Graham S. Kerr

Solar Astrophysicist

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Summary

My research interests are in the area of solar flare physics, particularly in the transport of energy, radiation, and mass through the solar atmosphere during flares or other transient heating events. This is achieved through a combination of state-of-the-art numerical modelling and the analysis of solar flare observations. I have expertise of imaging and spectroscopic data analysis, utilising the Hinode, IRIS, SDO & RHESSI observatories. I am a lead user/developer of radiation hydrodynamics & radiation transfer numerical simulations to model physical processes during solar flares, with a focus on understanding the formation of optically thick radiation. Performing model-data comparisons to assess the ability of models to stand up to the scrutiny of observations is the crucial final step.

Education

University of Glasgow | **PhD Physics and Astronomy** *Oct 2012 - Feb 2017*
Supervisor: Prof. Lyndsay Fletcher | Topic: Observations and Modelling of the Chromosphere During Solar Flares
- Funded by a College of Science and Engineering Research Scholarship.
- Thesis submitted Sept '16, Viva passed Dec '16 & PhD awarded Feb '17.

University of Glasgow | **MSci. (1st Class Hons.) Physics and Astronomy** *Oct 2012 - June 2012*
- Undergraduate integrated Masters in Science degree.

Career History

Catholic University of America | **Research Scientist** *April 2020 –*
PHaSER co-operative scientist based onsite at NASA Goddard Space Flight Center, Md USA.

NASA Postdoctoral Program (GSFC) | **NPP Fellow** *April 2017 – April 2020*
Competitive fellowship, administered by USRA, based at NASA Goddard Space Flight Center, Md USA.

University of Glasgow | **Postdoctoral Research Assistant** *Oct 2016 – Dec 2016*
PDRA as part of the FCRHOMA project.

University of Glasgow | **PhD Student** *Oct 2012 – Sept 2016*

High Altitude Observatory / CU LASP | **REU Student (solar physics)** *Summer 2011*

Montana State University | **REU Student (solar physics)** *Summer 2010*

Publications, Presentations and Grant funding

A publication list, a list of invited presentations, and a detailed list of grant funding is listed at the end. Summaries are:
- 34 peer-reviewed publications (13 as main author) | $h-$index = 17 | 790+ citations (91+ for most cited 1st author pub)
- 21 invited presentations at international conferences and seminars.
- Successfully proposed as PI/Co-PI (3 grants; $>\sim \$1$M) and Co-I (9 grants; $>\sim \$4.1$M)

Awards

NASA GSFC Science and Engineering Directorate Special Act Award (Group), 2024 *Awarded to NGAPS+ Co-Officers for 'outstanding service to the Center's early career personnel'*

NASA GSFC Robert H Goddard Award (DEIA category), 2024 *Awarded to the NGAPS+ Early Career Workplace Survey Team.*

NASA GSFC Heliophysics Science Division Peer Award, 2022 *(services to HSD, specifically for helping to advocate and foster inclusivity).*

Rolls-Royce Rolls-Royce Science Prize 2nd place, 2016 *(team award for a year long outreach project, from 2000 initial entrants and 6 finalists).*

University of Glasgow, Graduate School Hunter-Cumming outreach prize, 2016 | Thomson Experimental Prize, 2015 | Hunter-Cumming research prize, 2014 | College of Science and Engineering PhD Scholarship, 2012-2016.

University of Glasgow, Undergraduate Archibald McAulay Memorial, 2012 | Tannahill Bequest, 2012 | MacKay-Smith Prize, 2011 | Lang Scholarship, 2010 | Tannahill Bequest, 2010 | Lanfine Bursary, 2009 | Cleland Prize, 2009 | Astronomy 2 class prize, 2009.

Selected Community Involvement and Leadership

Leadership Roles and Committees

American Astronomical Society / Solar Physics Division Public Policy Committee member *2022 –*

Heliophysics Coalition *2022 –*

Member of the community advocacy group (2022-) and the first Catholic University of America rep (2024-).

NASA GSFC LGBTQ+ Employee Resource Group member *2018 –*

NASA Goddard Association of Postdoctoral Scholars (NGAPS+) co-officer *2021 –*

NGAPS+ rep for the Heliophysics Science Division | Member of the DEIA sub-committee | Co-wrote, analyzed, and disseminated two culture and climate surveys focussed on early career scientists at NASA GSFC.

