

Dr Raphael Shirley

I am an astronomer, physicist and data scientist with extensive Python programming experience. I am interested in extragalactic astronomy, astrostatistics, Bayesian inference, and machine learning.

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Education

PhD Theoretical Insights into the Combustion Synthesis of Titanium Dioxide Nanoparticles, Computational Modelling Group, Department of Chemical Engineering and Biotechnology, University of Cambridge. Thesis supervised by Professor Markus Kraft, 2011.

BA/MSci Natural Sciences; specialising in theoretical physics, St John's College, University of Cambridge, 2006. Final year project: Radio Astronomy with Focal Plane Arrays supervised by Dr Rachel Padman.

Employment

May 2019–present: Space IR Missions Fellowship. Post-doctoral research position at Instituto de Astrofísica de Canarias. Working on transient follow up and harnessing wide area surveys to understand galaxy formation and evolution.

2016–2019: Daphne Jackson Research Fellow; post-doctoral research assistant at the Astronomy Centre, University of Sussex, UK. Roles included being *Herschel* Extragalactic Legacy Project (HELP) Project Scientist; continuing development and scientific exploitation of HELP. HELP pipeline scientist; producing a multiwavelength database across over 1200 square degrees of *Herschel Space Observatory* extragalactic fields. I also worked on short data science projects involving the application of Bayesian inference and machine learning to problems relevant to public health, crop yield forecasting with the Met Office and lie detection with neural networks. This work was conducted as part of the newly formed Data Science Department at Sussex.

2011–2016: Co-owner and manager, Edwin Shirley Ltd. General management of family run transport business based in London (turnover ~£500k, small-medium enterprise with over 10 employees). Responsibilities included securing clients and payment, managing accounts, organising theatre tour logistics, and overseeing the transition to a new company director on my departure.

Presentations

I organised the Sussex Astronomy Centre extragalactic seminar series for 2017–2018. In addition to regular talks at Sussex and Cambridge, and numerous short talks and posters at international conferences I have presented the following talks:

I am currently organising a two day workshop on using JWST proposal tools in which I will give around half of the presentations. Having been selected to attend the ESA-JWST Master Class at European Space Astronomy Centre, Madrid. I will learn to teach astronomers to use the exposure time calculator and astronomers proposal tool. I will deliver two of these workshops; one at the IAC, Tenerife on 12 and 13 March 2020 and one at the Centro de Astrobiología (CAB), Madrid, Spain, on 16 and 17 March 2020.

20 minute contributed talk at *Herschel* ten years after launch celebration, European Space Astronomy Centre, Madrid, Spain, 2019.

1 hour talk on HELP project, National Centre for Nuclear Research Warsaw, Poland, 2019.

1 hour talk on HELP software pipeline, HELP European Research Council final review meeting, European Research Council Executive Agency, Brussels, Belgium, 2018.

30 minute talk on HELP database, HELP meeting, University of Sussex, UK, 2017.

30 minute talk on HELP project, Tufts University, Boston, USA, 2017.

10 minute talk at the National Astronomy Meeting, University of Hull, UK, 2017.

45 minute talk at the 33rd International Symposium on Combustion, Tsinghua University, Beijing, China, 2010.

Teaching

2019: I gave a short course of four two hour lectures on scientific computing with Python to astronomy masters students, Universidad de La Laguna.

2017–2019: Teaching Assistant on course Data Analysis Techniques for physics masters and first year PhD students, University of Sussex. Supervision of fourth year masters student and first year PhD students, University of Sussex.

2010–2011: Supervised two fourth year masters projects, both leading to publications, University of Cambridge.

2007–2011: Supervised third and fourth year undergraduate courses Statistics for Engineers, and Mathematical Methods for Engineering, University of Cambridge.

Journal Articles

I have 18 publications in refereed journals, 6 first author publications, 559 citations, and an h-index of 10. Statistics taken from [Google Scholar](#).

