Leo C. Stein

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EDUCATION Ph.D., Physics, Massachusetts Institute of Technology, Cambridge, MA, Dissertation Advisor: Prof. Scott Hughes Dissertation Title: <i>Probes of strong-field gravity</i>	
B.S., Physics, California Institute of Technology, Pasadena, CA, Degree conferred with honor. Senior Thesis Advisors: Dr. Patrick Sutton and Prof. Alan V	
Assistant Professor, University of Mississippi, Oxford, MS USA	August 2018–Present
Senior Postdoctoral Researcher, Caltech, Pasadena, CA USA S	September 2015–August 2018
NASA Einstein Fellow, Cornell, Ithaca NY, USA	September 2012–August 2015
Research and Teaching Assistant, MIT, Cambridge MA, USA September 2006-May 2012	
Teaching Assistant, Caltech, Pasadena, CA, USA	Fall 2004, Spring 2005
Summer Research Fellow, Caltech, Pasadena, CA, USA	${\bf June-September~2003/2005}$
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.	
CAREER Award, NSF	2021-2026
Einstein Postdoctoral Fellow, NASA	2012–2015
Henry Kendall Teaching Award, Massachusetts Institute of T	echnology 2011
Upperclass Merit Scholarship, California Institute of Technolo	ogy 2005–2006
	Spring 2021 Falls 2019–2021 Springs 2019–2021 Fall 2020, Spring 2021 Spring 2019, Falls 2020–2021 Fall 2018
	University, MS 38677-1848 USA Ph.D., Physics, Massachusetts Institute of Technology, Cambrid Dissertation Advisor: Prof. Scott Hughes Dissertation Title: Probes of strong-field gravity B.S., Physics, California Institute of Technology, Pasadena, CA, Degree conferred with honor. Senior Thesis Advisors: Dr. Patrick Sutton and Prof. Alan V. Assistant Professor, University of Mississippi, Oxford, MS USA Senior Postdoctoral Researcher, Caltech, Pasadena, CA USA Senior Postdoctoral Researcher, Caltech, Pasadena, CA USA Sesearch and Teaching Assistant, MIT, Cambridge MA, USA Teaching Assistant, Caltech, Pasadena, CA, USA Summer Research Fellow, Caltech, Pasadena, CA, USA Summer Research Fellow, Caltech, Pasadena, CA, USA General relativity (GR), gravitation, and astrophysical phenomena major theme is pushing numerical and analytical gravitational-wave frontier in advance of next-generation observatories. A second m GR against beyond-GR models, in both theory-independent and involves numerical relativity and renormalization methods applied for beyond-GR theories. CAREER Award, NSF Einstein Postdoctoral Fellow, NASA Henry Kendall Teaching Award, Massachusetts Institute of Tupperclass Merit Scholarship, California Institute of Technology, 213, General physics I Phys. 213, General physics I Phys. 401, Electromagnetism I Phys. 463/4, Senior research project

	Phys. 721, Graduate electrodynamics I	Spring 2022
	Phys. 750, General relativity II	Spring 2020
	Guest Lecturer, California Institute of Technology	
	Ph236, General relativity	Fall 2017
	Ph237, Gravitational Waves	Spring 2016
	Guest Lecturer, Massachusetts Institute of Technology	
	8.901, Graduate Astrophysics I	Spring 2011
	Teaching Assistant, Massachusetts Institute of Technology	
	8.942, Cosmology	Fall 2011
	8.901, Graduate Astrophysics I	Spring 2011
	8.286, The Early Universe	Fall 2009
	Teaching Assistant, California Institute of Technology	
	Ph 7, Nuclear and Quantum Physics Lab	Spring 2005
	Ph 5, Analog Electronics for Physicists	Fall 2004
Mentoring/	Postdoctoral researchers	
Supervision	Károly Csukás	Fall 2021–present
	José Tomás Gálvez Ghersi	Fall 2019–present
	Graduate students Lorena Magaña Zertuche, University of Mississippi	Fall 2018–present
	Sashwat Tanay, University of Mississippi	Fall 2018–present
	Maria (Masha) Okounkova, Caltech	Fall 2015–Summer 2019
	Baoyi Chen, Caltech	Fall 2016–Summer 2018
	Undergraduate students	
	Wayne Zhao, Harvard	Summer 2016
Professional	LISA Consortium, Full member	2020–Present
ACTIVITIES,	UMiss LISA Group leader	2020-Present
Outreach, and Service	Simulating eXtreme Spacetimes collaboration	2015–Present
	Executive committee member	2018–Present
	American Physical Society, member Division of Gravitational Physics	2010–Present
	Executive Committee Member-at-Large	2016-2019
	Division of Astrophysics	
	Conference organizer	
	Workshop on Numerical Relativity beyond General Relativity, Be Week-long international workshop, 59 participants	enasque June 2018
	$34^{\rm th}$ Pacific Coast Gravity Meeting (PCGM), Caltech Two-day conference, ~ 125 participants	March 2018

