

DR MARINA BATTAGLIA

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RESEARCH INTERESTS

My research interests are particle acceleration and transport in solar flares, using observations in radio, X-ray, and EUV wavelengths and putting them into context with theoretical models. Current projects aim at understanding the density structure of the chromosphere and corona during flares using X-ray imaging observations made by the RHESSI satellite and observations by SDO/AIA. As part of the STIX team at FHNW, I am further involved in the planning and development of the STIX X-ray telescope due to fly on the ESA Solar Orbiter mission.

EMPLOYMENT

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|--------------------------|--|
| 03/2014 – present | Lecturer / Senior Research Scientist
Fachhochschule Nordwestschweiz, Switzerland, Institute of 4D Technologies |
| 01/2012 – 02/2014 | Post-doctoral researcher
Fachhochschule Nordwestschweiz, Switzerland, Institute of 4D Technologies |
| 05/2009 – 11/2011 | Leverhulme Research Fellow
University of Glasgow, UK, School of Physics and Astronomy |
| 01/2009 – 03/2009 | Post-doctoral Research Assistant
ETH Zurich, Switzerland, Department of Physics, Institute for Astronomy |
| 02/2008 – 04/2008 | Visiting Graduate Research Assistant
University of Glasgow, UK, Department of Physics and Astronomy |

EDUCATION

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|--------------------------|--|
| 12/2004 – 12/2008 | Dr. sc. ETH
ETH Zurich, Switzerland
Thesis title: <i>Particle kinematics in solar flares: observations and theory</i> |
| 10/1999 – 08/2004 | dipl. phys. ETH
ETH Zurich, Switzerland
Studies of physics with focus on astrophysics and particle physics |

AWARDS & FELLOWSHIPS

- SGAA travel grant for international collaborations, Swiss Society for Astrophysics & Astronomy (2012)
- Honorary Research Fellow, School of Physics & Astronomy, University of Glasgow, UK, since 2012
- RAS grant for a summer student project (2011)
- Cover figure of A&A volume 533, 2011
- Participant at the “Building a successful international research career” workshop by the British Council, Amsterdam (2011)
- Leverhulme Research Fellowship (2009)
- SNSF Fellowship for Prospective Researchers, Swiss National Science Foundation (2009, declined due to clash with Leverhulme)
- Outstanding student paper award, Space Physics and Aeronomy Section of the American Geophysical Union (2008)
- Award for scientific excellency, Institute for Astronomy, ETH Zurich (2008)

- Student Travel Grant for participation at conferences, Swiss Society for Astrophysics & Astronomy (2005 & 2006)
- Undergraduate study grant, Kuffner Foundation (2002-2004)

TEACHING EXPERIENCE

- Lecturer for "Thermodynamik (WING)" and "Phänomene der Physik (WING)", FHNW, since 2013
- Lecturer for "Exploring the cosmos 2y" (University of Glasgow, 2011)
- Astronomy 2 supervisor (University of Glasgow, 2010/2011)
- Student BSc. project supervision. First supervisor of a student working on RHESSI data analysis, second supervisor of a student working on the physics of climbing falls (final report graded A4) (University of Glasgow, 2009 – 2010)
- Final Year Undergraduate Astronomy lab demonstration. Supervised an observational project on solar limb darkening and a computational project on stellar structure (University of Glasgow, 2010)
- Teaching Assistant for the lecture course "Physics II". Tutorials and exam preparation assistance for groups of up to 20 students (ETH Zurich, 2005 – 2009)
- Demonstrator for Beginner's Astronomy lab (ETH Zurich, 2005 – 2009)

COMMITTEE MEMBERSHIPS

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| 2015 – present | President of Swiss SCOSTEP committee |
| 2015 – present | Leader of SSALMON (Solar simulations for the Atacama large millimeter observatory network) expert team on solar flares |
| 2015 – present | Swiss representative on UN COPUOUS expert team on space weather |
| 2015 – present | Member of SKA science working group on Solar, Heliospheric & Ionospheric physics |

