



European
Solar Magnetometry
Network

TMR Network Contract No ERBFMRXCT980190

Annual Progress Report

May 1 2000 — April 30 2001

Summary

The *European Solar Magnetometry Network* has become a well-established entity in European solar physics. Major third-year milestones were the Mid-Term Meeting and the Second ESMN school. The ESMN “business” (improving solar magnetometry and studying solar magnetism) progresses well in all the diverse ESMN undertakings, ranging from telescope construction to observing and interpretation. The Network remains confident to achieve all deliverables including the contracted YVR man-months. A proposal for a future *European Solar Magnetism Network* to build on and expand the ESMN efforts has been submitted to the EC.

Highlights

The new solar telescopes (THEMIS and DOT) evolved well towards full-fledged deployment. The SVST was dismantled to make place for the NSST, with the new turret already in place. The IAC TIP at the German VTT has become a major international observing facility. The first channel of a new speckle-imaging system was installed at the DOT. SOHO performed well and made many headlines with breakthrough discoveries including the amazing ability to map active regions on the far side of the sun.

The second ESMN school became a larger-scale enterprise by being accepted as XIIth Canary Island Winter School on “Astrophysical Spectropolarimetry” (Instituto de Astrofísica de Canarias, Tenerife, November 13–24, 2000). The over 60 participants included 6 ESMN Fellows.

The ESMN Mid-Term Meeting was held at Santa Cruz, Tenerife on September 30, 2000, with pre-meetings and post-meetings during the SOLSPA Euroconference and the SOHO/GONG workshop that were held the week before and after at the same venue. Scheduling the Mid-Term Meeting between these two conferences led to considerable outside attention for the ESMN Fellow presentations of their research.

The first Sun-Earth Day on April 27th, 2001 led to large public outreach activity coordinated by the ESA partner, with some 70 public events taking place in 47 cities in 14

European countries and much media attention. Many ESMN researchers participated by lecturing on solar physics and SOHO achievements on this day.

Perhaps the largest highlight of this ESMN year was contributed by the sun herself during the first two weeks of April 2001 when the largest sunspot group of this cycle produced no less than 9 X-class flares, among them an X-20 (reportedly the largest X-ray flare ever recorded). This remarkable outburst of solar activity led to a media frenzy and a record 8,311,334 requests to the SOHO web servers in April 2001, with over 686 Gbytes served (almost twice the normal SOHO web traffic).

Accomplished research

All ESMN objectives were again addressed. As detailed more extensively in the Mid-Term Report, the Network activities keep fairly close to the schedule in section B.3 of the Project Programme, with some elements completed (such as developing on-line imagery) and others redirected (such as the rebuilding of the SVST into the NSST, not foreseen at contract time). A review:

- Science objectives (magnetic structure topology and dynamics, dynamo patterning): filament/prominence topology studies gain much from the cloud-model inversion techniques developed at OP, with UV diagnostics interpreted at OAC. The pioneering wave simulations of the UiO ESMN Fellow (in ESMN and other international context) probe the topology of the magnetic canopies outside active regions. Sunspot dynamics remains at the forefront of ESMN interest, with much emphasis on umbral flashes as indicator of magneto-acoustic shocks in the umbral chromosphere (KVA, UiO, UU, AIP, ESA, IAC) and on penumbral structure and waves (AIP, UU, IAC, OP). The acoustic oscillations outside active regions are studied by UU with OAC and AIP and are numerically simulated at UiO. Flare dynamics remained an OAC–OP interest. Dynamo patterning is mainly an IAC interest at present (MISMA and flux-concentration mechanisms, identification of weak internetwork fields) but represents a growing field now that quantitative infrared and image-restored magnetometry come of age; a dynamo issue presently in debate is the existence of “convective flux tube collapse”. A newly opening hot topic is the linear polarization of spectral lines near the solar limb which supplies Hanle diagnostics of weak fields high up in the solar atmosphere, from sensitive polarimetry at THEMIS, VTT and SVST (IAC team with OP and KVA) and the simultaneous development of density-matrix radiative transfer theory for interpretation (IAC).
- magnetometry techniques (telescope optimisation, magnetometers, image restoration): the SVST saw its last light in August in order to make place for the NSST of which the realization from conception to completion is likely to be achieved within the ESMN period. The new turret was realized in KVA–UU collaboration and the fabrication of the remainder of NSST progresses well. As highlighted in the Mid-Term Report, the NSST is expected to break the barrier of meter-class diffraction-limited observation and to be the world’s premier high-resolution optical solar telescope at least until the German GREGOR follows suit. THEMIS is steadily being improved, with MSDP polarimetry achieved for the first time, a new beam-switching polarimeter installed, and major plans

