Dr. Graham S. Kerr

Research Scientist

Catholic Univeristy of America, based at NASA GSFC

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Pronouns: He/Him/His

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 in my research. My research can be approached in a very modular fashion, with many avenues for student involvement, from short undergraduate projects to forming the basis for PhD theses.

Education

2012–2016 **PhD Solar Physics**, *University of Glasgow*, *U.K.*
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.

2007–2012 **MSci.(1st Class Hons.) Physics and Astronomy**, *University of Glasgow*, *U.K.*
(undergraduate integrated Masters in Science degree)

Career History (Research)

April 2020– **Research Scientist, Catholic University of America**, Washington D.C., U.S.A.
onsite contractor at NASA/Goddard Space Flight Center, Md USA.

April 2017– April 2020 **NASA Postdoctoral Program Fellow, NASA/Goddard Space Flight Center**, Md, U.S.A.
Competitive postdoctoral fellowship administered by Universities Space Research Association.

Jan – April 2017 **Affiliate Staff Member**, University of Glasgow, Glasgow, UK.

Oct–Dec 2016 **F-CHROMA Postdoctoral Research Assistant**, University of Glasgow, Glasgow, UK.

Oct 2012 – Sept 2016 **PhD Research**, University of Glasgow, Glasgow, UK.
Observations and modelling of the chromosphere during solar flares (Sup: Prof. L. Fletcher).

Jun–Aug 2011 **High Altitude Observatory Solar Physics REU Program**, Boulder CO, USA.
Global 2D Axisymmetric MHD Simulations of Coronal Streamers (Sup: Dr Y. Fan).

Jun–Aug 2010 **Montana State University Solar Physics REU Program**, Bozeman MT, USA.
HXR and UV Observations of a Two-Ribbon Solar Flare (Sup: Prof J. Qiu).

Publications

Refereed

→26 publications (11 as first-author); $h-$index = 15; 530+ citations (70 for most-cited 1st author pub.)

- **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 1: 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), 190.
- 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.
- 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 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`

Grants & Awards

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

Oct 2021-Oct 2022 **NASA GSFC**, *Heliophysics Innovation Fund*, Co-Investgator (PI: Dr. Joel Allred), 'RADYN_Arcade: Building 3D Flare Arcades with RADYN Loop Models.' Total Value $\sim \$98,000$.

June 2021-June 2025 **NASA**, *ROSES Early Career Investigator Program*, **Principal Investigator**, 'Corona to Photosphere: Exploring Solar Flare Energy Transport Throughout the Solar Atmosphere.' Total Value $\sim \$581,000$.

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

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

Oct 2019-Oct 2020 **NASA GSFC**, *Heliophysics Innovation Fund*, Co-Investigator (PI: Dr. Joel Allred), 'Suppression of Thermal Conduction in Flares.' Total Value $\sim \$98,000$.

April 2020-April 2022 **NASA ROSES**, *Heliophysics Supporting Research*, Co-Investigator (PI: Dr. Yan Xu), 'Spectral Analysis and Modeling of the Flaring Lower Solar Atmosphere in Multi-wavelengths.' Total Value $\sim \$640,000$.

April 2017-April 2020 **NASA**, *NASA Postdoctoral Program (NPP) Fellowship*, **Principal Investigator**, 'Understanding the Flaring Chromosphere.' Total Value $\sim \$300,000$.

Oct 2012-Sept 2016 **College of Science and Engineering, Univ. of Glasgow**, *Research Scholarship*: competitive scholarship that awarded full tuition and maintenance for PhD study. Total Value $\sim £61,000$.

Prizes

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

Rolls-Royce **2nd Place in the Rolls-Royce Science Prize (2016)**: *Team award for a year-long outreach project, from 2000 initial entrants and 6 finalists.*

U of Glasgow (postgrad) **Hunter-Cumming Prize (2016)**: Prize awarded in recognition of outstanding science outreach activities • **Post Graduate Thomson Experimental Prize (2015)**: 3 prizes awarded for excellence in research during 2nd year of PhD out of $\sim$ 30 candidates • **Hunter-Cumming Prize (2014)**: Awarded for best 1st year PhD Report, of $\sim$ 30 candidates

U of Glasgow (undergrad) **Archibald McAulay Memorial Prize (2012)** • **Tannahill Bequest (2012)** • **MacKay-Smith Prize (2011)** • **Lang Scholarship (2010)** • **Tannahill Bequest (2010)** • **Lanfine Bursary (2009)** • **Cleland Prize (2009)** • **Astronomy 2 (2009)**

Selected Community Involvement & Leadership

Student Mentoring

- **PhD Student Mentoring, 2021 - present:** Working closely with graduate students at Queen's Univeristy Belfast, providing mentoring in the modelling aspects of their PhD project. Hosting a research visit to GSFC Jan - May 2023.
- **NASA Intern Program, summer 2022:** Mentored a NASA intern who worked on IRIS flare data. This was their first introduction to research.

