Proposal for an ISSI International Team Project

SUBMILLIMETER SOLAR FLARE OBSERVATIONS

Team Leaders: Säm Krucker and Hugh Hudson

Abstract

We propose a small team (14 persons) to systematize our knowledge of the emission of solar flares in the THz range (submillimeter wavelengths). This is essentially a new field of solar flare research, with substantial ambiguities of interpretation but potentially great significance because of the implications for high-energy particle acceleration. It is also a timely topic due to the potential for future observations in the THz domain with the new instrumentation at SST (the Solar Submillimer-wave Telescope, Kaufmann et al., 2008b) and ALMA (the Atacama Large Millimeter Array, Hills and Beasley, 2008) and proposed space instrumentation such as DESIR (Trottet, 2008) on SMESE (the SMall Explorer for Solar Eruptions, Vial et al., 2008). We therefore anticipate good discussions of current observations, vigorous debate of the theories in the context of the broad coverage of solar flares now available at other wavelengths, and the potential of the new instruments to address the questions arising. The output of the team will be an overview paper setting out the properties of the existing observations and their interpretations, and goals for new observations. We ask for two meetings in late 2009 and mid 2010, with the overview paper to be submitted by Fall 2010.

1 Scientific Rationale

THz frequencies are a neglected wavelength domain for solar research due to the difficulty of observations from the ground. The dominant emission mechanism at submillimeter wavelengths in the quiet Sun is free-free (bremsstrahlung) absorption due to free electrons interacting with neutral hydrogen ("H^- opacity"), which makes the solar atmosphere opaque in the low chromosphere. However, during solar flares relativistic electrons can produce high-frequency emission extending into the mm-wave range via incoherent synchrotron radiation. For longer wavelengths (the cm range) the synchrotron emission spectrum provides a powerful (Bastian et al., 1998) and complementary tool to the hard X-ray spectrum (hard X-ray emission from bremsstrahlung of non-thermal electrons with energies above about 10 keV).

At mm or submm (THz) wavelengths, the situation had long been thought to be simple: relativistic electrons in the tail of the accelerated power–law distribution common in flares can radiate at high harmonics of the Larmor frequency ω_L (emission frequency $f \propto \gamma^2\omega_L$, where γ is the Lorentz factor). ω_L is typically 1–3 GHz in flares (magnetic fields up to 1000 G), so emission above 200 GHz requires $\gamma \sim 10$ (Trottet et al., 2002), and the spectrum should just be an extension of the optically–thin microwave spectrum falling with increasing frequency as a power law.

This simple picture has been overturned by recent data. Kaufmann et al. (2004) have made the exciting discovery of a new THz emission component, as illustrated in Figure 1 (left panel). The spectrum unexpectedly turns up into the THz range. This pioneering observation was made at the El Leoncito observatory in Argentina with the Solar Submillimer-wave Telescope (SST, Kaufmann et al., 2008b), and it was confirmed by a totally independent observation by KOSMA (the Köln Observatory for Submillimeter and Millimeter Astronomy) at Gornergrat

(Lüthi et al., 2004b). The right panel of Figure 1 shows this observation. Subsequent to these observations several other flares have shown similar behavior (Lüthi et al., 2004a; Silva et al., 2007; Trottet et al., 2008; Cristiani et al., 2008; Kaufmann et al., 2009).

There is as yet no consensus on the explanation for this unexpected behaviour, but at least six possibilities exist:

- The Rayleigh-Jeans tail of the white-light flare emission extending to long wavelengths (e.g., Hudson, 1975; Kašparová et al., 2009)
- Ordinary incoherent gyrosynchrotron emission (Silva et al., 2007)
- A combination of incoherent and coherent synchrotron emission (e.g., Kaufmann and Raulin, 2006)
- Synchrotron emission of high–energy positrons produced in pion decay (e.g., Trottet et al., 2008) or in proton-proton interactions by the Drell-Yan process (Szpigel et al., 2007)
- Coherent emission of particle beams (e.g., Sakai et al., 2006)
- Inverse Compton upscattering of microwave photons by relativistic electrons

Several of these emission mechanisms could be excluded for some events, but no comprehensive comparison of all flares and all possible mechanisms exists so far. Our group will systematically study these possibilities. The last item in particular is too new to have been described yet in the literature, and should be examined quantitatively. The "impulse response" flares (White et al., 1992) and another category of thermal-spectrum mm-wave events (Chertok et al., 1995) add to the general interest in this wavelength range, which is now becoming open for detailed observational work. Of further interest are observations that show that the THz emission consists of subsecond pulses (typically 0.2 seconds) speculated to be related to individual bursts of particle acceleration (Kaufmann et al., 2008a).

The newly available submillimeter observations also provide information on location and size of the emission source (Giménez de Castro et al., 1999; Lüthi et al., 2004a), and ALMA has the potential to revolutionize such observations. This will allow us to compare the submillimeter emission location with the flare ribbons and other diagnostics such as γ–ray sources (Figure 2). These context observations will provide crucial tests for the possible emission mechanisms listed above.

2 Expected output

The impending development of new instrumentation capable of observing at THz frequencies makes a review of this subject both timely and crucial. The THz (submillimeter) component in the spectra of solar flares potentially provides a new diagnostic tool to study electron acceleration to high energies and may reveal entirely new phenomena. We propose to summarize our current knowledge and contrast the observations with theories in a concise overview paper. This will make this exciting topic available to a wider audience and will be a crucial tool for planning future observations, in particular with ALMA (e.g., Bastian, 2002), and with SST at the newly available frequency bands (670 GHz and 850 GHz), and in the far IR at 30 THz (the 10-micron band, Kaufmann et al., 2008b). In addition to this short "research review" paper (4-6 pages) that is readable for a wider audience, we will also encourage the publication of additional papers on specific topics.

