Alexander Laroche

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PhD Candidate, Department of Astronomy & Astrophysics

Research Interests

My research is focused on finding and studying interacting binaries, through a combination of astrostastistics and stellar astrophysics. I develop data-driven machine learning models to discover new, rare stars in large-scale surveys. I also study observed binaries to constrain their evolution. I have previously worked on dark matter substructure with strong gravitational lensing and 21 cm signal constraints during the Epoch of Reionization.

Education

University of Toronto — **Toronto, ON, Canada**
PhD in Astronomy & Astrophysics — *2022 – Present*
Advisors: Maria Drout, Joshua S. Speagle
Title: Constraining binary evolution through discovery and characterization of post-interaction binaries in large-scale surveys

McGill University — **Montreal, QC, Canada**
HBSc. in Physics (First Class Honours) — *2018 – 2022*
Advisor: Adrian Liu
Title: Quantifying density-ionization correlations with the 21cm power spectrum while including X-ray heating effects

Additional Research Positions

Undergraduate Research Assistant - UofT Galactic Astrophysics Group — **2021-2022**
Department of Astronomy & Astrophysics — *University of Toronto*
Supervisors: Jo Bovy, Daniel Gilman
Project: Constraining ultra-light dark matter with strong gravitational lensing

Undergraduate Research Assistant - McGill Radio Lab — **2020-2021**
Department of Physics — *McGill University*
Supervisors: Jonathan Sievers, Fernando Zago
Project: Data analysis for Probing Radio Intensity at high-Z from Mario (PRIZM)

Awards & Fellowships

NSERC Canada Graduate Scholarships - Doctoral (CGS-D) — **Sep 2024 – Aug 2027**
120,000 CAD, Natural Sciences & Engineering Research Council

Data Sciences Institute (DSI) Doctoral Student Fellowship — **Sep 2024 – Aug 2027**
75,000 CAD, University of Toronto Data Sciences Institute

NSERC Canada Graduate Scholarships - Master's (CGS-M) — **Sep 2023 – Aug 2024**
17,500 CAD, Natural Sciences & Engineering Research Council

Graduate Entrance Scholarship — **Sep 2022 – Aug 2023**
5,000 CAD, David A. Dunlap Department of Astronomy & Astrophysics

NSERC Undegraduate Summer Research Award (USRA) — **May 2021 – Aug 2021**
9,600 CAD, Natural Sciences & Engineering Research Council

Canada 150 Research Chair Undergraduate Research Grant — **May 2020 – Aug 2020**
6,000 CAD, Canada 150 Research Chairs Program

Charles River Laboratories Scholarship — **Sep 2020 – Aug 2021**
2,000 CAD, McGill University

Wing Hing Chan Scholarship in Science — **Sep 2020 – Aug 2021**
500 CAD, McGill University

Dean's Honours List — **Sep 2020 – Aug 2021**
Top 10% of Faculty of Science, McGill University

Publications

Peer-Reviewed Journal Publications

1. **Laroche, A.**, Speagle, J.S. *"Closing the stellar labels gap: Closing the stellar labels gap: Stellar label independent evidence for* $[\alpha/M]$ *information in Gaia BP/RP spectra,"* 2024, ApJ, *submitted* (18 pages).
2. **Laroche, A.** et al. *"Quantum fluctuations masquerade as halos: Bounds on ultra-light dark matter from quadruply-imaged quasars,"* 2022, MNRAS, 517, 2, 1867–1883 (16 pages).

Peer-Reviewed Conference Abstracts

1. **Laroche, A.**, Speagle, J.S. *"Closing the stellar labels gap: An unsupervised, generative model for* Gaia *BP/RP spectra,"* 2023, ICML Workshop on Machine Learning for Astrophysics (6 pages).