NASA GSFC Science and Exploration Directorate (SED) Goals and Values Committee *2022 – 2023*

Part of a team re-evaluating the goals and values of the SED, with my sub-team's particular focus being retention and future of work | Co-wrote a report of findings and recommendations for SED leadership.

NASA GSFC Heliophysics Science Division Early Career Committee *2021 – 2024*

ISSI Team Leader *2019 – 2022*

Co-led an International Space Science Institute (ISSI) team on *Interrogating Field-Aligned Solar Flare Models: Comparing, Contrasting, and Improving* | Team comprised 12 scientists from six countries and ten institutions.

Student Mentoring

Undergraduate Research, Western Kentucky University (Mr. S. Sheppard) *Jan 2024-*

Mentoring undergraduate research, using IRIS data to study turbulence in solar flares.

PhD Committee/Examination, University of Oslo (Dr. H. Bakke) *Oct 2023*

Capstone Project, American University *Autumn 2023*

Mentored a senior thesis project, using Hubble Space Telescope data of stellar chromospheres.

NASA OSTEM Intern Program *Summer 2023*

Mentored Ms. M. Kane on an observational solar flare project. Ms. Kane now works in GSFC's Moon-to-Mars office.

Queen's University Belfast PhD Student) *2021–2024*

Mentored Dr. S. McLaughlin on modeling aspects of his PhD research, including a Jan-May 2023 research visit to GSFC. Now in private sector.

Reviewing

Journals Astrophysical Journal | Astronomy and Astrophysics | Frontiers in Astronomy & Space Science | Monthly Notices of the Royal Astronomical Society

Funding Agencies NASA | National Science Foundation | Czech Academy of Sciences

Conference Planning

Sessions AGU 2024 *(solar-stellar eruption connections)* | CoolStars 2024 *(solar-stellar eruptions splinter session)* | SHINE 2023 *(solar-stellar connections discussion)* | SHINE 2022 *(solar flare modeling discussion)* | AGU 2020 *(solar flare modelling session)* | RHESSI Workshop 2019 *(thermal response working group)*

Organizing Committees IRIS/Hinode 2022 *(science organizing committee)*

Missions & Research

MUSE Science Team member *2021 –*

ESCAPE Science Team member *2023 –*

ISSI Young Scientist team member *2017 - 2018*

Dr. H. Tian's ISSI team on *Diagnosing Heating Mechanisms in Solar Flare's Through Spectroscopic Observations*

ISSI Young Scientist team member *2012 - 2014*

Prof. L. Fletcher's ISSI team on *Observations and Modeling of Flare Chromospheres*

Selected Scientific Outreach and Media

ABC7DC, Eclipse Across America *April 2024*

Three hour televised live commentary of the 2024 total solar eclipse, with ABC7 & National Weather Desk meteorologists | Aired on cable and on over 100 online stream (streaming alone reached > 820,400 people).

Capital News Service, UMd *April 2024*

Interview regarding the 2024 total solar eclipse.

Astronomy on Tap DC *April 2024*

Public talk on 'The Sun's Dynamic Atmosphere' Washington D.C.'s DC9 nightclub.

National Air and Space Museum, Astronomy Education Volunteer *2020-2022*

Total Solar Eclipse *2017*

Eclipse related hands-on activities in downtown Washington D.C.

Rolls-Royce Science Prize | 2nd place winners *2015-2016*

Team member of the St Vincent's Primary School's entry to the Rolls Royce Science prize 2015/16, led by Danielle Timmons. We were awarded 2nd place, after working on a year long program of space & astronomy themed activities for the whole school community (ages 5-11 + parents). My involvement included advising on the purchase of specialist equipment, assisting with the planning and delivery of the weekly Astronomy Club, specific responsibility for delivering specialist sessions for each year group (e.g. building spectrometers) & assisting with stargazing evenings.

STEMNET Ambassador *2012-2016*
Various activities, including: careers events for high schoolers | public talks, e.g. 'Science of Star Wars' | Glasgow Science Center movie Q&As and Exporathon events.

