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Will Handley

Education

2012–2016 **University of Cambridge**, *PhD: Astrophysics*, Prof. A. Lasenby & Prof. M. Hobson.

2008–2012 **University of Cambridge**, *MSci, MA: Natural Sciences*, Gonville & Caius College.

2001–2008 **Alleyn's School**, *A levels, GCSEs*, London.

Research Experience

2016–present **Research fellow**, *Gonville & Caius College*, University of Cambridge.
Funded by Gonville & Caius College and an STFC IPS grant.

Jul-Sep 2016 **Postdoctoral researcher**, *Prof. H. Peiris*, University College London.
Searching for features in the primordial power spectrum.

2012–2016 **PhD: Astrophysics**, *Prof. A. Lasenby & Prof. M. Hobson*, University of Cambridge.
Kinetic initial conditions for inflation: Theory, observations & methods.

2011–2012 **Part III Dissertation**, *Prof. P. Alexander*, University of Cambridge.
Investigating the origins of cosmic magnetism.

Summer 2011 **Summer Research Student**, *Prof. M. Faulkes & Dr. J. Spencer*, Imperial College.
Folded spectrum full configuration interaction quantum Monte Carlo.

Summer 2011 **Summer Research Student**, *Dr. R. Blumenfeld*, University of Cambridge.
Geometry and field equations of granular systems.

2010–2011 **Research Review**, *Prof. S. Gull*, University of Cambridge.
Literature Survey of the Physics-Philosophy crossover field of measurement theory.

Summer 2010 **iGEM Team Physicist**, *Dr. J. Haseloff*, University of Cambridge.
E-glowli 2010 iGEM team (placed in final 6) http://2010.igem.org/Team:Cambridge

Awards & Prizes

Jul. 2019	Guiseppe and Vanna Cocconi Prize (WMAP and Planck)	*EPS-HEPP Division*
Jun. 2018	Gruber Prize (Planck)	*Gruber Foundation*
Dec. 2013	Best presentation	*Cavendish grad. students conference*
Jun. 2012	Best theoretical part III project	*University of Cambridge*
	Physics prize	*Gonville & Caius College*
Summer 2011	Undergraduate Research Bursary	*Nuffield Foundation*
	UROP Studentship	*Imperial College*
Summer 2010	iGEM Studentship	*Wellcome Trust*
2009–12	Junior and Senior Scholarships	*Gonville & Caius College*

Teaching

2017-present	Bayesian Statistics	*Graduate lecture course*
2013–2018	Part II Physics: General relativity	*Supervising*

2012–2017	Part IA Mathematics for NatSci	*Supervising, Tripos classes*
2013	Part II Theoretical Physics 1 & 2	*Demonstrating*
2006–2012	Maths and Science Tuition	*Individual coaching, key stage 1 — STEP*

Supervision of graduate students and postdoctoral fellows

Postdoc	Kamran Javid	*2018-2019*
PhD	Ian Roque, Harry Bevins	*2019-present*
	Dominic Anstey	*2018-present*
	Lukas Hergt, Fruzsina Agocs, Will Barker	*2017-present*
	Ed Higson	*2016-2017*
Masters	Tom Gessey-Jones, Aleks Petrosyan, Ayngaran Thavanesan, Emma Shen	*2019-present*
	Deaglan Bartlet, Jamie Bamber, Ian Roque	*2018-2019*
	Ward Haddadin, Jessica Rigley, Panagiotis Mavrogiannis	*2017-2018*
	Fruzsina Agocs, Robert Knighton, Stephen Pickman, Daniel Manela	*2016–2017*
Summer	Denis Werth, Maxime Jabarian, Liam Lau	*2019*
	Elizabeth Guest, Ward Haddadin, Shu-Fan Chen	*2018*

Grants won

£225,000	**STFC IPS 2019**, *PolyChord and Bayesian sparse facial recognition*.
£42,000	**STFC IAA 2018**, *PolyChord and Bayesian Neural network facial recognition*.
£25,000	**STFC IAA 2016**, *Interfacing PolyChord 2.0*.
£15,000	**KICC Workshop 2019**, *AstroHackWeek 2019*.
$6,000 AUS	**George Southgate Visiting Fellowship 2020**, *GAMBIT visit*.
£2,000	**KICC visitors 2019**, *Likelihood free inference workshop*.
£2,000	**KICC visitors 2017**, *Class and MontePython workshop*.
£1,800	**Caius + Kavli**, *Summer 2019 student funding*.
£1,500	**King's + Kavli**, *Summer 2018 student funding*.

