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Dr. Will Barker

Employment

2021 **Rosamund Chambers Junior Research Fellow (JRF) in Astrophysics**, *Girton College, Cambridge, Cavendish Astrophysics Group, Kavli Institute for Cosmology, Cambridge*

2021 **[concurrently] College Lecturer in Astrophysics**, *Girton College, Cambridge*

2021 **[concurrently] Part-time guest**, *Lorentz Institute, Leiden University*

Education

2017–2021 **Ph.D. Theoretical Physics: "Gauge theories of gravity"**, *Wolfson College, Cambridge, Cavendish Astrophysics Group, Kavli Institute for Cosmology, Cambridge*

- Advisors: Prof. A. N. Lasenby (principal), Prof. M. P. Hobson & Dr. W. J. Handley
- Examiners: Prof. A. D. Challinor (internal) & Dr. T. Złośnik (external)

2016–2017 **M.Sc. Master of Natural Sciences**, *Queens' College, Cambridge*, **1st/(4.0 GPA)**

- Natural Science Tripos Part III:, Quantum field theory, Gauge field theory, Particle physics, Relativistic astrophysics & cosmology, Formation of structure in the universe, General physics
- Dissertation: Pushing electrons in one dimension

2013–2016 **BA Bachelor of Arts**, *Queens' College, Cambridge*, **1st/(4.0 GPA)**

- Natural Science Tripos Part II:, Theoretical physics 1 & 2, Relativity, Thermal & statistical physics, Advanced quantum physics, Optics & electrodynamics, Astrophysical fluid dynamics, Particle & nuclear physics, Quantum condensed matter physics, Research review
- Natural Science Tripos Part IB:, Physics A, Physics B, Mathematics
- Natural Science Tripos Part IA:, Mathematics, Physics, Materials science, Earth science

2011–2013 **School**, *Truro and Penwith College*, **A-Level: 3A*, As-Level: 4A, GCSE: 10A***

Awards and funding

2021/11 **2021 Abdus Salam Prize in Theoretical Physics**

2021/06 **Secured 1,800€ funding**, *Delta ITP Ph.D. visitor program.*

2021/03 **University of Arizona Postdoctoral Fellowship (3 years)**, *declined.*

2021/02 **Vaidya–Raychaudhuri Postdoctoral Fellowship (3 years)**, *declined.*

2021/01 **KIAA Postdoctoral Fellowship (3 years)**, *declined.*

2020/03 **Secured 400,000¥ funding**, *Collaboration at Iwate University: geometric algebra techniques and transformation optics. On hold due to coronavirus pandemic.*

2015–2017 **Queens' College Cambridge Foundation Scholarship**, *for high exam performance.*

Research experience

2021 **Junior Research Fellow**, *Girton College*, fully independent

2021–2021 **Delta ITP Visitor (concurrently)**, *Lorentz Institute*, Prof. S. Patil

2017–2021 **Ph.D. Student**, *Cavendish Astrophysics Group*, Prof. A. N. Lasenby, Prof. M. P. Hobson & Dr. W. J. Handley

2016–2017 **M.Sc. Thesis**, *Cavendish Theory of Condensed Matter Group*, Prof. E. Artacho
Novel quantum description of fermionic fluid in quenched, one-dimensional systems, two-particle interactions via Hartree–Fock implemented in C++.

2016
2016

Summer Student, *Institute of Astronomy*, Prof. D. Lynden–Bell and Prof. J. Bičák
Gravitoelectromagnetic proof that the graviton has spin two, addressing Mach's principle by gravitomagnetically rotating inertial frames.

2016
2016

Research Review, *Cavendish Quantum Optics Group*, Prof. U. Schneider
Literature review of the eigenstate thermalisation hypothesis.

Published software (see github.com/wevbarker)

2023/9

Particle Spectrum for Any Tensor Lagrangian (PSALTer)
Predicting the propagating quantum particle states in any tensorial field theory, including (but not limited to) just about any theory of gravity

2023/7

xPlain
Formatting of unambiguous, lasting derivations in the Wolfram Language.

