

Thomas Wilson



Title

Characterising the internal structures of terrestrial exoplanets in multi-planet systems

Abstract

The successful Kepler and TESS missions have discovered thousands of exoplanets and let the community focus on the characterisation of these bodies. One area of research utilises ultra-high-precision photometric and spectroscopic follow-up observations in order to accurately constrain the bulk densities of terrestrial exoplanets. Combining these observables with Bayesian internal structure modelling that uses geological equations of state, we can start to learn about the compositions of planets around main-sequence stars for the first time. Importantly, by studying multi-planet systems we can conduct comparative planetology that can reveal important aspects that challenge our knowledge of planet formation and evolution via the contrastment of the observational and modelling results of a planet against its neighbours.

In this talk, I will present observational studies characterising multi-planet systems initially discovered with TESS and followed-up with the CHEOPS satellite and ground-based instruments, such as ESPRESSO. Additionally, I will discuss our Bayesian internal structure and atmospheric escape modelling, and present the results of utilising such models on several key, multi-planet systems observed with CHEOPS that are expected to become cornerstones of exoplanet characterisation due to the questions they raise about planet formation, the system multiplicity, or the amenability to atmospheric observations. Important knowledge about these systems was uncovered via a combination of precise observations using a new generation of instruments and cutting-edge planetary internal structure modelling. Therefore, utilising these resources we are at the beginning of a new era in characterising terrestrial bodies outside of our Solar System that will be strengthened with JWST.

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Education

University College London, UK
Ph.D. Physics & Astronomy, 2019
Thesis Title: *On the Formation, Evolution, and Destruction of Minor Planetary Bodies*
Supervisors: Jonathan M. C. Rawlings, Jay Farihi, Bruce M. Swinyard

International Space University, France
M.Sc. Space Studies, 2013
Supervisor: Chris Welch

Cardiff University, UK
M.Phys Astrophysics, 2012
Supervisor: Edward Gomez

Positions Held

Academic

Research Fellow under STFC consolidated grants ST/R000824/1 and ST/V000861/1, and UKSA grant ST/R003203/1, at the University of St Andrews, U.K., 2019-present

Management

St Andrews Centre for Exoplanet Science Board Junior Member, University of St Andrews, U.K, 2020-present

Manager of a *CHEOPS* Science Team Guaranteed Time Observation program, University of St Andrews, U.K, 2021-present

Principal Investigator of one *Spitzer*, one OPTICON at the TNG, two WHT, three LCO, and six INT programs, University of St Andrews & University College London, U.K, 2018-present

HARPS-N *TESS* Tiger Team/Target Selection Lead, University of St Andrews, U.K, 2020-present

Lead Organiser of the Scottish Exoplanet/Brown Dwarf 11 meeting, University of St Andrews, U.K, 2021

Member of the Organising Committee of the *TESS* Science Conference II - *CHEOPS* and *TESS* Synergies splinter session, University of St Andrews, U.K, 2021

Member of the Organising Committee of the Habitats beyond Earth Conference, University of St Andrews, U.K, 2022

Member of the Organising Committee of the St Andrews Astrophysics Seminar Series, University of St Andrews, U.K, 2020-present

Graduate Student Representative, University College London, U.K, 2014-2017

Referee for MNRAS and AJ journals, and OPTICON TAC and SNSF funding council expert consultant, University of St Andrews, U.K, 2019-present

Teaching

Lecturer for the ES5014 course - The Chemistry of the Solar System, University of St Andrews, U.K, 2020/2021 & 2021/2022

Lab Demonstrator for the AS4025 course - Observational Astrophysics, University of St Andrews, U.K, 2020/2021 & 2021/2022

Tutor for the AS2001/AS2101 course - Astronomy & Astrophysics 2, University of St Andrews, U.K, 2019/2020

Lab Demonstrator for the PHAS1130 and PHAS1240 courses, University College London, U.K, 2015-2017

Teaching Associate for the Planetary Defence Team Project, Ohio University, U.S.A, 2015

Teaching Associate for the Exoplanets Team Project, École de Technologie Supérieure (ÉTS), Canada, 2014

Research Experience

Research Fellow, University of St Andrews, U.K, 2019-present

Discovered and characterised the pair of sub-Neptunes around TOI-1064 with *CHEOPS*, *TESS*, LCOGT, NGTS, ASTEP, and HARPS data, finding similar radii for the planets, but significantly different masses, and hence densities, that may come from migration within the system as inferred from internal structure and atmospheric escape modelling (Wilson et al. 2022; *accepted*).

Developed a novel photometric detrending method based on measuring the shape changes of point spread functions (PSFs) using a principal component analysis approach (Wilson et al. 2022; *accepted*).

Developed a new MCMC infrared flux method (IRFM) with Bayesian modelling averaging (BMA) to produce stellar radius uncertainties of $\sim 1\%$ for hundreds of FGKM-type stars.

Conducted photometric validation analysis of *CHEOPS* light curves during In-Orbit Commissioning in order to verify the performance of the spacecraft prior to science operations.

Performed *TESS* and *CHEOPS* data extraction, stellar characterisation, and transit fitting of photometry of the TOI-178 and ν^2 Lupi systems that lead to the discovery of a Laplace resonance chain of planets in the former and that the long-period exterior planet is transiting around a naked-eye star in the later. These work have been highlighted in St Andrews press releases.

Built and managed a *CHEOPS* Science Team Guaranteed Time Observation program to probe the formation of planets as a function of stellar metallicity.

Post-Graduate Student Researcher, University College London, U.K, 2014–2019

Performed analysis, including aperture, PSF, and synthetic photometry, SED fitting, and infrared excess calculations, on *Spitzer* IRAC observations of 236 white dwarfs in order to determine the frequency of debris disks. *Gaia* astrometric data has been used to search for binary companions to the white dwarf sample (Wilson, Farihi, Gänsicke, & Swan, 2019, MNRAS, vol. 487, p. 133).

