

Peter Hayman

Curriculum Vitae

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Canadian Citizen

Work

2021

Research Fellow, *The University of Auckland*, Auckland, New Zealand

Research focussed on the Reheating phase of the early universe, especially using numerical methods to solve the Schrödinger-Poisson equation for the late-time dynamics of the inflaton field.

Education

2016

PhD in Physics, *McMaster University*, Hamilton, Ontario, Canada

2020

Point-Particle Effective Field Theories and the Helium Ion. (Supervisor: Dr. Cliff Burgess).

2016

MSc in Physics, *McMaster University*, Hamilton, Ontario, Canada

2014

Rocking the Inflationary Boat: Looking at the sensitivity to initial conditions of solutions to novel inflationary scenarios. (Supervisor: Dr. Cliff Burgess).

2009

BSc in Theoretical Physics, Minors in Computer Science and Mathematics, *Carleton University*, Ottawa, Ontario, Canada

2014

An investigation of the possible effect of black hole axionic hair on the polarization of electromagnetic waves. (Supervisor: Dr. Bruce Campbell).

Research Interests and Experience

I am interested in quantum field theory and general relativity. While most of my research has focussed on QFT (by way of effective field theories), I have experience with GR and am very interested in exploring their overlap. Curved spacetimes are ideal environments to probe QFTs, and doing so is doubly beneficial, as it can also illuminate aspects of GR, and larger problems, like the information loss problem, or dark energy.

Some projects I have been involved in:

- Developed the Point-Particle Effective Field Theory (PPEFT) framework, an effective theory for systems involving a hierarchy of length scales (e.g., atomic systems).
- Applied the PPEFT to a wide range of systems, including atomic systems, cold atom systems with non-Hermitian Hamiltonians, and topological systems (the magnetic monopole).
- Studied inflation, including a model in six dimensions, and a model inspired by ferromagnetic spin-waves.

Publications

Published

C. P. Burgess, P. Hayman, M. Rummel, and L. Zalavári, “Nuclear predictions for H spectroscopy without nuclear errors”, *Physics Letters A* **390**, 127105 (2021).

L. Zalavari, C. P. Burgess, P. Hayman, and M. Rummel, “Precision nuclear-spin effects in atoms: EFT methods for reducing theory errors”, *Annals of Physics* **429**, 168463 (2021).

P. Hayman* and C. P. Burgess, “Point-Particle Catalysis”, *Frontiers in Physics* **7**, 10.3389/fphy.2019.00167 (2019).

C. P. Burgess, P. Hayman*, M. Rummel, and L. Zalavári, “Reduced theoretical error for $^4\text{He}^+$ spectroscopy”, *Physical Review A* **98**, 052510 (2018).

D. Attié and *et al.*, “A time projection chamber with GEM-based readout”, *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment* **856**, 109 (2017).

C. P. Burgess, P. Hayman, M. Rummel, M. Williams, and L. Zalavári, “Point-particle effective field theory II: relativistic effects and Coulomb/inverse-square competition”, *Journal of High Energy Physics* **2017**, 72 (2017).

C. P. Burgess, P. Hayman, M. Rummel, and L. Zalavári, “Point-particle effective field theory III: relativistic fermions and the Dirac equation”, *Journal of High Energy Physics* **2017**, 7 (2017).

C. Burgess, P. Hayman, M. Williams, and L. Zalavári, “Point-particle effective field theory I: classical renormalization and the inverse-square potential”, *Journal of High Energy Physics* **2017**, 106 (2017).

P. Adshead, D. Blas, C. P. Burgess, P. Hayman, and S. P. Patil, “Magnon inflation: slow roll with steep potentials”, *Journal of Cosmology and Astroparticle Physics* **2016**, 009 (2016).

C. P. Burgess, J. J. H. Enns, P. Hayman*, and S. P. Patil, “Goldilocks models of higher-dimensional inflation (including modulus stabilization)”, *Journal of Cosmology and Astroparticle Physics* **2016**, 045 (2016).

*Indicates papers on which I was the lead author.

