

# Stephen Taylor | Curriculum Vitae

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## Education

**Institute of Astronomy, University of Cambridge**

**Cambridge, UK**

*PhD (Astronomy)*

*2010–2014*

**University of Oxford**

**Oxford, UK**

*MPhys, First Class*

*2006–2010*

Graduated 4<sup>th</sup> in University

## Doctoral Thesis

**Title:** *Exploring the cosmos with gravitational waves*

**Supervisor:** Dr. Jonathan R. Gair

**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 parametrized overlap-reduction function, and large accelerations to the Bayesian inference of single supermassive black-hole binary searches are proposed.

## Professional experience

**NASA Jet Propulsion Laboratory**

**Pasadena**

*NASA Postdoctoral Fellow*

*2014–Present*

**California Institute of Technology**

**Pasadena**

*Visting scholar (TAPIR group)*

*2014–Present*

## 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)

**2010:** Science and Technology Facilities Council (STFC) PhD Studentship at IoA Cambridge

**2007–2010:** Undergraduate Scholar of Jesus College, Oxford

**2008:** Examiner’s Prize, Oxford Physics Speaking Competition

**2007:** Oxford Physics department prize for laboratory work

**2006–2010:** Various Oxford undergraduate departmental and college examination prizes

## Teaching experience

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

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

**2011:** Updated Cambridge Part II undergraduate computing projects from C to Matlab

## Computer skills

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**OS:** Linux/Unix, Windows

**Programming:** C/C++, PYTHON

**Typography:** L<sup>A</sup>T<sub>E</sub>X, Microsoft Office, Pages, OpenOffice

**Scientific:** Mathematica, Matlab, PYTHON

**GPU Programming:** CUDA C, PyCUDA

## Outreach

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**2013:** Presentation at the 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

**2011:** Presentation at the Institute of Astronomy Open Day

## Professional affiliations

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**American Physical Society:** Member

**APS DGRAV:** Member

**American Astronomical Society:** Member

**Royal Astronomical Society:** Fellow

**North American Nanohertz Observatory for Gravitational waves (NANOGrav):** Full member

**European Pulsar Timing Array (EPTA):** Member

**International Pulsar Timing Array (IPTA):** Member

## Recent presentations

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**Invited talks.....**

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

**Apr 2016:** *Sources of nanohertz gravitational-waves for pulsar-timing array searches*, NANOGrav student workshop, California Institute of Technology, Pasadena CA, USA

**Contributed talks.....**

**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, California Institute of Technology, 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

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

**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

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

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

#### Seminars.....

**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), Hanover

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

**Dec 2012:** *Weighing the evidence for a gravitational-Wave background*, University of Birmingham

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

#### 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

## Publications

**Taylor, S. R.**, 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, March 2016.

**Taylor, S. R.**, 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, January 2016.

**Taylor, S. R.**, C. M. F. Mingarelli, J. R. Gair, A. Sesana, G. Theureau, S. Babak, C. G. Bassa, P. Brem, M. Burgay, R. N. Caballero, D. J. Champion, I. Cognard, G. Desvignes, L. Guillemot, J. W. T. Hessels, G. H. Janssen, R. Karuppusamy, M. Kramer, A. Lassus, P. Lazarus, L. Lentati, K. Liu, S. Osłowski, D. Perrodin, A. Petiteau, A. Possenti, M. B. Purver, P. A. Rosado, S. A. Sanidas, R. Smits, B. Stappers, C. Tiburzi, R. van Haasteren, A. Vecchio, J. P. W. Verbiest, and EPTA Collaboration. “Limits on Anisotropy in the Nanohertz Stochastic Gravitational Wave Background”. *Phys.Rev. Lett*, 115(4):041101, July 2015.

**Taylor, S.**, 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, November 2014.

**Taylor, S. R.** and J. R. Gair. “Searching for anisotropic gravitational-wave backgrounds using pulsar timing arrays”. *Phys. Rev. D*, 88(8):084001, October 2013.

**Taylor, S. R.**, 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, February 2013.

**Taylor, S. R.** and J. R. Gair. “Cosmology with the lights off: Standard sirens in the Einstein Telescope era”. *Phys. Rev. D*, 86(2):023502, July 2012.

**Taylor, S. R.**, J. R. Gair, and I. Mandel. “Cosmology using advanced gravitational-wave detectors alone”. *Phys. Rev. D*, 85(2):023535, January 2012.

