myself
- Featured in *Le Mérite*, at the Comédie de Caen, Théâtre des Cordes, France.
- Highlighted in the NeurIPS Workshop on ML for Creativity and Design's AI Art Gallery
- Digital exhibition at *Level Up*: The Dramaturgy of Digital Performance & Design
- Selected by the AI Transparency Institute & featured at the 2020 AI Governance Forum
- Boston Cyberarts Gallery exhibition *Perceptions / Distortions* (cancelled due to COVID)

Studio fellow, *Yale Center for Collaborative Arts & Media*
- Year-long paid fellowship to develop work across art & technology

2019 SIGMA: a short film of AI-generated choreography
- Featured in the NeurIPS 2019 Workshop on ML for Creativity & Design's AI Art Gallery

Live Performance

2022 Dancer, *Sublimation*
- By Kinetech Arts
- Supported by the Djerassi Resident Artists Program and Creative Work Fund
- Performed at David Ruth Glass Studio, Oakland, CA

Dancer, *Detour*
- By Kinetech Arts, commissioned by the Berkeley Dance Project
- Performed at Zellerbach Playhouse, Berkeley, CA

2020 Dancer & Coordinator, *Transpositions*
- Dancer in virtual pieces by Brian Seibert, Renee Robinson, and Elm City Dance Collective

Choreographer, *Elon Musk and the plan to Blow Up Mars the musical*
- Yale Cabaret, dir. Liam Bellman-Sharpe

Dancer, Coordinator, & Rehearsal Director, *Yale Dance Lab*
- New work by choreographer Vicky Shick: "*everywhere*"

2019 Bill T. Jones/Arnie Zane Dance Company Intensive, *Yale Dance Theater*
- Dancer in a restaging of *D-Man in the Waters*

Featured performer, *The Hexagonal Hive and a Mouse in a Maze*
- Interviewed for a documentary by the Derek Jarman Lab, directed by Tilda Swinton

2018 Dancer, *Dance Drawings (For Jock)*
- Choreography by Emily Coates located at the Yale Art Gallery's Sol LeWitt exhibit

Paul Taylor Dance Company Intensive, *Yale Dance Theater*
- Leading role as "The Hostess" in the first restaging of Taylor's *Party Mix* in four decades

Featured performer, *Machine Woman*, dir. Anna Hagen & Jeannie Sui Wonders
- A short film documenting my AI-generated choreography research

2017 Choreographer: "La Mort du Chorégraphe", *A Different Drum Dance Company*

Urban Bush Women Intensive, *Yale Dance Theater*

2016 Gaga Intensive with Saar Harari & Lee Sher, *Yale Dance Theater*

Choreographer: "Rang Cherries", *A Different Drum Dance Company*

2015 Actor, *Attempts on Her Life*, dir. Tania Clarke, Corpus Playroom, *University of Cambridge*

Dancer, *Evolution*, ADC Theatre, *University of Cambridge*

2014 Director/Writer/Choreographer: *Symmetry Breaking*, Farkas Hall, *Harvard University*

- My senior physics thesis: an immersive multimedia performance about the Higgs boson

Choreographer-in-Residence, *Harvard Dance Center*

Dancer, *Paper Wing*, chor. Jill Johnson, Farkas Hall

2013 Arts@CERN Internship

Eurydice, *Antigonick*, dir. Ianthe Demos, American Repertory Theater Mainstage

Isabelle & Executive Producer, *The Edge of the Map*, dir. Calla Videt (Sightline Theater Company)

Dancer, *At Last*, Loeb Experimental Theater, Harvard University

Dancer, *On The Run*, Harvard Dance Center

2012 Vice-President & Mainstage Coordinator, *The Harvard-Radcliffe Dramatic Club*

Lucy, *CryHurtFood*, Loeb Experimental Theater & Crucible Mainstage (Sheffield, UK)

Director: *for the purpose of catching ourselves in the act of being the most*

- Set the Guinness World Record for the longest telephone conversation between two people

2011 Co-founder and collaborator, *The Harvard Generalist* artistic collective

Drama & Dance Proctor, *Harvard University Freshman Arts Program* (2011-2014)