Academic Talks

Feb. 2020	**Nested Sampling: an efficient and robust Bayesian inference tool for physics and machine learning**, *Physics Colloquium*, Adelaide, Australia.
Jan. 2020	**Nested Sampling: an efficient and robust Bayesian inference tool for astrophysics and cosmology**, Oxford, UK.
Jan. 2020	**PolyChord: next generation nested sampling**, *Mathematical Challenges in the Electromagnetic Environment*, DAMTP, Cambridge, UK.
Dec. 2019	**Quantised primordial power spectra**, *Texas 2019*, Portsmouth, UK.
Nov. 2019	**Nested Sampling: an efficient and robust Bayesian inference tool for Machine Learning and Data Science**, *CDT talk*, Cambridge, UK.
Aug. 2019	**Curvature tension: evidence for a closed universe(?)**, ICG Portsmouth, UK.
Jul. 2019	**Quantifying cosmological tensions**, University College London, UK.
Jun. 2019	**Likelihood free inference**, *GAMBIT X*, Germany.
Mar. 2019	**Compromise-free Bayesian sparse reconstruction**, *LFI workshop*, Flatiron institute, US.
Dec. 2018	**Inflation, curvature and kinetic dominance**, *Future uses of Planck data*, ESAC, Spain.
Nov. 2018	**BAMBI Resurrection: Blind Accelerated Multimodal Bayesian Inference**, *Dark Machines*, Worldwide.

Nov. 2018 **Nested Sampling: an efficient and robust Bayesian inference tool for cosmology and particle physics**, *Dark Machines*, Worldwide.

Oct. 2018 **Bayesian Statistics**, *Third Asterics-Obelics workshop*, Cambridge, UK.

May. 2018 **Planck, inflation and the future of inflationary constraints**, *Consistency of Cosmological Datasets*, Cambridge, UK.

May. 2018 **MaxEnt priors with derived parameters in a specified distribution**, Cambridge, UK.

May. 2018 **Nested Sampling: an efficient and robust Bayesian inference tool for astrophysics and cosmology**, ICIC, UK.

April. 2018 **Introduction to statistics**, *CosmoTools 18*, RWTH Aachen, Germany.

Jan. 2018 **Advances in Nested Sampling & astrophysical application**, Cambridge, UK.

Aug. 2017 **PolyChord 2.0: Fast inference & nested sampling**, *Cosmo17*, Paris, France.

Jun. 2017 **Modern Bayesian Inference: Theory and Practice**, RWTH Aachen, Germany.

Mar. 2017 **Parameter estimation and Model comparison**, *CosmoTools 17*, Madrid, Spain.

Feb. 2017 **PolyChord 2.0: Advances in Nested Sampling & astrophysical application**, Flatiron institute, US.

Sep. 2016 **PolyChord 2.0 & the future of nested sampling**, University College London, UK.

May. 2016 **PolyChord 2.0 & the future of nested sampling**, University of Sussex, UK.

Mar. 2016 **PolyChord & the future of nested sampling**, Edinburgh, UK.

Dec. 2015 **PolyChord: next generation nested sampling**, Max Planck Institute, Germany.

Feb. 2015 **PolyChord: next generation nested sampling**, University of Sussex, UK.

Dec. 2013 **Kinetic dominance in the pre-inflationary universe**, Cavendish grad. conference.

Selected Outreach

Over the course of my career I have given 19 public outreach talks including:

May 2015 **Intro. to Astronomy: Beyond the Milky Way**, *IoA Public Talk*, Cambridge.