G. Desvignes, R. N. Caballero, L. Lentati, J. P. W. Verbiest, D. J. Champion, B. W. Stappers, G. H. Janssen, P. Lazarus, S. Osłowski, S. Babak, C. G. Bassa, P. Brem, M. Burgay, I. Cognard, J. R. Gair, E. Graikou, L. Guillemot, J. W. T. Hessels, A. Jessner, C. Jordan, R. Karuppusamy, M. Kramer, A. Lassus, K. Lazaridis, K. J. Lee, K. Liu, A. G. Lyne, J. McKee, C. M. F. Mingarelli, D. Perrodin, A. Petiteau, A. Possenti, M. B. Purver, P. A. Rosado, S. Sanidas, A. Sesana, G. Shaifullah, R. Smits, **Taylor, S. R.**, G. Theureau, C. Tiburzi, R. van Haasteren, and A. Vecchio. “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, J. P. W. Verbiest, R. van Haasteren, J. A. Ellis, R. N. Caballero, R. N. Manchester, Z. Arzoumanian, S. Babak, C. G. Bassa, N. D. R. Bhat, P. Brem, M. Burgay, S. Burke-Spolaor, D. Champion, S. Chatterjee, I. Cognard, J. M. Cordes, S. Dai, P. Demorest, G. Desvignes, T. Dolch, R. D. Ferdman, E. Fonseca, J. R. Gair, M. E. Gonzalez, E. Graikou, L. Guillemot, J. W. T. Hessels, G. Hobbs, G. H. Janssen, G. Jones, R. Karuppusamy, M. Keith, M. Kerr, M. Kramer, M. T. Lam, P. D. Lasky, A. Lassus, P. Lazarus, T. J. W. Lazio, K. J. Lee, L. Levin, K. Liu, R. S. Lynch, D. R. Madison, J. McKee, M. McLaughlin, S. T. McWilliams, C. M. F. Mingarelli, D. J. Nice, S. Osłowski, T. T. Pennucci, B. B. P. Perera, D. Perrodin, A. Petiteau, A. Possenti, S. M. Ransom, D. Reardon, P. A. Rosado, S. A. Sanidas, A. Sesana, G. Shaifullah, X. Siemens, R. Smits, I. Stairs, B. Stappers, D. R. Stinebring, K. Stovall, J. Swiggum, **Taylor, S. R.**, G. Theureau, C. Tiburzi, L. Toomey, M. Vallisneri, W. van Straten, A. Vecchio, J.-B. Wang, Y. Wang, X. P. You, W. W. Zhu, and X.-J. Zhu. “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, R. van Haasteren, P. B. Demorest, G. H. Janssen, J.-B. Wang, G. Desvignes, R. N. Caballero, M. J. Keith, D. J. Champion, Z. Arzoumanian, S. Babak, C. G. Bassa, N. D. R. Bhat, A. Brazier, P. Brem, M. Burgay, S. Burke-Spolaor, S. J. Chamberlin, S. Chatterjee, B. Christy, I. Cognard, J. M. Cordes, S. Dai, T. Dolch, J. A. Ellis, R. D. Ferdman, E. Fonseca, J. R. Gair, N. E. Garver-Daniels, P. Gentile, M. E. Gonzalez, E. Graikou, L. Guillemot, J. W. T. Hessels, G. Jones, R. Karuppusamy, M. Kerr, M. Kramer, M. T. Lam, P. D. Lasky, A. Lassus, P. Lazarus, T. J. W. Lazio, K. J. Lee, L. Levin, K. Liu, R. S. Lynch, A. G. Lyne, J. McKee, M. A. McLaughlin, S. T. McWilliams, D. R. Madison, R. N. Manchester, C. M. F. Mingarelli, D. J. Nice, S. Osłowski, N. T. Palliyaguru, T. T. Pennucci, B. B. P. Perera, D. Perrodin, A. Possenti, A. Petiteau, S. M. Ransom, D. Reardon, P. A. Rosado, S. A. Sanidas, A. Sesana, G. Shaifullah, R. M. Shannon, X. Siemens, J. Simon, R. Smits, R. Spiewak, I. H. Stairs, B. W. Stappers, D. R. Stinebring, K. Stovall, J. K. Swiggum, **Taylor, S. R.**, G. Theureau, C. Tiburzi, L. Toomey, M. Vallisneri, W. van Straten, A. Vecchio, Y. Wang, L. Wen, X. P. You, W. W. Zhu, and X.-J. Zhu. “The International Pulsar Timing Array: First data release”. *MNRAS*, 458:1267–1288, May 2016.