University of Glasgow, Astronomy and Astrophysics group *2010-2017*
Various activities, including: Pint of Science and Seven Minutes of Science events, | Public solar observing | Stargazing live themed events | Transit of venus open evening | many planetarium shows and schools sessions | Glasgow Film Theatre Q&A. | Royal Astronomical Society Masterclass demonstrator

Publication List

Refereed

- Simões, P.J.A., Fletcher, L, Hudson, H.S., **Kerr, G.S.**, Penn, M. & Lopez, K.F. (2024), *Precise timing of solar flare footpoint sources from mid-infrared observations*, Monthly Notices of the Royal Astronomical Society, 532(1).
- **Kerr, G.S.**, Polito, V., Xu, Y. & Allred, J.C. (2024), *Solar Flare Ribbon Fronts II. Evolution of heating rates in individual flare footpoints*, The Astrophysical Journal, 970(1).
- Calcines, A. and the SISA Team (inlc. **Kerr, G.S.**). (2024), *Spectral Imaging of the Solar Atmosphere (SISA): The First Extreme-UV Solar Integral Field Spectrometer Using Slicers*, Aerospace, 11(3), 208.
- **Kerr, G.S.**, Kowalski, A.F., Allred, J.C., Daw, A.N. & Kane, M.R. (2024), *An Optically Thin View of the Flaring Chromosphere: Nonthermal line widths in a chromospheric condensation during an X-class Solar Flare*, Monthly Notices of the Royal Astronomical Society, 527(2), 2523-2548.
- Sadykov, V.M., Kosovichev, A.G., Stefan, J.T., Stejko, A., Kowalski, A.F., Allred, J.C. & **Kerr, G.S.** (2024), *Can Proton Beam Heating Flare Models Explain Sunquakes?*, The Astrophysical Journal, 960(1), 80.
- Reid, H.A.S. and the SPARK Team (inlc. **Kerr, G.S.**). (2023), *The Solar Particle Acceleration Radiation and Kinetics (SPARK) mission concept*, Aerospace, 10(12), 1034.
- Yang, K., Sun, X., **Kerr, G.S.** & Hudson, H.S. (2023), *A Possible Mechanism for "Late Phase" in Stellar White-Light Flares*, The Astrophysical Journal, 959(1), 54.
- Xu, Y., **Kerr, G.S.**, Polito, V., Huang, N., Jing, J. & Wang, H. (2023), *Extreme Red-wing Enhancement of UV Lines During the 2022 March 30 X1.3 Solar Flare*, The Astrophysical Journal, 958(1), 67.
- **Kerr, G.S.**, Allred, J.C., Kowalski, A.F., Milligan, R.O., Hudson, H.S., Zambrana Prado, N., Kucera, T.A. & Brosius, J.W. (2023), *Prospects of Detecting Non-thermal Protons in Solar Flares via Lyman Line Spectroscopy: Revisiting the Orrall-Zirker Effect*, The Astrophysical Journal, 945(2), 118.
- McLaughlin, S.A., Milligan, R.O., **Kerr, G.S.**, Monson, A.J., Simões, P.J.A. & Mathioudakis, M. (2023), *Formation of the Lyman Continuum During Solar Flares*, The Astrophysical Journal, 944(2), 186.
- Polito, V., **Kerr, G.S.**, Xu, Y., Sadykov, V.M. & Lorincik, J. (2023), *Solar Flare Ribbon Fronts I. Constraining flare energy deposition with IRIS spectroscopy*, The Astrophysical Journal. 944(1), 104.
- **Kerr, G.S.** (2023), *Interrogating Solar Flare Loop Models with IRIS Observations 2: Plasma Properties, Energy Transport, and Future Directions*. Frontiers in Astronomy and Space Sciences, 9 (1060862).
- **Kerr, G.S.** (2022), *Interrogating Solar Flare Loop Models with IRIS Observations 1: Overview of the Models, and Mass flows*. Frontiers in Astronomy and Space Sciences, 9 (1060856).
- Yadav, R., de La Cruz Rodriguez, J., **Kerr, G.S.**, Diaz Baso, C.J. & Leenaarts, J. (2022), *On the Radiative Losses in the Chromosphere During a C-class Flare*. Astronomy & Astrophysics, 665, A50.
- Allred, J.C., **Kerr, G.S.** & Emslie, A.G. (2022), *Solar Flare Heating with Turbulent Suppression of Thermal Conduction*. The Astrophysical Journal, 931, 60.
- Kowalski, A.F., Allred, J.C., Carlsson, M., **Kerr, G.S**, Tremblay, P.E., Namekata, K., Kuridze, D., Uitenbroek, H. (2022), *The Atmospheric Response to High Nonthermal Electron Beam Fluxes in Solar Flares. II. Hydrogen Broadening Predictions for Solar Flare Observations with the Daniel K. Inouye Solar Telescope*. The Astrophysical Journal, 928(2).
- Cheung, M.C. M., Martínez-Sykora, J., Testa, P., De Pontieu, B., Chintzoglou, G., Rempel, M., Polito, V. **Kerr, G.S.**, *et al*. (2022), *Probing the Physics of the Solar Atmosphere with the Multi-slit Solar Explorer (MUSE): II. Flares and Eruptions*. The Astrophysical Journal, 926(1), 53.
- Xu, Y., Yang, X., **Kerr, G.S.**, Polito, V., Sadykov, V.M., Jing, J, Cao, W, & Wang, H. (2022), *Multi-passband Observations of a Solar Flare over the He I 10830 Å line*. The Astrophysical Journal Letters, 924(1), L18.
- **Kerr, G.S.**, Xu, Y., Allred, J.C., Polito, V., Sadykov, V.M., Huang, N. & Wang, H. (2021), *He I 10830Å Dimming During Solar Flares, I: The Crucial Role of Non-Thermal Collisional Ionisations* The Astrophysical Journal, 912(2).
- Allred, J.C., Alaoui, M., Kowalski, A.F. & **Kerr, G.S.** (2020), *Modeling the Transport of Nonthermal Particles in Flares Using Fokker-Planck Kinetic Theory*. The Astrophysical Journal, 902, 16.

