# Yong Gao


**Contact Information**

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**Education**

**Ph.D. candidate, Physics,** Peking University, Beijing, China **August 2018-Present**

Dissertation Advisor: Prof. Lijing Shao

Dissertation Title: *Probing Structures of Neutron Stars with Gravitational Waves*

**B.S., Physics,** Dalian University of Technology, Dalian, Liaoning Province, China **July 2018**

Degree conferred with honor.

Senior Thesis Advisors: Prof. Renxin Xu and Prof. Chong Li

Thesis Title: *The Electron Distributions of Strangelets in the Thomas-Fermi Model*

G.P.A.: 3.8/4.0

**Research Interests**

**Understanding the composition and state of matter under the extreme conditions inside neutron stars (NSs).** One major theme is modelling gravitational waves (GWs) from systems involving NSs, such as tidal effects in the inspiral phase of binary NS systems, GW asteroseismology of oscillating NSs. A second major theme is studying the dynamics and observational consequences of freely precessing NSs.

**Testing gravity in the strong-field regime of neutron stars.** Focusing on the structures of NSs in alternative theories of gravity, especially the universal relations between global properties.

**Honors and Awards**

**Principal Scholarship,** Peking University **2022-2023**

**Vela Prize for Oral presentation,** NASA **2012–2015**

**Teaching Experience**

**Teaching Assistant**, Peking University

Electrodynamics (B) **Fall 2022**

General Physics I, *incl. Mechanics & Electromagnetism **Fall 2021**

Theoretical Mechanics (A), **Excellent Teaching Assistant Award** **Fall 2019**

**Mentoring/ Supervision**

**Postdoctoral researchers**

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 Activities, Outreach, and Service

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

**Simulating eXtreme Spacetimes collaboration** **2015–Present**
Executive committee member **2018–Present**

**American Physical Society, member** **2010–Present**
Division of Gravitational Physics

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

Division of Astrophysics

### Conference organizer

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

34th Pacific Coast Gravity Meeting (PCGM), Caltech **March 2018**
Two-day conference, $\sim$ 125 participants

Workshop on 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, 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

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

### 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

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 `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 refereed LIGO and/or LIGO/Virgo collaboration publications. I only list short author-list publications below.

## Refereed 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].
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

## Invited Talks

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| 42. | ICERM, Advances in CS Classical and Quantum Gravity, | May 2022 |
| 41. | Flatiron CCA, Ringdown workshop, invited overview talk, | February 2022 |
| 40. | 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 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)

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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