William Thompson

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Research interests:
Exoplanet direct imaging, orbital modelling & multi-method detection, high contrast instrumentation, focal plane wavefront sensing, and spectroscopy.

Current Employment

2023-present	Herzberg Instrument Science Fellow (Assistant Research Officer) at NRC Herzberg Astronomy and Astrophysics

Education

2018-2023	**PhD in Astronomy**, University of Victoria	GPA:9.0 (9.0 scale)
	Supervisors: C. Marois and F. Herwig.	
	Thesis: "Lights in Motion: Observing Nearby Planets with Imaging, Wavefront Sensing, Orbital Detection, and Spectroscopy"	
2018	**Bachelor of Science (Honours) in Physics with Distinction**, Queen's University	
	Senior project: Building a radio telescope to detect neutral Hydrogen	
2016	**Bachelor of Computing with Distinction**, Queen's University	

Awards ($124k)

Competitive Scholarships and Grants

2023	$5,000	President's Research Scholarship, University of Victoria Faculty of Graduate Studies
2022	$63,000	PGS-D Scholarship, NSERC
2022	$5,000	President's Research Scholarship, University of Victoria Faculty of Graduate Studies
2021	$3,500	Alexander and Helen Stafford MacCarthy Muir Graduate Scholarship
2019	$12,000	New Technologies for Canadian Observatories, NSERC
2018	$17,500	CGS-M Scholarship, NSERC CREATE
2018	$13,000	University of Victoria Fellowship (declined)
2018	$5,000	President's Research Scholarship, University of Victoria Faculty of Graduate Studies
2016	$4,500	USRA Award, NSERC (declined)

Honours

2024	Nominated for Plaskett Medal to national level by the University of Victoria
2022	Best Poster at Canadian Astronomical Society AGM
2022	Astro Plot of the Week (online poll)
2021	Runner up best student presentation, NRC Herzberg Jamboree
2019	Nominated for Vanier Fellowship to national level by the University of Victoria
2019	Best Poster at Canadian Astronomical Society AGM
2016	International semi-finalist (innovation) Microsoft Imagine Cup

Publications (27)

Journal Articles (9)

Xuan, J. W., Mérand, A.[*], **Thompson, W.**[*], Zhang, Y., Lacour, S., Blakely, D., Mawet, D., Oppenheimer, R., Kammerer, J. Batygin, K., Wang., J., Ruffio., J.-B., Liu, M. C., Knutson, H., GRAVITY collaboration. "[redacted]" *Nature* (*accepted*).
[*]Both authors contributed equally to this work.

Mao, H., Woordward, P., Herwig., F., Denissenkov, P., Blouin, S., **Thompson, W.,** McDermott, B., 2024 "3D hydrodynamic simulations of massive main-sequence stars. III. The effect of radiation pressure and diffusion leading to a 1D equilibrium model" *The Astrophysical Journal (accepted)*

Thompson, W., Herwig, F., Woodward, P., Mao, H., Denissenkov, P., Bowman, D., Blouin, S. 2024 "3D hydrodynamic simulations of massive main-sequence stars II. Convective excitation and spectra of internal gravity waves." *Monthly Notices of the Royal Astronomical Society* **531** 1

Thompson, W., Lawrence, J., Blakely, D., Marois, D., Wang, J., Giordano, M., Brandt, T., Johnstone, D., Ruffio, J.B., Ammons, S. M., Crotts, K. A., Do Ó, C. R., Gonzales, E. C., and Rice, M. 2023 "Octofitter: Fast, Flexible, and Accurate Orbit Modeling to Detect Exoplanets." *The Astronomical Journal* **166** 164

Herwig, F. Woodward, P. Mao, H. **Thompson, W.,** Denissenkov, P., Lau, J., Blouin, S., Andrassy, R., Paul, A. 2023 "3D hydrodynamic simulations of massive main-sequence stars. I. Dynamics and mixing in the convective core and due to internal gravity waves." *Monthly Notices of the Royal Astronomical Society* **525** 2

Blouin, S., Mao, H., Herwig, F., Denissenkov, P., Woodward, P., **Thompson, W.** 2023 "3D hydrodynamics simulations of internal gravity waves in red giant branch stars." *Monthly Notices of the Royal Astronomical Society* **522** 2

