Jeffrey S. Hazboun | Curriculum Vitae

Physical Sciences Division, University of Washington Bothell
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Professional Experience

University of Washington Bothell **Bothell, WA**
- *NANOGrav Physics Frontiers Center Senior Postdoctoral Fellow* *August 2018–*

University of Texas Rio Grande Valley **Brownsville, TX**
- *NANOGrav Physics Frontiers Center Postdoctoral Fellow* *August 2016–July 2018*

Hendrix College **Conway, AR**
- *Visiting Assistant Professor* *August 2015–July 2016*

Utah State University **Logan, UT**
- *Postdoctoral Teaching Position/ Head Online Class Developer* *September 2014 - August 2015*

Georgia Institute of Technology **Atlanta, GA**
- *Visiting Scholar, Center for Relativistic Astrophysics* *June 2012 - May 2013*

Education

PhD in Physics **December 2014**
Utah State University *Logan, Utah*
Advisor: Dr. James T. Wheeler
Dissertation Title: *Conformal gravity and time*

MS Physics (Mathematics Minor) **June 2008**
Oregon State University *Corvallis, Oregon*
Advisor: Dr. Tevian Dray
Thesis Title: *The effects of negative-energy shells on Schwarzschild spacetime*

BS Biology **December 1999**
State University of New York, College of Environmental Science and Forestry *Syracuse, New York*

Grants, Funding & Awards

Proposal (PI): "Pulsar Timing Array GW Signal Analysis Using Big Data Techniques" *2019*
- PI Jeffrey Hazboun, a submission to Amazon Web Services Machine Learning Research Awards.
- Total award: $\$50,000$ in AWS Promotional Credits.

Observing Proposals

Co-I: **"High Time Resolution Observations of a Bright Millisecond Pulsar"** *November 2018*
- Greenbank Telescope, Project ID GBT$18B-355$
- Status: awarded 5 hours

Co-I: **"High Cadence Observations of MSPs for Gravitational Wave Detection"** *March 2020*
- Arecibo Radio Telescope, proposal P2945
- Status: awarded 32.5 hours

Publications

- **Metrics** available at Google Scholar.

Submitted

6. *Model Dependence of Bayesian Gravitational-Wave Background Statistics for Pulsar Timing Arrays*.
J. S. Hazboun, J. Simon, X. Siemens, J. D. Romano
Arxiv:2009.05143
5. *Multimessenger pulsar timing array constraints on supermassive black hole binaries traced by periodic light curves*.
Chengcheng Xin, Chiara M. F. Mingarelli, **J. S. Hazboun**
Arxiv:2009.11865
4. *The NANOGrav 12.5-year Data Set: Search For An Isotropic Stochastic Gravitational-Wave Background*.
Z. Arzoumanian, [...], **J. S. Hazboun**, et al. [61 Authors]
Arxiv:2009.04496
3. *Precision Timing of PSR J0437-4715 with the IAR Observatory and Implications for Low-Frequency Gravitational Wave Source Sensitivity*.
M. T. Lam, **J. S. Hazboun**
Arxiv:2007.00260
2. *The NANOGrav 12.5-year Data Set: Wideband Timing of 47 Millisecond Pulsars*.
Md F. Alam, [...], **J. S. Hazboun**, et al. [70 Authors]
Arxiv:2005.06495
1. *The NANOGrav 12.5-year Data Set: Observations and Narrowband Timing of 47 Millisecond Pulsars*.
Md F. Alam, [...], **J. S. Hazboun**, et al. [70 Authors]
Arxiv:2005.06490