Determined long- and short-term infrared flux and colour variations of circumstellar debris disks around white dwarfs on the 0.1 percent level using *Spitzer* and *WISE* observations by querying the large *WISE* IRSA database. Differential photometry was conducted on 40 white dwarfs using automated PSF photometry of all field stars in the images (Swan, Farihi, & Wilson, 2019, MNRAS, vol. 484, p. 109; Farihi et al., 2018, MNRAS, vol. 481, p.2601; Xu et al. 2018, ApJ, vol. 866).

Developed and utilised the CRETE radiative transfer model (de Val-Borro & Wilson, 2016, Astrophysics Source Code Library, record ascl:1612.009) to analyse the astrophysical and astrochemical water environments of four cometary comae observed with *Herschel* SPIRE (Wilson, Rawlings, & Swinyard, 2017, MNRAS, vol. 466, p. 1954).

Reduced and performed quality assurance analysis on VLT UVES spectra of 24 carbon-dominated white dwarf stars, and select other, so-far unpublished, polluted white dwarfs.

Analysed the O₂ to H₂O ratio in comet 67P/Churyumov-Gerasimenko, as determined by *Rosetta*, using astrochemical models simulating comet formation conditions (Rawlings, Wilson, & Williams, 2019, MNRAS, vol. 486, p. 10).

Conducted 32 nights of photometric and spectroscopic observations at the VLT, Keck, WHT, INT, and Mercator telescopes primarily for radial velocity variation and lightcurve analysis studies.

Isaac Newton Telescope Student Support Astronomer, Isaac Newton Group, Spain, 2017–2018

Helped develop the NEARBY moving source detection platform via live, on-sky testing in order to detect asteroids, with three new NEAs discovered (Vaduvescu, Popescu, Wilson, & Davison, MPEC, 2018, 2018-V09; Vaduvescu, Popescu, Wilson, & Davison, MPEC, 2018, 2018-V45; Vaduvescu et al. submitted)

Conducted high-cadence photometric observations on 18 nights to discovery and characterise physical characteristics of Near-Earth Asteroids using the INT and Mercator telescopes, with analysis of the lightcurves currently ongoing (Aznar, Vaduvescu, Wilson, & Zegmott, CBET, 2018, #4523).

Leading a team to observe and characterise the target of a potential future JAXA space mission; asteroid 2005UD, using TNG NICS, and INT IDS and WFC.

Conducted ~50 support and service nights at the INT in which I gained a lot of knowledge about telescope maintenance and problem solving, and observation planning.

ESAC Trainee Researcher, European Space Astronomy Centre, Spain, 2013–2014

Developed the boloSource code (Wilson & Vavrek, 2013, ESA Herschel Science Archive) for the removal of embedded sources in *Herschel* PACS images in order to provide a tool to the community to study the observed diffuse background. Aspects of the code included source identification, removal, and background interpolation to preserve the statistical properties of the background.

Visiting Researcher, NASA Goddard Space Flight Center, U.S.A, 2013

Interferometrically determined the optical imaging properties of off-axis parabolic mirrors in an instrumentational hardware simulation in order to demonstrate feasibility for inclusion in the Visible Nulling Coronagraph Testbed.

Graduate Student Researcher, International Space University, France, 2012-2013

Undertook radio observations in order to determine the thermal response of the lunar regolith in relation to the lunar phase.

Undergraduate Student Researcher, Cardiff University, U.K, 2008-2012

Performed aperture and differential photometry on high-cadence observations of exoplanet systems, using the GAIA image analysis tools, in order to detect additional planets via transit timing variation. Observations taken at the Las Cumbres Observatory were fitted with transit models.

Visiting Undergraduate Student Researcher, Universiteit Gent, Belgium, 2011

Conducted computational fluid dynamics simulations using the GAMBIT and Fluent codes in order to study the effect of plasma temperature on the morphology of air bubbles in a water medium.

Publications

H-index: 12, total number of citations on refereed work: 402.

Up to date metrics can be found [here](#).

First author

Wilson, T. G., Goffo, E., Alibert, Y., Gandolfi, D., Bonfanti, A., Persson, C. M., Collier Cameron, A., Fridlund, M., Fossati, L., Korth, J., Benz, W., Deline, A., Florén, H-G., Guterman, P., Adibekyan, V., Hooton, M. J., Hoyer, S., Leleu, A., Mustill, A. J., Salmon, S., Sousa, S., Suarez, O., Abe, L., Agabi, A., Alonso, R., Anglada, G., Asquier, J., Bárczy, T., Barrado y Navascues, D., Barros, S. C. C., Baumjohann, W., Beck, M., Beck, T., Billot, N., Bonfils, X., Brandeker, A., Broeg, C., Bryant, E. M., Burleigh, M. R., Buttu, M., Cabrera, J., Charnoz, S., Ciardi, D. R., Cloutier, R., Cochran, W. D., Collins, K. A., Colón, K. D., Crouzet, N., Csizmadia, Sz., Davies, M. B., Deleuil, M., Delrez, L., Demangeon, O., Demory, B-O., Dragomir, D., Dransfield, G., Ehrenreich, D., Erikson, A., Fortier, A., Gan, T., Gill, S., Gillon, M., Gnilka, C. L., Grieves, N., Grziwa, S., Güdel, M., Guillot, T., Haldemann, J., Heng, K., Horne, K., Howell, S. B., Isaak, K. G., Jenkins, J. M., Jensen, E. L. N., Kiss, L., Lacedelli, G., Lam, K., Laskar, J., Latham, D. W., Lecavelier des Etangs, A., Lendl, M., Lester, K. V., Levine, A. M., Livingston, J., Lovis, C., Luque, R., Magrin, D., Marie-Sainte, W., Maxted, P F L., Mayo, A. W., McLean, B., Mecina, M., Mékarnia, D., Nascimbeni, V., Nielsen, L. D., Olofsson, G., Osborn, H. P., Osborne, H. L. M., Ottensamer, R., Pagano, I., Pallé, E., Peter, G., Piotto, G., Pollacco, D., Queloz, D., Ragazzoni, R., Rando, N., Rauer, H., Redfield, S., Ribas, I., Ricker, G. R., Rieder, M., Santos, N. C., Scandariato, G., Schmider, F-X., Schwarz, R. P., Scott, N. J., Seager, S., Ségransan, D., Serrano, L. M., Simon, A., Smith, A. M. S., Steller, M., Stockdale, C., Szabó, Gy. M., Thomas, N., Ting, E. B., Triaud, A. H. M. J., Udry, S., Van Eylen, V., Van Grootel, V., Vanderspek, R. K., Viotto, V., Walton, N., & Winn, J. N. *A pair of Sub-Neptunes transiting the bright K-dwarf TOI-1064 characterised with CHEOPS*, MNRAS, 2022, accepted

