Theresa Mary Baker

Nationality:	British	*Alternative name:*	Tessa
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Research Interests & Experience:

My research centres around gravity, the role it plays in our universe, and its theoretical underpinnings. Extensions of our paradigmatic theory of gravity, General Relativity, have been put forwards to explain the accelerating expansion rate of the universe. I am working to develop new methods to test these ideas with current and future experiments.

I am the author a mathematical framework that unifies alternative theories of gravity, called the 'Parameterised Post-Friedmann formalism', which forms the basis of the widely-used EFT approaches to modified gravity. I am actively involved with numerous ground- and space-based experiments to test gravity with weak gravitational lensing, galaxy clustering and HI intensity mapping surveys. Most recently, I have started a new research direction in gravitational wave cosmology and the potential of multi-messenger astronomy.

Employment:

Royal Society University Research Fellow & Proleptic Senior Lecturer	Queen Mary University of London	Jan. 2019 - present.
Fulbright Scholar *Scholarship held at the Center for Particle Cosmology.*	University of Pennsylvania	Oct. 2015 - August 2016
Postdoctoral Research Fellow	All Souls College, University of Oxford	October 2013 – 2018.

Education:

Astrophysics D.Phil. — University of Oxford — October 2010 – September 2013
Thesis title: Cosmological Tests of General Relativity. Supervisor: Prof. Pedro Ferreira

Visiting Scholar — Harvard University, Massachusetts — September – December 2012
Formation of Black Holes in Scalar-Tensor theories of gravity. Supervisor: Prof. Dimitrios Psaltis

Physics (MPhys), 1st class — University of Oxford — Graduated 2010
Master's thesis title: Inflation and String Theory. Supervisor: Prof. Andre Lukas

Summer Research Student — Columbia University, New York — July & August 2010
Dark Energy from String Gases. Supervisor: Prof. Janna Levin

Summer Research Student — Institute of Astronomy, University of Cambridge — June – September 2009
Variable Broad Absorption Line Quasars in SDSS DR7. Supervisor: Prof. Paul Hewett

AAO Student Fellowship — Australian Astronomical Observatory, Sydney, Australia — June – September 2008
Quasar Spectroscopy with the Gemini GMOS Instrument. Supervisor: Dr. Rob Sharp

Summer Research Student — University of Oxford, Astrophysics — June – September 2007
Study of a Forming Galaxy Cluster with Gemini. Supervisor: Dr. Ilona Soechting

Awards:

Royal Society University Research Fellows Enhancement Award, held at Queen Mary University of London, 2019-2021.
Royal Society University Research Fellowship, held at Queen Mary University of London, 2019-2023.
Winner of the 'Women of the Future Award', science category, 2015.
Fulbright All-Disciplines Scholar Award, 2015-2016.
SET for Britain Cavendish medal for Physics, 2014.
Glasstone Research Fellowship in Science, University of Oxford, 2013 (declined).
STFC PhD Studentship, 2010-2013.
Academic Scholarship, Lady Margaret Hall, University of Oxford, 2009-2010.
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Academic Scholarship, Lady Margaret Hall, University of Oxford, 2007-2008.

Teaching & Supervision:

Student and Postdoctoral Supervision:

Dr. Bill Wright, postdoctoral researcher, QMUL, January 2020 - present.

Supervision of PhD students: Ashim Sen Gupta, QMUL, commencing Sept. 2020.

Samuel Kumagai, MSc Astrophysics student, QMUL, 2019 - 2020.

BSc project students 2019-2020: Aman Kapoor, Mohammed Arif.

Personal tutor (pastoral) for typically four undergraduates per year on BSc/MSc degrees.

Teaching:

Core lecturer for the SIGRAV International PhD School 'Gravity: General Relativity and Beyond. Astrophysics, Cosmology and Gravitational Waves', Vietri sul Mare, Italy, February 2020. Lectures on modified gravity, cosmology theory and observations.

Partial lecturer for Physical Cosmology module (third year of BSc/MSc course), QMUL, October 2019.

Lecturer for the Masters in Mathematical and Theoretical Physics course at University of Oxford, March 2017 & March 2018. Lectures on general relativity, cosmological models and gravitational lensing, part of the cosmology module.

Lecturer at the Young Experimentalists and Theorists Institute (YETI), 'Gravitational Probes of Fundamental Physics', Durham University, Jan. 2017.

Guest lecturer at the British Universities Summer School in Theoretical Elementary Particle Physics (BUSSTEPP), University of Manchester, September 2016.

Tutor for third-year undergraduate course on General Relativity at St. Catherine's College, Oxford, 2012.

Professional Activities:

Collaboration Memberships:

UK co-PI of LSST-DESC, member of LSST Theory and Joint Probes group, key contributor to topical team 'Beyond wCDM'.