defined for a new Italian IPM-replacing filtergraph and the deployment of adaptive optics. The IAC team joined OP to adapt and test a French stellar polarimeter to measure weak chromospheric fields at the German GCT. The DOT is being equipped with an advanced five-channel speckle imaging system of which the data-acquisition hardware was designed and largely completed during the report year and the initial G-band channel installed and tested in an initial observing campaign. The TIP (liquid-crystal polarimeter installed by the IAC on the German VTT) performs outstandingly well. The companion LPSP was used at the SVST in various IAC–KVA projects which are also useful precursors for future spectropolarimetry with the NSST since the new turret has comparable polarization properties. The OAC development of the VAMOS resonance-cell magnetometer progressed to the stage that funding can be sought for a high-resolution version for the DOT.

- Comprehensive observing (campaigns, data archiving, interpretation): at this time of maximum solar activity most observing concentrated on sunspots, active regions, and filaments and prominences, with the IAC, OP, UU and AIP teams most active, KVA until the demise of the SVST. The French BASS2000 database server is now fully operational. Polarimetry data inversion techniques continue to receive much attention at IAC, OP and AIP, with the latter team pioneering a neural-network automation approach (which brings the term “network” to three significant but very different meanings in ESMN context) that was tested on ESMN JOP097 data.
- Numerical modelling (boundary conditions, comparison with data): the UiO–KVA collaboration on modelling waves in magnetised regions of the solar atmosphere reveals a complex web of interacting wave phenomena. Extensions of these simulations towards the understanding of wave phenomena in sunspots by wave modelling based on actual observations is well underway. The implementation of radiation physics into the magnetohydrodynamic code also proceeds well. These simulations complement theoretical modelling of wave transmission in sunspot atmospheres by AIP and inversion modeling at IAC. Numerical simulations of emerging twisted magnetic flux tubes at KVA for the first time include realistic convective flows.

Principal networking activities

- Collaborative ESMN observing campaigns:
 - “Arch filament oscillations”, May 1–5, 2000, using THEMIS and SOHO, teams OP (leader) and ESA;
 - “Chromospheric Magnetism: the Na I D lines”, June 2000, LPSP polarimeter of the IAC at the SVST, teams IAC (leader) and KVA;
 - “Non-thermal particles in solar flares”, July 12–19, 2000, THEMIS MTR mode (multi-line spectropolarimetry). Teams OP (PI) and OAC.
 - “Chromospheric magnetism: the Ca II IR triplet”, September 2000, using an OP stellar polarimeter at the GCT, teams IAC (leader) and OP;
 - “Oscillations in sunspots and active regions”, September 19–29, 2000. AIP (leader), IAC, UU and ESA, using VTT, GCT, DOT, SOHO and TRACE. Details

at <http://sohowww.nascom.nasa.gov/soc/JOPs/jop097.txt>. Data presently being analysed by the AIP and ESA ESMN fellows together;

- “Active regions”, October 6–15, 2000, combining THEMIS and VTT with SOHO, YOHKOH and TRACE. Teams OP (leader) and ESA;
- ESMN workshop: “Astrophysical Flows and Magnetic Fields”, April 18–19 2001, Stockholm, organised by the KVA postdoctoral fellow.
- ESMN school: “Astrophysical Spectropolarimetry”, XIIth Canary Islands Winter School of Astrophysics, Instituto de Astrofísica de Canarias, Tenerife, Spain, November 13–24, 2000. The sequence of Canary Islands Winter Schools is very prestigious and it has been a great boon to us that the ESMN-initiated proposal was selected. The School was co-sponsored by the IAC, the European Commission, the Spanish Ministry of Science, IBERIA, the local governments (Cabildos) of La Palma and Tenerife, and the ESMN — which so got large return for a modest fee (only 10 Keuro). There were 62 participants from 17 countries including 6 ESMN Fellows. Topics and lecturers:
 - The physics of polarization (Prof. E. Landi Degl’Innocenti);
 - Polarized radiation diagnostics of solar magnetic fields (Prof. J. O. Stenflo);
 - Polarized radiation diagnostics of stellar magnetic fields (Dr. G. Mathys);
 - Spectropolarimetry of quasars and radiogalaxies (Prof. R. Antonucci);
 - Polarization from compact objects and accretion disks (Prof. R. Blandford);
 - Polarization from astronomical masers (Prof. M. Elitzur);
 - Infrared-submillimeter spectropolarimetry and interstellar magnetic fields (Prof. R. Hildebrand);
 - Instrumentation for astrophysical spectropolarimetry (Dr. C. Keller).

