

# Sunny Howard

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## Summary

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Physics and machine learning researcher focused on developing empirical methods to interpret complex systems. My PhD at Oxford developed deep-learning-based reconstruction techniques for understanding the high-dimensional fields of laser pulses — approaches I now aim to apply to interpretability and safety in AI systems. Experienced in compressed sensing, representation learning, and data-driven scientific discovery.

## Education

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### University of Oxford

*Oct 2021 – July 2025*

*DPhil in Physics*

- Designed machine learning algorithms to reconstruct high-dimensional laser fields from single measurements, using ideas from compressed sensing and deep unrolling. Broader research included exploring general ML architectures and representation learning.
- Involved in many [publications](#) [🔗](#), most of which using ML, including four first-authors and a ML review paper for the field. The final paper for this project was published at Nature Photonics and based on this content I won the best presentation prize at the ICUIL 2024 conference in Mexico.
- Spent one year at LMU Munich as a visiting researcher, where I am a member of the Munich Center for Machine Learning, and attended extra courses such as Mathematical Modelling of Financial Derivatives.

### University of Cambridge

*Sept 2020 – May 2021*

*Graduate Researcher*

- Using plasmon-enhanced light-matter interactions as a tool to investigate the switching mechanisms in memresistive devices.
- Performed analytical modelling of plasmonic resonances, density-functional theory simulations and experimental work in the lab, taking a range of optical measurements.

### University of Nottingham

*Sept 2019 – Aug 2020*

*MSc in Machine Learning in Science*

- Final grade: 78.5% (**highest mark in cohort**)
- MSc focused on teaching the underlying theories of machine learning. Included modules such as the Physics of Deep Learning, providing a fascinating link between these personal interests. Expanded my knowledge of probability, statistics and programming, and I had the opportunity to complete and write papers for many mini-projects.
- Final project involved developing a novel implementation of multi-agent reinforcement learning using tensor networks.

### University of Nottingham

*Sept 2016 – June 2019*

*BSc in Physics*

- Final grade: 84%
- Developed a broad experimental and mathematical ability, along with general problem solving skills. Excelled especially in mathematical modules, but maintained consistently high marks throughout. Completed a communication skills module that has given me a good ability to express my ideas.

## Experience

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### Machine Learning Consultancy

*Oxford, UK*

*Freelance*

*July 2023 – Sept 2023*

- Awarded a contract worth £10000 from the Department of Ecology (Prof Tim Coulson) to develop a computer vision algorithm to extract information from a dataset of photos of fish.
- The resulting algorithm was instrumental in the completion of the study.

Part time work to fund my DPhil studies. Supporting various aspects of the team, including the development of machine learning algorithms and development operations.

## Selected Publications and Projects

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**Single-shot Spatiotemporal Vector Field Measurements of Petawatt Laser Pulses** [Nature Photonics](#) 


*S. Howard et al.* (2025)

Final result of DPhil. Designed a new deep learning-based method to characterize ultra-intense laser pulses, including uncertainty estimates, and applied it to experiments in a groundbreaking result for the field.

**CoordGate: Efficiently Computing Spatially-Varying Convolutions in Convolutional Neural Networks** [BMVC](#) 

*S. Howard et al.* (2023)

Created a module to perform image denoising when the blur kernel is spatially-variant. Further developed this in my [thesis](#) , where I show a method to move smoothly between convolutional and locally-connected layers.

**Sparse Reconstruction of Wavefronts Using an Over-Complete Phase Dictionary** [Optica](#) 

*S. Howard et al.* (2025)

Used an over-complete dictionary to perform wavefront reconstruction, maximizing interpretability and efficiency.

**Hyperspectral Compressive Wavefront Sensing** [HPLSE](#) 

*S. Howard et al.* (2023)

Developed a technique based on the principals of compressed sensing, and implemented a deep unrolling algorithm to solve the under-determined reconstruction problem, combining physical priors with learned structure. Utilised 3D convolutions to exploit the spatiotemporal structure in the data.

**Data-driven Science and Machine Learning Methods in Laser-Plasma Physics** [HPLSE](#) 

A. Döpp, C. Eberle, *S. Howard et al.* (2023)

Involved in writing a review/tutorial paper on using machine learning within the field of Laser-Plasma physics.

**A Tensor Network Implementation of Multi-Agent Reinforcement Learning** [ArXiv](#) 

*S. Howard* (2020)

Final MSc thesis. Explored the possibility of using tensor networks to perform reinforcement learning, and the dimensionality reduction required to make this approach practical.

## Awards & Talks

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- Awarded DPhil funding, both from an Oxford Lambert Russell Studentship and a DAAD Scholarship.
- Best student presentation award at the International Conference on ultra-intense lasers (Mexico 2024).
- On the organising committee for the LMU workshop on Machine Learning and Control Systems.
- Invited talk at the Computational Aspects of Deep Learning workshop at the BMVC.
- Awarded the BSc first year scholarship award due to academic excellence.

## Other Interests

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- Practice meditation regularly, and have spent 150 days on silent retreats.
- Mountaineering in the Alps, North Africa and Nepal, as well as trad climbing in the UK.
- Trinity College Grade 8 Drums at the age of 16 and performed with a band at the O2 academy in Islington.
- Regularly consider effective altruism and have raised over £10000 for charities by working holiday jobs.