Wilson, T. G., Farihi, J., Gänsicke, B. T., & Swan. A. *The unbiased frequency of planetary signatures around single and binary white dwarfs using Spitzer and Hubble*, MNRAS, 2019, Volume 487, Issue 1, Page 133

Wilson, T. G., Rawlings, J. M. C., & Swinyard, B. M. *Herschel/SPIRE Observations of Water Production Rates and Ortho-to-Para Ratios in Comets*, MNRAS, 2017, Volume 466, Issue 2, Page 1954

Co-author

Deline, A., Hooton, M. J., Lendl, M., Morris, B., Salmon, S., Olofsson, G., Broeg, C., Ehrenreich, D., Beck, M., Brandeker, A., Hoyer, S., Sulis, S., Van Grootel, V., Bourrier, V., Demangeon, O., Demory, B-O., Heng, K., Parviainen, H., Serrano, L. M., Singh, V., Bonfanti, A., Fossati, L., Kitzmann, D., Sousa, S. G., **Wilson, T. G.**, + 61 additional co-authors. *The atmosphere and architecture of WASP-189 b probed by its CHEOPS phase curve*, A&A, 2022, accepted

Barros, S. C. C., Akincanmi, B., Boué, G., Smith, A. M. S., Laskar, J., Ulmer-Moll, S., Lillo-Box, J., Queloz, D., Collier Cameron, A., Sousa, S. G., Ehrenreich, D., Hooton, M. J., Bruno, G., Demory, B-O., Correia, A. C. M., Demangeon, O. D. S., **Wilson, T. G.**, + 66 additional co-authors. *Detection of the tidal deformation of WASP-103b at 3σ with CHEOPS*, A&A, 2022, Volume 657, id. A52

Farihi, J., Hermes, J. J., Marsh, T. R., Mustill, A. J., Wyatt, M. C., Guidry, J. A., **Wilson, T. G.**, Redfield, S., Izquierdo, P., Toloza, O., Gänsicke, B. T., Aungwerojwit, A., Dhillon, V. S., & Swan, A. *Relentless and Complex Transits from a Planetesimal Debris Disk*, MNRAS, 2021, accepted

Hooton, M. J., Hoyer, S., Kitzmann, D., Morris, B. M., Smith, A. M. S., Collier Cameron, A., Futyan, D., Maxted, P F L., Queloz, D., Demory, B-O., Heng, K., Lendl, M., Cabrera, J., Csizmadia, Sz., Deline, A., Parviainen, H., Salmon, S., Sulis, S., **Wilson, T. G.**, + 66 additional co-authors. *Spi-OPS: Spitzer and CHEOPS confirm the near-polar orbit of MASCARA-1 b and reveal a hint of dayside reflection*, A&A, 2021, accepted

Zhang, M., Knutson, H. A., Wang, L., Dai, F., dos Santos, L. A., Fossati, L., Henry, G. W., Ehrenreich, D., Alibert, Y., Hoyer, S., **Wilson, T. G.**, & Bonfanti, A. *Detection of Ongoing Mass Loss from HD 63433c, a Young Mini Neptune*, AJ, 2021, accepted

