Philip James Bull

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Research positions

07/2022 onwards	**Reader in Cosmology,** University of Manchester
03/2022 onwards	**Visiting Academic**, Centre for Radio Cosmology, U. Western Cape
02/2022 – 06/2022	**Reader in Cosmology,** Queen Mary University of London
10/2018 – 01/2022	**Lecturer in Cosmology,** Queen Mary University of London
01/2019 – 02/2022	**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)

Grants and funding awarded

2024 – 2027	STFC Early R&D Grant, PI (approx. £598k)
2021 – 2025	ERC Starting Grant, PI (approx. €1.67 million)
2023 – 2024	DiRAC 15th Call HPC allocation (3M CPU-hours)
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 10th Call HPC 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 (selected)

Collaborations: LSST Dark Energy Science Collaboration Publication Board member (2021-23) — LSST DESC Theory and Joint Probes working group co-convener (2018-20) — Member of the HERA collaboration (2017; Executive Board member since 2018) — HERA Statistics working group coordinator (2018-) — LSST Dark Energy Science Collaboration (2016; full member from 2017) — Member of the SKA Cosmology Science Working Group and Core Team (2013-) — SKA Cosmology SWG work package lead: HI galaxy surveys (2016-21) .

Professional activities: UK SKAO Science Committee (2023-) — Fellow of the Higher Education Academy (2021-) — JPL Astrophysics Diversity and Best Practices advisory panel (2016-17) — NASA ROSES 2016 review panel.

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) ORCiD ⓘ arXiv

2024

77. MeerKLASS L-band deep-field intensity maps: entering the HI dominated regime
    MeerKLASS Collaboration, [arXiv:2407.21626]

76. Mitigating calibration errors from mutual coupling with time-domain filtering of 21cm cosmological radio observations
    N. Charles, N. S. Kern, R. Pascua et al. [arXiv:2407.20923]

75. Investigating Mutual Coupling in HERA and Mitigating its Effects on the 21-cm Power Spectrum
    E. Rath, R. Pascua et al., [arXiv:2406.08549]

74. Constraining Post-Newtonian Parameters with the Cosmic Microwave Background
    D. B. Thomas, T. Anton, T. Clifton, **P. Bull** [arXiv:2405.20388]

73. RFI from Radio Navigation Satellite Systems: simulations and comparison to MeerKAT single-dish data
    B. Engelbrecht, M. G. Santos, J. Fonseca et al. [arXiv:2404.17908]

72. Modes of the Dark Ages 21 cm field accessible to a lunar radio interferometer
    P. Bull, C. Guandalin, C. Addis, Phil. Trans. R. Soc. A 382, 20230072 (2024)

71. High-dimensional inference of radio interferometer beam patterns I: Parametric model of the HERA beams
    M. J. Wilensky, J. Burba, **P. Bull** et al. [arXiv:2403.13769]

70. Disentangling the anisotropic radio sky: Fisher forecasts for 21cm arrays
    Z. Zhang, **P. Bull**, K. A. Glasscock, MNRAS 530, 3 (2024)

69. Sensitivity of Bayesian 21 cm power spectrum estimation to foreground model errors
    J. Burba, **P. Bull**, M. J. Wilensky, F. Kennedy, H. Garsden, K. A. Glasscock [arXiv:2403.13767]

68. Statistical estimation of full-sky radio maps from 21cm array visibility data w. Gaussian Constrained Realisations
    K. A. Glasscock, **P. Bull**, J. Burba, H. Garsden, M. J. Wilensky [arXiv:2403.13766]

67. A demonstration of the effect of fringe-rate filtering in the HERA delay power spectrum pipeline
    H. Garsden, **P. Bull**, M. Wilensky et al. [arXiv:2402.08659]

66. Mitigating the effect of 1/f noise on the detection of the HI IM power spectrum from single-dish measurements
    M. O. Irfan, Y. Li, M. G. Santos, **P. Bull**, J. Gu, S. Cunnington, K. Grainge, J. Wang, MNRAS 527, 3 (2024)

2023

65. matvis: A matrix-based visibility simulator for fast forward modelling of many-element 21 cm arrays
    P. Kittiwisit, S. G. Murray, H. Garsden, **P. Bull** et al. [arXiv:2312.09763]

64. Bayesian estimation of cross-coupling and reflection systematics in 21cm array visibility data
    G. Murphy, **P. Bull**, M. G. Santos et al. [arXiv:2312.03697]