In addition, there were hands-on polarimetry training sessions at the telescopes of the Teide Observatory on Tenerife and the Roque de los Muchachos Observatory on La Palma. The resulting book “Astrophysical Spectropolarimetry” will be published later this year by Cambridge University Press. It is edited by J. Trujillo Bueno, F. Moreno Insertis and F. Sánchez and will provide an unsurpassed introduction to spectropolarimetry in astrophysics.

- ESMN Mid-Term Meeting: Santa Cruz, Tenerife, Spain, September 29–30, 2000. All ESMN fellows and all team leaders except UiO, plus many other ESMN members. Public presentations by the ESMN coordinator, by each ESMN postdoctoral fellow on his/her research, and by Dr. Stephen Davies on EC science programmes were given to an audience also including participants of the 1st SOLSPA Euroconference and the combined SOHO/GONG workshop. The closed session, limited to ESMN team members, addressed the overall ESMN status, the ESMN effort of each team, and YVR experiences.
- ESMN sub-meetings at international conferences:
 - IAU Symposium 203 during the IAU General Assembly (Manchester, August 7–19 2000);

- AAS/SPD meeting (Nevada, June 18–22 2000);
 - 20th NSO/Sacramento Peak Summer Workshop (Sunspot, September 1–11 2000);
 - First SOLSPA Euroconference (Tenerife, September 25–29 2000);
 - SOHO/GONG workshop (Tenerife, October 2–6 2000);
 - THEMIS conference (Rome, March 19–21 2001).
- ESMN continuation: a proposal for an enlarged *European Solar Magnetism Network* building on the magnetometry hardware and techniques delivered by the present ESMN was submitted to the EC for the final round of the TMR programme.

Appointments of young researchers

ESA's slot for a postdoctoral fellow was filled per July 1 2000 by Eoghan O'Shea as reported in the Mid-Term report. Etienne Vogt left the OAC in January 2001 at the completion of his two-year fellowship. The OAC has since then hired Jack Ireland and Carla Gil for six-month periods and is searching other candidates for similar short-term appointments. Similar measures will be taken by other partners when ESMN fellows leave prematurely (as the IAC one does presently, taking up an attractive position in industry (Zeiss)), or when the present fellow came too late to fulfill the partner manmonth deliverable by April 30, 2002.

Interactions with industry

KVA maintains its close cooperation with Compaq Systems Research Center, in particular Dr. M. Shand and with emphasis on future NSST image handling. The team organised a mini-workshop on adaptive optics for solar telescopes in Munich (March 26 2000) in which Compaq participated through M. Shand and Laplacian Optics through Dr. B. Graves.

The UU collaborations with Flender AG and Hoesch Rothe Erde reported in the Mid-Term Report concerning the NSST turret fabrication (a joint KVA–UU activity) also extended into the third ESMN year. In addition, DOT builder R.H. Hammerschlag instructed DD-Optik in Kirchdorff im Walde (Germany) and WZW–Optic in Balgach (Switzerland) on interferometric optics quality test procedures, giving a seminar on solar telescope design at the latter firm.

The OAC continued its interactions with EIS SRL in Rome for VAMOS development.

Database report update

The Cordis Database update has been handled electronically.