- Maxted, P. F. L., Ehrenreich, D., **Wilson, T. G.**, + 76 additional co-authors. *Analysis of Early Science observations with the CHAracterising ExOPlanets Satellite (CHEOPS) using PUCHÉOPS*, MNRAS, 2021, accepted
- Vaduvescu, O., Gorgan, D., Copandean, D., Bacu, V., Stefanut, T., Sabou, A., Nandra, C., Boldea, C., Pinter, V., Popescu, M., Petrescu, E., Bertesteanu, D., Davison, T., Pérez Toledo, F. M., Boldea, A., Predatu, M., Zegmott, T., **Wilson, T. G.**, + 14 additional co-authors. *Ready for EURONEAR NEA Surveys using the NEARBY Moving Source Detection Platform*, New Astronomy, 2021, Volume 88, id. 101600
- Whitehouse, L. J., Farihi, J., Howarth, I. D., Mancino, S., Walters, N., Swan, A., **Wilson, T. G.**, & Guo, J. *Carbon-Enhanced Stars with Short Orbital and Spin Periods*, MNRAS, 2021, Volume 506, Issue 4, Page 4877
- Szabó, Gy. M., Gandolfi, D., Brandeker, A., Csizmadia, Sz., Garai, Z., Billot, N., Broeg, C., Ehrenreich, D., Fortier, A., Fossati, L., Hoyer, S., Kiss, L., Lecavelier des Etangs, A., Maxted, P. F. L., Ribas, I., Alibert, Y., Alonso, R., Anglada Escudé, G., Bárczy, T., Barros, S. C. C., Barrado, D., Baumjohann, W., Beck, M., Beck, T., Bekkelien, A., Bonfils, X., Benz, W., Borsato, L., Busch, M.-D., Cabrera, J., Charnoz, S., Collier Cameron, A., Corral Van Damme, C., Davies, M. B., Delrez, L., Deleuil, M., Demangeon, O. D. S., Demory, B.-O., Erikson, A., Fridlund, M., Futyan, D., García Muñoz, A., Gillon, M., Guedel, M., Guterman, P., Heng, K., Isaak, K. G., Lacedelli, G., Laskar, J., Lendl, M., Lovis, C., Luntzer, A., Magrin, D., Nascimbeni, V., Olofsson, G., Osborn, H. P., Ottensamer, R., Pagano, I., Pallé, E., Peter, G., Piazza, D., Piotto, G., Pollacco, D., Queloz, D., Ragazzoni, R., Rando, N., Rauer, H., Santos, N. C., Scandariato, G., Ségransan, D., Serrano, L. M., Sicilia, D., Simon, A. E., Smith, A. M. S., Sousa, S. G., Steller, M., Thomas, N., Udry, S., Van Grootel, V., Walton, N. A., & **Wilson, T. G.**. *The changing face of AU Mic b: stellar spots, spin-orbit commensurability, and Transit Timing Variations as seen by CHEOPS and TESS*, A&A, 2021, Volume 654, id. A159
- Borsato, L., Piotto, G., Gandolfi, D., Nascimbeni, V., Lacedelli, G., Marzari, F., Billot, N., Maxted, P. F. L., Sousa, S., Cameron, A. C., Bonfanti, A., **Wilson, T. G.**, +67 additional co-authors. *Exploiting Timing Capabilities of the CHEOPS Mission with Warm-Jupiter Planets*, MNRAS, 2021, Volume 506, Issue 3, Page 3810
- Swayne, M. I., Maxted, P. F. L., Triaud, A. H. M. J., Sousa, S. G., Broeg, C., Florén, H. -G., Guterman, P., Simon, A. E., Boisse, I., Bonfanti, A., Martin, D., Santerne, A., Salmon, S., Standing, M. R., Van Grootel, V., **Wilson, T. G.**, + 76 additional co-authors. *The EBLM project – VIII. First Results for M-dwarf Mass, Radius and Effective Temperature Measurements using CHEOPS Light Curves*, MNRAS, 2021, Volume 506, Issue 1, Page 306
- Morris, B. M., Delrez, L., Brandeker, A., Cameron, A. C., Simon, A. E., Futyan, D., Olofsson, G., Hoyer, S., Fortier, A., Demory, B. -O., Lendl, M., **Wilson, T. G.**, + 69 additional co-authors. *CHEOPS Precision Phase Curve of the Super-Earth 55 Cnc e*, A&A, 2021, Volume 653, id. A173
- Delrez, L., Ehrenreich, D., Alibert, Y., Bonfanti, A., Borsato, L., Fossati, L., Hooton, M. J., Hoyer, S., Pozuelos, F. J., Salmon, S., Sulis, S., **Wilson, T. G.**, + 68 additional co-authors. *Transit Detection of the Long-Period Volatile-Rich Super-Earth v^2 Lupi d with CHEOPS*, Nature Astronomy, 2021, Volume. 5, Page 775
- Van Grootel, V., Pozuelos, F. J., Thuillier, A., Charpinet, S., Delrez, L., Beck, M., Fortier, A., Hoyer, S., Sousa, S. G., Barlow, B. N., Billot, N., Dévora-Pajares, M., Østensen, R. H., Alibert, Y., Alonso, R., Anglada Escudé, G., Asquier, J., Barrado, D., Barros, S. C. C., Baumjohann, W., Beck, T., Bekkelien, A., Benz, W., Bonfils, X., Brandeker, A., Broeg, C., Bruno, G., Bárczy, T., Cabrera, J., Cameron, A. C., Charnoz, S., Davies, M. B., Deleuil, M., Demangeon, O. D. S., Demory, B. -O., Ehrenreich, D., Erikson, A., Fossati, L., Fridlund, M., Futyan, D., Gandolfi, D., Gillon, M., Guedel, M., Heng, K., Isaak, K. G., Kiss, L., Laskar, J., Lecavelier des Etangs, A., Lendl, M., Lovis, C., Magrin, D., Maxted, P. F. L., Mecina, M., Mustill, A. J., Nascimbeni, V., Olofsson, G., Ottensamer, R., Pagano, I., Pallé, E., Peter, G., Piotto, G., Plessier, J. -Y., Pollacco, D., Queloz, D., Ragazzoni, R., Rando, N., Rauer, H., Ribas, I., Santos, N. C., Scandariato, G., Ségransan, D., Silvotti, R., Simon, A. E., Smith, A. M. S., Steller, M., Szabó, G. M., Thomas, N., Udry, S., Viotto, V., Walton, N. A., Westendorff, K., & **Wilson, T. G.** *A Search for Transiting*

Planets Around Hot Subdwarfs. I. Methods and Performance Tests on Light Curves from Kepler, K2, TESS, and CHEOPS, A&A, 2021, Volume 650, id. A205

Leleu, A., Alibert, Y., Hara, N. C., Hooton, M. J., **Wilson, T. G.**, + 150 additional co-authors. *Six Transiting Planets and a Chain of Laplace Resonances in TOI-178*, A&A, 2021, Volume 649, id. A26

Dumusque, X., Cretignier, M., Sosnowska, D., Buchschacher, N., Lovis, C., Phillips, D. F., Pepe, F., Alesina, F., Buchhave, L. A., Burnier, J., Ceconi, M., Cegla, H. M., Cloutier, R., Collier Cameron, A., Cosentino, R., Ghedina, A., González, M., Haywood, R. D., Latham, D. W., Lodi, M., López-Morales, M., Maldonado, J., Malavolta, L., Micela, G., Molinari, E., Mortier, A., Pérez Ventura, H., Pinamonti, M., Poretti, E., Rice, K., Riverol, L., Riverol, C., San Juan, J., Ségransan, D., Sozzetti, A., Thompson, S. J., Udry, S., & **Wilson, T. G.** *Three Years of HARPS-N High-Resolution Spectroscopy and Precise Radial Velocity Data for the Sun*, A&A, 2021, Volume 648, id. A103

Lacedelli, G., Malavolta, L., Borsato, L., Piotta, G., Nardiello, D., Mortier, A., Stalport, M., Collier Cameron, A., Poretti, E., Buchhave, L. A., López-Morales, M., Nascimbeni, V., **Wilson, T. G.**, + 28 additional co-authors. *An Unusually Low Density Ultra-Short Period Super-Earth and Three Mini-Neptunes Around the Old Star TOI-561*, MNRAS, 2021, Volume 501, Issue 3, Page 4148

