Samuel C. Hoover

Contact Information

samuel.charles.hoover@gmail.com
samuelhoover.github.io
linkedin.com/in/samuel-hoover

Education

Ph.D., Chemical Engineering, UMass Amherst, Amherst, MA, USA **August 2024**

Dissertation Advisor: Prof. Murugappan Muthukumar

Dissertation Title: *Study of charged macromolecule phase behavior using conventional and modern modeling methods*

B.S., Chemical Engineering, Clarkson University, Potsdam, NY, USA **May 2018**

Degree conferred with distinction.

Minors: Mathematics and International & Cross-Cultural Perspectives

Employment

Research Assistant, UMass Amherst, Amherst, MA, USA **January 2021–Present**

Teaching Assistant, UMass Amherst, Amherst, MA, USA **Fall 2021–2023**

DTMD Intern, Triton Systems, Inc., Chelmsford, MA, USA **June–September 2023**

Research Assistant, UMass Amherst, Amherst, MA, USA **January 2019–December 2020**

Research Assistant, Clarkson University, Potsdam, NY, USA **September 2017–May 2018**

STEM Educator, Clarkson University, Potsdam, NY, USA **September 2017–May 2017**

Tutor, Clarkson University, Potsdam, NY, USA **Fall 2017, Spring 2018**

Teaching Assistant, Clarkson University, Potsdam, NY, USA **Spring 2016–2017, Fall 2017**

Global Manufacturing Tech. Intern, SI Group, Schenectady, NY, USA **May–August 2017**

Research Interests

General relativity (GR), gravitation, and astrophysical phenomena which can elucidate gravity. One major theme is pushing numerical and analytical gravitational-wave (GW) predictions to the precision frontier in advance of next-generation observatories. A second major theme is using GWs to test GR against beyond-GR models, in both theory-independent and theory-dependent models. This involves numerical relativity and renormalization methods applied to specific effective field models for beyond-GR theories.

Honors and Awards

PPG Fellowship, PPG Industries, Inc. **2024**

Teaching Assistant Award, University of Massachusetts Amherst **Fall 2022**

Clarkson Scholarship, Clarkson University **Fall 2014–Spring 2018**

Dean's List, Clarkson University **Fall 2014–Fall 2017**

Teaching Experience

Teaching Assistant, University of Massachusetts Amherst

CHEM-ENG 401, Senior laboratory	**Falls 2022–2023**
CHEM-ENG 338, Separation processes	**Spring 2022**
CHEM-ENG 446, Process control	**Fall 2021**

Tutor, Clarkson University

STAT 383, Probability and statistics	**Spring 2018**
CH 370, Transfer process fundamentals	**Fall 2017**

Teaching Assistant, Clarkson University

CH 370, Transfer process fundamentals	**Fall 2017**
ES 100, Intro to engineering use of computers	**Springs 2016–2017**

Professional Activities, Outreach, and Service

LISA Consortium, Full member **2020–Present**
UMiss LISA Group leader **2020–Present**

Order of the Engineer, member2018–Present Omega Chi Epsilon, member2016–Present
Delta Chapter President **2017–2018**

American Institute of Chemical Engineers, member **2014–Present**

Simulating Extreme Spacetimes with SpEC and SpECTRE, ICERM **August 2024**
Week-long international workshop, ∼85 participants

New frontiers in strong gravity, Benasque, Spain **July 2024**
Two week international conference, ∼70 participants

Nonlinear Aspects of General Relativity, Princeton PCTS **October 2023**
Four day workshop, ∼100 participants

Numerical Relativity Community Summer School, ICERM **August 2022**
Week-long international summer school, 150 participants

New frontiers in strong gravity, Benasque, Spain **July 2022**
Two week international conference, 100 participants

Numerical Relativity beyond General Relativity, Benasque, Spain **June 2018**
Week-long international workshop, 59 participants

34^{th} Pacific Coast Gravity Meeting (PCGM), Caltech **March 2018**
Two day conference, ∼ 125 participants

Unifying Tests of General Relativity, Caltech **July 2016**
Three day workshop, 52 participants

