

# Paul T. Baker

Department of Physics and Astronomy  
Kirkbride Hall, Widener University  
One University Place  
Chester, PA 19013, U.S.A.

Office Phone: (610) 499-4012

[ptbaker@widener.edu](mailto:ptbaker@widener.edu)  
[paul.baker@nanograv.org](mailto:paul.baker@nanograv.org)

<https://paulthebaker.github.io/>  
<https://sites.google.com/view/paultbaker>

ORCID: [0000-0003-2745-753X](https://orcid.org/0000-0003-2745-753X)

citizenship: USA

## Professional Appointments

- 2019- *Assistant Professor*, Widener University
- 2016-2019 *Postdoctoral Fellow*, Center for Gravitational Waves and Cosmology, West Virginia University
- 2013-2016 *Visiting Assistant Professor*, SUNY Geneseo

## Research interests

Gravitational wave data analysis • Bayesian statistical techniques  
Astrostatistics • Astrophysics • General relativity

## Education

- 2013 PhD (Physics), Montana State University  
· thesis: *Distinguishing Signal From Noise: new techniques for gravitational wave data analysis*
- 2008 MS (Physics), Montana State University
- 2006 BA (Physics), Reed College  
· thesis: *Electrodynamics and an Investigation of Weak-Field Kerr Geometry*

## Professional Experience

### TEACHING EXPERIENCE

- 2019- Assistant Professor (Widener Univ.)
- College Physics (algebra based; includes lecture, recitation, labs)
  - Physics Seminar
- 2018 & 2019 Co-Instructor (WVU)
- Astrophysics Seminar (survey of topics for first year grad students)
    - Bayesian Statistics (2 class period block)
- 2013-2016 Visiting Assistant Professor of Physics and Astronomy (SUNY Geneseo)
- General Physics I and II (algebra based, for non-physics science majors)
  - Analytical Physics I and II labs (100 level, physics majors only)
  - Analytical Physics III (200 level ‘modern physics I’)
  - Statistical Thermodynamics (300 level)
  - Gravity (300 level, general relativity)
  - Seminar in Physics (300 level, student presentations)
  - Directed Studies:
    - Scientific Computation (fall 2015)
    - Particle Physics and Quantum Field Theory (spring 2015)
    - Astrophysics Research (spring 2015, fall 2014)
  - Guest Lecturer:
    - Big Data (2 class periods, fall 2014)  
introduction to machine learning and applications in physics
- 2011 Instructor (Montana State Univ): Physics by Inquiry
- lab based physics for Elementary Education majors
- 2006-2011 Teaching Assistant (Montana State Univ): College Physics I and II
- tutorial leader, grader

### RESEARCH EXPERIENCE

- 2016-2019 Postdoctoral Fellow, Center for Gravitational Waves and Cosmology, West Virginia University (advisor: Maura McLaughlin)
- 2006-2013 Research Assistant, Montana State University (advisor: Neil Cornish)
- 2005-2006 Undergraduate Thesis, Reed College (advisor: Joel Franklin)
- 2004 REU, Dept of Chemistry, Pennsylvania State University (advisor: Ayusman Sen)

## PROFESSIONAL AFFILIATIONS

2018-	Member, American Astronomical Society
2017-	Full Member, North American Nanohertz Observatory for Gravitational Waves
2012-	Member, American Physical Society
2007-2019	Member, LIGO Scientific Collaboration
2016-2017	Associate Member, North American Nanohertz Observatory for Gravitational Waves
2015-2016	Affiliate, Center for Computational Relativity and Gravitation, RIT

## PROFESSIONAL SERVICE

	Referee – Physical Review D, Physical Review Letters
2019	Judge – AAS223 Chambliss poster competition

## OTHER ACADEMIC EXPERIENCE

2018	<a href="#">Software Carpentry</a> Instructor Training
2017	Scientific Organizing Committee, NANOGrav fall meeting
2017	IPTA Student Workshop, Seminar leader
2015	SUNY Geneseo Colloquium Coordinator
2014	NY State Master Teacher Program, Seminar leader
2011-2012	Graduate Student Representative to the Faculty Committee (Montana State Univ)

