Matthew C. H. Leung

✉ matthew.leung@cfa.harvard.edu | 🖥 mchleung.com

🆔 orcid.org/0000-0001-5716-6851 | in linkedin.com/in/matthewchleung | ○ github.com/mattleung10

EDUCATION

Harvard University
2023 – Present

Doctor of Philosophy (Ph.D.) in Astronomy and Astrophysics — Cambridge, MA, USA

- Research Project: "Novel High Resolution Spectrograph for the Helium 10830Å Absorption Line", supervised by Prof. David Charbonneau and Dr. Andrew Szentgyorgyi

University of Toronto
2018 – 2023

Bachelor of Applied Science (B.A.Sc.) in Engineering Science, GPA: 3.90/4.00, High Honours — Toronto, ON, Canada

- Engineering Physics Specialization, Minor in Artificial Intelligence Engineering
- Bachelor's Thesis: "Light Curve Analysis of a Young Type II-L Supernova from the KMTNet Supernova Program", supervised by Prof. Dae-Sik Moon
- Completed a co-op/gap year internship at the Harvard-Smithsonian Center for Astrophysics

PUBLICATIONS

[6] **M. C. H. Leung**, C. A. Jurgenson, A. Szentgyorgyi, B. McLeod, C. Onyuksel, J. Zajac, D. Charbonneau, W. Podgorski, A. Unger, M. Mueller, M. Smith, D. Baldwin, and V. A. Villar, "Off-axis Hartmann wavefront sensing for the GMT-Consortium Large Earth Finder (G-CLEF) red camera optics," in *Ground-based and Airborne Instrumentation for Astronomy X*, Proc. SPIE 13096, 130964M (2024), DOI: 10.1117/12.3018467

[5] A. Szentgyorgyi, S. Ben-Ami, J. S. Oh, [and 49 others, including **M. Leung**], "Innovations in the design and construction of the GMT-Consortium Large Earth Finder (G-CLEF), a first-light instrument for the Giant Magellan Telescope (GMT)," in *Ground-based and Airborne Instrumentation for Astronomy X*, Proc. SPIE 13096, 130960Z (2024), DOI: 10.1117/12.3018439

[4] C. Jurgenson, A. Szentgyorgyi, M. Mueller, [and 7 others, including **M. Leung**], "Assembly, integration, and verification of the GMT-Consortium Large Earth Finder (G-CLEF) red channel camera optics," in *Ground-based and Airborne Instrumentation for Astronomy X*, Proc. SPIE 13096, 130964P (2024), DOI: 10.1117/12.3020389

[3] **M. C. H. Leung**, S. Chen, and C. Jurgenson, "Accurately measuring hyperspectral imaging distortion in grating spectrographs using a clustering algorithm," in *Advances in Optical and Mechanical Technologies for Telescopes and Instrumentation V*, Proc. SPIE 12188, 121883W (2022), DOI: 10.1117/12.2630442

[2] S. Chen, **M. C. H. Leung**, X. Yao, S. Sivanandam, I. Sanders, and R. Liang, "Optical design and wavelength calibration of a DMD-based multi-object spectrograph," in *Advances in Optical and Mechanical Technologies for Telescopes and Instrumentation V*, Proc. SPIE 12188, 1218856 (2022), DOI: 10.1117/12.2630372

[1] **M. C. H. Leung**, "Light Curve Analysis of a Young Type II-L Supernova from the KMTNet Supernova Program", B.A.Sc. Thesis, University of Toronto (2022)

RESEARCH EXPERIENCE

Harvard-Smithsonian Center for Astrophysics
September 2023 – Present

Graduate Research Assistant — Cambridge, MA, USA

- Working with **Prof. David Charbonneau** and **Dr. Andrew Szentgyorgyi** on a new near-infrared high resolution spectrograph concept for characterizing exoplanet atmospheres
- Also involved with **G-CLEF**, a high resolution first-light spectrograph for the **Giant Magellan Telescope**; **Published 3 papers** (1 first author) in SPIE Astronomical Telescopes + Instrumentation 2024

Harvard-Smithsonian Center for Astrophysics
Research Intern, Optical and Infrared Astronomy Division

September 2021 – June 2022
Cambridge, MA, USA

- Worked with **Dr. Andrew Szentgyorgyi** and **Dr. Colby Jurgenson** on **G-CLEF**
- Designed and created a prototype **optical fiber mode scrambler** for G-CLEF, and an optical fiber testing setup for fiber near field and far field imaging and focal ratio degradation measurement
- Designed and analyzed optical systems in **Zemax OpticStudio**; wrote custom image analysis software in **Python**