Seminar organizer

TAPIR seminar, Caltech	**Fall 2015–Spring 2018**
General Relativity Informal Tea-Time Series (GRITTS), MIT	**Fall 2011–Spring 2012**
MKI Journal Club, MIT	**Fall 2007–Spring 2010**

Conference session chair; Judge for best student speaker award

April APS meeting, NY, NY	**April 2022**
Midwest relativity meeting, Grand Rapids, MI	**October 2019**

April APS meeting, Columbus, OH **April 2018**

34th Pacific Coast Gravity Meeting (PCGM), Caltech **March 2018**

33rd Pacific Coast Gravity Meeting (PCGM), UCSB **March 2017**

"April" APS meeting, Washington D.C. **January 2017**

32nd Pacific Coast Gravity Meeting (PCGM), CSU Fullerton **April 2016**

Theoretical Astrophysics in Southern California (TASC), CSU Fullerton **November 2015**

Journal referee

American Journal of Physics, Classical and Quantum Gravity, Journal of Cosmology and Astroparticle Physics, Journal of Open Source Software, General Relativity and Gravitation, Monthly Notices of the Royal Astronomical Society, Physics Letters B, Physical Review D, Physical Review Letters, Physical Review X, Reviews of Modern Physics, The Astrophysical Journal Letters, The Physics Teacher

Agency work

Reviewer for NSF, NASA

Outreach

Oxford Science Café **April 2019**
Lecture: "The truth about black holes"

Guest on the *Starts With a Bang* podcast **March 25, 2019**
Episode 42: Black holes and gravitation

Invited speaker for Latin American Webinar on Physics **March 13, 2019**
Webinar 75: "Testing Einstein with numerical relativity"

Caltech astronomy public lecture series speaker **March 2018**
Lecture: "The truth about black holes"

Astronomy on Tap public lecture series speaker and volunteer **2016–2018**
Close to a monthly basis

Caltech astronomy public lecture series panelist and emcee **2016–2018**
Approximately every three months

Invited guest lecture on black holes and gravitational waves **November 2017**
Science of Space and Time, Hampshire College

Invited video Q&A session, public high school physics class **June 2017**
The Nova Project school, Seattle

Guest on *The Titanium Physicists Podcast*
Episode 80: Picturing the Bach Hole **August 21, 2019**
Episode 64: The edges of Einstein **April 25, 2016**
Episode 62: Black Bells **February 1, 2016**

Quora Q&A Session on gravitational waves and first detection **February 17, 2016**
83.9k+ views, 20.8k+ followers

Invited guest host, public screening of *COSMOS* with Q&A, **March/June 2014**
Science Cabaret/Cornell

Invited public talk at *Frontiers of Cornell Astronomy*, **November 2013**
Cornell Friends of Astronomy

Invited video chat, *Topics in Physics* course, **July 2013**
Stanford Education Program for Gifted Youth

Computer Skills

Expert in Mathematica. Proficient in C/C++, Python, Bash, Javascript. Experience in Java, Haskell. Proficient at *nix and HPC. Markup languages: LaTeX, HTML, CSS, Markdown.

Software—Most contributions can be found at https://github.com/duetosymmetry. Member of the *Simulating eXtreme Spacetimes* (SXS) collaboration, contributor to the Spectral Einstein Code (SpEC). Member of the *Black Hole Perturbation Toolkit*. Author of `qnm` python package (https://github.com/duetosymmetry/qnm). Core collaborator on xAct (http://xact.es) abstract tensor calculus package for Mathematica. Coauthor of xTerior package for exterior differential geometry under xAct. Co-maintainer of community contributions at http://contrib.xact.es. Developed arXiv-keys browser extension/add-on for Chrome/Firefox. Author of `orcidlink` and coauthor of `gridpapers` packages for LaTeX.

Publication Summary

h-index —As of 2024-06-03: 61 (according to Google Scholar), or 53 (according to INSPIRE). Both include collaboration papers.

Top five cited —Excluding LIGO/Virgo collaboration papers.

