

**Philip James Bull**

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**Research positions**

- 10/2018 onwards      **Lecturer in Cosmology**, Queen Mary University of London
- 01/2019 onwards      **Visiting Senior Researcher**, Centre for Radio Cosmology, U. Western Cape
- 10/2017 – 10/2018      **BCCP/RAL Postdoctoral Fellow**, University of California at Berkeley
- 10/2015 – 10/2017      **NASA Postdoctoral Fellow (NPP)**, Jet Propulsion Lab / Caltech
- 05/2013 – 10/2015      **Postdoctoral Fellow**, Institute of Theoretical Astrophysics, University of Oslo

**Education and qualifications**

- 10/2010 – 04/2013      **DPhil Astrophysics, University of Oxford**  
Theoretical cosmology, supervised by Pedro Ferreira and Tim Clifton.
- 09/2006 – 07/2010      **MPhys Physics with Astrophysics, University of Manchester**  
First class honours, top of class. Specialised in astrophysics and theoretical physics.

**Awards and scholarships**

- 2016 onwards      Elected Affiliate Lecturer at the University of Malta (ISSA)
- 2010      Outstanding Academic Achievement Award (University of Manchester)
- 2010      Samuel Bright Research Scholarship in Physical Sciences (U. Manchester)
- 2006 – 2010      President's Award (University of Manchester)
- 2006 – 2010      Foresters Scholarship
- 2009      Hatfield-Heginbottom Scholarship (University of Manchester)
- 2008      Hatfield Scholarship (University of Manchester)
- 2004      Award for Academic Achievement (Staffordshire University)

**Grants and funding awarded**

- 2021 – 2025      ERC Starting Grant, PI (approx. €1.67 million)
- 2020 – 2023      STFC Consolidated Grant, AGP/Astro Observations project, PI (approx. £212k)
- 2020 – 2023      STFC Consolidated Grant, AGP/Astro Theory project, Co-I (approx. £280k)
- 2019 – 2022      HERA research subcontract with UC Berkeley, PI (\$278k)
- 2018 – 2019      DiRAC 10<sup>th</sup> Call supercomputer allocation (0.3M CPU-hours)
- 2016      NASA Innovative Advanced Concepts, Phase I Step B study, Co-I (up to \$125k)
- 2015 – 2017      NASA Postdoctoral Program Fellowship, Co-I (\$127k)

**Professional activities and collaborations**

- 2019 onwards      Member of the Institute of Applied Data Science at QMUL
- 2018 onwards      HERA Statistics working group coordinator
- 2018 – 2020      LSST DESC Theory and Joint Probes working group co-convener
- 2017 onwards      Member of the HERA collaboration (Executive Board member since 2018)
- 2016 onwards      LSST Dark Energy Science Collaboration (full member from 2017)
- 2016      Reviewer, NASA ROSES 2016 review panel
- 2016 – 2017      JPL Astrophysics Diversity and Best Practices advisory panel
- 2016 onwards      SKA Cosmology SWG work package lead: HI galaxy surveys
- 2013 onwards      Member of the SKA Cosmology Science Working Group (Core Team)
- 2013 – 2015      Member of the Planck Collaboration (LFI Core team)
- 2012 onwards      Regular referee for ApJ, JCAP, MNRAS, PRD, and PRL

## Research

My research covers the intersection of theoretical and observational cosmology. I am interested in what large-scale structure can tell us about dark energy, and how novel observables and statistical tools can be used to make inferences about the cosmos on the largest scales. Research topics include:

- ◆ Cosmology with multiple tracers, including optical and radio (21cm) surveys
- ◆ Secondary anisotropies and spectral distortions of the CMB as cosmological probes
- ◆ General Relativistic effects on matter inhomogeneities and light propagation
- ◆ Bayesian inference, stochastic processes, and computational physics

## Journal articles (published/submitted)

### 2021

44. [Patterns of primary beam non-redundancy in close-packed 21cm array observations](#)  
S. Choudhuri, **P. Bull**, H. Garsden, MNRAS submitted [2101.02684]
43. [Observing relativistic features in large-scale structure surveys – I: Multipoles of the power spectrum](#)  
C. Guandalin, J. Adamek, **P. Bull**, C. Clarkson, L.R. Abramo, L. Coates, MNRAS 501, 2 (2021)