May 2015 **To infinity and beyond: Dark Energy**, *Pint of Science*, Cambridge Brewhouse.

Feb 2014 **The Physics of Juggling**, *CCPE*, Cavendish Laboratory.

Jan 2014 **The first 3 yocto-pico seconds**, *Three minute wonder*, Cavendish Laboratory.

Institutional responsibilities

2020–present	Convener of CosmoBit	*GAMBIT*
2020–present	Leader of data analysis team	*REACH*
2017–present	Organiser of weekly group seminars	*Cavendish astrophysics group*
2019	Gonville & Caius college council	*Gonville & Caius college*
2018–2020	Investments committee	*Gonville & Caius college*
2018–2020	Education and research committee	*Gonville & Caius college*
2016–2019	Undergraduate Admissions	*Gonville & Caius college*

Examination

Sep 2020 **Machine Learning Applied to Gaia and Other Survey Data: Applications Supporting a Polarisation Survey**, *Kyriakos Stylianiopoulos*, MPhil.

Organisation of scientific meetings

2020	Scientific organising committee member of 3rd Global 21-cm Workshop	*KICC*
2019	Local organising committee member of KICC 10th anniversary symposium	*KICC*
2019	Secured funding for Likelihood free inference workshop (currently organising)	*KICC*

2019	Helped secure funding and organised AstroHack week 2019	*KICC*
2018	Secured funding for and organised CLASS+MontePython software workshop	*KICC*

Peer review

Performed 46 reviews for journals including Physical Review D and Physical Review Letters;
`https://publons.com/researcher/1596769/will-handley/peer-review/`
PRD (27), PLB (4), PRL (4), MNRAS (3), JCAP (5). JOSS (1), Entropy (2)

Collaborations

2018–present	REACH	*www.mrao.cam.ac.uk/research/research-projects/reach*
2018–present	GAMBIT	*gambit.hepforge.org*
2018–present	DarkMachines	*darkmachines.org*
2017–2018	Terra Hunter Experiment	*terrahunting.org*
2016–2017	CORE	*core-mission.org*
2015–2016	AMI	*www.mrao.cam.ac.uk/research/research-projects/AMI*
2015–2019	Planck	*cosmos.esa.int/web/planck*

Software

PolyChord	Sole author and maintainer: github.com/PolyChord/PolyChordLite
pyBAMBI	Team maintainer: github.com/DarkMachines/pyBAMBI
anesthetic	Sole author and maintainer: github.com/williamjameshandley/anesthetic
fgivenx	Sole author and maintainer: github.com/williamjameshandley/fgivenx
primordial	Sole author and maintainer: github.com/williamjameshandley/primordial
ModeCode	Maintainer: modecode.org
MultiNest	Maintainer: github.com/farhanferoz/MultiNest
Open source	scipy: Weighted kernel density estimation in scipy.stats.gaussian_kde
	matplotlib: Vertical slider in matplotlib.widgets.Slider

Interaction with industry

PolyChord	Founded start-up company PolyChord Ltd. to bring Bayesian methods & tools from cosmology to Machine Learning & Biotech industries: polychord.co.uk
AnyVision	Working collaboratively as part of STFC grant to apply Bayesian sparse reconstruction to facial recognition
Shell	Work with department postdocs in the department applying nested sampling to geophysics
CMAM	Consult for local finance company on Bayesian algorithmic trading

Computer skills

Programming	MPI parallelisation, C++, FORTRAN, Mathematica, Maple, Python
Computing	Unix, Bash, zsh, vim, git, svn, LaTeX, Ti*k*Z, VMs, CI
OS	Arch Linux & HPC supercomputing (Experienced), Windows & OSX (Familiar)

References

Prof. Anthony Lasenby, +44 (0)1223 337293/4, a.n.lasenby@mrao.cam.ac.uk,
Prof. Mike Hobson, +44 (0)1223 339992, mph@mrao.cam.ac.uk
Prof. Hiranya Peiris, +44 (0)203 5495831, h.peiris@ucl.ac.uk
Prof. Alan Heavens, +44 (0)207 5942930, a.heavens@imperial.ac.uk