Bonfanti, A., Delrez, L., Hooton, M. J., **Wilson, T. G.**, + 105 additional co-authors. *CHEOPS Observations of the HD 108236 Planetary System: a Fifth Planet, Improved Ephemerides, and Planetary Radii*, A&A, 2021, Volume 646, id. A157

Mortier, A., Zapatero Osorio, M. R., Malavolta, L., Alibert, Y., Rice, K., Lillo-Box, J., Vanderburg, A., Oshagh, M., Buchhave, L., Adibekyan, V., Delgado Mena, E., Lopez-Morales, M., Charbonneau, D., Sousa, S. G., Lovis, C., Affer, L., Allende Prieto, C., Barros, S. C. C., Benatti, S., Bonomo, A. S., Boschin, W., Bouchy, F., Cabral, A., Collier Cameron, A., Cosentino, R., Cristiani, S., Demangeon, O. D. S., Di Marcantonio, P., D'Odorico, V., Dumusque, X., Ehrenreich, D., Figueira, P., Fiorenzano, A., Ghedina, A., González Hernández, J. I., Haldemann, J., Harutyunyan, A., Haywood, R. D., Latham, D. W., Lavie, B., Lo Curto, G., Maldonado, J., Manescau, A., Martins, C. J. A. P., Mayor, M., Mégevand, D., Mehner, A., Micela, G., Molaro, P., Molinari, E., Nunes, N. J., Pepe, F. A., Palle, E., Phillips, D., Piotta, G., Pinamonti, M., Poretti, E., Riva, M., Rebolo, R., Santos, N. C., Sasselov, D., Sozzetti, A., Suárez Mascareño, A., Udry, S., West, R. G., Watson, C. A., & **Wilson, T. G.** *K2-111: an Old System with Two Planets in Near-Resonance*, MNRAS, 2020, Volume 499, Issue 4, Page 5004

Schanche, N., Hébrard, G., Collier Cameron, A., Dalal, S., Smalley, B., **Wilson, T. G.**, + 12 additional co-authors. *WASP-186 and WASP-187: Two Hot Jupiters Discovered by SuperWASP and SOPHIE with Additional Observations by TESS*, MNRAS, 2020, Volume 499, Issue 1, Page 428

Lendl, M., Csizmadia, Sz., Deline, A., Fossati, L., Kitzmann, D., Heng, K., Hoyer, S., Salmon, S., Benz, W., Broeg, C., Ehrenreich, D., Fortier, A., Queloz, D., Bonfanti, A., Brandeker, A., Collier Cameron, A., Delrez, L., García Muñoz, A., Hooton, M. J., Maxted, P. F. L., Morris, B. M., Van Grootel, V., **Wilson, T. G.**, + 85 additional co-authors. *The Hot Dayside and Asymmetric Transit of WASP-189 b Seen by CHEOPS*, A&A, 2020, Volume 643, id. A94

Mann, A. W., Johnson, M. C., Vanderburg, A., Kraus, A. L., Rizzuto, A. C., Wood, M. L., Bush, J. L., Rockcliffe, K., Newton, E. R., Latham, D. W., Mamajek, E. E., Zhou, G., Quinn, S. N., Thao, P. C., Benatti, S., Cosentino, R., Desidera, S., Harutyunyan, A., Lovis, C., Mortier, A., Pepe, F. A., Poretti, E., **Wilson, T. G.**, + 31 additional co-authors. *TESS Hunt for Young and Maturing Exoplanets (THYME). III. A Two-planet System in the 400 Myr Ursa Major Group*, AJ, 2020, Volume 160, Issue 4

Sestito, F., Martin, N. F., Starkeburg, E., Arentsen, A., Ibata, R. A., Longeard, N., Kiefty, C., Youakim, K., Venn, K. A., Aguado, D. S., Carlberg, R. G., González Hernández, J. I., Hill, V., Jablonka, P., Kordopatis, G., Malhan, K., Navarro, J. F., Sánchez-Janssen, R., Thomas, G., Tolstoy, E., **Wilson, T. G.**, + 8 additional co-authors. *The Pristine Survey - X. A Large Population of Low-Metallicity Stars Permeates the Galactic Disc*, MNRAS, 2020, Volume 497, Issue 1, Page L7