### 2020

42. [HI intensity mapping with MeerKAT: Calibration pipeline for multi-dish autocorrelation observations](#)  
J. Wang, M.G. Santos, **P. Bull** et al., MNRAS submitted [2011.13789]
41. [Observing relativistic features in LSS – II: Doppler magnification in an ensemble of relativistic simulations](#)  
L. Coates, J. Adamek, **P. Bull**, C. Guandalin, C. Clarkson, MNRAS submitted [2011.12936]
40. [Searching for dark energy in the matter-dominated era](#)  
**P. Bull**, M. White, A. Slosar, MNRAS submitted [2007.02865]
39. [DAYENU: A Simple Filter of Smooth Foregrounds for Intensity Mapping Power Spectra](#)  
A. Ewall-Wice et al., MNRAS submitted [2004.11397]
38. [Redundant-Baseline Calibration of the Hydrogen Epoch of Reionization Array](#)  
J.S. Dillon et al., submitted [2003.08399]
37. [Cosmology with Phase 1 of the Square Kilometre Array: Red Book 2018](#)  
Square Kilometre Array Cosmology Science Working Group, PASA 37, E007 (2020)
36. [Fundamental Physics with the Square Kilometre Array](#)  
A. Weltman, **P. Bull**, S. Camera et al., PASA 37, E002 (2020)
35. [Absolute Calibration for HERA and Its Impact on the 21cm Power Spectrum](#)  
HERA Collaboration (N.S. Kern et al.), ApJ 890, 122 (2020)
34. [Mitigating Internal Instrument Coupling II: A Method Demonstration with HERA](#)  
HERA Collaboration (N.S. Kern et al.), ApJ 888, 70 (2020)

### 2019

33. [Electrical and electromagnetic co-simulations of the HERA Phase I receiver system](#)  
HERA Collaboration (N. Fagnoni et al.), MNRAS submitted [1908.02383]
32. [The HERA-19 Commissioning Array: Direction-dependent Effects](#)  
HERA Collaboration (S. Kohn et al.), ApJ 882, 58 (2019)
31. [Core Cosmology Library: Precision Cosmological Predictions for LSST](#)  
LSST Dark Energy Science Collaboration, ApJS 242, 2 (2019)
30. [Testing General Relativity with the Doppler magnification effect](#)  
S. Andrianomena, C. Bonvin, D. Bacon, **P. Bull** et al, MNRAS 488, 3759 (2019)

### 2018

29. [Inflation and Early Dark Energy with a Stage II Hydrogen Intensity Mapping experiment](#)  
Cosmic Visions 21 cm Collaboration, arXiv:1810.09572
28. [Mitigating complex dust foregrounds in future CMB polarization experiments](#)  
B. Hensley, **P. Bull**, ApJ 853, 127 (2018)
27. [Model-independent curvature determination with 21cm intensity mapping experiments](#)  
A. Witzemann, **P. Bull**, C. Clarkson et al. MNRAS Letters 477, 1 (2018)

## 2017

26. Line-Intensity Mapping: 2017 Status Report  
E. Kovetz et al., Phys. Reports submitted [1709.09066]
25. MeerKLASS: MeerKAT Large Area Synoptic Survey  
M. Santos (Ed.) et al. [1709.06099]
24. Priors on the effective Dark Energy equation of state in scalar-tensor theories  
M. Raveri, **P. Bull**, A. Silvestri, L. Pogosian, Phys. Rev. D 96, 083509 (2017)
23. Dipolar modulation in the size of galaxies: The effect of Doppler magnification  
C. Bonvin, ..., **P. Bull**, MNRAS 472, 4 (2017)
22. A Galaxy-Halo Model for Multiple Cosmological Tracers  
**P. Bull**, MNRAS 471, 12 (2017)

## 2016

21. Science Impacts of the SPHEREx All-Sky Optical to Near-Infrared Spectral Survey  
O. Doré, M. W. Werner (Eds.) et al. [1606.07039]
20. Spatial curvature endgame: Reaching the limit of curvature determination  
C. D. Leonard, **P. Bull**, R. Allison, Phys. Rev. D 94, 023502 (2016)
19. Reconstructing cosmic growth with kSZ observations in the era of Stage IV experiments  
D. Alonso, T. Louis, **P. Bull**, P. G. Ferreira, Phys. Rev. D 94, 043522 (2016)
18. Distinguishing screening mechanisms with environment-dependent velocity statistics  
M. F. Ivarsen, **P. Bull**, C. Llinares, D. F. Mota, A&A 595 (2016) A40
17. Beyond  $\Lambda$ CDM: Problems, solutions, and the road ahead [review]  
**P. Bull**, Y. Akrami (Eds.) et al., Phys. Dark. Univ. 12, 56 (2016)
16. Extending cosmological tests of General Relativity with the Square Kilometre Array  
**P. Bull**, ApJ 817, 26 (2016)