Observing Programs

Observing Experience

6.5-meter Magellan Telescope [in-person and remote observing] — **Las Campanas Observatory, Chile**
PIs: Maria Drout & Ylva Götberg — *2023, 2024*
Spectroscopy of candidate binary-stripped helium stars

Successful Observing Proposals

[Co-I] Observational Constraints for Mass Transfer with SB2s) — **Magellan**
PIs: Maria Drout & Ylva Götberg (Awarded: 16 hours) — *2024A*

Academic Presentations

Conferences & Workshops

From discovery to a population: benchmarking stripped stars and companions — **July 2024**
Lightning talk - Non-conservative mass transfer in observed stripped star + MS binaries — *Leiden, Netherlands*

New Computational Methods in Milky Way Dynamics and Structure — **July 2024**
Talk - Modeling stellar spectra without stellar labels: a variational auto-encoder for Gaia XP spectra — *Bavaria, Germany*

Rare Gems in Big Data — **May 2024**
Talk - Discovering rare stellar populations in Gaia with stellar label independent modeling — *Tucson, Arizona*

Stable Mass Transfer in Binaries: from onset to remnants — **March 2024**
Lightning talk - Non-conservative mass transfer in observed stripped star binaries — *New York, USA*

3,2,1: Massive Triples, Binaries and Mergers 2023 — **July 2023**
Poster - An envelope lost in transport (Awarded best poster) — *Leuven, Belgium*

The Fortieth International Conference on Machine Learning — **July 2023**
Poster - Closing the stellar labels gap — *Honolulu, USA*

Canadian Astro-Particle Physics Summer Student Talk Competition — **Aug 2022**
Talk - Quantum fluctuations masquerade as halos — *Subdury, ON*

University of Toronto 2022 Stellar Stats Workshop — **May 2022**
Talk - Constraining ultra-light dark matter by forward modeling flux ratios — *Toronto, ON*

Departmental Presentations, Seminars & Talks

Talk - McGill University Undergraduate Research Project Presentation — **Dec 2021**
Probing the quantum mechanics of ultra-light dark matter with strong lensing — *Montreal, QC*

Talk - University of Toronto NSERC USRA Poster Seminar — **Aug 2021**
Probing the quantum mechanics of ultra-light dark matter with strong lensing — *Toronto, ON*

Talk - McGill University Undergraduate Research Thesis Presentation — **Apr 2021**
Density-ionization correlations with the 21cm power spectrum including X-ray heating — *Montreal, QC*

Mentorship

Supervisor, Alejandro Ortega-Cruz Pietro — **May 2024 – Present**
Project: Multi-modal learning for a fundamental understanding of variable stars
(Co-supervisors: Josh Speagle, Maria Drout)

Undergraduate Mentor, University of Toronto **2022 – 2023**
Advising undergraduate students on research and graduate school applications

Teaching Experience

AST325/326: Introduction to/Practical Astronomy **Fall 2024**
Graduate TA, University of Toronto

AST222: Galaxies & Cosmology **Winter 2024**
Graduate TA, University of Toronto

AST199: Astronomy at the Frontier **Fall 2023**
Graduate TA, University of Toronto

AST201: Stars & Galaxies **Winter 2023**
Graduate TA, University of Toronto

AST101: The Sun and Its Neighbours **Fall 2022**
Graduate TA, University of Toronto

PAPER Tutor **2019-2020**
Undergraduate math and physics tutor, Montreal, QC

Selected Service & Outreach

Treasurer - UofT Graduate Astronomy Student Association **2023 – Present**
Manage finances for the Graduate Astronomy Student Association (GASA)

UofT Graduate Student Union Representative **2022 – 2023**
Represent the interests of the astronomy grad student body within the Graduate Student Union (GSU)

UofT AstroTours - Filmographer **2022 – 2023**
Monthly organization of AstroTours, manage video content for organization

Panelist – *"Applying to grad school"* **Fall 2022**
UofT Astronomy Union

Reviewer for MNRAS **2022 - Present**