

Philippe Landry

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CURRENT POSITION

POSTDOCTORAL FELLOW • UNIVERSITY OF TORONTO

Sep 2021 - Present

Postdoctoral fellow at the **Canadian Institute for Theoretical Astrophysics**; member of the **LIGO Scientific Collaboration** and **Cosmic Explorer**

RESEARCH INTERESTS

Gravitational waves • Neutron stars • Compact object populations • General relativity • Ultra-dense matter • Relativistic tides • Post-Newtonian theory • Perturbation theory

EDUCATION

PHD, PHYSICS

UNIVERSITY OF GUELPH • 2017

Advisor: Eric Poisson

Thesis: Tidal response of a rotating neutron star in general relativity

MSC, PHYSICS

UNIVERSITY OF GUELPH • 2014

Advisor: Eric Poisson

Thesis: Tidal deformations of compact bodies in general relativity

BSC (HONS.), PHYSICS

QUEEN'S UNIVERSITY • 2012

Advisor: Kayll Lake

Thesis: McVittie solution with a negative cosmological constant

RESEARCH EXPERIENCE

POSTDOCTORAL ASSOCIATE • CALIFORNIA STATE UNIVERSITY, FULLERTON

Sep 2019 - Aug 2021

Postdoctoral research associate at the **Nicholas & Lee Begovich Center for Gravitational Wave Physics & Astronomy**; co-authored the NSF-mandated horizon study for **Cosmic Explorer**

POSTDOCTORAL SCHOLAR • UNIVERSITY OF CHICAGO

Sep 2017 - Aug 2019

Postdoctoral scholar at the **Enrico Fermi Institute** and associate fellow at the **Kavli Institute for Cosmological Physics**; worked in gravitational wave astronomy within the **LIGO Scientific Collaboration**

GRADUATE RESEARCH ASSISTANT • UNIVERSITY OF GUELPH

Sep 2012 - Aug 2017

Contributed to the development of the theory of relativistic tides in compact binary systems, including gravitomagnetic and spin effects

UNDERGRADUATE RESEARCHER • QUEEN'S UNIVERSITY

Sep 2011 - Apr 2012

Studied the global structure of an exact solution in general relativity for an undergraduate thesis

UNDERGRADUATE RESEARCHER • ROYAL MILITARY COLLEGE OF CANADA

May - Aug 2011

Worked on an observational space science project about derelict satellites for **Defence Research & Development Canada** as part of an NSERC undergraduate student research award

RESEARCH GRANTS

NSF RUI AWARD • NATIONAL SCIENCE FOUNDATION

Jul 2021 - Present

Co-PI of the NSF Research in Undergraduate Institutions grant PHY-2110441, “RUI: Neutron-Star Matter in the LIGO A+ Era and Beyond,” developed with PI Jocelyn Read and funded at \$225k over three years to support research at Cal State Fullerton

FELLOWSHIPS & AWARDS

NSERC POSTDOCTORAL FELLOWSHIP • NSERC

Sep 2017 - Aug 2019

Fellowship awarded by the Natural Sciences & Engineering Research Council of Canada for research potential and academic achievement; held at the University of Chicago

DTP/WITP THESIS PRIZE • CANADIAN ASSOCIATION OF PHYSICISTS

Jun 2018

Award for best PhD thesis by a graduate of a Canadian university in the field of theoretical physics

ALEXANDER GRAHAM BELL CANADA GRADUATE SCHOLARSHIP • NSERC

May '16 - Aug '17

Scholarship awarded for research potential and academic achievement; held at the University of Guelph

DEAN'S SCHOLARSHIP • UNIVERSITY OF GUELPH

Sep 2012 - Aug 2017

Scholarship for academic achievement

HARTLE AWARD • GR21

Jul 2016

Award for best student talk in section of GR21 gravity conference at Columbia University