Leadership Roles & Committees

- **ISSI Team Leader** (2019-2022) - Led an International Space Science Institute (ISSI) team *Interrogating Field-Aligned Solar Flare Models: Comparing, Contrasting and Improving*. The team consists of 12 scientists from six countries and ten institutions, and aims to critically compare and benchmark the three commonly used flare (radiation-) hydrodynamic models, identify needs for next-generation models, and assess models' consistency with observations.

- **GSFC Science and Exploration Directorate (SED) Goals & Values Committee** (2022-2023) - Part of a team re-evaulating the goals and values of the Science and Exploration Directorate, with a particular focus on retention and future of work.
- **Solar Physics Division (SPD) of the American Astronomical Society (AAS) Public Policy Committee member**, (2022 -)
- **LGBTQ+ ERG, Goddard Space Flight Center** (2018 -)
- **GSFC Heliophysics Division Early Career Committee** (2021 -)
- **NASA Goddard Association of Postdoctoral Scholars (NGAPS+) co-officer** (2021 -) - NGAPS+ rep for the Heliophysics Science Division; member of the DEIA sub-committee; wrote, analysed, and disseminated a culture and climate survey focussed on early career scientists at NASA GSFC.

Editing & Reviewing

- **Astrophysical Journal**
- **Astronomy and Astrophysics Journal**
- **Frontiers in Astronomy and Space Sciences**
- **Czech Academy of Sciences**

Conference Planning

- **SHINE 2023** - Co-Convener of a solar-stellar flare connections discussion session.
- **IRIS/Hinode 2022** - Member of the science organising committee.
- **SHINE 2022** - Co-Convener of a solar flare modelling & observations discussion session.
- **AGU Fall Meeting 2020** - Primary Convener of a solar flare modelling session (SH020).
- **RHESSI-18 Workshop 2019** - Co-leader of the 'Thermal Response' group.
- **STFC Intro. Solar System Plasma School 2015** - member of the local organising committee.

Missions & Research

- **MUSE Science Team Member**: member of the science team for the Multi-slit Solar Explorer mission concept, currently in Phase A study for a NASA Midex solicitation.
- **SNOUT Co-I**: Co-Investigator of the Small NASA Optical and Ultraviolet Telescope smallsat concept, currently in being proposed to the 2022/2023 NASA Astro Pioneers solicitation.
- **ESCAPE Science Team Member**: member of the science team for the Extreme-ultraviolet Stellar Characterization for Atmospheric Physics and Evolution spacecraft concept, helping to formulate a proposal to the 2025 NASA Astrophysics SMEX solicitation.
- **ISSI Young Scientist member (Jan 2017 – Oct 2018)**: Member of Dr. H. Tian's ISSI team on *Diagnosing Heating Mechanisms in Solar Flares Through Spectroscopic Observations.*
- **ISSI Young Scientist member (Sept 2012 – April 2014)**: Member of Prof. L. Fletcher's ISSI team on *Observations and Modelling of Flare Chromospheres.*
- **DKIST Observing Time**: PI (one) and Co-I (three) of DKIST Cycle observing proposals.
- **BBSO Observing Time**: PI of several selected observing proposals on the GST at BBSO, looking at flare ribbon dynamics.

Scientific Outreach

- **2020 – present** - Astronomy Education volunteer at the National Air and Space Museum, Washington DC.
- **2017 Total Solar Eclipse** - I assisted with some eclipse related outreach in downtown Washington DC. We provided hands-on activities about the solar eclipse and the magnetic nature of the Sun.
- **Rolls Royce Science Prize** - 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** - I have taken part in various STEMNET activities in Glasgow, including careers events for high school students, and delivering a 'Science of Star Wars' talk
- **Glasgow University Astronomy and Astrophysics group (2010-2017)** - Assisted with various outreach activities. Past events include delivering talks at the *Pint of Science* and *Seven Minutes of Science* events, public solar observing, Stargazing live themed events, transit of venus open evening, delivering many planetarium shows and schools sessions, and a Glasgow Film Theatre Q&A.
- **Glasgow Science Centre** - Meet the expert/Explore Your Universe program (Sept 2013, 2014), *Space Station 3D* movie introduction and Q&A session, and 2015 *Exploration*.
- **Glasgow University Public Engagement Internship** - Development and delivery of a new supernovae outreach project

for the Glasgow Science Festival (June 2013).

