Steven D. Cunnington

Curriculum Vitae

Personal Details

Address: Jodrell Bank Centre for Astrophysics, Alan Turing Building, Department of Physics & Astronomy, The University of Manchester, Manchester, M13 9PL, UK
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Nationality: British

Research Overview

I am a cosmologist focusing on how surveys of large-scale cosmic structure can test our understanding of the Universe. My primary research is developing a technique that maps emission intensity from neutral hydrogen at radio wavelengths. I have leading roles in the collaborations that are at the forefront of this technique, known as HI intensity mapping. I am also involved in optical/near-infrared collaborations and am interested in the benefits gained from cross-correlation between optical surveys and HI intensity maps.

Academic Positions

Apr 2022 - Present
Post-Doctoral Research Associate
The University of Manchester
Line Manager: Dr Laura Wolz (Grant PI)

Dec 2021 - Apr 2022
Post-Doctoral Research Assistant
The University of Edinburgh
Line Manager: Dr Alkistis Pourtsidou (Grant PI)

Oct 2019 - Dec 2021
Post-Doctoral Research Assistant
Queen Mary University of London
Line Manager: Dr Alkistis Pourtsidou (Grant PI)

Education

Oct 2016 - Sep 2019
Post-Graduate Research Student
Institute of Cosmology & Gravitation, University of Portsmouth
PhD in Cosmology - 2019
Thesis: Synergies Between 21cm and Optical Redshift Surveys for Probing Large Scale Cosmic Structure
Supervisors: Prof David Bacon and Dr Alkistis Pourtsidou

Oct 2012 - Jun 2016
Undergraduate Student
University of Southampton
BSc (Hons) Physics - *First Class Honours*
BSc Final Year Project: Investigating the Shape of the Stellar-to-Halo Mass Relationship for Galaxies at a Range of Redshifts - Supervisor: Dr Francesco Shankar

Summer 2015
Summer Research Placement
Institute of Cosmology & Gravitation, University of Portsmouth
8-week placement studying strong gravitational lensing, resulting in a MNRAS publication.
Placement Supervisor: Dr Thomas Collett

Collaborations

In approximate descending order of active contribution

MeerKLASS (2019 - Present)
- Focussing on using the MeerKAT radio telescope to perform single-dish intensity mapping LSS surveys. Lead author for the work which obtained a first cosmological detection using a multi-dish array in single-dish mode. I am also the lead for the Power Spectrum and Foreground Cleaning focus groups. We are now working with more incoming data to make detections in auto-correlation, along with other science goals.

SKAO Cosmology SWG (2018 - Present)
- Lead the Simulations working group, focusing on coordinating simulations for the cosmology collaboration. An active member of other focus groups (HI Intensity Mapping and Synergies). Founding member of the SKAO intensity mapping data challenge programme, the first of its kind.

Euclid (2018 - Present)
- Leading the 21cm-Euclid synergies project within the Additional Probes Galaxy Clustering WP in Euclid. This has the potential to improve photometric redshift constraints and limit other systematics.

Selected Talks

Cosmology from Home 2022 *Virtual Conference*	7th Jul 22
EAS Annual Meeting 2022 *Valencia Conference Centre, Valencia, Spain*	1st Jul 22
LSS Seminar *Institute for Fundamental Physics of the Universe, Trieste, Italy*	26th May 22
SAZERAC 21cm 2022 *Virtual Conference*	17th Mar 22
Tata Institute of Fundamental Research, Mumbai *Virtual Physics Seminar*	11th Feb 22
Technical University of Athens *Virtual Physics Colloquium*	19th May 21
SKAO: A Precursor View of the SKA Sky *Virtual Conference*	18th Mar 21
SKA-Cosmology SWG Meeting *Virtual Conference*	14th Jan 21
London Cosmology Discussion Meeting *Virtual Conference*	19th Nov 20
SKA SWG Meeting *École Normale Supérieure, Paris, France*	22nd Jan 20
Texas Symposium *University of Portsmouth, Guildhall, Portsmouth, UK*	17th Dec 19
CoSyne: Cosmological Synergies *Institut d'astrophysique de Paris, France*	11th Dec 19
Cosmology Seminar *University of the Western Cape, South Africa*	29th Nov 19
Euclid UK Meeting *University of Oxford, UK*	18th Dec 18
Cosmology Seminar *Queen Mary University of London, UK*	7th Nov 18
Cosmology Seminar *Institute of Cosmology & Gravitation, Portsmouth, UK*	24th Apr 18
EWASS/NAM 2018 *Arena & Convention Centre (ACC), Liverpool, UK*	3rd Apr 18
South Coast Cosmo *Institute of Cosmology & Gravitation, Portsmouth, UK*	29th Nov 17
LSST:UK Multi-wavelength Workshop *University of Cambridge, UK*	27th Sep 17