ONTARIO GRADUATE SCHOLARSHIP • PROVINCE OF ONTARIO

May 2015 - Apr 2016

Scholarship for academic achievement held at the University of Guelph

BEST STUDENT TALK • 17TH EASTERN GRAVITY MEETING

Jun 2014

Award for best student talk at gravity conference at West Virginia University

UNDERGRADUATE STUDENT RESEARCH AWARD • NSERC

May - Aug 2011

Research fellowship held at the Royal Military College of Canada

TEACHING, SERVICE & OUTREACH

CHAIR • LVK EXTREME MATTER R&D GROUP

Jul 2022 - Present

Chair the LIGO-Virgo-KAGRA Collaboration's working group on neutron stars; manage related collaboration analyses, code review and papers, lead biweekly group meetings

GROUP LEADER • CITA FOCUS GROUP ON GRAVITATIONAL WAVES

Sep 2021 - Present

Founded gravitational-wave astronomy discussion group for researchers at CITA and national affiliates; coordinate and lead biweekly group meetings

REFEREE • AAS, PHYSICAL REVIEW, NATURE, SCIENCE

Sep 2017 - Present

Referee scientific articles for The Astrophysical Journal, The Astrophysical Journal Letters, Physical Review D, Physical Review Letters, Nature and Science

SCIENTIFIC ORGANIZING COMMITTEE MEMBER • PAX VIII

Feb - Aug 2022

Served on the scientific organizing committee for the 8th Physics & Astrophysics at the Extreme (PAX) workshop at MIT; organized and chaired a panel on the neutron star equation of state

UNDERGRADUATE RESEARCH ADVISOR • UNIVERSITY OF TORONTO

Sep 2021 - Aug 2022

Supervised a summer undergraduate research fellowship project, and two undergraduate research theses in neutron star astrophysics for the Astronomy & Astrophysics Department's AST425 course

LECTURER • LIFELONG LEARNING LECTURES

Sep 2018 - Dec 2020

Participated in lifelong learning programs, giving public outreach talks on the topic of tides in Chicago and on the topic of gravitational waves in Fullerton

CO-EDITOR • HUMANS OF LIGO BLOG

Jul 2018 - Dec 2020

Conducted interviews and curated posts for public outreach blog profiling individual LIGO scientists

SPACE VISUALIZATION LAB PRESENTER • ADLER PLANETARIUM

Jan 2018 - Aug 2019

Regularly volunteered as science presenter for Astronomy Conversations public outreach program

LECTURER • UNDERGRADUATE PHYSICS READING SEMINAR

Oct - Dec 2018

Helped design an interest-based non-credit course on computational methods in gravitational wave astrophysics for advanced undergraduates; delivered two lectures and devised a final assignment

COMMITTEE MEMBER • GUELPH/PERIMETER INSTITUTE FACULTY SEARCH

Jan 2016 - Apr 2017

Student representative on the joint University of Guelph/Perimeter Institute search committee for two faculty positions in theoretical physics

SEMINAR SERIES ORGANIZER • UNIVERSITY OF GUELPH

Sep 2014 - Apr 2017

Co-founded, coordinated and secured funding for a series of outreach talks delivered by graduate students and aimed at physics undergraduates; also personally delivered several talks

COMMITTEE MEMBER • GWPI COORDINATING COMMITTEE

Sep 2014 - Apr 2017

Student representative on the graduate program committee for the Guelph-Waterloo Physics Institute and member of the 2016 institute director search committee

TEACHING ASSISTANT • UNIVERSITY OF GUELPH

Sep 2012 - Apr 2017

Served as a teaching assistant for undergraduate courses in introductory physics, mechanics and electromagnetism, leading tutorials, supervising laboratories, grading assignments and exams, and occasionally delivering lectures

POSTER SESSION ORGANIZER • UNIVERSITY OF GUELPH

May - Aug 2013

Organized a poster session for undergraduate summer researchers in the physical sciences

AFFILIATIONS

SCIENTIFIC COLLABORATIONS

LIGO Scientific Collaboration • Cosmic Explorer

PROFESSIONAL SOCIETIES

American Physical Society • American Astronomical Society • International Society on General Relativity & Gravitation • Canadian Association of Physicists