- **Kerr, G.S.**, Allred, J.C. & Polito, V. (2020), *Solar Flare Arcade Modelling: Bridging the gap from 1D to 3D Simulations of Optically Thin Radiation*. The Astrophysical Journal, 900(1), 18.
- Sadykov, V.M., Kosovichev, A.G., Kitiashvili, I.N. & **Kerr, G.S.** (2020), *Response of SDO/HMI Observables to Heating of the Solar Atmosphere by Precipitating High-energy Electrons*. The Astrophysical Journal, 893(1), 24.
- **Kerr, G.S.**, Carlsson, M. & Allred, J.C. (2019), *Modelling Mg II During Solar Flares, II: Non-Equilibrium Effects*. The Astrophysical Journal, 885(2), 119.
- **Kerr, G.S.**, Allred, J.C. & Carlsson, M. (2019), *Modelling Mg II During Solar Flares, I: Partial Frequency Redistribution, Opacity, and Coronal Irradiation*. The Astrophysical Journal, 883(1), 57.
- Kowalski, A.F., Butler, E., Daw, A.N., Fletcher, L., AllredJ.C., de Pontieu, B., **Kerr, G.S.** & Cauzzi, G. (2019), *Spectral Evidence for Heating at Large Column Mass in Umbral Solar Flare Kernels. I. IRIS Near-UV Spectra of the X1 Solar Flare of 2014 October 25*. The Astrophysical Journal, 878(2), 135;
- Sadykov, V.M., Kosovichev, A.G., Sharykin, I.N. & **Kerr, G.S.** (2019), *Statistical Study of Chromospheric Evaporation in the Impulsive Phase of Solar Flares*. The Astrophysical Journal, 871(1), 2.
- **Kerr, G.S.**, Carlsson, M., Allred, J.C., Young, P.R. & Daw, A.N. (2019) *Si IV Resonance Line Emission During Solar Flares: Non-LTE, Non-Equilibrium, Radiation Transfer Simulations*. The Astrophysical Journal, 871(1), 23;
- Brown, S.A., Fletcher, L., **Kerr, G.S.**, Labrosse, N., Kowalski, A.F., de la Cruz Rodriguez, J. (2018), *Modelling the Hydrogen Lyman Lines In Solar Flares*. The Astrophysical Journal, 862(1), 59.
- Simões, P.J.A., **Kerr, G.S.**, Fletcher, L., Hudson, H.S., Giménez de Castro, C.G. & Penn, M. (2017), *Formation of the Thermal Infrared Continuum in Solar Flares*. Astronomy & Astrophysics, 605, A125.
- **Kerr, G.S.**, Fletcher, L., Russell, A.J.B. & Allred, J. (2016), *Simulations of the Mg II k and Ca II 8542 Lines from an Alfvén Wave-Heated Flare Chromosphere*. The Astrophysical Journal, 827(2), 101
- **Kerr, G.S.**, Simões, P.J.A., Qiu, J. & Fletcher, L. (2015), *IRIS Observations of the Mg II h & k Lines During a Solar Flare*. Astronomy & Astrophysics, 582, (A50).
- Milligan, R.O., **Kerr, G.S.**, Dennis, B.R., Hudson, H.S., Fletcher, L., Allred, J.C., Chamberlin, P.C., Ireland, J., Mathioudakis, M. & Keenan, F.P. (2014), *The Radiated Energy Budget of Chromospheric Plasma in a Major Solar Flare Deduced from Multi-Wavelength Observations*. The Astrophysical Journal 793(2), 70.
- **Kerr, G.S.** & Fletcher, L. (2014), *Physical Properties of White-Light Sources in the 2011 Feb 15 Solar Flare*. The Astrophysical Journal 783(2), 98.
- Cheng, J. X., **Kerr, G.S.** & Qiu, J. (2012), *Hard X-ray and Ultraviolet Observations of the 2005 January 15 Two-Ribbon Flare*. The Astrophysical Journal 744(1), 48.