Co-lead of Fundamental Physics project team within LISA Multimessenger Multi-band Astrophysics(MMMBA) work package.

Co-lead of Modified Gravity project team within LISA cosmology working group.

Member of the Theory Working Group (TWG) for the ESA Euclid satellite mission; member of the review document editorial board 2013 - 2016. Key contributor to TWG work packages 1 (Dark Energy), 7 (Nonlinear Structure) & 10 (Novel Probes).

Admissions & Assessments:

Selection panel member for faculty and postdoctoral positions in exoplanet research, QMUL, 2019.

Assessor for student BSc Physics projects, QMUL, 2019.

Lead examiner for Post-Doctoral Research Fellowships at Christchurch College, University of Oxford, 2018.

Member of selection panel for Skynner Fellowship at Balliol College, University of Oxford, 2017.

Subject lead (physical sciences) for Postdoctoral Research Fellowship appointments, All Souls College, University of Oxford, 2016.

Examiner for Prize Fellowships, All Souls College, University of Oxford, 2016.

Reviewer for STFC consolidated grants proposals, 2016.

Assessor for student BA Physics projects, University of Oxford, 2016.

Committees:

Gender Champion and member of Equality, Diversity and Inclusion committee, QMUL School of Physics & Astronomy, 2019 - present.

Member of General Purposes Committee of All Souls College, University of Oxford, 2016-2018.

Postdoc. representative officer at Oxford Astrophysics, 2015 – 2017. Duties include sitting on the Physics Postdoctoral Liaison Committee and organisation of careers workshops.

Organiser for Britgrav 2017 conference at University of Oxford.

Founding member of the Oxford Women in Physics Society, 2013.

Student representative for the Astrophysics Computer Users Group at Oxford, 2011 – 2013.

Organiser for Oxford Astrophysics journal club, 2011 – 2013.

Academic Societies:

Fellow of the Royal Astronomical Society, 2006 - present.

Associate member of the Institute of Physics, 2006 - present.

Journal Reviewing: JCAP, Phys. Rev. D, General Relativity and Gravitation (GRG), Annals of Physics, Physics Letters B.

PUBLICATIONS:

1. J. Baker, **T. Baker** et al., *'High angular resolution gravitational wave astronomy'* (2019), `https://arxiv.org/abs/1908.11410`.

2. M. Arca Sedda et al. incl. **T. Baker**, *'The Missing Link in Gravitational-Wave Astronomy: Discoveries waiting in the decihertz range'* (2019), `https://arxiv.org/abs/1908.11375`.

3. **T. Baker** et al., *'The Novel Probes Project – Tests of Gravity on Astrophysical Scales'* (2019), accepted to appear in Reviews of Modern Physics, `https://arxiv.org/abs/1908.03430`.

4. M. Ishak, **T. Baker** et al., *'Modified Gravity and Dark Energy models Beyond w(z)CDM Testable by LSST'* (2019), `https://arxiv.org/abs/1905.09687`.

5. A. Pisani, E. Massara, D. Spergel, D. Alonso, **T. Baker** et al., *'Cosmic voids: a novel probe to shed light on our Universe'* (2019), `https://arxiv.org/abs/1903.0516`.

6. **T. Baker**, J. Clampitt, B. Jain, & M. Trodden, *'Void Lensing as a Test of Gravity'*, Phys. Rev. D 98, 023511 (2018), `https://arxiv.org/abs/1803.07533`.

7. M. Lagos, E. Bellini, J. Noller, P.G. Ferreira, **T. Baker**, *'A general theory of linear cosmological perturbations: stability conditions, the quasistatic limit and dynamics',* JCAP 03 (2018) 021, `https://arxiv.org/abs/1711.09893`.

8. **T. Baker**, E. Bellini, P. Ferreira, M. Lagos, J. Noller & I. Sawicki, *'Strong constraints on cosmological gravity from GW170817 and GRB 170817A'*, Phys. Rev. Lett. 119, 251301 (2017). Selected as a PRL Editor's Highlight contribution. `https://arxiv.org/abs/1710.06394`

9. **T. Baker**, M. Trodden, *'Multi-Messenger Time Delays from Lensed Gravitational Waves'*, Phys. Rev. D., Vol. 95 063512 (2017), https://arxiv.org/abs/1612.02004.

10. M. Lagos, **T. Baker**, P.G. Ferreira, J. Noller, *'A General Theory of Linear Cosmological Perturbations: scalar-tensor and vector-tensor theories'*, Journal of Cosmology and Astroparticle Physics, Issue 08, article id. 007 (2016), https://arxiv.org/abs/1604.01396.