ESMN team constitutions and ESMN efforts**UU (Utrecht)**

Name	Position	Funding	Months
Felix Bettonvil	Scientist/Engineer	UU/NWO	8
Rob Hammerschlag	Scientist/Engineer	UU	8
Max Kuperus	Professor	UU	1
Thijs Krijger	PhD Student	NWO	5
Rob Rutten	Senior Scientist	UU	4
Jan Kuijpers	Senior Scientist	UU/KUN	1
Pit Sütterlin	Post Doc	ESMN	12
7			39

NWO = Nederlandse Organisatie voor Wetenschappelijk Onderzoek

KUN = Katholieke Universiteit Nijmegen

IAC (La Laguna)

Name	Position	Funding	Months
Javier Trujillo Bueno	Científico Titular	CSIC	6
Manolo Collados Vera	Profesor Titular	ULL	6
Jorge Sánchez Almeida	Research Scientist	IAC	6
Valentin Martínez Pillet	Research Scientist	IAC	4.5
Olaf Dittmann	Post Doc	ESMN	12
Ines Rodriguez Hidalgo	Research Scientist	IAC	3
Luis Bellot Rubio	Support Astronomer	IAC	3
Rafael Manso Sainz	PhD Student	IAC	12
8			52.5

CSIC = Consejo Superior de Investigaciones Científicas

ULL = University of La Laguna

OAC (Naples)

Name	Position	Funding	Months
Vincenzo Andretta	Research Astronomer	OAC, MURST	6
Carla Gill	PhD Student	ESMN	2
Maria Teresa Gomez	Research Astronomer	OAC, MURST	2
Jack Ireland	Post Doc	ESMN	4
Pier Francesco Moretti	Post Doc	OAC, MURST	6
Maurizio Oliviero	Research Astronomer	OAC	5
Kevin Reardon	Graduate Researcher	OAC, MURST	3
Giuseppe Severino	Associate Astronomer	OAC, MURST	6
Thomas Straus	Research Astronomer	OAC, MURST	5
Alfredo Tripicchio	Graduate Researcher	OAC, MURST	3
Etienne Vogt	Post Doc	ESMN	8
11			50

MURST = Ministero dell'Università e della Ricerca Scientifica e Tecnologica

UiO (Oslo)

Name	Position	Funding	Months
Mats Carlsson	Professor	UiO	6
Oddbjorn Engvold	Professor	UiO	2
Viggo Hansteen	Professor	UiO	4
Per Maltby	Professor	UiO	2
Andrew McMurry	Post Doc	NFR	10
Colin Rosenthal	Post Doc	ESMN	12
6			36

NFR = Norsk Forskningsråd

KVA (Stockholm)

Name	Position	Funding	Months
Pete Dettori	Science Engineer	KVA	10
Bertil Dorch	Post Doc	ESMN	12
Boris Gudiksen	PhD student	ESMN	12
Dan Kiselman	Research Associate	KVA	6
Mats Löfdahl	Research Associate	KVA	6
Luc Rouppe van der Voort	PhD student	KVA	8
Göran Scharmer	Professor	KVA	10
7			64

AIP (Potsdam)

Name	Position	Funding	Months
Horst Balthasar	Staff Scientist	AIP	12
Thorsten Carroll	PhD Student	DLR	6
Axel Hofmann	Staff Scientist	AIP	6
Karin Muglach	Post Doc	ESMN	12
Jürgen Staude	Professor	AIP	6
5			42

DLR = Deutsche Luft- und Raumfahrt

OP (Paris)

Name	Position	Funding	Months
Guillaume Aulanier	Post Doc	CNES	2
Pascal Demoulin	Astronome Adjoint	MEN	2
Jean-Marie Malherbe	Astronome	MEN	6
Pierre Mein	Astronome	MEN	6
Sylvie Sahal-Bréchet	Directeur de Recherche	CNRS	1
Brigitte Schmieder	Astronome	MEN	5
Meir Semel	Directeur de Recherche	CNRS	2
Kostas Tziotziou	Post Doc	ESMN	12
8			36

MEN = Ministère de l'Éducation Nationale

CNRS = Centre National de la Recherche Scientifique

Dr. Pierre Mein retired officially during the year but remains active in ESMN research.

Dr. Jean-Marie Malherbe has taken over as the new OP ESMN coordinator. The change was notified in writing to the EC.

ESA (Noordwijk)

Name	Position	Funding	Months
Paal Brekke	Staff Scientist	ESA	2
Bernhard Fleck	Staff Scientist	ESA	3
Bernard Foing	Staff Scientist	ESA	1
Stein Haugan	Staff Scientist	ESA	4
Jack Ireland	Post Doc	ESMN	1
	Fellow	ESA	4
Scott McIntosh	Fellow	ESA	3
Eoghan O'Shea	Post Doc	ESMN	11
7			29

Travel and conference participation by ESMN Fellows

These entries detail all ESMN-related journeys of the ESMN Young Visiting Researchers, also travel funded from other sources. The order is alphabetical by person.