## 2015

15. Weighing neutrinos with cosmic neutral hydrogen  
F. Villaescusa-Navarro, **P. Bull**, M. Viel, ApJ 814, 146 (2015)
14. A systematic study of Ly- $\alpha$  transfer through outflowing shells: Model parameter estimation  
M. Gronke, **P. Bull**, M. Dijkstra, ApJ 812, 123 (2015)
13. Observational signatures of modified gravity on ultra-large scales  
T. Baker, **P. Bull**, ApJ 811, 2 (2015)
12. Ultra-large scale cosmology with next-generation experiments  
D. Alonso, **P. Bull**, P. G. Ferreira, R. Maartens, M. G. Santos, ApJ 814, 145 (2015)
11. Cosmological performance of SKA HI galaxy surveys  
S. Yahya, **P. Bull**, M. G. Santos, M. Silva et al., MNRAS 450, 2251 (2015)
10. Cross-correlating 21cm intensity maps with LBGs in the post-reionization era  
F. Villaescusa-Navarro, ..., **P. Bull** et al., JCAP 03, 034 (2015)
9. A CMB Gibbs sampler for localized secondary anisotropies  
**P. Bull**, I. K. Wehus, H. K. Eriksen, P. G. Ferreira et al., ApJS 219, 10 (2015)
8. Blind foreground subtraction for intensity mapping experiments  
D. Alonso, **P. Bull**, P. G. Ferreira, M. G. Santos, MNRAS 447, 400 (2015)
7. Late-time cosmology with 21cm intensity mapping experiments  
**P. Bull**, P. G. Ferreira, P. Patel, M. G. Santos, ApJ 803, 21 (2015)

## 2014

6. Quintessence in a quandary: On prior dependence in dark energy models  
D. J. E. Marsh, **P. Bull**, P. G. Ferreira, A. Pontzen, Phys. Rev. D 90, 105023 (2014)
5. A multi-level solver for Gaussian constrained CMB realizations  
D. S. Seljebotn, ..., **P. Bull**, ApJS 210, 24 (2014)

2013

4. What if Planck's Universe isn't flat?  
P. Bull, M. Kamionkowski, Phys. Rev. D 87, 081301(R) (2013)

2012

3. Local and nonlocal measures of acceleration in cosmology  
P. Bull, T. Clifton, Phys. Rev. D 85, 103512 (2012)
2. The isotropic blackbody CMB as evidence for a homogeneous universe  
T. Clifton, C. Clarkson, P. Bull, Phys. Rev. Lett. 109, 051303 (2012)
1. The KSZ effect as a test of general radial inhomogeneity in LTB cosmology  
P. Bull, T. Clifton & P. G. Ferreira, Phys. Rev. D 85, 024002 (2012)

### Conference proceedings

12. Weak gravitational lensing with CO galaxies  
P. Bull, I. Harrison, E. Huff, ASP Conf. 7, “Science with a Next-Generation Very Large Array” (2018)
11. Cosmology from HI galaxy surveys with the SKA  
F. B. Abdalla, P. Bull, S. Camera et al., PoS AASKA14 (2015) 017
10. Cosmology from a SKA HI intensity mapping survey  
M. Santos, P. Bull, D. Alonso et al., PoS AASKA14 (2015) 019
9. Cross correlation surveys with the Square Kilometre Array  
D. Kirk, F. B. Abdalla, A. Benoit-Levy et al., PoS AASKA14 (2015) 020
8. HI galaxy simulations for the SKA: number counts and bias  
M. Santos, D. Alonso, P. Bull et al., PoS AASKA14 (2015) 021
7. Measuring baryon acoustic oscillations with future SKA surveys  
P. Bull, S. Camera, A. Raccanelli et al., PoS AASKA14 (2015) 024
6. Cosmology on the Largest Scales with the SKA  
S. Camera, A. Raccanelli, P. Bull et al., PoS AASKA14 (2015) 025
5. Measuring redshift-space distortion with future SKA surveys  
A. Raccanelli, P. Bull, S. Camera et al., PoS AASKA14 (2015) 031
4. Foreground Subtraction in Intensity Mapping with the SKA  
L. Wolz, F. B. Abdalla, D. Alonso, et al., PoS AASKA14 (2015) 035
3. Synergy between the Large Synoptic Survey Telescope and the Square Kilometre Array  
D. Bacon, S. Bridle, F. B. Abdalla et al., PoS AASKA14 (2015) 145
2. Euclid & SKA Synergies  
T. Kitching, D. Bacon, M. Brown, P. Bull et al., PoS AASKA14 (2015) 146
1. 21cm Cosmology  
M. G. Santos, D. Alonso, P. Bull et al., Proc. IAU 306, CUP (2015)