Agrawal, S., Ruffio, J.B., Konopacky, Q. M., Macintosh, B., Mawet, D., Nielsen, E., Hoch, K. K. W., Liu, M. C., Barman, T., **Thompson, W.,** Greenbaum, A. Z., Marois, C., Patience, J. 2023 "Detecting Exoplanets Closer to Stars with Moderate Spectral Resolution." *The Astronomical Journal* **166** 15

Thompson, W., Marois, C., Do Ó, C. R., Konopacky, Q., Ruffio, J.B., Wang, J., Skemer, A. J., De Rosa, R. J., Macintosh, B. 2022 "Deep orbital search for additional planets in the HR8799 system." *The Astronomical Journal* **165** 29

Currie, T., Brandt, G. M., Brandt, T. D., Lacy, B., Burrows, A., Guyon, O., Tamura, M., Liu, R. Y., Sagynbayeva, S., Tobin, T., Chilcote, J., Groff, T., Marois, C., **Thompson, W.,** Murphy, S., Kuzuhara, M., Lawson, K., Lozi, J., Deo, V., Vievard, S., Skaf, N., Uyama, T., Jovanovic, N., Martinache, F., Kasdin, N. Jeremy, Kudo, T., McElwain, M., Janson, M., Wisniewski, J., Hodapp, K., Nishikawa, J., Hełminiak, K., Kwon, J., Hayashi, M. 2023 "Direct imaging and astrometric detection of a gas giant planet orbiting an accelerating star." *Science* **380** 6641

Thompson, W., Marois, C. 2021 "Improved Contrast in Images of Exoplanets using Direct SNR Optimization." *The Astronomical Journa***161** 236

Conference Proceedings (15) (* = refereed)

*****Thompson, W.,** Gamroth, D., Marois, C., Lardière, O. 2024 "Real-time adaptive optics control with a high level programming language" *Proceedings of the SPIE*

*****Marois, C., Lardière, O., Fitzsimmons, J., Demers, M., Johnson, A. B., Dutt, S., Nkwari, P., Gerard, B., Dunn, J., Li, D., Fu, Q., Brousseau, D., Sivanandam, S., **Thompson, W.,** Mann, C., Singh, G., Boucher, M.-A., Hardy, T., Caputa, K., Thibault, S., Savransky, D., Heidrich, W., van Kooten, M., Véran, J.-P., Clem, R. J., Gamroth, D., Bradley, C., Rawat, Galvan, Ö. S., Herriot, G., Landry, J.-T. 2024 "CAL2: project update of the NRC Canada facility-class focal plane wavefront sensor for the Gemini Planet Imager 2 upgrade" *Proceedings of the SPIE*

*****Johnson, A. B., Marois, C., **Thompson, W., Jackson, K.,** Véran, J.-P**.,** van Kooten, M., Lardière, O., Gamroth, G., Bradley, C. 2024 "An optical feasibility study for STARLITE: superluminous

tomographic atmospheric reconstruction with laser-beacons for imaging terrestrial exoplanets" *Proceedings of the SPIE*

*Mann, C., Marois, C., **Thompson, W.**, Lardière, O., Véran, J.-P. "Coherent differential imaging: squeezing additional imaging contrast behind the self-coherent camera on SPIDERS" *Proceedings of the SPIE*

Thompson, W., Johnson, A., Marois, C., Lardière, O., Grandmont, F., Hardy, T., Caputa, K., Bradley, C., Singh, G. 2023 "High-Spectral Resolution Dark Holes: Concept, Results, and Promise" *Proceedings of Adaptive Optics for Extremely Large Telescopes 7*

Johnson, A. B., **Thompson, W.**, Caputa, K., Grandmont, F., Marois, C., Hardy, C., Fitzsimmons, J., Lardière, O., Bradley, C. "Exoplanet Detection and Characterization: Development and Results of a New Generation Imaging Fourier Transform Spectrometer" *Proceedings of Adaptive Optics for Extremely Large Telescopes 7*