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

August 21, 2019 April 25, 2016

February 1, 2016

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 2018	April APS meeting, Columbus, OH
March 2018	34 th Pacific Coast Gravity Meeting (PCGM), Caltech
March 2017	33 rd Pacific Coast Gravity Meeting (PCGM), UCSB
January 2017	"April" APS meeting, Washington D.C.
April 2016	32 nd Pacific Coast Gravity Meeting (PCGM), CSU Fullerton
November 2015	Theoretical Astrophysics in Southern California (TASC), CSU Fullerton

Journal referee

Classical and Quantum Gravity, Journal of Cosmology and Astroparticle Physics, 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 Physics Teacher

Agency work

Reviewer for NSF, NASA

Guest on *The Titanium Physicists Podcast* Episode 80: Picturing the Bach Hole

Episode 64: The edges of Einstein

Episode 62: Black Bells

Outreach

Guest on the Starts With a Bang podcast Episode 42: Black holes and gravitationa	March 25, 2019
Invited speaker for Latin American Webinar on Physics Webinar 75: "Testing Einstein with numerical relativity"	March 13, 2019
Caltech astronomy public lecture series speaker Lecture: "The truth about black holes"	March 2018
Astronomy on Tap public lecture series speaker and volunteer Close to a monthly basis	2016–2018
Caltech astronomy public lecture series panelist and emcee Approximately every three months	2016-2018
Invited guest lecture on black holes and gravitational waves Science of Space and Time, Hampshire College	November 2017
Invited video Q&A session, public high school physics class $The\ Nova\ Project$ school, Seattle	June 2017

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

February 17, 2016

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

March/June 2014

Invited public talk at Frontiers of Cornell Astronomy, Cornell Friends of Astronomy

November 2013

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

COMPUTER SKILLS Expert in MATHEMATICA. Proficient in C/C++, Python, Bash, Javascript. Experience in Java, Haskell. Proficient at *nix and HPC. Markup languages: IATFX, 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 gripapers packages for LATEX.

Submitted **PUBLICATIONS**

- 51. Bronicki, D., Cárdenas-Avendaño, A., Stein, L. C., (2022) Tidally-induced nonlinear resonances in EMRIs with an analogue model, [arXiv:2203.08841].
- 50. Tanay, S., Cho, G., Stein, L. C., (2021) Action-angle variables of a binary black-hole with arbitrary eccentricity, spins, and masses at 1.5 post-Newtonian order, [arXiv:2110.15351].
- 49. Okounkova, M, Farr, W. M., Isi, M., Stein, L. C., (2021) Constraining gravitational wave amplitude birefringence and Chern-Simons gravity with GWTC-2, [arXiv:2101.11153].

ACCEPTED **PUBLICATIONS**

48. Clark, W. A., Gomes, M. W., Rodriguez-Gonzalez, A., Stein, L. C., Strogatz, S. H., (2021) Surprises in a classic boundary-layer problem, [arXiv:2107.11624].