### Talks and seminars

- 2020      Invited talk: International Symposium on Physics, UFCG (Brazil)
- 2019      Invited talk: London Cosmology Discussion Meeting (UK)  
Departmental/group seminars (3): Sussex, ICG Portsmouth (UK); ENS Paris (France)
- 2018      Invited talks (3): Berkeley extragalactic modelling workshop (Berkeley, USA); Direct detection of Dark Energy workshop (Caltech, USA); Tremendous Radio Arrays (Brookhaven, USA)  
Departmental/group seminars (2): Perimeter Institute (Canada); Cambridge/DAMTP (UK)
- 2017      Invited plenary talk: Fundamental Physics with the SKA conference (Mauritius)  
Invited colloquia (2): UC Berkeley, Stanford SITP (USA)  
Invited talks (4): Berkeley Neutral Hydrogen workshop, Johns Hopkins Intensity Mapping workshop, LBNL Cosmic Visions workshop, JPL DES Modified Gravity workshop (USA)  
Departmental/group seminars (3): Carnegie Mellon, Stanford, USC (USA)
- 2016      Departmental/group seminars (6): Heidelberg (DE); Caltech, CCA, JPL, U. Penn, Princeton, IAS (USA)  
Invited talks (3): LSST DESC meeting (Stanford, USA); Future Cosmic Surveys workshop (Chicago, USA); Science for the SKA Generation (Goa, India)

Contributed talks (2): Statistical sampling and non-sampling methods in cosmology workshop (Berkeley, USA); Pasadena annual postdoc retreat (Los Angeles, USA)

- 2015** Invited colloquium: Oskar Klein Centre (Sweden)  
Departmental/group seminars (5): Caltech, JPL, Fermilab (USA); Heidelberg (Germany); QMUL (UK)  
Contributed talks (3): Building an Open UK SKA-Science Consortium (RAS, UK); Nordic Physics Days (Trondheim, Norway); NAM 2015 (RAS, UK)
- 2014** Invited talk: Radio intensity mapping as a new cosmological tool (RAS, UK)  
Invited colloquia (2): Oxford (UK); Oslo (Norway)  
Contributed talks (2): Advancing Astrophysics with SKA (Sicily); Dark Energy Interactions (Stockholm)  
Departmental/group seminars (6): Oslo (Norway); 2 x Perimeter Institute, U. British Columbia (Canada); INAF/OATS Trieste (Italy); LBNL Berkeley (USA)
- 2013** Contributed talk: Synergistic science with Euclid and the SKA (Oxford, UK)  
Departmental/group seminars (2): Johns Hopkins (USA); Manchester (UK)
- 2012** Contributed talk: National Astronomy Meeting 2012, Manchester (UK)  
Departmental/group seminars (10): Helsinki (Finland); Lyon (France); Heidelberg, Bielefeld (Germany); Oslo (Norway); Geneva (Switzerland); Queen Mary (UK); Pittsburgh, Stanford, Berkeley/LBL (USA)
- 2011** Contributed talk: Inhomogeneous Cosmologies Workshop, Jyväskylä (Finland)  
Departmental/group seminars (2): Dalhousie (Canada); Cape Town (S. Africa)

## Teaching experience

- 2020** School of Physics and Astronomy online learning taskforce member (QMUL)
- 2020** *Mathematical Techniques 3*, 2<sup>nd</sup> year, Deputy Module Organiser (QMUL)
- 2019 onwards** Physics with Data Science BSc/MSci programme director (QMUL)
- 2019 onwards** *Physical Cosmology*, 3<sup>rd</sup> year, Lecturer/Module Organiser (QMUL)
- 2019 onwards** *Electric and Magnetic Fields*, 1<sup>st</sup> year, Deputy Module Organiser (QMUL)
- 2019 – 2020** *Physics Lab*, 2<sup>nd</sup> year, Module Organiser (2020) / Deputy Module Organiser (2019) (QMUL)
- 2019** 5x lectures on Cosmo. Perturbation Theory, 20<sup>th</sup> Swieca School on Particles and Fields (Brazil)
- 2016** 3x lectures on radio cosmology, INAF Lucchin summer school (Naples, Italy)
- 2011 – 2013** *Symmetry and Relativity*, 3<sup>rd</sup> year, Tutor (St. Edmund Hall, Oxford)
- 2011 – 2012** *Python for Astrophysicists*, Astrophysics graduate course, short-course lecturer (Oxford)

