# Paul James Wright


CONTACT INFORMATION

Rm 614, Kelvin Building
University of Glasgow
Glasgow, G12 8QQ
United Kingdom

Work: +44 (0)14133 08855
Web: www.pauljwright.co.uk
Email: paul.wright@glasgow.ac.uk
Publication List: SAO/NASA ADS


RESEARCH SUMMARY

My research interests are in solar and stellar physics, and my Ph.D. research has concentrated on one of the unsolved problems in Heliophysics – the coronal heating problem. During my Ph.D. I have gained expertise in numerous time-series analysis techniques and methods for recovering the differential emission measure (an ill-posed inverse problem) from a wide range of spectroscopic and narrowband data. I am a member of the *NuSTAR* Heliophysics working group and I led the analysis of the first solar flare observed by the *NuSTAR* hard X-ray *astrophysics* imaging spectrometer. I have also developed a stellar flare detection algorithm based on the observations obtained by the *Kepler* space telescope to determine the superflare rate of the Sun.

EDUCATION

**University of Glasgow**, Glasgow, UK — 2014 – present
Ph.D. Solar Physics
Thesis Topic: *The Energetics of Small Flares and Brightenings*
Advisers: Dr Iain G. Hannah, Dr Alexander MacKinnon

**University of Southampton**, Southampton, UK — 2010 – 2014
MPhys Astrophysics with a year abroad
First-class honours (1:1)
Adviser: Professor Malcolm Coe

**Smithsonian Astrophysical Observatory**, Cambridge, MA, USA — 2013 – 2014
MPhys Astrophysics with a year abroad
Thesis Topic: *The Superflare Rates of Solar-Like Stars*
Advisers: Dr Steven H. Saar, Dr Jeremy J. Drake

CURRENT ACADEMIC APPOINTMENT

**Affiliate Staff Member**, University of Glasgow — 2017 – present
SUPA School of Physics and Astronomy

- Using the EBTEL hydrodynamics code to model light curves from coronal loops. The parameter space of these simulations will be constrained by observations obtained during the *NuSTAR* heliophysics campaign, and these simulations will be used to test a variety of analysis techniques.

PREVIOUS ACADEMIC APPOINTMENTS

**Researcher**, NASA Frontier Development Lab (FDL) — 2018
SETI Institute/NASA Ames Research Center, Mountain View, CA
Project: *Predicting Solar Spectral Irradiance from SDO/AIA Observations*

- A selective (12% acceptance rate) 8-week applied Artificial Intelligence accelerator established to tackle knowledge gaps useful to NASA's science and exploration goals, and humanity.
- Implemented Deep Learning algorithms (Convolutional Neural Networks; CNNs) such as U-Net, AlexNet and ResNet to predict disk-integrated Solar Spectral Irradiance (SSI) observed by *SDO*/EVE (MEGS-A) from high-resolution *SDO*/AIA images which share a common latent space.
- Predicted MEGS-A SSI with median absolute relative discrepancies of less than 1.6% using a CNN augmented with a Multi-Layer Perceptron (MLP).
- Used a 1x1 CNN (equivalent to an MLP) to improve the computational speed for differential emission measure (DEM) inversion. Further improvement to the resulting DEMs were obtained by training a CNN to correct the DEMs to minimise the residual between observed and synthesized SSI.
- Received the NASA Frontier Development Lab "Contribution to Science" award.

## Previous Academic Appointments (Cont.)

**Post-Graduate Research Assistant**, University of Glasgow 2014 – 2017
SUPA School of Physics and Astronomy
Project: *The Energetics of Small Flares and Brightenings*

- Analysed observations of the Sun with *NuSTAR*, a telescope not designed for heliophysics. These observations are the most sensitive of their kind and have resulted in numerous, wide-ranging, highly-collaborative peer-reviewed publications.
- Analysed non-flaring coronal time-series in pursuit of signatures of the coronal heating mechanism. Techniques included time-lag analysis (cross-correlation), Fourier analysis, wavelet analysis, and local intermittency measure (LIM).
- Studied the temperature distribution of the solar atmosphere through the recovery of an ill-posed inverse problem (the differential emission measure, DEM) using techniques such as Tikhonov regularisation, Markov-chain Monte Carlo, Spline fitting, and Sparse Inversion (by Basis Pursuit).
- The press-release image produced from the *NuSTAR* observations obtained for Wright *et al.* 2017 was published by numerous news outlets and is one of the five iconic images from *NuSTAR*'s first five years in space.

Primary Collaborators: *Dr Iain Hannah, Dr Alexander MacKinnon, Dr Hugh Hudson, Dr Paulo Simões*

**Visiting Researcher**, NASA Goddard Space Flight Center (GSFC) 2016
Heliophysics Science Division

- Explored the possibility of implementing DEM maps in the Helioviewer project, and their usefulness as an input for various established time-series analysis techniques.

