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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**, *MSc, 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.

Jul-Sep 2016 **Postdoctoral research fellow**, *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

July. 2019	Guiseppe and Vanna Cocconi Prize (shared with WMAP and Planck)	*EPS-HEPP Division*
Jun. 2018	Gruber Prize (shared with 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-present*
PhD	Ed Higson, Lukas Hergt, Fruzsina Agocs, Will Barker	*2016-present*
Masters	Deaglan Bartlet, Jamie Bamber	*2018-present*
	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*.

£2,000 **KICC visitors 2019**, *Likelihood free inference workshop*.

£15,000 **KICC Workshop 2019**, *AstroHack week 2019*.

£1,500 **King's + Kavli**, *Summer 2018 student funding*.

£42,000 **STFC IAA 2018**, *PolyChord and Bayesian Neural network facial recognition*.

£2,000 **KICC visitors 2017**, *Class and MontePython workshop*.

£25,000 **STFC IAA 2016**, *Interfacing PolyChord 2.0*.

Academic Talks

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

Institutional responsibilities

2017–present	Organiser of weekly group seminars	*Cavendish astrophysics group*
2019–present	Gonville & Caius college council	*Gonville & Caius college*
2018–present	Investments committee	*Gonville & Caius college*
2018–present	Education and research committee	*Gonville & Caius college*
2016–present	Undergraduate Admissions	*Gonville & Caius college*

Organisation of scientific meetings

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 for AstroHack week 2019 (currently helping organise)	*KICC*
2018	Secured funding for and organised CLASS+MontePython software workshop	*KICC*

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–present	Terra Hunter Experiment	*terrahunting.org*
2016–2017	CORE	*core-mission.org*
2015–2016	AMI	*www.mrao.cam.ac.uk/research/research-projects/AMI*
2015–2018	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

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**. The primordial power spectrum of curved inflating universes. *In Preparation*, Jun 2019.
[2] **Will Handley** and Justin Alsing. Compromise-free likelihood-free inference. *In Preparation*, Jul 2019.
[3] **Will Handley**, A. Lasenby, H. Peiris, and M Hobson. Bayesian inflationary reconstructions from Planck 2018 data. *Awaiting likelihood release*, Jun 2019.
[4] **Will Handley**. anesthetic: nested sampling visualisation. *JOSS*, 4(37), Jun 2019.
[5] **Will Handley** and Pablo Lemos. Quantifying dimensionality: Bayesian cosmological model complexities. *arXiv*, 1903.06682, Mar 2019.
[6] **Will Handley** and Pablo Lemos. Quantifying tension: interpreting the DES evidence ratio. *arXiv*, 1902.04029, Feb 2019.
[7] **Will Handley**, Anthony Lasenby, and Mike Hobson. Kinetically dominated curved universes: Logolinear series expansions. *arXiv*, 1901.07540, Jan 2019.
[8] **Will Handley** and Marius Millea. Maximum-Entropy Priors with Derived Parameters in a Specified Distribution. *Entropy*, 21(3):272, Mar 2019.
[9] **Will Handley**. fgivenx: A Python package for functional posterior plotting. *JOSS*, 3(28):849, Aug 2018.
[10] **W. J. Handley**, A. N. Lasenby, and M. P. Hobson. The Runge-Kutta-Wentzel-Kramers-Brillouin Method. *arXiv*, 1612.02288, Dec 2016.
[11] **W. J. Handley**, A. N. Lasenby, and M. P. Hobson. Novel quantum initial conditions for inflation. *PRD*, 94(2):024041, Jul 2016.
[12] **W. J. Handley**, M. P. Hobson, and A. N. Lasenby. POLYCHORD: next-generation nested sampling. *MNRAS*, 453(4):4384–4398, Nov 2015.
[13] **W. J. Handley**, M. P. Hobson, and A. N. Lasenby. polychord: nested sampling for cosmology. *MNRAS*, 450:L61–L65, Jun 2015.
[14] **W. J. Handley**, S. D. Brechet, A. N. Lasenby, and M. P. Hobson. Kinetic initial conditions for inflation. *PRD*, 89(6):063505, Mar 2014.