Z. Arzoumanian, A. Brazier, S. Burke-Spolaor, S. J. Chamberlin, S. Chatterjee, B. Christy, J. M. Cordes, N. J. Cornish, K. Crowter, P. B. Demorest, X. Deng, T. Dolch, J. A. Ellis, R. D. Ferdman, E. Fonseca, N. Garver-Daniels, M. E. Gonzalez, F. Jenet, G. Jones, M. L. Jones, V. M. Kaspi, M. Koop,

M. T. Lam, T. J. W. Lazio, L. Levin, A. N. Lommen, D. R. Lorimer, J. Luo, R. S. Lynch, D. R. Madison, M. A. McLaughlin, S. T. McWilliams, C. M. F. Mingarelli, D. J. Nice, N. Palliyaguru, T. T. Pennucci, S. M. Ransom, L. Sampson, S. A. Sanidas, A. Sesana, X. Siemens, J. Simon, I. H. Stairs, D. R. Stinebring, K. Stovall, J. Swiggum, **Taylor, S. R.**, M. Vallisneri, R. van Haasteren, Y. Wang, W. W. Zhu, and The NANOGrav Collaboration. "*The NANOGrav Nine-year Data Set: Limits on the Isotropic Stochastic Gravitational Wave Background*". *Astrophys. J.*, 821:13, April 2016.

R. N. Caballero, K. J. Lee, L. Lentati, G. Desvignes, D. J. Champion, J. P. W. Verbiest, G. H. Janssen, B. W. Stappers, M. Kramer, P. Lazarus, A. Possenti, C. Tiburzi, D. Perrodin, S. Osłowski, S. Babak, C. G. Bassa, P. Brem, M. Burgay, I. Cognard, J. R. Gair, E. Graikou, L. Guillemot, J. W. T. Hessels, R. Karuppusamy, A. Lassus, K. Liu, J. McKee, C. M. F. Mingarelli, A. Petiteau, M. B. Purver, P. A. Rosado, S. Sanidas, A. Sesana, G. Shaifullah, R. Smits, **Taylor, S. R.**, G. Theureau, R. van Haasteren, and A. Vecchio. "*The noise properties of 42 millisecond pulsars from the European Pulsar Timing Array and their impact on gravitational-wave searches*". *MNRAS*, 457:4421–4440, April 2016.

S. Babak, A. Petiteau, A. Sesana, P. Brem, P. A. Rosado, **Taylor, S. R.**, A. Lassus, J. W. T. Hessels, C. G. Bassa, M. Burgay, R. N. Caballero, D. J. Champion, I. Cognard, G. Desvignes, J. R. Gair, L. Guillemot, G. H. Janssen, R. Karuppusamy, M. Kramer, P. Lazarus, K. J. Lee, L. Lentati, K. Liu, C. M. F. Mingarelli, S. Osłowski, D. Perrodin, A. Possenti, M. B. Purver, S. Sanidas, R. Smits, B. Stappers, G. Theureau, C. Tiburzi, R. van Haasteren, A. Vecchio, and J. P. W. Verbiest. "*European Pulsar Timing Array limits on continuous gravitational waves from individual supermassive black hole binaries*". *MNRAS*, 455:1665–1679, January 2016.

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

L. Lentati, **Taylor, S. R.**, C. M. F. Mingarelli, A. Sesana, S. A. Sanidas, A. Vecchio, R. N. Caballero, K. J. Lee, R. van Haasteren, S. Babak, C. G. Bassa, P. Brem, M. Burgay, D. J. Champion, I. Cognard, G. Desvignes, J. R. Gair, L. Guillemot, J. W. T. Hessels, G. H. Janssen, R. Karuppusamy, M. Kramer, A. Lassus, P. Lazarus, K. Liu, S. Osłowski, D. Perrodin, A. Petiteau, A. Possenti, M. B. Purver, P. A. Rosado, R. Smits, B. Stappers, G. Theureau, C. Tiburzi, and J. P. W. Verbiest. "*European Pulsar Timing Array limits on an isotropic stochastic gravitational-wave background*". *MNRAS*, 453:2576–2598, November 2015.

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

J. D. Romano, **Taylor, S. R.**, 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, August 2015.

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

J. Gair, J. D. Romano, **Taylor, S.**, 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, October 2014.*

L. Lentati, P. Alexander, M. P. Hobson, **Taylor, S.**, 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, May 2013.*