Phil Travis

phil@physicistphil.com • Los Angeles, CA

Education

- **Ph.D., plasma physics**, 2025, University of California, Los Angeles
- **Master of Science, Physics**, 2018, University of California, Los Angeles
- **Bachelor of Science, Physics**, 2017, University of Illinois at Urbana-Champaign

Core Competencies and Experience

Machine learning
- Deep and generative modeling
- From diagnostics to deployment

Fusion physics
- Turbulence and transport
- Mirror machines and tokamaks
- Broad understanding of the field

Computing
- Generally competent; power user

Data handling
- 29 million discharges, multiple TBs

Plasma diagnostics
- Probes and fundamental fusion diagnostics

Projects

Optimization of ICF simulations using JAX 2025 - present
- **Goals**: learn the fundamentals of simulating plasmas; optimize ICF plasma instabilities
- Utilizing the ADEPT differentiable simulation framework
- Optimized beam parameters to reduce growth rate of the two-stream instability

Evidence of interchange modes in LAPD mirrors 2024 - 2025
- **Goal**: destabilize the curvature-induced interchange instability in the LAPD
- Achieved $\beta \sim 1\%$ — an order of magnitude higher than previous LAPD mirror studies
- Analysis included Thomson scattering, Langmuir probes, a fast framing camera, and other diagnostics
- Observed low-m, low-frequency, high-amplitude mode **consistent with the interchange instability**

Reconstructing diagnostic signals using (generative) energy-based models 2021 - 2025
- **Goal**: learn correlations between diagnostics and machine state information via generative modeling
- Trained (generative) energy-based models (EBMs) using transformer-like inputs heads and CNNs
- **Reconstructed missing diagnostics** from the learned distribution via conditional sampling

Inferring trends in the LAPD mirrors using machine learning 2024 - 2025
- **Goal**: infer trends from a model trained on randomly varied LAPD actuator states
- Built neural network model to predict ion saturation current given a mirror machine actuator state
- Inferred trends in discharge current, mirror configurations, and gas puffing durations
- **Used model to infer state required to optimize axial variation in a mirror cell**
- Made public the code, models, data, poster, and writeup: doi:10.5281/zenodo.15007853

Upgrading LAPD diagnostic pipelines for machine learning applications 2021 - 2023

- **Goal**: collect as much data as possible from every shot on the Large Plasma Device for ML purposes
- Constructed a new LabVIEW- and python-based system that ties into the existing acquisition system
- Aggregated machine state information and auxiliary diagnostics for every discharge
- **Recorded over 29 million shots** — largest known magnetized plasma dataset by shot count

Gradient-based optimization of a 0d mirror machine reactor 2022 - 2023

In collaboration with WHAM *Funder: ORFEAS competition*

- **Goal**: develop and optimize a 0D mirror machine reactor model for minimal cost
- Built a 0d mirror machine model in SymPy and JAX
- **Optimized estimated dollar cost, Q, and other cost functions** with respect to particular machine and physics parameters, including stability constraints
- Demonstrated superiority of the tandem mirror approach over simple mirrors

Automating Langmuir sweep analysis using neural networks 2019 - 2020

- **Goal**: automate the analysis of noisy or otherwise non-ideal Langmuir probe sweeps
- Aggregated Langmuir sweep data and built an NN-, attention-based fitting routine in TensorFlow
- Built a surrogate model for the theoretical Langmuir sweep curve
- **Fitting routine was robust** to strong drift wave turbulence

Study of turbulence and transport in magnetic mirror geometries in the LAPD 2017 - 2019

- **Goal**: explore and determine the effect of a magnetic mirror geometry on the turbulence spectrum
- Analyzed ion saturation current, floating potential, and magnetic fluctuation probe measurements using cross-correlation techniques in Python
- **Saw no mirror-driven instabilities**, but observed modification of the turbulence spectrum and **decreased cross-field particle flux** with increased mirror ratio