1. Berti, E., (5 authors), **Stein, L. C.**, (46 more authors) (2015) *Testing General Relativity with Present and Future Astrophysical Observations*, Class. Quantum Grav. **32** 243001 [arXiv:1501.07274].
2. Barack, L., *et al.* (2019) *Black holes, gravitational waves and fundamental physics: a roadmap*, Class. Quantum Grav. **36** 143001 [arXiv:1806.05195].
3. Boyle, M., *et al.* (**LCS** is corresponding author) (2019) *The SXS Collaboration catalog of binary black hole simulations*, Class. Quantum Grav. **36** 195006 [arXiv:1904.04831].
4. Varma, V, *et al.* (2019) *Surrogate models for precessing binary black hole simulations with unequal masses*, Phys. Rev. Research **1**, 033015 [arXiv:1905.09300].
5. Yunes, N., **Stein, L. C.** (2011), *Nonspinning black holes in alternative theories of gravity*, Phys. Rev. D **83** 104002 [arXiv:1101.2921].

Submitted Publications

62. Magaña Zertuche, L., **Stein, L. C.**, *et al.*, (2024) *High-Precision Ringdown Surrogate Model for Non-Precessing Binary Black Holes*, [arXiv:2408.05300].
61. Mitman, K., Boyle, M., **Stein, L. C.**, *et al.*, (2024) *A Review of Gravitational Memory and BMS Frame Fixing in Numerical Relativity*, [arXiv:2405.08868].
60. Zhu, H., (9 authors), **Stein, L. C.**, (2024) *Imprints of Changing Mass and Spin on Black Hole Ringdown*, [arXiv:2404.12424].
59. Sun, D., Boyle, M., Mitman, K., Scheel, M. A., **Stein, L. C.**, Teukolsky, S. A., Varma, V., (2024) *Optimizing post-Newtonian parameters and fixing the BMS frame for numerical-relativity waveform hybridizations*, [arXiv:2403.10278].

Collaboration Publications

From 2008–2012, I was coauthor on 34 refereed LIGO and/or LIGO/Virgo collaboration publications. I only list short author-list publications below.

Refereed Publications

58. **Stein, L. C.**, (2024) *Can a radiation gauge be horizon-locking?*, Class. Quantum Grav. **41** 157001 [arXiv:2404.10113].
57. Samanta, R., Tanay, S., **Stein, L. C.**, (2023) *Closed-form solutions of spinning, eccentric binary black holes at 1.5 post-Newtonian order*, Phys. Rev. D **108**, 124039 [arXiv:2210.01605].
56. Bronicki, D., Cárdenas-Avendaño, A., **Stein, L. C.**, (2023) *Tidally-induced nonlinear resonances in EMRIs with an analogue model*, Class. Quantum Grav. **40** 215015 [arXiv:2203.08841].
55. Yoo, J., *et al.*, (2023) *Numerical relativity surrogate model with memory effects and post-Newtonian hybridization*, Phys. Rev. D **108**, 064027 [arXiv:2306.03148].

