

Matthew C. H. Leung

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EDUCATION

Harvard University

Doctor of Philosophy (Ph.D.) in Astronomy and Astrophysics

2023 – Present

Cambridge, MA, USA

University of Toronto

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

2018 – 2023

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

- [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

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**, a precision radial velocity echelle spectrograph which will be the first light instrument for the **Giant Magellan Telescope**
- 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

May 2019 – August 2019

Research Assistant, Department of Electrical and Computer Engineering

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

- **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

- “Accurately Measuring Hyperspectral Imaging Distortion in Grating Spectrographs Using a Clustering Algorithm” July 2022
SPIE Astronomical Telescopes + Instrumentation 2022
- “Optical Design and Wavelength Calibration of a DMD-based Multi-Object Spectrograph” July 2022
SPIE Astronomical Telescopes + Instrumentation 2022
- “Light Curve Analysis of a Young Type II-L Supernova KSP-ZN7090” August 2021
University of Toronto Astronomy and Astrophysics SURP 2021 Poster Symposium
- “DMD-Based Multi-Object Spectrograph Design and Wavelength Calibration” September 2020
Royal Astronomical Society Early Career Poster Exhibition

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

- 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:** Zemax OpticStudio, SketchUp, LTspice, KiCad

Last Updated: September 27, 2023