Talks and Panels

2019

● **Canada-America-Mexico Conference, Panel on Funding in Science**, Sudbury ON, (Invited)

2019

● **Canada-America-Mexico Conference, Point-Particle Catalysis**, Sudbury ON, (Contributed)

2019

● **Quantum Theory and Symmetries XI, Point-Particle Catalysis**, Montréal QC, (Contributed)

2017

● **Theory Canada 12, PPEFT II: Spin and the Hydrogen Atom**, Toronto ON, (Contributed)

Summer Schools and Workshops

2020

● **Cornerstone Models of Quantum Computing**, Virtual Seminar and Tutorial Series

2018

● **Precision Measurements and Fundamental Physics: The Proton Radius Puzzle and Beyond**, Workshop, Mainz Institute for Theoretical Physics, Mainz, Germany

2017

● **Summer School on Particle Physics**, Summer School, International Centre for Theoretical Physics, Trieste, Italy

2017

● **Summer School on Geometric Analysis**, Summer School, Fields Institute, Toronto ON

2017

Fields Medal Symposium, Symposium, Fields Institute, Toronto ON

2015

Tri-Institute Summer School on Elementary Particles, Summer School, Perimeter Institute, Waterloo ON

Awards and Honours

2022

NSERC Postdoctoral Fellowship, *Natural Sciences and Engineering Research Council of Canada*, Auckland, New Zealand, \$90 000 (CAD)

2017

2020

NSERC Canada Graduate Scholarship-Doctoral Program, *Natural Sciences and Engineering Research Council of Canada*, Hamilton, Ontario, Canada, \$140 000 (CAD)

2017

Buchalter Cosmology Prize, \$500 (USD)

2017

Ann Poucher Windsor Graduate Scholarship in Science and Technology, *McMaster University and the Province of Ontario*, Hamilton, Ontario, Canada, \$5 000 (CAD)

2017

2016

Queen Elizabeth II Graduate Scholarship in Science and Technology, *McMaster University and the Province of Ontario*, Hamilton, Ontario, Canada, \$10 000 (CAD)

2016

2014

Ontario Graduate Scholarship, *McMaster University and the Province of Ontario*, Hamilton, Ontario, Canada, \$30 000 (CAD)

2014

NSERC Canada Graduate Scholarship-Master's Program, *Natural Sciences and Engineering Research Council of Canada*, Hamilton, Ontario, Canada, \$17 500 (CAD) (Declined)

2010

2013

Dean's Honour List, *Carleton University*, Ottawa, Ontario, Canada

2009

2012

University Entrance Scholarship, *Carleton University*, Ottawa, Ontario, Canada, \$13 000 (CAD)

2011

2012

NSERC Undergraduate Student Research Award, *Natural Sciences and Engineering Research Council of Canada*, Ottawa, Ontario, Canada, \$19 200 (CAD)

2011

E.P. Hincks Memorial Scholarship in Physics, *Carleton University*, Ottawa, Ontario, Canada, \$870 (CAD)

Technical Skills

Programming: Proficient in \LaTeX , Mathematica, Maple, C, C++, and Python. Adept at learning new languages.

Mathematical specialties: Boundary conditions, special functions, asymptotics, linear algebra, renormalization group techniques.

Teaching Experience

2021

Lecturer, *Department of Physics and Astronomy, The University of Auckland*, Auckland, New Zealand

I taught the first half of a fourth-year course on General Relativity, taking the students from a basic understanding of special relativity through the language of differential geometry, up to the Einstein Field Equations.

2014
2020

Teaching Assistant, *Department of Physics and Astronomy, McMaster University*, Hamilton, Ontario, Canada

Courses included all quantum mechanics-related courses (from second-year Modern Physics to graduate Quantum Mechanics). Also included quantum field theory, general relativity, and analytical mechanics.

2017
2020

Undergraduate Course Mentor, *McMaster University*, Hamilton ON

I aided students preparing a particle astrophysics project for the integrated science course “Light, the Universe, and Everything”

Outreach and Service

2020

Graduate-Undergraduate Mentor Program, *McMaster University*, Hamilton ON

I serve as a resource for a couple of final-year undergraduate students looking to go to grad school.

2020

PIRSA Kodi App

I coded a Kodi app for viewing lectures and seminars from the Perimeter Institute’s video archive. <https://gitlab.com/phayman/plugin.video.pirsa>

2015
2020

Sidewalk Astronomy Volunteer, *McMaster University*, Hamilton ON

I assist with providing live views of astronomical objects to the public, on a weekly basis (weather permitting).

2015
2020

Planetarium Presenter, *William J. McCallion Planetarium, McMaster University*, Hamilton ON

I prepare and present planetarium shows for the public, and for private audiences. Average feedback rating of 4.34/5.

Professional Memberships

2020

American Physical Society

2020

Canadian Association of Physicists

2016

Canadian Association of Physicists

2014