TALKS

INVITED

- ¹ Probing neutron stars with gravitational waves. **Department of Physics, Engineering Physics & Astronomy Seminar**, Queen's University (2022).
- ² Prospects and challenges for dense matter studies with gravitational waves. **ACFI Workshop: The Future of Neutron Rich Matter, From Neutron Skins to Neutron Stars**, University of Massachusetts - Amherst (2022).
- ³ Extreme matter in Cosmic Explorer. **GWPAC 10-Year Anniversary Meeting: Exploring Extreme Matter and Spacetimes with Gravitational Waves**, Cal State Fullerton (2022).
- ⁴ Panel: Nuclear physics. **PAX VIII Workshop**, MIT (2022).
- ⁵ Gravitational-wave constraints on neutron star matter from the third LIGO-Virgo observing run. **AAS 240**, Pasadena CA, online (2022).
- ⁶ The high-density equation of state and maximum mass of neutron stars. **INT Workshop 20R-1b**, Institute for Nuclear Theory (2022).
- ⁷ Neutron star binaries: mergers, matter and modeling. **Storming the Gravitational-Wave Frontier**, Kavli Institute for Theoretical Physics (2022).
- ⁸ Probing neutron star matter with gravitational waves. **CITA Seminar**, CITA, online (2021); **UVA Gravity Seminar**, University of Virginia, online (2021).
- ⁹ Mapping the QCD phase diagram with LIGO's neutron star mergers. **Nuclear & Particle Physics Seminar**, Rice University, online (2021).
- ¹⁰ Panel: Neutron stars and dense matter. **JINA Horizons Workshop**, Joint Institute for Nuclear Astrophysics, online (2020).
- ¹¹ Dense matter science with Cosmic Explorer. **1st CE Conference**, Penn State, online (2020).
- ¹² Compact binaries as probes of dense matter and dark matter. **Snowmass 2021 Community Planning Meeting**, online (2020).
- ¹³ Panel: QCD matter in equilibrium. **From Heavy Ion Collisions to Neutron Stars**, University of Illinois at Urbana-Champaign, online (2020).
- ¹⁴ GW190814: An unexpected compact binary coalescence from the mass gap. **DESY Astroparticle Seminar**, DESY Zeuthen, online (2020).

SKILLS

LANGUAGES

English • French • Italian

PROGRAMMING

Python • C

COMPUTER ALGEBRA

Mathematica • Maple • Matlab

- ¹⁵ GW190814: Gravitational waves from the coalescence of a $23 M_{\odot}$ black hole with a $2.6 M_{\odot}$ compact object. **LIGO-Virgo-Kagra Webinar**, online (2020).
- ¹⁶ Insights on neutron-star matter from gravitational waves, hotspots and massive pulsars. **CaJAGWR Seminar**, Caltech (2020).
- ¹⁷ Neutron star tides and quasi-universal relations. **Merging Visions**, Kavli Institute for Theoretical Physics (2019).
- ¹⁸ New developments in gravitational-wave inference of the neutron star equation of state. **IUCAA Seminar**, Inter-University Center for Astronomy & Astrophysics (2019).
- ¹⁹ Inferring the neutron star equation of state from gravitational waves: a nonparametric approach. **Center for Gravitation, Cosmology & Astrophysics Seminar**, University of Wisconsin - Milwaukee (2018).
- ²⁰ Tides in spinning neutron star binaries. **Theory Canada 13**, St Francis Xavier University (2018).
- ²¹ Dynamical tidal response of a rotating neutron star. **Canadian Institute for Theoretical Astrophysics Seminar**, University of Toronto (2016).
- ²² Photometry of derelict GEO and GPS satellites for rotation rate characterization. **Physics Department Colloquium**, Royal Military College (2011).