63. Direct Optimal Mapping Image Power Spectrum and its Window Functions
    Z. Xu et al. [arXiv:2311.10711]

62. Search for the Epoch of Reionisation with HERA: Upper Limits on the Closure Phase Delay Power Spectrum
    P. M. Keller et al., MNRAS 524, 1 (2023)

61. Foreground transfer function for HI IM signal reconstruction: MeerKLASS and precision cosmology applications
    S. Cunnington, L. Wolz, **P. Bull** et al., MNRAS 523, 2 (2023)

60. Statistical recovery of 21cm visibilities and their PS with Gaussian constrained realisations and Gibbs sampling
    F. Kennedy, **P. Bull**, M. Wilensky, S. Choudhuri, ApJS 266, 23 (2023)

59. Characterization Of Inpaint Residuals In Interferometric Measurements of the Epoch Of Reionization
    M. Pagano et al. MNRAS 520, 4 (2023)

58. What does an interferometer really measure? Including instrument and data characteristics in the reconstruction of the 21cm power spectrum
    A. Gorce et al., MNRAS 520, 1 (2023)

57. Characterizing line-of-sight variability of polarized dust emission with future CMB experiments
   L. McBride, **P. Bull**, B. S. Hensley, MNRAS 519, 3 (2023)

56. HI intensity mapping with MeerKAT: power spectrum detection in cross-correlation with WiggleZ galaxies
   S. Cunnington, Y. Li et al., MNRAS 518, 4 (2023)

55. Bayesian jackknife tests with a small number of subsets: Application to HERA 21cm power spectrum upper limits
   M. J. Wilensky, F. Kennedy, **P. Bull**, J. S. Dillon, HERA Collaboration, MNRAS 518, 4 (2023)

54. Improved Constraints on the 21cm EoR Power Spectrum & X-Ray Heating of the IGM with HERA Phase I Obs.
   HERA Collaboration, ApJ 945, 2 (2023)

2022

53. Direct Optimal Mapping for 21cm Cosmology: A Demonstration with the Hydrogen Epoch of Reionization Array
   Z. Xu et al., ApJ 938, 128 (2022)

52. First Results from HERA Phase I: Upper Limits on the Epoch of Reionization 21 cm Power Spectrum
   HERA Collaboration, ApJ 925, 2 (2022)

51. Validation of the HERA Phase I Epoch of Reionization 21 cm Power Spectrum Software Pipeline
   HERA Collaboration (J. E. Aguirre et al.), ApJ 924, 85 (2022)

50. HERA Phase I Limits on the Cosmic 21cm Signal: Constraints on Astrophysics & Cosmology During the EoR
   HERA Collaboration, ApJ 924, 51 (2022)

49. Measurements of the diffuse Galactic synchrotron spectral index and curvature from MeerKLASS pilot data
   M. O. Irfan, **P. Bull**, M. G. Santos et al., MNRAS 509, 4 (2022)

2021

48. Automated Detection of Antenna Malfunctions in Large-N Interferometers: A Case Study with HERA
   D. Storer et al., Radio Science 57, 007376 (2021)

47. Spin-based removal of instrumental systematics in 21cm intensity mapping surveys
   N. McCallum, D. B. Thomas, **P. Bull**, M. L. Brown, MNRAS 508, 4 (2021)

46. Cleaning foregrounds from single-dish 21cm intensity maps with Kernel Principal Component Analysis
   M. O. Irfan, **P. Bull**, MNRAS 508, 3 (2021)

45. Effects of model incompleteness on the drift-scan calibration of radio telescopes
   HERA Collaboration (B. K. Gehlot et al.), MNRAS 506, 3 (2021)

44. A Real Time Processing System for Big Data in Astronomy: Applications to HERA
   HERA Collaboration (P. La Plante et al.), Astron. Comput. 36 (2021) 100489

43. Methods of Error Estimation for Delay Power Spectra in 21cm Cosmology
   HERA Collaboration (J. Tan et al.), ApJS 255, 26 (2021)

42. Statistical recovery of the BAO scale from multipoles of the beam-convolved 21cm correlation function
   F. Kennedy, **P. Bull**, MNRAS 506, 2 (2021)

41. Patterns of primary beam non-redundancy in close-packed 21cm array observations
   S. Choudhuri, **P. Bull**, H. Garsden, MNRAS 506, 2 (2021)