11. P. Bull, Y. Akrami, J. Adamek, **T. Baker** et al., *'Beyond ΛCDM: Problems, solutions, and the road ahead'*, Physics of the Dark Universe, Volume 12, p. 56-99 (2016), https://arxiv.org/abs/1512.05356.

12. **T. Baker**, P. Bull, *'Observational signatures of modified gravity on ultra-large scales'*, The Astrophysical Journal, Vol. 811 No. 2 (2015), http://arxiv.org/abs/1506.00641

13. E. Berti, E. Barausse, V. Cardoso, L. Gualtieri, P. Pani, U. Sperhake, L.C. Stein, N. Wex, K. Yagi, **T. Baker** et al., *'Testing General Relativity with Present and Future Astrophysical Observations'*, Classical and Quantum Gravity, Vol. 32 No. 24 (2015), http://arxiv.org/abs/1501.07274

14. C.D. Leonard, **T. Baker**, P.G. Ferreira, *'Exploring degeneracies in modified gravity with weak lensing'*, Phys. Rev. D., Vol.91 083504 (2015), http://arxiv.org/abs/1501.03509v1

15. **T. Baker**, D. Psaltis, C. Skordis, *'Linking Tests of Gravity On All Scales: from the Strong-Field Regime to Cosmology'*, The Astrophysical Journal, 802 63 (2015), http://arxiv.org/abs/1412.3455

16. **T. Baker**, P.G. Ferreira, M. Motta, C.D. Leonard, *'New Gravitational Scales in Cosmological Surveys'*, Phys. Rev. D., Vol.90 124030 (2014) , http://arxiv.org/abs/1409.8284

17. **T. Baker**, P.G. Ferreira, C. Skordis, *'A Fast Route to Modified Gravitational Growth'*, Phys. Rev. D, Vol.89, 024026 (2014), http://arxiv.org/abs/1310.1086

18. **T. Baker**, P.G. Ferreira, C. Skordis, *'The Parameterized Post-Friedmann Framework for Theories of Modified Gravity: Concepts, Formalism and Examples',* Phys. Rev. D, Vol.87, 024015 (2013), http://arxiv.org/abs/1209.2117

19. L. Amendola, S. Appleby, D. Bacon, **T. Baker** et al., *'Cosmology and fundamental physics with the Euclid satellite'*, Living Reviews in Relativity, vol.16, no.6, September 2013, http://arxiv.org/abs/1206.1225

20. **T. Baker**, *'Phi Zeta Delta: Growth of Perturbations in Parameterized Gravity for an Einstein-de Sitter Universe',* Phys. Rev. D, Vol.85, Issue 4 (2012), http://arxiv.org/abs/1111.3947

21. J. Zuntz, **T. Baker**, P.G. Ferreira, C. Skordis, *'Ambiguous Tests of General Relativity on Cosmological Scales',* JCAP 06 (2012) 032, http://arxiv.org/abs/1110.3830

22. **T. Baker**, P.G. Ferreira, C. Skordis, J. Zuntz, *'Towards a Fully Consistent Parameterization of Modified Gravity',* Phys. Rev. D, Vol. 84, Issue 12 (2011), http://arxiv.org/abs/1107.0491

Public Outreach

I tweet regular from the Twitter handle @Tessa_M_Baker.

Talk at the Rotary Club of Reading Abbey, Reading, UK, 17th October 2018.

Public talk at the Royal Greenwich Observatory, London, at the launch event of their 'Universe Unseen' exhibition, 12th April 2018.

Appearance on Channel 5 News dedicated program in memory of Stephen Hawking, 14th March 2018.

General public talks at All Souls College, Oxford, 2014 & 2017: *'Primordial Gravitational Waves?'* and *'Gravitational Waves 101'.*

Interviewed for article by sciencenews.org on the implications of GW170817 and counterparts: https://www.sciencenews.org/article/what-detecting-gravitational-waves-means-expansion-universe

Interviewed for article by Gizmodo blog on tests of gravity near the Galactic centre: http://www.gizmodo.co.uk/2017/08/einsteins-theory-passes-a-massive-test/

Article for the IoP Gravitational Physics Group winter newsletter, 2017.

'Space and You' day for children with learning disabilities, St Hughes College and Oxford Astrophysics, September 2017.

Extensive interview for the 'Frontiers of Knowledge' podcast by Yurtesh Sohal, February 2017, available at `https://www.youtube.com/watch?v=VlQpWt2GPss&feature=youtu.be`.

Interview for the podcast 'Awesome Women Doing Awesome Things' by Erin Stewart, January 2016, available at `https://itunes.apple.com/au/podcast/awesome-women-doing-awesome/id1042227282`.

Appearance on Channel 5 News, explaining the discovery of gravitational waves for a general audience, 11th February 2016.

