Ben Kain

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Experience

Professor of Physics — 2022 – Present
College of the Holy Cross — Worcester, MA

Associate Professor of Physics — 2015 – 2022
College of the Holy Cross — Worcester, MA

Assistant Professor of Physics — 2011 – 2015
College of the Holy Cross — Worcester, MA

Visiting Scientist (while on sabbatical leave from College of the Holy Cross) — Fall, 2013
Rowan University — Glassboro, NJ

Visiting Assistant Professor of Physics — 2009 – 2011
Rowan University — Glassboro, NJ

Lecturer (Physics and Mathematics) — Winter, 2009
Santa Clara University — Santa Clara, CA

Physics Lecturer — 2007
The Princeton Review — Berkeley, CA

Graduate Student Instructor — 2002 – 2007
University of California, Berkeley — Berkeley, CA

Education

Ph.D. Physics — 2007
University of California, Berkeley — Berkeley, CA
- Specialization: Theoretical high energy particle physics

M.A. Physics — 2005
University of California, Berkeley — Berkeley, CA

B.S. Physics and Mathematics — 2002
Santa Clara University — Santa Clara, CA

Research Interests

I am a theoretical physicist and I have done research in the areas of particle physics, cosmology, numerical relativity, and cold atomic physics. My current research focuses on numerical solutions of black holes and wormholes.

Publications

* = undergraduate coauthor

43. B. Kain, "Dynamical wormholes," Class. Quantum Grav. **43,** 045014 (2026) [arXiv:2602.18231].
42. B. Kain, "Dynamical evolution and stability of quantum corrected Schwarzschild black holes in semiclassical gravity," Phys. Rev. D **111**, 124057 (2025) [arXiv:2507.00109].
41. B. Kain, "Quantum corrected Einstein-Yang-Mills black holes in semiclassical gravity," Phys. Rev. D **111**, 044033 (2025) [arXiv:2502.08278].
40. *J. Cronin, *X. Zhang, and B. Kain, "Rotating dark matter admixed neutron stars," Phys. Rev. D **108**, 103016 (2023) [arXiv:2311.07714].
39. B. Kain, "Einstein-Dirac-Maxwell wormholes in quantum field theory," Phys. Rev. D **108**, 084010 (2023) [arXiv:2308.00049].
38. B. Kain, "Probing the connection between entangled particles and wormholes in general relativity," Phys. Rev. Lett. **131**, 101001 (2023) [arXiv:2309.03314].
37. B. Kain, "Are Einstein-Dirac-Maxwell wormholes traversable?," Phys. Rev. D **108**, 044019 (2023) [arXiv:2305.11217].
36. B. Kain, "Einstein-Dirac system in semiclassical gravity," Phys. Rev. D **107**, 124001 (2023) [arXiv:2304.10627].
35. *K. Calhoun, *B. Fay, and B. Kain, "Matter traveling through a wormhole," Phys. Rev. D **106**, 104054 (2022) [arXiv:2210.04905].
34. *J. E. Nyhan and B. Kain, "Dynamical evolution of fermion-boson stars with realistic equations of state," Phys. Rev. D **105** 123016 (2022) [arXiv:2206.07715].
33. H. Y. Ling and B. Kain, "Topological study of a Bogoliubov-de Gennes system of pseudo spin-1/2 bosons with conserved magnetization in a honeycomb lattice," Phys. Rev. A **105** 023319 (2022) [arXiv:2110.03139].
32. *T. Gleason, *B. Brown, and B. Kain, "Dynamical evolution of dark matter admixed neutron stars," Phys. Rev. D **105**, 023010 (2022) [arXiv:2201.02274].
31. B. Kain, "Fermion-charged-boson stars," Phys. Rev. D **104**, 043001 (2021) [arXiv: 2108.01404].
30. H. Y. Ling and B. Kain, "Selection rule for topological amplifiers in Bogoliubov-de Gennes systems," Phys. Rev. A **104**, 013305 (2021) [arXiv:2011.14935].
29. B. Kain, "Boson stars and their radial oscillations," Phys. Rev. D **103**, 123003 (2021) [arXiv:2106.01740].
28. B. Kain, "Searching a quantum database with Grover's search algorithm," Am. J. Phys. **89,** 618 (2021).
27. B. Kain, "Dark matter admixed neutron stars," Phys. Rev. D **103**, 043009 (2021) [arXiv:2102.08257].
26. B. Kain, "Radial oscillations and stability of multiple-fluid compact stars," Phys. Rev. D **102**, 023001 (2020) [arXiv:2007.04311].
25. *E. Daka, *N. N. Phan, and B. Kain, "Perturbing the ground state of Dirac stars," Phys. Rev. D **100**, 084042 (2019) [arXiv:1909.04205].
24. B. Kain, "Are gravitating magnetic monopoles stable?" Phys. Rev. D **100**, 063003 (2019) [arXiv:1909.04205].
23. B. Kain, "Type II critical behavior of gravitating magnetic monopoles," Phys. Rev. D. **99**, 104017 (2019) [arXiv:1905.04355].