Collaborators: *Dr Nicholeen Viall, Dr Jack Ireland*

**Research Scholar**, Center for Astrophysics | Harvard & Smithsonian 2013 – 2014
Solar and Stellar X-ray Group
Project: *The Superflare Rates of Solar-Like Stars*

- Designed and implemented a sophisticated stellar flare detection routine for long-cadence (30 mins) *Kepler* data obtained from a proprietary set of spectroscopically verified solar-type stars in three open clusters.
- A preliminary report on this work had coverage by Science and the Smithsonian Magazine.

Collaborators: *Dr Steven Saar, Dr Søren Meibom, Dr Jeremy Drake, Dr José D. do Nascimento Jr, Dr Vinay Kashyap*

**Summer Research Intern**, University of Southampton 2013
Astronomy Group

- Investigated the presence of double blue straggler sequences in globular clusters using Hubble Space Telescope (ACS, WFPC2) data.

Collaborators: *Dr Andrea Dieball*

## Refereed Journal Publications

[1] Marsh, A. J., Smith, D. M., Glesener, L. *et al* 2017. *First NuSTAR Limits on Quiet Sun Hard X-Ray Transient Events*, ApJ, 849, 131

[2] Wang, J., Simões, P. J. A., Jeffrey, N. L. S. *et al* 2017. *Observations of Reconnection Flows in a Flare on The Solar Disk*, ApJL, 847, L1

[3] **Wright, P. J.**, Hannah, I. G., Grefenstette, B. W., *et al* 2017. *Microflare Heating of a Solar Active Region Observed with NuSTAR, Hinode/XRT, and SDO/AIA*, ApJ, 844, 132

[4] Kuhar, M., Krucker, S., Hannah, I. G., *et al* 2017. *Evidence of Significant Energy Input in the Late Phase of a Solar Flare from NuSTAR X-ray Observations*, ApJ, 835, 6

FIRST AUTHOR PUBLICATIONS IN PREPARATION (WORKING TITLES)

[5] **Wright, P. J.**, MacKinnon, A., Hannah, I. G., and Simões, P. J. A. 2019. *Local Intermittency Measure: The Application to Active Region Light Curves*

[6] **Wright, P. J.**, Hannah, I. G., Viall, N. M., *et al* 2019. *The Thermal Time Evolution of Active Regions Determined by SDO/AIA*

[7] **Wright, P. J.**, Saar, S. H., Meibom, S., *et al* 2019. *The Age-Dependent Superflare Rates of G-Type Dwarfs In Three Kepler Clusters*

[8] **Wright, P. J.**, Saar, S. H., Meibom, S., *et al* 2019. *An Extension of The Age-Dependent Superflare Rates to F- and K-Type Dwarfs*

CONFERENCES, WORKSHOPS, & SCHOOLS

**Invited Oral Presentations**

| | |
|---|---|
| *ISSI Team Meeting: Coronal Nanoflares*, Bern, CH | 2018 |
| *ISSI Team Meeting: Coronal Nanoflares*, Bern, CH | 2016 |
| *Center for Astrophysics | Harvard & Smithsonian*, Cambridge, MA, USA | 2014 |

**Oral/e-Poster Presentations**

| | |
|---|---|
| *Living with a Star (SDO/LWS) Workshop*, Ghent, Belgium | 2018 |
| *Solar Physics Division Meeting (SPD/AAS)*, Portland, OR, USA | 2017 |
| *Coronal Loops Workshop* VIII, Palermo, Sicily, IT | 2017 |
| *Living with a Star (SDO/LWS) Workshop*, Burlington, VT, USA | 2016 |
| *Hinode 10*, Nagoya, JP | 2016 |
| *National Astronomy Meeting 2016*, Nottingham, UK | 2016 |
| *Hinode 9*, Belfast, UK | 2015 |
| *Glasgow-Cambridge Flare Workshop*, Glasgow, UK | 2015 |

**Poster Presentations**

| | |
|---|---|
| *European Solar Physics Meeting (ESPM)*, Budapest, HU | 2017 |
| *Solar Physics Division Meeting (SPD/AAS)*, Portland, OR, USA | 2017 |
| *Living with a Star (SDO/LWS) Workshop*, Burlington, VT, USA | 2016 |
| *Coronal Loops Workshop* VII, Cambridge, UK | 2015 |
| *National Astronomy Meeting (NAM) 2015*, Llandudno, UK | 2015 |
| *223rd AAS Meeting*, National Harbor, MD, USA | 2014 |

**Schools Attended**

| | |
|---|---|
| *CESRA Radio Summer School 2015*, Glasgow, UK | 2015 |
| *STFC Advanced Summer School in Solar Physics*, Dundee, UK | 2014 |