Published

18. *Multi-Messenger Gravitational Wave Searches with Pulsar Timing Arrays: Application to 3C66B Using the NANOGrav 11-year Data Set*.
Z. Arzoumanian, [...], **J. S. Hazboun**, et al. [59 Authors]
The Astrophysical Journal, **900**, 2, (2020)
17. *Modeling the Uncertainties of Solar System Ephemerides for Robust Gravitational-wave Searches with Pulsar-timing Arrays*.
M. Vallisneri, [...], **J. S. Hazboun**, et al. [64 Authors]
The Astrophysical Journal, **893**, 2, (2020)
16. *The NANOGrav 11 yr Data Set: Evolution of Gravitational-wave Background Statistics*.
J. S. Hazboun, et al. [63 Authors]
The Astrophysical Journal, **890**, 2, (2020)
15. *The NANOGrav 11 yr Data Set: Limits on Gravitational Wave Memory*.
K. Aggarwal, [...], **J. S. Hazboun**, et al. [61 Authors]
The Astrophysical Journal, **889**, 1, (2020)
14. *The International Pulsar Timing Array: second data release*.
B. B. P. Perera, [...], **J. S. Hazboun**, et al. [75 Authors]
Monthly Notices of the Royal Astronomical Society, **490**, 4, (2019)
13. *The NANOGrav 11 yr Data Set: Limits on Gravitational Waves from Individual Supermassive Black Hole Binaries*.
K. Aggarwal, [...], **J. S. Hazboun**, et al. [64 Authors]
The Astrophysical Journal, **880**, 2, (2019)

12. *The astrophysics of nanohertz gravitational waves*.
S. Burke-Spolaor, [...], **J. S. Hazboun**, et al. [15 Authors]
The Astronomy and Astrophysics Review, **27**, 1, (2019)
11. *Realistic sensitivity curves for pulsar timing arrays*.
J. S. Hazboun, J. D. Romano, T. L. Smith
Physical Review D, **100**, 10, (2019)
10. *Hasasia: A Python package for Pulsar Timing Array Sensitivity Curves*.
J. S. Hazboun, J. D. Romano, T. L. Smith
Journal of Open Software Science, **4**, 42, (2019)
9. *An acoustical analogue of a galactic-scale gravitational-wave detector*.
M. T. Lam, J. D. Romano, J. S. Key, M. Normandin, **J. S. Hazboun**
American Journal of Physics, **86**, 10, (2018)
8. *A Second Chromatic Timing Event of Interstellar Origin toward PSR J1713+0747*.
M. T. Lam, [...], **J. S. Hazboun**, et al. [37 Authors]
The Astrophysical Journal, **861**, 2, (2018)
7. *The NANOGrav 11-year Data Set: Pulsar-timing Constraints on the Stochastic Gravitational-wave Background*.
Z. Arzoumanian, [...], **J. S. Hazboun**, et al. [62 Authors]
The Astrophysical Journal, **859**, 1, (2018)
6. *Constructing an explicit AdS/CFT correspondence with Cartan geometry*.
J. S. Hazboun
Nuclear Physics B, **929**, pp. 254-265, (2018)
5. *Power radiated by a binary system in a de Sitter universe*.
B. Bonga, **J. S. Hazboun**
Physical Review D, **96**, 6, (2017)
4. *C7 multi-messenger astronomy of GW sources*.
M. Branchesi, [...], **J. S. Hazboun**, et al. [45 Authors]
General Relativity and Gravitation, **46**, 9, (2014)
3. *Time and dark matter from the conformal symmetries of Euclidean space*.
J. S. Hazboun, J. T. Wheeler
Classical and Quantum Gravity, **31**, 21, (2014)
2. *A systematic construction of curved phase space: A gravitational gauge theory with symplectic form*.
J. S. Hazboun, J. T. Wheeler
Journal of Physics: Conference Series, **360**, 012013, (2012)
1. *The Effect of Negative-Energy Shells on the Schwarzschild Black Hole*.
J. S. Hazboun, T. Dray
General Relativity and Gravitation, **42**, pp. 1457-1467, (2010)

Technical and White Papers

8. *Pulsar Timing Arrays: Gravitational Waves from Supermassive Black Holes and More*.
I. Stairs, [...], **J. S. Hazboun**, et al. [32 Authors]
Canadian Long Range Plan for Astronony and Astrophysics White Papers, **2020**, pp. 16, (2019)
7. *The NANOGrav Program for Gravitational Waves and Fundamental Physics*.
S. Ransom, [...], **J. S. Hazboun**, et al. [15 Authors]
Bulletin of American Astronomical Society, **51**, pp. 195, (2019)
6. *NANOGrav Education and Outreach: Growing a Diverse and Inclusive Collaboration for Low-Frequency Gravitational Wave Astronomy*.