40. HI intensity mapping with MeerKAT: Calibration pipeline for multi-dish autocorrelation observations
   J. Wang, M.G. Santos, **P. Bull** et al., MNRAS 505, 3 (2021)

39. Searching for dark energy in the matter-dominated era
   P. Bull, M. White, A. Slosar, MNRAS 505, 2 (2021)

38. 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 504, 3 (2021)

37. Observing relativistic features in LSS – I: Multipoles of the power spectrum
   C. Guandalin, J. Adamek, **P. Bull**, C. Clarkson, L.R. Abramo, L. Coates, MNRAS 501, 2 (2021)

36. DAYENU: A Simple Filter of Smooth Foregrounds for Intensity Mapping Power Spectra
   A. Ewall-Wice et al., MNRAS 500, 4 (2021)

35. Understanding the HERA Phase I receiver system with simulations and its impact on the detectability...
   HERA Collaboration (N. Fagnoni et al.), MNRAS 500, 1 (2021)

2020

34. Imaging and Modeling Data from the Hydrogen Epoch of Reionization Array
   HERA Collaboration (C. Carilli et al.), ApJS 247, 2 (2020)

33. Redundant-Baseline Calibration of the Hydrogen Epoch of Reionization Array
    HERA Collaboration (J.S. Dillon et al.), MNRAS 499, 4 (2020)
32. Cosmology with Phase 1 of the Square Kilometre Array; Red Book 2018
    Square Kilometre Array Cosmology Science Working Group, PASA 37, E007 (2020)
31. Fundamental Physics with the Square Kilometre Array
    A. Weltman, **P. Bull**, S. Camera et al., PASA 37, E002 (2020)
30. Absolute Calibration for HERA and Its Impact on the 21cm Power Spectrum
    HERA Collaboration (N.S. Kern et al.), ApJ 890, 122 (2020)
29. Mitigating Internal Instrument Coupling II: A Method Demonstration with HERA
    HERA Collaboration (N.S. Kern et al.), ApJ 888, 70 (2020)

2019

28. The HERA-19 Commissioning Array: Direction-dependent Effects
    HERA Collaboration (S. Kohn et al.), ApJ 882, 58 (2019)
27. Core Cosmology Library: Precision Cosmological Predictions for LSST
    LSST Dark Energy Science Collaboration, ApJS 242, 2 (2019)
26. Testing General Relativity with the Doppler magnification effect
    S. Andrianomena, C. Bonvin, D. Bacon, **P. Bull** et al, MNRAS 488, 3759 (2019)

2018

25. Mitigating complex dust foregrounds in future CMB polarization experiments
    B. Hensley, **P. Bull**, ApJ 853, 127 (2018)
24. Model-independent curvature determination with 21cm intensity mapping experiments
    A. Witzemann, **P. Bull**, C. Clarkson et al. MNRAS Letters 477, 1 (2018)

2017

23. 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)
22. Dipolar modulation in the size of galaxies: The effect of Doppler magnification
    C. Bonvin, …, **P. Bull**, MNRAS 472, 4 (2017)
21. A Galaxy-Halo Model for Multiple Cosmological Tracers
    P. Bull, MNRAS 471, 12 (2017)

2016

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 ΛCDM: 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-α 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); Erratum Phys. Rev. D 87, 129901(E) (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)

White papers etc.

5. Modified Gravity and Dark Energy models Beyond w(z)CDM Testable by LSST
   LSST DESC, M. Ishak, T. Baker, **P. Bull** et al., [1905.09687]

4. Inflation and Early Dark Energy with a Stage II Hydrogen Intensity Mapping experiment
   Cosmic Visions 21 cm Collaboration [1810.09572]

3. Line-Intensity Mapping: 2017 Status Report
   E. Kovetz et al. [1709.09066]

2. MeerKLASS: MeerKAT Large Area Synoptic Survey
   M. Santos (Ed.) et al. [1709.06099]

1. Science Impacts of the SPHEREx All-Sky Optical to Near-Infrared Spectral Survey
   O. Doré, M. W. Werner (Eds.) et al. [1606.07039]

Talks and seminars

2024   Invited speaker: Science with the 21-cm line (Kavli Science Focus Meeting), Cambridge

Contributed talk: SKA Cosmology SWG meeting

2023   Invited plenary speaker: COSMO'23, Madrid

Invited panellist: Astronomy on the Moon, Royal Society

Invited talks (3): SKA Cosmology SWG meeting; RAS Spectral Distortions meeting; Tianlai 21cm Cosmology workshop