***Thompson, W.**, Marois, C., Singh, G., et al. 2022 *"*Performance of the Fast Atmospheric Self Coherent camera at the NEW-EARTH lab and a simplified measurement algorithm." *Proceedings of the SPIE*

Thompson. W., Marois, C. 2019 "Extremely Bright Orbital Guide Beacons for Extremely Large Telescopes." *Adaptive Optics for Extremely Large Telescopes 6*

*Li, D., **Thompson, W.,** Savransky, D., Marois, C. 2023 "Focal plane wavefront control for the Gemini Planet Imager 2.0 calibration system (CAL2)" *Proceedings of the SPIE*. Techniques and Instrumentation for Detection of Exoplanets XI vol. 12680.

*Singh, G., **Thompson, W.**, Lardière, O., Marois, C., N'Diaye, M., Johnson, A. B., Véran, J.P, Herriot, G., Gerard, B. L., Fu, Q., Heidrich , W. 2022 "Pupil-plane LLOWFS simulation and laboratory results from NEW-EARTH's high-contrast imaging testbed." *Proceedings of the SPIE*

*Marois, C., Lardière, O., **Thompson, W.,** Singh, G., Johnson, A., Hardy, T., Fitzsimmons, J., Gerard, B. L., Sivanandam, S., Thibault, S., Savransky, D., Bradley, C., Jensen-Clem, R., Demers, M., Fu, Q., Heidrich, W., N'Diaye M. 2022 "Deployment of focal plane WFS technologies on 8-m telescopes: from the Subaru SPIDERS pathfinder, to the facility-class GPI 2.0 CAL2 system." *Proceedings of the SPIE*

*Marois, C., Gerard, B., Lardière, O., Anthony, A., Bradley, C., Dunn, J., Fu, Q., Hardy, T., Heidrich, W., Herriot, G., Nielsen, E., Sivanandam, S., Sivransky, D., Thibault, S., **Thompson, W.**, Véran, J-P 2020 "Upgrading the Gemini Planet Imager calibration unit with a photon counting focal plane wavefront sensor" *Proceedings of the SPIE*. Adaptive Optics Systems VII vol. 11448

*Lardière, O., Marois, C., **Thompson, W.**, Singh, G., Johnson, A., Fitzsimmons, J., Hardy, T., N'diaye, M., Heidrich, W., Fu, Q., Brousseau, D., Thibault S. 2022 "Optical design of SPIDERS, a Subaru Pathfinder Instrument for Detecting Exoplanets & Retrieving Spectra." *Proceedings of the SPIE*

*Lardière, O., Marois, C., **Thompson, W.**, Singh, G., Johnson, A., Fitzsimmons, J., Hardy, T., N'diaye, M., Heidrich, W., Fu, Q., Brousseau, D., Thibault S. 2022 "Blinking the fringes, initial development and results of the Ultra-Low Speed Optical Chopper for the Self-Coherent Camera." *Proceedings of the SPIE*

*Lardière, O., Gerard, B., **Thompson, W.**, Marois, C., Véran, Jean-P., Blain, C., Heidrich, W., Fu, Q. 2020 "Optical design and preliminary results of NEW EARTH, first Canadian high-contrast imaging laboratory test bench." *Proceedings of the SPIE*

White Papers (1)

Marois, C., Gerard, B., **Thompson, W.**, Dong, R., Metchev, S., van der Marel, N., Sivanandam, S., Baron, F., Rowe, J., Chapman, S., Grandmont, F., Lee, E., Macintosh, B., Roberts, S., Benneke, B., Blain, C., Boley, A. C., Bradley, C., Burley, G., Butko, A., Cook, N., Cowan, N., Doyon, R., Goldblatt, C., Hardy, T., Lardiere, O., Matthews, B., Millar-Blanchar, M., Veran, J. P., Artigau, E., Thibault, S. 2020 "Exoplanet Imaging: a technological and scientific road-map for finding Life signatures on other Worlds." *Canadian Long Range Plan For Astronomy and Astrophysics White Paper*

Presentations (23)