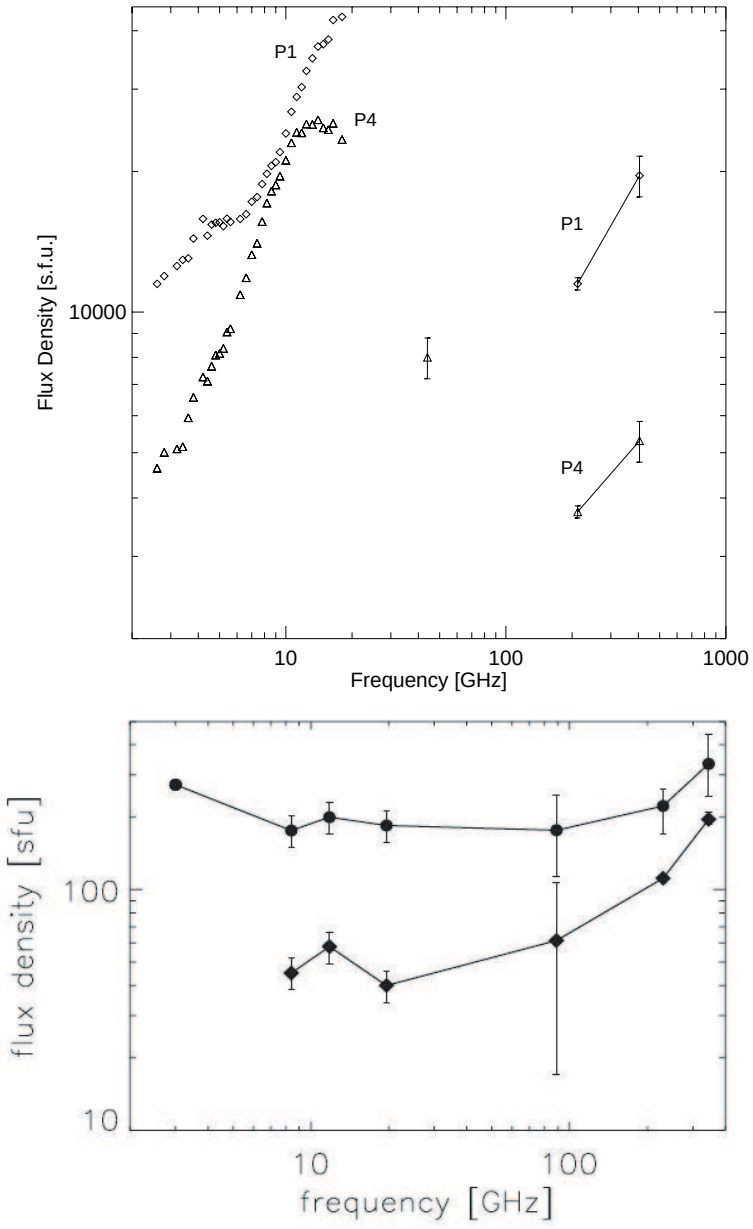

Figure 1: The first two flare observations with increasing spectra in the THz range. *Top:* GOES X28 flare on November 4, 2003 from Kaufmann et al. (2004): The spectrum on top labeled P1 corresponds to the main flare peak, while P4 is an interval about 3 minutes later, but still during the impulsive phase of the flare. *Bottom:* GOES X2.0 flare on April 12, 2001 observed by Lüthi et al. (2004b). The two spectra shown were taken after the impulsive phase (top: Soft X-ray peak time at 10:33 UT; bottom: decay phase at 11:00 UT). While the spectrum at the soft X-ray peak could be flat (i.e. of thermal origin), the spectrum during the decay phase clearly shows an increasing spectrum with frequency.

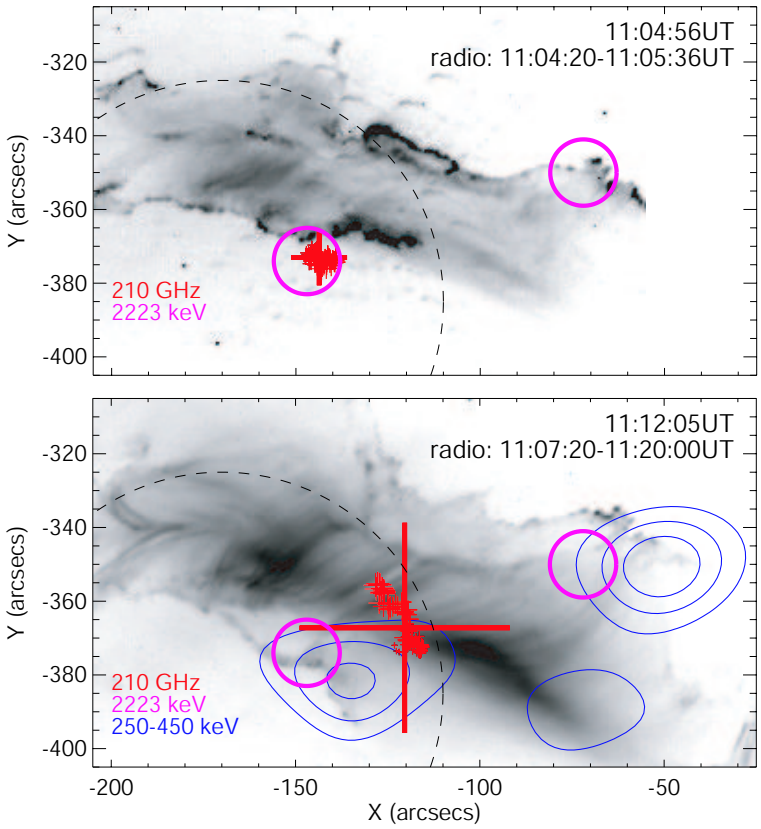

Figure 2: Imaging in sub-millimeter, UV, HXR, and γ-rays for two intervals during the impulsive phase of the October 28, 2003 flare from Trottet et al. (2008). A TRACE UV image is shown with 210 GHz centroid positions overplotted as red crosses (cadence is 10 seconds, increasing symbol size represents time). The average position and apparent source size of the radio emission during each time interval is represented by a thick red cross. The dashed circle gives a rough size of the field-of-view of the radio imaging; radio sources outside this circle still influence the derived source position and size, but have less weighting than sources within. The thick magenta circles give the flare-averaged 2.2 MeV footpoint point location (Hurford et al., 2006). The bottom image additionally shows RHESSI 250-450 keV imaging with 23 arcsec FWHM resolution integrated over the decay phase (Krucker et al., 2008). The submillimeter emission comes initially from one of the γ-ray footpoints (compact source). The spatial correlation with penetrating proton beams suggests that the submillimeter emission could be produced by synchroton emission of positrons produce by pion decay. Later, the submillimeter source is extended and originates from in-between the flare ribbons suggesting that a different emission mechanism is operating at the later times.

3 ISSI Implementation

The ISSI facility is ideal for this kind of workshop. The team leaders are familiar with the arrangements, and the team proposed below rather naturally worked out to contain good representation from the different regions. We expect to proceed with minimal overhead on a clearly-defined program of substantial scientific importance.

4 List of Participants

The following participants have confirmed their willingness to participate in the proposed projects (see the attached CV's for details):

- T.S. Bastian (NRAO, USA): radio observations and instrumentation
- C.G. Giménez de Castro (CRAAE, Brazil): SST observations and instrumentation
- G.D. Cristiani (IAFE, Argentina): SST observations
- A.S. Hales (NRAO, USA): ALMA
- H.S. Hudson (U. California, USA): observations; history
- J. Kašparová (Ondrejov, Czech Republic): theory, X-ray observations
- K.-L. Klein (Obs. de Paris, France): radio observations, instrumentation (DESIR)
- M. Kretzschmar (LPCEE Orleans, France): total solar irradiance observations
- S. Krucker (U. California, USA): RHESSI X-ray and multi-wavelength imaging
- T. Lüthi (Leica, Switzerland): KOSMA instrumentation and observations
- A.L. McKinnon (Glasgow, UK): theory
- S. Pohjolainen (University of Turku, Finland): Tuorla observations/instrumentation
- G. Trottet (Obs. de Paris, France): instrumentation (DESIR), γ-ray observations
- S.M. White (U. Maryland, USA): radio observations and theory

This team has extensive experience covering essentially all aspects of the proposal.