- **Glasgow University / RAS** - Demonstrator for RAS Physics Masterclasses 2013, 2014.
- **Stars Over Yellowstone** - Demonstrator at a star party held in Yellowstone National Park (July 2010), where I helped the public use telescopes, find astronomical objects and answered questions about astrophysics.

Teaching (University of Glasgow)

Jan–April 2013, '14 & '15 — **Astronomy 3/4 (Honours) Laboratory Demonstrator**: Supervised undergraduate students working on small research projects • Helped develop a new project for the 2015 students.

Sept–Dec 2013 & 2014 — **Astronomy 1 Tutor**: Assisted with class tutorials, helping to develop first year student's problem solving skills • Graded assignments and provided feedback.

Sept–Dec 2013 — **Physics 1 Laboratory Demonstrator**: Worked in the first year labs, teaching techniques and critical analysis of experiments • Marked and provided feedback on records and reports.

Sept 2013 & 2014 — **Physics 3 Skills Revolution Demonstrator**: Worked with honours physics students to develop their communication, team working and leadership skills.

June 2013 — **Physics summer school**: Taught at a pre-university school for students entering 1st year.

Invited Presentations

April 2023 — **UMass Lowell Colloquium** - USA

Feb 2023 — **ROCMI Workshop** - Svalbard, Norway

Jun 2022 — **SPHERE Workshop (session facilitator)** - Boulder Co, USA

Dec 2020 — **American Physical Society, Mid-Atlantic Section annual meeting** - USA (virtual)

April 2020 — **University of St. Andrews Seminar** - St. Andrews, UK (virtual)

April 2020 — **University of Glasgow Seminar** - Glasgow, UK (virtual)

March 2020 — **New Jersey Institute of Technology Seminar** - New Jersey, USA

Feb 2020 — **High Altitude Observatory Colloquium** - Boulder Co, USA

Nov 2019 — **IRIS-10 Science Meeting** - Bangalore, India

Nov 2018 — **ISSI Team Meeting: Nanoflares (Testa)** - Bern, Switzerland

Oct 2018 — **ISSI Team Meeting: Flare Heating Mechanisms (Tian)** - Beijing, China

Dec 2017 — **AGU Fall Meeting** - New Orleans, USA

June 2017 — **Naval Research Laboratory Seminar** - Washington D.C., USA

May 2017 — **IRIS-8 / Hinode-11Joint Science Meeting** - Seattle Wa, USA

May 2017 — **RHESSI Group Seminar (GSFC)** - Washington D.C., USA

Jan 2017 — **ISSI Team Meeting: Flare Heating Mechanisms (Tian)** - Bern, Switzerland

April 2014 — **Mullard Space Science Lab Seminar** - Guildford, UK

April 2014 — **ISSI Team Meeting: Chromospheric Flares (Fletcher)** - Bern, Switzerland

Jan 2013 — **ISSI Team Meeting: Chromospheric Flares (Fletcher)** - Bern, Switzerland

Voluntary Work

Smithsonian National Air and Space Museum — **Astronomy Education volunteer**, *(2020-present)*, Public solar and night time observing, distilling scientific concepts, explaining research and observing methods.

British Red Cross — **Event First Aid volunteer**, *(2008-2017)*, I volunteered with the first aid team at various public events in the Glasgow area · Required excellent team working sometimes under high pressured situations · Trained to an advanced level of first aid.

Volunteer Council Member, *(2013-2017)*, Elected member of the Glasgow and Renfrewshire Volunteer Council, representing volunteers views at quarterly meetings.

Glasgow University Red Cross, *(2008-2013)*, I was a leading member of GURC · elected Humanitarian Coordinator (2012/13), Secretary (2011/12), Humanitarian Action Coordinator (2010/11), Ordinary Board Member (2009/10) · Developed, organised and ran activities, events and meetings in humanitarian action, fundraising and first aid training/awareness on the Glasgow University campus · GURC was awarded a BRC Excellence Award.

The Scout Association **Cub Scout Leader**, *(2006-2017)*, I assisted in the planning, organisation and delivery of weekly group nights, as well as camps and other weekend activities, and the training of Young Leaders.

Career History (non-research)

Jun – Aug 2012 **Head of Waterfront, Head of Swimming, Senior Counselor**.

Jun – Aug '08,'09 **Head of Woodcraft, Senior Counselor**, *Camp Greenbrier for Boys*, Alderson WV, USA.

Jun '06 – Jun '08 **Customer Assistant**, *Homebase Ltd.*, East Kilbride, UK.