54. Ma, S., Varma, V., **Stein, L. C.**, *et al.* (2023) *Numerical simulations of black hole–neutron star mergers in scalar-tensor gravity*, Phys. Rev. D **107**, 124051 [arXiv:2304.11836].
53. Tanay, S., **Stein, L. C.**, Cho, G., (2023) *Action-angle variables of a binary black-hole with arbitrary eccentricity, spins, and masses at 1.5 post-Newtonian order*, Phys. Rev. D **107**, 103040 [arXiv:2110.15351].
52. Grant, A. M., Saffer, A., **Stein, L. C.**, Tahura, A., (2023) *Gravitational-wave energy and other fluxes in ghost-free bigravity*, Phys. Rev. D **107**, 044041 [arXiv:2208.02123].
51. Mitman, K., Lagos, M., **Stein, L. C.**, *et al.* (2023) *Nonlinearities in black hole ringdowns*, Phys. Rev. Lett. **130**, 081402 [arXiv:2208.07380]. Editors' Suggestion, Featured in Physics.
50. Clark, W. A., Gomes, M. W., Rodriguez-Gonzalez, A., **Stein, L. C.**, Strogatz, S. H., (2023) *Surprises in a classic boundary-layer problem*, SIAM Review 2023 65:1, 291-315 [arXiv:2107.11624].
49. Mitman, K., **Stein, L. C.**, Boyle, M., *et al.* (2022) *Fixing the BMS Frame of Numerical Relativity Waveforms with BMS Charges*, Phys. Rev. D **106**, 084029 [arXiv:2208.04356].
48. Okounkova, M, Farr, W. M., Isi, M., **Stein, L. C.**, (2022) *Constraining gravitational wave amplitude birefringence and Chern-Simons gravity with GWTC-2*, Phys. Rev. D **106**, 044067 [arXiv:2101.11153].
47. Magaña Zertuche, L., Mitman, K., Khera, N., **Stein, L. C.**, et al., (2022) *High Precision Ringdown Modeling: Multimode Fits and BMS Frames*, Phys. Rev. D **105**, 104015 [arXiv:2110.15922].
46. Gálvez Ghersi, J. T., **Stein, L. C.**, (2021) *Numerical renormalization group-based approach to secular perturbation theory*, Phys. Rev. E **104**, 034219 [arXiv:2106.08410].
45. Mitman, K., Khera, N., Iozzo, D. A. B., **Stein, L. C.**, et al., (2021) *Fixing the BMS frame of numerical relativity waveforms*, Phys. Rev. D **104**, 024051 [arXiv:2105.02300].
44. Iozzo, D. A. B., Khera, N., **Stein, L. C.**, et al., (2021) *Comparing Remnant Properties from Horizon Data and Asymptotic Data in Numerical Relativity*, Phys. Rev. D **103**, 124029 [arXiv:2104.07052].
43. Tahura, S., Nichols, D. A., Saffer, A., **Stein, L. C.**, Yagi, K. (2020) *Brans-Dicke theory in Bondi-Sachs form: Asymptotically flat solutions, asymptotic symmetries and gravitational-wave memory effects*, Phys. Rev. D **103**, 104026 [arXiv:2007.13799].
42. Tanay, S., **Stein, L. C.**, Gálvez Ghersi, J. T., (2020) *Integrability of eccentric, spinning black hole binaries up to second post-Newtonian order*, Phys. Rev. D **103**, 064066 [arXiv:2012.06586].
41. Gálvez Ghersi, J. T., **Stein, L. C.**, (2020) *A fixed point for black hole distributions*, Class. Quantum Grav. **38** 045012 [arXiv:2007.11578].
40. Okounkova, M., **Stein, L. C.**, Moxon, J., Scheel, M. A., Teukolsky, S. A., (2020) *Numerical relativity simulation of GW150914 beyond general relativity*, Phys. Rev. D **101**, 104016 [arXiv:1911.02588].
39. **Stein, L. C.**, Warburton, N., (2020) *Location of the last stable orbit in Kerr spacetime*, Phys. Rev. D **101**, 064007 [arXiv:1912.07609].
38. Okounkova, M., **Stein, L. C.**, Scheel, M. A., Teukolsky, S. A., (2019) *Numerical binary black hole collisions in dynamical Chern-Simons gravity*, Phys. Rev. D **100**, 104026 [arXiv:1906.08789].
37. Varma, V, *et al.* (2019) *Surrogate models for precessing binary black hole simulations with unequal masses*, Phys. Rev. Research **1**, 033015 [arXiv:1905.09300].
36. **Stein, L. C.**, (2019) `qnm`: *A Python package for calculating Kerr quasinormal modes, separation constants, and spherical-spheroidal mixing coefficients*, J. Open Source Softw., 4(42), 1683 [arXiv:1908.10377].
35. Boyle, M., *et al.* (**LCS** is corresponding author) (2019) *The SXS Collaboration catalog of binary black hole simulations*, Class. Quantum Grav. **36** 195006 [arXiv:1904.04831].

34. Barack, L., *et al.* (2019) *Black holes, gravitational waves and fundamental physics: a roadmap*, Class. Quantum Grav. **36** 143001 [arXiv:1806.05195].

33. Varma, V., **Stein, L. C.**, Gerosa, D., (2019) *The binary black hole explorer: on-the-fly visualizations of precessing binary black holes*, Class. Quantum Grav. **36** 095007 [arXiv:1811.06552], [project website].

