Abel Lawrence Peirson

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Education

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

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

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 drosophilia 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

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.

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.

Selected Invited Talks

IXPE: Science so far, *IAUS 375: The Multimessenger Chakra of Blazar Jets*, 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

Telescope & Computing Allocations

ALMA — *High-frequecy 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+)

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**

Graduate Coursework

- ***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)

Teaching

Stanford PHYS113 — *Computational Physics* (Lecturer and Teaching Assistant) *Winter 2021*
Stanford PHYS100 — *Introduction to Observational Astrophysics* (Teaching Assistant) *Spring 2019*

First and Co-Authored Publications

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

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

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