

## C.V. for Steven Murray

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CONTACT INFORMATION School of Earth and Space Exploration  
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📄 ResearchGate: [Steven\\_Murray2](#) [in steven-g-murray](#) [🌐 steven-murray](#)

ACADEMIC REFERENCES  
**Prof. Judd Bowman** judd.bowman@asu.edu (+1)480 965-8880  
**Dr. Cathryn Trott** cathryn.trott@curtin.edu.au (+61)8 9266 1306  
**Prof. Andrei Mesinger** andrei.mesinger@sns.it (+39) 050 509 688

RESEARCH INTERESTS  
**21cm Cosmology:** validation, parameter inference, statistical foreground modelling, connecting instruments to theoretical predictions, simulations.  
**Large-scale structure:** halo mass function, halo model, warm dark matter, fast synthetic catalogues.  
**Astrostatistics:** hierarchical Bayesian models, non-parametric statistics, count distributions, PCA.  
**Software and computing:** high-standard development practices, accessible web-applications for the community, robust mathematical tools in Python.

EDUCATION **University of Western Australia**, Perth, Western Australia

PhD, Physics (2012–2015)

- Thesis Title: Next-generation tools for next-generation surveys
- Supervisors: Prof. Chris Power, Dr. Aaron Robotham
- Area of Study: Cosmology/Structure formation
- Courses Taken:
  - General Relativity (HD)
  - Computer Intensive Methods in Statistics (D)
  - Bayesian Astronomy in R

Honours, Physics (2011)

- Graduated: First Class
- Thesis Topic: Large-Scale Structure in the SDSS and GAMA surveys
- Supervisor: Prof. John Hartnett
- Courses Taken:
  - Differential Geometry (HD)
  - Mathematical Methods (HD)
  - Computational Quantum Mechanics (D)
  - Astrophysics (D)

**University of Queensland**, Brisbane, Queensland, Australia

Bachelor of Science in Mathematics (2007-2009)

- Graduated: GPA of 6.583

PROFESSIONAL EXPERIENCE **Arizona State University**, Tempe, Arizona  
HERA/EDGES Postdoc, (2018 – )

**Curtin University**, Perth, Western Australia  
CAASTRO Postdoc, (2015 – 2018)

**University of Western Australia**, Perth, Western Australia  
APA funded PhD student, (2012 – 2015)

**ICRAR/Pawsey**, Perth, Western Australia  
ICRAR/Pawsey Summer Internship, (2011 – 2012)

**University of Western Australia**, Perth, Western Australia  
First-year Physics Lab Demonstration Tutor, (2011)

**University of Queensland**, Brisbane, Queensland  
First-year Mathematics Tutor, (2009)

ACADEMIC  
EXPERIENCE

**Grants** **2012 – Present**

- Lisa Kewley et al. (Murray listed as Ass. Investigator), 2017, ‘*ASTRO 3D*’, ARC CoE.
- Chris Power et. al., 2013, ‘*Fast, approximate synthetic universes for the SKA*’, UWA Research Collaboration Awards.
- Chris Power, Steven Murray, 2012, ‘*Building model universes for the Square Kilometre Array and its pathfinders*’, UWA Research Collaboration Awards.
- Aaron Robotham et al., 2012, ‘*Building galaxies with trees*’, UWA Research Collaboration Awards.

**Collaborations** **2013 – Present**

- EDGES [CI Judd Bowman], (2019 – )
- 21cmFAST [CI Andrei Mesinger], (2019 – )
- HERA [CI Dave DeBoer], (2018 – )
- GENESIS Project (Primary Liaison between MWA EoR and GENESIS) [CI Chris Power & Cath Trott], (2017 – )
- ASTRO 3D (Affiliate Investigator, Listed as Associate Investigator on Proposal) [CI Lisa Kewley], (2017 – )
- SKA CD/EoR SWG [CI Leon Koopmans], (2017 – )
- MWA EoR Team, ICRAR/Curtin [CI Cathryn Trott], (2015 – )
- Computational Theory Group, ICRAR/UWA [CI Chris Power], (2013 – 2018)
- UAM, Madrid [CI Alexander Knebe], (2013 – 2014)

**Memberships and Committees** **2012 – Present**

- SKA CD/EoR SWG [Member], (2017 – )
- ASA [Member], (2017 – )
- CAASTRO Postdoc Committee [Member], (2016 – 2018)
- CAASTRO Student Committee [Chair], (2014 – 2015)
- CAASTRO [Member], (2012 – 2018)

