

Stephen Taylor | Curriculum Vitae

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Objectives

- My goal is to probe **compact objects** (neutron stars and black holes), their **environments**, and their **demographic properties** across the **full gravitational-wave spectrum**.
- I use the most sensitive **pulsar-timing** datasets to probe the dynamics and astrophysical environments of **supermassive black-hole binaries** in the nanohertz gravitational-wave band.
- My future goals include performing full model-independent recoveries of the **demographics of LIGO-detected systems** to investigate their progenitor properties and evolutionary paths.

Research Interests

Primary interests: gravitational-wave astronomy • theoretical astrophysics • massive black-hole binaries • stellar-mass compact objects • pulsar timing • statistical inference

Secondary interests: galaxy formation and evolution • cosmology • pulsar physics and demographics • ionised interstellar medium

Specific interests: pulsar-timing data-analysis for nanohertz gravitational-wave searches • pulsar-timing noise characterisation and mitigation • waveform modelling for supermassive black-hole binary searches • modelling final-parsec dynamics of supermassive black-hole binaries • stochastic signal analysis strategies • compact-binary demographics and population inference • Bayesian hierarchical modelling

Education

Institute of Astronomy, University of Cambridge

Cambridge, UK

PhD (Astronomy)

2010–2014

Advisor: Dr. Jonathan R. Gair; **Thesis Title:** *Exploring The Cosmos With Gravitational Waves*

Description: A new Bayesian hierarchical modelling scheme is introduced to use compact-binary gravitational-wave standard sirens to infer the mass-distribution of the binary population, the progenitor star-formation rate, and cosmological parameters. Advanced pulsar-timing array techniques are developed to map the nanohertz gravitational-wave sky through a parametrised overlap-reduction function, and large accelerations to the Bayesian searches for single supermassive black-hole binaries are proposed.

University of Oxford

Oxford, UK

MPhys (1st Class), [ranked 1st in Jesus College, 4th across University]

2006–2010

Advisor: Prof. Steven Rawlings; **Thesis Title:** *The Cosmic Evolution Of Black-hole Accretion*

Professional Experience

CALIFORNIA INSTITUTE OF TECHNOLOGY

Pasadena, USA

Caltech Postdoctoral Scholar (TAPIR group)

2016–Present

Visiting scholar (TAPIR group)

2014–2016

NASA JET PROPULSION LABORATORY

Pasadena, USA

NASA Postdoctoral Fellow

2014–2016

INSTITUTE OF ASTRONOMY, UNIVERSITY OF CAMBRIDGE

Cambridge, UK

PhD candidate

2010–2014

Grants & Funding

Jun 2016: “New Directions and New Opportunities for NANOGrav Astrophysics”

Awarded \$11k by the NANOGrav Physics Frontier Center for a proposal on behalf of the collaboration’s Astrophysics Working Group. Funding will ensure undergraduate/graduate students and outside experts can attend a sprint week in March 2017 to advance several key areas of interest, and to achieve rapid progress on collaboration projects.

Honors & Awards

2015: International Pulsar Timing Array (IPTA) Steering Committee Prize — “Honourable Mention”

2015: Gravitational Wave International Committee (GWIC) Thesis Prize — “Honourable Mention”

2014: NASA Postdoctoral Fellowship (JPL)

2014: Royal Astronomical Society Travel Award — £750

2013: Royal Astronomical Society Travel Award — £700

2012–2014: Christ’s College (Cambridge) Travel Grants [various; total exceeds £1k]

2010: Science and Technology Facilities Council (STFC) — full PhD studentship award

2008: Examiner’s Prize, Oxford Physics Speaking Competition

2007: Oxford Physics department prize for laboratory work

2007–2010: Undergraduate Scholar of Jesus College, Oxford

2006–2010: Regularly awarded Oxford undergraduate departmental and college examination prizes

Teaching Experience

Jun–Aug 2016: Co-supervisor of Caltech summer undergraduate student (Maya Fuller)

May 2016: Guest Lecturer for Caltech Ph237 class “Gravitational Waves”

Mar 2016: Co-organiser of student workshop at NANOGrav Spring meeting

Sep 2015: Lecturer for NANOGrav detection-group workshop at Caltech

Jun 2015: Lecturer at “CSI PTA” Aspen summer workshop

2011–2013: Supervisor for Cambridge Part II undergraduate students in RELATIVITY

2011: Prepared computing coursework for Cambridge Part II undergraduate students

Professional Service

Reviewer for international journals.....

Monthly Notices of the Royal Astronomical Society (MNRAS), Physical Review D (PRD)

Conference organisation.....

Oct 2016: Chair of SOC for NANOGrav Fall meeting at University of Illinois Urbana-Champaign

Mar 2016: SOC and LOC member for NANOGrav Spring meeting at Caltech

Mar 2016: Co-organiser of NANOGrav student workshop at Caltech

Mar 2014: SOC and LOC member for British Gravity meeting (BritGrav) at Cambridge, UK

Seminar organisation.....