Timothy Dolch, [...], **J. S. Hazboun**, et al. [27 Authors]
Bulletin of American Astronomical Society, **51**, pp. 254, (2019)

5. *The Gravitational View of Massive Black Hole Mergers*.
Monica Colpi, [...], **J. S. Hazboun**, et al. [19 Authors]
Bulletin of American Astronomical Society, **51**, 3, (2019)
4. *Physics Beyond the Standard Model With Pulsar Timing Arrays*.
Xavier Siemens, **J. S. Hazboun**, et al. [8 Authors]
Bulletin of American Astronomical Society, **51**, 3, (2019)
3. *The Second International Pulsar Timing Array Mock Data Challenge*.
J. S. Hazboun, C. M. F. Mingarelli, K. J. Lee
Arxiv:1810.10527
2. *Null-stream pointing with pulsar timing arrays*.
J. S. Hazboun, S. L. Larson
Arxiv:1607.03459
1. *Limiting alternative theories of gravity using gravitational wave observations across the spectrum*.
J. S. Hazboun, M. P. Marcano, S. L. Larson
Arxiv:1311.3153

Teaching & Mentoring

Teaching Positions

- **Visiting Assistant Professor**, Hendrix College, Fall 2015 - Spring 2016
Astronomy, Cosmology, Quantum Mechanics, and General Physics I
Mentored 4 undergraduate researchers.
- **Physics Instructor**, Utah State University, Spring 2015
General Physics II: Physics for the Life Sciences class.
Instructor of Record for 165 students.
Supervised nine teaching assistants.
- **Astronomy Instructor**, Utah State University, Fall 2014
Instructor of record for a 300+ person astronomy class.
Supervised two teaching assistants.
- **Online Physics Course Developer & Instructor**, Utah State University, 2012-2014
The Universe: Proposed, developed and taught an online cosmology class.
Aimed at non-science majors.
Continuously offered for the last 7 semesters.
Over 2000 students have taken this class.
- **Physics Instructor**, Utah State University, Summer 2011
General Physics I: Instructor of Record
- **MCAT Physics Instructor** Princeton Review, Portland, Oregon, Summer 2007
Developed curriculum to help students review for physics portion of the MCAT exam.
Taught students test-taking strategies to prepare for a stressful and fast-paced exam.

Courses

Courses Instructed, *Textbook* (Students × Credit Hours) [cumulative]

- **Quantum Mechanics,** *Griffiths* (39 hrs)
- **Cosmology,** *Ryden* (27 hrs)
- **Astronomy,** *Bennett, et al.* (1300 hrs)
- **The Universe,** *Ratcliffe* (1200 hrs)
- **Physics for the Life Sciences 1,** *Cutnell & Johnson* (75 hrs)

- **Physics for the Life Sciences 2,** *Cutnell & Johnson* (450 hrs)
- **Physics for Engineers 1,** *Halliday & Resnick* (75 hrs)

Graduate Student Research Mentoring

- *Brent Shapiro-Albert*, West Virginia University 2018-2020
  "Chromatic Covariances with the Pulsar Signal Simulator"
- *Andrew Kaiser*, University of Washington Bothell 2018-2020
  "Python package for gravitational-wave sensitivities across the spectrum"