**Journal Referee** **2017 – Present**

- Referee for JOSS (2019 – )
- Referee for MNRAS (2017 – )

**Supervision** **2017 – Present**

- Supervised Undergraduate : Lily Whitler (2019 – 2020)
- Co-supervised PhD student: Bella Nasirudin (2017 – 2020)

- Teaching** **2004 – Present**
- First-Year Undergraduate Physics: *Lab Demonstration; Report Grading* (UWA, 2011 – 2011)
  - First-Year Undergraduate Mathematics: *Class Tutor; Assignment Grading* (UQ, 2009 – 2009)
  - Yr 10-12 Mathematics: *Private Tutor* (Private, 2006 – 2010)
  - Yr 10-12 Chemistry: *Private Tutor* (Private, 2006 – 2010)
  - Yr 10-12 Physics: *Private Tutor* (Private, 2006 – 2010)
  - Grades Pre-2 Piano: *Private Tutor* (Private, 2004 – 2020)

- Outreach** **2016 – Present**
- Outreach stall at ASU Open Door (Arizona State University, 2020)
  - Elementary School Presentation: "Deserts and Radio Astronomy" (Eagleridge Enrichment Center, 2019)
  - Outreach Stall at Perth Science Festival (Claremont Showgrounds, 2018)
  - CAASTRO in the Classroom Lecture: "Special Relativity" (Aurora College, NSW via Skype, 2017)
  - School Science Club Presentation: "From Plasma to Planets: How the Universe formed Structures out of Soup" (Perth Modern School, 2017)
  - Q and A Session (Penguin District School, TAS via Skype, 2017)
  - Q and A Session (Pilgrim Primary school SA via Skype, 2017)
  - CAASTRO in the Classroom Lecture: "Special Relativity" (NSW Schools via Skype, 2016)

- Professional Training** **2013 – Present**
- Laboratory Safety Training (ASU) (Oct 2018)
  - HDR Supervisor Induction (Feb 2017)
  - MWA Data Reduction Workshop (May 2016)
  - Code Testing for HPC (ASA Webinar Series) (Jul 2014)
  - Bayesian Astronomy with R (Jul 2013)

- Personal Training** **2015 – Present**
- Visual Communication for Scientists (Jul 2017)
  - Stress Management and Resilience (Nov 2017)
  - The Perfect Pitch (Nov 2017)
  - Atlassian ShipIt Hackathon (5th place) (Jul 2016)
  - Conversations at the Right Wavelength (Dec 2015)
  - How to benefit from and contribute to Open Science (Dec 2015)
  - Building Strong Leaders (Dec 2015)
  - Creative Thinking in the Workplace (Dec 2015)
  - ICRAR Media Training Workshop (Jul 2015)

**AWARDS AND  
SCHOLARSHIPS**

- Curtin**
- Most Entertaining Talk at ICRAR-CON (2017)
  - Most Scientifically Challenging Talk at ICRAR-CON (2017)
  - Best Overall Talk, CAASTRO Retreat (2017)

- UWA**
- Most Exciting Talk at ICRAR-CON (2014)
  - Ernest and Evelyn Shacklock Scholarship (2012, for 3 years)
  - CAASTRO Student Talk Prize (2012)

- ICRAR**
- ICRAR/Pawsey Summer Internship (2011, for 10 weeks)

## UQ

- UQ Excellence Scholarship (2007, for 3 years)
- Dean’s Commendation for High Achievement (2007, for 3 years)

## TECHNICAL SKILLS

Proficiency with Linux (Ubuntu and Arch) operating systems. Working knowledge of Windows and MacOS operating systems

Intimate knowledge of a variety of programming languages, in particular Python, Fortran and C, and to varying extents R, HTML, CSS, Javascript and SQL.

In-depth experience with matplotlib, numpy, scipy, emcee and emacs programs and frameworks, and to varying extents django, plotly-dash, bokeh, pandas and regex.

## SOFTWARE

Complete information at [github.com/steven-murray](https://github.com/steven-murray).

