

# Philip James Bull

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Date of Birth: 30th Nov 1987 // Nationality: British

## Research positions

- Oct 2015 –** NASA Postdoctoral Program (NPP) Fellow  
Jet Propulsion Lab. / California Institute of Technology
- May 2013 –** Postdoctoral Fellow, University of Oslo  
**Oct 2015** Institute of Theoretical Astrophysics

## Education and qualifications

- Oct 2010 –** DPhil Astrophysics, University of Oxford  
**Apr 2013** Theoretical cosmology, supervised by Pedro Ferreira and Tim Clifton. Thesis title: “Dark Energy and the Inhomogeneous Universe”.
- 2006 – 2010** MPhys Physics with Astrophysics, University of Manchester  
First class honours, top of class. Specialised in astrophysics/theoretical physics.

## Awards and scholarships

- 2016** NASA Innovative Advanced Concepts proposal “A direct probe of dark energy interactions with a Solar System laboratory”, selected for Phase I Step B study
- 2012** Pollard Fund travel grant (Wadham College, University of Oxford)
- 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)

## Professional activities and collaborations

- 2016** LSST Dark Energy Science Collaboration, member
- 2016** Reviewer, NASA ROSES 2016 review panel
- 2016** JPL Astrophysics Diversity and Best Practices advisory panel
- 2016** SKA Cosmology SWG work package lead: HI galaxy surveys
- 2016** Co-organiser, Unifying tests of GR workshop, Pasadena (July 2016)
- 2016** Discussion session chair, Intensity Mapping workshop, Stanford (Mar 2016)
- 2015** Parallel session chair, UK National Astronomy Meeting (Llandudno, UK)
- 2014 – 2015** Local organiser, Beyond  $\Lambda$ CDM international conference, Oslo (Jan 2015)
- 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 inhomogeneities 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 radio surveys and 21cm intensity mapping
- ◆ Secondary anisotropies and spectral distortions of the CMB as cosmological probes
- ◆ General Relativistic effects on matter inhomogeneities and light propagation
- ◆ Long-range peculiar velocity surveys and tests of gravity using (e.g.) the kinetic SZ effect
- ◆ Bayesian inference, stochastic processes, and computational physics

## Journal articles (published/submitted)

### 2016

23. A Galaxy-Halo Model for Multiple Cosmological Tracers  
P. Bull, MNRAS submitted [1610.08948]
22. Dipolar modulation in the size of galaxies: The effect of Doppler magnification  
C. Bonvin, ..., P. Bull, MNRAS submitted [1610.05946]
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**

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

- 2016**     Departmental/group seminars (6): Heidelberg (Germany); 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); Queen Mary (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 the SKA (Sicily, Italy); Dark Energy Interactions (Stockholm, Sweden)  
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

- 2016**             Summer student supervision: A. Brown (Princeton U.)
- 2016**             3x lectures on radio cosmology, INAF Lucchin summer school (Naples, Italy)
- 2015 – 2016**     PhD student supervision: M. B. Steen (University of Oslo)
- 2014 – 2016**     Masters student supervision: R. O. Fauli; M. F. Ivarsen (University of Oslo)
- 2011 – 2013**     Tutor, “Symmetry and Relativity”, 3rd year physics (St. Edmund Hall, Oxford)
- 2011 – 2012**     Short-course lecturer, “Python for Astrophysicists”, Oxford Astro. Grad. course

## Research visits *(2 weeks or longer)*

- 2015**             Perimeter Institute (Canada)
- 2014**             Perimeter Institute (Canada); Oxford Astrophysics (UK); JPL/Caltech (USA)
- 2013**             JPL/Caltech (USA); Oxford Astrophysics (UK)
- 2012**             Dalhousie University (Canada)
- 2011**             University of Cape Town (S. Africa)

## Public outreach and media

- 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 grad. research forum
- 2012 – 2013** STEM Ambassador (STEMNET/University of Oxford)
- 2012 and 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 and reproducibility, and to enable others to re-use and build on my work. Recent projects include:

- ◆ **ghost (Python)**  
Analytic, probabilistic galaxy-halo model, with mock galaxy catalogue generator.
- ◆ **FIST (Python)**  
CMB Gibbs-sampling code tailored for localised signals (e.g. SZ clusters) on the flat sky.
- ◆ **Commander 2 (Python/C/Fortran)**  
Full-sky CMB component separation code, with high-performance multi-level linear solver for constrained realisations of the CMB.
- ◆ **RadioFisher (Python)**  
General, fully-featured Fisher-forecasting code for 21cm intensity mapping experiments.
- ◆ **Bubble (C++/Python)**  
Background solver and ray-tracer for spherically-symmetric inhomogeneous spacetimes.

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

## Technical computing skills

- ◆ Experienced Python, C/C++, and Fortran 90 programmer.
- ◆ Extensive experience with high-performance computing, including complex hybrid MPI and OpenMP codes, and use of large HPC facilities.
- ◆ Expert in plotting/visualisation with Matplotlib (Python).

## Open source projects

I have been involved in the open source software movement for the past decade. This has exposed me to a variety of interesting ideas and experiences that I often find useful in my scientific work, and has given me valuable experience in working across disciplinary boundaries.

- ◆ **GNOME Documentation Project**  
Contributor/member of steering committee. Responsible for designing, writing, and editing end user and developer documentation. Designed terminology and style guidelines. Coordinated major rewrite in Mallard XML with the introduction of GNOME 3.
- ◆ **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), both with Rickford Grant, and published by No Starch Press, San Francisco.
- ◆ **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 of students.