- Swan, A., Farihi, J., **Wilson, T. G.**, & Parsons, S. G. *The Dust Never Settles: Collisional Production of Gas and Dust in Evolved Planetary Systems*, MNRAS, 2020, Volume 496, Issue 4, Page 5233
- Cloutier, R., Rodriguez, J. E., Irwin, J., Charbonneau, D., Stassun, K. G., Mortier, A., Latham, D. W., Isaacson, H., Howard, A. W., Udry, S., **Wilson, T. G.**, + 70 additional co-authors. *TOI-1235 b: A Keystone Super-Earth for Testing Radius Valley Emergence Models around Early M Dwarfs*, AJ, 2020, Volume 160, Issue 1
- Monguió, M., Greimel, R., Drew, J. E., Barentsen, G., Groot, P. J., Irwin, M. J., Casares, J., Gänsicke, B. T., Carter, P. J., Corral-Santana, J. M., Gentile-Fusillo, N. P., Greiss, S., van Haften, L. M., Hollands, M., Jones, D., Kupfer, T., Manser, C. J., Murphy, D. N. A., McLeod, A. F., Oosting, T., Parker, Q. A., Pyrzas, S., Rodríguez-Gil, P., van Roestel, J., Scaringi, S., Schellart, P., Toloza, O., Vaduvescu, O., van Spaandonk, L., Verbeek, K., Wright, N. J., Eisloffel, J., Fabregat, J., Harris, A., Morris, R. A. H., Philipps, S., Raddi, R., Sabin, L., Unruh, Y., Vink, J. S., Wesson, R., Cardwell, A., de Burgos, A., Cochrane, R. K., Doostmohammadi, S., Mocnik, T., Stoev, H., Suárez-Andrés, L., Tudor, V., **Wilson, T. G.**, & Zegmott, T. *J. IGAPS: the Merged IPHAS and UVEX Optical Surveys of the Northern Galactic Plane*, A&A, 2020, Volume 638, id. A18
- Aguado, D. S., Youakim, K., González Hernández, J. I., Allende Prieto, C., Starkenburg, E., Martin, N., Bonifacio, P., Arentsen, A., Caffau, E., Peralta de Arriba, L., Sestito, F., Garcia-Diaz, R., Fantin, N., Hill, V., Jablonca, P., Jahandar, F., Kiefty, C., Longeard, N., Lucchesi, R., Sánchez-Janssen, R., Osorio, Y., Palicio, P. A., Tolstoy, E., **Wilson, T. G.**, + 6 additional co-authors. *The Pristine Survey – VII. The First Three Years of Medium Resolution Follow-Up Spectroscopy of Pristine EMP Star Candidates*, MNRAS, 2019, Volume 490, Issue 2, Page 2241
- Rawlings, J. M. C., **Wilson, T. G.**, & Williams, D. A. *A Gas-Phase Primordial Origin of O₂ in Comet 67P/Churyumov-Gerasimenko*, MNRAS, 2019, Volume 486, Issue 1, Page 10
- Swan, A., Farihi, J., & **Wilson, T. G.** *Most White Dwarfs with Detectable Dust Discs show Infrared Variability*, MNRAS, 2019, Volume 484, Issue 1, Page 109
- Farihi, J., van Lieshout, R., Cauley, P. W., Dennihy E., Su, K. Y. L., Kenyon, S. J., **Wilson, T. G.**, Toloza, O., Gänsicke, B. T., von Hippel, T., Redfield, S., Debes, J. H., Xu, S., Rogers, L., Bonsor, A., Swan, A., Pala, A. F., & Reach, W. T. *Dust Production and Depletion in Evolved Planetary Systems*, MNRAS, 2018, Volume 481, Issue 2, Page 2601
- Xu, S., Su, K. Y. L., Rogers, L., Bonsor, A., Olofsson, J., Veras, D., van Lieshout, R., Dufour, P., Green, E. M., Schlawin, E., Farihi, J., **Wilson, T. G.**, Wilson, D. J., & Gänsicke, B. T. *Infrared Variability of Two Dusty White Dwarfs*, ApJ, 2018, Volume 866, Issue 2
- Whitehouse, L. J., Farihi, J., Green, P., **Wilson, T. G.**, & Subasavage, J. P. *Dwarf Carbon Stars are Likely Metal-Poor Binaries and Unlikely Hosts to Carbon Planets*, MNRAS, 2018, Volume 479, Issue 3, Page 3873
- Hussein, A. A., Silva-Martinez, J., & **Wilson, T. G.** *From Project Management to Planetary Defense: Implementation of a Systems Engineering Approach Using Integrated Product and Process Development (IPPD)*, IEEE AERO EL SYS MAG, 2018, Volume 33, Issue 1, Page 6
- Chubb, K., Hood, R., **Wilson, T. G.**, Holdship, J., & Hutton, S. *Discovering New Variable Stars at Key Stage 3*, PHYS. EDUC., 2017, Volume 52, Issue 3

Grants Awarded

Isaac Newton Group Studentship

- To complete the Isaac Newton Group Studentship in La Palma, Spain.

Royal Astronomical Society Grant - £ 960

- To attend and present at Asteroids, Comets, Meteors 2017 conference in Montevideo, Uruguay.

- University College London - Postgraduate Training Committee Travel Grant - £ 250
- To attend and present at Asteroids, Comets, Meteors 2017 conference in Montevideo, Uruguay.
- University College London - Postgraduate Training Committee Travel Grant - £ 250
- To observe at the European Southern Observatory's Very Large Telescope.
- Science and Technology Facilities Council Ph.D Scholarship
- To complete a Ph.D in Physics and Astronomy at University College London.
- European Space Agency Traineeship
- To undertake a traineeship at the European Space Astronomy Centre in Madrid, Spain.

Observing Experience

95 nights observing experience (47 as the observer, 48 as a support astronomer)

Observer

The GTO Observing Program

- High Accuracy Radial velocity Planet Searcher (HARPS-N) & GIANO-B, Telescopio Nazionale Galileo 2020A, 6 nights, PI: GTO

Follow-up Spectroscopy of Extremely-Low Mass White Dwarfs Identified in Gaia DR2

- Intermediate Dispersion Spectrograph (IDS), Isaac Newton Telescope 2019B, 9 nights, PI: Alina Istrate

Spectroscopic Follow-Up of Metal-Poor Star Candidates from Pristine

- Intermediate Dispersion Spectrograph (IDS), Isaac Newton Telescope 2018B, 3 nights, PI: Eline Tolstoy

Testing the EURONEAR Automated Moving Source Detection Pipeline

- Wide Field Camera (WFC), Isaac Newton Telescope 2018B, 2 nights, PI: Ovidiu Vaduvescu

INT Global Observing Campaign of JAXA Target 2005UD; Spectroscopy

- Intermediate Dispersion Spectrograph (IDS), Isaac Newton Telescope 2018B, 0.5 nights, PI: Thomas Wilson

Constraining Orbital Periods of Carbon-Rich Dwarf Stars

- Intermediate dispersion Spectrograph and Imaging System (ISIS), William Herschel Telescope 2018B, 3 nights, PI: Thomas Wilson

Continuing the EURONEAR Lightcurve Survey of Near Earth Asteroids

- Wide Field Camera (WFC), Isaac Newton Telescope & Mercator Advanced Imager for Asteroseismology (MAIA), Mercator Telescope 2018A, 2018B, 16 nights, PI: Ovidiu Vaduvescu

Follow-Up Observations Probing SDSS ELM Candidates

- Intermediate Dispersion Spectrograph (IDS), Isaac Newton Telescope 2018A, 2018B, 1 night, PI: Thomas Wilson