Notable repositories:

- ☆ 39 🔄 25 **hmf**: Python halo mass function calculator
- ☆ 20 🔄 3 **hankel**: Implementation of Ogata’s (2005) method for Hankel transforms.
- ☆ 07 🔄 6 **halomod**: Python package for dealing with the Halo Model
- ☆ 07 🔄 4 **powerbox**: A python package for making arbitrarily structured, arbitrary-dimension boxes

## PRESENTATIONS

### Invited Talks

1. “Overview of new 21cmFAST and 21cmMC” at Inaugural 21cmFAST Developers Workshop, Pisa, Italy (Sep 2019)

### Contributed Talks

1. “Making EDGES Bayesian” at Global 21cm Workshop, Montreal, Canada (Oct 2019)
2. “Bridging the Great Divide: Connecting Physical Foregrounds with Interferometric Instruments” at Rise and Shine, Strasbourg, France (Jun 2018)
3. “Getting the Edge on the Wedge” at ANITA Theory Workshop, Perth, Australia (Feb 2018)
4. “The Wedge and the Window” at CAASTRO Annual Retreat, Adelaide, Australia (Nov 2017) [**Prize for Best overall talk**]
5. “Between Wedge and Window: An Improved Statistical Point-Source Foreground Model for the EoR” at Peering Towards Cosmic Dawn, Dubrovnik, Croatia (Oct 2017)
6. “The Wedge and the Window” at ICRAR CON, Mandurah, Australia (Sep 2017) [**Prize for Most scientifically challenging talk and Most entertaining talk**]
7. “Between Wedge and Window: An Improved Statistical Point-Source Foreground Model for the EoR” at Fundamental Physics with the SKA, Flic-en-Flac, Mauritius (May 2017)
8. “Realistic Visibility Covariance for the EoR in the presence of. . . well, just about everything.” at ANITA Theory Workshop, Hobart, Australia (Feb 2017)

9. “An Improved Statistical Foreground Model for the EoR” at CAASTRO Annual Retreat, Busselton, Australia (Nov 2016)
10. “A Simple Halo Mass Function Distribution” at Diving into the Dark, Cairns, Australia (Jul 2016)
11. “Eddington Bias vs. Hierarchical Bayes in the Halo Mass Function” at Statistical Challenges in 21st Century Cosmology, Chania, Greece (May 2016)
12. “Simplifying the Halo Mass Function” at ICRAR CON, Rottnest Island, Australia (Sep 2015)
13. “Dark Matters” at CAASTRO Annual Retreat, Twin Waters, Australia (Nov 2014)
14. “HALOgen: A Fast Approximate Halo Generator” at ICRAR CON, Rottnest Island, Australia (Sep 2014) [**Prize for Most Exciting Talk**]
15. “HALOgen” at nIFTy Cosmology, Madrid, Spain (Jun 2014)
16. “Tools and Statistics with Dark Matter Halos” at ANITA Theory Workshop, Sydney, Australia (Feb 2014)
17. “The Generalised 2-Point Correlation Function” at ANITA Theory Workshop, Brisbane, Australia (Feb 2013)
18. “The Generalised 2-Point Correlation Function” at CAASTRO Annual Retreat, Pinnacles, Australia (Sep 2012) [**Prize for Best Student Talk**]
19. “Current Status and Future Plans for EDGES” at Next-Generation Cosmology with Next-Generation Radio Telescopes: II, Sesto, Italy (Jan 2020)

### Local Science Talks

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1. “Properties of Dense, Regular, Low-Frequency Radio Interferometers” at Engineering Coffee, ASU (20/05/2020)
2. “Between Wedge and Window: An Improved Statistical Point-Source Foreground Model for the EoR” at Curtin Journal Club, Curtin University (20/06/2017)
3. “Next-generation tools for next-generation surveys” at Curtin Journal Club, Curtin University (12/01/2017)
4. “An Improved Statistical Point-Source Foreground Model for the EoR” at CAASTRO Perth Area Meeting, Curtin University (01/10/2016)
5. “Simplifying the Halo Mass Function” at Curtin Journal Club, Curtin University (08/02/2016)
6. “Modeling Galaxies in the Era of Big Data” at ICRAR Student Day, UWA (17/07/2014)
7. “Tools and Statistics with Dark Matter Halos” at CAASTRO Perth Area Meeting, UWA (24/02/2014)
8. “How well do we know the Halo Mass Function?” at ICRAR/UWA Astro Morning Tea, UWA (03/07/2013)
9. “Testing the CDM model with the Halo Mass Function” at ICRAR Student Day, Curtin University (20/05/2012)

