Joshuah Heath

Postdoctoral Research Associate
Many-body physics & quantum information science
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Education

June 2021 — Ph.D. in Physics,
Boston College, Chestnut Hill, MA, USA
Field: Theoretical Condensed Matter Physics | Advisor: Kevin S. Bedell
Thesis: *Novel metallic behavior in topologically non-trivial, quantum critical, and low-dimensional matter*
Committee: Kevin S. Bedell, Fazel Tafti, Jan Engelbrecht, Xiao Chen

May 2017 — M.Sc. in Physics,
Boston College, Chestnut Hill, MA, USA

May 2015 — B.Sc. in Mathematics, with honors, *cum laude*
University of Vermont, Burlington, VT, USA

May 2015 — B.Sc. in Physics, with honors
University of Vermont, Burlington, VT, USA

Employment

Aug 2021–Present — **Postdoctoral Research Associate**
Dartmouth College, Dept. of Physics and Astronomy, Hanover, NH, USA
Research Groups of Lorenza Viola & James Whitfield

Aug 2015–July 2021 — **Graduate Research & Teaching Assistant**
Boston College, Dept. of Physics, Chestnut Hill, MA, USA
Research Group of Kevin S. Bedell

Scholarships, Awards, & Recognitions

March 2021 — IOP Outstanding Reviewer for Physica Scripta for 2020
Oct 2020 — IOP Trusted Reviewer Status (top 15% of referees for IOP Publishing in terms of quality, insightfulness, and timeliness of reviews)
April 2017 — Donald J. White Teaching Excellence Award
May 2013/14/15 — UVM Mathematics Sophomore, Junior, & Senior Awards
May 2014 — Mortar Board Senior Honors Society
May 2013 — Sigma Pi Sigma Physics Honor Society
June 2011 — Vermont Scholar's Award

Scientific Background & Interests

General

- Condensed matter theory, quantum information, quantum statistical mechanics

Present

- Quantum simulation, quantum advantage, open quantum systems, strongly correlated fermionic liquids, collective behavior of itinerant Majorana fermions, unconventional Kitaev magnets, quantum phase transitions, Luttinger's theorem

Past

- Floquet-engineered superconductivity, low-dimensional dipolar bosons, non-equilibrium classical plasmas

Teaching Background

Past

- Graduate teaching assistant for non-physics major and physics major undergraduate classes; duties include recitations, homework grading, test grading, quiz administration, homework help, and occasionally substitute lecturer for classes of up to 100+ students
- Graduate teaching assistant for graduate-level physics classes; duties include homework grading, test grading, and homework help
- Graduate teaching assistant for undergraduate physics and non-physics major laboratory; duties include lab report grading, lab quiz grading, and setting up labs
- Undergraduate teaching assistant for undergraduate physics, math, and philosophy courses; duties ranged from general assistance and coding help to grading of homework sets and exams.

Outreach

Nov. 2018, March 2021	Volunteer Lecturer for BC Splash | Mini-courses on special and general relativity & quantum computing for high school students Boston College, Chestnut Hill, MA, USA
April 2017	"Bridging the Gap between Research and Education" | Public lecture for the Graduate Teaching Recognition Ceremony Boston College, Chestnut Hill, MA, USA
Nov. 2011–April 2015	Volunteer Science Educator | Physics demos to K-12 students and professionals ECHO Lake Aquarium and Science Center, Burlington, VT, USA

Professional Activities and Service

2021-Present	Organizer | Dartmouth Quantum/Nano Hybrid Seminar Series
2020-Present	Referee | Physica Scripta, Journal of Physics G, Journal of Physics: Condensed Matter
2021	Organizer | Quantum Computation in Isolation Virtual Seminar Series
2020-2021	Organizer | Quantum Fluids in Isolation Virtual Seminar Series
2018–2019	Organizer | Emerging Results Seminar Series, Boston College Physics Dept.
2016–2017	Representative | BC Physics Dept. Grad Affairs & Teaching Committees
2015–Present	Member |International Society for Relativistic Quantum Information
2013–Present	Member |American Physical Society