Undergraduate Student Research Mentoring

- *Min Young Kim*, University of Washington Seattle 2018-2019
  "Bayesian Pulsar Timing"
- *Kyle Gersbach*, University of Washington Bothell 2018-2020
  "Teaching with the Pulsar Signal Simulator"
- *Jacob Hesse*, University of Washington Bothell 2017-2018
  "Efficiently Simulating NANOGrav Pulsars"
- *Amelia Henkel*, REU UT Rio Grande Valley Summer 2017
  "Dispersing Simulated Baseband Pulsar Signals"
- *Cassidy Wagner*, REU UT Rio Grande Valley Summer 2017
  "Simulating Interstellar Medium Effects with Convolution"
- *Chris Griffin*, Hendrix College 2015-2016
  "Conformal Diagrams of Crossing Spherical Shells in Schwarzschild Spacetime"
- *Devon Roell*, Hendrix College 2015-2016
  "The Quantum Exchange Force and Gravity"
- *Eric Mullins*, Hendrix College 2015-2016
  "Localizing Gravitational Wave Sources with Noisy Null Signals"
- *Connor Nelson*, Hendrix College 2015-2016
  "Localizing Multiple Gravitational Wave Sources with Null Signals"
- *Manuel Pichardo Marcano*, Utah State University 2012-2013
  "Multi-messenger Pulsar Timing Array Sources and Propagation Tests"

Teaching assistant

- Utah State University Fall 2009-Spring 2012
  General Physics I: Recitation Leader and Lab Instructor
  General Physics II: Recitation Leader and Lab Instructor
- Oregon State University Fall 2006-Spring 2009
  Paradigms in Physics TA: NSF funded higher division class reform project. Facilitated group work and took part in curriculum meetings.
  Physics for the Life Sciences: Recitation Leader and Lab Instructor
  General Physics II: Lab Instructor

Leadership & Professional Service

Research leadership

- ***Co-chair***, IPTA Gravitational Wave Analysis Group *Jan 2019–*
- ***Co-chair***, IGRAV Diversity, Equity & Inclusion Working Group *Jan 2019–*
- ***Co-chair***, IPTA Data Challenge Group *Mar 2018–*

Reviewer for international journals

- The Astrophysical Journal
- Classical and Quantum Gravity
- Physical Review D
- General Relativity & Gravitation
- Monthly Notices of the Royal Astronomical Society
- Physical Review Letters
- European Journal of Physics

Conference organization

- Local Organizing Committee, Conferences for Undergraduate Women in Physics, UW Seattle 2019
- Local Organizing Committee Chair, NANOGrav Spring Meeting, UW Bothell 2019
- LISA Data Analysis Workshop, AAS233 2019
- Scientific Organizing Committee, LISA Symposium, Chicago 2018
- Scientific Organizing Committee, NANOGrav Spring Meeting, University of Virginia 2018
- Scientific Organizing Committee, NANOGrav Spring Student Workshop, University of Virginia 2018
- Student Workshop Organizer, IPTA Meeting, Paris, France 2017
- Session Chair, AAS235
- Session Chair, LISA Symposium 2018

Code & data sharing

- Developer of open-source Python GW analysis software `enterprise` *2017–*
  https://github.com/nanograv/enterprise

Professional affiliations

- LISA Consortium, *Member*
- North American Nanohertz Observatory for Gravitational-waves (NANOGrav), *Full member*
- International Pulsar Timing Array (IPTA), *Member*
- American Physical Society (DGRAV), *Member*
- American Astronomical Society, *Member*

Software Development

Lead Developer

`Hasasia`
- *Python package for calculating pulsar timing array sensitivity curves and signal-to-noise ratios.*
- https://pypi.org/project/hasasia/

`Pulsar Signal Simulator`
- *Python package for simulating pulsar observation data.*
- https://github.com/PsrSigSim/PsrSigSim

`La Forge`
- *Python package for processing data from Bayesian analyses of PTA data.*
- https://pypi.org/project/la-forge/

`Pulsar Data Toolbox`
- *Python package for accessing pulsar data files.*
- https://pypi.org/project/pdat/

Development Team

`Enterprise`
- *Python package for bayesian PTA data analysis.*
- https://github.com/nanograv/enterprise

`enterprise_extensions`
- *Python package for building bayesian analysis models.*
- https://github.com/nanograv/enterprise_extensions

`gwent`
- *Python package calculating gravitational wave sensitivities across the spectrum*
- https://pypi.org/project/gwent/

`Tabletop PTA`
- *Python package for an acoustical PTA demonstration.*
- https://pypi.org/project/tabletop_pta/