Publications

First Author Publications

[1] **Will Handley** and Pablo Lemos. Quantifying the global parameter tensions between ACT, SPT and Planck. *arXiv*, 2007.08496, July 2020.
[2] **Will Handley**. Curvature tension: evidence for a closed universe. *arXiv*, 1908.09139, August 2019.
[3] **Will J. Handley**, Anthony N. Lasenby, Hiranya V. Peiris, and Michael P. Hobson. Bayesian inflationary reconstructions from Planck 2018 data. *PRD*, 100(10):103511, November 2019.
[4] **Will Handley**. Primordial power spectra for curved inflating universes. *PRD*, 100(12):123517, July 2019.
[5] **Will Handley** and Pablo Lemos. Quantifying tensions in cosmological parameters: Interpreting the DES evidence ratio. *PRD*, 100(4):043504, August 2019.
[6] **Will Handley** and Pablo Lemos. Quantifying dimensionality: Bayesian cosmological model complexities. *PRD*, 100(2):023512, July 2019.
[7] **Will Handley**, Anthony Lasenby, and Mike Hobson. Logolinear series expansions with applications to primordial cosmology. *PRD*, 99(12):123512, June 2019.
[8] **Will Handley**. anesthetic: nested sampling visualisation. *JOSS*, 4:1414, May 2019.
[9] **Will Handley** and Marius Millea. Maximum-Entropy Priors with Derived Parameters in a Specified Distribution. *Entropy*, 21(3):272, March 2019.
[10] **Will Handley**. fgivenx: A Python package for functional posterior plotting. *JOSS*, 3(28):849, August 2018.
[11] **W. J. Handley**, A. N. Lasenby, and M. P. Hobson. The Runge-Kutta-Wentzel-Kramers-Brillouin Method. *arXiv*, 1612.02288, December 2016.
[12] **W. J. Handley**, A. N. Lasenby, and M. P. Hobson. Novel quantum initial conditions for inflation. *PRD*, 94(2):024041, July 2016.
[13] **W. J. Handley**, M. P. Hobson, and A. N. Lasenby. POLYCHORD: next-generation nested sampling. *MNRAS*, 453(4):4384–4398, November 2015.
[14] **W. J. Handley**, M. P. Hobson, and A. N. Lasenby. polychord: nested sampling for cosmology. *MNRAS*, 450:L61–L65, June 2015.
[15] **W. J. Handley**, S. D. Brechet, A. N. Lasenby, and M. P. Hobson. Kinetic initial conditions for inflation. *PRD*, 89(6):063505, March 2014.