Mentoring

Past

- Roy Forestano | Undergrad researcher, Boston College. Jan. 2019–April 2021
  - Project: Unconventional superconductivity in itinerant ferromagnets
  - Current Position: Ph.D. student at University of Florida
- Luke Martin | Undergrad researcher, Boston College. Jan. 2019–April 2021
  - Project: KSS viscosity bound in ultra-massive hairy black holes
  - Current Position: Ph.D. student at University of New Hampshire
- Adeyemi Lawal | Undergrad researcher, Boston College. July–Aug. 2018
  - Project: Basics of quantum statistical mechanics
  - Current Position: Software engineer
- Paul Menker | Undergrad researcher, Boston College. Jan.–April 2018
  - Project: Basics of conformal field theory and its relation to holography
  - Current Position: Ph.D. student at University of Southern California

Technical Skills

Fluency:	Julia, Python, Mathematica, Linux, MacOS, LaTeX
Basic Knowledge:	BASH, MATLAB, HTML, C++

Publications & Preprints

In Progress

- **Joshuah T. Heath** |"Fermi liquids in the absence of charge quantization"
  Manuscript in preparation | arXiv TBA

2021

- **Joshuah T. Heath**, Faranak Bahrami, Roman Movshovich, Xiao Chen, Fazel Tafti, & Kevin S. Bedell |"Signatures of a Majorana-Fermi surface in the Kitaev magnet $Ag_3LiIr_2O_6$"
  Under review at Physical Review Letters | arXiv:2108.03246

- **Joshuah T. Heath** & Kevin S. Bedell |"Gauging away the Stoner model: Engineering unconventional metallic ferromagnetism with artificial gauge fields"
  Submitted to SciPost Physics | arXiv:2008.07535

2020

- **Joshuah T. Heath** & Kevin S. Bedell |"Universal Signatures of Majorana-like Quasiparticles in Strongly Correlated Landau-Fermi Liquids"
  J. Phys.: Condens. Matter **32** 485602 (2020) | arXiv:1903.00619

- **Joshuah T. Heath** |"Landau Quasiparticles in Weak Power-Law Liquids"
  J. Low Temp. Phys. **201**, 200-212 (2020) | arXiv:2001.08230

- **Joshuah T. Heath** & Kevin S. Bedell |"Necessary and Sufficient Conditions for the Validity of Luttinger's Theorem"
  New J. Phys. **22** 06301 (2020) | arXiv:1906.00929

- **Joshuah T. Heath**, Matthew P. Gochan, and Kevin S. Bedell |"Chebyshev polynomial expansion of two-dimensional Landau-Fermi liquid parameters"
  J. Phys. A: Math. Theor. **53** 225203 (2020) | arXiv:1912.03427

- Matthew P. Gochan, **Joshuah T. Heath**, & Kevin S. Bedell |"Atypical Behavior of Collective Modes in Two-Dimensional Fermi Liquids"
  J. Phys.: Condens. Matter **32** 345602 (2020) | arXiv:1912.02699

2019

- **Joshuah T. Heath** & Kevin S. Bedell |"Exotic quantum statistics and thermodynamics from a number-conserving theory of Majorana fermions"
  J. Phys. A: Math. Theor. **52** 315001 (2019) | arXiv:1709.04483

2016

- Kenneth I. Golden & **Joshuah T. Heath** |"Generalized Nonlinear Fluctuation-Dissipation Relation for the One-Component Plasma"
  J. Stat. Phys. **162**, 199-217 (2016)

2014

- Kenneth I. Golden & **Joshuah T. Heath** |"Hierarchy of Fluctuation-Dissipation Theorems for the Classical One-Component Plasma"
  Contributions to Plasma Physics, **X**, 1-7 (2014)| arXiv:1410.4889