2022/6

Hamiltonian Gauge Gravity Surveyor (HiGGS)
Tools for Hamiltonian constraint, canonical and Dirac–Bergmann analysis of gravity theories with spacetime curvature and torsion

2020/12

BarXiv
Beamer arXiv citations aged with Matplotlib colormaps

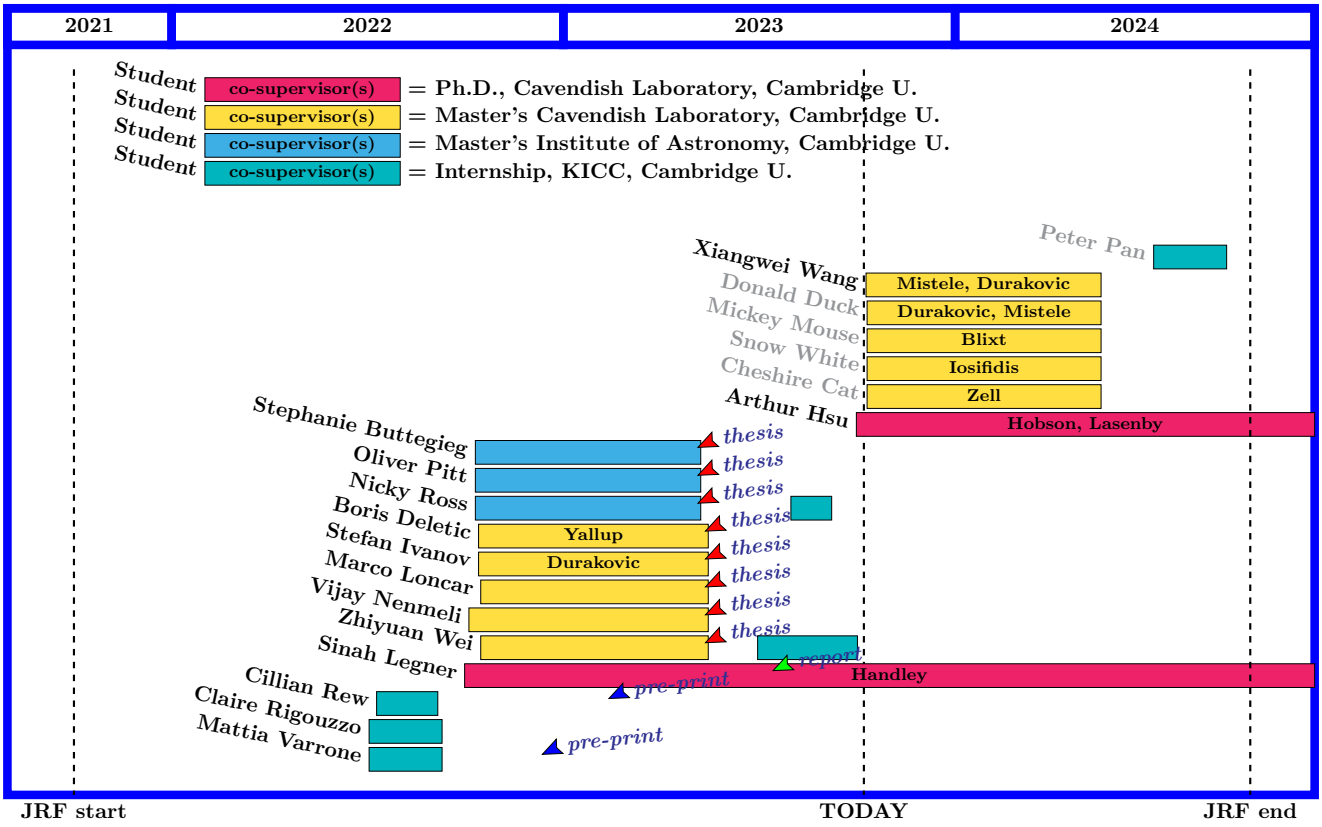
Published papers (see INSPIRE HEP/W.E.V.Barker.2)

