

# Abel Lawrence Peirson

Kavli Institute for Particle Astrophysics and Cosmology, Stanford CA 94305

✉ [alpv95@stanford.edu](mailto:alpv95@stanford.edu) [in](https://www.linkedin.com/in/abel-lawrence-peirson-v) [abel-lawrence-peirson-v](https://www.linkedin.com/in/abel-lawrence-peirson-v)  
🌐 [www.alpeirson.com](http://www.alpeirson.com) [github](https://www.github.com/alpv95) [www.github.com/alpv95](https://www.github.com/alpv95)  
🆔 [orcid.org/0000-0001-6292-1911](https://orcid.org/0000-0001-6292-1911)

## Education

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- Stanford University** — *Ph.D in Physics* 2017 - Sep 2023
- Thesis: High Energy Polarization Statistics and Geometry.
  - GPA: 4.0 (in required coursework).
- University of Oxford** — *MPhys in Physics* 2017
- First Class Honours with Distinction – top 10% of graduating class.
  - College: Christ Church

## Fellowships, Honors & Awards

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- Stanford Data Science Scholar (\$100k+)** — Stanford, USA 2021
- Future Investigator in NASA Earth and Space Science and Technology (\$160k+)** — Stanford, USA 2019
- Hooke and Roach prizes for most outstanding member of Christ Church across the sciences** — Oxford, UK 2017
- Oxford International Strategy Scholarship** — Oxford, UK 2016
- Christ Church Academic Scholarship** — Oxford, UK 2014-2017
- Gold, British Physics Olympiad** — London, UK 2013

## Research

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- Google Brain** — Google Research, CA June 2022 - Present  
*with Rohan Anil, Ehsan Amid, and Prof. Manfred K. Warmuth*
- Natural gradient descent inspired second order methods for deep learning.
  - Explored layerwise Bregman exponential families for preconditioning with local Fisher approximations.
- Kavli Institute for Particle Astrophysics and Cosmology** — Stanford University, CA July 2018 - Present  
*with Prof. Roger Romani*
- Set current state of the art in X-ray polarization recovery using Simulation-based inference.
  - Improved NASA IXPE polarization sensitivity by > 30% (code adopted as official data analysis pipeline).
  - Created quadratic program + nested sampling approach to fit gravitational microlenses.
  - Designed testable (and fittable) emission models to explain observed polarization in relativistic plasma jets.
- Wu Tsai Neurosciences Institute** — Stanford University, CA Mar 2018 - Jun 2018  
*with Prof. Shaul Druckmann*
- Developed biologically inspired recurrent neural network to reproduce 2D path integration in the drosophila fly brain.
- NeuroAI Lab** — Stanford University, CA Dec 2017 - Mar 2018  
*with Prof. Dan Yamins*
- Unsupervised learning: found transfer-learning with shear transformations of images does not improve classification accuracies.
- Department of Physics** — University of Oxford, UK Sep 2016 - May 2017  
*with Prof. Garret Cotter*
- Placed limits on whether the Cherenkov Telescope Array will constrain the existence of axion-like particles.
- CLIC Test Facility** — CERN, Switzerland June - Aug 2016  
*with Prof. Philip Burrows*
- Improved CTF3's Quadrupole scan and reduced uncertainty in the beam energy spread.

## Selected Experience

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- Google Research, Brain Team** — Mountain View, CA June - Sep 2022  
*Student Researcher*
- Working with Rohan Anil and Ehsan Amid on practical optimization for deep learning.
- G-Research** — London, UK June - Sep 2021  
*Quantitative Researcher*
- Quantitative research intern working on forecasting capital markets.
- Peirson & Freedman** — Stanford, CA Aug 2018 - Present  
*Co-founder*
- Conceived and designed iOS app *Dank Learning* that uses RNNs to generate memes. [[Webpage](#)]

## Publications

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Refereed: **10 first / second author papers**, 10 collaboration papers (see attached publication list).  
Metrics: **h-index: 7**, **citations: 112**. Journals: ApJ (Letters), Science, Nature, NIMA, Neurips (workshops).