RESEARCH RELATED EXPERIENCE

- Head of LOC for the 13th RHESSI workshop, FHNW, Switzerland (2014)
- Initiator and organiser of Solar Physics Journal Club, FHNW, Switzerland (2014 –)
- Served on NASA grant review panel
- Participant at "Standing up for Science Media Workshop", University of Glasgow, 18. November 2011
- Member of the LOC for the 11th RHESSI workshop, Glasgow (2011)
- Helper at the National Astronomy Meeting (NAM), Glasgow (2009)
- Group leader at the 8th RHESSI workshop, Potsdam (2008)
- Webmaster and Assistant System Administrator, Institute for Astronomy, ETH Zurich (2006 – 2009)
- Referee for the Astrophysical Journal, Astronomy & Astrophysics, and Solar Physics

COMMUNITY OUTREACH

- Ambassador for the Science, Technology, Engineering and Mathematics Network (STEMNET) (2009-2012). Activities: Show with the University of Glasgow mobile planetarium at Lochwinnoch Primary, Tours of the University of Glasgow observatory for Glasgow Scouts and a group of RAF pensioners, "Speed-networking" careers event at Springburn Academy
- Talks at meetings of amateur astronomers. Highlights include the 7th International Week of Astronomy (Arosa, 2006) and the 6th Teleskoptreffen Falera (2007)

- Organized a study week for high-school students, ETH Zurich 2008
- Support at science events: “Night of Physics” (ETH Zurich 2005), “World of science” (Zurich 2005), “Physics for kids and teens” (ETH Zurich 2005)
- Article on the Sun in the professional magazine “SCHULEkonkret” for primary school teachers, *Die Sonne - unser Stern*, F. Joos, P.C. Grigis, M. Battaglia (6/2005)

SKILLS

- Expert knowledge of RHESSI data analysis and visibility imaging techniques
- IDL/Solar Soft, L^AT_EX document preparation language
- Basic knowledge in Unix system administration
- Languages: German (native), English (fluent), Italian (intermediate), French (intermediate)

PROFESSIONAL AFFILIATIONS

- Individual member: International Astronomical Union
- Fellow: Royal Astronomical Society (F.R.A.S.)
- Member: Swiss Society for Astronomy and Astrophysics
- Member: American Geophysical Union

INVITED TALKS

- 2015** • *Recent advances in understanding electron acceleration in solar flares*, IUGG, Prague CZ (24.6.)
- 2013** • *X-ray and EUV observations of solar flares as diagnostic of chromospheric and coronal plasma parameters*, University of Stockholm (29. November)
- *Combined RHESSI and SDO observations of solar flares*, XIIth IAGA Scientific Assembly, Mexico (29. August)
- 2012** • *RHESSI and SDO/AIA observations of the chromospheric and coronal plasma parameters during a solar flare*, Goddard Space Flight Center, MD (24. August)
- 2011** • *High accuracy height and size measurements of X-ray solar flare sources as diagnostic of particle transport mechanisms and chromospheric density*, University of St. Andrews, UK (9. November)
- 2010** • *A new method to image X-ray albedo and study X-ray directivity*, Goddard Space Flight Center, MD, US (13. August)
- 2009** • *Chromospheric diagnostics using RHESSI flare observations*, University of St. Andrews, UK (16. December)
- 2008** • *RHESSI observations beyond the standard flare model*, UC Berkeley, US (4. December)
- *New evidence for return currents in solar flare loops*, AGU, Florida, US (30. May)
- 2006** • *RHESSI observations of solar flares with three hard X-ray sources*, UC Berkeley, US (15. February)

PRESENTATIONS AT CONFERENCES

- 2015** • *Distributions of flare accelerated electrons from combined X-ray and EUV observations*, First joint SPP-SO workshop, Artimino, Italy (4.9.)
- *A multi-thermal representation of the kappa-distribution and its application on RHESSI and AIA observations of flares*, 14th RHESSI meeting, NJIT, US (13.8.)
- *RHESSI and IRIS observations of chromospheric evaporation during the 29th March 2014 flare*, IUGG, Prague (24. June)