22. B. Kain and H. Y. Ling, "Analytical study of static beyond-Fröhlich Bose polarons in one dimension," Phys. Rev. A. **98**, 033610 (2018) [arXiv:1809.10601].
21. B. Kain, "Stability and critical behavior of gravitational monopoles," Phys. Rev. D **97**, 024012 (2018) [arXiv:1801.03044].
20. B. Kain and H. Y. Ling, "Hartree-Fock treatment of Fermi polarons using the Lee-Low-Pine transformation," Phys. Rev. A **96**, 033627 (2017) [arXiv:1709.07408].
19. B. Kain and H. Y. Ling, "Generalized Hartree-Fock-Bogoliubov description of the Fröhlich polaron," Phys. Rev. A **94**, 013621 (2016) [arXiv:1607.07736].
18. *J. Scaramazza, B. Kain, and H. Y. Ling, "Competing orders in a dipolar Bose-Fermi mixture on a square optical lattice: Mean-field perspective," Eur. Phys. J. D **70**, 147 (2016) [arXiv:1412.6672].
17. B. Kain and H. Y. Ling, "Nonequilibrium States of a Quenched Bose Gas," Phys. Rev. A **90**, 063626 (2014) [arXiv:1401.2390].
16. B. Kain and H. Y. Ling, "Polarons in a Dipolar Condensate," Phys. Rev. A **89**, 023612 (2014) [arXiv:1401.2961].
15. B. Kain and H. Y. Ling, "The roton-assisted chiral p-wave superfluid in a quasi-two-dimensional dipolar Bose-Fermi quantum gas mixture," Phys. Rev. A **88**, 033616 (2013) [arXiv:1309.1139].
14. *A. Hanken, B. Kain, and *C. Manning, "Extraordinary Gauge Mediation at Finite Temperature," Phys. Rev. D **87**, 125019 (2013) [arXiv:1306.3898].
13. B. Kain and H. Y. Ling, "Mixing Dipolar Condensates: A new Opportunity for Enhancing Superfluid Pairings in a Spin-Polarized Fermi Gas," Proc. of 21st Annual International Laser Physics Workshop (LPHYS'12), Calgary (2012), J. Phys.: Conf. Ser. **414**, 012030 (2013).
12. B. Kain and H. Y. Ling, "Superfluid Pairing in a Mixture of a Spin-Polarized Fermi Gas and a Dipolar Condensate," Phys. Rev. A **85**, 013631 (2012) [arXiv:1112.4222].
11. B. Kain and H. Y. Ling, "Cosmological Inhomogeneities with Bose-Einstein Condensate Dark Matter," Phys. Rev. D **85**,023527 (2012) [arXiv:1112.4169].
10. B. Kain and H. Y. Ling, "Singlet and Triplet Superfluid Competition in a Mixture of Two-Component Fermi and One-Component Dipolar Bose Gases," Phys. Rev. A **83**, 061603(R) (2011) [arXiv:1104.4759].
9. B. Kain and H. Y. Ling, "Vortices in Bose-Einstein Condensate Dark Matter," Phys. Rev. D **82**, 064042 (2010) [arXiv:1004.4692].
8. *S. Benjamin, *C. Freund, and B. Kain, "The Effective Kähler Potential, R-Symmetry Breaking and Metastable Vacua in O'Raifeartaigh Models," Nucl. Phys. B **842**, 529 (2011) [arXiv:1003.5628].
7. B. Kain, "Retrofitting Models of Inflation," Nucl. Phys. B **821**, 170 (2009) [arXiv:0903.0123].
6. B. Kain, "'Semi-Realistic' F-term Inflation Model Building in Supergravity," Nucl. Phys. B **800**, 270 (2008) [arXiv:hep-ph/0608279].
5. B. Kain, "Cosmological Consequences of String Axions," Phys. Rev. D **73**, 123521 (2006) [arXiv:hep-th/0512199].
4. M. K. Gaillard and B. Kain, "Is the Universal String Axion the QCD Axion?" Nucl. Phys. B **734**, 116 (2006) [arXiv:hep-th/0510190].
3. *B. Kain and R. P. Barber, Jr., "Resistive transitions in quench-condensed Bi films near a normal-metal ground plane," Phys. Rev. B **68**, 134502 (2003).

