

## Leo C. Stein

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EDUCATION	<b>Ph.D., Physics</b> , Massachusetts Institute of Technology, Cambridge, MA, USA Dissertation Advisor: Prof. Scott Hughes Dissertation Title: <i>Probes of strong-field gravity</i> <b>May 2012</b>  <b>B.S., Physics</b> , California Institute of Technology, Pasadena, CA, USA Degree conferred with honor. Senior Thesis Advisors: Dr. Patrick Sutton and Prof. Alan Weinstein <b>June 2006</b>	
EMPLOYMENT	<b>Assistant Professor</b> , University of Mississippi, Oxford, MS USA <b>Senior Postdoctoral Researcher</b> , Caltech, Pasadena, CA USA <b>NASA Einstein Fellow</b> , Cornell, Ithaca NY, USA <b>Research and Teaching Assistant</b> , MIT, Cambridge MA, USA <b>Teaching Assistant</b> , Caltech, Pasadena, CA, USA <b>Summer Research Fellow</b> , Caltech, Pasadena, CA, USA	<b>August 2018–Present</b> <b>September 2015–August 2018</b> <b>September 2012–August 2015</b> <b>September 2006–May 2012</b> <b>Fall 2004, Spring 2005</b> <b>June–September 2003/2005</b>
RESEARCH INTERESTS	General relativity (GR), gravitation, and astrophysical phenomena which can elucidate gravity. Recent work is focused on gravitational-wave predictions in beyond-GR theories of gravity. Work in progress and future work includes numerical simulations of black hole mergers in beyond-GR theories, cosmological signatures of beyond-GR theories, and investigations in near-horizon extremal Kerr.	
HONORS AND AWARDS	<b>Einstein Postdoctoral Fellow</b> , NASA <b>Henry Kendall Teaching Award</b> , Massachusetts Institute of Technology <b>Upperclass Merit Scholarship</b> , California Institute of Technology	<b>2012–2015</b> <b>2011</b> <b>2005–2006</b>
TEACHING EXPERIENCE	<b>Assistant Professor</b> , University of Mississippi Phys. 402, Electromagnetism II Phys. 709, Advanced Mechanics I  <b>Guest Lecturer</b> , California Institute of Technology Ph236, General relativity Ph237, Gravitational Waves  <b>Guest Lecturer</b> , Massachusetts Institute of Technology 8.901, Graduate Astrophysics I	<b>Spring 2019</b> <b>Fall 2018</b>  <b>Fall 2017</b> <b>Spring 2016</b>  <b>Spring 2011</b>

**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

**Graduate students**

Maria (Masha) Okounkova, Caltech	Fall 2015–Summer 2019
Baoyi Chen, Caltech	Fall 2016–present

**Undergraduate students**

Wayne Zhao, Harvard	Summer 2016
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PROFESSIONAL  
ACTIVITIES,  
OUTREACH, AND  
SERVICE**Simulating eXtreme Spacetimes collaboration**

2015–Present

Executive committee member	2018–Present
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**Member, American Physical Society**

2010–Present

Division of Gravitational Physics

Executive Committee Member-at-Large	2016–2019
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Division of Astrophysics

**Conference organizer**

Workshop on <b>Numerical Relativity beyond General Relativity</b> , Benasque	June 2018
Week-long international workshop, 59 participants	
34 <sup>th</sup> Pacific Coast Gravity Meeting (PCGM), Caltech	March 2018
Two-day conference, ~ 125 participants	
Workshop on <b>Unifying Tests of General Relativity</b> , 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, Columbus, OH	April 2018
34 <sup>th</sup> Pacific Coast Gravity Meeting (PCGM), Caltech	March 2018
33 <sup>rd</sup> Pacific Coast Gravity Meeting (PCGM), UCSB	March 2017
“April” APS meeting, Washington D.C.	January 2017
32 <sup>nd</sup> Pacific Coast Gravity Meeting (PCGM), CSU Fullerton	April 2016
Theoretical Astrophysics in Southern California (TASC), CSU Fullerton	November 2015

**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

**Agency work**

External reviewer for NSF, NASA

**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 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** **Languages**—Expert in MATHEMATICA. Proficient in C/C++, Python, Bash, Javascript. Experience in Java, Haskell. Markup languages: L<sup>A</sup>T<sub>E</sub>X, 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.

SUBMITTED  
PUBLICATIONS

39. Okounkova, M., **Stein, L. C.**, Moxon, J., Scheel, M. A., Teukolsky, S. A., (2019) *Numerical relativity simulation of GW150914 beyond general relativity*, [[arXiv:1911.02588](#)].

ACCEPTED  
PUBLICATIONS

38. Okounkova, M., **Stein, L. C.**, Scheel, M. A., Teukolsky, S. A., (2019) *Numerical binary black hole collisions in dynamical Chern-Simons gravity*, [[arXiv:1906.08789](#)].

COLLABORATION  
PUBLICATIONS

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

REFEREED  
PUBLICATIONS

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. (2013) *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](#)].
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

## INVITED TALKS

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 workshop	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
3. Kyoto University, YITP long-term workshop	June 2013
2. Cambridge MA, Einstein fellows symposium	October 2012
1. Cornell University, Relativity lunch	November 2011

CONTRIBUTED TALKS (SELECTED)	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	<del>April</del> January 2017
	15. Testing Gravity 2017	January 2017
	14. 21 <sup>st</sup> 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 <sup>th</sup> 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

**Scott A. Hughes**, Professor of Physics, Massachusetts Institute of Technology  
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 Cambridge, MA 02139  
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**Nico Yunes**, Professor of Physics, University of Illinois  
 237B Loomis Laboratory  
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**Éanna É. Flanagan**, Professor of Physics and Astronomy, Cornell University  
 606 Space Sciences, Cornell University  
 Ithaca, NY 14853  
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