Teaching & Supervision

Oliver Thomason - *Y12 Placement Student, University of Manchester* — Aug 2022
Devised and supervised the three-week Nuffield placement programme

Zhaoting Chen - *PhD Student, University of Manchester* — Apr 2022 - Present
Assisting the supervision of PhD projects

Paula S. Soares - *PhD Student, Queen Mary University of London* — Oct 2019 - Present
Assisting the supervision of PhD projects

Isabelle Ye - *MSc Student, Queen Mary University of London* — Feb 2021 - Aug 2021
Assisting the supervision of Masters project

Andrew Scullane - *MSc Student, Queen Mary University of London* — Oct 2020 - Jan 2021
Assisting the supervision of Masters project

Departmental Responsibilities

JCBA Weekly Colloquium (*University of Manchester*) - co-organiser — Jun 2022 - Present
LSS Weekly Journal Club (*Queen Mary University of London*) - co-organiser — Apr 2021 - Nov 2021

Assessment & Refereeing

Referee for Monthly Notices of the Royal Astronomical Society — Feb 2020 - Present
Referee for Astronomy & Astrophysics — May 2022 - Present

Technical Skills

Coding Languages — Python, C++, C, Fortran, MATLAB, Mathematica

OS and HPC — Mac OS X and Unix/Linux operating systems. Regular experience with High Performance Computing (HPC) Clusters.

Public Code

HI intensity mapping multipole expansion (*Python*) - Core Developer
→ github.com/IntensityTools/MultipoleExpansion - pipeline for measuring and modelling the HI intensity mapping power spectrum and its multipole decomposition. Provides example simulated data and investigates the impact from 21cm foreground removal and beam effects.

Gaussian Process Regression (GPR) for foreground removal (*Python*) - Contributing Developer
→ github.com/paulassoares/gpr4im - demonstrative toolkit of how GPR techniques can be used for foreground removal in HI intensity maps.

Public Outreach & Volunteering

- Astronomy on Tap Organiser (28th Feb 2018)
- Stargazing Live Portsmouth Volunteer (2017-2019)
- Student representative for Athena Swan Committee (2017-2019)
- Organiser for a series of University of Portsmouth Physics Staff v Students charity football matches (2017-2019)

Outreach Talks Presented:

The Local Group Astronomy Club - *Virtual Talk* — 8th Mar 22
East Sussex Astronomical Soc. - *Egerton Park, East Sussex, UK* — 4th Jul 19
Chichester U3A Science Group - *Fishbourne Centre, West Sussex, UK* — 24th Jun 19
The Local Group Astronomy Club - *Cooden Beach Hotel, East Sussex, UK* — 12th Feb 19
Eastbourne Astronomical Soc. - *Willingdon Memorial Hall, East Sussex, UK* — 6th Oct 18
Winchester Cafe Sci - *Winchester Discovery Centre, Hampshire, UK* — 3rd Sep 18
The Local Group Astronomy Club - *Cooden Beach Hotel, East Sussex, UK* — 8th May 18

List of Publications

18. HI intensity mapping with MeerKAT: power spectrum detection in cross-correlation with WiggleZ galaxies
Cunnington, S., Li, Y., Santos, M., Wang, J., et al. (2022)
Submitted to MNRAS, arXiv:2206.01579

17. Detecting the power spectrum turnover with HI intensity mapping
Cunnington, S., (2022)
MNRAS 512, Issue 2, May 2022, 2408–2425, arXiv:2202.13828

16. Baryon acoustic oscillations from HI intensity mapping: the importance of cross-correlations in the monopole and quadrupole
Rubiola, A., **Cunnington, S.**, Camera, S., (2021)
Submitted to MNRAS, arXiv:2111.11347

