

Steven D. Cunnington

Personal Details

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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.

Research 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 - <i>First Class Honours</i> 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

Collaboration Membership & Roles

MeerKAT Large Area Synoptic Survey (MeerKLASS) (member since 2019)

- Lead for the **first intensity mapping detection** using MeerKAT Dec 2021 - Oct 2022
I led the analysis which provided the first HI intensity mapping detection using a multi-dish array in single-dish mode
- Power Spectrum and Foreground Cleaning Working Group lead Jun 2022 - Present
I coordinate projects and bi-weekly meetings which aim to optimise our power spectra estimation and foreground cleaning pipelines

SKAO Cosmology SWG (member since 2018)

- Simulations Working Group lead Mar 2021 - Present
This role focuses on coordinating simulations for the cosmology collaboration
- Founding member of SKAO intensity mapping data challenge Jan 2020 - Present
This group began with the aim to coordinate efforts and produce the most realistic end-to-end simulations of intensity maps. This led to first of its kind **foreground cleaning challenge**.

Euclid Consortium (member since 2018)

- Leading the 21cm-Euclid synergies project Dec 2020 - Present
This is a 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

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| 2022 | Invited colloquia/seminar (2): <ul style="list-style-type: none"> ● LSS Seminar <i>IFPU, Trieste, Italy</i> ● Physics Seminar <i>Tata Institute of Fundamental Research, Mumbai, India</i> [Virtual Talk] Invited talks (1): <ul style="list-style-type: none"> ● 21cm Cosmology Workshop <i>University of Wisconsin, USA</i> [Virtual Talk] Contributed talks (5): <ul style="list-style-type: none"> ● A Cosmic Window to Fundamental Physics <i>IFT, Madrid, Spain</i> ● SKAO HI IM Workshop <i>University of Edinburgh, UK</i> ● Cosmology from Home 2022 <i>Virtual Conference</i> ● EAS Annual Meeting 2022 <i>Valencia, Spain</i> ● SAZERAC 21cm 2022 <i>Virtual Conference</i> |
| 2021 | Invited colloquia/seminar (1): <ul style="list-style-type: none"> ● Physics Colloquium <i>Technical University of Athens, Athens, Greece</i> [Virtual Talk] Contributed talks (2): <ul style="list-style-type: none"> ● A Precursor View of the SKA Sky <i>Virtual Conference</i> ● SKA Cosmology SWG Meeting <i>Virtual Conference</i> |
| 2020 | Invited talks (1): <ul style="list-style-type: none"> ● London Cosmology Discussion Meeting <i>Virtual Conference</i> Contributed talks (1): <ul style="list-style-type: none"> ● SKA SWG Meeting <i>École Normale Supérieure, Paris, France</i> |
| 2019 | Invited colloquia/seminar (1): <ul style="list-style-type: none"> ● Cosmology Seminar <i>University of the Western Cape, South Africa</i> Contributed talks (2): <ul style="list-style-type: none"> ● Texas Symposium <i>University of Portsmouth, Guildhall, Portsmouth, UK</i> ● CoSyne: Cosmological Synergies <i>Institut d'astrophysique de Paris, France</i> |
| 2018 | Invited colloquia/seminar (2): <ul style="list-style-type: none"> ● Cosmology Seminar <i>Queen Mary University of London, UK</i> ● Cosmology Seminar <i>Institute of Cosmology & Gravitation, Portsmouth, UK</i> Contributed talks (2): <ul style="list-style-type: none"> ● Euclid UK Meeting <i>University of Oxford, UK</i> ● EWASS/NAM 2018 <i>Arena & Convention Centre (ACC), Liverpool, UK</i> |
| 2017 | Contributed talks (2): <ul style="list-style-type: none"> ● South Coast Cosmo <i>Institute of Cosmology & Gravitation, Portsmouth, UK</i> ● LSST:UK Multi-wavelength Workshop <i>University of Cambridge, UK</i> |

Teaching & Supervision

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| Georgia Kiddier - <i>MPhys Student, University of Manchester</i> | Sep 2022 - Present |
| Devised and co-supervised the Masters project | |
| Dounia Nanadoumgarlacroze - <i>MPhys Student, University of Manchester</i> | Sep 2022 - Present |
| Devised and co-supervised the Masters project | |
| Oliver Thomason - <i>Y12 Placement Student, University of Manchester</i> | Aug 2022 |
| Devised and supervised the three-week Nuffield placement programme | |

Zhaoting Chen - <i>PhD Student, University of Manchester</i> Mentored and assisted the supervision of PhD projects	Apr 2022 - Present
Paula S. Soares - <i>PhD Student, Queen Mary University of London</i> Mentored and assisted the supervision of PhD projects	Oct 2019 - Sep 2022
Isabelle Ye - <i>MSc Student, Queen Mary University of London</i> Devised and co-supervised the Masters projects	Feb 2021 - Aug 2021
Andrew Scullane - <i>MSc Student, Queen Mary University of London</i> Devised and co-supervised the Masters projects	Oct 2020 - Jan 2021

Departmental Responsibilities

JBCA Weekly Colloquium (<i>University of Manchester</i>) - co-organiser	Jun 2022 - Present
LSS Weekly Journal Club (<i>Queen Mary University of London</i>) - 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
Referee for Journal of Cosmology & Astroparticle Physics	Aug 2022 - Present

Technical Skills

<i>Coding Languages</i>	Python, C++, C, Fortran, MATLAB, Mathematica
<i>OS and HPC</i>	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, & Media

- Quoted in article on MeerKAT cosmological detection (scitechdaily.com and others)
- 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 - <i>Virtual Talk</i>	Mar 2022
East Sussex Astronomical Soc. - <i>Egerton Park, East Sussex, UK</i>	Jul 2019
Chichester U3A Science Group - <i>Fishbourne Centre, West Sussex, UK</i>	Jun 2019
The Local Group Astronomy Club - <i>Cooden Beach Hotel, East Sussex, UK</i>	Feb 2019
Eastbourne Astronomical Soc. - <i>Willingdon Memorial Hall, East Sussex, UK</i>	Oct 2018
Winchester Cafe Sci - <i>Winchester Discovery Centre, Hampshire, UK</i>	Sep 2018
The Local Group Astronomy Club - <i>Cooden Beach Hotel, East Sussex, UK</i>	May 2018

Journal Articles (published/submitted)

Summary as of 07/10/2022:

Total publications: 18 (1 awaiting referee acceptance)

First author: 8

Solo author: 1

Total citations: 500

h-index: 11

Highest cited paper: 204

Highest cited first author: 31

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. **Baryon acoustic oscillations from HI intensity mapping: the importance of cross-correlations in the monopole and quadrupole**
Rubiola, A., **Cunnington, S.**, Camera, S., (2021)
Accepted by MNRAS, arXiv:2111.11347
16. **Detecting the power spectrum turnover with HI intensity mapping**
Cunnington, S., (2022)
MNRAS 512, Issue 2, May 2022, 2408–2425, arXiv:2202.13828
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