2015–2016: Caltech TAPIR and LIGO postdoctoral lunch seminar series

Professional affiliations.....

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

- American Astronomical Society, *Member*
- Royal Astronomical Society, *Fellow*

Outreach & Media Engagement

Outreach.....

- 2016:** Featured gravitational-wave expert at NASA's "Ticket to Explore JPL" event
- 2013:** Interactive presentation at Cambridge's Institute of Astronomy Open Day
- 2012–2014:** Presentation to prospective students (Institute of Astronomy graduate interviews)
- 2012:** Outreach talk at Institute of Astronomy public-observing evening: "The Space Race"
- 2011:** Interactive presentation at Cambridge's Institute of Astronomy Open Day

Press releases.....

- Feb 2016:** First-author research: "[Pulsar Web Could Detect Low-Frequency Gravitational Waves](#)" (JPL press release)
- Apr 2016:** Collaboration research: "[Gravitational Wave Search Provides Insights into Galaxy Evolution and Mergers](#)" (NRAO press release)

Media coverage.....

- Interviewed and quoted by *Science* magazine: "[In Search of Spacetime Megawaves](#)" by Daniel Clery, *Science* 11 Mar 2016: Vol. 351, Issue 6278, pp. 1124–1125
- Quoted, with research featured in [Gizmodo](#), [Engadget](#), [Phys.org](#), [Astronomy magazine](#), [Universe Today](#)
- Collaboration research featured in [Science Daily](#), [Astronomy Now](#) (online)

Publications

- 22 **peer-reviewed publications (of which 8 are first-author) with 317 citations, h-index 10.**
- Metrics available at <https://scholar.google.com/citations?user=iN2djBMAAAAJ&hl=en>.
- 5 key publications are indicated below with preceding asterisks.

Submitted & In Preparation.....

S. R. Taylor, L. Lentati, S. Babak, P. Brem, J. R. Gair, A. Sesana, A. Vecchio. "*All correlations must die: Assessing the significance of a stochastic gravitational-wave background in pulsar-timing arrays*". Submitted to Physical Review D. [arXiv:1606.09180](#).

S. R. Taylor, R. van Haasteren. "*Optimized anisotropic modelling of the nanohertz gravitational-wave sky with pulsar-timing arrays*". (In Prep.)

S. R. Taylor, J. Simon, L. Sampson. "*Bayesian model emulation of stochastic gravitational-wave spectra for final-parsec probes with pulsar-timing arrays*". (In Prep.)

Publications In Peer-reviewed International Journals.....

May 2016: G. Desvignes, R. N. Caballero, L. Lentati, [and 40 others, including **S. R. Taylor**]. "*High-precision timing of 42 millisecond pulsars with the European Pulsar Timing Array*". [MNRAS](#), **458**:3341–3380.

May 2016: L. Lentati, R. M. Shannon, W. A. Coles, [and 80 others, including **S. R. Taylor**]. "*From spin noise to systematics: stochastic processes in the first International Pulsar Timing Array data release*". [MNRAS](#), **458**:2161–2187.

May 2016 : J. P. W. Verbiest, L. Lentati, G. Hobbs, [and 89 others, including **S. R. Taylor**]. "*The International Pulsar Timing Array: First data release*". [MNRAS](#), **458**:1267–1288.

Apr 2016 : Z. Arzoumanian, A. Brazier, S. Burke-Spolaor, [and 48 others, including **S. R. Taylor**]. "*The NANOGrav Nine-year Data Set: Limits on the Isotropic Stochastic Gravitational Wave Background*". [Astrophys. J.](#), **821**:13.

Apr 2016 : R. N. Caballero, K. J. Lee, L. Lentati, [and 36 others, including **S. R. Taylor**]. "*The noise properties of 42 millisecond pulsars from the European Pulsar Timing Array and their impact on gravitational-wave*

searches". [MNRAS](#), 457:4421–4440.

***Mar 2016** : **S. R. Taylor**, M. Vallisneri, J. A. Ellis, C. M. F. Mingarelli, T. J. W. Lazio, and R. van Haasteren. "Are We There Yet? Time to Detection of Nanohertz Gravitational Waves Based on Pulsar-timing Array Limits". [Astrophys. J. Lett](#), 819:L6.

Jan 2016 : **S. R. Taylor**, E. A. Huerta, J. R. Gair, and S. T. McWilliams. "Detecting Eccentric Supermassive Black Hole Binaries with Pulsar Timing Arrays: Resolvable Source Strategies". [Astrophys. J.](#), 817:70.