Collaboration **PUBLICATIONS**

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

Refered Publications

- 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].
- 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].
- 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].
- 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].
- 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].
- 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].
- 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].
- 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].
- 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

- 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

INVITED TALKS

42.	ICERM, Advances in CS Classical and Quantum Gravity,	May 2022
41.	Flatiron CCA, Ringdown workshop, invited overview talk,	February 2022
40.	${\tt DAMTP~(University~of~Cambridge),~HEP/GR~colloquium,}\\$	January 2022
39.	SISSA, Current challenges in gravitational physics workshop,	April 2021
38.	Flatiron CCA, Gravitational wave astronomy group seminar,	January 2021
37.	University of Birmingham, astrophysics seminar	September 2020
36.	Albert Einstein Institute, ACR division seminar	July 2020
35.	Black Hole Perturbation Toolkit, Spring 2020 workshop	May 2020
34.	American Physical Society Meeting	April 2020
33.	UVA, physics department colloquium	November 2019
32.	UT Dallas, physics department colloquium	October 2019
31.	Northwestern University, CIERA astrophysics seminar	May 2019
30.	ETH-ITS Zurich, "New horizons for gravity" workshop	May 2018
29.	UC San Diego, astrophysics seminar	March 2018
28.	UC Berkeley, 4D particle physics seminar	March 2018
27.	Kyoto University, YKIS2018a Symposium	February 2018
26.	Oakland University physics seminar	February 2018
25.	University of Wisconsin-Milwaukee gravity seminar	January 2018
24.	Caltech/JPL Gravitational-Wave (CaJAGWR) seminar	January 2018
23.	ICN UNAM, Relativity seminar	December 2017
22.	University of Mississippi, Astrophysics seminar	November 2017
21.	University of Florida, Astrophysics seminar	November 2017
20.	University of Nottingham, Mathematical Physics seminar	July 2017
19.	Sapienza University of Rome, New Frontiers in Gravitational-Wave	Astrophysics June 2017
18.	Rochester Institute of Technology, CCRG seminar	March 2017
17.	Penn State, IGC seminar	March 2017
16.	University of Mississippi, Strong Gravity/Binary Dynamics worksho	op February/March 2017
15.	SUNY Stony Brook, "The universe through gravitational waves"	December 2016
14.	University of Pennsylvania, New Frontiers in Gravitational Radiation	workshop December 2016
13.	Cambridge MA, Event Horizon Telescope collaboration meeting	November/December 2016
12.	Northwestern University CIERA, "Fellows at the Frontiers"	August/September 2016
11.	Princeton University, GR@100 $++$ panel discussion	April 2016
10.	Cambridge MA, Einstein fellows symposium	October 2014
9.	Perimeter Institute, Strong gravity seminar	October 2014
8.	Cornell University, Friends of astronomy outreach event	November 2013
7.	Cambridge MA, Einstein fellows symposium	October 2013
6.	SUNY Geneseo, Physics colloquium	October 2013
5.	University of Maryland, UMD gravity seminar	October 2013
4.	Yale University, YCAA seminar	September 2013
	Kyoto University, YITP long-term workshop	June 2013
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Contributed
Talks (selected)

2. Cambridge MA, Einstein fellows symposium	October 2012
1. Cornell University, Relativity lunch	November 2011
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20. American Physical Society Meeting	April 2021
19. American Physical Society Meeting	April 2019
18. American Physical Society Meeting	April 2018
17. Pacific Coast Gravity Meeting	March 2017
16. American Physical Society Meeting	April January 2017
15. Testing Gravity 2017	January 2017
14. 21^{st} International meeting on GR (GR21)	July 2016
13. American Physical Society Meeting	April 2016
12. Eastern Gravity Meeting	May 2015
11. American Physical Society Meeting	April 2015
10. NEB 16 Recent developments in gravity	September 2014
9. American Physical Society Meeting	April 2014
8. XXVII Texas symposium on relativistic astrophysics	December 2013
7. 20^{th} International meeting on GR (GR20)	July 2013
6. Eastern Gravity Meeting	June 2013
5. American Physical Society Meeting	April 2013
4. Caltech TAPIR Seminar	December 2011
3. Eastern Gravity Meeting	June 2011
2. American Physical Society Meeting	April 2011
1. American Physical Society Meeting	April 2010

References

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