Olaf Dittmann (IAC)

- Collaborative visit to OP team, Paris, France, August 8-17, 2000.
- “Advanced Solar Polarimetry — Theory, Observation and Instrumentation”, 20th NSO/Sacramento Peak Summer Workshop, Sunspot, New Mexico, September 11–15, 2000
- ESMN Mid-Term Meeting, Santa Cruz, Tenerife, Spain, September 29–30, 2000
- “Astrophysical Spectropolarimetry”, XIIth Canary Islands Winter School of Astrophysics, Instituto de Astrofísica de Canarias, Tenerife, Spain, November 13–24, 2000
- “THEMIS and the new frontiers of solar atmosphere dynamics”, THEMIS conference, Rome, Italy, March 19–21, 2001

Bertil Dorch (KVA)

- “Recent Insights into the Physics of the Sun and Heliosphere — Highlights from SoHO and Other Space Missions”, IAU Symposium 203, IAU General Assembly, Manchester, UK, August 7–19, 2000
- “The Solar Cycle and Terrestrial Climate”, 1st SOLSPA Euroconference, Santa Cruz, Tenerife, Spain, September 25–29, 2000
- ESMN Mid-Term Meeting, Santa Cruz, Tenerife, Spain, September 29–30, 2000
- “Boiling stars — Convection, radiation, and magnetic fields at stellar surfaces”, Lund, Sweden, April 6, 2001
- ESMN Workshop “Astrophysical Flows and Magnetic Fields”, Saltsjöbaden, Sweden, April 18–19, 2001

Carla Gil (OAC)

- “THEMIS and the new frontiers of solar atmosphere dynamics”, THEMIS conference, Rome, Italy, March 19–21, 2001

Boris Gudiksen (KVA)

- “Recent Insights into the Physics of the Sun and Heliosphere — Highlights from SoHO and Other Space Missions”, IAU Symposium 203, IAU General Assembly, Manchester, UK, August 7–19, 2000
- Advanced Summer School in Solar Physics, Mullard Space Science Laboratory, London, UK, September 4–8, 2000
- ESMN Mid-Term Meeting, Santa Cruz, Tenerife, Spain, September 29–30, 2000

- Workshop on “Dynamos in the Laboratory, Computer and the Sky”, Copenhagen, Denmark, March 15–17, 2001
- “Boiling stars — Convection, radiation, and magnetic fields at stellar surfaces”, Lund, Sweden, April 6, 2001
- ESMN Workshop “Astrophysical Flows and Magnetic Fields”, Saltsjöbaden, Sweden, April 18–19, 2001

Jack Ireland (OAC)

- “THEMIS and the new frontiers of solar atmosphere dynamics”, THEMIS conference, Rome, Italy, March 19–21, 2001

Karin Muglach (AIP)

- “Recent Insights into the Physics of the Sun and Heliosphere — Highlights from SoHO and Other Space Missions”, IAU Symposium 203, IAU General Assembly, Manchester, UK, August 7–19, 2000
- “Advanced Solar Polarimetry — Theory, Observation and Instrumentation”, 20th NSO/Sacramento Peak Summer Workshop, Sunspot, New Mexico, September 11–15, 2000
- International observing campaign, Teide Observatory, Tenerife, September 18–27, 2000
- ESMN Mid-Term Meeting, Santa Cruz, Tenerife, Spain, September 29–30, 2000
- “Astrophysical Spectropolarimetry”, XIIth Canary Islands Winter School of Astrophysics, Instituto de Astrofísica de Canarias, Tenerife, Spain, November 13–24, 2000
- GREGOR Meeting, Potsdam, Germany, February 22–23, 2001
- “THEMIS and the new frontiers of solar atmosphere dynamics”, THEMIS conference, Rome, Italy, March 19–21, 2001

Eoghan O’Shea (ESA)