Reference	Contribution (%)	Citations
Michael Hobson, Anthony Lasenby, and **Will Barker**. "Manifestly covariant variational principle for gauge theories of gravity". In: (Sept. 2023). arXiv: 2309.14783 [gr-qc]	30	0
W. E. V. Barker, M. P. Hobson, and A. N. Lasenby. "Comment on Eur. Phys. J. C 77, 412 (2017) and Eur. Phys. J. C 81, 213 (2021)". In: *Eur. Phys. J. C* 83.7 (2023), p. 611. DOI: 10.1140/epjc/s10052-023-11676-8	80	0
Will Barker and Sebastian Zell. "A Purely Gravitational Origin for Einstein-Proca Theory". In: (June 2023). arXiv: 2306.14953 [hep-th]	75	1
W. E. V. Barker, M. P. Hobson, and A. N. Lasenby. "Does gravitational confinement sustain flat galactic rotation curves without dark matter?" In: (Mar. 2023). arXiv: 2303.11094 [gr-qc]	70	3
A. N. Lasenby, M. P. Hobson, and **W. E. V. Barker**. "Gravitomagnetism and galaxy rotation curves: a cautionary tale". In: *Class. Quant. Grav.* 40.21 (Mar. 2023), p. 215014. DOI: 10.1088/1361-6382/acef8b. arXiv: 2303.06115 [gr-qc]	30	3
C. Rew and **W. E. V. Barker**. "The effective inflationary potential of constant-torsion emergent gravity". In: (Feb. 2023). arXiv: 2302.07250 [gr-qc]	40	0
Mattia Varrone and **William E. V. Barker**. "Hausdorff dimension of fermions on a random lattice". In: (Dec. 2022). arXiv: 2212.07412 [hep-lat]	40	0
William Edward Vandepeer Barker. "Gauge theories of gravity". PhD thesis. Cambridge U., 2022. DOI: 10.17863/CAM.86972	95	0
W. E. V. Barker. "Supercomputers against strong coupling in gravity with curvature and torsion". In: *Eur. Phys. J. C* 83.3 (2023), p. 228. DOI: 10.1140/epjc/s10052-023-11179-6. arXiv: 2206.00658 [gr-qc]	100	5
W. E. V. Barker. "Geometric multipliers and partial teleparallelism in Poincaré gauge theory". In: *Phys. Rev. D* 108.2 (2023), p. 024053. DOI: 10.1103/PhysRevD.108.024053. arXiv: 2205.13534 [gr-qc]	100	4
W. E. V. Barker et al. "Nonlinear Hamiltonian analysis of new quadratic torsion theories: Cases with curvature-free constraints". In: *Phys. Rev. D* 104.8 (2021), p. 084036. DOI: 10.1103/PhysRevD.104.084036. arXiv: 2101.02645 [gr-qc]	95	8
W. E. V. Barker et al. "Mapping Poincaré gauge cosmology to Horndeski theory for emergent dark energy". In: *Phys. Rev. D* 102.8 (2020), p. 084002. DOI: 10.1103/PhysRevD.102.084002. arXiv: 2006.03581 [gr-qc]	95	12
W. E. V. Barker et al. "Systematic study of background cosmology in unitary Poincaré gauge theories with application to emergent dark radiation and H_0 tension". In: *Phys. Rev. D* 102.2 (2020), p. 024048. DOI: 10.1103/PhysRevD.102.024048. arXiv: 2003.02690 [gr-qc]	95	37
William E. V. Barker et al. "Static energetics in gravity". In: *J. Math. Phys.* 60.5 (2019), p. 052504. DOI: 10.1063/1.5082730. arXiv: 1811.09844 [gr-qc]	95	2
W. Barker et al. "Rotation of inertial frames by angular momentum of matter and waves". In: *Class. Quant. Grav.* 34.20 (2017), p. 205006. DOI: 10.1088/1361-6382/aa8a34. arXiv: 1710.10360 [gr-qc]	75	3

William Barker. "Effects of the circularly polarized beam of linearized gravitational waves". In: *Class. Quant. Grav.* 34.16 (2017), p. 167001. DOI: 10.1088/1361-6382/aa7da9. arXiv: 1612.00905 [gr-qc]	100	2

Research student supervision (see wevbarker.com/mastersprojects)

My portfolio of solo- and co-supervised research students (at Master's and Ph.D. level) is presented below. Note that this includes five Master's projects and one internship planned for the current year (candidates D. Duck, M. Mouse, S. White and C. Cat to be selected within days).



Master's thesis — Stephanie Buttigieg and **Will Barker**. "Is space haunted? Exorcising ghosts from the gravitational particle spectrum". MA thesis. Institute of Astronomy, University of Cambridge, May 2023. URL: https://wevbarker.com/assets/pdf/2305.00001.pdf

Master's thesis — Oliver Pitt and **Will Barker**. "Cosmological perturbations in a novel theory of gravity". MA thesis. Institute of Astronomy, University of Cambridge, May 2023. URL: https://wevbarker.com/assets/pdf/2305.00002.pdf

Master's thesis — Nicky Ross and **Will Barker**. "Astrophysics out of triangles: quantum gravity with exotic geometry". MA thesis. Institute of Astronomy, University of Cambridge, May 2023. URL: https://wevbarker.com/assets/pdf/2305.00003.pdf

Master's thesis — Boris Deletic, David Yallup, and **Will Barker**. "Imaging quantum gravity on a lattice with supercomputers". MA thesis. Cavendish Laboratory, University of Cambridge, May 2023. URL: https://wevbarker.com/assets/pdf/2305.00004.pdf

Master's thesis — Stephan Ivanov, Amel Durakovic, and **Will Barker**. "Interstellar with preferred frames: black holes in a theory of modified Newtonian dynamics". MA thesis. Cavendish Laboratory, University of Cambridge, May 2023. URL: https://wevbarker.com/assets/pdf/2305.00005.pdf