ADVISING

Advised four UCLA physics undergraduates:

- **Juri Alhuthali** *Summer 2024 - Fall 2024*
  - Supervised Bayesian inference of swept Langmuir probe traces
  - Used PyStan (a Bayesian inference package) and Pyro (a probabilistic computing package)
- **Jessica Gonzalez** *Summer 2023 - Summer 2024*
  - Supervised analysis of time-series monochromator signals of three Helium neutral lines
  - Analyzed time traces using CollRadPy, a collisional-radiative solver
  - Compared results with measurements from the LAPD Thomson scattering system
- **Tyler Hadsell** *Spring 2022 - Spring 2024*
  - Supervised python-based analysis of Phantom v7.3 fast framing camera footage of the LAPD
  - Supervised development of clustering routines to quantify dataset diversity and extract trends
- **Kian Orr** *Summer 2021 - Spring 2022*
  - Supervised construction and deployment of software to control and read from an Ocean Insight HR4000 spectrometer
  - Integrated spectra into the existing machine state and auxiliary diagnostics system
  - Advised analysis of recorded spectral lines using CollRadPy to deduce electron temperature and densities in the LAPD

Publications

- **P. Travis**, J. Bortnik, T. Carter, “Machine-learned trends in mirror configurations in the Large Plasma Device” *Physics of Plasmas* 32, 082106 (2025). doi:10.1063/5.0270755
- **P. Travis**, T. Carter, “Turbulence and transport in mirror geometries in the Large Plasma Device” *Journal of Plasma Physics* 91 (2025). doi:10.1017/S0022377825000029
- Qian, Yuchen, et al. "Design of the Lanthanum hexaboride based plasma source for the large plasma device at UCLA." *Review of Scientific Instruments* 94, 085104 (2023). doi:10.1063/5.0152216

Selected Presentations (*see physicistphil.com/presentations for full list*)

- Generative, energy-based models for diagnostic reconstruction and analysis *Poster*
  Phil Travis, Troy Carter — APS Division of Plasma Physics 2025, Long Beach, CA
- An open dataset from the Large Plasma Device for machine learning and profile prediction *Poster*
  Phil Travis, Troy Carter — APS Division of Plasma Physics 2024, Atlanta, GA
- Study of turbulence and transport in magnetic mirror geometries in the LAPD *Poster*
  Phil Travis and Troy Carter — Transport Task Force 2018, San Diego, CA
- Dependence of edge profiles and stability on neutral beam power in NSTX *Poster*
  P. Travis, G. Canal, T. Osborne, R. Maingi, S. Sabbagh, and the NSTX-U team — APS Division of Plasma Physics 2016, San Jose, CA

Skills

Computing

- Proficient in Python, C/C++, LabView, LaTeX
- Experience with CUDA, OpenMP, MPI
- Experience with MATLAB/Octave
- Proficient in PyTorch, TensorFlow, JAX
- Proficient in Linux (Ubuntu and Debian)
- Proficient in handling TB-scale data aggregation and storage (sockets/networking, HDF5, binary data)

Diagnostics and analysis

- Proficient in analysis of: magnetic flux (bdot), electrostatic (Langmuir) probes, non-collective Thomson scattering, heterodyne interferometry
- Experience with analyzing spectroscopic data and visible-light diagnostics
- Proficient in using cross-correlation and spectral techniques

Simulation

- Experience with Vlasov and fluid solvers
- Experience optimizing through simulators

Machine learning and statistics

- Proficient in using neural networks, generative modeling, gradient-based optimization
- Experience with Bayesian inference, MCMC methods, uncertainty quantification
- Experience with classical ML techniques (regression forests, clustering, support vector machines, gaussian processes)

Laboratory techniques

- Proficient in using general lab electronics (oscilloscopes, function generators, etc…)
- Experience with operating a 300 mJ laser and supporting equipment
- Proficient in using probe biasing and signal conditioning equipment
- Proficient in interfacing with general lab hardware and DAQ devices