## Outreach and Service

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- Wonderfest** — Bay Area, CA June 2019 - June 2020  
*Science Envoy*
- Selected as one of 10 graduate students from Stanford and Berkeley to communicate science to public audiences.
- Stanford Diversity and First Generation Office** — Stanford, CA Oct 2018 - June 2020  
*First Generation and Low Income Student Mentor*
- Mentoring undergraduates from underprivileged backgrounds in all matters of student life.
- Stanford Astronomical Society** — Stanford, CA Oct 2018 - Oct 2019  
*Organizing Member*
- Organizing and leading stargazing events for local schools and the public.
- Stanford Science Pen Pals** — Stanford, CA Oct 2018 - Oct 2019  
*Pen Pal*
- Corresponding about science with 5th graders from a low-income school in Catalonia.

## Mentoring

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- Jack Dinsmore (graduate)** — Polarization leakage in the IXPE gas pixel detector 2022-Present
- Josephine Wong (graduate)** — Simultaneous polarization fitting of the Crab nebula and pulsar 2021-Present

## Media

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*IXPE: Science so far*, IAUS 375: *The Multimessenger Chakra of Blazar Jets*, 2022  
*Episode 68*, The NVIDIA AI Podcast, 2018 [[Recording](#)]

## Recent & Upcoming Presentations

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### Invited

*IXPE: Science so far*, IAUS 375: *The Multimessenger Chakra of Blazar Jets*, Dec 2022  
*X-ray Polarimetry: A data intensive science*, Stanford Data Science Seminar, 2022  
*Tests of gravitational milli-lensing in the blazar PKS 1413+135*, Max Planck Institute for Radio Astronomy, 2022  
*Optimal Signal Extraction for IXPE and an Application to Blazars*, Naval Research Laboratory Colloquium, 2021  
*Towards Optimal Signal Extraction for IXPE*, Third Science Collaboration Meeting (SCM03), 2021  
*The Polarization Behavior of Synchrotron Self-Compton Emission in Blazars*, Understanding the Multiwavelength Blazar Variability - Workshop, Stanford, 2019

*AI in Design, Used Future: Symposium by Current Obsession*, Pratt Institute NY, 2018

*Episode 68, The NVIDIA AI Podcast*, 2018 [[Recording](#)]

### Contributed

*High-Energy Polarization Properties of Relativistic Jets*, Columbia Theoretical High-Energy Astrophysics Seminar, Nov 2022

*Fishy: Local Fisher Approximation via Shampoo*, Alphabet ML Summit, Nov 2022

*Blazar rotations with IXPE*, KIPAC Tea, Oct 2022

*A Geometric Model for Blazar Rotations*, Meeting of the European Astronomical Society, 2020

## Telescope & Computing Allocations

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**ALMA** — *High-frequency radio observations of IXPE targets*, 7-14 day (Co-I) 2021

**Nordic Optical Telescope** — *Multi-band polarization observations of IXPE targets*, 87ks (Co-I) 2021

**NuStar** — *Multi-Energy X-ray observations of IXPE blazar targets*, 140ks (Co-I) 2021

**Swift** — *Monitoring IXPE blazar targets with Swift*, 240ks (Co-I) 2020

**Google Cloud Platform** — *Parametric Density Estimation with Uncertainty using Deep Ensembles*, \$1000 2020

**XMM-Newton** — *Exploring the Synchro-Compton transition in CGRaBS J0211+1051*, 57ks (Co-I) 2019

## Open Source Software (★500+)

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**MulensModel**: Python package for modelling gravitational microlensing events. [[Code](#)][[Paper](#)][[Webpage](#)]

**SSCpol**: Polarized relativistic jet simulation in C with Python wrapper. [[Code](#)][[Paper](#)]

**Dank Learning**: ‘Show and Tell’ image captioning for meme generation in Tensorflow. [[Code](#)][[Paper](#)][[Webpage](#)]

*Software skills*: Python — C/C++ — PyTorch — JAX — Tensorflow

## Teaching

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**Stanford PHYS113** — *Computational Physics* (Lecturer and Teaching Assistant) Winter 2021

**Stanford PHYS100** — *Introduction to Observational Astrophysics* (Teaching Assistant) Spring 2019

## Graduate Coursework

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- **APPHYS293** (Theoretical Neuroscience)
- **CS379C** (Computational Models of the Neocortex)
- **CS238** (Decision Making Under Uncertainty)
- **STATS207** (Time Series)
- **CS224N** (Natural Language Processing)
- **CS230** (Deep Learning)
- **CME212** (Advanced Software Development)
- **EE364a & b** (Convex Optimization I & II)
- **PHYS266** (Statistical Methods in Physics)
- **AA 214** (Numerical Methods for Compressible Flows)
- **CS361** (Engineering Design Optimization)
- **EE263** (Linear Dynamical Systems)