Other publications

[16] H. T. J. Bevins, **W. J. Handley**, A. Fialkov, E. de Lera Acedo, L. J. Greenhill, and D. C. Price. maxsmooth: Rapid maximally smooth function fitting with applications in Global 21-cm cosmology. *arXiv*, 2007.14970, July 2020.
[17] Kamran Javid, **Will Handley**, Mike Hobson, and Anthony Lasenby. Compromise-free Bayesian neural networks. *arXiv*, 2004.12211, April 2020.
[18] F. J. Agocs, M. P. Hobson, **W. J. Handley**, and A. N. Lasenby. Dense output for highly oscillatory numerical solutions. *arXiv*, 2007.05013, July 2020.
[19] F. J. Agocs, L. T. Hergt, **W. J. Handley**, A. N. Lasenby, and M. P. Hobson. Quantum initial conditions for inflation and canonical invariance. *PRD*, 102(2):023507, July 2020.
[20] Jamie Bamber and **Will Handley**. Beyond the Runge-Kutta-Wentzel-Kramers-Brillouin method. *PRD*, 101(4):043517, February 2020.
[21] F. J. Agocs, **W. J. Handley**, A. N. Lasenby, and M. P. Hobson. Efficient method for solving highly oscillatory ordinary differential equations with applications to physical systems. *Physical Review Research*, 2(1):013030, January 2020.
[22] L. T. Hergt, **W. J. Handley**, M. P. Hobson, and A. N. Lasenby. Constraining the kinetically dominated universe. *PRD*, 100(2):023501, July 2019.
[23] L. T. Hergt, **W. J. Handley**, M. P. Hobson, and A. N. Lasenby. Case for kinetically dominated initial conditions for inflation. *PRD*, 100(2):023502, July 2019.
[24] W. E. V. Barker, A. N. Lasenby, M. P. Hobson, and W. J. Hand ley. Mapping Poincaré cosmology to Horndeski theory for emergent dark energy. *arXiv*, 2006.03581, June 2020.
[25] W. E. V. Barker, A. N. Lasenby, M. P. Hobson, and **W. J. Handley**. Addressing H_0 tension with emergent dark radiation in unitary gravity. *arXiv*, 2003.02690, March 2020.
[26] W. E. V. Barker, A. N. Lasenby, M. P. Hobson, and W. J. Hand ley. Static energetics in gravity. *JMAP*, 60(5):052504, May 2019.
[27] W. I. J. Haddadin and **W. J. Handley**. Rapid numerical solutions for the Mukhanov-Sazaki equation. *arXiv*, 1809.11095, September 2018.
[28] Edward Higson, **Will Handley**, Michael Hobson, and Anthony Lasenby. Bayesian sparse reconstruction: a brute-force approach to astronomical imaging and machine learning. *MNRAS*, 483(4):4828–4846, March 2019.
[29] Edward Higson, **Will Handley**, Michael Hobson, and Anthony Lasenby. NESTCHECK: diagnostic tests for nested sampling calculations. *MNRAS*, 483(2):2044–2056, February 2019.
[30] Edward Higson, **Will Handley**, Mike Hobson, and Anthony Lasenby. Dynamic nested sampling: an improved algorithm for parameter estimation and evidence calculation. *Statistics and Computing*, 29(5):891–913, September 2019.
[31] Edward Higson, **Will Handley**, Mike Hobson, and Anthony Lasenby. Sampling Errors in Nested Sampling Parameter Estimation. *Bayesian Analysis*, 13(3):873–896, March 2018.