Invited talks (5)

upcoming	*Astronomy department seminar (University of Washington)*
2024	"Orbit modelling to detect exoplanets" *Statistics department seminar (University of British Columbia)*
2024	"Orbit modelling to detect exoplanets" *Dominion Astrophysical Observatory Colloquium (Victoria)*
2023	"Review on spatial modulation techniques for coherent differential imaging" *Use of light coherence for high-contrast exoplanet imaging with ground-based telescopes (Paris)*
2022	**"**Deployment of focal plane wavefront sensing on 8-meter telescopes and beyond." *Wavefront Sensing in the VLT/ELT era VII (Porto)*

Contributed talks (7)

2024	"Real-time adaptive optics control with a high level programming language" *SPIE (Yokohama)*
2024	"Deploying focal plane wavefront sensing and coherent imaging at Subaru with SPIDERS, a pathfinder 4th generation planet imager" *Canadian Astronomical Society Annual General Meeting (Toronto)*
2023	"Deep orbital search for additional planets in the HR 8799 system." *AAS 241 (Seattle)*
2022	"Performance of the FAST Self Coherent Camera at the NEW-EARTH Lab and a Simplified SCC Measurement Algorithm." *SPIE Astronomical Telescopes + Instrumentation (Montreal)* recording link
2022	"AstroImages.jl" *JuliaCon* recording link
2022	"Julia for Adaptive Optics." *Julia in Astronomy & Astrophysics Research Symposium at JuliaCon*
2021	"Characterizing Exoplanets with an Imaging Fourier Transform Spectrograph", *Canadian Astronomical Society Annual General Meeting*

Misc. Seminars (2)

2022	"Fireflies, wobbles, sirens, and sunsets." *University of Victoria Summer Seminar Series*
2019	"Exoplanet Direct Imaging and the Search for HR8799 f." *University of Victoria Summer Seminar Series*

Panels and Interviews (3)

2022	Panelist at "Julia in Astronomy & Astrophysics Research Symposium." *JuliaCon*
2016	"Team FuelE.co from Queen's University wins Imagine Cup 2016 Online Finals Innovation Competition." *Canadian Developer Connection, Microsoft Channel 9*
2014	"School board roles out new mark tracking application developed by Ottawa students." *CBC Radio One Ottawa*

Poster Presentations (13)

2024	"SPIDERS: A pathfinder 4th generation planet imager" *SPIE (Yokohama)*
2024	"Joint modelling to discovery and characterise exoplanets: 51 Eri and Eps Eri seen with imaging, VLTI-GRAVITY, RV, and GAIA" *Canadian Astronomical Society Annual General Meeting (Toronto)*
2023	"High-Spectral Resolution Dark Holes: Concept, Results, and Promise" *Adaptive Optics for Extremely Large Telescopes 7 (Avignon)*
2023	"Octofitter: Uniting all exoplanet detection methods under a single code" *Canadian Astronomical Society Annual General Meeting (Penticton)*
2022	"Limits on additional planets in HR8799: Orbital detection through 12 years of L-band imaging at Keck." *In the Spirit of Lyot (Leiden)*
2022	"Combining Direct Imaging with orbital motion, radial velocity, and GAIA." *Canadian Astronomical Society Annual General Meeting (online)*
2022	"Imaging Planets with Kepler's Laws." *NRC Herzberg Jamboree (online)*
2021	"Soft Realtime Control of an Exoplanet Imaging Instrument." JuliaCon *(online)*

2020	"Searching for Additional Outer Planets Around HR8799." *Canadian Astronomical Society Annual General Meeting (online)*
2019	"An EMCCD for Wavefront Sensing at 3kfps." *NTCO AGM (Penticton)*
2019	"Searching the HR8799 system for additional planets with forward-model SNR optimization." *In the Spirit of Lyot (Tokyo)*
2019	"Is There Another Planet Hiding Around HR8799?" *CASCA (Montreal)*
2019	"Extremely Bright Orbital Guide Beacons for Extremely Large Telescopes." *AO4ELT6 (Quebec City)*
2019	"Is There Another Planet Hiding Around HR8799?" *New Horizons in Planetary Systems (Victoria)*

Experience

Mentoring (4)