## Tutorials




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1. “Introduction to Git and Github” at CHAMP Camp, Virtual (19/06/2020)
2. “Reionization Theory and 21cmFAST” at CHAMP Camp, Virtual (16/06/2020)
3. “Advanced Python” at CHAMP Camp, Virtual (10/06/2020)
4. “The new 21cmFAST and 21CMMC” at Next-Generation Cosmology with Next-Generation Radio Telescopes: II, Sesto, Italy (31/01/2020)
5. “Modern Python Tooling” at Inaugural 21cmFAST Developer’s Workshop, Pisa, Italy (01/10/2019)
6. “Introduction to Git and Github” at CHAMP Camp, Santa Fe, NM (07/06/2019)
7. “Advanced Python” at CHAMP Camp, Santa Fe, NM (04/06/2019)
8. “Bayesian Statistics and MCMC” at StdErr, Curtin University (12/03/2018)
9. “Coding Practices and Documentation” at CAASTRO Coding Workshop, Curtin University (07/12/2017)
10. “Bokeh vs. Dash: Interactive Python Visualisation” at StdErr, Curtin University (21/07/2017)
11. “The Jupyter Notebook” at Pyclub, Curtin University (01/10/2016)
12. “Documentation in Python” at PyClub, Curtin University (01/02/2016)




## PUBLICATIONS















To see a configurable list of all my publications, see my [ADS list](#). Information correct as of 14 Aug 2020. Any arxiv e-prints displayed have been accepted.

Total Papers = 26, Total Citations = 492, H-index = 11, M-index = 1.57.

Key:  Papers,  Citations,  Reads (on NASA ADS)

### First author papers

 7  241  203









1. **Murray, Steven**, Poulin, Francis (2019), *hankel: A Python library for performing simple and accurate Hankel transformations*, [JOSS](#), **4**, 1397  2  32
2. **Murray, Steven G.**, Trott, C. M. (2018), *The Effect of Baseline Layouts on the Epoch of Reionization Foreground Wedge: A Semianalytical Approach*, [ApJ](#), **869**, 25  3  6
3. **Murray, S. G.**, Robotham, A. S. G., Power, C. (2018), *An Empirical Mass Function Distribution*, [ApJ](#), **855**, 5  0  16
4. **Murray, Steven G.** (2018), *powerbox: A Python package for creating structured fields with isotropic power spectra*, [JOSS](#), **3**, 850  2  12
5. **Murray, S. G.**, Trott, C. M., Jordan, C. H. (2017), *An Improved Statistical Point-source Foreground Model for the Epoch of Reionization*, [ApJ](#), **845**, 7  18  6
6. **Murray, S. G.**, Power, C., Robotham, A. S. G. (2013), *HMFcalc: An online tool for calculating dark matter halo mass functions*, [A&C](#), **3**, 23  181  91
7. **Murray, S. G.**, Power, C., Robotham, A. S. G. (2013), *How well do we know the halo mass function ?*, [MNRAS](#), **434**, L61  35  40

8. Nasirudin, A., **Murray, S. G.**, Trott, C. M. et. al. (2020), *The Impact of Realistic Foreground and Instrument Models on 21 cm Epoch of Reionization Experiments*, [ApJ](#), **893**, 118 ✍ 0 👁 37
9. Trott, Cathryn M., Fu, Shih Ching, **Murray, S. G.** et. al. (2019), *Robust statistics towards detection of the 21 cm signal from the Epoch of Reionization*, [MNRAS](#), **486**, 5766 ✍ 3 👁 18
10. Wolz, L., **Murray, S. G.**, Blake, C., Wyithe, J. S. (2019), *Intensity mapping cross-correlations II: HI halo models including shot noise*, [MNRAS](#), **484**, 1007 ✍ 9 👁 22
11. Trott, Cathryn M., Watkinson, Catherine A., Jordan, Christopher H. et. al. (2019), *Gridded and direct Epoch of Reionisation bispectrum estimates using the Murchison Widefield Array*, [PASA](#), **36**, e023 ✍ 10 👁 9
12. Meyers, B. W., Tremblay, S. E., Bhat, N. D. R. et. al. (2018), *Hunting for Radio Emission from the Intermittent Pulsar J1107-5907 at Low Frequencies*, [ApJ](#), **869**, 134 ✍ 8 👁 13
13. Obreschkow, D., **Murray, S. G.**, Robotham, A. S. G., Westmeier, T. (2018), *Eddington's demon: inferring galaxy mass functions and other distributions from uncertain data*, [MNRAS](#), **474**, 5500 ✍ 7 👁 15
14. Trott, Cathryn M., Jordan, C. H., **Murray, S. G.** et. al. (2018), *Assessment of Ionospheric Activity Tolerances for Epoch of Reionization Science with the Murchison Widefield Array*, [ApJ](#), **867**, 15 ✍ 4 👁 0
15. Jordan, C. H., **Murray, S.**, Trott, C. M. et. al. (2017), *Characterization of the ionosphere above the Murchison Radio Observatory using the Murchison Widefield Array*, [MNRAS](#), **471**, 3974 ✍ 20 👁 4
16. Avila, Santiago, **Murray, Steven G.**, Knebe, Alexander et. al. (2015), *HALO-GEN: a tool for fast generation of mock halo catalogues*, [MNRAS](#), **450**, 1856 ✍ 34 👁 9