- SOHO observing campaign JOP097, NASA Goddard Space Flight Center, Greenbelt, USA, September 11–25, 2000
- ESMN Mid-Term Meeting, Santa Cruz, Tenerife, Spain, September 29–30, 2000
- “Helio- and Asteroseismology at the Dawn of the Millenium’, SOHO/GONG workshop, Santa Cruz, Tenerife, Spain, October 2–6, 2000
- Collaborative visit to the IAC, La Laguna, Tenerife, October 23 – November 10, 2000
- “Astrophysical Spectropolarimetry”, XIIth Canary Islands Winter School of Astrophysics, Instituto de Astrofísica de Canarias, Tenerife, Spain, November 13–24, 2000

Colin Rosenthal (UiO)

- “Recent Insights into the Physics of the Sun and Heliosphere — Highlights from SoHO and Other Space Missions”, IAU Symposium 203, IAU General Assembly, Manchester, UK, August 7–19, 2000
- ESMN Mid-Term Meeting, Santa Cruz, Tenerife, Spain, September 29–30, 2000
- Collaborative visit to HAO/NCAR, Boulder, USA, February 11–16, 2001
- ESMN Workshop “Astrophysical Flows and Magnetic Fields”, Saltsjöbaden, Sweden, April 18–19, 2001

Pit Sütterlin (UU)

- “Advanced Solar Polarimetry — Theory, Observation and Instrumentation”, 20th NSO/Sacramento Peak Summer Workshop, Sunspot, New Mexico, September 11–15, 2000
- ESMN Mid-Term Meeting, Santa Cruz, Tenerife, Spain, September 29–30, 2000
- “Astrophysical Spectropolarimetry”, XIIth Canary Islands Winter School of Astrophysics, Instituto de Astrofísica de Canarias, Tenerife, Spain, November 13–24, 2000
- “THEMIS and the new frontiers of solar atmosphere dynamics”, THEMIS conference, Rome, Italy, March 19–21, 2001

Kostas Tziotziou (OP)

- Observing campaign, Teide Observatory, Tenerife, Spain, August 16–21, 2000
- “The Solar Cycle and Terrestrial Climate”, 1st SOLSPA Euroconference, Santa Cruz, Tenerife, Spain, September 25–29, 2000
- ESMN Mid-Term Meeting, Santa Cruz, Tenerife, Spain, September 29–30, 2000
- Collaborative visit to the IAC, La Laguna, Tenerife, Spain, October 2–16, 2000
- MEDOC Prominence Workshop, Orsay, France, October 23–26, 2000
- “Astrophysical Spectropolarimetry”, XIIth Canary Islands Winter School of Astrophysics, Instituto de Astrofísica de Canarias, Tenerife, Spain, November 13–24, 2000
- Collaborative visit to Athens University Astronomy Department, Athens, Greece, December 19–23, 2000
- “THEMIS and the new frontiers of solar atmosphere dynamics”, THEMIS conference, Rome, Italy, March 19–21, 2001
- Conference Programme National Soleil Terre, Orsay, France, April 3–5, 2001

Etienne Vogt (OAC)

- Collaborative visit to OP, Meudon, France, May 1–28, 2000
- THEMIS observing campaign, “Non-thermal particles in solar flares” Teide Observatory, Tenerife, Spain, July 12–19, 2000

- “The Solar Cycle and Terrestrial Climate”, 1st SOLSPA Euroconference, Santa Cruz, Tenerife, Spain, September 25–29, 2000
- ESMN Mid-Term Meeting, Santa Cruz, Tenerife, Spain, September 29–30, 2000
- “Astrophysical Spectropolarimetry”, XIIth Canary Islands Winter School of Astrophysics, Instituto de Astrofísica de Canarias, Tenerife, Spain, November 13–24, 2000
- Collaborative visit to the IAC, La Laguna, Tenerife, Spain, November 25–30, 2000

ESMN Publications

Balthasar, H., Collados, M., and Muglach, K.: 2000, “Magnetic Field Oscillations in Sunspots and Active Regions”, in *Helio- and Asteroseismology at the Dawn of the Millenium*, Procs. of SOHO 10/GONG 2000 workshop, ESA SP-464, ESA Publ. Div., ESTEC, Noordwijk, 163–167

- Balthasar, Muglach: AIP, Collados: IAC
- Muglach: ESMN Fellow
- Objective (b)

Balthasar, H., Collados, M., and Muglach, K.: 2000, “Oscillations in a Solar Pore”, *Astronomische Nachrichten* **321**, 121–127