An Exploratory Search for Further Disintegrating Asteroids Around White Dwarfs

- Wide Field Camera (WFC), Isaac Newton Telescope 2018A, 2018B, 0.5 nights, PI: Thomas Wilson

Optical Observations of PG1132+471 to Determine White Dwarf Infrared Flux

- Wide Field Camera (WFC), Isaac Newton Telescope 2018A, 0.5 nights, PI: Thomas Wilson

The Origin of Dwarf Carbon Stars: Orbital Periods and Mass Transfer

- Intermediate dispersion Spectrograph and Imaging System (ISIS), William Herschel Telescope
2017B, 2 nights, PI: Jay Farihi

The History of Star and Planet Formation: A Search for Substellar Companions to Cool Subdwarfs

- Spectro-Polarimetric High-contrast Exoplanet REsearch (SPHERE), Very Large Telescope
97A, 2.5 nights, PI: Carolina Bergfors

A Chemical Inventory of Planetary Debris in the First Known Polluted White Dwarf with a Circumbinary Disk

- High Resolution Echelle Spectrometer (HIRES), Keck Telescope
2016A, 1 night, PI: Seth Redfield

The following are a list of the programs I am PI or Co-I of, but have not observed for:*Transiting Exoplanets (continuation)*

- Las Cumbres Observatory (LCO)
2021B, PI: Thomas Wilson

Inside Out: Detecting a Rock Vapor Atmosphere on the Lava World TOI-2431 b

- Wide Field Camera 3 (WFC3)/IR Spectroscopic G141, Hubble Space Telescope
Cycle 29, PI: Samuel Quinn

Transiting Exoplanets (continuation)

- Las Cumbres Observatory (LCO)
2021A, PI: Thomas Wilson

TOI-178: the Best Laboratory for Testing Planetary Formation Theories

- NIRSpec - Bright Object Time-Series mode (BOTS), James Webb Space Telescope
Cycle 1, PI: Matthew Hooton

Probing the Starspots of WASP-85 A

- CHAracterising ExOPlanets Satellite (CHEOPS)
AO-2, PI: Heather Cegla

Improving the Bulk Densities for Small Planets Observed with HARPS-N, K2, TESS, and CHEOPS

- CHAracterising ExOPlanets Satellite (CHEOPS)
AO-2, PI: Annelies Mortier

Transiting Exoplanets (continuation)

- Las Cumbres Observatory (LCO)
2020B, PI: Thomas Wilson

Transiting Exoplanets (continuation)

- Las Cumbres Observatory (LCO)
2020A, PI: Andrew Collier Cameron

Targeting the Low-End of the NEA Brightness Distribution: the INT 1000 Square Degrees Survey

- Wide Field Camera (WFC), Isaac Newton Telescope
2019B, PI: Ovidiu Vaduvescu

Dust Recycling over the 2 hour Period of a White Dwarf Planetesimal

- InfraRed Array Camera (IRAC), Spitzer Space Telescope
Cycle 14 - DDT, PI: Thomas Wilson

The Second Life of Planetary Systems: Youthful Variability in White Dwarf Debris Disks

- InfraRed Array Camera (IRAC), Spitzer Space Telescope
Cycle 14 - DDT, PI: Jay Farihi

Differentiating Mass Transfer Mechanisms in Carbon-Rich Dwarf Stars

- Intermediate dispersion Spectrograph and Imaging System (ISIS), William Herschel Telescope
2019A, PI: Thomas Wilson

INT Global Observing Campaign of JAXA Target 2005UD; Photometric Lightcurve

- Wide Field Camera (WFC), Isaac Newton Telescope
2018B, PI: Thomas Wilson

INT Global Observing Campaign of JAXA Target 2005UD; Photometric Colours

- Wide Field Camera (WFC), Isaac Newton Telescope
2018B, PI: Thomas Wilson

A Changing Legacy for Dead Rock Stars

- InfraRed Array Camera (IRAC), Spitzer Space Telescope
Cycle 13 - DDT, PI: Jay Farihi

Support astronomer*Multiple programmes*

- Long-slit Intermediate Resolution Infrared Spectrograph (LIRIS), William Herschel Telescope
2018A, 0.5 nights

Multiple programmes

- Auxiliary-port CAMera (ACAM), William Herschel Telescope
2018A, 0.5 nights

Multiple programmes

- Intermediate Dispersion Spectrograph (IDS), Isaac Newton Telescope
2017B, 2018A, 2018B, 30 nights

Multiple programmes

- Wide Field Camera (WFC), Isaac Newton Telescope
2017B, 2018A, 2018B, 17 nights

Presentations

"Unveiling the TOI-1064 system with TESS, CHEOPS, and HARPS", CHEOPS Science Workshop VI, online, 2022

"Characterising the internal structures of exoplanets with CHEOPS", Exoplanet Group Seminar Series, University of Warwick, U.K, 2021

"Two cornerstone exoplanet systems unveiled by CHEOPS: TOI-178 & Nu2 Lupi", SUPA/Cormack meeting 2021, online, 2021

"CHEOPS and HARPS characterisation of a multi-planet system discovered by TESS", PLATO Mission Conference 2021, online, 2021

"CHEOPS characterisation of multi-planet systems found with TESS: TOI-1064", TESS Science Conference II, online, 2021

"Characterising Multi-Planet Systems with CHEOPS: The HD 108236 Planetary System and the Compact Laplace Chain of Planets in TOI-178", STScI Spring Symposium 2021, Space Telescope Science Institute (STScI), U.S.A, 2021

"Characterising Multi-Planet Systems with CHEOPS: The HD 108236 Planetary System and the Compact Laplace Chain of Planets in TOI-178", UK Exoplanet Meeting, University of Birmingham, U.K, 2021

"1 Year of Science with CHEOPS", Scottish Exoplanet/Brown Dwarf 11 Meeting, University of St Andrews, U.K, 2021

"The First Science Results from CHEOPS", Scottish Exoplanet/Brown Dwarf 10 Meeting, University of Edinburgh, U.K, 2020