R. Shirley, E. Pope, M. Bartlett, S. Oliver, N. Quadrianto, P. Hurley, S. Duivenvoorden, P. Rooney, A. Baratt, C. Kent, J. Bacon. An empirical, Bayesian approach to modelling crop yield: Maize in USA, *Environmental Research Communications (in press 2020)* doi:10.1088/2515-7620/ab67fo

C.F. Lim, W.H. Wang, I. Smail, D. Scott, C.C. Chen, Y.Y. Chang, J.M. Simpson, Y. Toba, X. Shu, D. Clements, J. Greenslade, Y. Ao, A. Babul, J. Birkin, S.C. Chapman, T.A. Cheng, B.S. Cho, H. Dannerbauer, U. Dudzeviciute, J. Dunlop, Y. Gao, T. Goto, L.C. Ho, L.T. Hsu, H. Seong Hwang, W.S. Jeong, M. Koprowski, C.H. Lee, M.Y. Lin, W.C. Lin, M.J. Michałowski, H. Parsons, M. Sawicki, **R. Shirley**, H. Shim, S. Urquhart, J. Wang, T. Wang. SCUBA-2 Ultra Deep Imaging Eao Survey (Studies) III: Multi-wavelength properties, luminosity functions and preliminary source catalog of 450- μ m-selected galaxies, *The Astrophysical Journal (in press 2019)*, arXiv:1912.03669.

N. Krefting, A. Sajina, M. Lacy, K. Nyland, D. Farrah, B. Darvish, S. Duivenvoorden, K. Duncan, V. Gonzalez-Perez, C. P. Lagos, S. Oliver, **R. Shirley**, M. Vaccari. The role of environment in galaxy evolution in the SERVS Survey I: density maps and cluster candidates, *The Astrophysical Journal* (in press 2019), *arXiv:1912.02238*.

R. Marques-Chaves, I. Pérez-Fournon, Y. Shu, L. Colina, A. Bolton, J. Álvarez-Márquez, J. Brownstein, M. Cornachione, S. Geier, C. Jiménez-Ángel, T. Kojima, S. Mao, A. Montero-Dorta, M. Oguri, M. Ouchi, F. Poidevin, **R. Shirley**, and Z. Zheng. Rest-frame UV Properties of Luminous Strong Gravitationally Lensed Ly α Emitters from the BELLS GALLERY Survey. *Monthly Notices of the Royal Astronomical Society* (in press 2019), *arXiv:1912.04033*.

S. Duivenvoorden, S. Oliver, M. Béthermin, D. L. Clements, G. De Zotti, A. Efstathiou, D. Farrah, P. D. Hurley, R. J. Ivison, G. Lagache, D. Scott, **R. Shirley**, L. Wang, and M. Zemcov. Have we seen all the galaxies that comprise the cosmic infrared background at 250 μm —500 μm . *Monthly Notices of the Royal Astronomical Society* 491.1, 1355-1368, 2019.

R. Shirley, Y. Roehly, P. D. Hurley, V. Buat, M. C. C. Varillas, S. Duivenvoorden, K. J. Duncan, A. Efstathiou, D. Farrah, E. González Solares, K. Małek, L. Marchetti, I. McCheyne, E. Pons, A. Papadopoulos, R. Scipioni, M. Vaccari, and S. Oliver. HELP: A catalogue of 170 million objects, selected at 0.36—4.5 μm , from 1270 deg^2 of prime extragalactic fields, *Monthly Notices of the Royal Astronomical Society*, 490.1, 634-656, 2019.

K. Małek, V. Buat, Y. Roehly, D. Burgarella, P. D. Hurley, **R. Shirley**, K. Duncan, A. Efstathiou, A. Papadopoulos, M. Vaccari, D. Farrah, L. Marchetti, and S. Oliver. HELP: modelling the spectral energy distributions of Herschel detected galaxies in the ELAIS N1 field, *Astronomy and Astrophysics*, 619, A135, 2018.

V. Buat, M. Boquien, K. Małek, D. Corre, Y. Roehly, **R. Shirley**, and A. Efstathiou. Dust attenuation and H α emission in a sample of galaxies observed with Herschel at $0.6 < z < 1.6$, *Astronomy and Astrophysics*, 620, A50, 2018.

R. Shirley, J. Akroyd, L. A. Miller, O. I. Inderwildi, U. Riedel, and M. Kraft. Theoretical insights into the surface growth of rutile TiO $_2$, *Combustion and Flame*, 158:10, 2011.

T. Totton, **R. Shirley**, and M. Kraft. First-principles thermochemistry for the combustion of TiCl $_4$ in a methane flame, *Proceedings of the Combustion Institute*, 33, 2011.

J. Akroyd, A. J. Smith, **R. Shirley**, and M. Kraft. A coupled CFD-population balance approach for nanoparticle synthesis in turbulent reacting flows, *Chemical Engineering Science*, 66:17, 2011.