CONTRIBUTED

- ²³ The mass distribution of neutron stars in gravitational-wave binaries. **APS April Meeting**, New York NY (2022).
- ²⁴ The Cosmic Explorer Horizon Study: Science, observatories, and community. **SACNAS National Diversity in STEM Digital Conference**, online (2021).
- ²⁵ Distinguishing the nature of the lighter compact object in the binary merger GW190814. **APS April Meeting**, online (2021).
- ²⁶ Constraints on the neutron-star equation of state with gravitational-wave and pulsar observations. **APS April Meeting**, online (2020).
- ²⁷ A nonparametric approach to gravitational-wave inference of the neutron star equation of state. **GR22 + Amaldi13**, University of Valencia (2019).
- ²⁸ Inferring neutron star properties from GW170817 with universal relations. **28th Midwest Relativity Meeting**, University of Wisconsin - Milwaukee (2018); **APS April Meeting**, Denver CO (2019).
- ²⁹ Rotational-tidal phasing of the binary neutron star waveform. **18th Atlantic General Relativity Meeting**, St Francis Xavier University (2018).
- ³⁰ Extended I-Love relations for slowly rotating neutron stars. **27th Midwest Relativity Meeting**, University of Michigan (2017); **APS April Meeting**, Columbus OH (2018).
- ³¹ Dynamical tidal response of a rotating neutron star. **GR21**, Columbia University; **26th Midwest Relativity Meeting**, Perimeter Institute (2016); **APS April Meeting**, Washington DC (2017).
- ³² Tidal deformation of a slowly rotating compact body. **International Conference on Black Holes**, University of Toronto; **General Relativity & Gravitation: A Centennial Perspective**, Penn State; **25th Midwest Relativity Meeting**, Northwestern University (2015).
- ³³ Tidal deformation of an irrotational fluid body. **18th Eastern Gravity Meeting**, Rochester Institute of Technology; **Fields Institute Focus Program on General Relativity**, University of Toronto (2015).

- ³⁴ Relativistic theory of surficial Love numbers. **17th Eastern Gravity Meeting**, West Virginia University; **24th Midwest Relativity Meeting**, Oakland University (2014).
- ³⁵ Tides in higher-dimensional Newtonian gravity. **16th Eastern Gravity Meeting**, University of Toronto; **23rd Midwest Relativity Meeting**, University of Wisconsin - Milwaukee (2013).

PUBLIC

- ³⁶ Listening for black holes and neutron stars: LIGO's recent gravitational wave discoveries. **Osher Lifelong Learning Institute Lecture**, Cal State Fullerton (2020).
- ³⁷ Tides in the solar system and the universe. **Art of Science Lecture Series**, Agitator Art Gallery, Chicago (2019).
- ³⁸ Tides: from the seas to the stars. **Lifelong Learning Lecture Series**, Chicago Cultural Center (2018); Sulzer Regional Library, Chicago (2019).
- ³⁹ Neutron stars: dense, strange and not too bright. **Astronomy on Tap**, Marz Community Brewing, Chicago (2018).
- ⁴⁰ Gravitational waves and transient astronomy: a discussion of GW170817. **Public Lecture**, University of Chicago (2017).

PRESS

- ¹ F. Nicot, L'étoile à neutrons, astre de tous les extrêmes. **Sciences et avenir**, 2 Oct 2021.
- ² M. Koren, An Event So Wild It Could Make Anyone Feel Cosmically Small. **The Atlantic**, 29 Jun 2021.
- ³ D. Cano Ramos, Neutron Stars Swallowed by Black Holes in Rare Cosmic Collisions. **CSUF News Service**, 29 Jun 2021.
- ⁴ C. Wood, Mystery Object Blurs Line between Neutron Stars and Black Holes. **Scientific American**, 30 Jun 2020.
- ⁵ D. Cano Ramos, CSUF Scientists Unravel Mystery Merger in the Universe. **CSUF News Service**, 23 Jun 2020.
- ⁶ C. Wood, Why are big neutron stars like Tootsie Pops? **Popular Science**, 5 Jun 2020.

PUBLICATIONS

PEER-REVIEWED

- ¹ V. Srivastava *et al.* [incl. **P. Landry**], Science-driven Tunable Design of Cosmic Explorer Detectors, **Astrophys. J.** **931**, 1 (2022), [arXiv:2201.10668](#).
- ² I. Legred, K. Chatziioannou, R. Essick & **P. Landry**, Implicit correlations within phenomenological parametric models of the neutron star equation of state, **Phys. Rev. D** **105**, 043016 (2022), [arXiv:2201.06791](#).
- ³ R. Essick, **P. Landry**, A. Schwenk & I. Tews, A Detailed Examination of Astrophysical Constraints on the Symmetry Energy and the Neutron Skin of ^{208}Pb with Minimal Modeling Assumptions, **Phys. Rev. C** **104**, 065804 (2021), [arXiv:2107.05528](#).
- ⁴ **P. Landry** & J. S. Read, The Mass Distribution of Neutron Stars in Gravitational-wave Binaries, **Astrophys. J. Lett.** **921**, L25 (2021), [arXiv:2107.04559](#).