Conference Proceedings

- Simões, P.J.A., Fletcher, L., Labrosse, N. & **Kerr, G.S.** (2016), *Observations and Modelling of Helium Lines in Solar Flares*. In: 'Ground-based Solar Observations in the Space Instrumentation Era', Coimbra Portugal. ASP Conf. Series, Vol. 504.

White Papers (leading role)

- **Kerr, G.S.**, *et al* (2022), *Requirements for Progress in Understanding Solar Flare Energy Transport: The Impulsive Phase*. White Paper submitted to the NASEM Solar and Space Physics Decadal Survey 2024-2033.
- **Kerr, G.S.**, *et al* (2022), *Requirements for Progress in Understanding Solar Flare Energy Transport: The Gradual Phase*. White Paper submitted to the NASEM Solar and Space Science Decadal Survey 2024-2033.
- Allred, J.C., **Kerr, G.S.**, *et al* (2022), *Next-Generation Comprehensive Data-Driven Models of Solar Eruptive Events*. White Paper submitted to the NASEM Solar and Space Physics Decadal Survey 2024-2033.
- **Kerr, G.S.**, *et al* (2020), *Solar Flare Energy Partitioning and Transport – the Impulsive Phase*. White Paper submitted to the Heliophysics 2050 Workshop https://doi.org/10.5281/zenodo.4036955
- **Kerr, G.S.**, *et al* (2020), *Solar Flare Energy Partitioning and Transport – the Gradual Phase*. White Paper submitted to the Heliophysics 2050 Workshop https://doi.org/10.5281/zenodo.4036973

Invited Presentations

AGU Fall Meeting	*Dec 2024, Washington D.C., USA (upcoming)*
Naval Research Laboratory (Astrophysics group) Colloquium	*Nov 2024, USA (upcoming)*
AGU Fall Meeting	*Dec 2023, San Francisco, USA*
UMass Lowell Colloquium	*April 2023, USA (virtual)*
ROCMI Workshop	*Feb 2023, Svalbard, Norway*
SPHERE Workshop (session facilitator)	*Jun 2022, Boulder Co, USA*
American Physical Society, Mid-Atlantic Section annual meeting	*Dec 2020, USA (virtual)*
University of St. Andrews Seminar	*April 2020, St. Andrews, UK (virtual)*
University of Glasgow Seminar	*April 2020, Glasgow, UK (virtual)*
New Jersey Institute of Technology Seminar	*March 2020, New Jersey, USA*
High Altitude Observatory Colloquium	*Feb 2020, Boulder Co, USA*