## First and Co-Authored Publications

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*Fishy: Layerwise Fisher Approximation for Higher-Order Neural Network Optimization*

A.L.Peirson, E.Amid, M.K.Warmuth, R.Anil *Neurips HITY workshop* submitted, 2022

*Testing High-Energy Emission Models for Blazars with X-ray Polarimetry*

A.L.Peirson, I.Liodakis, R.W.Romani *ApJ*, 931, 59, 2022

*A Deep Ensemble Approach to X-ray Polarimetry*

A.L.Peirson, R.W.Romani *Neurips ML4PS workshop*, 2021

*New Tests of Millilensing in the Blazar PKS 1413+135*

A.L.Peirson, I.Liodakis, A.C.S.Readhead et al. *ApJ*, 927, 24, 2022

*Towards Optimal Signal Extraction for Imaging X-ray Polarimetry*

A.L.Peirson, R.W.Romani. *ApJ*, 920, 40, 2021

*Deep Ensemble Analysis for Imaging X-ray Polarimetry*

A.L.Peirson, R.W.Romani, H.L.Marshall, J.F.Steiner, L.Baldini. *NIMA*, 986, 2020

*The Polarization Behavior of Relativistic Synchrotron Self-Compton Jets* [Code]

A.L.Peirson, R.W.Romani. *ApJ*, 885, 1, 2019

*Prospects for Detecting X-ray Polarization in Blazar Jets*

I.Liodakis, A.L.Peirson, R.W.Romani. *ApJ*, 880, 1, 2019

*The Polarization Behavior of Relativistic Synchrotron Jets*

A.L.Peirson, R.W.Romani. *ApJ*, 864, 2, 2018

*Dank Learning: Generating Memes Using Deep Neural Networks* [Code][Techcrunch][The Next Web]

A.L.Peirson & E.M.Tolunay, 1806.04510, 2018

## Publications

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*The X-ray Polarization View of Mrk 421 in an Average Flux State as Observed by IXPE*

Laura Di Gesu, et al. (IXPE collaboration, incl. A.L.Peirson) *ApJ Letters*, accepted, 2022

*Polarized Blazar X-rays imply Particle Acceleration in Shocks*

I.Liodakis, et al. (IXPE collaboration, incl. A.L.Peirson) *Nature*, accepted, 2022

*Polarized X-rays from a Magnetar*

R.Taverna, et al. (IXPE collaboration, incl. A.L.Peirson) *Science*, accepted, 2022

*X-ray Polarization Detection of Cassiopeia A with IXPE*

J.Vink, et al. (IXPE collaboration, incl. A.L.Peirson) *ApJ*, accepted, 2022

*Angling for X-ray Pulsar Geometry with Polarimetry*

V.Doroshenko, et al. (IXPE collaboration, incl. A.L.Peirson) *Nature Astronomy*, accepted, 2022

*Polarized X-rays Constrain The Disk-Jet Geometry in a Black Hole X-ray Binary*

H.Krawczynski, et al. (IXPE collaboration, incl. A.L.Peirson) *Science*, accepted, 2022

*Simultaneous Space and Phase Resolved X-ray Polarimetry of the Crab Pulsar and Nebula*

N.Bucciantini, et al. (IXPE collaboration, incl. A.L.Peirson) *Nature Astronomy*, accepted, 2022

*Limits on X-ray Polarization at the Core of Centaurus A as Observed with the Imaging X-ray Polarimetry Explorer*

S.R.Ehlert, et al. (IXPE collaboration, incl. A.L.Peirson) *ApJ*, accepted, 2022

*The Relativistic Jet Orientation and Host Galaxy of the Peculiar Blazar PKS 1413+135*

A.C.S.Readhead et al. (incl. A.L.Peirson) *ApJ*, 907, 61, 2020

*Transverse Beam Phase-Space Measurement Experience at CTF3*

D.Gamba, L.Martin et al. (incl. A.L.Peirson) *IPAC2017*, 2017

## Whitepapers & Textbooks

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*Neural Network Analysis of X-ray Polarimeter Data*

**A.L.Peirson**, *The Handbook of X-ray and Gamma Ray Astrophysics*, [Springer Nature](#), 2022

*The X-ray Polarization Probe Mission Concept*

K.Jahoda et al. (incl. **A.L.Peirson**) *Decadal Survey on Astronomy and Astrophysics*, [1907.10190](#), 2020