2024	Kaitlyn Hessel (masters)
2024	**Andre Fogal** (masters)
2023	**Angus Bews** (undergraduate) *Remote monitoring of the SPIDERS direct imaging instrument*
2022	**Jensen Lawrence** (undergraduate) *Exoplanet radial velocity modelling and Bayesian simulation based calibration.*

Teaching Assistant (6)

2023	University of Victoria, PHYS248: "Computer Assisted Mathematics and Physics"
2022	University of Victoria, PHYS248: "Computer Assisted Mathematics and Physics"
2020	University of Victoria, PHYS248: "Computer Assisted Mathematics and Physics"
2020	University of Victoria, ASTR101: "Introduction to the Night Sky"
2019	University of Victoria, PHYS248: "Computer Assisted Mathematics and Physics"
2019	University of Victoria, ASTR101: "Introduction to the Night Sky"

Observing Experience

VLTI/GRAVITY	2 nights × 4 telescopes	ExoGRAVITY survey and follow-up of HR8799 f
Keck II/NIRC2	9 quarter nights	HR8799 planet search (Co-I)
Keck II/NIRC2	2 half nights	Astrometric Monitoring of Imaged Planets (Co-I)
Keck II/NIRC2	1 half night	Thermal Imaging of AF Lep b (Co-I)
Gemini Planet Imager	2 nights	Gemini Planet Imager Exoplanet Survey

Service & Outreach

2023	Public outreach talk: "Seeing is believing: capturing images of nearby solar systems" at Royal Astronomical Society Vancouver Island Summer Star Party.
2023	co-host of "Introduction to Julia Workshop" at AAS (Seattle)
2019-2022	CASCA Graduate Student Committee representative for the University of Victoria
2020-2022	Mentor to incoming graduate students
2022	Created orbit animations for public outreach with more than 1M online impressions.
2022	Creator and maintainer of the @JuliaAstro official Twitter account
2021	"Introduction to Julia for astronomy" Software Workshop
2019	Judge, Vancouver Island Regional Science Fair
2019	Volunteer for International Astronomy Day, UVic Observatory / Royal BC Museum
2018	"Next Level Python" Software Workshop
2017	Volunteer, Canadian Association of Physicists Congress

Employment History   (total 5.5 years full time equivalent)

2023-present Herzberg Astronomy and Astrophysics, Herzberg Instrument Science Fellow (Associate Research Officer)

2020   **NRC Herzberg Astronomy and Astrophysics, Intern (ATD)**
Developed control software for the NEW-EARTH Lab VIPER bench and demonstrated closed loop control of the self-coherent camera.

2019   **Nüvü Cameras, Intern via NSERC CREATE: New Technologies for Canadian Observatories**
Contributed to development of a high speed, electron multiplying CCD camera (EMCCD) for adaptive optics applications.

2017–2018 Ciena, Submarine Network Platform Solutions
Continued lead development of software for characterizing submarine fiber optic cables and optimization of optical modem performance.

2017   Summer Student, Queen's University Department of Physics
Education research and lab development for undergraduate Physics labs.

2016   Ciena, Submarine Optical Systems R&D
Development of software for optical spectrum analysis, instrument control, fiber link characterization, and signal optimization.

2015   Ciena, Submarine Optical Systems R&D
Spectral analysis, instrument control, dispersion compensation, and optimization of optical launch power to balance SNR against effects of non-linear optical propagation.

2014   Ottawa-Carleton District School Board
Design and implementation of a student grade tracking & visualization system.

2012 – 2013 Semtech Corporation
Design and implementation of automated firmware flashing and testing framework.

2010 – 2012 Magor Communications
Design and implementation of automated testing framework for a multi-party video conferencing product.

Selected Software Contributions
- Official Julia in Astronomy Tutorial Series
- Contributions to the Canadian Astronomical Data Centre's Science Platform
- Octofitter.jl: radial velocity, astrometry, proper motion, and direct imaging modelling software
- SNAP: Signal to Noise Analysis Pipeline for reducing direct imaging data

- PairPlots.jl : statistical visualization package
- PlanetOrbits.jl : orbital modelling and visualization package
- AstroImages.jl : image processing, visualization, FITS, and astronomical coordinate handling package