University of Toronto
Research Assistant, Department of Astronomy and Astrophysics

May 2021 – April 2022
Toronto, ON, Canada

- Worked with **Prof. Dae-Sik Moon** to investigate a **young Type II-L supernova** (SN)
- Analyzed a large dataset (>230GB) of images from the KMTNet Supernova Program, using **Python** to construct multi-band light curves of the SN; performed image subtraction, PSF photometry, and filtering of light curves
- Fitted **analytic models** to SN light curves in order to estimate the SN's **physical parameters** and to infer the **physical processes** behind the light curve's rise (e.g. radioactive decay and shock cooling emission)

University of Toronto
Research Assistant, Dunlap Institute for Astronomy and Astrophysics

May 2020 – August 2022
Toronto, ON, Canada

- Worked with **Dr. Shaojie Chen** in **Prof. Suresh Sivanandam**'s research group on a multi-object spectrograph (MOS) which uses a **digital micromirror device (DMD)** as a programmable slit
- Created a **novel clustering algorithm** for hyperspectral imaging distortion correction in astronomical spectra; **Published 2 papers** (1 first author, 1 second author) in SPIE Astronomical Telescopes + Instrumentation 2022
- Used **MATLAB ZOS-API** to generate simulated ray tracing data in **Zemax OpticStudio** for the DMD-based MOS; analyzed data in **Python**

National University of Singapore
Research Assistant, Department of Electrical and Computer Engineering

May 2019 – August 2019
Singapore

- Worked with **Prof. Ghim Wei Ho** in a multidisciplinary nanophotonics laboratory to investigate surface plasmon resonance in **photocatalytic hydrogen generation** and **solar reflective nanofilms**
- Experimented with different reactants to synthesize TiO_2/Ag nanofibers by electrospinning; wrote Python code to interface with an ADC; worked safely with high voltages (>17.5 kV) and hazardous substances

SELECTED AWARDS

- **NASA Academy Alumni Association** Dr. Gerald A. Soffen Memorial Fund Grant ($500) — 2024
- **U of T Division of Engineering Science** Award of Excellence — 2023
- **U of T Department of Astronomy and Astrophysics** SURP Research Fellowship ($9,595) — 2021
- **U of T Engineering Competition** 2nd Place, Programming Category — 2021
- **IEEE (Institute of Electrical and Electronics Engineers)** Toronto Scholarship ($2,000) — 2020
- **U of T Dunlap Institute for Astronomy and Astrophysics** SURP Research Fellowship ($9,500) — 2020
- **Hack The 6ix 2020** Major League Hacking Best Use of Google Cloud Prize — 2020
- **Electro-Federation Canada** Scholarship Award ($1,000) — 2019
- **U of T Division of Engineering Science** ESROP Global Research Fellowship ($4,000) — 2019
- **U of T** Bennett Scholar ($10,000) — 2018
- **U of T Faculty of Applied Science and Engineering** Admission Scholarship ($5,000) — 2018
- **TransCanada** Community Leaders Scholarship ($1,000) — 2018

Selected Posters

- "The GMT-Consortium Large Earth Finder (G-CLEF) at the Magellan Clay Telescope" — July 2024
  Two HoRSEs: High-Resolution Exoplanet and Stellar Characterization Today and in the ELT Era — Berlin, Germany
- "Off-axis Hartmann wavefront sensing for the GMT-Consortium Large Earth Finder (G-CLEF) red camera optics" — June 2024
  SPIE Astronomical Telescopes + Instrumentation 2024 — Yokohama, Japan
- "Accurately Measuring Hyperspectral Imaging Distortion in Grating Spectrographs Using a Clustering Algorithm" — July 2022
  SPIE Astronomical Telescopes + Instrumentation 2022 — Montréal, Canada
- "Light Curve Analysis of a Young Type II-L Supernova KSP-ZN7090" — August 2021
  University of Toronto Astronomy and Astrophysics SURP 2021 Poster Symposium — Toronto, Canada
- "DMD-Based Multi-Object Spectrograph Design and Wavelength Calibration" — September 2020
  Royal Astronomical Society Early Career Poster Exhibition — Remote

Summer Schools

European Adaptive Optics Summer School 2023 — June 2023
Newcastle Univ., Durham Univ., Univ. of Manchester, Univ. of Oxford, Institut d'Optique, and others — Remote

- Attended a week-long summer school about **adaptive optics (AO)**, covering wavefront measurement, wavefront correction, control systems, AO systems design, and AO simulations and algorithms in Python
- Learned about cutting-edge AO techniques in astronomy, ophthalmology, microscopy, and optical communications

