# Matthew C. H. Leung

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## Education

### University of Toronto
2018 – Present

Bachelor of Applied Science (B.A.Sc.) in Engineering Science — 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"
- 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
September 2021 – June 2022

Research Intern, Optical and Infrared Astronomy Division — Cambridge, MA, USA

- Worked 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
May 2021 – April 2022

Research Assistant, Department of Astronomy and Astrophysics — Toronto, ON, Canada

- Investigated a **young Type II-L supernova** (SN) from the **KMTNet Supernova Program**
- Analyzed a large dataset (>230GB) of images with **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
May 2020 – August 2022

Research Assistant, Dunlap Institute for Astronomy and Astrophysics — Toronto, ON, Canada

- Worked 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 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 Department of Astronomy and Astrophysics** SURP Research Fellowship ($9,595) 2021
- **U of T Engineering Competition** 2nd Place, Programming Category 2021
- **U of T Dunlap Institute for Astronomy and Astrophysics** SURP Research Fellowship ($9,500) 2020
- **IEEE (Institute of Electrical and Electronics Engineers)** Toronto Scholarship ($2,000) 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

- **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

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

- Created a custom neural network architecture for Toronto real estate price prediction using TensorFlow and scikit-learn, achieving 9% MAPE; investigated the use of 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 people in the largest engineering professional development organization at U of T
- Organized technical workshops and large-scale hackathons (e.g. MakeUofT, MLH NewHacks) backed by major sponsors; created graphics for 10+ professional development events and managed social media accounts

**NSight Mentorship Program** September 2019 – Present
Mentor Toronto, ON, Canada

- Mentored freshman Engineering Science students at U of T
- Provided students with advice in transitioning to university and finding summer research opportunities

## 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