Supervised Student Publications

[15] F. A. Agocs, **W. J. Handley**, M. P. Hobson, and A. N. Lasenby. An efficient method for solving highly oscillatory ordinary differential equations with applications to physical systems. *In preparation*, Jun 2019.
[16] L. T. Hergt, **W. J. Handley**, M. P. Hobson, and A. N. Lasenby. Constraining the kinetically dominated Universe. *arXiv*, 1809.07737, Sep 2018.
[17] L. T. Hergt, **W. J. Handley**, M. P. Hobson, and A. N. Lasenby. A case for kinetically dominated initial conditions for inflation. *arXiv*, 1809.07185, Sep 2018.
[18] William E V Barker, Anthony N Lasenby, Michael P Hobson, and **William J Handley**. Static energetics in gravity. *arXiv*, 1811.09844, Nov 2018.
[19] W. I. J. Haddadin and **W. J. Handley**. Rapid numerical solutions for the Mukhanov-Sazaki equation. *arXiv*, 1809.11095, Sep 2018.
[20] 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, Mar 2019.
[21] Edward Higson, **Will Handley**, Michael Hobson, and Anthony Lasenby. NESTCHECK: diagnostic tests for nested sampling calculations. *MNRAS*, 483(2):2044–2056, Feb 2019.
[22] Edward Higson, **Will Handley**, Mike Hobson, and Anthony Lasenby. Dynamic nested sampling: an improved algorithm for parameter estimation and evidence calculation. *arXiv*, 1704.03459, Apr 2017.
[23] Edward Higson, **Will Handley**, Mike Hobson, and Anthony Lasenby. Sampling Errors in Nested Sampling Parameter Estimation. *Bayesian Analysis*, 13(3):873–896, Mar 2018.

[24] 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, Apr 2017.
[25] 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, Jan 2016.

Collaboration Publications

[26] 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, Sep 2018.
[27] 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, Jul 2018.
[28] 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, Aug 2017.
[29] 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, Jul 2016.
[30] 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. *arXiv*, 1811.11679, Nov 2018.

CORE Collaboration

[31] Exploring cosmic origins with CORE: Survey requirements and mission design. *JCAP*, 2018(4):014, Apr 2018.
[32] Exploring cosmic origins with CORE: The instrument. *JCAP*, 2018(4):015, Apr 2018.
[33] Exploring cosmic origins with CORE: Inflation. *JCAP*, 2018(4):016, Apr 2018.
[34] Exploring cosmic origins with CORE: Cosmological parameters. *JCAP*, 2018(4):017, Apr 2018.
[35] Exploring cosmic origins with CORE: Gravitational lensing of the CMB. *JCAP*, 2018(4):018, Apr 2018.
[36] Exploring cosmic origins with CORE: Cluster science. *JCAP*, 2018(4):019, Apr 2018.
[37] Exploring cosmic origins with CORE: Extragalactic sources in CMB maps. *JCAP*, 2018(4):020, Apr 2018.
[38] Exploring cosmic origins with CORE: Effects of observer peculiar motion. *JCAP*, 2018(4):021, Apr 2018.
[39] Exploring cosmic origins with CORE: Mitigation of systematic effects. *JCAP*, 2018(4):022, Apr 2018.
[40] Exploring cosmic origins with CORE: B-mode component separation. *JCAP*, 2018(4):023, Apr 2018.

Planck Collaboration

[41] Planck 2018 results. I. Overview and the cosmological legacy of Planck. *arXiv*, 1807.06205, Jul 2018.
[42] Planck 2018 results. II. Low Frequency Instrument data processing. *arXiv*, 1807.06206, Jul 2018.
[43] Planck 2018 results. III. High Frequency Instrument data processing. *arXiv*, 1807.06207, Jul 2018.
[44] Planck 2018 results. IV. Diffuse component separation. *arXiv*, 1807.06208, Jul 2018.
[45] Planck 2018 results. V. Likelihoods. *In preparation*, Jun 2019.
[46] Planck 2018 results. VI. Cosmological parameters. *arXiv*, 1807.06209, Jul 2018.
[47] Planck 2018 results. VII. Isotropy and Statistics. *In preparation*, Jun 2019.
[48] Planck 2018 results. VIII. Gravitational lensing. *arXiv*, 1807.06210, Jul 2018.
[49] Planck 2018 results. IX. Constraints on primordial non-Gaussianity. *arXiv*, 1905.05697, May 2019.
[50] Planck 2018 results. X. Constraints on inflation. *arXiv*, 1807.06211, Jul 2018.
[51] Planck 2018 results. XI. Polarized dust foregrounds. *arXiv*, 1801.04945, Jan 2018.
[52] Planck 2018 results. XII. Galactic astrophysics using polarized dust emission. *arXiv*, 1807.06212, Jul 2018.
[53] Planck intermediate results. LIII. Detection of velocity dispersion from the kinetic Sunyaev-Zeldovich effect. *A&A*, 617:A48, Sep 2018.
[54] Planck intermediate results. LIV. The Planck multi-frequency catalogue of non-thermal sources. *A&A*, 619:A94, Nov 2018.
[55] Planck 2015 results. I. Overview of products and scientific results. *A&A*, 594:A1, Sep 2016.
[56] Planck 2015 results. XX. Constraints on inflation. *A&A*, 594:A20, Sep 2016.