## STUDENT RESEARCH MENTORING

2018-2019	William Fiore, Andrew Kaiser, Brent Shapiro-Albert, Caitlin Witt (graduate students, WVU) <ul style="list-style-type: none"> <li>• Pulsar timing data analysis with <code>enterprise</code>.</li> <li>• submitted entry to IPTA Mock Data Challenge 2.</li> </ul>
2016-	Belinda Cheeseboro (graduate student, WVU) <ul style="list-style-type: none"> <li>• LIGO data analysis, targeted search for eccentric binaries, <code>BayesWave</code> development</li> <li>• Ongoing. Lead to APS meeting poster (2016) and talk (2017, 2018). Paper draft in progress.</li> </ul>
2014-2015	Michael O'Boyle (undergraduate, SUNY Geneseo) <ul style="list-style-type: none"> <li>• LIGO data analysis, testing MCMC methods (summer project)</li> <li>• stellar modeling, tidal interactions of polytropic stars during hyperbolic encounters (course credit)</li> </ul>

## Honors &amp; Awards

2016	Breakthrough Prize in Fundamental Physics (as member of LIGO Scientific Collaboration)
2016	Gruber Prize in Cosmology (as member of LIGO Scientific Collaboration)

## Publications

### REFEREED SHORT AUTHOR LIST PUBLICATIONS

- 2015 **P.T. Baker**, S. Caudill, K. Hodge, D. Talukder, C. Capano, and N.J. Cornish; Multivariate classification with random forests for gravitational wave searches of black hole binary coalescence. *Phys. Rev. D* **91**, 062004.
- 2013 D. Talukder, S. Bose, S. Caudill, and **P.T. Baker**; Improved coincident and coherent detection statistics for searches for gravitational wave ringdown signals. *Phys. Rev. D* **88**, 122002.
- 2007 J. Franklin, **P.T. Baker**; Linearized Kerr and Spinning Massive Bodies: an electrodynamics analogy. *Am. J. Phys.* **75** (4):336-42.
- 2006 W.F. Paxton, **P.T. Baker**, T.R. Kline, Y. Wang, T.E. Mallouk and A. Sen; Catalytically Induced Electrokinetics for Motors and Micropumps *J. Am. Chem. Soc.* **128** (46), 14881-14888.

### SELECTED NANOGrAV COLLABORATION PUBLICATIONS

- 2019 NANOGrav Collaboration: K. Aggarwal *et al.*; The NANOGrav 11-year Data Set: Limits on Gravitational Waves from Individual Supermassive Black Hole Binaries. *Astrophys. J.* **880**, 2.
- 2019 NICER Collaboration with NANOGrav Observers: J. S. Deneva *et al.*; High-Precision X-ray Timing of Three Millisecond Pulsars with NICER: Stability Estimates and Comparison with Radio. *Astrophys. J.* **874**, 2.
- 2018 NANOGrav Collaboration: Z. Arzoumanian *et al.*; The NANOGrav 11-year Data Set: Pulsar-timing Constraints On The Stochastic Gravitational-wave Background. *Astrophys. J.* **859**, 1.