Presentations

2021

- "Novel metallic behavior in topologically non-trivial, quantum critical, and low-dimensional matter" (includes work done w/Faranak Bahrami, Kevin Bedell, Xiao Chen, Matthew Gochan, Sangyun Lee, Roman Movshovich, & Fazel Tafti)
  - (hybrid virtual/in-person presentation) Doctoral Thesis Defense, Boston College, Chestnut Hill, MA. June 16th, 2021

- "Luttinger's Theorem-Violating Fermi Liquids and Power-law Green's Functions" (includes work done w/Kevin Bedell)
  - (virtual) Contributed talk, 2021 Princeton Summer School on Condensed Matter Physics, Princeton University. June 10th, 2021

- "How useful are quantum computers? Quantum advantage for high school students"
  - (virtual) Presentation for BC Splash outreach to local high school and middle school students. March 28th, 2021

- "Gauging away the Stoner model: Engineering unconventional metallic ferromagnetism with artificial gauge fields" (work down w/Kevin Bedell)
  - (virtual poster) Contributed talk, APS March Meeting, March 18, 2021

- "Evidence of a weakly-correlated Majorana liquid in the Kitaev magnet Ag3LiIr2O6" (work done w/Faranak Bahrami, Sangyun Lee, Roman Movshovich, Xiao Chen, Kevin Bedell, & Fazel Tafti)
  - (virtual) Contributed talk, APS March Meeting, March 16, 2021

- "The Marriage of Heaven and Hell: Kitaev Materials at the Crossroads of Theory and Experiment" (work done w/Faranak Bahrami, Sangyun Lee, Roman Movshovich, Xiao Chen, Fazel Tafti, & Kevin Bedell)
  - (virtual) Invited talk, Quantum/Nano seminar at Dartmouth College. Feb. 25th, 2021

- "Evidence of a Majorana-Fermi surface in the Kitaev magnet $Ag_3LiIr_2O_6$" (work done w/Faranak Bahrami, Roman Movshovich, Xiao Chen, Fazel Tafti, & Kevin Bedell)
  - (virtual) Contributed talk, waiting for the conference on Highly Frustrated Magnetism, Max Planck Institute for the Physics of Complex Systems. Jan. 27th, 2021
  - (virtual) Contributed talk, MagLab Theory Winter School, National High Magnetic Field Laboratory. Jan. 12th, 2021

2020

- "Landau quasiparticles in weak power-law liquids" (includes work done w/Kevin Bedell)
  - (virtual) Contributed talk, Speakers' Corner seminar, Virtual Science Forum. November 17th, 2020

- "Luttinger's Theorem: The first 60 years" (work done w/Kevin Bedell)
  - (virtual) Invited talk, group seminar of K. Hazzard's Condensed Matter Theory group, Rice University. July 20th, 2020

- "Observation of a weakly-correlated Majorana liquid in the silver-lithium iridate $Ag_3LiIr_2O_6$" (work done w/Faranak Bahrami, Fazel Tafti, Roman Movshovich, and Kevin Bedell)
  - (virtual) Contributed talk, 2020 Princeton Summer School on Condensed Matter Physics, Princeton University. June 12th, 2020

- "The Hunting of the Snark: Generic Conditions for Luttinger's Theorem in Strongly Correlated Systems" (work done w/Kevin Bedell)
  - (presentation) Contributed talk, Boston College Mini-March Meeting, Boston College, Chestnut Hill, MA. March 4th, 2020

2019

- "The Hunting of the Snark: Generic Conditions for Luttinger's Theorem in Strongly Correlated Systems" (work done w/Kevin Bedell)
  - (presentation) Contributed talk, 21st Annual Greater Boston Area Statistical Mechanics Meeting (GBASM), Brandeis University, Waltham, MA. Oct. 19th, 2019

- "Exotic quantum statistics from a many-body theory of Majorana fermions" (work done w/Kevin Bedell)
  - (poster) Contributed talk, APS March Meeting, Boston, MA, March 6th, 2019