2. *B. Kain, *S. R. Khan, and R. P. Barber, Jr., "Tuning the transition temperature of superconducting Ag/Pb films via the proximity effect," Physica C, **382**, 411, (2002).
1. *S. R. Khan, *E. M. Pederson, *B. Kain, *A. J. Jordan, and R. P. Barber, Jr., "Superconductor-insulator transition in granular Pb films near a superconducting ground plane," Phys. Rev. B **61**, 5909 (2000).

Presentations and Posters

14. B. Kain, "Simulating wormholes," invited talk at Santa Clara University, November 12, 2025, Santa Clara, CA.
13. B. Kain, "Is it really possible to teleport? Quantum computing and quantum teleportation," Holy Cross Alumni Revisited, March 24, 2022, online.
12. B. Kain, "Simulating neutron stars on a computer," Holy Cross Faculty Research Lunch, September 13, 2021, Worcester, MA.
11. Y. Ling and B. Kain, "One-dimensional Bose polarons beyond the Fröhlich paradigm: localized impurities," APS March Meeting 2019, March 5, 2019, Boston, MA.
10. B. Kain, "Recent-(non)discoveries: Primordial gravitational waves and the Higgs boson," 2015 Weiss Summer Research Program seminar, July 1, 2015, Worcester, MA.
9. B. Kain and H. Y. Ling, "Polarons in a dipolar condensate," APS March Meeting 2014, March 3, 2014, Denver, CO.
8. B. Kain, A. Hanken, and C. Manning, "Extraordinary Gauge Mediation at Finite Temperature," APS April Meeting 2013, April 14, 2013, Denver, CO.
7. B. Kain and H. Y. Ling, "P-wave superfluid in a quasi-two-dimensional dipolar Bose-Fermi quantum gas mixture," APS March Meeting 2013, March 20, 2013, Baltimore, MD.
6. B. Kain, "The Higgs Boson," College of the Holy Cross Department of Physics colloquium, September 17, 2012, Worcester, MA.
5. B. Kain and H. Y. Ling, "Mixing dipolar condensates: a new opportunity for enhancing superfluid pairing in a spin-polarized Fermi gas," 21st International Laser Physics Workshop, July 22-28, 2012, Calgary Canada.
4. B. Kain, "Particle Physics and Cosmology," talk given to high school class at Boston Latin School, June 14, 2012, Boston, MA.
3. B. Kain and H. Y. Ling, "Superfluid pairing in a mixture of spin-polarized Fermi gas and dipolar condensate," APS March Meeting 2012, March 2, 2012, Boson, MA.
2. B. Kain, S. Benjamin, and C. Freund, "The Effective Kahler Potential, Metastable Vacua and R-Symmetry Breaking in O'Raifeartaigh Models," APS April Meeting 2010, February 14, 2010, Washington, DC.
1. B. Kain, "Particle Physics!," Rowan University Department of Physics and Astronomy colloquium, Fall 2009, Glassboro, NJ.

Grants and Awards

Summer Course Development Grant 2024

- Awarded for recording videos for teaching Thermal Physics in Fall 2024 using the approach of a flipped-classroom.

Mary Louise Marfuggi Faculty Award for Outstanding Scholarship 2022

Course Development Summer Faculty Fellowship 2022

- Awarded from Dean's Office for recording videos for teaching Methods of Physics in Fall 2022 using the approach of a flipped-classroom.

J. D. Power Center Grant 2021

- Awarded Summer 2021 Research Associates Program Grant to fund one summer research student.

J. D. Power Center Grant 2020

- Awarded Summer 2020 Research Associates Program Grant to fund two summer research students.

Center for Teaching Grant 2016

- Awarded to attend the Physics Education and Research Conference on "Relativity and Gravitation: Contemporary Research and Teaching of Einstein's physics," from June 5-10, 2016, which was a Gordon Research Conference.

Summer Course Development Fellowship 2014

- Awarded from Dean's Office for implementing Just-in-Time-Teaching in my General/Intro Physics courses.

New Jersey Space Grant Consortium 2009-2010

- Used for research student salary and to fund travel expenses for research students to present at the APS Meeting.