5 Timeliness

The two sessions of the workshop will take place just at the beginning of the new solar cycle, and coincidentally we expect that ALMA will be operational for the next solar maximum. We therefore feel that the timing of this particular topic will be optimally effective in helping to understand the new data from the next maximum – solar cycle 24.

6 Facilities required

No special facilities are required besides the usual ISSI workshop facilities: one meeting room with projector and internet access.

7 Financial Requirements

No special financial requirements besides the usual ISSI financial support is required. ISSI is asked to provide the living expenses of team members while they reside in Bern. For the two 4-day-long meetings (5 days maximal stay per meeting per person), at most 140 person days is required for the 14 team members. Funding to cover travel costs is the responsibility of the team members.

References cited

Bastian, T. S., 2002: ALMA and the Sun. *Astronomische Nachrichten*, **323**, 271–276.

Bastian, T. S., A. O. Benz, and D. E. Gary, 1998: Radio Emission from Solar Flares. *Ann. Revs. Astron. Astrophys.*, **36**, 131–188.

Chertok, I. M., V. V. Fomichev, R. V. Gorgutsa, J. Hildebrandt, A. Krüger, A. Magun, and V. V. Zaitsev, 1995: Solar Radio Bursts with a Spectral Flattening at Millimeter Wavelengths. *Solar Phys*, **160**, 181–198.

Cristiani, G., C. G. Giménez de Castro, C. H. Mandrini, M. E. Machado, I. D. B. E. Silva, P. Kaufmann, and M. G. Rovira, 2008: A solar burst with a spectral component observed only above 100 GHz during an M class flare. *Astron. Astrophys.*, **492**, 215–222.

Giménez de Castro, C. G., J.-P. Raulin, V. S. Makhmutov, P. Kaufmann, and J. E. R. Costa, 1999: Instantaneous positions of microwave solar bursts: Properties and validity of the multiple beam observations. *Astron. Astrophys. Supplement*, **140**, 373–382.

Hills, R. E. and A. J. Beasley, 2008: The Atacama Large Millimeter/submillimeter Array. In *Society of Photo-Optical Instrumentation Engineers (SPIE) Conference Series*, vol. 7012 of *Society of Photo-Optical Instrumentation Engineers (SPIE) Conference Series*.

Hudson, H. S., 1975: The solar-flare infrared continuum - Observational techniques and upper limits. *Solar Phys*, **45**, 69–78.

Hurford, G. J., S. Krucker, R. P. Lin, R. A. Schwartz, G. H. Share, and D. M. Smith, 2006: Gamma-Ray Imaging of the 2003 October/November Solar Flares. *ApJL*, **644**, L93–L96.

Kaufmann, P., C. Guillermo Gimenez de Castro, E. Correia, J. E. R. Costa, J.-P. Raulin, and A. Silva Valio, 2008a: Rapid pulsations in sub-THz solar bursts. *ArXiv e-prints*.

Kaufmann, P., H. Levato, M. M. Cassiano, E. Correia, J. E. R. Costa, C. G. Giménez de Castro, R. Godoy, R. K. Kingsley, J. S. Kingsley, A. S. Kudaka, R. Marcon, R. Martin, A. Marun, A. M. Melo, P. Pereyra, J.-P. Raulin, T. Rose, A. Silva Valio, A. Walber, P. Wallace, A. Yakubovich, and M. B. Zakia, 2008b: New telescopes for ground-based solar observations at submillimeter and mid-infrared. In *Society of Photo-Optical Instrumentation Engineers (SPIE) Conference Series*, vol. 7012 of *Society of Photo-Optical Instrumentation Engineers (SPIE) Conference Series*.

Kaufmann, P. and J.-P. Raulin, 2006: Can microbunch instability on solar flare accelerated electron beams account for bright broadband coherent synchrotron microwaves? *Physics of Plasmas*, **13(7)**, 070701–+.

Kaufmann, P., J.-P. Raulin, C. G. G. de Castro, H. Levato, D. E. Gary, J. E. R. Costa, A. Marun, P. Pereyra, A. V. R. Silva, and E. Correia, 2004: A New Solar Burst Spectral Component Emitting Only in the Terahertz Range. *ApJL*, **603**, L121–L124.

Kaufmann, P., G. Trottet, C. G. Giménez de Castro, J.-P. Raulin, S. Krucker, A. Y. Shih, and H. Levato, 2009: Sub-terahertz, Microwaves and High Energy Emissions During the 6 December 2006 Flare, at 18:40 UT. *Solar Phys*, **255**, 131–142.

Kašparová, J., P. Heinzel, M. Karlický, Z. Moravec, and M. Varady, 2009: Far-IR and radio thermal continua in solar flares. *ArXiv e-prints*.

Krucker, S., G. J. Hurford, A. L. MacKinnon, A. Y. Shih, and R. P. Lin, 2008: Coronal γ-Ray Bremsstrahlung from Solar Flare-accelerated Electrons. *ApJL*, **678**, L63–L66.

Lüthi, T., A. Lüdi, and A. Magun, 2004a: Determination of the location and effective angular size of solar flares with a 210 GHz multibeam radiometer. *Astron. Astrophys.*, **420**, 361–370.

Lüthi, T., A. Magun, and M. Miller, 2004b: First observation of a solar X-class flare in the submillimeter range with KOSMA. *Astron. Astrophys.*, **415**, 1123–1132.

Sakai, J. I., Y. Nagasugi, S. Saito, and P. Kaufmann, 2006: Simulating the emission of electromagnetic waves in the terahertz range by relativistic electron beams. *Astron. Astrophys.*, **457**, 313–318.

Silva, A. V. R., G. H. Share, R. J. Murphy, J. E. R. Costa, C. G. G. de Castro, J.-P. Raulin, and P. Kaufmann, 2007: Evidence that Synchrotron Emission from Nonthermal Electrons Produces the Increasing Submillimeter Spectral Component in Solar Flares. *Solar Phys*, **245**, 311–326.

Szpigel, S., F. O. Durães, and F. Steffens, 2007: *Braz. J. Phys.*, **37**, 52.

Trottet, G., 2008: Lyman-alpha, Far Infrared and , X-ray and Gamma-ray Observations Around the Maximum of Cycle 24 by the French-Chinese SMall Explorer for Solar Eruptions. In *37th COSPAR Scientific Assembly*, vol. 37 of *COSPAR, Plenary Meeting*, pp. 3223–+.

Trottet, G., S. Krucker, T. Lüthi, and A. Magun, 2008: Radio Submillimeter and γ-Ray Observations of the 2003 October 28 Solar Flare. *ApJ*, **678**, 509–514.

Trottet, G., J.-P. Raulin, P. Kaufmann, M. Siarkowski, K.-L. Klein, and D. E. Gary, 2002: First detection of the impulsive and extended phases of a solar radio burst above 200 GHz. *Astron. Astrophys.*, **381**, 694–702.

Vial, J.-C., F. Auchère, J. Chang, C. Fang, W. Q. Gan, K.-L. Klein, J.-Y. Prado, F. Rouesnel, A. Sémery, G. Trottet, and C. Wang, 2008: SMESE (SMall Explorer for Solar Eruptions): A microsatellite mission with combined solar payload. *Advances in Space Research*, **41**, 183–189.

