

Matthew C. H. Leung

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RESEARCH INTERESTS

Astronomical instrumentation, photonics, spectroscopy, exoplanets, machine learning

EDUCATION

Harvard University

Doctor of Philosophy (Ph.D.) in Astronomy and Astrophysics, GPA: 4.0/4.0

2023 – Present

Master of Arts (A.M.) in Astronomy and Astrophysics, GPA: 4.0/4.0

2023 – 2025

- Thesis Project: “Novel high-resolution spectrograph for the helium 1083 nm line”, supervised by Prof. David Charbonneau and Dr. Andrew Szentgyorgyi
- Selected Coursework: Optics and Photonics, Integrated Nonlinear Photonics (audited), Exoplanet Systems, Extragalactic Astronomy and Cosmology, Machine Learning for Astrophysicists

University of Toronto

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

2018 – 2023

- 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

RESEARCH EXPERIENCE

Harvard University

September 2023 – Present

Graduate Research Assistant, Department of Astronomy

Cambridge, MA, USA

- Leading the development of a novel high-resolution spectrograph called **VIPER**, which will study exoplanet atmospheres; tasks include mathematical modeling, optical design, data reduction, requirements development, etc.
- Supervised by **Prof. David Charbonneau** and **Dr. Andrew Szentgyorgyi**
- Also involved with **G-CLEF**, a high-resolution first-light spectrograph for the **Giant Magellan Telescope** that will search for “Earth 2.0”

Smithsonian Astrophysical Observatory

September 2021 – June 2022

Research Intern, Optical and Infrared Astronomy Division

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

May 2021 – April 2022

Research Assistant, Department of Astronomy and Astrophysics

Toronto, ON, Canada

- Worked with **Prof. Dae-Sik Moon** to investigate a **young Type II 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

• NSERC Canada Graduate Scholarship (converted to PGS-D) (\$120,000)	2025
• 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
• Society of Petroleum Engineers Canadian Educational Foundation Scholarship Award (\$2,500)	2020
• Electro-Federation Canada Scholarship Award (\$1,000)	2019
• U of T / National University of Singapore 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
• TC Energy / TransCanada Community Leaders Scholarship (\$1,000)	2018

PUBLICATIONS

11 total publications: 6 first author, 1 second author

- [11] **Leung, M. C. H.**, Szentgyorgyi, A., Jurgenson, C., Charbonneau, D., “Coupling loss and transmission in a multimode fiber-fed virtually imaged phased array (VIPA),” *Optics Express* 34, 19, 35089-35114 (2026). 10.1364/OE.608392
- [10] **Leung, M. C. H.**, Charbonneau, D., Szentgyorgyi, A., Jurgenson, C., “Optical design of VIPER: a high-resolution multimode fiber-fed VIPA spectrograph for characterizing exoplanet atmospheric escape”, in *Ground-based and Airborne Instrumentation for Astronomy XI*, Proc. SPIE 14149, 141490V (2026), DOI: 10.1117/12.3102463
- [9] Rukdee, S., Sablowski, D. P., Sithajan, S., [and 9 others, including **Leung, M.**], “Preliminary design of VIOLA prototype: vipa instrument for oxygen loaded atmospheres”, in *Ground-based and Airborne Instrumentation for Astronomy XI*, Proc. SPIE 14149, 14149BB (2026), DOI: 10.1117/12.3104480
- [8] Chang, E., Moon, D.-S., Sandoval, P., **Leung, M. C. H.**, [and 6 others], “Infant Core-collapse Supernova with Circumstellar Interactions from KMTNet. II. Luminous, Long-lasting Case of KSP-SN-2020f,” *The Astrophysical Journal* 1001, 103 (2026), DOI: 10.3847/1538-4357/ae5494