- 2014**
 - *The Spectrometer/Telescope for Imaging X-rays (STIX) on Solar Orbiter*, ESPM-14, Dublin (poster)
 - *Filling the gap: Electron distribution function in solar flare derived from combined X-ray and EUV observations*, ESPM-14, Dublin (poster)
 - *Inhibited thermal conduction during the pre-impulsive phase of a solar flare?*, Solar and Stellar flares meeting, Prague (poster)
 - *Where is the chromospheric response to conductive energy input from a hot pre-flare coronal loop?*, 13th RHESSI workshop, FHNW, Windisch, Switzerland (4. April)
- 2013**
 - *Electron distribution function in solar flares from 100 eV to 10 keV*, NAM, St. Andrews, UK (poster)
 - *Using X-ray absorption to measure the height of the solar atmosphere*, NAM, St. Andrews, UK (poster)
- 2012**
 - *Direct imaging and spectroscopy of flare accelerated electron beams with STIX*, 5th Solar Orbiter Meeting, Brugge, Be (11. September)
 - *Combined RHESSI and AIA DEM analysis of solar flares*, Workshop on High Energy Flare Physics, University of Glasgow, UK (25. June)
 - *RHESSI and SDO observations of the chromospheric and coronal plasma parameters during a solar flare*, UK National Astronomy Meeting, Manchester, UK (30. March)
 - *The Spectrometer/Telescope for Imaging X-rays (STIX) (Poster)*, UK National Astronomy Meeting, Manchester, UK (28. March)
- 2011**
 - *X-ray observations and theory of electron transport in the chromosphere*, 4th Glasgow-Meudon alliance workshop, Glasgow (6. October)
 - *Diagnostics of electron transport in the solar chromosphere using hard X-ray solar flare observations*, 13th European Solar Physics Meeting, Rhodes, Greece (15. September)
 - *Heights of X-ray, EUV and white light sources in a limb flare observed by RHESSI and SDO (Poster)*, 13th European Solar Physics Meeting, Rhodes, Greece (15. September)
 - *Hard X-ray solar flare observations as diagnostics of electron transport in the chromosphere*, National Astronomy Meeting, Llandudno, UK (19. April)
 - *Implications of hard X-ray footpoint sizes and positions on the thick target model*, 11th RHESSI meeting, Glasgow, UK (7. April)
- 2010**
 - *Exploring the chromosphere using RHESSI data*, Glasgow-Meudon alliance workshop, Glasgow (6. October)
 - *Science applications of visibility forward fitting*, 10th RHESSI meeting, Annapolis, US (4. August)
 - *Footpoint sizes in theory and practice*, 10th RHESSI meeting, Annapolis, US (4. August)
 - *Imaging observations of X-ray albedo in a compact disc flare (Poster)*, COSPAR, Bremen, Germany (21. July)
 - *Footpoint sizes and positions of limb flares observed with RHESSI (Poster)*, COSPAR, Bremen, Germany (21. July)
 - *Diagnostics of X-ray directivity and electron beaming in solar flares using RHESSI visibilities*, CESRA meeting, La Roche-en-Ardenne, Belgium (15. July)
 - *Imaging observations of X-ray albedo in a compact disc flare (Poster)*, RAS National Astronomy Meeting, Glasgow, UK (14. April)
- 2009**
 - *Chromospheric diagnostics using RHESSI visibilities*, 9th RHESSI workshop, Genoa, Italy (2. September)
- 2008**
 - *Pre-flares observed by RHESSI*, Solar activity during the onset of solar cycle 24, Napa Valley, US (9. December)
 - *Adding a new piece to the puzzle of particle acceleration and propagation in solar flares*, General Assembly of the Swiss Society for Astronomy and Astrophysics, Zurich, Switzerland (26. September)
 - *The pre-flare phase: key to understanding energy and mass transport in flare loops*, ESPM-12, Freiburg i.B., Germany (9. September)