Contributed talk: ARGOS project meeting

2022   Invited talks (4): SKA Cosmology SWG meeting; Helsinki; Heidelberg; London Cosmo. Discussion Mtg.

2021   Invited colloquia (3): Oslo; Sussex; SKA India

2020   Invited talk: International Symposium on Physics, UFCG

2019   Invited talk: London Cosmology Discussion Meeting

Departmental/group seminars (3): Sussex, ICG Portsmouth; ENS Paris

2018   Invited talks (3): Berkeley extragalactic modelling workshop; Direct detection of Dark Energy workshop, Caltech; Tremendous Radio Arrays, Brookhaven

Departmental/group seminars (2): Perimeter Institute; Cambridge/DAMTP

2017   Invited plenary talk: Fundamental Physics with the SKA conference, Mauritius

Invited colloquia (2): UC Berkeley, Stanford SITP

Invited talks (4): Berkeley Neutral Hydrogen workshop, Johns Hopkins Intensity Mapping workshop, LBNL Cosmic Visions workshop, JPL DES Modified Gravity workshop

Departmental/group seminars (3): Carnegie Mellon, Stanford, USC

2016   Departmental/group seminars (6): Heidelberg; Caltech, CCA, JPL, U. Penn, Princeton, IAS

Invited talks (3): LSST DESC meeting, Stanford; Future Cosmic Surveys workshop, Chicago; Science for the SKA Generation, Goa

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

2015   Invited colloquium: Oskar Klein Centre

Departmental/group seminars (5): Caltech, JPL, Fermilab; Heidelberg; QMUL

Contributed talks (3): Building an Open UK SKA-Science Consortium, RAS; Nordic Physics Days, Trondheim; NAM 2015

2014   Invited talk: Radio intensity mapping as a new cosmological tool, RAS

Invited colloquia (2): Oxford; Oslo

Contributed talks (2): Advancing Astrophysics with SKA, Sicily; Dark Energy Interactions, Stockholm

Departmental/group seminars (6): Oslo; 2 x Perimeter Institute, U. British Columbia; INAF/OATS Trieste; LBNL Berkeley

2013   Contributed talk: Synergistic science with Euclid and the SKA, Oxford

Departmental/group seminars (2): Johns Hopkins; Manchester

2012	Contributed talk: National Astronomy Meeting 2012, Manchester
	Departmental/group seminars (10): Helsinki; Lyon; Heidelberg, Bielefeld; Oslo; Geneva; Queen Mary ; Pittsburgh, Stanford, Berkeley/LBL
2011	Contributed talk: Inhomogeneous Cosmologies Workshop, Jyväskylä
	Departmental/group seminars (2): Dalhousie; Cape Town

Public outreach and media

2019	Quoted in article on Starlink satellites (The Verge)
2018 – 2022	Public engagement champion for the Astronomy Unit (QMUL)
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)

Thesis examining

PhD examining (12): Dr I. Towler (U. Manchester, 15 May 2024) — Dr R.-M. Weideman (Stellenbosch/Antwerp, 19 Jan 2024) — Dr Z. Zhang (Paris/APC, 12 Oct 2023) — Dr T. Rennie (U. Manchester, 23 Aug 2023) — Dr D. Anstey (U. Cambridge, 3 Oct 2022) — Dr R. Martínez Carrillo (QMUL, 24 Sep 2021) — Dr M. Foss (U. Oslo, 29 Jan 2021) — Dr D. Kodwani (U. Oxford, 11 Feb 2020) — Dr D. Sarkar (IIT Kharagpur, 23 Dec 2019) — Dr A. Maniyar (LAM Marseille, 19 Sep 2019) — Dr S. Jolicoeur (U. Western Cape, 23 Dec 2018) — Dr A. Obuljen (SISSA, 7 Sep 2018).

MSc examining (4): Z. Chen (U. Manchester, 2 Dec 2020) — L. F. Randrianjanahary (U. Western Cape, 19 Mar 2020) — O. H. Moloko (U. Cape Town, 15 Jan 2020) — E. McBride (SFSU, 22 May 2019).

Teaching development

BSc/MSci Physics with Data Science: I led the development of a new undergraduate degree programme at QMUL that launched in 2021 and has been accredited by the IOP. My roles included meeting with stakeholders to establish the goals and structure of the programme, leading the proposal of an overarching topical structure, design of the relevant curricula, formulating the materials and proposal forms, and presenting promotion videos.

