Patrick Horlaville

Astronomy Student, Researcher & Communicator

French & Canadian citizen

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Education

Bishop's University **2023 – expected 2025**

MSc. in Physics + Certificate in Knowledge Mobilization *Sherbrooke, Canada*

- Thesis advisor: Dr. John J. Ruan

McGill University **2019 – 2023**

BSc. in Honours Physics *Montreal, Canada*

- Thesis advisor: Dr. Matt Dobbs & Dr. Dallas Wulf
- Graduated with distinction: First Class Honours in Physics + Dean's Multidisciplinary Research List

Selected Honours & Awards

FRQNT Master's Scholarship **2024 – 2026**

$26,667 CAD

- Received a competitive graduate scholarship from the *Fonds de Recherche du Québec – Nature et Technologie* (FRQNT) Quebec provincial agency (**1 of 4** to receive the scholarship in astronomy in Quebec)

NSERC Canada Graduate Scholarship – Master's **2024 – 2025**

$27,000 CAD

- Received a competitive graduate scholarship from the National Science and Engineering Research Council (NSERC) Canadian federal agency (**1 of 1** to receive the scholarship at Bishop's University)

Bishop's Graduate Entrance Scholarship **2023 – 2024**

$10,000 CAD

- Received a competitive scholarship from the Bishop's University Foundation for the first year of my Master's degree

NSERC Undergraduate Student Research Award + Summer Research Fellowship **Summer 2022**

$6,000 CAD + $3,500 CAD

- Received a competitive Summer Undergraduate Research Fellowship (SURF) from the University of Toronto for a Summer internship at the Canadian Institute of Theoretical Astrophysics (CITA), supplemented by an NSERC Undergraduate Student Research Award (USRA)

NSERC Undergraduate Student Research Award **Summer 2021**

$6,000 CAD + $2,500 CAD

- Received a competitive Undergraduate Student Research Award (USRA) from NSERC for a Summer internship at the Exoplanets Research Institute at the *Université de Montréal*, supplemented by my supervisor's funding

Publications

Published peer-reviewed journal articles

- **Horlaville, P.**, Chung, D. T., Bond, J. R., & Liang, L., "The informativeness of [C II] line intensity mapping as a probe of the H I content and metallicity of galaxies at the end of reionization", 2024, MNRAS, 531, 2958 [DOI: 10.1093/mnras/stae1333]

Pre-print articles submitted for publication

- Bardati, J., Ruan, J. J., Haggard, D., Tremmel, M., **Horlaville, P.**, "Signatures of Massive Black Hole Merger Host Galaxies from Cosmological Simulations II: Unique Stellar Kinematics in Integral Field Unit Spectroscopy", submitted to ApJ (2024) [DOI: 10.48550/arXiv.2407.14061]

Articles in preparation

- **Horlaville, P.**, Ruan, J. J., Runnoe, J. C., Eracleous, M., Haggard, D., Bardati, J., "Identifying the Potential Host Galaxies of Upcoming Supermassive Black Hole Binary Gravitational Wave Detection", 2024, in prep.
- Carlson, N. J., Bond, J.R., Chung, D.T., **Horlaville, P.**, Morrison, T., "Simulated CO-line intensity maps for wide field millimeter-wave surveys", 2024, in prep.

Theses

- **Horlaville, P.**, Wulf, D., Dobbs, M., "Monitoring of Blazars with the CHIME Telescope", 2022, McGill University, BSc. Honours Research Thesis

Research Experiences

Black Hole Pair & Binary Host Galaxies Kinematics and Surface Brightness **2023 – present**

Master's Degree *Bishop's University*

- For my Master's research project, I am developing a novel method to select candidate supermassive black hole pair and binary host galaxies among archival galaxy surveys based on their stellar kinematics and surface brightness
- Supervisor: Prof. John J. Ruan

[C II] Line Intensity Mapping **2022 – present**

Undergraduate Internship *CITA, University of Toronto*

- For my internship at the Canadian Institute for Theoretical Astrophysics (CITA) in Toronto during the Summer of 2022, I revitalized a line intensity mock map program and used it to implement a new model for the parametrization of the cosmological [C II] signal. All of the follow-up work and analysis I've done culminated with a first-author paper, published in 2024 in the *Monthly Notices of the Royal Astronomical Society* (*cf.* § Publications)
- Today, I pursue my work at CITA part-time by helping others to use the tools I have developed towards other endeavours, such as studying the imprint of cosmological primordial non-gaussianities in the line intensity signal of $z \sim 3$ galaxies
- Supervisor: Dr. Dongwoo Chung & Prof. J. R. Bond