- ⁵ R. Essick, I. Tews, **P. Landry** & A. Schwenk, Astrophysical Constraints on the Symmetry Energy and the Neutron Skin of ^{208}Pb with Minimal Modeling Assumptions, **Phys. Rev. Lett.** **127**, 192701 (2021), [arXiv:2102.10074](#).
- ⁶ I. Legred, K. Chatziioannou, R. Essick, S. Han & **P. Landry**, Impact of the PSR J0740+6620 radius constraint on the properties of high-density matter, **Phys. Rev. D** **105**, 063003 (2021), [arXiv:2106.05313](#).
- ⁷ C. Stachie *et al.* [incl. **P. Landry**], Predicting electromagnetic counterparts using low-latency gravitational-wave data products, **Mon. Not. R. Astron. Soc.** **505**, 4235 (2021), [arXiv:2103.01733](#).
- ⁸ R. Abbott *et al.* [incl. **P. Landry**] (LIGO Scientific Collaboration, Virgo Collaboration and KAGRA Collaboration), Observation of Gravitational Waves from Two Neutron Star-Black Hole Coalescences, **Astrophys. J.** **915**, L5 (2021), [arXiv:2106.15163](#).
- ⁹ R. Essick, I. Tews, **P. Landry**, S. Reddy & D. Holz, Direct astrophysical tests of chiral effective field theory at supranuclear densities [Editor's Suggestion], **Phys. Rev. C** **102**, 055803 (2020), [arXiv:2004.07744](#).
- ¹⁰ R. Essick & **P. Landry**, Discriminating between Neutron Stars and Black Holes with Imperfect Knowledge of the Maximum Neutron Star Mass, **Astrophys. J.** **904**, 80 (2020), [arXiv:2007.01372](#).
- ¹¹ **P. Landry**, R. Essick & K. Chatziioannou, Nonparametric constraints on neutron star matter with existing and upcoming gravitational wave and pulsar observations, **Phys. Rev. D** **101**, 123007 (2020), [arXiv:2003.04880](#).
- ¹² R. Abbott *et al.* [incl. **P. Landry**] (LIGO Scientific Collaboration and Virgo Collaboration), GW190814: Gravitational Waves from the Coalescence of a 23 Solar Mass Black Hole with a 2.6 Solar Mass Compact Object, **Astrophys. J. Lett.** **896**, L44 (2020), [arXiv:2006.12611](#).
- ¹³ R. Essick, **P. Landry** & D. Holz, Nonparametric inference of neutron star composition, equation of state, and maximum mass with GW170817, **Phys. Rev. D** **101**, 063007 (2020), [arXiv:1910.09740](#).
- ¹⁴ B. P. Abbott *et al.* [incl. **P. Landry**] (LIGO Scientific Collaboration and Virgo Collaboration), GW190425: Observation of a Compact Binary Coalescence with Total Mass $\sim 3.4 M_{\odot}$, **Astrophys. J. Lett.** **892**, L3 (2020), [arXiv:2001.01761](#).
- ¹⁵ B. P. Abbott *et al.* [incl. **P. Landry**] (LIGO Scientific Collaboration and Virgo Collaboration), Model comparison from LIGO-Virgo data on GW170817's binary components and consequences for the merger remnant, **Class. Quantum Grav.** **37**, 045006 (2020), [arXiv:1908.01012](#).
- ¹⁶ B. Kumar & **P. Landry**, Inferring neutron star properties from GW170817 with universal relations, **Phys. Rev. D** **99**, 123026 (2019), [arXiv:1902.04557](#).
- ¹⁷ **P. Landry** & R. Essick, Nonparametric inference of the neutron star equation of state from gravitational wave observations, **Phys. Rev. D** **99**, 084049 (2019), [arXiv:1811.12529](#).
- ¹⁸ M. Lagos, M. Fishbach, **P. Landry** & D. Holz, Standard sirens with a running Planck mass, **Phys. Rev. D** **99**, 083504 (2019), [arXiv:1901.03321](#).
- ¹⁹ B. P. Abbott *et al.* [incl. **P. Landry**] (LIGO Scientific Collaboration and Virgo Collaboration), Properties of the binary neutron star merger GW170817, **Phys. Rev. X** **9**, 011001 (2019), [arXiv:1805.11579](#).