- 2007**
 - *Particle acceleration and propagation in solar flares*, HINODE Data Analysis Workshop, Orsay, France (14. November)
 - *Can a simple thin-thick target model explain the observed connections between coronal footpoint sources?*, 7th RHESSI workshop, Santa Cruz CA, US (27. June)
- 2006**
 - *Relations between concurrent hard X-ray sources in solar flares*, AAS-SPD Meeting Durham NH, US (28. June)
 - *Coronal and footpoint hard X-ray sources in solar flares*, 6th RHESSI workshop, Paris, France (5. April)
- 2005**
 - *Size dependence of solar X-ray flare properties*, 5th RHESSI workshop, Ascona, Switzerland (9. June)
 - *Solar Flare Parameters vs. Flare Size* (Poster), EGU General Assembly, Vienna, Austria (26. April)

SEMINAR TALKS

- 2013**
 - *Combined RHESSI and SDO observations of solar flares*, Trinity College Dublin (7. November)
- 2012**
 - *STIX on Solar Orbiter: A new X-ray view of the Sun*, Astro Seminar, University of Glasgow (11. October)
 - *Heliophysik an der FHNW, Grundlagenforschung bis Hardwareentwicklung*, Transfer Transparent, FHNW, Switzerland (2. October)
 - *X-ray and EUV observations of solar flares as diagnostic of chromospheric and coronal plasma parameters*, PMOD WRC, Davos, Switzerland (7. May)
- 2011**
 - *Wait a moment - exploring the chromosphere using RHESSI data*, University of Glasgow, UK (17. November)
- 2010**
 - *Wait a moment - exploring the chromosphere using RHESSI data*, University of Glasgow, UK (22. April)
- 2008**
 - *The puzzle of particle acceleration and propagation in Solar Flares*, ETH Zurich, Switzerland (7. October)
 - *Three's company - new insight into particle acceleration and transport in solar flares*, University of Glasgow, UK (April)
- 2007**
 - *Can a simple thin-thick target model explain the observed connections between coronal and footpoint sources?*, ISSI Bern, Switzerland (8. May)
 - *Can a unified thin-thick target model explain the observed connections between coronal and footpoint sources in solar flares?*, ETH Zurich, Switzerland (23. January)
- 2005**
 - *Three is company - RHESSI observations of solar flares with three hard X-ray sources*, ETH Zurich, Switzerland (29. November)

OUTREACH TALKS

- 2013**
 - *Hochenergie Heliophysik im Raumfahrtzeitalter*, AGB Wettingen, (15. February)
- 2012**
 - *Mit der Sonne auf Du, Hochenergie Heliophysik im Raumfahrtzeitalter*, AGG, Chur, (26. Oktober)
- 2011**
 - *The dark side of the Sun*, Stars over the Botanics, Glasgow (15. February)
 - *Solar research in the space age*, East-Renfrewshire Astronomical Society, Paisley, Scotland (27. January)
 - *Solar research in the space age*, Dundee Astronomical Society, Dundee, Scotland (14. January)
- 2010**
 - *Solare Flares: Ein explosives Gebiet der modernen Sonnenphysik*, 50th Anniversary of the Kuffner Foundation, Zurich, Switzerland (18. June)
- 2009**
 - *Sonnenforschung im Raumfahrtzeitalter*, Urania Amateur Astronomers' society, Zurich, Switzerland (27. March)
- 2007**
 - *Ein Stern entsteht*, 6th yearly meet ("Teleskoptreffen") of Amateur Astronomers, Falera, Switzerland (8. September)

- *Die aktive Sonne*, Monthly get-together of the Astronomische Gesellschaft Luzern, Switzerland (3. September)
- *Aus dem Leben eines Sterns*, General Assembly of the Swiss Amateur Astronomer's society, Falera, Switzerland (2. June)
- 2006** • *Die Sonne in ungewohntem Licht*, 5th yearly meet ("Teleskoptreffen") of Amateur Astronomers, Falera, Switzerland (23. September)
- *Die aktive Sonne*, 7th International Astronomy Week, Arosa, Switzerland (23. July)

