Dr Dani Leonard

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My research applies statistical methods to analyse large data sets from cosmological galaxy surveys. I use Bayesian parameter inference and model comparison, as well as machine learning techniques, to constrain and compare cosmological models. I am interested in inference in high-dimensional spaces (including via novel MCMC methods) and approximate modelling to accelerate inference within complex physical systems. I have six years of experience teaching undergraduate students and supervising postgraduate researchers, and I am passionate about creating safe and welcoming spaces for marginalised groups, particularly LGBT+ people, in the mathematical and physical sciences.

Education

- **University of Oxford** — **Oxford, UK**
  PhD, Astrophysics — *2016*
  Thesis title: *Beyond the standard cosmological paradigm with weak gravitational lensing*
  Rhodes Scholarship

- **Memorial University** — **St. John's, Canada**
  Bachelor of Science (Honours), Applied Mathematics and Physics — *2012*

Employment

- **School of Mathematics, Statistics and Physics, Newcastle University** — **Newcastle upon Tyne, UK**
  Lecturer in Astronomy — *09/2019–Present*

- **McWilliams Center for Cosmology, Carnegie Mellon University** — **Pittsburgh, USA**
  McWilliams Postdoctoral Fellow — *09/2016 – 08/2019*

Awards and Funding

- **Science and Technology Facilities Council (STFC)** — **£377K**
  STFC Astronomy Small Awards — *2025-2028*
  3-year PDRA position, 0.2 FTE PI time, computing equipment and travel, for proposal *Galaxy Intrinsic Alignments for LSST with the Multi-Estimator Method*.

- **DiRAC High Performance Computing Facility** — **2.9M CPU-hours**
  DiRAC RAC17 — *2025-2028*
  Awarded for proposal *Optimised modelling for precision cosmology with LSST and Euclid*.

- **DiRAC High Performance Computing Facility** — **£9600**
  DiRAC Innovation Placements — *2025*
  Funding for an intra-PhD industrial placement taken up by primary-supervised PhD student C. MacMahon-Gellér, working with industry partner DDN (DataDirect Networks), on project *Accelerating AI Pipelines to Accelerate Science*.

- **Association of Commonwealth Universities** — **£5000**
  ACU Fellowship — *2024*
  Funding for collaboration between Newcastle University (UK) and University of Waterloo (Canada) on testing 4-Dimensional Einstein-Gauss-Bonnet gravity with cosmic structure data.

- **DiRAC High Performance Computing Facility** — **100K CPU-hours**
  DiRAC Seedcorn — *2024*
  Awarded for proposal *Optimising modelling and data selection for late-time cosmology with galaxy surveys.*

- **LSST:UK** — **£8000**
  Travel Funding — *2024, 2023, 2022, 2020*
  Funding awarded to support attendance and participation at collaboration meetings of LSST DESC in Tuscon (USA), Chicago (USA), Pittsburgh (USA) and Zurich (Switzerland).

- **LSST Discovery Alliance** **$5000 (USD)**
  Science Catalyst Grant *2021*
  Awarded for proposal *Joint Modelling of Astrophysical Systematics for Cosmology with LSST Weak Lensing and Galaxy Clustering*. (Grant programme formerly known as *Enabling Science Awards*.)

- **Pittsburgh Supercomputing Center** **52K CPU-hours**
  Pittsburgh Research Computing Initiative Award *2018*
  Awarded for proposal *Testing the standard cosmological model with current and future galaxy survey data*.

Selected Papers

[1] C MacMahon-Gellér, **C. D. Leonard**, P. Bull, and M. M. Rau. Meta-learning for cosmological emulation: Rapid adaptation to new lensing kernels. *Submitted to RAS Techniques and Instruments*, arXiv: 2504.00552, 2025.

[2] C. M. A. Zanoletti and **C. D. Leonard**. Principal Components for Model-Agnostic Modified Gravity with 3x2pt. *Under review at Physical Review D*, arXiv: 2503.20951, 2025.

[3] N. Šarčević, **C. D. Leonard**, M. M. Rau, and the LSST Dark Energy Science Collaboration. Joint Modelling of Astrophysical Systematics for Cosmology with LSST Cosmic Shear. *Monthly Notices of the Royal Astronomical Society*, 527 (2), arXiv: 2406.03352, 2025.

[4] C. MacMahon-Gellér and **C. D. Leonard**. Intrinsic alignment from multiple shear estimates: A first application to data and forecasts for Stage IV. *Monthly Notices of the Royal Astronomical Society*, 528 (2): 2024, arXiv: 2306.11428, 2024.