White, S. M., M. R. Kundu, T. S. Bastian, D. E. Gary, G. J. Hurford, T. Kucera, and J. H. Bieging, 1992: Multifrequency observations of a remarkable solar radio burst. *ApJ*, **384**, 656–664.

CURRICULUM VITAE

Timothy S. Bastian
National Radio Astronomy Observatory, 520 Edgemont Road
Charlottesville, VA 22903

EDUCATION

Ph.D. University of Colorado, Astrophysics, 1987
B.S. University of Chicago, Mathematics, 1978

APPOINTMENTS

2000-present	Adjunct faculty member, Astronomy Dept., University of Virginia
1999-2000	Visiting Professor, Paris University 7 and Paris Observatory
1995-present	Astronomer, National Radio Astronomy Observatory
1992-1995	Associate Astronomer, National Radio Astronomy Observatory
1990-1992	Assistant Astronomer, National Radio Astronomy Observatory
1987-1990	Jansky Fellow, National Radio Astronomy Observatory

PROFESSIONAL SOCIETIES

International Astronomical Union (IAU)
International Union of Radio Science (URSI)
American Geophysical Union (AGU)
American Astronomical Society (AAS)
Community of European Solar Radio Astronomers (CESRA)

RESEARCH INTERESTS

Solar and stellar radiophysics; solar chromosphere and corona; solar and stellar flares; coronal mass ejections; coronal and interplanetary radio bursts; solar wind and heliosphere; radio emission from planets and exoplanets; wave propagation in random media; radiative processes; interferometry; data inversion

RECENT SYNERGISTIC ACTIVITIES

Scientific Editor, Astrophysical Journal, 2003-2008
Principle Investigator, Solar Radio Burst Spectrometer project, 2003-present
Faculty, NCAR Summer School on *Heliophysics*, 2008
Faculty and co-organizer, AAS Summer School on *High Energy Solar Physics*, 2006
Co-organizer, workshop on *Space Physics and the Vision for Space Exploration*, 2005

PUBLICATIONS

Over 200 publications in refereed journals, books, articles, and abstracts.

Radio Astronomy – Solar Physics

Curriculum Vitae

Carlos Guillermo Giménez de Castro

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Scientific Interests: Solar Activity, Solar Radio Astronomy, Submillimeter & Infrared Astronomy

Scientific Experience:

- Interstellar Medium, Massive Stars, Optical Astronomy: observations and spectral analysis.
- Team member of the Solar Submillimeter Telescope (SST): implementation, commissioning, data reduction and analysis.
- Researcher Level II, National Council on Scientific and Technological Development (CNPq), Brazil
- Member of the Schedule and User's Committee of the Itapetinga Observatory, Brazil

Present Position: Since 1999, Adjunct Professor, with the Center for Radio Astronomy and Astrophysics Mackenzie (CRAAM), Universidade Presbiteriana Mackenzie, São Paulo, Brazil.

Education: Ph.D. in Physics, August 1996, Universidad de Buenos Aires, Buenos Aires, Argentina

Publications:

- Journal Articles: 28
- Complete Articles in Proceedings: 7
- Scientific Popularization Articles: 25
- Chapters in Book: 1

Advise:

- Master Thesis: 2
- PhD Thesis: 1

CURRICULUM VITAE
GERMÁN DIEGO CRISTIANI

PERSONAL DATA

• Nationality: Argentine

• Date of birth: July 7^{th} 1970

• Working Address: IAFE Ciudad Universitaria (1428) Buenos Aires, Argentina

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• E-mail: gcristiani@iafe.uba.ar

EDUCATION

• Ph.D. in Physics, Universidad de Buenos Aires, March 2008. Thesis: "Physical characteristics and magnetic topology of solar regions originating suprathermal electrons"

• Licenciado en Ciencias Físicas (Equivalent to M. Sc. in Physiscs) Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, March 2004

PROFESSIONAL EXPERIENCE

• Member of the Carrera del Investigador Científico, CONICET (Consejo Nacional de Investigaciones Científicas y Técnicas) from June 2008

• Internal Doctoral Fellow, ANPCyT (Agencia Nacional de Promoción Científica y Tecnológica) from June 2004 to October 2007

INTEREST AREA

• Solar Flares

• Radio observations from microwaves to submillimeter wavelengths

• Gyrosynchrotron emission

PUBLICATIONS

• *A solar burst with a spectral component observed only above 100 GHz during an M class flare*
Cristiani G., Giménez de Castro C.G., Mandrini C.H., Machado M., Silva, I.D.B.E., Kaufmann P., Rovira, M.G.
Astronomy & Astrophysics, 2008, 492, 215-222

• *Observed flux density enhancement at submillimeter wavelengths during an X1.2 flare*
Cristiani G., Giménez de Castro C.G., Luoni M.L., Mandrini C.H., Rovira M.G., Kaufmann, P., Machado M.
Advances in Space Research, 2007, 39, 1445-1450..

• *The magnetic field topology associated to two M flares*
Luoni M.L., Mandrini C.H., Cristiani G., Démoulin P.
Advances in Space Research, 2007, 39, 1382-1388.

• *Spatial characterizacion of a flare using radio observations and magnetic field topology*
Cristiani G., Martinez G., Mandrini C.H., Giménez de Castro C.G., da Silva C.W., Rovira M.G., Kaufmann, P.
Solar Physics, 2007, 240(2), 271-281.

• *Submillimeter-wave and Hα observations of the event on 28 November, 2001*
Cristiani G., Martinez G., Mandrini C.H., Giménez de Castro C.G., Rovira, M.G., Kaufmann P., Levato, H.
Journal of Atmospheric and Solar Terrestrial Physics, 2005, 67 (17), 1744-1750.

CURRICULUM VITÆ

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PLACE AND DATE OF BIRTH	Santiago, Chile, January 18th, 1980
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NATIONALITY	Chilean
CURRENT ADDRESS (OFFICE)	National Radio Astronomy Observatory 520 Edgemont Road Charlottesville, VA 22903 United States Email: ahales@nrao.edu Phone: 434-244-6846
ACADEMIC AND SCIENTIFIC ACTIVITIES	**October 2008 – 2011** ALMA Comissioning Scientist, Joint ALMA Observatory/National Radio Astronomy Observatory, Santiago, Chile.. **October 2006 – present** ALMA Postdoctoral Research Fellow at the North American ALMA Science Center, National Radio Astronomy Observatory, Charlottesville, USA. **September 2003 – September 2006** *PhD in Astronomy* – Degree awarded by the University College London, UK. Thesis Topic: **Circumstellar Environments of Dusty Young Stars**, under supervision of Prof. M.J. Barlow. **March 1998 - December 2002** — *Bachelors Degree* in Astronomy – Degree awarded by the Facultad de Ciencias Físicas y Matemáticas of the Universidad de Chile - Santiago, Chile.
ASTRONOMICAL SCHOOLS	**June 13 th- June 20th 2006** *Tenth Summer Synthesis Imaging Workshop* - NRAO, Socorro, USA. **January 14 th- January 16th 2002** *Interferometry week* - European Southern Observatory (ESO), Santiago, Chile.
HONOURS AND AWARDS	**January 2002** *GEMINI PhD studentship* - Particle Physics and Astronomy Research Council (UK) & Fundacion Andes (Chile). **December 2002** *Overall Undergraduate Distinction* - Universidad de Chile
TEACHING DUTIES	**2003 – 2006** Problem solving classes in Classical Mechanics and Mathematics (bachelor), UCL. **2000 – 2003** Teaching assistant, Universidad de Chile. courses: *Introduction to Mechanics* (bachelor), *Statistical Mechanics* (bachelor), *Classical Mechanics* (bachelor).
LANGUAGES	**Spanish** & **Portuguese** (mother tongue, fluent), **English** (fluent), **French** (fluent), **German** (beginner)
PERSONAL INTERESTS	-cycling, squash, football (soccer) -history, hispanoamerican literature, playing guitar -general travel, foreign cultures, world music