REFEREES

on request

- 2015** 30) **M. Battaglia**, G. Motorina, E. P. Kontar *Multi-thermal representation of the kappa-distribution of solar flare electrons and application to simultaneous X-ray and EUV observations*, ApJ, in press
- 29) **M. Battaglia**, L. Kleint, S. Krucker, D. Graham *How Important Are Electron Beams in Driving Chromospheric Evaporation in the 2014 March 29 Flare?*, ApJ, 813, 113
doi:10.1088/0004-637X/813/2/113
- 28) M. Kuhar, S. Krucker, J.C. Martinez Oliveros, **M. Battaglia**, L. Kleint, D. Casadei, H. Hudson *Correlation of hard X-ray and white light fluxes in solar flares*, ApJ, submitted
- 27) L. Kleint, **M. Battaglia**, K. Reardon, A. Sainz Dalda, P. R. Young, S. Krucker *The fast filament eruption leading to the X-flare on March 29, 2014* ApJ, 806, 9
doi:10.1088/0004-637X/806/1/9
- 26) S. Krucker, P. Saint-Hilaire, H. S. Hudson et al. *Co-spatial whith light and hard X-ray flare footpoints seen above the solar limb* ApJ, 802, 19
doi:10.1088/0004-637X/802/1/19
- 25) M. Stienen, N. Smoll, **M. Battaglia**, B. Schatlo et al. *Intracranial Aneurysm Rupture is predicted by measures of solar activity* World Neurosurgery, 83, 588
doi:0.1016/j.wneu.2014.12.021
- 2014** 24) **M. Battaglia**, L. Fletcher, P. J. A. Simoões, *Where is the chromospheric response to conductive energy input from a hot pre-flare loop?* ApJ, 789,47
doi:10.1088/0004-637X/789/1/47
- 23) **S. Krucker**, M. Battaglia, *Particle Densities within the Acceleration Region of a Solar Flare* ApJ, 780, 107
doi:10.1088/0004-637X/780/1/107
- 2013** 22) **M. Battaglia**, E. P. Kontar, ApJ, 779, 107
doi:10.1088/0004-637X/779/2/107
- 21) Krucker, S., Benz, A. O., Hurford, G. J. et al. *The spectrometer/telescope for imaging X-rays on board the ESA Solar Orbiter spacecraft* Nuclear Inst. and Methods in Physics Research, 732, 295
doi:10.1016/j.nima.2013.05.050
- 2012** 20) **M. Battaglia**, E. P. Kontar, *RHESSI and SDO/AIA of the chromospheric and coronal plasma parameters during a solar flare* ApJ, 760, 142
doi:10.1088/0004-637X/760/2/142
- 19) **M. Battaglia**, E. P. Kontar, L. Fletcher, A. MacKinnon, *Numerical Simulations of Chromospheric Hard X-ray Source Sizes in Solar Flares* ApJ, **752** 4B
doi:10.1088/0004-637X/752/1/4
- 18) Benz. A.O., Krucker, S., Hurford, G. J. et al. *The spectrometer telescope for imaging x-rays on board the Solar Orbiter mission* SPIE, **8443** 3LB
doi:10.1117/12.927793
- 2011** 17) **M. Battaglia**, E. P. Kontar *Height structure of X-ray, EUV and white-light emission in a solar flare* A&A, **533** L2
doi:10.1051/0004-6361/201117605
- 16) **M. Battaglia**, E. P. Kontar *Hard X-ray footpoint sizes and positions as diagnostic of flare accelerated electrons in the low solar atmosphere* ApJ, **735** 42B
doi:10.1088/0004-637X/735/1/42
- 15) **M. Battaglia**, E. P. Kontar, I. G. Hannah *The influence of albedo on the size of hard X-ray flare sources* A&A **526** 3B
doi:10.1051/0004-6361/201014798
- 14) A. O. Benz, **M. Battaglia**, N. Vilmer *Location of decimetric pulsation in solar flares* Sol. Phys

[doi:10.1007/s11207-011-9760-3](https://doi.org/10.1007/s11207-011-9760-3)