[5] C. M. A. Zanoletti, B. R. Hull, **C. D. Leonard**, and R. B. Mann. Cosmological constraints on 4-dimensional Einstein-Gauss-Bonnet gravity. *Journal of Cosmology and Astroparticle Physics*, 2024(01), 043, arXiv: 2310.19871, 2024.

[6] **C. D. Leonard**, M. M. Rau, and R. Mandelbaum. Photometric redshifts and intrinsic alignments: degeneracies and biases in 3×2 pt analysis. *Physical Review D*, 109(8), 083528, arXiv:2401.06060, 2024.

[7] N. Van Alfen, D. Campbell, J. Blazek, **C. D. Leonard**, F. Lanusse, A. Hearin, R. Mandelbaum, and the LSST Dark Energy Science Collaboration. An empirical model for intrinsic alignments: Insights from cosmological simulations. *The Open Journal of Astrophysics*, 7 (2024), arXiv:2311.07374, 2024.

[8] A. Paopiamsap, N. Porqueres, D. Alonso, J. Harnois-Deraps, and **C. D. Leonard**. Accuracy requirements on intrinsic alignments for stage-IV cosmic shear. *The Open Journal of Astrophysics*, 7 (2024), arXiv:2311.16812, 2024.

[9] DES Collaboration: T. M. C. Abbott et al. (inc. **C. D. Leonard**). Dark Energy Survey Year 3 Results: Constraints on extensions to ΛCDM with weak lensing and galaxy clustering. *Physical Review D*, 107 (8), 083504, arXiv: 2207.05766, 2023.

[10] **C. D. Leonard** et al. for the LSST Dark Energy Science Collaboration. The N5K Challenge: Non-Limber Integration for LSST Cosmology. *The Open Journal of Astrophysics*, 6 (2023), arXiv: 2212.04291, 2023.

[11] DES Collaboration: T. M. C. Abbott et al. (inc. **C. D. Leonard**). Dark Energy Survey Year 1 results: Constraints on extended cosmological models from galaxy clustering and weak lensing. *Physical Review D*, 99(12), 123505, arXiv: 1810.02499, 2019.

[12] N. E. Chisari, D. Alonso, E. Krause, and **C. D. Leonard** et al. Core cosmology library: Precision cosmological predictions for LSST. *The Astrophysical Journal Supplement Series*, 242 (1):2, arXiv: 1812.05995, 2019.

[13] **C. D. Leonard**, R. Mandelbaum, and the LSST Dark Energy Science Collaboration. Measuring the scale dependence of intrinsic alignments using multiple shear estimates. *Monthly Notices of the Royal Astronomical Society*, 479 (1), arXiv: 1802.08263, 2018.

[14] **C. D. Leonard**, P. Bull, and R. Allison. Spatial curvture endgame: Reaching the limit of curvature determination. *Physical Review D*, 94(2), 023502, arXiv: 1604.01410, 2016.

[15] **C. D. Leonard**, P. G. Ferreira, and C. Heymans. Testing gravity with E_G: mapping theory onto observations. *Journal of Cosmology and Astroparticle Physics*, 12 (051), arXiv: 1510.04287, 2015.

[16] **C. D. Leonard**, T. Baker, and P. G. Ferreira. Exploring degeneracies in modified gravity with weak lensing. *Physical Review D*, 91(8), 083504, arXiv: 1501.03509, 2015.

h-index = 18, Total citations = 1413 (Google Scholar, May 18, 2025)

Research Leadership Roles

- **LSST Dark Energy Science Collaboration**
  Working Group Convener *2022–2024*
  Co-lead, Modelling and Combined Probes Working Group.

- **LSST Dark Energy Science Collaboration**
  Team Leader *2020–2022*
  Team leader and active developer for the public LSST software package Core Cosmology Library, a key component of the LSST cosmology data analysis pipeline with a conservative user base estimate of 2500 scientists.

- **LSST:UK Consortium**
  Board Member *2019–2023*
  LSST:UK Affiliate PI and member of the Board of the LSST:UK Consortium.

- **LSST Dark Energy Science Collaboration Council**
  Collaboration Council Member *2017–2021*
  Twice elected to the 20-seat council to represent the interests of the 1000+ LSST DESC members in policy decisions.