**Additional Conferences/Workshops Attended**

| | |
|---|---|
| *NuSTAR Heliophysics Workshop (remote participation)*, Berkeley, CA, USA | 2017 |
| *SUPA Cormack Astronomy Meeting*, Edinburgh, UK | 2015 |
| *Royal Astronomical Society Discussion Meeting: Results from IRIS*, London, UK | 2015 |
| *SUPA Cormack Astronomy Meeting*, Edinburgh, UK | 2014 |
| *1st Space Glasgow Research Conference*, Glasgow, UK | 2014 |

AWARDS AND GRANTS TOTAL: £7000

**University of Glasgow**

| | |
|---|---|
| NASA Frontier Development Lab, Contribution to Science Award | 2018 |
| Solar Physics Division Meeting (AAS/SPD) Student Poster Award | 2017 |
| Solar Physics Division Meeting (AAS/SPD) Studentship Award | 2017 |
| Coronal Loops Workshop VIII Travel Award | 2017 |
| National Astronomical Observatory of Japan Travel Award | 2016 |
| Hinode 9 Travel Award | 2015 |
| European Space Agency/Cambridge Philosophical Society Travel Award | 2015 |

AWARDS AND GRANTS (CONT.)

**University of Southampton**
- Research Scholarship 2013
- Summer Studentship Grant 2013

TEACHING

**Coursera Inc.**
- **"Data Scientists Toolbox" Community Mentor** 2017 – present
  An invited mentor of a course in the Data Science specialisation offered by Johns Hopkins University.

**University of Glasgow**
- **Astronomy 1 Tutorial Demonstrator** 2016 - 2017
  Supervised students, and marked first-year astronomy problem sets.
- **Astronomy 3/4 (Honours) Laboratory Demonstrator** 2015 - 2016
  Demonstrated, supervised, and marked a number of final-year research projects covering topics such as asteroid light curves, and solar limb darkening.
- **Physics Pre-University Summer School** 2015
  Taught at a pre-university school for students entering the first year of undergraduate education.

MEMBERSHIPS

- ***NuSTAR* Heliophysics Working Group**, Member 2015 – present
- **International Space Science Institute (ISSI)**, Young Scientist Member 2015 – present
  Member of Paola Testa's ISSI Team: *New Diagnostics of Particle Acceleration in Solar Coronal Nanoflares from Chromospheric Observations and Modelling*
- **Royal Astronomical Society**, RAS Fellow 2014 – present

COMMUNITY INVOLVEMENT

- **Nature Communications**, Reviewer 2017 – present
- **Glasgow Astronomy & Astrophysics Group Meeting**, Organiser 2017
- **CESRA Radio Summer School**, Volunteer Organiser 2015

SCIENTIFIC OUTREACH

- **Glasgow Science Centre**, Demonstrator 2016
- **British Science Week**, Demonstrator 2016
- **Institute of Physics:** *Women and Girls in Science*, Demonstrator 2016
- **Scottish Television (STV)**, Guest Presenter 2015
- **World Wide Telescope**, Ambassador 2013 – 2014
- **BBC Stargazing Live**, Demonstrator 2013
- **So'ton Astrodome**, Demonstrator 2012
- **BBC Bang Goes The Theory Roadshow**, Demonstrator 2012

**UK Solar Physics (UKSP) Nuggets**, concise, easy-to-read science articles
- 84. The first *NuSTAR* microflare 2017

**Hinode/XRT Picture of the Week (XPOW)**
- The First Microflare Observations with *Hinode*/XRT & *NuSTAR* 2017

PERSONAL PROJECTS

- **ColourBlind**, A repository for colour-blind-friendly colour tables.

PROFESSIONAL DEVELOPMENT

**Coursera, Inc. (MOOC Platform)**
Using Coursera.org, a massive open online course (MOOC) platform, to take specialisations (a series of related courses plus a final capstone project) offered by accredited universities to further develop skills and understanding in a wide range of topics.

**Data Science**, Johns Hopkins University 2017 – present
Nine-course (plus capstone) introduction to data science.

**Mastering Software Development in R**, Johns Hopkins University 2018 – present
Four-course (plus capstone) specialisation providing rigorous training in R.

TECHNICAL SKILLS:

*Computing:* IDL (5+ years), Python (2+ years), PyTorch, R, Bash, LaTeX, PyCharm, IRAF, git (GitHub, Gitlab), Microsoft Office, Adobe Creative Cloud, Linux/Unix, Mac OSX, Microsoft Windows

*General:* Data Analysis, Data Visualisation, Interdisciplinary Collaboration, Public Speaking, Teaching, Writing (Technical & Lay)