32. Varma, V., Gerosa, D., **Stein, L. C.**, Hébert, F., Zhang, H., (2019) *High-accuracy mass, spin, and recoil predictions of generic black-hole merger remnants*, Phys. Rev. Lett. **122**, 011101 [arXiv:1809.09125].

31. Isi, M., **Stein, L. C.** (2018) *Measuring stochastic gravitational-wave energy beyond general relativity*, Phys. Rev. D **98**, 104025 [arXiv:1807.02123].

30. Prabhu, K., **Stein, L. C.** (2018) *Black hole scalar charge from a topological horizon integral in Einstein-dilaton-Gauss-Bonnet gravity*, Phys. Rev. D **98**, 021503(R) (Rapid Communication) [arXiv:1805.02668].

29. Gerosa, D., Hébert, F., **Stein, L. C.** (2018) *Black-hole kicks from numerical-relativity surrogate models*, Phys. Rev. D **97**, 104049 [arXiv:1802.04276].

28. Chen, B., **Stein, L. C.** (2018) *Deformation of extremal black holes from stringy interactions*, Phys. Rev. D **97**, 084012 [arXiv:1802.02159].

27. Chen, B., **Stein, L. C.** (2017) *Separating metric perturbations in near-horizon extremal Kerr*, Phys. Rev. D **96**, 064017 [arXiv:1707.05319].

26. Okounkova, M., **Stein, L. C.**, Scheel, M. A., Hemberger, D. A. (2017) *Numerical binary black hole mergers in dynamical Chern-Simons: I. Scalar field*, Phys. Rev. D **96**, 044020 [arXiv:1705.07924].

25. Tso, R., Isi, M., Chen, Y., **Stein, L. C.** (2017) *Modeling the Dispersion and Polarization Content of Gravitational Waves for Tests of General Relativity*, CPT and Lorentz Symmetry: pp. 205–208 [arXiv:1608.01284].

24. McNees, R., **Stein, L. C.**, Yunes, N. (2016) *Extremal Black Holes in Dynamical Chern-Simons Gravity*, Class. Quantum Grav. **33** 235013 [arXiv:1512.05453].

23. Flanagan, É. É., Nichols, D. A., **Stein, L. C.**, Vines, J. (2016) *Prescriptions for Measuring and Transporting Local Angular Momenta in General Relativity*, Phys. Rev. D **93**, 104007 [arXiv:1602.01847].

22. Yagi, K., **Stein, L. C.** (2016) *Black Hole Based Tests of General Relativity*, Class. Quantum Grav. **33** 054001 [arXiv:1602.02413].

21. Yagi, K., **Stein, L. C.**, Yunes, N. (2016) *Challenging the Presence of Scalar Charge and Dipolar Radiation in Binary Pulsars*, Phys. Rev. D **93** 024010 [arXiv:1510.02152].

20. Berti, E., (5 authors), **Stein, L. C.**, (46 more authors) (2015) *Testing General Relativity with Present and Future Astrophysical Observations*, Class. Quantum Grav. **32** 243001 [arXiv:1501.07274].

19. Tsang, D., Galley, C. R., **Stein, L. C.**, Turner, A. (2015) *"Slimplectic" Integrators: Variational Integrators for General Nonconservative Systems*, ApJ **809** L9 [arXiv:1506.08443].

18. Yagi, K., **Stein, L. C.**, Pappas, G., Yunes, N., Apostolatos, T. (2014) *Why I-Love-Q: Explaining why universality emerges in compact objects*, Phys. Rev. D **90** 063010 [arXiv:1406.7587].

17. **Stein, L. C.** (2014) *Rapidly rotating black holes in dynamical Chern-Simons gravity: Decoupling limit solutions and breakdown*, Phys. Rev. D **90** 044061 [arXiv:1407.2350].

16. **Stein, L. C.**, Yagi, K., Yunes, N. (2014) *Three-Hair Newtonian Relations for Rotating Stars*, ApJ **788** 15 [arXiv:1312.4532].

15. **Stein, L. C.**, Yagi, K. (2014) *Parameterizing and constraining scalar corrections to general relativity*, Phys. Rev. D **89** 044026 [arXiv:1310.6743].

