Paul James Wright

CONTACT INFORMATION

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Publication List: SAO/NASA ADS

RESEARCH SUMMARY

My research experience includes in utilising numerous time-series analysis techniques and methods for recovering the differential emission measure (the temperature distribution of the solar atmosphere; an ill-posed inverse problem) from a wide range of spectroscopic and narrowband data (e.g *Solar Dynamics Observatory*/Atmospheric Imaging Assembly, *SDO*/AIA). I have attended and presented at a wide range of international conferences including 11 oral presentations (3 invited), and have presented an invited workshop talk on accelerating differential emission measure inversion with neural networks.

EDUCATION

University of Glasgow, Glasgow, UK — 2014 – present
Ph.D. Solar Physics
Thesis Topic: *The Energetics of Small Flares and Brightenings*

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

Smithsonian Astrophysical Observatory, Cambridge, MA, USA — 2013 – 2014
MPhys Astrophysics with a year abroad
Thesis Topic: *The Superflare Rates of Solar-Like Stars*

EXPERIENCE & SKILLS

Visiting Scientist, Center for Astrophysics | Harvard & Smithsonian — 2019 – present
Solar and Stellar X-ray Group

- Primarily preparing two first-author manuscripts for publication on a Python-based stellar flare detection routine.

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

- Using a 0-D 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) — 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 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.

EXPERIENCE & SKILLS (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.

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.

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.

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 Differential Emission Measure Inversion*. In M. Bobra & J. Mason, eds., *Machine Learning, Statistics, and Data Mining for Heliophysics*, Chapter 4

SELECTED 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
National Astronomical Observatory of Japan Travel Award	2016
European Space Agency/Cambridge Philosophical Society Travel Award	2015

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.

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

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)