Conversion to online/mixed-mode teaching: In 2020, I played a major School-level leadership role in adapting teaching practices to deal with the Covid challenge at QMUL. This included sourcing research on online delivery, and distilling this information into documents and workshops for staff to summarise best practice for remote education. These recommendations were widely adopted, and supported a successful School-wide conversion.

Physics Laboratory overhaul: In 2020, I took over the undergraduate Physics Laboratory module at QMUL. I implemented a scheduling overhaul (rebalancing homework vs lab time), added web-based learning of underlying theoretical concepts, and provided new teaching staff with opportunities to develop their own improvements to delivery. Despite extensive disruption in 2020, student outcomes were good (stable) compared with previous years.

Teaching experience

2024 onwards	Galaxy Formation, 4th year, Lecturer (Manchester)
2022 onwards	1st and 2nd-year small-group physics tutorials (Manchester)
2020	School of Physics and Astronomy online learning taskforce member (QMUL)
2020	Mathematical Techniques 3, 2nd year, Deputy Module Organiser (QMUL)
2019 – 2022	Physics with Data Science BSc/MSci programme director (QMUL)
2019 – 2022	Physical Cosmology, 3rd year, Lecturer/Module Organiser (QMUL)
2019 – 2020	Electric and Magnetic Fields, 1st year, Deputy Module Organiser (QMUL)
2019 – 2020	Physics Lab, 2nd year, Module Organiser (2020) / Deputy MO (2019) (QMUL)

2019	5x lectures on Cosmo. Perturbation Theory, 20th Swieca School (Brazil)
2016	3x lectures on radio cosmology, INAF Lucchin summer school (Naples, Italy)
2011 – 2013	Symmetry and Relativity, 3rd year, Tutor (St. Edmund Hall, Oxford)
2011 – 2012	Python for Astrophysicists, Astrophysics graduate course, short-course lecturer (Oxford)

Advising, mentoring, and student supervision

Postdoc advising (8):
- Zheng Zhang (2023–)
- Jacob Burba (2022–2024; went to Research Scientist position at the UK SKA Regional Centre)
- Carol Guandalin (2022–2023, at QMUL; went to do a postdoc in Edinburgh)
- Mike Wilensky (2021–)
- Mel Irfan (2021–2023; went to Research Scientist position at the University of Cambridge)
- Piyanat Kittiwisit (2021–2023; went to a Research Scientist position at SARAO/UWC)
- Hugh Garsden (2020–2024; went to a Research Scientist position at Jodrell Bank)
- Samir Choudhuri (2019–2022; went to a faculty position at IIT Madras)

PhD supervision (8):
- Sohini Dutta (Manchester 2023–)
- Katrine Glasscock (Manchester 2021–)
- Isabelle Ye (Manchester 2021–)
- Chris Addis (QMUL 2021–, co-supervisor)
- Geoff Murphy (UWC 2021–, co-supervisor)
- Fraser Kennedy (QMUL 2019–)
- Carol Guandalin (USP 2018–2022, co-supervisor; now a postdoc in Edinburgh)
- Mikael B. Steen (Oslo, 2015–2016, co-supervisor; now working in industry)

Masters supervision (15): R. O. Fauli, M. F. Ivarsen (Oslo); E. McBride (SFSU); B. Cooper-Barnard, A. Dev, A. Dragovic, T. Murray, T. Oates, B. Parry, A. Reedy, M. Warner, D. Zografos (QMUL); K. Malapane (UWC); T. Hughes, M. Toal (Manchester)

Summer student supervision (12): A. Brown, E. Kimura, L. Penafiel (JPL); S. Modak. D. Rocha (Berkeley); T. Boyer, K.-H. Chan, P. Pan, R. Pioch, M. Vilatte, R. Xavier (QMUL); M. Wirawan (Manchester)

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:
- **Hydra (Python):** Gibbs sampler for 21cm radio arrays.
- **HERA Power Spectrum pipeline (Python):** Optimal quadratic estimator for radio interferometer data.
- **Core Cosmology Library (C/Python):** Validated computations of LSST observables (core team).
- **FastBox (Python):** Fast approximate simulations of the late-time 21cm intensity field.
- **HERA Sim (Python):** User-friendly wrapper for multiple visibility simulation codes.
- **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 for more.

Open source projects

I was involved in the open source software movement for a decade, and contributed to a number of projects, including the GNOME desktop environment and the Ubuntu project.

- **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.