

# Garett Brown

PHYSICIST · COMPUTATIONAL

Toronto, ON, Canada

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## Education

### PhD in Physics

Toronto, Ontario, Canada

April 2024 (anticipated)

UNIVERSITY OF TORONTO

- GPA 3.93/4.0
- Advisor: Hanno Rein
- Admissions Award recipient
- E.F. Burton Fellowship recipient
- Dr John Romanko Graduate Fellowship recipient
- Cray Fellowship in Physics recipient
- 2020 Compute Canada Resources for Research Groups – 60 core years
- 2022 Compute Canada Resources for Research Groups – 78 core years
- 2023 Compute Canada Resources for Research Groups – 50 core years
- Ontario Graduate Scholarship (OGS), 2020-2021
- DPES Teaching Fellowship Program, 2022
- DPES Graduate Student Best Paper Award, 2023
- NSERC - PGSD, 2021-2024

### BS in Physics

Provo, Utah, USA

April 2017

BRIGHAM YOUNG UNIVERSITY

- **Minors in Mathematics and Computer Science**
- GPA 3.96/4.0
- *Magna Cum Laude*
- University Honors with Thesis; Manuel Berrondo (advisor)
- Member of The Honor Society of Phi Kappa Phi
- Dean's List – College of Physical and Mathematical Sciences
- BYU Astronomical Society President
- John Einar Anderson Scholarship and Brigham Young Full-Tuition Merit Scholarship recipient

### Pembroke-Kings Programme

Cambridge, UK

June-August 2016

UNIVERSITY OF CAMBRIDGE

- First Class Honours
- Member of the Pembroke Circle
- Courses in world politics, mathematics, and research in theoretical physics
- Worked independently to reduce and combine sophisticated models for application to gravitational wave detection using Bayesian compressed sensing; reported and counselled weekly with research advisor Dr. Priscilla Canizares.

## Publications

### General relativistic precession and the long-term stability of the solar system

MNRAS

Mar. 2023

GARETT BROWN, HANNO REIN

- MNRAS, Volume 521, Issue 3, May 2023, Pages 4349–4355
- arXiv: 2303.05567

### On the long-term stability of the Solar System in the presence of weak perturbations from stellar flybys

MNRAS

Jun. 2022

GARETT BROWN, HANNO REIN

- MNRAS, Volume 515, Issue 4, October 2022, Pages 5942–5950
- arXiv: 2206.14240

### A Repository of Vanilla Long-term Integrations of the Solar System

RNAAS

Dec. 2020

GARETT BROWN, HANNO REIN

- RNAAS, Volume 4, Number 12, 9 December 2020
- arXiv: 2012.05177

## On the accuracy of symplectic integrators for secularly evolving planetary systems

MNRAS

HANNO REIN, **GARETT BROWN**, DANIEL TAMAYO

Aug. 2019

- MNRAS, Volume 490, Issue 4, December 2019, Pages 5122–5133
- arXiv: 1908.03468

## High order symplectic integrators for planetary dynamics and their implementation in REBOUND

MNRAS

HANNO REIN, DANIEL TAMAYO, **GARETT BROWN**

July 2019

- MNRAS, Volume 489, Issue 4, November 2019, Pages 4632–4640
- arXiv: 1907.11335

## Hybrid Symplectic Integrators for Planetary Dynamics

MNRAS

HANNO REIN, DAVID M. HERNANDEZ, DANIEL TAMAYO, **GARETT BROWN**, EMILY ECKELS, EMMA HOLMES, MICHELLE

Mar. 2019

LAU, REJEAN LEBLANC, ARI SILBURT

- MNRAS, Volume 485, Issue 4, June 2019, Pages 5490–5497
- arXiv: 1903.04972

## Beyond Phase Transitions: an Algorithmic Approach to Flocking Behavior

BYU Thesis

**GARETT BROWN**, MANUEL BERRONDO

Apr. 2017

- BYU Thesis/Capstone Archive ([physics.byu.edu/department/theses//berrondo/2017](https://physics.byu.edu/department/theses//berrondo/2017))

## Research Experience

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### Department of Physics, University of Toronto

Toronto, Ontario, Canada

RESEARCH ASSISTANT

Jan. 2018 - Present

- Computational physicist developing additional software, techniques, and algorithms for REBOUND motivated by the long-term (secular) dynamics of planetary systems.
- Participated in mentoring 3 undergraduate students from the Fields Summer Undergraduate Research Program 2018, developing and evaluating a fully symplectic, hybrid, Wisdom-Holman n-body integrator with switching method for close encounters. (See Publications below)

### Department of Physics and Astronomy, Brigham Young University

Provo, Utah, USA

RESEARCH ASSISTANT

Jan. 2014 - Aug. 2017

- University Honors Thesis titled, “Beyond Phase Transitions: an Algorithmic Approach to Flocking Behavior” based on independent original research done with research advisor, Dr. Manuel Berrondo.
- Developed and coded algorithms for modeling and analyzing dynamic systems.

