

Dr. Graham S. Kerr

Research Associate

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Pronouns: He/Him/His

Research Interests: 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. I have expertise of imaging and spectroscopic data analysis, utilising the Hinode, IRIS & SDO satellites. I use and further develop 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.

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 Associate, Catholic University of America**, Washington D.C., U.S.A.
onsite contractor at NASA/Goddard Space Flight Center, Md USA.
- April 2017– **NASA Postdoctoral Program Fellow, NASA/Goddard Space Flight Center**, Md, U.S.A.
April 2020 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 – **PhD Research**, University of Glasgow, Glasgow, UK.
Sept 2016 *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

- 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 (in press).
- 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 (in press).
- **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., Allred, J.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

- **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>

Submitted / In Preparation

- Kowalski, A.F., Allred, J.C., Carlsson, M., **Kerr, G.S.**, Tremblay, P.E., Namekata, K., Kuridze, D., Uitenbroek, H. (2021), *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*. Under review at the Astrophysical Journal.
- Qiu, J. & **Kerr, G.S.** (2021), *Solar Flare Ribbons and Kernels*, Living Reviews in Solar Physics. Invited review in preparation.

Grants & Awards

- Oct 2021- **NASA GSFC**, *Heliophysics Innovation Fund*, Co-Investigator (PI: Dr. Joel Allred), 'RADYN_Arcade: Building 3D Flare Arcades with RADYN Loop Models.' Total Value ~ \$98,000.
- June 2021- **NASA**, *ROSES Early Career Investigator Program*, **Principal Investigator**, 'Corona to Photosphere: Exploring Solar Flare Energy Transport Throughout the Solar Atmosphere.' Total Value ~ \$581,000.
- Oct 2021- **NASA GSFC**, *Heliophysics Innovation Fund*, Co-Investigator (PI: Dr. Joel Allred), 'Are Proton Beams Required to Explain White Light Flares?' Total Value ~ \$100,000.
- Oct 2020- **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 ~ \$340,000.
- Oct 2019- **NASA GSFC**, *Heliophysics Innovation Fund*, Co-Investigator (PI: Dr. Joel Allred), 'Suppression of Thermal Conduction in Flares.' Total Value ~ \$98,000.

- April 2020- **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 ~ \$640,000.
- April 2022
- April 2017- **NASA**, *NASA Postdoctoral Program (NPP) Fellowship*, **Principal Investigator**, 'Understanding the Flaring Chromosphere.' Total Value ~ \$300,000.
- April 2020
- Oct 2012- **College of Science and Engineering, Univ. of Glasgow**, *Research Scholarship*: competitive scholarship that awarded full tuition and maintenance for PhD study. Total Value ~ £61,000.
- Sept 2016

Prizes

- 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 ~ 30 candidates
 - **Hunter-Cumming Prize (2014)**: Awarded for best 1st year PhD Report, of ~ 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 involvement

- Working closely with a graduate student at Queen's University Belfast, providing mentoring in the modelling aspects of their PhD project.

Leadership Roles & Committees

- **ISSI Team Leader (June 2019–)** - Leads 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.
- **LGBT Advisory Committee Member, Goddard Space Flight Center**
- **GSFC Heliophysics Division Early Career Committee**

Editing & Reviewing

- **Astrophysical Journal** - I have refereed articles for the Astrophysical Journal since June 2015.
- **Czech Academy of Sciences** - I have provided reviews for proposals and evaluated outputs for the Czech Academy of Sciences.

Conference Planning

- **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.

Other

- **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.
- **Heliosphysics 2050 Workshop White Papers**: Lead author on white papers and associated abstracts describing outstanding questions in flare physics, and how to address those questions.
- **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 (two) of DKIST Cycle 1 observing proposals, placed in Group B.
- **BBSO Observing Time**: PI of a selected observing proposal on the GST at BBSO, looking for 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

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 - Colorado, USA
Jan 2020	ISSI Team Meeting: Flare Modelling Comparisons (Kerr) - Bern, Switzerland
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-11 Joint Science Meeting - Seattle, 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.