Selected Academic Presentations

- **Invited plenary talks:**
  - 2025: *CosmoVerse@Naples*, Scuola Superiore Meridionale, Italy
  - 2022: *Key Challenges in Galaxy and CMB Lensing*, University of Cambridge, UK
  - 2021: *Dark Energy Spectroscopic Instrument Collaboration Meeting (Virtual)*
  - 2018: *Exploring the Dark Side of the Universe*, University of Antilles, France
- **Invited colloquia and seminars:**
  - 2025: University of Waterloo (Canada), Perimeter Institute (Canada)
  - 2024: Institut d'Astrophysique de Paris (France)
  - 2023: Queen Mary University of London, Durham University, Imperial College London, University of Oxford, University of Manchester
  - 2022: ETH Zurich (Switzerland), University of Edinburgh, Liverpool John Moores University
  - 2021: University of Chile (Chile) (remote)
  - 2020: University of Sussex (remote), Memorial University of Newfoundland (Canada) (remote)
  - 2019: Indiana University (USA), University of Illinois at Urbana-Champaign (USA)
  - 2018: Lawrence Berkeley National Laboratory (USA)
- **Public Lectures:**
  - 2023: Lorentz Centre / Rijksmuseum Boerhaave, Leiden, The Netherlands
  - 2017: Allegheny Observatory Public Lecture Series, Pittsburgh, USA

Teaching, Supervision, and Pastoral Support

- **Fellow of the Higher Education Academy** **UK Higher Education Academy**
  Fellow *2022-Present*
  Achieved via successful completion of the Newcastle Educational Practice Scheme (NEPS). My Account of Professional Practice submission has been used as an example for later NEPS participants.

- **The Education Awards (TEA), Newcastle University** **Newcastle upon Tyne, UK**
  Nominee, Category of Outstanding Contribution to Pastoral Support *2022*

- **PHY3042: Cosmology** **School of MSP, Newcastle University**
  Module Leader / Lecturer *2021-Present*
  I developed this new module from scratch for first delivery in 2021-2022.

- **Module Moderation Group (Physics)** **School of MSP, Newcastle University**
  Member *2021-2024*

- **PHY8046/8050/8054: MPhys Extended Project** **School of MSP, Newcastle University**
  Module Leader *2020-Present*
  I coordinate the Physics integrated masters project module(s).

- **PHY3027/3034: BSc Physics Individual Project** — **School of MSP, Newcastle University**
  Module Leader — *2020-Present*
  I coordinate the Physics 3rd year individual project module(s). I co-led the team that fully overhauled this module for 2024-2025 to increase efficiency of delivery.

- **Postgraduate Research Supervision** — **School of MSP, Newcastle University**
  Supervisor — *2020-Present*
  I have acted as primary supervisor for 1 Masters by Research student (completed 2021) and 5 PhD students (1 completed 2024).

- **Personal tutoring** — **School of MSP, Newcastle University**
  Tutor, all stages. — *2020-Present*
  I have considerable experience supporting the Support to Study process. I provided small group tutorials as part of first year physics tutoring in 2024-2025.

- **PHY1021: Introductory Astrophysics** — **School of MSP, Newcastle University**
  Module Leader / Lecturer — *2019-Present*
  I have considerably redeveloped this module to incorporate popular sections on galaxies and cosmology, and regularly integrate interactive teaching methods such as Think-Pair-Share, which are very well received in student feedback.

- **Undergraduate and Integrated Masters Supervision** — **School of MSP, Newcastle University**
  Supervisor — *2019-Present*
  I have acted as a supervisor for BSc individual projects (2019-2023) and MPhys extended research projects (2020, 2023), as well as as an advisor for the Physics Group Project module (2021, 2022, 2024).

Equality, Diversity and Inclusion

- **Kielder Observatory Pride Month Project** — **Kielder, UK**
  Featured LGBT+ Astronomer — *2025*
- **SAgE Faculty Women in Leadership Forum Steering Group** — **Newcastle upon Tyne, UK**
  Member — *2024–Present*
- **WISDOM, School of Mathematics, Statistics and Physics** — **Newcastle upon Tyne, UK**
  Lecturer, Women In Science Doing Outstanding Maths secondary school event. — *2022*
- **The Education Awards (TEA), Newcastle University** — **Newcastle upon Tyne, UK**
  Nominee, Category of Outstanding Contribution to EDI — *2022*
- **Out in Space Podcast**
  Podcast Guest, Out in Space Podcast featuring LGBT+ astronomers — *2020*
- **School of MSP LGBT+ Staff / Student Coffee Hours** — **Newcastle upon Tyne, UK**
  Creator and organiser — *2019–Present*
- **Equality, Diversity and Inclusion Committee** — **Newcastle upon Tyne, UK**
  Member, Occasional panel member for EDI hiring interviews — *2019–2022*
- **Constructive Interference: Women and Minorities in Physics** — **Pittsburgh, USA**
  Member and Website Officer — *2017-2019*

Computing

- **Expert:** Python, C, Fortran.
  Considerable experience with High Performance Computing including slurm environments and parallelisation.
- **Strong working knowledge:** R, C++, Matlab.

Languages

English: Native

French: Fluent