IRIS-10 Science Meeting *Nov 2019, Bangalore, India*
ISSI Team Meeting: Nanoflares (Testa) *Nov 2018, Bern, Switzerland*
ISSI Team Meeting: Flare Heating Mechanisms (Tian) *Oct 2018, Beijing, China*
AGU Fall Meeting *Dec 2017, New Orleans, USA*
Naval Research Laboratory (Solar Physics group) Seminar *June 2017, Washington D.C., USA*
IRIS-8 / Hinode-11Joint Science Meeting *May 2017, Seattle Wa, USA*
RHESSI Group Seminar (GSFC) *May 2017, Washington D.C., USA*
ISSI Team Meeting: Flare Heating Mechanisms (Tian) *Jan 2017, Bern, Switzerland*
Mullard Space Science Lab Seminar *April 2014, Guildford, UK*
ISSI Team Meeting: Chromospheric Flares (Fletcher) *April 2014, Bern, Switzerland*
ISSI Team Meeting: Chromospheric Flares (Fletcher) *Jan 2013, Bern, Switzerland*

Grants and Awards

NSF AAG (Co-PI) $\sim \$158,000$, *Sept 2024 – Sept 2027*
'Characterizing Energy Release and Flare Heating with High-Resolution Imaging and Spectral Observations and Modeling: Early DKIST Science' | Co-PI: Graham Kerr

NASA ROSES Heliophysics Guest Investigator (Co-I) $\sim \$522,000$, *Jan 2024 – Jan 2027*
'The Solar Atmosphere's Response to Impulsive Energy Input.' | PI: Jeffrey Brosius

NASA ROSES Heliophysics Supporting Research (Co-I) $\sim \$1,000,000$, *Oct 2023 – Oct 2026*
'Turbulence in the Active Sun.' | PI: Gordon Emslie

NASA ROSES Heliophysics Theory, Modelling and Simulations (Co-I) $\sim \$1,200,000$, *Oct 2023 – Oct 2026*
'Comprehensive Solar Eruption Models: Understanding Flare Arcades from the Global to Kinetic Scales.' | PI: Joel Allred

NASA GSFC Heliophysics Innovation Fund (Co-I) $\sim \$100,000$, *Oct 2022 – Oct 2023*
'Turbulence and Time Scales in Solar Flares.' | PI: Joel Allred

NASA GSFC Heliophysics Innovation Fund (Co-I) $\sim \$100,000$, *Oct 2021 – Oct 2022*
'RADYN_Arcade: Building 3D Flare Arcades with RADYN Loop Models.' | PI: Joel Allred

NASA ROSES Early Career Investigator Program (PI) $\sim \$581,000$, *June 2021 – June 2025*
'Corona to Photosphere: Exploring Solar Flare Energy Transport Throughout the Solar Atmosphere'. | PI: Graham Kerr

NASA GSFC Heliophysics Innovation Fund (Co-I) $\sim \$100,000$, *Oct 2021 – Oct 2022*
'Are Proton Beams Required to Explain White Light Flares?' | PI: Joel Allred

NASA ROSES Heliophysics Supporting Research (Co-I) $\sim \$340,000$, *Oct 2020 – Oct 2023*
'Data Constrained Modelling of Hydrogen Line and Continuum Emission During Solar Flares.' | PI: Ryan Milligan

NASA ROSES Heliophysics Supporting Research (Co-I) $\sim \$640,000$, *April 2019 – Oct 2022*
'Spectral Analysis and Modeling of the Flaring Lower Solar Atmosphere in Multi-wavelengths.' | PI: Yan Xu

NASA GSFC Heliophysics Innovation Fund (Co-I) $\sim \$100,000$, *Oct 2019 – Oct 2020*
'Suppression of Thermal Conduction in Flares.' | PI: Joel Allred

NASA Postdoctoral Program (NPP) Fellowship (PI) $\sim \$300,000$, *April 2017 – April 2020*
'Understanding the Flaring Chromosphere' | PI: Graham Kerr

College of Science and Engineering, Univ. of Glasgow PhD Scholarship (PI) $\sim £61,000$, *2012 – 2016*
Competitive proposal based scholarship | PI: Graham Kerr