Jan 2016 : S. Babak, A. Petiteau, A. Sesana, P. Brem, P. A. Rosado, **S. R. Taylor**, [and 30 others]. "European Pulsar Timing Array limits on continuous gravitational waves from individual supermassive black hole binaries". [MNRAS](#), 455:1665–1679.

Nov 2015 : J. R. Gair, J. D. Romano, and **S. R. Taylor**. "Mapping gravitational-wave backgrounds of arbitrary polarisation using pulsar timing arrays". [Phys. Rev. D](#), 92(10):102003.

***Nov 2015** : L. Lentati, **S. R. Taylor**, C. M. F. Mingarelli, [and 33 others]. "European Pulsar Timing Array limits on an isotropic stochastic gravitational-wave background". [MNRAS](#), 453:2576–2598.

Sep 2015 : E. A. Huerta, S. T. McWilliams, J. R. Gair, and **S. R. Taylor**. "Detection of eccentric supermassive black hole binaries with pulsar timing arrays: Signal-to-noise ratio calculations". [Phys. Rev. D](#), 92(6):063010.

Aug 2015 : J. D. Romano, **S. R. Taylor**, N. J. Cornish, J. Gair, C. M. F. Mingarelli, and R. van Haasteren. "Phase-coherent mapping of gravitational-wave backgrounds using ground-based laser interferometers". [Phys. Rev. D](#), 92(4):042003.

***Jul 2015**: **S. R. Taylor**, C. M. F. Mingarelli, J. R. Gair, [and 32 others]. "Limits on Anisotropy in the Nanohertz Stochastic Gravitational Wave Background". [Phys.Rev. Lett](#), 115(4):041101.

Mar 2015: C. J. Moore, **S. R. Taylor**, and J. R. Gair. "Estimating the sensitivity of pulsar timing arrays", [Classical and Quantum Gravity](#), 32(5):055004.

Nov 2014: **S. R. Taylor**, J. Ellis, and J. Gair. "Accelerated Bayesian model-selection and parameter-estimation in continuous gravitational-wave searches with pulsar-timing arrays". [Phys. Rev. D](#), 90(10):104028.

Oct 2014: J. Gair, J. D. Romano, **S. R. Taylor**, and C. M. F. Mingarelli. "Mapping gravitational-wave backgrounds using methods from CMB analysis: Application to pulsar timing arrays". [Phys. Rev. D](#), 90(8):082001.

Aug 2014: R. M. Shannon, S. Chamberlin, N. J. Cornish, J. A. Ellis, C. M. F. Mingarelli, D. Perrodin, P. Rosado, A. Sesana, **S. R. Taylor**, [and 14 others]. "Summary of Session C1: pulsar timing arrays". [General Relativity and Gravitation](#), 46:1765.

***Oct 2013**: **S. R. Taylor** and J. R. Gair. "Searching for anisotropic gravitational-wave backgrounds using pulsar timing arrays". [Phys. Rev. D](#), 88(8):084001.

May 2013: L. Lentati, P. Alexander, M. P. Hobson, **S. R. Taylor**, J. Gair, S. T. Balan, and R. van Haasteren. "Hyper-efficient model-independent Bayesian method for the analysis of pulsar timing data". [Phys. Rev. D](#), 87(10):104021.

Feb 2013 : **S. R. Taylor**, J. R. Gair, and L. Lentati. "Weighing the evidence for a gravitational-wave background in the first International Pulsar Timing Array data challenge". [Phys. Rev. D](#), 87(4):044035.

Jul 2012: **S. R. Taylor** and J. R. Gair. "Cosmology with the lights off: Standard sirens in the Einstein Telescope era". [Phys. Rev. D](#), 86(2):023502.

***Jan 2012**: **S. R. Taylor**, J. R. Gair, and I. Mandel. "Cosmology using advanced gravitational-wave detectors alone". [Phys. Rev. D](#), 85(2):023535.

Presentations

- 29 oral presentations (of which 10 were invited), with 4 conference leadership roles.
- Recent presentations are available to view at <https://speakerdeck.com/stevortaylor>.

Invited Talks.....

Oct 2016: *New data-analysis approaches for gravitational-wave searches with pulsar-timing arrays*, Montana State University seminar, Bozeman MT, USA

Jul 2016: *New horizons in gravitational-wave astronomy with pulsar-timing arrays*, Armagh Observatory seminar, Armagh, UK

Jul 2016: *Probing the final-parsec problem with pulsar-timing arrays*, Anton Pannekoek Instituut seminar, University of Amsterdam, Amsterdam, Netherlands

Jul 2016: *Probing the final-parsec problem with pulsar-timing arrays*, Radboud University astrophysics seminar, Radboud, Netherlands

Jun 2016: *Gravitational-wave data-analysis techniques for pulsar-timing arrays*, IPTA conference, Stellenbosch, South Africa