- "Collective Excitations in a Landau-Majorana Liquid" (work done w/Kevin Bedell)
  - (presentation) Contributed talk, APS March Meeting, Boston, MA, March 6th, 2019

2018

- "Fermi Liquids from Spin Liquids" (work done w/Kevin Bedell)
  - (presentation) Contributed talk, Emerging Results Seminar, Boston College, Chestnut Hill, MA. Nov. 28th, 2018

- "Majorana Lives! Many-body Majorana physics beyond the anyonic paradigm" (work done w/Kevin Bedell)
  - (presentation) Contributed talk, 20th Annual Greater Boston Area Statistical Mechanics Meeting (GBASM), Brandeis University, Waltham, MA. Oct. 27th, 2018
  - (presentation) Invited talk, Condensed Matter Theory Kids Seminar, Harvard University, Cambridge, MA. Oct. 10th, 2018

- "Majorana Physics beyond the anyonic paradigm: Towards a Landau-Majorana liquid theory" (work done w/Kevin Bedell)
  - (poster) Contributed talk, Gordon Research Seminar and Conference on Correlated Electron Systems, Mount Holyoke College, South Hadley, MA. June 23th–June 29th, 2018

2017

- "Exotic quantum statistics from a many-body theory of Majorana fermions" (work done w/Kevin Bedell)
  - (poster) Contributed talk, Majorana Fermions & Beyond Workshop, Yale Quantum Institute, Yale University, Hartford, CT. Oct. 27th, 2017
  - (presentation) Contributed talk, 19th Annual Greater Boston Area Statistical Mechanics Meeting (GBASM), Massachusetts Institute of Technology, Cambridge, MA. Oct. 21st, 2017

2015

- "Pressure-energy relation in canonical 2D dipolar bosons: A path integral Monte Carlo study " (work done w/Adrian Del Maestro)
  - (presentation) Contributed talk, New England APS Spring Meeting, Boston University, Boston, MA. April 24th, 2015
  - (presentation) Contributed talk, Student Research Conference, University of Vermont, Burlington, VT. April 23rd, 2015

- "Suppression of conventional pairing in Floquet engineered fermionic systems" (work done w/Marin Bukov & Anatoli Polkovnikov)
  - (presentation) Invited talk, Condensed Matter Theory Seminar, University of Vermont, Burlington, VT, March 12th, 2015

2014

- "Floquet realization of unconventional superconductivity in periodically driven fermionic systems" (work done w/Marin Bukov & Anatoli Pokovnikov)
  - (presentation) Invited talk, group seminar of A. Polkovnikov's Condensed Matter Theory group, Boston University, Boston, MA. Nov. 3rd, 2014
- "Hierarchy of fluctuation-dissipation theorems for the classical one-component plasma" (work done w/Kenneth Golden)
  - (poster given by Kenneth Golden) Contributed talk, International Conference on Strongly Coupled Coulomb Systems, Santa Fe, NM. July 29th, 2014
- "Hierarchy in the static fluctuation-dissipation theorem of one-component plasmas" (work done w/Kenneth Golden)
  - (poster) Contributed talk, Student Research Conference, University of Vermont, Burlington, VT. April 16th, 2014
  - (poster) Contributed talk, New England APS Spring Meeting, Boston College, Chestnut Hill, MA. April 4th, 2014

2013

- "Computational study of ferromagnetic phase transitions in the Ising and XY models via the Monte Carlo method" (work done w/Adrian Del Maestro)
  - (poster) Contributed talk, Student Research Conference, University of Vermont, Burlington, VT. April 23rd, 2013
- "The Kosterlitz-Thouless transition: Complexity in the XY-Model" (work done w/Adrian Del Maestro)
  - (presentation) Contributed talk, Student Complexity Research and Pizza Seminar, University of Vermont, Burlington, VT, Feb. 4th, 2013