OBSERVATIONAL TECHNIQUES

Radio-interferometry, Single Dish, Imaging Polarimetry, High-Resolution Spectroscopy, Wide-field photometry.

PROGRAMING AND DATA REDUCTION

CASA, AIPS, AIPS++, DIFMAP, Perl, PDL, IDL, C++, IRAF, STARLINK software, ALMA Observing Tool (Official Tester/Unrealeased), ALMA Operator Master Client (unrealeased)

OBSERVING EXPERIENCE

Oct.. 2006 - Dec. 2007 2 months of Science support at the ALMA Test Facility, performing Holography, Optical Pointing, Radiometric Pointing, and Dynamic Interferometry.
Oct. 2007 100m Green Bank Telescope ('The 1 cm continua of HAeBe stars, 1 night, PI: Hales, A).
Jun. 2007 VLT/NACO ('Near-IR Imaging Polarimetry of the disk around HD169142', 1 night, PI: Hales, A).
Oct. 2006 - Feb. 2007 Green Bank Telescope NH_3 observations ('The Class 0 source Barnard 1c, 1 night, PI: Matthews, B).
Nov. 2003 - 2005 2.5m Isaac Newton Telescope, La Palma, Spain (22 nights, IPHAS survey; PI: Drew J.).
Jul. - Aug. 2005 Commissioning and Demo-science runs of the bench-mounted High-Resolution Optical Spectrograph for Gemini South (bHROS, Chile; 15 nights, Project Scientist: Barlow, M.J.).
Jun. 2003 3 nights of VLT/UVES observations for the project 'the C^{12}/C^{13} ratio in the solar neighbourhood'. (ESO, Antofagasta, Chile; PI: Casassus, S.).
2002 - 2003 7 nights observing with the Cosmic Background Imager (CBI) radio-interferometer. (Chajnantor, Antofagasta, Chile; PI: Readhead, A.)

PUBLICATIONS IN REFEREED JOURNALS

IPHAS A-type Stars with Mid-IR Excesses in Spitzer Surveys :
Hales A.S. , Barlow M. J., Drew, J.E., Unruh Y. C. & Greimel, R., *submitted to ApJ*

Initial Data Release from the INT Photometric H-alpha Survey of the Northern Galactic Plane (IPHAS) :
Gonzalez-Solares et al., *submitted to MNRAS*, astro-ph : 0712.0384

Near-infrared imaging polarimetry of dusty young stars:
Hales A.S., Gledhill T.M., Barlow M. J. & Lowe K.T.E., 2006, MNRAS, 365, 1348

The INT Photometric H_α Survey of the Northern Galactic Plane (IPHAS):
Drew et al., 2005, MNRAS, 362, 753

Vela X at 31 GHz:
Hales A.S., Casassus S., Alvarez H., May, J., Bronfman, L., Readhead, A. C., Pearson, T. J., Mason, B. S., Dodson, R., 2004, ApJ, 613, 977

PUBLISHED COMMUNICATIONS

Minor Planet Observations [950 La Palma]:
Fitzsimmons, A. et al., 2003, Minor Planet Circular, 50134, 2

Minor Planet Observations [950 La Palma]:
Fitzsimmons, A. et al., 2004, Minor Planet Circular, 50908, 4

COLLABORATORS

Simon Casassus, Leonardo Bronfman (U. de Chile, Chile), Timothy J. Pearson (Caltech, USA), David Wilner (CfA, USA), Brenda Matthews (Herzberg Insitute, Canada), Janet Drew, (Imperial College, UK), Michael Barlow (UCL, UK), Tim Gledhill (U. of Hertfordshire, UK), Richard Dodson (ISAS, Japan)

Curriculum Vitae

Hugh S. Hudson

Personal:

Birth: San Antonio, Texas, May 18, 1939
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Education:

Undergraduate degree: Rice University, B.A. *cum laude* Physics, Math, 1961
Graduate degree: University of California (Berkeley), Ph.D., Physics, 1966

Employment:

University of California, Berkeley (1966)
University of California, San Diego (1966-1991)
University of Hawaii (1991-1996)
Solar Physics Research Corp. (1996-2002)
University of California, Berkeley (2001-present)

Visitor appointments (recent):

University of Glasgow, UK (2005-present), Honorary Research Fellow
Osservatorio Astronomico di Palermo, Italy (2005), Visiting Astronomer

Research interests:

Magnetospheric physics
X-ray and γ-ray astronomy
Infrared astronomy
Solar flares and CMEs
Solar coronal physics
Solar infrared/submillimeter astronomy
Solar radius
Solar energy distribution

Publications and presentations:

http://sprg.ssl.berkeley.edu/∼hhudson/publications.html
http://sprg.ssl.berkeley.edu/∼hhudson/presentations.html

Often-cited publications:

Hudson, H. S., *Solar flares, microflares, nanoflares, and coronal heating*, Solar Physics 133, 357 (1991)

Hudson, H. S. *Thick-Target Processes and White-Light Flares*, Solar Physics 24, 414 (1972)

Lin, R. P. & Hudson, H. S. *Non-thermal processes in large solar flares*, Solar Physics 50, 153 (1976)

Willson, R. C. & Hudson, H. S. *The sun's luminosity over a complete solar cycle* Nature 351, 42 (1991)

Curriculum Vitae

Family name	Kašparová
First name	Jana (Ms)
Address (work)	Astronomický ústav AV ČR, v.v.i., Fričova 298, Ondřejov, 251 65, Czech Republic
Email	kasparov@asu.cas.cz
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Fax	+420 323 620 110
Citizenship	Czech Republic

Education

2004 Ph.D. in Theoretical Physics, Astronomy and Astrophysics, Charles University, Prague
1999 M.Sc. in Physics, Charles University, Prague

Employment to date

2009 – present time	scientist, Astronomický ústav AV ČR
2006, Mar - Jun	research assistant, University of Glasgow
2004 – 2008	young researcher, Astronomický ústav AV ČR
1999 – 2004	PhD student, Astronomický ústav AV Č

Study fellowships

2005, Apr - Jun	Royal Society Incoming Short Visit, University of Glasgow, UK
2002, Sep - Dec	NATO Science Fellowship, Goddard Space Flight Center, USA