- 13) S. Krucker, H. S. Hudson, N. L. S. Jeffrey, **M. Battaglia**, E. P. Kontar, A. O. Benz, A. Csillagy, R. P. Lin *High-resolution imaging of solar flare ribbons and its implication on the thick-target beam model* ApJ **739** 96
[doi:10.1088/0004-637X/739/2/96](https://doi.org/10.1088/0004-637X/739/2/96)
- 12) L. Fletcher, B. R. Dennis, H. S. Hudson, S. Krucker, K. Phillips, A. Veronig, **M. Battaglia**, L. Bone, Q. Chen, P. Gallagher, P. C. Grigis, H. Ji, W. Liu, R. O. Milligan, M. Temmer *An Observational Overview of Solar Flares* Space Sciences Reviews
[doi:10.1007/s11214-010-9701-8](https://doi.org/10.1007/s11214-010-9701-8)
- 11) I. G. Hannah, H. S. Hudson, **M. Battaglia**, S. Christe, J. Kasparova, M. Kundu, S. Krucker, A. Veronig *Microflares and the Statistics of X-ray Flares* Space Sciences Reviews
[doi:10.1007/s11214-010-9705-4](https://doi.org/10.1007/s11214-010-9705-4)
- 10) G. Holman, M. J. Aschwanden, H. Aurass, **M. Battaglia**, P. C. Grigis, E. P. Kontar, W. Liu, P. Saint-Hilaire, V. V. Zharkova *Implications of X-ray observations for electron acceleration and propagation in solar flares* Space Science Reviews
[doi:10.1007/s11214-010-9680-9](https://doi.org/10.1007/s11214-010-9680-9)
- 2010** 9) E. P. Kontar, I. G. Hannah, N. L. S. Jeffrey, **M. Battaglia** *The sub-arcsecond hard X-ray structure of loop footpoints in a solar flare* ApJ **717** 250
[doi:10.1088/0004-637X/717/1/250](https://doi.org/10.1088/0004-637X/717/1/250)
- 2009** 8) **M. Battaglia**, A. O. Benz *Do decimetric spikes originate in coronal X-ray sources?* A&A **499** L33
[doi:10.1051/0004-6361/200912143](https://doi.org/10.1051/0004-6361/200912143)
- 7) **M. Battaglia**, L. Fletcher, A. O. Benz *Observations of conduction driven evaporation in the early rise phase of solar flares* A&A **498** 891
[doi:10.1051/0004-6361/200811196](https://doi.org/10.1051/0004-6361/200811196)
- 2008** 6) S. Krucker, **M. Battaglia**, P. J. Cargill, L. Fletcher, H. S. Hudson, A. L. MacKinnon, S. Masuda, L. Sui, M. Tomczak, A. L. Veronig, L. Vlahos, S. M. White *Hard X-ray emission from the solar corona* A&A Review **16** 155
[doi:10.1007/s00159-008-0014-9](https://doi.org/10.1007/s00159-008-0014-9)
- 5) **M. Battaglia**, A. O. Benz *Observational evidence for return currents in solar flare loops* A&A **487** 337
[doi:10.1051/0004-6361:200809418](https://doi.org/10.1051/0004-6361:200809418)
- 2007** 4) **M. Battaglia**, A. O. Benz *Exploring the connection between coronal and footpoint sources in a thin-thick target solar flare model* A&A **466** 713
[doi:10.1051/0004-6361:20077144](https://doi.org/10.1051/0004-6361:20077144)
- 2006** 3) A. O. Benz, P. C. Grigis, **M. Battaglia** *Particle acceleration in solar flares: observations versus numerical simulations* Plasma Phys. Control. Fusion **48** B115
[doi:10.1088/0741-3335/48/12B/S12](https://doi.org/10.1088/0741-3335/48/12B/S12)
- 2) **M. Battaglia**, A. O. Benz *Relations between concurrent hard X-ray sources in solar flares* A&A **456** 751
[doi:10.1051/0004-6361:20065233](https://doi.org/10.1051/0004-6361:20065233)
- 2005** 1) **M. Battaglia**, P. C. Grigis, A. O. Benz *Size dependence of solar X-ray flare properties* A&A **439** 737
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