### SELECTED LIGO SCIENTIFIC COLLABORATION PUBLICATIONS

- 2019 LIGO Scientific Collaboration and Virgo Collaboration: B.P. Abbott *et al.*; All-sky search for short gravitational-wave bursts in the second Advanced LIGO and Virgo run. *Phys. Rev. D*, **100**, 024017
- 2017 The LIGO Scientific Collaboration and the Virgo Collaboration: B.P. Abbott, *et al.*; GW170817: Observation of Gravitational Waves from a Binary Neutron Star Inspiral. *Phys. Rev. Lett.* **119**, 161101
- 2016 The LIGO Scientific Collaboration and the Virgo Collaboration: B.P. Abbott, *et al.*; Observing gravitational-wave transient GW150914 with minimal assumptions. *Phys. Rev. D*. **93**, 122004.
- 2016 The LIGO Scientific Collaboration and the Virgo Collaboration: B.P. Abbott, *et al.*; Observation of Gravitational Waves from a Binary Black Hole Merger. *Phys. Rev. Lett.* **116**, 061102;
- 2014 The LIGO Scientific Collaboration and the Virgo Collaboration: J. Aasi, *et al.*; The search for gravitational wave ringdowns from perturbed intermediate mass black holes in LIGO-Virgo data from 2005-2010. *Phys. Rev. D* **89**, 102006.
- 2013 The LIGO Scientific Collaboration, the Virgo Collaboration, and the Kagra Collaboration: B.P. Abbott, *et al.*; Prospects for Observing and Localizing Gravitational-Wave Transients with Advanced LIGO, Advanced Virgo and KAGRA. [arXiv:1304.0670](https://arxiv.org/abs/1304.0670) [[gr-qc](https://arxiv.org/abs/1304.0670)].
- 2009 The LIGO Scientific Collaboration: B.P. Abbott, *et al.*; The search for gravitational wave ringdowns from perturbed black holes in LIGO S4 data. *Phys. Rev. D* **80**, 062001.

### NON-REFEREED PUBLICATIONS

- 2019 The NANOGrav Collaboration, **P.T. Baker** *et al.*; NANOGrav Education and Outreach: Growing a Diverse and Inclusive Collaboration for Low-Frequency Gravitational Wave Astronomy. (submitted to the Astro2020 Decadal Survey) [arXiv:1907.07348](https://arxiv.org/abs/1907.07348) [[astro-ph.IM](https://arxiv.org/abs/1907.07348)]

- 2019 X. Siemens, J.S. Hazboun, **P.T. Baker**, S. Burke-Spolaor, D. Madison, C. Mingarelli, J. Simon, T. Smith; Physics Beyond the Standard Model With Pulsar Timing Arrays (submitted to the Astro2020 Decadal Survey) [arXiv:1907.04960](https://arxiv.org/abs/1907.04960) [gr-qc]
- 2019 S.R. Taylor, S. Burke-Spolaor, **P.T. Baker**, M. Charisi, K. Islo, L.Z. Kelley, D.R. Madison, J. Simon, S. Vigeland; Supermassive Black-hole Demographics & Environments With Pulsar Timing Arrays. (submitted to the Astro2020 Decadal Survey) [arXiv:1903.08183](https://arxiv.org/abs/1903.08183) [astro-ph.GA]
- IN PREPARATION
- TBD NANOGrav Collaboration: K. Aggarwal *et al.*; The NANOGrav 11-year Data Set: Pulsar-timing Constraints On Gravitational-wave Memory from Supermassive Black Hole Mergers.
- TBD **P.T. Baker**, J.A. Ellis, S.R. Taylor, M. Vallisneri; Enterprise: A new data analysis suite for pulsar timing arrays.
- TBD **P.T. Baker**, B. Cheeseboro, S.T. McWilliams; A Search for Highly Eccentric Binary Black Holes with BayesWave.

## Presentations & Colloquia

### INVITED CONFERENCE TALKS

- 2018 Appalachian Section of the AAPT, “The Universe in HD, Surround Sound, and Smell-o-Vision”

### INVITED COLLOQUIA

- 2019 Gettysburg College, “NANOGrav: a galactic scale gravitational wave detector”
- 2018 Green Bank Observatory, “NANOGrav: pulsar searching, pulsar timing, GW detection” (with Joe Swiggum and Kevin Stovall)
- 2018 University of Cincinnati, “The NANOGrav 11-year data release: Limits on Low Frequency Gravitational Waves”
- 2018 Bucknell University, “NANOGrav: a galactic scale gravitational wave detector”  
Dickinson College, *same*
- 2017 Franklin and Marshall College, “Detecting gravitational waves with pulsar timing arrays”  
SUNY Geneseo, *same*  
Marshall University, *same*  
American University, *same*
- 2015 University of Rochester Lab for Laser Energetics, “Gravitational Wave Astronomy”
- 2013 Cornell University Relativity Group, “Machine Learning for Gravitational Wave Data Analysis”
- 2013 SUNY Geneseo, “Listening to the Universe: detecting gravitational waves”

