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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

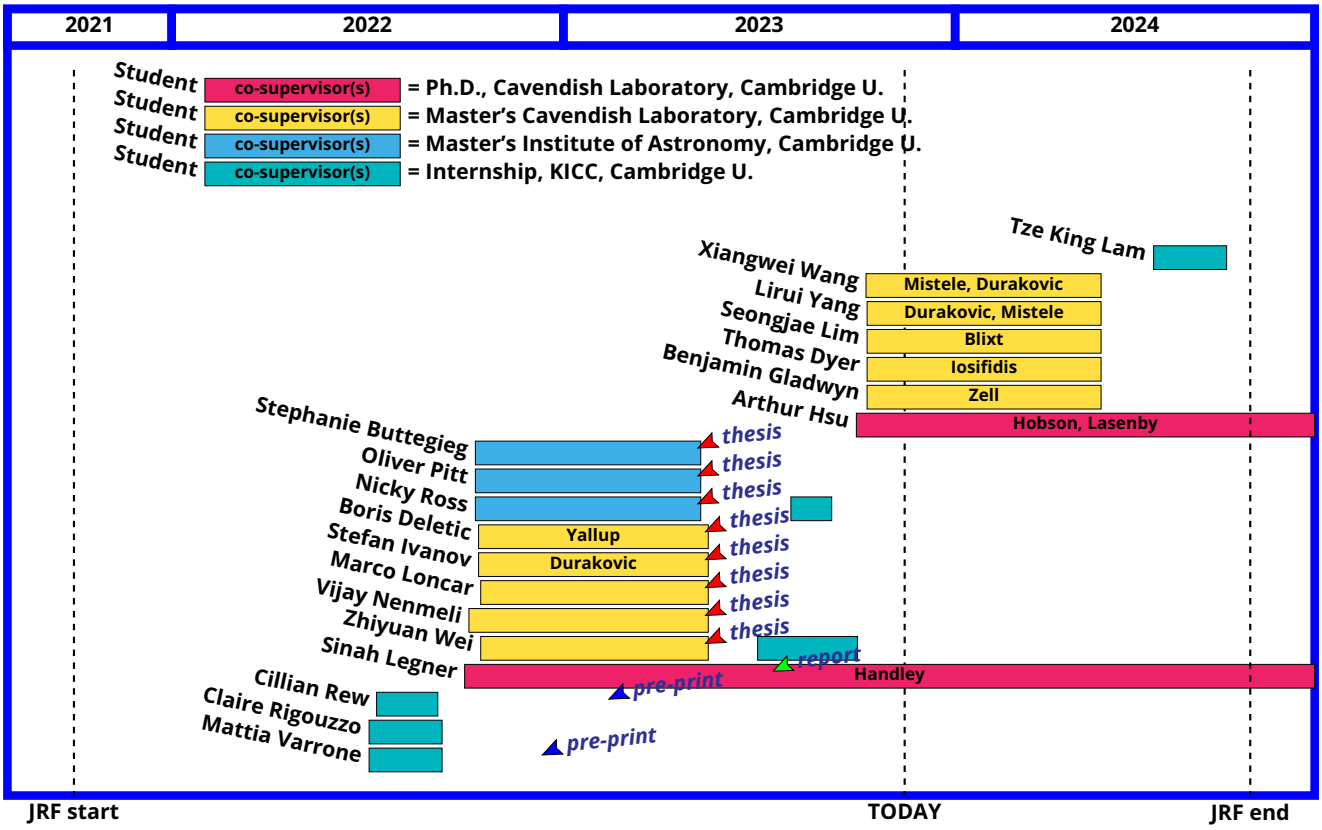
Published papers (see INSPIRE HEP/W.E.V.Barker.2)

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	5
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	4
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	6
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	38
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.



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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