## Student supervision and mentoring

- 2019 onwards** PhD supervision (2): F. Kennedy (QMUL); C. Guandalin (co-supervision, USP)
- 2014 onwards** Masters supervision (10): R. O. Fauli, M. F. Ivarsen (Oslo); E. McBride (SFSU); B. Cooper-Barnard, A. Dev, T. Murray, T. Oates, A. Reedy, M. Warner (QMUL); K. Malapane (UWC)
- 2016 onwards** Summer student supervision (10): A. Brown, E. Kimura, L. Penafiel (JPL); S. Modak, D. Rocha (Berkeley); K.-H. Chan, P. Pan, R. Pioch, M. Vilatte, R. Xavier (QMUL)
- 2015 – 2016** PhD student co-supervision: M. B. Steen (Oslo)

## Thesis examining

(6 PhD theses; 4 Masters theses)

- 2021 (pending)** M. Foss, PhD examiner, University of Oslo
- 02 Dec 2020** Z. Chen, Masters examiner, University of Manchester
- 19 Mar 2020** L. F. Randrianjanahary, Masters examiner, University of the Western Cape
- 11 Feb 2020** D. Kodwani, PhD examiner, University of Oxford
- 15 Jan 2020** O. H. Moloko, Masters examiner, University of Cape Town
- 23 Dec 2019** Dr D. Sarkar, PhD examiner, IIT Kharagpur

19 Sep 2019	Dr A. Maniyar, PhD examiner, Laboratoire d'Astrophysique de Marseille
22 May 2019	E. McBride, Masters examiner, San Francisco State University
23 Dec 2018	Dr S. Jolicoeur, PhD examiner, University of the Western Cape
07 Sep 2018	Dr A. Obuljen, PhD examiner, SISSA

### Public outreach and media

2019	Quoted in article on Starlink satellites (The Verge)
2015	Interviewed in series of five articles on the SKA in Norwegian (forskning.no) Quoted in articles on BICEP2 (Smithsonian), SKA (CBS, Astronomy Now)
2013	Interview: The Register (news website) Public lectures: BBC Stargazing Live Newbury; Wadham graduate research forum
2012 – 2013	STEM Ambassador (STEMNET/University of Oxford)
2012 – 2013	Co-organiser: Stargazing Oxford space science festival
2012	Interviews: PBS Nova Physics Blog; JodCast (astronomy podcast)
2011 – 2012	Public outreach coordinator for Astrophysics (University of Oxford)

### Public scientific code

I make much of my scientific computer code publicly-available, for the sake of transparency, reproducibility, and to enable others to re-use and build on my work. Recent projects include:

- ◆ **HERA Power Spectrum pipeline (Python):** Code to calculate optimal quadratic estimates of the power spectrum from radio interferometer visibility data (core developer).
- ◆ **Core Cosmology Library (C/Python):** Validated computations of LSST observables (core team).
- ◆ **ghost (Python):** Analytic, probabilistic galaxy-halo model, with mock galaxy catalogue generator.
- ◆ **Commander 2 (Python/C/Fortran):** CMB component separation/full-sky constrained realisations.
- ◆ **RadioFisher (Python):** General, fully-featured Fisher-forecasting code for 21cm intensity mapping.
- ◆ **Bubble (C++/Python):** Background solver and ray-tracer for spherically-symmetric spacetimes.
- ◆ Experienced Python, C/C++, and Fortran 90 programmer. Experience with JavaScript and SQL.
- ◆ Experienced HPC user and developer, including work on complex hybrid MPI and OpenMP codes.

See [www.philbull.com/#code](http://www.philbull.com/#code) for more.

### Open source projects

I was involved in the open source software movement for a decade.

- ◆ **GNOME Documentation Project:** Contributor/member of steering committee. Responsible for designing/writing end user and developer documentation. Coordinated major rewrite in Mallard XML.
- ◆ **Books on Ubuntu Linux:** Co-author of two (related) books on Ubuntu Linux: *Ubuntu for Non Geeks 4th Ed.* (ISBN 978-1593272579) and *Ubuntu Made Easy* (ISBN 978-1593274252), No Starch Press.
- ◆ **GNOME Outreach Programme for Women:** Mentor for two rounds of the outreach programme. Responsible for designing and coordinating documentation projects, and training and pastoral care.