Outreach, Diversity, & Media Engagement

Outreach

- Science Wednesday Panel Discussion, King's Live Music *"The Science of Time Travel"* *2015*
- Science Fiction Club Talk, Hendrix College *"Black Holes and Wormholes"* *2015*
- Science Unwrapped (500 person public lecture), Utah State University *"Explore to Conserve"* *2013*
- Conservation Club Talk, Weber State *"A Scientist's Role in Conservation"* *2012*
- Science Unwrapped, Swaner Ecocenter *"A Scientist's Role in Modern Exploration"* *2012*
- Cache Valley Stargazers Talk, Logan, UT *"Black Holes: Ninjas of the Night Sky"* *2009*

Diversity & Equity

- Founding Co-chair, Diversity Equity & Inclusion Working Group, International Gravitational Outreach Group
- Member of the NANOGrav chapter of the APS Inclusion, Diversity, & Equity Alliance
- Local Organizing Committee, UW, Seattle (2019) Conferences for Undergraduate Women in Physics

Press releases

- *"To find giant black holes, start with Jupiter"* *Jun 2020*
  Collaboration research (Vanderbilt press release)
- *"To find giant black holes, start with Jupiter"* *Jun 2020*
  Collaboration research (Green Bank Observatory press release)
- *"Listening for Gravitational Waves Using Pulsars"* *Nov 2017*
  Collaboration research (JPL press release)
- *"Gravitational Wave Search Provides Insights into Galaxy Evolution and Mergers"* *Apr 2016*
  Collaboration research (NRAO press release)

Full Presentation List

Invited talks

19. **Gravitational Wave Astronomy Northwest, GW Updates**, June, 2020
    "Update on the search for gravitational waves in NANOGrav and IPTA datasets"
18. **LIGO Hanford Seminar**, March, 2020
    "The Search for Lumbering Giants"
17. **American Astronomical Society 235th Meeting, NANOGrav Special Session**, January, 2020
    "Highlights from the search for gravitational waves in NANOGrav datasets"
16. **Montana State University, Physics Colloquium**, November, 2019
    "Exploring the discovery space of pulsar timing arrays with realistic sensitivity curves"
15. **Whitman College, Physics Colloquium**, October, 2019
    "The Search for Lumbering Giants:
    Observing the Nanohertz Gravitational-Wave Sky with Pulsar Timing Arrays"
14. **22nd International Conference on General Relativity and Gravitation (GR22) & 13th Edoardo Amaldi Conference on Gravitational Waves (Amaldi13)**, July, 2019
    "Education and Public Outreach Efforts by Pulsar Timing Array Collaborations"
13. **Northwest APS Meeting**, May, 2019
    "The Search for Lumbering Giants:
    Observing the Nanohertz Gravitational-Wave Sky with Pulsar Timing Arrays"
12. **Gravitational Wave Physics and Astronomy Workshop**, December, 2019
    "Current Status of Pulsar Timing Array Gravitational Wave Astronomy"
11. **University of Washington Bothell Physical Sciences Division Seminar**, December, 2018
    "Observing the Nanohertz Gravitational-Wave Sky with Pulsar Timing Arrays"
10. **University of Washington Seattle AstroLunch Talk**, February, 2018
    "A Galactic Scale Gravitational Wave Detector: The NANOGrav 11yr Limits"
9. **University of Washington Bothell Physical Sciences Division Seminar Seminar**, November, 2017
    "The NANOGrav Pulsar Timing Array:
    Using simulations to characterize our galactic gravitational wave detector."
8. **University of Texas Rio Grande Valley Arecibo Remote Command Center Meeting**, February, 2017
    "Simulating Pulsar Signals for Noise Characterization of PTAs"