Master's thesis — Marco Loncar and **Will Barker**. "Cosmological perturbations near the quantum vacuum of a spacetime torsion condensate". MA thesis. Cavendish Laboratory, University of Cambridge, May 2023. URL: https://wevbarker.com/assets/pdf/2305.00006.pdf

Master's thesis — Vijay Nenmeli and **Will Barker**. "Quantised fermions and compact gauge fields in causal quantum gravity". MA thesis. Cavendish Laboratory, University of Cambridge, May 2023. URL: https://wevbarker.com/assets/pdf/2305.00007.pdf

Master's thesis

Zhiyuan Wei and **Will Barker**. "Quantum propagator poles in quantum Weyl gravity and beyond". MA thesis. Cavendish Laboratory, University of Cambridge, May 2023. URL: https://wevbarker.com/assets/pdf/2305.00008.pdf

Seminars, colloquia, conferences and talks

2023/6 **Geometric Foundations of Gravity**, *contributed*
Particle spectrum for any metric affine gravity

2023/3 **Rencontres de Moriond**

2022/9 **31st Texas Symposium on Relativistic Astrophysics**, *contributed*
Supercomputers against strong coupling in gravity with curvature and torsion

2022/5 **Cosmology from Home**, *contributed*
Supercomputers against strong coupling in gravity with curvature and torsion

2022/2 **IoA Wednesday Seminar Series**, *invited*
Torsion-squared gravity... and its multiplier extensions

2021/11 **Cavendish Graduate Conference**, *invited plenary*
Torsion gravity

2021/9 **Lorentz Institute Cosmology Seminar**, *invited*
Torsion-squared gravity... and its multiplier extensions

2020/12 **Queen Mary London Cosmology Seminar**, *invited*
Exorcism of nonlinear ghosts in Hamiltonian gravity

2020/11 **PITP Cosmology Seminar**, *invited*
Torsion cosmology and beyond

2020/8 **Probing Effective Theories of Gravity in Strong Fields and Cosmology**

2020/8 **CEICO Cosmology Seminar**, *invited*
Dark energy in the novel gauge gravity theories

2020/5 **Cosmology from Home**, *contributed*
Dark energy in the novel gauge gravity theories

2020/5 **Cosmology from Home**, *invited panel*
Theoretical requirements of modified gravity

2020/2 **DAMTP GR Seminar Series**, *invited*
Addressing Hubble tension with emergent dark radiation in unitary gravity

2020/1 **Battcock Wednesday Seminar Series**, *invited*
Addressing Hubble tension with emergent dark radiation in unitary gravity

2019/12 **KICC 10th Anniversary Symposium**, *invited*
Habitable tordion worlds

2019/12 **30th Texas Symposium on Relativistic Astrophysics**, *contributed*
Habitable tordion worlds

2019/3 **Strings, Cosmology & Gravity 2019**, *contributed*
Habitable tordion worlds

2018/1 **Battcock Wednesday Seminar Series**, *invited*
Gravitational fields of massless particles

2017/1 **Theory of Condensed Matter Group Seminar**, *invited*
Pushing electrons in one dimension

Press and media

2023/4 **Deur Gravitational self-interaction Doesn't Explain Galaxy Rotation Curves**, *lengthy public discussion of our work on Physics Forums.*

2021/8 **Constructing an alternative to general relativity: torsion and curvature squared?**, *KICC annual report 2020*

2020/6 **Top arXiv papers from week 24, 2020**, *His Dark CMBlog*

2020/4 **Why is the Universe expanding so fast?**, *Quanta Magazine*, featured alongside work by Lisa Randall and Marc Kamionkowski.

Academic service, teaching and outreach

Peer Review

2023 **MDPI Universe (Impact Factor 2.9)**

2021 **Springer Advances in applied Clifford algebras (Impact Factor 1.1)**

2020 **Elsevier Physics of the dark universe (Impact Factor 4.5)**

Undergraduate teaching (see wevbarker.com/teaching)

2021 **2nd-year Oscillations, waves and optics (50 hours)**

2021 **2nd-year Quantum physics (50 hours)**

2021 **2nd-year Condensed matter physics (50 hours)**

2021 **2nd-year Experimental methods (25 hours)**

2018–2022 **4th-year Relativistic astrophysics and cosmology (30 hours)**

2017–2021 **3rd-year Relativity (70 hours)**

2017–2018 **1st-year Mathematics B (100 hours)**

Outreach

2019/6 **REACH Summer School Astronomy and Astrophysics (40 hours)**

2013/12 **Academic Life**, *Truro and Penwith College*

Computing

OS	Manjaro Linux, Arch Linux, CentOS Linux, Ubuntu Linux
Languages	Wolfram Language, Maple, TEX, TikZ, Python, C++, Bash
Tools	Mathematica, xAct, Git, Vi, tmux

References

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