Blazar Radio Variability Monitoring with the CHIME Telescope **2021 – 2022**

Undergraduate Honours Research Thesis *McGill University*

- For my honours research thesis, I surveyed the radio variability exhibited by all the northern hemisphere blazars as observed by the telescope CHIME. I retrieved the daily radio spectrum for each source over a period of 466 days (producing a radio lightcurve for each source), derived the instrumental gain drift, from which I normalized the sources' lightcurve, and quantified the variability of each resulting lightcurve
- Studying this variability across different classes of blazars has notably revealed that Flat Spectrum Radio Quasars (FSRQs) are marginally less radio variable than BL Lac objects, despite both objects' classification being solely dependent on optical spectrum features. I presented all this work in front of the CHIME collaboration and my peers
- Supervisor: Dr. Dallas Wulf & Prof. Matt Dobbs

M-stars Exoplanets Occurrence Rates **Summer 2021**

Undergraduate Internship *iREx, Université de Montréal*

- For my internship at the Exoplanets Research Institute (iREx) at the *Université de Montréal*, I explored the modelling statistics of generating populations of exoplanets and the retrieval of their transit signature with synthetic TESS lightcurves in order to investigate the occurrence rate of different types of exoplanets from observational TESS data
- I presented the key steps of this investigation in front of iREx members at the end of my internship
- Supervisor: Prof. Björn Benneke

Daily Validation with the CHIME Telescope **Winter 2021**

Undergraduate Research *McGill University*

- For the 2021 Winter semester, I was an undergraduate research apprentice in the Matt Dobbs cosmology group at McGill, where I worked on the daily validation of the CHIME telescope data. I notably analyzed the spectrum of radio invariable sources, built template models for each one and investigated why the data deviated from the model template day-to-day
- I presented the key steps of this investigation in front the CHIME collaboration at many occasions
- Supervisor: Dr. Saurabh Singh & Prof. Matt Dobbs

Research Interests

- Transient astrophysics – AGNs – galaxy statistics – gravitational waves – multi-messenger astronomy
- Cosmology – line-intensity mapping – large-scale structure – galaxy formation – dark energy & dark mattert – CMB
- Computational astrophysics – simulation & forecast building – observational astrophysics – multi-disciplinary astronomy
- Bayesian inference – application of novel statistical tools in astronomy

Programming Skills

- Python (`numpy`, `matplotlib`, `astropy`, `pandas`, `emcee`...), R, bash, git/GitHub, LaTeX, Unix/Mac/Windows OS

Relevant References

- **John J. Ruan**, associate professor in the department of physics and astronomy at Bishop's University, QC, CA
- **Dongwoo Chung**, assistant professor in the department of astronomy at Cornell University, NY, USA
- **J. R. Bond**, University professor in the department of astronomy & astrophysics at the University of Toronto, ON, CA
- **Matt Dobbs**, professor in the department of physics at McGill University, QC, CA

Community Engagement, Outreach & Public Speaking

Physics Help Center Tutor — **Winter 2024 & Fall 2024**

Paid position — *Bishop's University*

- I'm currently a tutor at the physics help center at Bishop's University, where I help every week during the school semester undergraduate students to work through their homework assignments and to understand the concepts learned in their physics class

CASCA AGM Graduate Grader — **June 3–6 2024**

Volunteer position — *Toronto, Canada*

- I was a grader for posters and talks made by graduate students during the 2024 Annual General Assembly (AGM) of the Canadian Astronomical Society (CASCA), which was held in Toronto and hosted by the University of Toronto

Science Animator — **May 24–26 2024**

Paid position — *Montreal, Canada*

- I was a science animator for the *Centre de Recherche en Astrophyisque du Québec* (CRAQ) during Montreal's biggest science festival, *Eurêka!* in May 2024. My responsibilities included setting up science outreach activities and animating them (including a solar viewing session with a solar telescope and a solar system planets placing activity)