In 2014 I won the SET for Britain Cavendish medal for Physics (i.e. first place). SET for Britain is a public speaking competition for the communication of science to a general audience, which takes place at the Houses of Parliament.

Collaboration with author Joshua Coppersmith-Heaven and Dr Norman Gray (University of Glasgow) on a popular science book entitled 'The Longest Story in the Universe'. The book explains cosmology from the Big Bang to the present day, via rhyme and cartoons. Draft manuscript submitted to publishers, March 2016.

Annual participation in the Oxford Astrophysics 'Stargazing Live' festival, linking to an annual set of BBC programs.

I have provided comments for the Guardian newspaper on science stories relating to cosmology and gravity.

Talk at Oxford University Space and Astronomical Society, Oxford, May 2011: *'Putting Gravity to the Test'*.

Oxford Astrophysics student seminar series, March 2011: *'A Phenomenological Approach to Modified Gravity'*.

Publicity officer for Oxford University Space and Astronomical Society, 2008 – 2009.

Computing & Observing:

I have worked extensively with the cosmology codes CAMB, hi_class, and Cosmosis, and have developed modified versions of these. I program mainly in Python, and use Mathematica frequently. I also have experience with C++ and the IRAF data reduction software.

I have assisted with seven nights observing on the 3.9m Australian Astronomical Telescope (AAT) at Siding Springs Observatory.

Selected Talks:

Invited talk at workshop 'Gravitational Wave Probes of Fundamental Physics', Amsterdam, November 2019.

Invited speaker and participant at the Kavli Institute for Theoretical Physics workshop 'Merging Visions: Exploring Compact-Object Binaries with Gravity and Light', Santa Barbara, June 2019.

Invited plenary at Gordan Research Conference String Theory and Cosmology, Castelldefels, Spain, June 2019.

Invited talk at workshop 'Cross-disciplinary perspectives on model-independent searches', University of Edinburgh, Edinburgh, UK, 11-12th February 2019: *'Testing the Gravitational Landscape'*.

Invited talk at workshop 'International Conference on Dark Matter and Dark Energy', Aachen University, Aachen, Germany, 6-8th February 2019: *'Testing the Gravitational Landscape'*.

Invited talk at 'South American Workshop on Cosmology in the LSST Era', International Centre for Theoretical Physics (ICTP-SAFIR), Sao Paulo, Brazil, 17-20th December 2018: *'The Gravitational Landscape for the LSST Era'*.

Invited talk at workshop 'Cosmological Voids', Center for Computational Astrophysics, Flatiron Institute, New York, 24-26th September 2018: *'Testing Gravity in Voids'*.

Invited talk at the 'Models of Gravity' Research Training Group workshop, Jacobs University, Bremen, Germany, 19-20th February 2018: *'Tests of Gravity with Gravitational Waves and Cosmology'*.

Invited talk at the annual UK-HEP Forum, the Cosener's House, Abingdon, 29th November 2017: *'Modified Gravity: Theory and Constraints'*.

Invited talk at Lorentz Center workshop on 'Dark Energy in the Laboratory', 13-17th November 2017, University of Leiden, Netherlands: *'Frameworks for Testing Gravity: Theory and Recent Constraints'*.

Seminar at the Central European Institute for Cosmology (CEICO), Prague, 16th October 2017: *'Frameworks for*

Testing Beyond-Einstein Gravity'.

Plenary talk at the DESY Theory Workshop 2017, Oct.2017: *'Tests of Beyond-Einstein Gravity'.*

CERN theory colloquium, featured talk of the CERN summer theory institute, August 2017: *'Cosmological Tests of Gravity'.*

Seminar at the Albert Einstein Institute (AEI), Berlin, 1st February 2017: *'Multi-Messenger Time Delays'.*

Invited talk at Burke Institute Workshop: 'Unifying Tests of General Relativity', California Institute of Technology, 19th-21st July 2016: *'Cosmological Frameworks for Testing Gravity'.*

Plus previous seminars at the Aspen Center for Physics, University of Arizona, University of California Berkeley, Caltech, University of Cambridge, Cornell University, University of Crete, DARK Cosmology Centre (Copenhagen), Durham University, University of Erlangen, Harvard University, University of Helsinki, Imperial College London, Kings College London, the Lorentz Center (Leiden), Massachusetts Institute of Technology, University of Montana Institute for Extreme Gravity, NORDITA (Stockholm), University of Nottingham, University of Pennsylvania, the Institute of Physics, Princeton University, the Royal Astronomical Society, the Royal Society, Queen Mary University of London, Institute for Cosmology and Gravitation (University of Portsmouth), University of Southampton, the University of Sussex and the University of Virginia.