15. Gaussian Process Regression for foreground removal in HI intensity mapping experiments
Soares, P., Watkinson, C., **Cunnington, S.**, Pourtsidou, A., (2022)
MNRAS 510, Issue 4, March 2022, 5872–5890, arXiv:2105.12665

14. HI constraints from the cross-correlation of eBOSS galaxies and Green Bank Telescope intensity maps
Wolz, L., Pourtsidou, A., Masui, K., Chang, T.-C., ..., **Cunnington, S.** et al. (2022)
MNRAS 510, Issue 3, March 2022, 3495–3511, arXiv:2102.04946

13. Measurements of the diffuse Galactic synchrotron spectral index and curvature from MeerKLASS pilot data
Irfan, M. O., Bull, P., Santos, M. G., ..., **Cunnington, S.** et al.., (2022)
MNRAS 509, Issue 4, February 2022, 4923–4939, arXiv:2111.08517

12. HI intensity mapping correlation function from UNIT simulations: BAO and observationally induced anisotropy
Avila, S., Vos-Ginés, B., **Cunnington, S.** et al, (2022)
MNRAS 510, Issue 1, February 2022, 292-308, arXiv:2105.10454

11. SKAO HI Intensity Mapping: Blind Foreground Subtraction Challenge
Spinelli, M., Carucci, I., **Cunnington, S.** et al.., (2022)
MNRAS 509, Issue 2, January 2022, 2048–2074, arXiv:2107.10814

10. The HI intensity mapping bispectrum including observational effects
Cunnington, S., Watkinson, C., Pourtsidou, A., (2021)
MNRAS 507, Issue 2, October 2021, 1623–1639, arXiv:2102.11153

9. 21cm foregrounds and polarization leakage: a user's guide on cleaning and mitigation strategies
Cunnington, S., Irfan, M., Carucci, I., Pourtsidou, A., Bobin, J., (2021)
MNRAS 504, Issue 1, June 2021, 208–227, arXiv:2010.02907

8. HI intensity mapping with MeerKAT: Calibration pipeline for multi-dish autocorrelation observations
Wang, J., Santos, M., Bull, P., Grainge, K., **Cunnington, S.** et al. (2021)
MNRAS 505, Issue 3, May 2021, 3698-3721, arXiv:2011.13789

7. Multipole expansion for HI intensity mapping experiments: unbiased parameter estimation
Soares, P., **Cunnington, S.**, Pourtsidou, A., Blake, C., (2021)
MNRAS 502, Issue 2, January 2021, 2549–2564, arXiv:2008.12102

6. The degeneracy between primordial non-Gaussianity and foregrounds in 21cm intensity mapping experiments
Cunnington, S., Camera, S., Pourtsidou, A., (2020)
MNRAS 499, Issue 3, December 2020, 4054–4067, arXiv:2007.12126

5. Multipole expansion for HI intensity mapping experiments: simulations and modelling
Cunnington, S., Pourtsidou, A., Soares, P., Blake, C., Bacon, D., (2020)
MNRAS 496, Issue 1, July 2020, 415–433, arXiv:2002.05626

4. Cosmology with Phase 1 of the Square Kilometre Array: Red Book 2018: Technical specifications and performance forecasts
   Square Kilometre Array Cosmology Science Working Group: Bacon, D., ..., **Cunnington, S.** et al. (2020)
   Publ. Astron. Soc. Austral. 37, e007, March 2020, arXiv:1811.02743

3. Impacts of Foregrounds on HI Intensity Mapping Cross-Correlations
   Cunnington, S., Wolz, L., Pourtsidou, A., Bacon, D., (2019)
   MNRAS 488, Issue 4, October 2019, 5452–5472, arXiv:1904.01479

2. HI Intensity Mapping for Clustering-Based Redshift Estimation
   Cunnington, S., Harrison, I., Pourtsidou, A., Bacon, D., (2019)
   MNRAS 482, Issue 3, January 2019, 3341–3355, arXiv:1805.04498

1. Observational Selection Biases in Time-Delay Strong Lensing and their Impact on Cosmography
   Collett, T., **Cunnington, S.**, (2016)
   MNRAS 462, Issue 3, November 2016, 3255–3264, arXiv:1605.08341