## Collaboration papers





17. Kern, Nicholas S., Parsons, Aaron R., Dillon, Joshua S. et. al. (2020), *Mitigating Internal Instrument Coupling for 21 cm Cosmology. II. A Method Demonstration with the Hydrogen Epoch of Reionization Array*, [ApJ](#), **888**, 70 ✍ 10 👁 31
18. Kern, Nicholas S., Dillon, Joshua S., Parsons, Aaron R. et. al. (2020), *Absolute Calibration Strategies for the Hydrogen Epoch of Reionization Array and Their Impact on the 21 cm Power Spectrum*, [ApJ](#), **890**, 122 ✍ 9 👁 40
19. Weltman, A., Bull, P., Camera, S. et. al. (2020), *Fundamental physics with the Square Kilometre Array*, [PASA](#), **37**, e002 ✍ 58 👁 111
20. Liu, Adrian, Aguirre, James, Ali-Haimoud, Yacine et. al. (2019), *Cosmology with the Highly Redshifted 21 cm Line*, [Bulletin of the American Astronomical Society](#), **51**, 63 ✍ 2 👁 28
21. La Plante, Paul, Alvarez, Marcelo, Fialkov, Anastasia et. al. (2019), *Mapping Cosmic Dawn and Reionization: Challenges and Synergies*, [Bulletin of the American Astronomical Society](#), **51**, 394 ✍ 0 👁 7
22. Furlanetto, Steven, Bowman, Judd D., Mirocha, Jordan et. al. (2019), *Fundamental Cosmology in the Dark Ages with 21-cm Line Fluctuations*, [Bulletin of the American Astronomical Society](#), **51**, 144 ✍ 0 👁 4



23. Furlanetto, Steven, Beardsley, Adam, Carilli, Chris L. et. al. (2019), *Synergies Between Galaxy Surveys and Reionization Measurements*, [Bulletin of the American Astronomical Society](#), 51, 142  0  2
24. Furlanetto, Steven, Carilli, Chris L., Mirocha, Jordan et. al. (2019), *Insights Into the Epoch of Reionization with the Highly-Redshifted 21-cm Line*, [Bulletin of the American Astronomical Society](#), 51, 143  0  3
25. Li, W., Pober, J. C., Hazelton, B. J. et. al. (2018), *Comparing Redundant and Sky-model-based Interferometric Calibration: A First Look with Phase II of the MWA*, [ApJ](#), 863, 170  20  17
26. Chuang, Chia-Hsun, Zhao, Cheng, Prada, Francisco et. al. (2015), *nIFTy cosmology: Galaxy/halo mock catalogue comparison project on clustering statistics*, [MNRAS](#), 452, 686  57  13

### Conference proceedings

 2  3  2

27. **Murray, S. G.**, Trott, C. M., Jordan, C. H. (2018), *A Clustered Extragalactic Foreground Model for the EoR*, [Peering towards Cosmic Dawn](#), 333, 199  3  2
28. **Murray, S. G.**, Power, C., Robotham, A. S. G. (2014), *Modelling Galaxy Populations in the Era of Big Data*, [Statistical Challenges in 21st Century Cosmology](#), 306, 304  0  0