- [7] **Leung, M. C. H.**, Charbonneau, D., Szentgyorgyi, A., [and 7 others], “VIPER: A high-resolution multimode fiber-fed VIPA spectrograph concept for characterizing exoplanet atmospheric escape,” in *Techniques and Instrumentation for Detection of Exoplanets XII*, Proc. SPIE 13627, 136271P (2025), DOI: 10.1117/12.3062307
- [6] **Leung, M. C. H.**, Jurgenson, C., Szentgyorgyi, A., [and 7 others], “Crank-rocker optical fiber mode scrambler prototype for the GMT-Consortium Large Earth Finder (G-CLEF),” in *Techniques and Instrumentation for Detection of Exoplanets XII*, Proc. SPIE 13627 (2025), 136271J, DOI: 10.1117/12.3063478
- [5] **Leung, M. C. H.**, Jurgenson, C. A., Szentgyorgyi, A., [and 10 others], “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
- [4] Szentgyorgyi, A., Ben-Ami S., Oh, J. S., [and 49 others, including **Leung, M.**], “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
- [3] Jurgenson, C., Szentgyorgyi, A., Mueller, M. [and 7 others, including **Leung, M.**], “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
- [2] **Leung, M. C. H.**, Chen, S., and Jurgenson, C., “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
- [1] Chen, S., **Leung, M. C. H.**, Yao, X., Sivanandam, S., Sanders, I., and Liang, R., “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

SELECTED POSTERS AND TALKS

- “Optical design of VIPER: a high-resolution multimode fiber-fed VIPA spectrograph for characterizing exoplanet atmospheric escape”
SPIE Astronomical Telescopes + Instrumentation 2026 July 2026
Copenhagen, Denmark
- “VIPA Spectrograph at the GMT Scale” (invited)
MIT GMT Instrumentation Workshop May 2026
Cambridge, MA, USA
- “VIPER: An $R = 300,000$ spectrograph for characterizing exoplanet atmospheric escape”
STScI Atmospheric Escape and Replenishment in Planetary Systems Workshop November 2025
Baltimore, MD, USA
- “VIPER: A high-resolution multimode fiber-fed VIPA spectrograph concept for characterizing exoplanet atmospheric escape”
SPIE Optics + Photonics 2025 August 2025
San Diego, CA, USA
- “The GMT-Consortium Large Earth Finder (G-CLEF) at the Magellan Clay Telescope”
Two HoRSEs: High-Resolution Exoplanet and Stellar Characterization Today and in the ELT Era July 2024
Berlin, Germany
- “Off-axis Hartmann wavefront sensing for the GMT-Consortium Large Earth Finder (G-CLEF) red camera optics”
SPIE Astronomical Telescopes + Instrumentation 2024 June 2024
Yokohama, Japan
- “Accurately Measuring Hyperspectral Imaging Distortion in Grating Spectrographs Using a Clustering Algorithm”
SPIE Astronomical Telescopes + Instrumentation 2022 July 2022
Montréal, Canada
- “Light Curve Analysis of a Young Type II-L Supernova KSP-ZN7090”
University of Toronto Astronomy and Astrophysics SURP 2021 Poster Symposium August 2021
Toronto, Canada
- “DMD-Based Multi-Object Spectrograph Design and Wavelength Calibration”
Royal Astronomical Society Early Career Poster Exhibition September 2020
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

TEACHING

- **Teaching Fellow** for ASTRON 1: The Big Questions of Astronomy, *Harvard University* 2025
Received student evaluation ratings of 5.00/5.00 (Spring 2025, 72% response rate) and 4.91/5.00 (Fall 2025, 48% response rate), both above department and faculty means.
Prepared and delivered lectures about exoplanets and dark energy.

PROFESSIONAL SERVICE

- Reviewer for IEEE Transactions on Instrumentation and Measurement 2025 – 2026

SKILLS

- **Programming Languages:** Python, C/C++, Java, MATLAB, Verilog
- **Libraries and Frameworks:** NumPy, Pandas, SciPy, scikit-learn, PyTorch, TensorFlow, OpenCV
- **Graphics and Media:** Photoshop, Lightroom, Illustrator, Figma, Vegas Pro, After Effects
- **Engineering Design/Simulation:** Ansys Zemax OpticStudio, Tidy3D FDTD, SketchUp, LTspice, KiCad

Last Updated: September 2026