## Teaching Experience

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### Department of Physics, University of Toronto

Toronto, Ontario, Canada

TEACHING ASSISTANT

Sep. 2017 - Present

- Created and tested course development four (4) labs for undergraduate practical astronomy course. Utilizing Unistellar telescopes to provide hands-on experience for observational astronomy techniques.
- Planned and executed tutorial sessions for students taking Classical Mechanics course involving ordinary differential equations.
- Practicals, tutorials, and discussions leader for introductory physics and life science students.

PHYSICS OUTREACH COMMITTEE

Sep. 2018 - Aug. 2022

- Led graduate students in the department of physics in multiple public outreach activities to local high school students.
- Led activities and discussions relating to gravitational waves, gravitational lensing, projectile motion, and university academic life.
- Since the COVID-19 pandemic, I have created four (4) online programming-focused outreach activities aimed towards grade 6 students, grade 12 students, and every age in between.

### Department of Physics and Astronomy, Brigham Young University

Provo, Utah, USA

LAB MAINTENANCE ASSISTANT

Sep. 2014 - Aug. 2017

- Designed, built, and installed vacuum lab equipment, including the construction of a velocity/Wein filter, a classroom lab demonstration vapor deposition system (aluminum onto glass), assisting in the repair of a 2MeV particle accelerator, and the installation of pipelines for spontaneously combustible gas (silane).
- Repaired and maintained oil mechanical roughing vacuum pumps; leak tested laboratory research vacuum equipment.
- Taught and developed curriculum under professor supervision for a lab class on vacuum system design and operation.
- Simplified the lecture component by weaving it into the hands-on building of a two stage vacuum system.

## TEACHING ASSISTANT

Sep. 2013 - Apr. 2017

- Tutored students from all majors and backgrounds in all aspects of introductory undergraduate physics and calculus including Newtonian physics, special relativity, electrostatics, electromagnetism, circuits, waves, optics, fluid dynamics, thermodynamics, topics in modern physics, and descriptive astronomy.
- Graded students' assignments and tests; aided professor in classroom, lectured in professor's absence.
- Operated non-motorized 12" Dobsonian telescopes for introductory descriptive astronomy course. Responsible for locating astronomical objects such as planets, galaxies, open clusters, globular clusters, binary star systems, and comets for students to observe as part of their lab projects.

## Presentations

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### DPS54

London, Ontario, Canada

#### TOO CLOSE FOR COMFORT

4 Oct. 2022

- Presentation (Submitted)
- American Astronomical Society's (AAS) 54th annual meeting for the Division of Planetary Sciences (DPS).
- Summary: We explore stellar flyby scenarios that are too weak to immediately destabilize the Solar System but are nevertheless strong enough to measurably perturb its secular dynamical state. We show that altering the semi-major axis of Neptune by as little as 0.1% can increase the likelihood of instability by ten times.

### CITA Planet Day

Toronto, Ontario, Canada

#### TOO CLOSE FOR COMFORT

9 Aug. 2022

- Presentation (Submitted)
- A Canada-wide symposium on the formation, composition, and dynamics of planets and planetary systems.
- Summary: We explore stellar flyby scenarios that are too weak to immediately destabilize the Solar System but are nevertheless strong enough to measurably perturb its secular dynamical state. We show that altering the semi-major axis of Neptune by as little as 0.1% can increase the likelihood of instability by ten times.

### ERES VII

State College, Pennsylvania, USA

#### SMALL CHANGES WITH BIG CONSEQUENCES: SOLAR SYSTEM STABILITY

1 Aug. 2022

- Poster (Submitted)
- The seventh annual Emerging Researchers in Exoplanet Science (ERES) Symposium. ERES is aimed at early career scientists working in all branches of exoplanetary science and related disciplines.
- Summary: We explore stellar flyby scenarios that are too weak to immediately destabilize the Solar System but are nevertheless strong enough to measurably perturb its secular dynamical state. We show that altering the semi-major axis of Neptune by as little as 0.1% can increase the likelihood of instability by ten times.

### ERES VI

Princeton University - Online

#### QUANTIFYING THE EFFECTS OF WEAK STELLAR FLYBYS ON THE SOLAR SYSTEM

25 May 2021

- Poster (Submitted)
- The sixth annual Emerging Researchers in Exoplanet Science (ERES) Symposium. ERES is aimed at early career scientists working in all branches of exoplanetary science and related disciplines.
- Summary: We explore stellar flyby scenarios that are too weak to immediately destabilize the Solar System but are nevertheless strong enough to measurably perturb its secular dynamical state. We show that altering the semi-major axis of Neptune by as little as  $> 0.03 \text{ AU}$  can increase the likelihood of instability by ten times.