Mar 2016: *Sources of nanohertz gravitational-waves for pulsar-timing array searches*, NANOGrav student workshop, Caltech, Pasadena CA, USA

Dec 2015: *Prospects for near future detection and astrophysical inference with PTAs*, Gravitational-wave group seminar, University of Birmingham, UK

Dec 2015: *Prospects for near future detection and astrophysical inference with PTAs*, Statistics group seminar (School of Mathematics), University of Edinburgh, UK

Dec 2015: *Prospects for near future detection and astrophysical inference with PTAs*, CaJAGWR seminar, California Institute of Technology

May 2013: *Searching For Anisotropic Gravitational-wave Backgrounds Using Pulsar Timing Arrays*, Albert Einstein Institute (AEI) GW seminar, Hanover

Dec 2012: *Weighing the evidence for a gravitational-wave background*, Gravitational-wave group seminar, University of Birmingham, UK

Contributed Presentations.....

May 2016: *Carrying the physics of supermassive black-hole binary evolution into pulsar-timing array searches*, EPTA meeting, Bielefeld, Germany

Apr 2016: *Are we there yet? Time to detection of nanohertz gravitational waves*, American Physical Society meeting, Salt Lake City UT, USA

Mar 2016: *Carrying the physics of supermassive black-hole binary evolution into pulsar-timing array searches*, NANOGrav meeting, Caltech, Pasadena CA, USA

Oct 2015: *Are we there yet? Time to detection of nanohertz gravitational waves*, NANOGrav meeting, McGill University, Montreal, Canada

Jun 2015: *Eccentric supermassive black-hole binary signals in pulsar-timing data*, European Pulsar Timing Array meeting, Bonn, Germany

Apr 2015: *Eccentric supermassive black-hole binary signals in pulsar-timing data*, American Physical Society meeting, Baltimore MD, USA

Feb 2015: *Eccentric supermassive black-hole binary signals in pulsar-timing data*, NANOGrav meeting, Arecibo, Puerto Rico

Jan 2015: *Exploring the cosmos with gravitational waves*, American Astronomical Society meeting, Seattle WA, USA

Nov 2014: *EPTA constraints on gravitational-wave anisotropy*, European Pulsar Timing Array meeting, Cambridge, UK

Jun 2014: *EPTA and IPTA searches for gravitational-wave background anisotropy*, International Pulsar Timing Array meeting, Banff, Canada

May 2014: *EPTA limits on gravitational-wave anisotropy*, European Pulsar Timing Array meeting, Astron, Netherlands

Oct 2013: *The pulsar-term in PTA continuous-wave searches: a blessing and a curse*, European Pulsar Timing Array meeting, Pula, Sardinia

Jul 2013: *Probing anisotropy of the GW background with pulsar timing arrays*, 20th International Conference on General Relativity and Gravitation and 10th Amaldi Conference on Gravitational Waves, Warsaw

Jun 2013: *The first PTA search pipeline for anisotropy in the GW background*, International Pulsar Timing Array meeting, Krabi, Thailand

Apr 2013: *Searching For Anisotropic Gravitational-wave Backgrounds Using Pulsar Timing Arrays*, European Pulsar Timing Array meeting, l'Observatoire de Paris, Paris

Feb 2013: *Weighing the evidence for a gravitational-wave background*, Institute of Astronomy seminar, University of Cambridge

Nov 2012: *Weighing the evidence for a gravitational-wave background*, European Pulsar Timing Array meeting, Albert Einstein Institute (AEI), Potsdam, Germany

Jun 2012: *Milestones in Spacetime: Double Neutron-Star Binaries as Gravitational-Wave Standard Sirens*, Institute of Astronomy seminar, University of Cambridge, UK

Feb 2012: *Hubble without the Hubble: Cosmology using advanced gravitational-wave detectors alone*, Gravitational-Wave Meeting, Institut de Ciències de l'Espai, Barcelona, Spain

Posters.....

Aug 2015: *Galactic environment effects on gravitational wave signals in pulsar timing arrays*, Postdoc Research Day, NASA Jet Propulsion Laboratory

Aug 2012: *Cosmology without EM counterparts: Standard sirens in the advanced era and beyond*, Rattle and Shine, KITP Santa Barbara

Dec 2011: *Cosmology using advanced gravitational-wave detectors alone*, Graduate Student Conference 2011, Cavendish Laboratory, University of Cambridge

Computing Skills

- **OS:** Linux/UNIX, Windows
- **Programming:** C/C++, PYTHON, UNIX shell scripting, HTML, GPU programming (CUDA C, Py-CUDA)
- **Typography:** L^AT_EX, Bibtex, Microsoft Office, Pages, OpenOffice
- **Scientific:** Mathematica, Matlab, PYTHON

References

Dr Jonathan R. Gair [*PhD advisor*]

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