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 — 10/2014 – 04/2019
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 — 10/2010 – 06/2014
MPhys Astrophysics with a year abroad
First-class honours (1:1)
Adviser: Professor Malcolm Coe

Smithsonian Astrophysical Observatory, Cambridge, MA, USA — 10/2013 – 06/2014
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

Postdoctoral Research Fellow Stanford University — 05/2019 – present
W. W. Hansen Experimental Physics Laboratory

PREVIOUS ACADEMIC APPOINTMENTS

Affiliate Staff Member, University of Glasgow — 10/2017 – 04/2019
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.

Researcher, NASA Frontier Development Lab (FDL) — 06/2018 - 08/2018
SETI Institute/NASA Ames Research Center, Mountain View, CA
Project: *Predicting Solar Spectral Irradiance from SDO/AIA Observations*

- A selective 8-week applied Artificial Intelligence (AI) 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 uncertainties of less than 1.6% per emission line using a CNN augmented with a Multi-Layer Perceptron (MLP).
- Used a 1x1 CNN (equivalent to an MLP) to improve the computational speed ($10000\times$ increase) 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 10/2014 – 07/2017
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) 04/2016
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 10/2013 – 06/2014
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 07/2013
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

BOOK CHAPTERS

[5] **Wright, P. J.**, Cheung, M. C. M., Thomas, R., *et al* 2018 *DeepEM: A Deep Learning Approach to DEM Inversion*. In M. Bobra & J. Mason, eds., *Machine Learning, Statistics, and Data Mining for Heliophysics*, Chapter 4

FIRST AUTHOR PUBLICATIONS IN PREPARATION (WORKING TITLES)

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

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

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

[9] **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)