Awards and academic honours

2005 Honorary Research Associate in the Department of Physics and Astronomy, University of Glasgow
2004 Josef Hlávka award

Professional activities

Member Internatinal Astronomical Union

Grants

2006 - 2008 Postdoctoral grant, Czech Science Foundation

Research interests

solar flare processes, non-LTE radiative transfer, continuum and spectral line emission, hard X-ray emission

Relevant publications

Kašparová, J., Heinzel, P., Karlický, M. et al.: 2009, *Far-IR and radio thermal continua in solar flares*, accepted to Central European Astrophysical Bulletin

Kašparová, J., Karlický, M.: 2009, *Kappa distribution and hard X-ray emission of solar flares*, accepted to A&AL

Štěpán, J., Kašparová, J., Karlický, M. et al.: 2007, *Hydrogen Balmer line formation in solar flares affected by return currents*, A&A, **472**, L55

Karlický, M., Kašparová, J., & Heinzel, P.: 2004, *Collisional excitation and ionisation of hydrogen by return current in solar flares*, A&AL, **416**, L13

Kašparová, J. & Heinzel, P. 2002, *Diagnostics of electron bombardment in solar flares*, A&A, **382**, 688

Personal data

Name:	Klein	First name:	Karl-Ludwig
Born :	20 August 1954,	Siegen	(Federal Republic of Germany)
Citizenship:	French		

Professional status

Sep 2005 – present :	Astronome, Observatoire de Paris (Meudon)
1987–2005 :	Astronome adjoint, Observatoire de Paris (Meudon)
1984–1986 :	ESA fellow, Observatoire de Paris - Section Meudon

Education

1973-1980 :	Physics & astronomy, University of Bonn (Germany)
1980:	*Diploma* in Physics (Radio astronomy), University of Bonn
1984	Thesis (Dr. rer. nat., Physics), University of Bonn

Research activities

- radio and X-ray studies of energetic electron populations in the solar corona,
- radio activity and high-energy particles in close binary systems (1986-1994),
- radio studies of large-scale disturbances - CME and shock waves - in the solar corona,
- solar origin of energetic particles detected in interplanetary space.

Selected references:

1. Klein K.-L., Chupp E.L., Trottet G. *et al.* : *Flare-associated energetic particles in the corona and at 1 AU*, Astron. Astrophys. 348, 271-285 (1999)

2. Klein K.-L., Trottet G., Lantos P., Delaboudinière J.-P.: *Coronal electron acceleration and relativistic proton production during the 14 July 2000 flare and CME*, Astron. Astrophys. 373, 1073–1082 (2001)

3. Klein K.-L., Schwartz R.A., McTiernan J.M., Trottet G., Lecacheux A.: *An upper limit of the number and energy of electrons accelerated at an extended coronal shock wave*, Astron. Astrophys. 409, 317–324 (2003)

4. Klein K.-L., Krucker S., Trottet G., Hoang, S.: *Coronal phenomena at the release of solar energetic electron events*, Astron. Astrophys. 431, 1047–1060 (2005)

5. Klein K.-L., Posner A.: *The onset of solar energetic particle events: prompt release of deka-MeV protons and associated coronal activity*, Astron. Astrophys. 438, 1029–1042 (2005)

6. Miroshnichenko, L.I., Klein K.-L., Trottet G. *et al.* : *Relativistic Nucleon and Electron Production in the 2003 October 28 Solar Event*, J. Geophys. Res. 110, A09S08 (2005)

7. Marqué C., Posner A., Klein K.-L.: *Solar energetic particles and radio-silent fast coronal mass ejections*, Astrophys. J. 642, 1222–1235 (2006)

8. Klein K.-L., Krucker S., Lointier G., Kerdraon A. : *Open magnetic flux tubes in the corona and the transport of solar energetic particles*, Astron. Astrophys. 486, 589-596 (2008)

Matthieu KRETZSCHMAR's CV

Name	Kretzschmar
First name	Matthieu
Birth date	1975
Position	Lecturer (Associate Professor) at the University of Orléans/CNRS, France
Institute	Laboratory for Physics and Chemistry of Environment and Space (LPC2E, Orléans, france)

Diplomas

- Masters in Astronomy and Astrophysics (1999, University of Montpellier/University of grenoble)
- PhD in Astronomy and Astrophysics (2002, University of grenoble)

Positions

- Post-docs in and space plasmas turbulence (2003-2005 Institute for the physics of the interplanetary space, CNR/INAF, Rome, 2 years)
- Post-doc in solar ultraviolet total irradiance (2005, Centre for the Study of Solar variability, Rome Observatory, Italy, 4 months)
- Post-doc in Solar Physics (2006-2007, SIDC/Royal Observatory of Belgium, Brussels, 1.6 years)
- Lecturer (Associate professor) at the University of Orléans (since 2007, LPCE, Orléans)

Research themes

- Physical and statistical modelling of solar irradiance
- Solar flare physics and flares impact on irradiance.
- Statistical analysis of plasma turbulence.
- Instrument development/exploitation: member of the scientific consortium for SWAP and LYRA (PROBA2, ESA, 2008) ; Co-investigator on Solar Orbiter/RPW (waves experiment).

Professional experience related to this project

- Member of the ISSI team: "Science Consortium for SWAP and LYRA"
- Member of the local organising committee of the solar physics meeting SoHO20 (Gent, 2007)
- Member of the "Irradiance" workpage in the SOTERIA European collaborative project (2008-2010)
- Strong involvement in the preparation of the irradiance instrument LYRA onboard PROBA2 (ESA, 2008)

Relevant publications for this project (since 2002: 16 publications in peer-reviewed journals)

- M. Kretzschmar, T. Dudok de Wit, J. Lilensten, J.F. Hochedez, J. Aboudarham, P.-O. Amblard, F. Auchère, S. Moussaoui, *Solar EUV/FUV irradiance variation: analysis and observational strategy*, Acta Geophysica 57, 42-51 DOI:10.2478/s11600-008-0066-2, 2008
- J. Lilensten, T. Dudok de Wit, M. Kretzschmar, P.-O. Amblard, S. Moussaoui, J. Aboudarham and F. Auchère, *Review on the solar variability spectrum for space weather purposes*, Annales Geoph. (2008) in press.
- M. Kretzschmar, J. Lilensten, J. Aboudarham, *Retrieving the Whole Solar EUV Flux from 6 Irradiance Line Measurements*, Advances in Space Research, 37(2) :341-346, 2006.
- T. Dudok de Wit, J. Lilensten, J. Aboudarham, P.-O. Amblard and M. Kretzschmar, *Retrieving the solar EUV spectrum from a reduced set of spectral lines*, Annales Geoph. 23 (2005) 3055-3069.
- M. Kretzschmar, J. Lilensten, J. Aboudarham, *Variability of the EUV quiet Sun emission and reference spectrum using SUMER*, Astronomy&Astrophysics, 419, 345-356, 2004

Curriculum Vitae

Personal Data:

Name:	Samuel (Säm) Krucker
Date of birth:	June 13, 1967
Nationality:	USA & CH

Education & Professional Status:

1987 - 1992	Study of experimental physics,
	Swiss Federal Institute of Technology (ETH) Zürich, Switzerland
1993 - 1996	PhD student at the Institute of Astronomy, ETH Zürich (Prof. A. O. Benz)
November 1996	Ph. D. Thesis: "Small Solar Flares in Radio and X-rays: Microflares and Radio Bursts"
1997 - 2000	Post-doctorate position at the Space Sciences Laboratory,
	University of California, Berkeley (with Prof. R. P. Lin)
2000 - 2006	Assistant research physicist at the Space Sciences Laboratory
2003	Named Co-Investigator of the NASA small explorer mission RHESSI
2006 to present	Senior Fellow at the Space Sciences Laboratory
2003	Named Co-Investigator of STEREO/WAVES
2007	PI of NASA Low Cost Access to Space (LCAS) mission FOXSI
2008	Member of the Executive Committee to the director of the Space Sciences Laboratory

Experience relevant to the proposal:

Data analysis and interpretation of solar flare observations (imaging and spectroscopy) in radio waves, in the optical range, in EUV, X-rays, and γ-rays.

Publications

I have published 78 papers in refereed journals, 24 as a first author.

Curriculum Vitae of Thomas Lüthi

PERSONAL DATA

Name:	Thomas Lüthi	Date of birth:	14.05.1974
Address:	Wiesenstrasse 8a	Marital status:	unmarried
	CH-5000 Aarau	Nationality:	Swiss
Phone (office):	+41-(0)62 737 6864		
Phone (private):	+41-(0)79 680 1334		
Email:	thomas.luethi@leica-geosystems.com		

EDUCATION

1989-1994	Matura (Typus C), Gymnasium Langenthal
1994-1995	Military service
1995-1998	Basic studies in physics at the University of Bern Secondary subjects: mathematics and astronomy
1998-2000	Diploma work at the Microwave Department of the Institute of Applied Physics, University of Bern. Topic: „Nulling Interferometer for Solar Flare Observations at 90 GHz“
2000	Diploma in physics (MSc/dipl. phys. unibe)
2000-2004	PhD thesis at the Microwave Department of the Institute of Applied Physics, University of Bern. Topic: „Solar Flares at Millimeter and Submillimeter Wavelengths – Instrumental Techniques and Observations“
2001	Plasmaphysics sommerschool in Culham (GB)
2004	PhD in physics (Dr. phil.-nat.)

EXPERIENCE

1994-1998	Several temporary jobs before and during my studies: Work on scaffolding, Sollberger AG, Ochlenberg Shop assistant, Migros Herzogenbuchsee
1998-2000	Assistant at the Institute of Applied Physics, University of Bern: Conversion of lecture notes into Latex
2000-2004	Assistant at the Institute of Applied Physics, University of Bern: Study of critical components in imaging radiometers at millimeter wavelengths
2004	Postdoc at the Institute of Applied Physics, University of Bern: Passive millimeter-wave imaging and ranging
2004-2005	Postdoc at the I. Physics Institute, University of Cologne (funded by a grant for prospective researchers from the Swiss National Science Foundation): Development of a modular array receiver at millimeter and submillimeter wavelengths
From 2005	Physicist with Leica Geosystems AG, Mönchmattweg 5, CH-5035 Oberentfelden: R&D laser trackers

CURRICULUM VITAE: Alexander Lachlan MacKinnon

DACE/Physics and Astronomy, University of Glasgow, GLASGOW, UK

Education: BSc (Hons), Class 2(i), Mathematics and Natural Philosophy, University of Glasgow, 1980

PhD, 1984, University of Glasgow, for thesis 'Hard X-ray and Microwave Emission from Solar Flares'

Employment history

1/10/91 - present	Lecturer in Astronomy (Senior Lecturer since 2002), Dept. of Adult and Continuing Education, University of Glasgow
1/6/88 - 30/9/91	SERC Advanced Fellow, Dept. of Physics and Astronomy, University of Glasgow
8/4/86 - 31/5/88	Research Assistant, Dept. of Physics and Astronomy, University of Glasgow
1/1/86 - 7/4/86	Temporary Lecturer, Dept. of Astronomy, University of Glasgow
1/6/83 - 31/12/85	Research Assistant, Dept. of Astronomy, University of Glasgow

MacKinnon has worked since 1980 on analysis and interpretation of radio, X-ray and γ-ray emission from solar flares. His PhD applied Maximum Entropy image deconvolution, to data from the HXIS X-ray imager on the Solar Maximum Mission. In 1984 work as a summer visitor with R Ramaty at GSFC broadened his interests to include flare γ-rays. Since then he has authored or co-authored 49 refereed journal article papers, on solar high energy phenomena and energy release. Recent work includes contributions particularly to Glasgow efforts on RHESSI X-ray data. He has long-standing collaborations with Ryan et al. (UNH) and with Trottet and Vilmer (Meudon, France). Invited talks in recent years for CESRA, EPS, COSPAR, AGU. With colleagues in the Dept. of Physics and Astronomy he co-holds PPARC funds supporting a Rolling Programme of solar physics and astrophysics research (currently £780,992, 2005-10**)**. He is a member of the board of CESRA (Community of European Solar Radio Astronomers - **http://calys.obspm.fr/cesra/**) and organised the 2004 CESRA meeting in Scotland. His work, in an equivalent of a US Extension Studies department, combines an extensive outreach role with a research remit,

Selected publications

MacKinnon, A. L.: 2006, 'Remote Diagnoses of Energetic Particles', in N Gopalswamy et al. (eds.), *Solar Eruptions and Energetic Particles*, Amer. Geophys. Union, Geophysical Monograph Series 165

Kontar, E. P., **MacKinnon, A. L.**:, Schwartz, R., Brown, J. C.: 2006, 'Compton backscattered and primary X-rays from solar flares: angle-dependent Green's function correction for photospheric albedo', *Astron. Astrophys.*, 446, 1157-1163

Galloway, R., **MacKinnon, A. L.**, Helander, P., Kontar, E. P.: 2005, 'Fast electron slowing down and diffusion in a high-temperature source', *Astron. Astrophys.* 438, 1107-1114

Toner, M. P., **MacKinnon, A. L.**: 2004, 'Do fast protons and alpha particles have the same energy distributions in solar flares?', *Solar Phys.* **223**, 155-168

Vilmer, N., **MacKinnon, A. L.,** Trottet, T., Barat, C.: 2003, 'High energy particles during the large solar flare of 1990 May 24: X/gamma ray observations', *Astron. Astrophys.*, **412**, 865-874

MacKinnon, A. L., Craig, I. J. D.: 1991, 'Stochastic Simulation of Fast Particle Diffusive Transport', *Astron. Astrophys.* **251**, 693 – 699

MacKinnon, A. L.: 1989, 'A Potential Diagnostic for Low Energy, Nonthermal Protons in Solar Flares', *Astron. Astrophys.* **226**, 284 - 287

MacKinnon, A. L., Brown, J. C.: 1989, 'Implications of the Solar Flare γ-ray Limb-brightening Observations for Particle Acceleration and the Flare Magnetic Environment 1. Approximate, analytical treatment', *Astron. Astrophys.* **215**, 371 – 380

