Leo C. Stein

Contact Information

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Education

Ph.D., Physics, Massachusetts Institute of Technology, Cambridge, MA, USA **May 2012**

Dissertation Advisor: Prof. Scott Hughes

Dissertation Title: *Probes of strong-field gravity*

B.S., Physics, California Institute of Technology, Pasadena, CA, USA **June 2006**

Degree conferred with honor.

Senior Thesis Advisors: Dr. Patrick Sutton and Prof. Alan Weinstein

Employment

Senior Postdoctoral Researcher, Caltech, Pasadena, CA USA **September 2015–Present**

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 **June–September 2003/2005**

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

Einstein Postdoctoral Fellow, NASA **2012–2015**

Henry Kendall Teaching Award, Massachusetts Institute of Technology **2011**

Upperclass Merit Scholarship, California Institute of Technology **2005–2006**

Teaching Experience

Guest Lecturer, California Institute of Technology

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

Graduate students

Maria (Masha) Okounkova, Caltech — **Fall 2015–present**

Undergraduate students

Wayne Zhao, Harvard — **Summer 2016**

Professional Activities, Outreach, and Service

Member, American Physical Society — **2010–Present**

Division of Gravitational Physics

Executive Committee Member-at-Large — **2016–2019**

Division of Astrophysics

Conference organizer

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

Seminar organizer

TAPIR seminar, Caltech — **Fall 2015–Present**

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

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

Journal of Cosmology and Astroparticle Physics, Monthly Notices of the Royal Astronomical Society, Physics Letters B, Physical Review D, Physical Review Letters, Reviews of Modern Physics

Outreach

Caltech astronomy public lecture series panelist — **June 10, 2016**, **February 19, 2016**

Guest on *The Titanium Physicists Podcast*
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, 12.8k+ 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++. Experience in Python, Javascript, Java, Bash, Haskell; LaTeX, HTML, CSS.

Operating systems—Mac OS, Linux/*nix.

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). 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 for Chrome.

Publications in Progress

3. Chen, B., **Stein, L. C.** (2017) *Deformation of extremal black holes from stringy interactions.*
2. Chen, B., **Stein, L. C.** (2017) *Separation of variables for linear metric perturbations in near-horizon extremal Kerr.*
1. **Stein, L. C.**, McNees, R. (2017) *Cosmological perturbations in dynamical Chern-Simons.*

Submitted Publications

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

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

19. 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]
18. McNees, R., **Stein, L. C.**, Yunes, N. (2016) *Extremal Black Holes in Dynamical Chern-Simons Gravity*, Class. Quantum Grav. **33** 235013 [arXiv:1512.05453]
17. 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]
16. Yagi, K., **Stein, L. C.** (2016) *Black Hole Based Tests of General Relativity*, Class. Quantum Grav. **33** 054001 [arXiv:1602.02413]
15. 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]
14. 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]
13. 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]
12. 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]
11. **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]
10. **Stein, L. C.**, Yagi, K., Yunes, N. (2014) *Three-Hair Newtonian Relations for Rotating Stars*, ApJ **788** 15 [arXiv:1312.4532]
9. **Stein, L. C.**, Yagi, K. (2013) *Parameterizing and constraining scalar corrections to general relativity*, Phys. Rev. D **89** 044026 [arXiv:1310.6743]
8. 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]

7. 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]
6. Vigeland, S., Yunes, N., **Stein, L. C.** (2011), *Bumpy black holes in alternative theories of gravity*, Phys. Rev. D **83** 104027 [arXiv:1102.3706]
5. Yunes, N., **Stein, L. C.** (2011), *Nonspinning black holes in alternative theories of gravity*, Phys. Rev. D **83** 104002 [arXiv:1101.2921]
4. **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]
3. 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]
2. 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]
1. 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

Invited Talks

18. *Numerical black holes and mergers beyond general relativity*, CCRG seminar, RIT, March 2017
17. *Numerical black holes and mergers beyond general relativity*, IGC seminar, Penn State, March 2017
16. *Bumpy black hole parameterizations*, Strong Gravity and Binary Dynamics workshop (StronG BaD), University of Mississippi, February/March 2017
15. *Modifications and tests of general relativity*: round table discussion at The universe through gravitational waves conference, Stonybrook, December 2016
14. *Numerical black holes and mergers beyond general relativity*, New Frontiers in Gravitational Radiation workshop, UPenn, December 2016
13. *Present and future tests of general relativity*, Event Horizon Telescope collaboration meeting, Cambridge MA, November/December 2016
12. *Black hole mergers: beyond general relativity*, Fellows at the Frontiers 2016, CIERA, August/September 2016.
11. *Alternative theories of gravity, novel physics around compact objects*: panel discussion at GR@100++ conference, Princeton, April 2016
10. *Rapidly rotating black holes in dynamical Chern-Simons gravity: Decoupling limit solutions and breakdown*, Einstein fellows symposium, October 2014.
9. *Probing (beyond) general relativity with compact binaries and gravitational waves*, Strong gravity seminar, Perimeter Institute, October 2014.

8. Friends of astronomy outreach event, Cornell, November 2013
7. *Parameterizing and constraining scalar corrections to general relativity*, Einstein fellows symposium, October 2013
6. *Corrections to general relativity, and where to look for them*, Physics colloquium, SUNY Geneseo, October 2013
5. *Parameterizing scalar corrections to general relativity*, UMD gravity seminar, University of Maryland, October 2013
4. *Corrections to general relativity, and where to look for them*, YCAA seminar, Yale University, September 2013
3. *Scalar gravitational effects*, YITP long-term workshop, Kyoto University, June 2013
2. *Conditions for Preheating*, Einstein fellows symposium, October 2012
1. *Signatures of strong gravity corrections to GR*, Cornell Relativity Lunch, November 2011

Contributed Talks (selected)

12. *Numerical black holes and mergers in dynamical Chern-Simons gravity*, GR21, July 2016
11. *Extremal black holes in dynamical Chern-Simons gravity*, April APS Meeting 2016
10. *Hiding corrections to GR with topology*, Eastern Gravity Meeting, May 2015
9. *Why neutron stars have three hairs*, April APS Meeting 2015
8. *Rapidly rotating black holes in dynamical Chern-Simons gravity: Decoupling limit solutions and breakdown*, NEB 16—Recent developments in gravity, September 2014
7. *Three-Hair Newtonian Relations for Rotating Stars*, April APS Meeting 2014
6. *Parameterizing and constraining scalar corrections to general relativity*, XXVII Texas symposium, December 2013
5. *Eccentric binary effects in dynamical Chern-Simons gravity*, April APS Meeting 2013
4. *Signatures of strong gravity corrections to GR*, Caltech TAPIR Seminar, December 2011
3. *Effective gravitational wave stress-energy tensor in alternative theories of gravity*, Eastern Gravity Meeting, June 2011
2. *Effective gravitational wave stress-energy tensor in alternative theories of gravity*, April APS Meeting 2011
1. *Tuning advanced gravitational-wave detectors to optimally measure neutron-star merger waves*, April APS Meeting 2010

References

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