7. **University of Arkansas Physics Colloquium**, February, 2016
   "Gravitational Wave Astronomy in the 2nd Century of GR"
6. **Western Washington University Physics Colloquium**, May, 2015
   "A New Window into the Cosmos"
5. **Brigham Young University Physics Theory Seminar**, February, 2015
   "Gravitational Gauge Theory and the Dark Cosmological Constituents"
4. **Georgia Tech Center for Relativistic Astrophysics, Departmental Colloquium**, March, 2013
   "Biconformal Space & Testing Alternative Theories of Gravity using Multi-Messenger Astronomy"
3. **Utah State University Physics Colloquium**, February, 2013
   "Best Practices for the Online Classroom"
2. **Utah State University Physics Colloquium**, September 2010
   "Curved Phase Space from conformal symmetry"
1. **Oregon State Physics Colloquium**, March 2009
   "Spherical Shells in a Schwarzschild Background"

Contributed presentations

38. *Model Dependence of Bayesian Gravitational Wave Background Statistics in PTAs*
    International Pulsar Timing Array Meeting, Virtual, September, 2020
37. *Predicting NANOGrav's Sensitivity into the future with* `hasasia`
    American Physical Society April Meeting, Virtual, April, 2020
36. *Exploring the Nanohertz Gravitational-Wave Discovery Space with Sensitivity Curves and* `hasasia`
    American Astronomical Society Meeting, Honolulu, HI, January, 2020
35. *Gravitational Wave Astronomy with the NANOGrav Pulsar Timing Array*
    Texas Symposium on Relativistic Astrophysics, Portsmouth, UK, December, 2019
34. *Modeling Astrophysical Noise Sources in PTAs*
    Fall NANOGrav Meeting, Ithaca, NY, October, 2019
33. *Realistic Pulsar Timing Array Sensitivity Curves*
    GR22/Amaldi13, Valencia, Spain, July, 2019
32. *Pulsar Timing Array Sensitivity Curves*
    American Physical Society April Meeting, Denver, Colorado, April, 2019
31. *Characterizing the Sensitivity of the NANOGrav 11-year Data Set*
    Spring NANOGrav Meeting, Bothell, Washington, March, 2019
30. *Bayesian Monitoring of Solar Electron Density Using NANOGrav Data sets*
    American Astronomical Society Meeting, Seattle, Washington, January, 2019
29. *Bayesian Monitoring of the Solar Wind with Pulsar Timing Arrays*
    AstroNWxSW, Vancouver, British Columbia, November, 2018
28. *Spurious Gravitational Wave Detections in the NANOGrav 11 Year Data Set*
    Fall NANOGrav Meeting, Green Bank, West Virginia, October, 2018
27. *The International Pulsar Timing Array Mock Data Challenge*
    LISA Symposium, Chicago, Illinois, July, 2018
26. *Evolution of the Detection Statistics in the NANOGrav Dataset*
    International Pulsar Timing Array Meeting, Albuquerque, New Mexico, June, 2018
25. *Noise Evolution in the NANOGrav 11 Year Data Set*
    Northwest Section APS Meeting, Tacoma, Washington, June, 2018
24. *Publishing a Gravitational Wave Stochastic Background Analysis*
    Python in Astronomy, New York, New York, May, 2018
23. *Slicing the NANOGrav 11 Year Data Set*
    American Physical Society April Meeting, Columbus, Ohio, April, 2018

22. *Evolution of the NANOGrav 11 Year Data Set*
Spring NANOGrav Meeting, Charlottesville, Virginia, March, 2018

21. *Slicing the NANOGrav 11 Year Data Set*
Fall NANOGrav Meeting, Easton, Pennsylvania, October, 2017

20. *The NANOGrav pulsar signal simulator*
International Pulsar Timing Array, Sèvres, France, July, 2017

19. *Late-time quadrupolar gravitational wave power in de Sitter space*
American Physical Society April Meeting, Washington, DC, January, 2017

18. *Null Stream Approach with PTAs: Noise Characterization and Excess Power*
American Astronomical Society 227th Meeting, Grapevine, Texas, January, 2017

17. *Assessing the null stream approach for source localization in PTAs*
Fall NANOGrav Meeting, Urbana, Illinois, October, 2016

16. *Comparing transverse-traceless decompositions of symmetric tensors*
Int. Soc. for General Relativity and Gravitation 21st Meeting, New York City, New York, July, 2016

15. *Null Stream Approach for finding Sky Position of Pulsar Timing Array sources*
American Physical Society April Meeting, Salt Lake City, Utah, April, 2016