### ERES V

Ithaca, New York, USA

#### QUANTIFYING THE EFFECTS OF STELLAR FLYBYS ON PLANETARY SYSTEMS

18 June 2019

- Presentation (Submitted)
- The fifth annual Emerging Researchers in Exoplanet Science (ERES) Symposium. ERES is aimed at early career scientists working in all branches of exoplanetary science and related disciplines.
- Summary: We use long term n-body integrations to measure small cascading effects by analyzing the secular frequencies using frequency analysis (Laskar 1988, 1990). Using the solar system as a model, we have measured the response and long-term variations of the fundamental secular frequencies to external perturbations.

### Planetary Dynamics Conference

Heidelberg, Germany

#### QUANTIFYING THE EFFECTS OF STELLAR FLYBYS ON PLANETARY SYSTEMS

6 June 2018

- Presentation (Submitted)
- The conference brought together experts and students working in the field of extrasolar planets and planetary dynamics
- Summary: We use long term n-body integrations to measure small cascading effects by analyzing the secular frequencies using frequency analysis (Laskar 1988, 1990). Using the solar system as a model, we have measured the response and long-term variations of the fundamental secular frequencies to external perturbations.

## TC13

*Antigonish, Nova Scotia, Canada*

### COORDINATE INTERPOLATION AND DATA COMPRESSION USING REBOUND

7 June 2018

- Poster (Submitted)
- Theory Canada 13 (TC13) is the thirteenth edition of a series of annual conferences organized by the Division of Theoretical Physics (DTP) of the Canadian Association of Physicists (CAP), as a satellite conference to the annual CAP Congress.
- Summary: Using REBOUND (an n-body integrator), our work has been to compress detailed descriptions of the coordinates of each planetary body in a simulation to aid in more quickly determining celestial events (such as transits) without the need for a second integration.

## CPMS Convocation, BYU

*Provo, Utah, USA*

### ON CHARACTER, IDENTITY, AND COMMUNITY

28 April 2017

- Speech (Invited)
- The College of Physical and Mathematical Sciences (CPMS) at Brigham Young University (BYU) houses seven departments: Chemistry & Biochemistry, Computer Science, Geological Sciences, Mathematics, Mathematics Education, Physics & Astronomy, and Statistics.
- Summary: Our character and identity are not solely defined by how we view ourselves, but rather the way in which we interact with others.

## APS4C Annual Meeting

*Las Cruces, New Mexico, USA*

### BEYOND PHASE TRANSITIONS: AN ALGORITHMIC APPROACH TO FLOCKING BEHAVIOR

22 Oct. 2016

- Presentation (Submitted)
- The American Physics Society Four Corners Section (APS4C), has a strong commitment to support the work of physics students and to give them opportunities to present their research and to meet physicists in our region.
- Summary: Discussion of the perturbation used in our model along with a directional correlation function enabling comparisons to observations.

## APS4C Annual Meeting

*Las Cruces, New Mexico, USA*

### ORDER IN CHAOS: AN ALGORITHMIC APPROACH TO HOLISTIC FLOCKING BEHAVIOR

21 Oct. 2016

- Poster (Submitted)
- Summary: Discussion of the resemblance the model has to observations of physical flocks and physical flocking behavior based on results obtained through order parameters and correlation functions.

## APS4C Annual Meeting

*Phoenix, Arizona, USA*

### ORDER IN CHAOS: AN ALGORITHMIC APPROACH TO FLOCKING BEHAVIOUR

17 Oct. 2015

- Presentation (Submitted)
- Summary: Introduction of flocking model including a basic description of the algorithm and order parameters used to analyze results.

## Skills

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### COMPUTER LANGUAGES, COMMAND LINE TOOLS, AND FRAMEWORKS

- Proficient in Python, C++, Mathematica, MATLAB, Git, and Bash.
- Experience using C#, Java, Swift, HTML, CSS, JavaScript, SolidWorks (DreamSpark), Android Studio, SQLite, LabVIEW, and Fortran77.