14. Yagi, K., **Stein, L. C.**, Yunes, N., Tanaka, T. (2013) *Isolated and Binary Neutron Stars in Dynamical Chern-Simons Gravity*, Phys. Rev. D **87** 084058 [arXiv:1302.1918].
13. Yagi, K., **Stein, L. C.**, Yunes, N., Tanaka, T. (2012), *Post-Newtonian, Quasi-Circular Binary Inspirals in Quadratic Modified Gravity*, Phys. Rev. D **85** 064022 [arXiv:1110.5950].
12. Vigeland, S., Yunes, N., **Stein, L. C.** (2011), *Bumpy black holes in alternative theories of gravity*, Phys. Rev. D **83** 104027 [arXiv:1102.3706].
11. Yunes, N., **Stein, L. C.** (2011), *Nonspinning black holes in alternative theories of gravity*, Phys. Rev. D **83** 104002 [arXiv:1101.2921].
10. **Stein, L. C.**, Yunes, N. (2011), *Effective gravitational wave stress-energy tensor in alternative theories of gravity*, Phys. Rev. D **83** 064038 [arXiv:1012.3144].
9. Lutomirski, A., Tegmark, M., Sanchez, N. J., **Stein, L. C.**, Urry, W. L., Zaldarriaga, M. (2011), *Solving the corner-turning problem for large interferometers*, MNRAS **410** 2075 [arXiv:0910.1351].
8. Sutton, P., Jones, G., Chatterji, S., Kalmus, P., Leonor, I., Poprocki, S., Rollins, J., Searle, A., **Stein, L.**, Tinto, M., Was, M. (2010), *X-Pipeline: an analysis package for autonomous gravitational-wave burst searches*, New J. Phys. **12** 053034 [arXiv:0908.3665].
7. Chatterji, S., Lazzarini, A., **Stein, L.**, Sutton, P., Searle, A. (2006), *Coherent network analysis technique for discriminating gravitational-wave bursts from instrumental noise*, Phys. Rev. D **74** 082005 [arXiv:gr-qc/0605002].

Unrefereed Publications

6. Galley, C. R., Tsang, D., **Stein, L. C.** (2014) *The principle of stationary nonconservative action for classical mechanics and field theories*, [arXiv:1412.3082].
5. **Stein, L. C.** (2014), *Note on Legendre decomposition of the Pontryagin density in Kerr*, [arXiv:1407.0744].
4. **Stein, L. C.** (2012), *Probes of Strong-field Gravity*, Ph.D. thesis at Massachusetts Institute of Technology [hdl:1721.1/77256].
3. Betancourt, M., **Stein, L. C.** (2011) *The Geometry of Hamiltonian Monte Carlo*, [arXiv:1112.4118].
2. **Stein, L. C.** (2009), *Binary Inspiral Gravitational Waves from a Post-Newtonian Expansion*, Contribution to the Wolfram Demonstrations Project, `http://demonstrations.wolfram.com/BinaryInspiralGravitationalWavesFromAPostNewtonianExpansion/`
1. **Stein, L. C.** (2006), *Gravitational Wave Burst Source Localization in a Coherent Network Analysis*, Senior thesis at California Institute of Technology

References

Scott A. Hughes, Professor of Physics, Massachusetts Institute of Technology
77 Massachusetts Avenue, Bldg. 37-602A
Cambridge, MA 02139
email: sahughes@mit.edu
office phone: 1-617-258-8523

Nico Yunes, Professor of Physics, University of Illinois
249 Loomis Laboratory
1110 West Green Street
Urbana, IL 61801-3003
email: nyunes@illinois.edu
office phone: 1-814-883-2069

Éanna É. Flanagan, Professor of Physics and Astronomy, Cornell University
463 Physical Sciences Building
Ithaca, NY 14853
email: eef3@cornell.edu
office phone: 1-607-255-6534

Yanbei Chen, Professor of Physics, California Institute of Technology
TAPIR 350-17, Caltech
1200 E. California Boulevard
Pasadena, CA 91125
email: yanbei@caltech.edu (please send correspondence to joann@caltech.edu)
office phone: 1-626-395-4258