14. *A Cartan Geometry approach to the AdS/CFT*
Midwest Gravity Meeting, Evanston, Illinois, October, 2015

13. *Tracing the AdS/CFT Degrees of Freedom using Cartan Geometry*
American Physical Society April Meeting, Baltimore, Maryland, April 2015

12. *Conformal gravity, dark matter and time*
Midwest Gravity Meeting, Rochester, MI, November, 2014

11. *Conformal gravity, dark matter and time*
APS Four Corners Meeting, Orem, Utah, October 2014

10. *Time from the conformal symmetries of a Euclidean space*
Midwest Gravity Meeting, Milwaukee, Wisconsin, October 2013

9. *Lorentzian geometry from the conformal symmetries of a Euclidean space*
Loops 13: International Conference on Quantum Gravity, Waterloo, Canada, July 2013

8. *Testing Bimetric and Massive Gravity Theories using Multi-Messenger Astronomy*
GR20/AMALDI 10, Warsaw, Poland, July 2013

7. *Lorentzian spin connection from the conformal symmetries of a Euclidean space*
53rd Cracow School of Theoretical Physics, Zakopane, Poland, June 2013

6. *General relativity in signature changing phase space*
Pacific Coast Gravity Meeting, Davis, California, March 2013

5. *General relativity in phase space with a natural notion of time*
Pacific Coast Gravity Meeting, Santa Barbara, California, March 2012

4. *A systematic construction of curved phase space: A gravitational gauge theory with symplectic form*
Loops 11: International Conference on Quantum Gravity, Madrid, Spain, May 2011

3. *Quantum gravity in relativistic phase space*
Intermountain Graduate Research Symposium, Logan, Utah, March 2010

2. *Multiple Spherical Shells in Schwarzschild Spacetime*
12th Marcel Grossman Gravity Meeting, Paris, France, July 2009

1. *Single Spherical Shells in Schwarzschild Spacetime*
Pacific Coast Gravity Meeting, Eugene, Oregon, March 2009

Posters

3. *The NANOGrav Pulsar Signal Simulator*
American Astronomical Society Meeting, Honolulu, HI, January, 2020

2. *Pulsar Timing Array Source Location Using the Null Signal Approach*
   American Astronomical Society 225th Meeting, Seattle, Washington, January 2015
1. *Multiple Spherical Shells in Schwarzschild Spacetime*
   TEXAS Symposium on Relativistic Astrophysics, Vancouver, Canada, December 2008

References

- **Dr. Xavier Siemens** *NANOGrav PI/ Collaborator*
  Professor of Physics
  Oregon State University, Corvallis, OR 97331
  Phone: 541-737-7512 *email:* xavier.siemens@oregonstate.edu

- **Dr. Stephen Taylor** *NANOGrav Detection Working Group Co-chair/ Collaborator*
  Professor of Physics
  Vanderbilt University, Nashville, TN 37235
  Phone: 615-322-7311 email:stephen.r.taylor@vanderbilt.edu

- **Dr. Joey Key** *Post Doctoral Advisor*
  Professor of Physics
  University of Washington Bothell, Bothell, WA 98011
  Phone: 425-352-5497 email:joey.key@uw.edu

- **Dr. Joseph Romano**
  Professor of Physics
  Texas Tech University, Lubbock, TX 79409
  Phone: 806-834-6522 email:joseph.d.romano@ttu.edu

- **Dr. James T. Wheeler** *PhD Advisor, Utah State University*
  Associate Professor of Physics
  Utah State University, Logan, UT 84321
  Phone: 435-770-7601 email:jim.wheeler@usu.edu

- **Dr. Tevian Dray** *MS Advisor, Oregon State University*
  Professor of Mathematics
  Oregon State University, Corvallis, OR 97331
  Phone: 541-737-5159 *email:* tevian@math.oregonstate.edu

- **Dr. Jan Sojka**
  Department Chair & Professor of Physics
  Utah State University, Logan, UT 84321
  Phone: 435-797-2857 email: jan.sojka@usu.edu