- ²⁰ **P. Landry** & B. Kumar, Constraints on the Moment of Inertia of PSR J0737-3039A from GW170817, **Astrophys. J. Lett.** **868**, L22 (2018), [arXiv:1807.04727](#).
- ²¹ B. P. Abbott *et al.* [incl. **P. Landry**] (LIGO Scientific Collaboration and Virgo Collaboration), GW170817: Measurements of Neutron Star Radii and Equation of State, **Phys. Rev. Lett.** **121**, 161101 (2018), [arXiv:1805.11581](#).
- ²² J. Gagnon-Bischoff, S. Green, **P. Landry** & N. Ortiz, Extended I-Love relations for slowly rotating neutron stars, **Phys. Rev. D** **97**, 064042 (2018), [arXiv:1711.05694](#).
- ²³ **P. Landry**, Tidal deformation of a slowly rotating material body: Interior metric and Love numbers, **Phys. Rev. D** **95**, 124058 (2017), [arXiv:1703.08168](#).
- ²⁴ **P. Landry** & E. Poisson, Dynamical response to a stationary tidal field, **Phys. Rev. D** **92**, 124041 (2015), [arXiv:1510.09170](#).
- ²⁵ **P. Landry** & E. Poisson, Gravitomagnetic response of an irrotational body to an applied tidal field, **Phys. Rev. D** **91**, 104026 (2015), [arXiv:1504.06606](#).
- ²⁶ **P. Landry** & E. Poisson, Tidal deformation of a slowly rotating material body: External metric, **Phys. Rev. D** **91**, 104018 (2015), [arXiv:1503.07366](#).
- ²⁷ **P. Landry** & E. Poisson, Relativistic theory of surficial Love numbers, **Phys. Rev. D** **89**, 124011 (2014), [arXiv:1404.6798](#).
- ²⁸ **P. Landry**, M. Abdelqader & K. Lake, McVittie solution with a negative cosmological constant, **Phys. Rev. D** **86**, 084002 (2012), [arXiv:1207.6350](#).

WHITE PAPERS

- ²⁹ A. Lovato *et al.* [incl. **P. Landry**], Long Range Plan: Dense matter theory for heavy-ion collisions and neutron stars, [arXiv:2211.02224](#) (2022).
- ³⁰ S. Bogdanov *et al.* [incl. **P. Landry**], Snowmass 2021 Cosmic Frontier White Paper: The Dense Matter Equation of State and QCD Phase Transitions, [arXiv:2209.07412](#) (2022).
- ³¹ H. Schatz *et al.* [incl. **P. Landry**], Horizons: Nuclear Astrophysics in the 2020s and Beyond, [arXiv:2205.07996](#) (2022).
- ³² M. Evans *et al.* [incl. **P. Landry**], A Horizon Study for Cosmic Explorer: Science, Observatories, and Community, [arXiv:2109.09882](#) (2021).

PREPRINTS

- ³³ S. Biscoveanu, **P. Landry** & S. Vitale, Population properties and multimessenger prospects of neutron star-black hole mergers following GWTC-3, [arXiv:2207.01568](#) (2022).
- ³⁴ B. P. Abbott *et al.* [incl. **P. Landry**], The population of merging compact binaries inferred using gravitational waves through GWTC-3, [arXiv:2111.03634](#) (2021).
- ³⁵ **P. Landry**, Rotational-tidal phasing of the binary neutron star waveform, [arXiv:1805.01882](#) (2018).