- Balthasar, Muglach: AIP, Collados: IAC
- Muglach: ESMN Fellow
- Objectives (a), (b)
- Refereed journal
- Abstract: Temporal variations of a solar pore were observed at the ground based Vacuum Tower Telescope (VTT) on Tenerife and with the satellite TRACE. At the VTT Stokes I and V of the iron line at $1.56 \mu\text{m}$, originating in the deep photosphere, were measured. TRACE delivered UV images at 170 nm which show chromospheric continuum. In a part of the pore we find oscillations of the magnetic field in the 5 minute range. Velocities derived from shifts of the Stokes V profiles show 5 minutes everywhere in the pore, but the coherence of magnetic field and velocities is low. The intensity at 170 nm varies with 3 minutes, and for a part of the whole time series additionally with 4 minutes.
- Acknowledgement: This research is part of the TMR–ESMN (European Solar Magnetometry Network) supported by the European Commission. The VTT on Tenerife is operated by the Kiepenheuer-Institut für Sonnenphysik (Germany) in the Spanish Observatorio del Teide of the Instituto de Astrofísica de Canarias. We would like to thank the TRACE instrument team for their help and advice, especially the TRACE operators J. Wolfson, D. Myers and M. Wills-Davey.

Banerjee, D., O’Shea, E., Doyle, J., Goossens, M., and Fleck, B.: 2001a, “On the Nature of Network Oscillations”, in A. Wilson (Ed.), *Helio- and Asteroseismology at the Dawn of the Millenium*, Procs. SOHO 10/GONG 2000 Workshop, ESA SP-464, ESA Publ. Div., ESTEC, Noordwijk, 175–178

- O’Shea: ESMN Fellow at ESA; Fleck: ESA
- Objective (b)

Banerjee, D., O’Shea, E., Doyle, J. G., and Goossens, M.: 2001b, “The Nature of Network Oscillations”, *Astronomy and Astrophysics* **371**, 1137–1149

- O’Shea: ESMN Fellow at ESA
- Objective (b)
- Refereed journal, pre-ESMN research
- Abstract: We examine time-series of spectral data obtained from the Coronal Diagnostic Spectrometer (CDS) and the Solar Ultraviolet Measurements of Emitted Radiation instrument (SUMER) onboard the Solar Heliospheric Observatory (SOHO)

spacecraft, in the period 30–31 July 1996. The observations were obtained in lines, ranging in temperature from 12 000 K to 106 K, covering the low chromosphere to the corona. We report here on a time series analysis, using wavelet methods, of small individual network regions in the quiet Sun. The wavelet analysis allows us to derive the duration as well as the periods of the oscillations. The statistical significance of the oscillations was estimated by using a randomisation method. The oscillations are considered to be due to waves, which are produced in short bursts with coherence times of about 10–20 min. The low chromospheric and transition region lines show intensity and velocity power in the 2–4 mHz range. The coronal line Mg x does not show any statistically significant power in this range. In general, it is thought likely that the chromosphere and possibly the transition region oscillates in response to forcing by the p-modes, but they are also influenced strongly by the presence of magnetic fields. The observed 2–4 mHz network oscillations can thus be interpreted in terms of kink and sausage waves propagating upwards along thin magnetic flux tubes. We perform a linear numerical computation comparing the results with our observations.

Brekke, P., Brynildsen, N., Kjeldseth-Moe, O., Maltby, P., and Wilhelm, K.: 2000, “Signatures of Magnetic Reconnection and Observed EUV Emission Line Profiles in An Active Region”, *Advances in Space Research* **26**, 457–460

- Brekke: ESA, Brynildsen, Kjeldseth-Moe, Maltby: UIO
- Refereed journal
- Objective (b1)

Brynildsen, N., Brekke, P., Haugan, S. V. H., Kjeldseth-Moe, O., Maltby, P., and Wikstøl, Ø.: 2000, “Structure and Dynamics in the Atmosphere Above Sunspot Regions”, *Advances in Space Research* **25**, 1743–1746

- Brekke: ESA, Brynildsen, Kjeldseth-Moe, Maltby, Wikstøl : UIO
- Refereed journal
- Objective (b)

Deng, Y. Y., Schmieder, B., Engvold, O., DeLuca, E., and Golub, L.: 2000, “Emergence of sheared magnetic flux tubes in an active region observed with the SVST and TRACE”, *Solar Physics* **195**, 347–366