### INVITED PUBLIC LECTURES

- 2019 Morgantown Community Physics Festival, “Black Holes”
- 2016 Blackwater Falls Astronomy Weekend, “Detecting Gravitational waves with LIGO”
- 2015 Geneseo Astronomy Club, “Black Holes: How do they work?”
- 2014 Geneseo Astronomy Club, “Gravitational Wave Astronomy”

## INVITED SEMINARS

- 2018 Appalachian Section of the AAPT, “Gravitational wave science in your classroom”
- 2017 IPTA Student Week, “Gravitational Wave Data Analysis for PTAs”
- 2017 NANOGrav Student Workshop, “Basic Physics of Compact Objects”
- 2014 NY State Master Teacher Program, “Bayesian Statistics for Fun and Profit”

## CONTRIBUTED TALKS &amp; POSTERS

- 2019 13th Edoardo Amaldi Conference on Gravitational Waves, “IPTA DR2: preliminary gravitational wave results”
- 2019 NANOGrav Spring Meeting, “IPTA DR2 – GW Data Analysis: an update”
- 2019 223rd Meeting of the American Astronomical Society , “The NANOGrav 11-year Data Set: Pulsar-timing Constraints On Gravitational-wave Memory” (poster)
- 2018 IPTA Science Week, “Resolving the NANOGrav 9yr Anomaly: a DR2-lite analysis”
- 2018 American Physical Society April Meeting, “Limits on gravitational wave memory from the NANOGrav 11-year data set”
- 2018 NANOGrav Spring Meeting, “Searching for GW Memory in the 11 yr Dataset”
- 2017 Meeting of the International Pulsar Timing Array, “Enterprise! a new GW analysis suite for PTAs”
- 2017 Eastern Gravity Meeting, “Where are we? the solar system ephemeris and the NANOGrav gravitational wave background analysis”
- 2017 NANOGrav Spring Meeting, “Enterprise! a new GW analysis suite for PTAs”
- 2017 American Physical Society ‘April’ Meeting, “Targeting highly eccentric black hole binaries with a gravitational wave burst search”
- 2014 UP-STAT: Upstate Chapter of the American Statistical Association, “Using a Multivariate Statistical Classifier in a Gravitational Wave Search”
- 2013 American Physical Society April Meeting, “BayesWave: a novel method for detecting un-modeled gravitational wave bursts”
- 2011 Gravitational Wave Physics and Astronomy Workshop, “Taming Instrument Glitches and Detecting Gravitational Wave Signals” (poster)
- 2011 LIGO Collaboration Meeting, “Using a Multi-Variate Statistical Classifier in Black Hole Ringdown Searches”
- 2009 LIGO Collaboration Meeting, “Using a template metric to improve coincident analysis”

## Open Source Software

### DEVELOPMENT LEAD

- `ceedub` – an awesome and simple continuous wavelet transform (Python)  
<https://github.com/paulthebaker/ceedub>  
<https://pypi.python.org/pypi/ceedub/0.1.0>
- `enterprise` – gravitational wave data analysis for PTAs (Python)  
<https://github.com/nanograv/enterprise>
- `PsrSigSim` – NANOGrav Pulsar Signal Simulator (Python)  
<https://github.com/PsrSigSim/>
- `IPTA_DR2_analysis` – utilities for working with data from IPTA's second data release  
[https://github.com/IPTA/IPTA\\_DR2\\_analysis](https://github.com/IPTA/IPTA_DR2_analysis)

### KEY CONTRIBUTOR

- `enterprise_extensions` – recipes and utilities for using the enterprise PTA toolbox  
[https://github.com/stevertaylor/enterprise\\_extensions](https://github.com/stevertaylor/enterprise_extensions)

### CONTRIBUTOR

- `BayesWave` – Bayesian inference for gravitational wave bursts and instrument glitches (C)  
<https://git.ligo.org/lscsoft/bayeswave>
- `LALSuite` – LIGO Algorithms Library (C)  
<https://git.ligo.org/lscsoft/lalsuite>
- `PTMCMCSampler` – Parallel Tempered Markov chain Monte Carlo (Python)  
<https://github.com/jellis18/PTMCMCSampler>