[32] S. Hee, J. A. Vázquez, **W. J. Handley**, M. P. Hobson, and A. N. Lasenby. Constraining the dark energy equation of state using Bayes theorem and the Kullback-Leibler divergence. *MNRAS*, 466(1):369–377, April 2017.
[33] S. Hee, **W. J. Handley**, M. P. Hobson, and A. N. Lasenby. Bayesian model selection without evidences: application to the dark energy equation-of-state. *MNRAS*, 455(3):2461–2473, January 2016.
[34] Andrew Fowlie, **Will Handley**, and Liangliang Su. Nested sampling cross-checks using order statistics. *arXiv*, 2006.03371, June 2020.
[35] Pablo Lemos, Fabian Köhlinger, **Will Handley**, Benjamin Joachimi, Lorne Whiteway, and Ofer Lahav. Quantifying Suspiciousness within correlated data sets. *MNRAS*, 496(4):4647–4653, June 2020.
[36] F. Lienhard, D. Queloz, M. Gillon, A. Burdanov, L. Delrez, E. Ducrot, **W. Handley**, E. Jehin, C. A. Murray, A. H. M. J. Triaud, E. Gillen, A. Mortier, and B. V. Rackham. Global Analysis of the TRAPPIST Ultra-Cool Dwarf Transit Survey. *MNRAS*, July 2020.
[37] Richard D. Hall, Samantha J. Thompson, **Will Handley**, and Didier Queloz. On the Feasibility of Intense Radial Velocity Surveys for Earth-Twin Discoveries. *MNRAS*, 479(3):2968–2987, September 2018.
[38] A. J. K. Chua, S. Hee, **W. J. Handley**, E. Higson, C. J. Moore, J. R. Gair, M. P. Hobson, and A. N. Lasenby. Towards a framework for testing general relativity with extreme-mass-ratio-inspiral observations. *MNRAS*, 478(1):28–40, July 2018.
[39] Gong-Bo Zhao, Marco Raveri, Levon Pogosian, Yuting Wang, Robert G. Crittenden, **Will J. Handley**, Will J. Percival, Florian Beutler, Jonathan Brinkmann, Chia-Hsun Chuang, Antonio J. Cuesta, Daniel J. Eisenstein, Francisco-Shu Kitaura, Kazuya Koyama, Benjamin L'Huillier, Robert C. Nichol, Matthew M. Pieri, Sergio Rodriguez-Torres, Ashley J. Ross, Graziano Rossi, Ariel G. Sánchez, Arman Shafieloo, Jeremy L. Tinker, Rita Tojeiro, Jose A. Vazquez, and Hanyu Zhang. Dynamical dark energy in light of the latest observations. *Nature Astronomy*, 1:627–632, August 2017.
[40] Clare Rumsey, Malak Olamaie, Yvette C. Perrott, Helen R. Russell, Farhan Feroz, Keith J. B. Grainge, **Will J. Handley**, Michael P. Hobson, Richard D. E. Saunders, and Michel P. Schammel. AMI observations of 10 CLASH galaxy clusters: SZ and X-ray data used together to determine cluster dynamical states. *MNRAS*, 460(1):569–589, July 2016.
[41] James S. Spencer, Nick S. Blunt, Seonghoon Choi, Jiri Etrych, Maria-Andreea Filip, W. M. C. Foulkes, Ruth S. T. Franklin, **Will J. Handley**, Fionn D. Malone, Verena A. Neufeld, Roberto Di Remigio, Thomas W. Rogers, Charles J. C. Scott, James J. Shepherd, William A. Vigor, Joseph Weston, RuQing Xu, and Alex J. W. Thom. The HANDE-QMC project: open-source stochastic quantum chemistry from the ground state up. *Journal of Chemical Theory and Computation*, 15(3):1728–1742, January 2019.

CORE Collaboration

[42] Exploring cosmic origins with CORE: Survey requirements and mission design. *JCAP*, 2018(4):014, April 2018.
[43] Exploring cosmic origins with CORE: The instrument. *JCAP*, 2018(4):015, April 2018.
[44] Exploring cosmic origins with CORE: Inflation. *JCAP*, 2018(4):016, April 2018.
[45] Exploring cosmic origins with CORE: Cosmological parameters. *JCAP*, 2018(4):017, April 2018.
[46] Exploring cosmic origins with CORE: Gravitational lensing of the CMB. *JCAP*, 2018(4):018, April 2018.
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[49] Exploring cosmic origins with CORE: Effects of observer peculiar motion. *JCAP*, 2018(4):021, April 2018.
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Planck Collaboration

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[53] Planck 2015 results. XX. Constraints on inflation. *A&A*, 594:A20, September 2016.
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[56] Planck 2018 results. III. High Frequency Instrument data processing and frequency maps. *arXiv*, 1807.06207, July 2018.
[57] Planck 2018 results. IV. Diffuse component separation. *arXiv*, 1807.06208, July 2018.
[58] Planck 2018 results. V. CMB power spectra and likelihoods. *arXiv*, 1907.12875, July 2019.
[59] Planck 2018 results. VI. Cosmological parameters. *arXiv*, 1807.06209, July 2018.
[60] Planck 2018 results. VII. Isotropy and Statistics of the CMB. *arXiv*, 1906.02552, June 2019.
[61] Planck 2018 results. VIII. Gravitational lensing. *arXiv*, 1807.06210, July 2018.
[62] Planck 2018 results. IX. Constraints on primordial non-Gaussianity. *arXiv*, 1905.05697, May 2019.
[63] Planck 2018 results. X. Constraints on inflation. *arXiv*, 1807.06211, July 2018.
[64] Planck 2018 results. XI. Polarized dust foregrounds. *arXiv*, 1801.04945, January 2018.
[65] Planck 2018 results. XII. Galactic astrophysics using polarized dust emission. *arXiv*, 1807.06212, July 2018.
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