### SCIENTIFIC COMPUTING SKILLS

- Numerical and symbolic computation; graphical analysis
- Numerical solutions of ordinary differential equations, partial differential equations, static and dynamic boundary value problems, linear algebra and eigenvalues
- Applications to mechanics, chaos, optics, special relativity, electrostatics, thermodynamics, waves, and quantum mechanics

### COMPUTER PROGRAMMING SKILLS

- Basics in neural network machine learning, deep learning, convolutional neural networks, and autoencoders.
- Parallel computing in Python and C++ using Open MP, Open MPI, and GNU Parallel
- Object-oriented program design and development
- Object-oriented data abstraction; interfaces
- Principles of algorithm formulation, implementation, and analysis; recursion
- Lists, stacks, queues, sets, trees, tries, hashing; sorting and searching
- Grammars and parsing; XML and JSON parsing
- Predicate and propositional logic; relations, relational data model; graphs and graph algorithms
- Try, catch, exception handling
- Unit testing, white and black box testing
- Data persistence techniques, user interface, mobile programming
- Asynchronous programming, accessing web services (html protocol basics)

## OTHER SKILLS

- Experienced carpenter apprentice
- Proficient tire technician
- Proficient in drywall trade (mud and taping)
- Proficient with power tools (metal and woodworking)
- Basics in electrical, welding, and pipeline trades

## Extracurricular Activity

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### Podcasting

*Peace River Country*

*Life North of the 54th*

*Aug. 2021 - Present*

- With my younger brother, I interview people who have lived in the region of my hometown and talk with them about their life.
- I manage the entire production of the show.
- Our show can be found wherever you find podcasts and at: [PeaceCountryLife.ca](https://www.peacecountrylife.ca).

### Club President

*Provo, Utah, USA*

**BRIGHAM YOUNG UNIVERSITY ASTRONOMICAL SOCIETY**

*Sep. 2015 - Apr. 2017*

- I organized and managed a group of 30 or so individuals from various backgrounds and interests, and helped foster enthusiasm and interest in learning about the universe and its myriad celestial bodies.
- I also helped organize and execute public outreach activities that extended these interests and understanding to the general public.
- I budgeted the club's money and was instrumental in planning and executing the club's first public outreach planetarium show.
- Before becoming President of the club in Sep. 2015 I was a public outreach officer for the club.

### Travelling

**PERSONAL INTEREST**

- I enjoy moving to other countries for extended periods of time and getting to know the local areas. To date I have lived in 3 different countries (Canada, United Kingdom, and USA).
- Beyond the 3 countries that I've lived in, I've also visited Mexico and South Korea.
- In the USA I've visited 35/50 states; in Canada I've visited 7/10 provinces and 2/3 territories; in the United Kingdom I've visited 21/100 counties; and in Mexico I've visited 2/31 states.
- I particularly enjoy driving because it helps me appreciate the scale and beauty of the landscapes, but I also enjoy cycling and hiking.
- I'm interested in the world at large, peoples, history, and cultures.
- For photographs and small snippets from my travels visit: [zyrxvo.github.io/travel](https://zyrxvo.github.io/travel).

## Honours & Awards

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### HONOURS

2023	<b>DPES Graduate Student Best Paper Award</b> , University of Toronto	<i>Toronto, Canada</i>
2017	<b>University Honors Graduate</b> , Brigham Young University	<i>Provo, Utah, USA</i>
2017	<b>Magna Cum Laude</b> , Brigham Young University	<i>Provo, Utah, USA</i>

### RESEARCH GRANTS

2021-2024	<b>NSERC - PGS D</b> , NSERC Postgraduate Scholarships - Doctoral	<i>Canada</i>
2020-2021	<b>OGS</b> , Ontario Graduate Scholarship	<i>Ontario, Canada</i>
2023	<b>RRG</b> , Resources for Research Groups (RRG) – 50 core years, Compute Canada	<i>Toronto, Canada</i>
2022	<b>RRG</b> , Resources for Research Groups (RRG) – 78 core years, Compute Canada	<i>Toronto, Canada</i>
2020	<b>RRG</b> , Resources for Research Groups (RRG) – 60 core years, Compute Canada	<i>Toronto, Canada</i>
2017	<b>ORCA</b> , Office of Research and Creative Activities (ORCA) Grant, Brigham Young University	<i>Provo, Utah, USA</i>

### TUITION & STIPEND AWARDS

2022	<b>DPES Teaching Fellowship Program</b> , University of Toronto Scarborough	<i>Toronto, Canada</i>
2020-2021	<b>Cray Fellowship in Physics</b> , University of Toronto	<i>Toronto, Canada</i>
2019	<b>Dr John Romanko Graduate Fellowship</b> , University of Toronto	<i>Toronto, Canada</i>
2019	<b>E.F. Burton Fellowship</b> , University of Toronto	<i>Toronto, Canada</i>
2017-2018	<b>University of Toronto Fellowship - Stipend Award</b> , University of Toronto	<i>Toronto, Canada</i>
2017	<b>Admissions Award</b> , University of Toronto	<i>Toronto, Canada</i>
2015-2017	<b>Brigham Young Full-Tuition Merit Scholarship</b> , Brigham Young University	<i>Provo, Utah, USA</i>
2014-2015	<b>John Einar Anderson Scholarship</b> , Brigham Young University	<i>Provo, Utah, USA</i>