"Exploring the Exoplanet Zoo with CHEOPS and HARPS-N", UFRGS Departamento de Astronomia Seminar, Universidade Federal do Rio Grande do Sul, Brazil, 2020

"A CHEOPS Update: Revealing the Pictures of Exoplanetary Systems through Precise Photometry", StA-CES 2020 Summer Mini-Conference, University of St Andrews, U.K, 2020

"6 (Simple?) Steps To Destroy a Planet: Or How we Discover White Dwarf Planetary Systems and What we can Learn about Them", Lunchtime Talk, University of St Andrews, U.K, 2020

"The Life of a Planetary System", Berlin Astronomy Outreach Seminar, Berlin Astronomy and Astrophotography, Germany, 2019

"On the Formation, Evolution, and Destruction of Minor Planetary Bodies", Isaac Newton Group Seminar, Isaac Newton Group, Spain, 2018

"Planetary Debris Disk Frequencies & Herschel Observations of Non-Typical Cometary Water Ortho-to-Para Ratios", Centre for Planetary Science Summer Meeting, University College London, U.K, 2017

"Herschel/SPIRE Observations of Water Production Rates and Ortho-to-Para Ratios in Comets", Origins of Solar Systems - Gordon Research Conference, Mount Holyoke College, U.S.A, 2017

"Herschel/SPIRE Observations of Water Production Rates and Ortho-to-Para Ratios in Comets", Asteroids, Comets, Meteors 2017, Universidad de la República, Uruguay, 2017

"An Extended Unbiased Survey to Determine the Frequency of White Dwarf Debris Disks", Planetary Systems Beyond The Main Sequence II, Technion – Israel Institute of Technology, Israel, 2017

"Herschel/SPIRE Observations of Water Production Rates and Ortho-to-Para Ratios in Comets", Scottish Planetary Research Network (SPERO), The University of Edinburgh, U.K, 2017

"Herschel/SPIRE Observations of Water Production Rates and Ortho-to-Para Ratios in Comets", UK Planetary Forum, The University of Manchester, U.K, 2017

"Water Production Rates of the Oort Cloud and Jupiter Family Comets Observed by Herschel/SPIRE", National Astronomy Meeting, The University of Nottingham, U.K, 2016

"Water Production Rates Of Long- And Short-Period Comets Observed by Herschel/SPIRE", Water in the Universe, European Space Research and Technology Centre, The Netherlands, 2016

"Determining the Imaging Properties of Off Axis Parabolas for Use in the Visible Nulling Coronagraph Testbed", 2013 Summer Intern Session, NASA Goddard Space Flight Center, U.S.A, 2013

"Phobos Next: Human Exploration of Mars from Martian Orbit", Humans 2 Mars Summit, George Washington University Space Policy Institute, U.S.A, 2013

Teaching

Students Supervised or Co-Supervised

Fraser Cameron, AS5101 - M.Phys in Astrophysics, University of St Andrews, U.K, 2021/2022

Harry Pearce, AS5101 - M.Phys in Astrophysics, University of St Andrews, U.K, 2021/2022

Cameron Newby, AS5101 - M.Phys in Astrophysics, University of St Andrews, U.K, 2021/2022

Charles Finnie, AS4103 - B.Sc in Astrophysics, University of St Andrews, U.K, 2021/2022

Brandon Myers, AS5599 - M.Sc in Astrophysics, University of St Andrews, U.K, 2021

Chloe Love, summer student, University of St Andrews, U.K, 2021

Sheila Long, M.Sc in Astrophysics, University College London, U.K, 2016-2017

Giuseppe Ussia, visiting summer intern, University College London, U.K, 2017

Lectures Given

"Learning about Planetary Properties from Exoplanet Detection and Characterisation", ES5014 - The Chemistry of the Solar System, University of St Andrews, U.K, 2020/2021 & 2021/2022

"Understanding Alien Worlds", International Space University Space Studies Program 2017, Cork Institute of Technology, Ireland, 2017

"Understanding Alien Worlds", International Space University Space Studies Program 2015, Ohio University, U.S.A, 2015

Labs and Tutorials Given

Exoplanets, AS4025 - Observational Astrophysics, University of St Andrews, U.K, 2020/2021 & 2021/2022

Stellar Structure and Evolution; Exoplanets; Galactic Structure, and Observational Techniques (2 groups), AS2001/AS2101 - Astronomy & Astrophysics 2, University of St Andrews, U.K, 2019/2020

Practical Skills 1C, PHAS1240 - Computing, University College London, U.K, 2015-2017

Practical Skills 1A, PHAS1130 - Practical Astronomy, University College London, U.K, 2015-2017

Telescope Training

Trained five graduate students on the Isaac Newton Telescope using the IDS instrument, Spain, 2018

Public Outreach

Conducted multiple tours of the Isaac Newton Telescope to general public and local students, Spain, 2017-2018

Provided tours of the University College London Observatory as part of the Centre for Planetary Science Summer Meeting, U.K, 2017

Organised and ran 10-week long practical astronomy course to teach 10/11 year old high school students basic astronomy, and asteroid and variable star detection methods. In collaboration and funded by the Mayor's Fund for London, U.K, 2015-2017

Skills

Data Analysis

Large astronomical datasets (*Gaia* DR2, IRSA)

Photometric and spectroscopic data reduction (HIPE, Reflex, Gasgano, IRAF, MOPEX, and SExtractor)

Mutli-wavelength data reduction and analysis (optical, infrared, and sub-millimetre)

Radiative transfer modeling

SED fitting and infrared excess determination

Aperture, PSF, synthetic and differential photometry

High-cadence photometric observations and lightcurve analysis

Programming

Expert: Python, Latex, Shell scripting

Intermediate: Fortran77/90, C++, JavaScript, HTML/CSS, SQL/ADQL, Jython, Git

Infrequent use: C#, IDL, Java

Further Project Management

Lead two separate teams to study the physical and orbital properties of asteroids and comets.

Team project management of two 30+ people teams for Exoplanet and Planetary Defense projects.

References

Available upon request.

Last updated: January 12, 2022