R. Shirley, M. Kraft, and O. I. Inderwildi. Electronic and optical properties of aluminium-doped anatase and rutile TiO $_2$ from *ab initio* calculations, *Physical Review B*, 81:075111, 2010.

R. Shirley, W. Phadungsukanan, M. Kraft, J. Downing, N. E. Day, and P. Murray-Rust. First-principles thermochemistry for gas phase species in an industrial rutile chlorinator. *Journal of Physical Chemistry A*, 114:43, 2010.

A. Raj, P. L. W. Man, T. Totton, M. Sander, **R. Shirley**, and M. Kraft. New polycyclic aromatic hydrocarbon (PAH) surface processes to improve the model prediction of the composition of combustion-generated PAHs and soot, *Carbon*, 48, 319-332, 2010.

R. Shirley, Y. Liu, T. S. Totton, R. H. West, and M. Kraft. First-principles thermochemistry for the combustion of a TiCl $_4$ and AlCl $_3$ mix, *Journal of Physical Chemistry A*, 113:13790-13796, 2009.

R. H. West, **R. Shirley**, M. Kraft, C. F. Goldsmith, and W. H. Green. A detailed kinetic model for combustion synthesis of titania from TiCl_4 , *Combustion and Flame*, 156:1764–1770, 2009.

A. Raj, M. S. Celnik, **R. Shirley**, M. Sander, R. I. A. Patterson, R. H. West, and M. Kraft. A statistical approach to develop a detailed soot growth model using PAH characteristics, *Combustion and Flame*, 156, 896-913, 2009.

W. Phadungsukanan, S. Shekar, **R. Shirley**, M. Sander, R. H. West, and M. Kraft. First-principles thermochemistry for silicon species in the decomposition of tetraethoxysilane, *Journal of Physical Chemistry A*, 113, 9041-9049, 2009.

Not Refereed

I contributed to the following article on a proposed far infrared space observatory:

J. Glenn, K. Alatalo, R. Amini, L. Armus, A. Benson, C. M. Bradford, J. Darling, P. Day, J. Domber, D. Farrah, A. Fyhrie, M. Shannon, B. Hensley, S. Lipsky, B. Moore, S. Oliver, B. Oppenheimer, D. Reddin, M. Rodgers, E. Rosolowsky, **R. Shirley**, J. Steeves, A. Tielen, C. Tucker, G. Wu, and J. Zmuidzinas. The Galaxy Evolution Probe Concept Study, *Astro2020: Decadal Survey on Astronomy and Astrophysics, APC white papers, no. 112; Bulletin of the American Astronomical Society, Vol. 51, Issue 7, id. 112, 2019.*

Observing

11 October 2019 - 12 October 2019 Two nights using the 80cm IAC80 at Observatorio del Tiede. Observing supernovae with imaging.

13 June 2019 - 16 June 2019 Three nights at 4m William Herschel Telescope, Observatorio Roque de los Muchachos, La Palma, Canarias. Observing supernovae with LIRIS long slit spectrometer.

I have also been involved with the scheduling of remote observations on the Liverpool robotic telescope and the Gran Telescopio Canarias following up detections of supernova. We used these observations to discover and classify supernova with spectra to accurately determine redshifts. We have currently made 32 such discoveries and classifications. These reports are listed on [ADS](#).

Computer Skills

I have extensive experience with Python having developed code for my PhD to run and diagnose the results of quantum chemistry simulations, and going on to build the pipeline for HELP in Jupyter notebooks running Python. I have experience developing Python packages and using a large number of popular Python packages. I have used the modern open-sourced neural network and artificial intelligence codes to classify video, audio and text for various applications as part of a three month project on lie detection.

As part of my Daphne Jackson Fellowship at Sussex I built the Virtual Observatory at susseX (VOX): <https://herschel-vos.phys.sussex.ac.uk/>. This database serves measurements and derived physical quantities for 170 million astronomical objects covering 1270 square degrees.

Some of the technologies I have experience with are:

Programming: Python, Astropy, Keras, TensorFlow, SciKit-Learn, Jupyter notebooks, Anaconda, Pandas, Shell, Matlab, fortran, HTML, XML, PHP, SQL, and ADQL.

Other Skills: Linux, high performance computer clusters, \LaTeX , Topcat, Alladin, Virtual Observatory, Gaussian, CASTEP, Adobe Creative Suite, Mathematica, GitHub, and Wordpress.

References

Please email me for details about prospective referees.

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