MacKinnon, A. L., Brown, J. C., Hayward, J.: 1985, 'Quantitative Analysis of Hard X-ray "Footpoint" Flares Observed by the Solar Maximum Mission', *Solar Phys.* **99**, 231 – 262

CURRICULUM VITAE

March 25, 2009

Full Name: Silja Helena Pohjolainen
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Gender: Female
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Address: Tuorla Observatory, Väisäläntie 20, FIN-21500 Piikkiö, Finland
Homepage: http://users.utu.fi/silpoh
Current Employer: University of Turku, Department of Physics and Astronomy
Present Post: Adjunct Professor in Astronomy since April 2002, Teaching Assistant in Astronomy since January 2003

Degrees
Ph.D. degree in Space Technology and Astronomy, Helsinki University of Technology, 1996
Masters degree in Social Sciences, University of Helsinki, 1985

Publications
Refereed articles in international journals: 37
Articles in other scientific journals: 13
Conference proceedings: 34
Other publications: 18
Total number of publications: 102

Referee/Reviewer/Guest Editor for
Advances in Space Research (2006); American Geophysical Union AGU Books (2005); Astronomy & Astrophysics (2001, 2007, 2008); Astrophysical Journal Letters (2005, 2008); Astrophysics and Space Science (2008); CESRA Proceedings (2002); Journal of Atmospheric and Solar-Terrestrial Physics (2004); Solar Physics (2004, 2006, 2007, 2008, 2009); U.S. National Science Foundation NSF (2004); Grant Agency of the Academy of Science of the Czech Republic (2006, 2008); Solar Physics Topical Issue 'Radio Physics and the Flare-CME Relationship' Guest Editor (2007–2008)

Invited Reviews and Chairmanships:
IAU Symposium 223 (2004), invited review 'Multi-wavelength studies from optical to radio wavelengths'; CESRA Workshop (2007), Co-Chair of Working Group 'Multi-frequency observations related to flare/CME shocks'; 12th European Solar Physics Meeting (2008), invited review 'CMEs, shocks and their radio signatures'

Recent Projects
Interacting Solar and Heliospheric Disturbances and Their Significance for the Transport and Acceleration of Energetic Particles (Academy of Finland-Deutscher Akademischer Austausch Dienst) 2006-2008
Energetic Particles and Turbulence in Coronal and Heliospheric Plasmas (Academy of Finland, project leader T. Laitinen) 2008-2011
Solar Orbiter, Co-investigator in the proposal for Energetic Particle Detector/Low Energy Telescope (PI E. Valtonen)

CURRICULUM VITAE

TROTTET Gérard
Directeur de Recherche au CNRS
Observatoire de Paris-Meudon
Laboratoire d'Etudes Spatiales et d'Instrumentation en Astrophysique (LESIA)
92190 Meudon, France
Tel :+ 33 1 4507 7808
e-mail gerard.trottet@obspm.fr

Education

- Maîtrise ès Sciences, Université de Paris XI (1968)
- Diplôme d'études approfondies: Université de Paris VI (1969)
- Doctorat de 3ème cycle, Université de Paris VI (1971)
- Doctorat d'état, Université de Paris VII (1981)

Experience

- Leader of Solar radio astronomy group of Paris observatory (1986-1991)
- Co-PI of European programs (Lab-twining, Networks)
- Co-investigator, guest-investigator and research associate of various space missions (ICE, SMM, GRANAT, ULYSSES, SoHO)

Main scientific interest

- Characteristics and dynamics of the magnetic structure of the quiet and active corona
- Acceleration and transport of electrons and ions during and outside flares

Present responsibilities

PI of the DESIR experiment for the French-Chinese micro satellite SMESE. DESIR will provide the first observations of solar eruptions in the far infrared domain.

Selected references (relevant to the ISSI workshop on Submillimeter solar flare observations)

Trottet G., Raulin J.-P., Kaufmann P., Siarkowski M., Klein K.-L., Gary D.E. : 2002, *A&A*, **381**, 694
« First detection of the impulsive and extended phases of a solar radio burst above 200 GHz"
Vilmer, N., MacKinnon, A.L., Trottet G., Barat C., : 2003, *A&A* **412**, 865,
« High energy particles accelerated during the large solar flare of 1990 May 24 : X/γ-ray observations »
Trottet G., Krucker, S., Luthi, T., Magun A. : 2008, *ApJ*, **678,** 609
« Radio submillimeter and γ-ray observations of the 2003 October 28 solar flare »

Curriculum Vitae

Stephen M. White

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Department of Astronomy
University of Maryland
College Park MD 20742
Telephone: 301 405 1547
E-mail: white@astro.umd.edu

Home Address:
8529 58th Avenue
Berwyn Heights, MD 20740

March, 2009

Employment and Appointments

Current position: **Associate Research Scientist**, Department of Astronomy, University of Maryland, 1991-present. Under this position, also Co-Director, "Science, Discovery and the Universe" program of College Park Scholars (Living–Learning community for undergraduates), University of Maryland, 2006-present

Faculty Research Associate, Department of Astronomy, University of Maryland, 1987–1991

Alexander-von-Humboldt Scholar, Max Planck Institut fur Astrophysik, Garching-bei-Munchen, West Germany, 1986–87

Faculty Research Associate, Astronomy Program, University of Maryland, 1985–86

Tutor in the School of Physics, University of Sydney, 1980–83

Publications

143. *"On the relationship between chromospheric emission, millimeter emission and the magnetic field"*, Loukitcheva, M. A., S. K. Solanki, and **S. M. White**, Astronomy & Astrophysics, in press, 2009.

136. *"Solar Flare Hard X-Ray Emission from the High Corona"*, Krucker, S., **S. M. White**, and R. P. Lin, Astrophysical Journal, 669, L49, 2007.

134. *"Solar Radio Bursts and Space Weather"*, **S. M. White**, Asian Journal of Physics, **16**, 189, 2007.

129. *"Radio Measurements of the Height of Strong Coronal Magnetic Fields Above Sunspots at the Solar Limb"*, J. W. Brosius & **S. M. White**, Astrophys. J. Lett., 641, L69, 2006.

124. *"High–Resolution Millimeter–Interferometer Observations of the Solar Chromosphere"*, **S. M. White**, M. Loukitcheva & S. K. Solanki, Astron. Astrophys., 456, 697, 2006.

121. *"High Cadence Radio Observations of an EIT Wave"*, **S. M. White** & B. J. Thompson, Ap. J. Lett., 620, L63, 2005.

120. *"Radio Observations of Rapid Acceleration in a Slow Filament Eruption/Fast CME Event"*, M. R. Kundu, V. I. Garaimov, **S. M. White**, P. K. Manoharan, P. Subramanian, S. Ananthakrishnan, & P. Janardhan, Astrophys. J., 607, 530, 2004.

Synergistic Activities

Maintain the archive for the Green Bank Solar Radio Burst Spectrometer at **http://gbsrbs.nrao.edu**.

Maintain a web site on solar and stellar astrophysics at **http://www.astro.umd.edu/∼white/**