Eclipse Ambassador — **Winter 2024**

Volunteer position — *Bishop's University*

- In anticipation of the April 8th 2024 solar eclipse in North America (which was total in Sherbrooke!), I participated as a volunteer to the *Eclipse-Estrie* committee as an ambassador and guide. My responsibilities included visiting elementary schools and teaching children about the upcoming solar eclipse, notably how to best and safely view it. I also guided and informed visitors during the eclipse viewing event on Bishop's campus

CASCA Graduate Students Committee Representative — **2023 – 2024**

Volunteer position — *Bishop's University*

- During my first year of Master's, I was a representative of Bishop's University astronomy graduate students for the Graduate Students Committee (GSC) of the Canadian Astronomical Society (CASCA)

Elementary School Mentor & Conference Speaker — **Winter 2023**

Volunteer position — *Montreal, Canada*

- During the Winter 2023 semester, I volunteered as an elementary school mentor for the McGill-led STEAM Squad Program (Science, Technology, Engineering, Arts and Math), which accompanies children towards the elaboration of an after-school project related to STEM and/or Arts. I notably led a group of students in 5th grade to conceptualize, storyboard, direct and shoot a short stop-motion movie. This gave me the opportunity to present the initiative of this project at the International Society of the Learning Sciences 2023 annual meeting at Concordia University, in Montreal

Cégep Speaker — **Winter 2022**

Volunteer activity — *Montreal, Canada*

- In the Winter of 2022, I gave two conferences at *cégep du Vieux-Montréal* and Vanier College to demystify to pre-university students in natural sciences how it is to study undergraduate physics and astronomy, how to get into the world of research and particularly how to conciliate both classes and research

Outreach Volunteer — **2019 – 2023**

Volunteer position — *McGill University*

- For the entirety of my undergraduate studies, I was a volunteer for the outreach branch of the McGill Space Institute, *AstroMcGill*. My responsibilities and activities included guiding during public lectures and observation nights at the Anna I. McPherson Observatory, translating internal documents as well as animating hands-on science activities in elementary schools. My commitment to *AstroMcGill* allowed me to be twice awarded the Tomlinson Engagement Award for Mentoring (*cf.* § Other Honours & Awards)

Magazine Columnist — **2018 – present**

Volunteer position — *Montreal Planetarium, Montreal, Canada*

- Since 2018, I have been a volunteer columnist for the magazine of the Montreal Planetarium, *Hyperespace*. My columns typically cover astronomy research latest news, explain an astronomical concept or tell a story from astronomy's history

Peer Tutor — **2017 – 2019**

Paid position — *Cégep du Vieux-Montréal, Canada*

- During my studies at *cégep du Vieux-Montréal*, I was a peer-tutor for my biology, chemistry, physics and math classes

Planetarium Speaker — **November 24th, 2017**

Invited — *Montreal Planetarium, Montreal, Canada*

- In the Fall of 2017, I was invited to the Montreal Planetarium to present a conference I had elaborated as my high school senior project on our history of observing the sky, from the naked eye to the latest generation of telescopes. It also included a section on a future generation of cosmic instruments that I imagined (more details on my LinkedIn page)

Other Honours & Awards

Research Week Award **Winter 2024**
$150 CAD *Bishop's University*

- For Bishop's University 2024 Research Week, I gave a 3-minute presentation of my thesis project in front of the local academic community, which was voted second best graduate presentation

GIS Day Award **Fall 2023**
$100 CAD *Bishop's University*

- For the 2023 Geographic Information System (GIS) Day, I gave a 3-minute presentation of my thesis project in front of the local academic community, which was voted third best overall presentation

First Class Honours & Dean's Multidisciplinary Undergraduate Research List **Winter 2023**
Honourary recognition *McGill University*

- For graduating from McGill with a cumulative GPA ≥ 3.5 in the Honours Physics program and for having completed at least three classes of research-based courses with an average GPA ≥ 3.0, one of which having been completed in a different unit

Tomlinson Engagement Award for Mentoring **Fall 2021 + Winter 2022**
$300 CAD + $300 CAD *McGill University*

- In recognition of my volunteer involvement for the outreach branch of the McGill Space Institute, *AstroMcGill*, I was awarded the Tomlinson Engagement Award for Mentoring twice for the Fall 2021 and Winter 2022 semesters