Astromatic 2022 — August 2022
University of Montréal — Montréal, QC, Canada

- Attended a week-long workshop and hackathon in **machine learning and astrophysics**; completed a project in a team of 3 to estimate cosmological density parameters using CNNs with **PyTorch**; awarded "Judge's Prize"
- 1 of 15 selected attendees out of 120 applicants worldwide

GROWTH Astronomy School 2020 — August 2020
California Institute of Technology — Remote

- Attended a week-long summer school in **multi-messenger astronomy**; learned about a variety of data analysis techniques and tools (e.g. Astropy, MCMC, SExtractor, DS9) which I ultimately applied to my Bachelor's thesis
- 1 of 85 selected attendees out of 875 applicants worldwide

Extracurricular Activities

NSight Mentorship Program — September 2019 – April 2023
Mentor — Toronto, ON, Canada

- Mentored freshman Engineering Science students at U of T, helping them transition to university
- Provided my mentees advice in **finding summer research opportunities** (e.g. CVs, statements, cold emailing)

U of T Machine Intelligence Student Team (UTMIST) — September 2020 – May 2022
Project Developer — Toronto, ON, Canada

- Created custom neural network architectures for Toronto real estate price prediction using **TensorFlow** and **scikit-learn**, achieving **9% MAPE**; used autoencoders, CNNs, MLPs, ensemble methods, and SVR

IEEE University of Toronto Student Branch   April 2019 − April 2022

Marketing Managing Director and Advisor   Toronto, ON, Canada

- Led a marketing team of 5 students in the largest engineering professional development organization at U of T; designed graphics for **10+ professional development events** and managed social media accounts
- Organized technical workshops and large-scale hackathons backed by major sponsors, most notably **MLH NewHacks 2020**, a 24-hour hackathon with 200+ attendees, for students with no programming experience
- Was awarded the **IEEE Toronto Scholarship** for my academic excellence and community involvement

EXTRACURRICULAR TECHNICAL PROJECTS

For more details and links, please see: https://mchleung.com/projects

- **UTMIST: RealTime**   2021 − 2022
  - Custom neural network for Toronto real estate price prediction, utilizing an autoencoder and regression tree ensemble, and a MongoDB database with live updates from a multiple listing service API; achieved 9% MAPE
  - Incorporated many variables such as images, location, size, age, public amenities, building materials, etc.
  - Was awarded the "Best Project Award" at UTMIST 2022 Project Showcase from a panel of industry judges
- **UTMIST: RealValue**   2020 − 2021
  - Custom neural network for Toronto real estate price prediction, combining a CNN with a MLP, allowing for image and numerical inputs simultaneously; achieved 15% MAPE
  - Applied extensive data augmentation and applied transfer learning from a dataset of California houses
- **Hack The 6ix 2020: Omakase**   2020
  - Kotlin mobile app that uses machine learning to recommend food recipes from an image of a fridge
  - Was awarded the "Best Use of Google Cloud Prize" at the Hack The 6ix 2020 hackathon
- **GoTo Telescope Mount**   2019 − 2020
  - Alt-azimuth computerized telescope mount for my 4.5-inch telescope, controlled by a Raspberry Pi and Arduinos
  - Features: Internal database of 7000+ objects, feedback control system using rotary encoders, object tracking using Astropy and Python Multiprocessing libraries

EXTRACURRICULAR COURSES

- **Laser Safety Training**, *University of Toronto*   October 2022
  An 8 hour course in using ANSI Class 3B and Class 4 lasers in research settings
- **Astrophysics XSeries Program**, *Australian National University (through EdX)*   December 2020
  A series of 4 courses about modern astrophysics, covering exoplanets, cosmology, compact objects, etc.
- **First Order Optical System Design**, *University of Colorado Boulder (through Coursera)*   July 2020
  A course I took to self-learn Zemax OpticStudio and basic optical system design
- **Basic Machining**, *George Brown College*   March 2020
  A course in using a lathe, mill, and drill press to cut metal parts; final project: machining a piston

SKILLS

- **Programming Languages:** Python, C/C++, Java, MATLAB
- **Libraries and Frameworks:** NumPy, SciPy, Pandas, OpenCV, PyTorch, TensorFlow, scikit-learn, Astropy
- **Hardware:** Arduino, Raspberry Pi, Verilog
- **Graphics, Media, and Typesetting:** Photoshop, Illustrator, Figma, Inkscape, Vegas Pro, After Effects, LaTeX
- **Engineering Design/Simulation Software:** Ansys Zemax OpticStudio, SketchUp, LTspice, KiCad

Last Updated: December 20, 2024