Golden Key Society Fellow **September 2020**
Honourary recognition *McGill University*

- For being in the top 15% of my academic program after my first year of undergraduate studies at McGill University

Senior Cégep Thesis Award **May 2019**
$100 CAD *Cégep du Vieux-Montréal*

- The final project and thesis my team and I developed and wrote for my *cégep* senior semester was voted 3rd best of our graduating cohort by a jury of professors

Conferences & Specialized Schools

2024 CRAQ Summer School **June 26–28 2024**
Attendee *Université de Montréal, Canada*

- I attended the 2024 *Centre de Recherche d'Astrophysique du Québec* (CRAQ) Summer school, which focused on scientific machine learning applied to astrophysical data

2024 CASCA AGM **June 3–6 2024**
Attendee & Presenter *Toronto, Canada*

- I attended the 2024 Annual General Meeting (AGM) of the Canadian Astronomical Society (CASCA) in Toronto, and presented there a poster I made which briefly presented my Master's thesis project

2023 Pan-Canadian Reionization Workshop **August 3–4 2023**
Attendee *Toronto, Canada*

- I attended the 2023 Pan-Canadian Reionization workshop hosted by the Canadian Institute for Theoretical Astrophysics (CITA) in Toronto, for which I was generously granted $1000 CAD for my travel and lodging expenses. It featured discussion panels and lectures by a wide array of renown researchers in cosmology, all focused on the latest developments towards answering fundamental questions regarding the Epoch of Reionization (EoR)

2022 CMB+EoR Workshop **July 18–22 2022**
Attendee *Montreal, Canada*

- I attended the 2022 CMB-EoR workshop hosted by McGill University in Montreal. It featured keynotes and talks by a plethora of renown researchers presenting and discussing about the most pressing challenges in cosmology, in particular about the Epoch of Reionization (EoR) and other CMB related science

2022 CRAQ Summer School **June 15–17 2022**
Attendee *Montreal, Canada*

- I attended the 2022 *Centre de Recherche d'Astrophysique du Québec* (CRAQ) Summer school, which focused on cutting-edge observational probes in cosmology such as the CMB, intensity mapping and gravitational lensing

Completed Graduate Physics Courses

PHYS 512: Computational Physics with Applications **Fall 2022**

Instructor: Prof. Jon Sievers *McGill University*

- I completed the graduate course PHYS 512: *Computational Physics with Applications* during my undergraduate studies at McGill. The bulk of the work in the class consisted of completing computational assignments using python, notably getting familiar with various fitting routines such as least-squares, Chebyshev polynomials and MCMC

PHYS 641: Observational Techniques of Modern Astrophysics **Fall 2022**

Instructor: Prof. Jon Sievers *McGill University*

- I completed the graduate course PHYS 641: *Observational Techniques of Modern Astrophysics* during my undergraduate studies at McGill. The bulk of the work in the class consisted of completing computational assignments using python and astronomical data, notably getting acquainted with standard numerical tools used in astronomy like fitting data, computing the power spectrum or the matched filter of an astronomical map, identifying gravitational wave events in LIGO data, and more

PHY 574: Cosmology **Fall 2023**

Instructor: Prof. John J. Ruan *Bishop's University*

- I completed the graduate course PHY 574: *Cosmology* as a part of my Master's degree at Bishop's University. The bulk of the work in the class consisted of completing assignments comprised of analytical and computational questions using python. The content covered fundamental aspects of cosmology such as the Hubble parameter equation and the cosmological parameters, Universe ionization, the CMB, the matter power spectrum, the virialization of halos, the initial mass function, and more. I also gave a 30-minute presentation at the end of the semester on gravitational lensing

PHY 576: Stellar Astrophysics **Winter 2023**

Instructor: Prof. Lorne Nelson *Bishop's University*

- I completed the graduate course PHY 576: *Stellar Astrophysics* as a part of my Master's degree at Bishop's University. The bulk of the work in the class consisted of completing assignments comprised of analytical and computational questions using python. The content covered aspects of stellar astronomy such as the fundamental equations of stellar structure, the polytropic equation, the black body radiation spectrum, white dwarf modelling, HR diagrams, stellar nucleosynthesis processes and more. I also gave a 30-minute presentation at the end of the semester on the origin of the elements of the periodic table, from the Big Bang nucleosynthesis to the r-process