- Engvold: UiO, Schmieder: OP
- Objectives (a), (b)
- Refereed journal
- Abstract: The active region NOAA AR 8331 was a target of an international ground-based observational campaign in the Canaries and coordinated with space instruments (TRACE and Yohkoh). We focus our study on observations obtained with the SVST at LaPalma, and with TRACE. On 10 September 1998, arch-filament systems were observed with high spatial and temporal resolution, from the lower to the upper atmosphere of the Sun, during five hours. Flux tubes emerged with increasing shear, which apparently led to energy release and heating in the overlying corona. A model for filament formation by the emergence of U-shaped loops from the subphotosphere, as proposed by Rust and Kumar (1994), is supported by the present observations. The coronal response to these events is visualized by rising, medium-scale loop brightenings. The low-lying X-ray loops show short-lived, bright knots which are thought to

result from interaction between different loop systems.

Dorch, B.: 2000, “Aktive stjerner med pletter”, *Aktuel Astronomi* **4**, 24–27

- *Dorch: ESMN Fellow*
- *Popular science outreach article*

Dorch, B. and Nordlund, Å.: 2000, “The solar dynamo: Flux pumping by stratified convection”, in *The solar cycle and terrestrial climate*, 1st. SOLSPA Euro-conference (Eds. M. Vázquez and b. Schmieder) ESA SP-436, ESA Publ. Div., ESTEC, Noordwijk, 305–308

- *Dorch: ESMN Fellow*
- *Objective (b), (c), (f)*

Dorch, B. and Nordlund, Å.: 2001, “On the transport of magnetic fields by solar-like stratified convection”, *Astronomy & Astrophysics* **365**, 562–570

- *Dorch: ESMN Fellow*
- *Objective (b), (c), (f)*
- *Refereed journal*
- *Abstract:* The interaction of magnetic fields and stratified convection was studied in the context of the solar and late type stellar dynamos by using numerical 3-d MHD simulations. The topology of stratified asymmetric and over-turning convection enables a pumping mechanism that may render the magnetic flux storage problem obsolete. The inclusion of open boundary conditions leads to a considerable flux loss unless the open boundary is placed close to the physical boundary. Simulations including solar-like latitudinal shear indicates that a toroidal field of several tens of kilo-Gauss may be held down by the pumping mechanism.
- *Acknowledgement:* This work was supported in part by the Danish Research Foundation, through its establishment of the Theoretical Astrophysics Center. Computing time at the UNI•C computing center was provided by the Danish Natural Science Research Council. BD acknowledges support through an EC-TMR grant to the European Solar Magnetometry Network.

Emslie, A. G., Miller, J. A., Vogt, E., Hénoux, J. C., and Sahal-Bréchet, S.: 2000a, “H α Polarization during a Well-observed Solar Flare: Proton Energetics and Implications for Particle Acceleration Processes”, *Astrophysical Journal* **542**, 513–520

- *Vogt: ESMN Fellow at OAC, but pre-ESMN analysis*
- *Hénoux, Sahal-Bréchet: OP*
- *Objective (b)*
- *Refereed journal*
- *Abstract:* Observations of polarization of chromospheric lines in solar flares can constrain the energy flux in accelerated protons. In this paper, we analyze recently-reported observations of H α linear polarization obtained during a rather well-observed flare on 1989 June 20. Modeling of the magnitude and orientation of the H α polarization provides a constraint on the flux of low energy (> 200 keV) protons, while simultaneous gamma-ray and hard X-ray observations provide constraints on the fluxes of > 10 MeV protons and > 50 keV electrons, respectively. These, plus information on the energetics of the low-temperature and high-temperature thermal emissions, permit

evaluation of both the absolute and relative roles of electrons and protons in the flare energy budget. We find that accelerated protons with energies > 200 keV can contain a significant portion of the total energy released during the flare, consistent with a steep extrapolation of the proton spectrum to such relatively low energies. We discuss these results in light of a unified electron/proton stochastic particle acceleration model, and show that the energetics are indeed consistent with this large proton energy content.

Emslie, A. G., Miller, J. A., Vogt, E., Hénoux, J. C., and Sahal-Bréchet, S.: 2000b, “H α Polarization Observations and Flare Energetics”, in *AAS/Solar Physics Division Meeting*, Vol. 32, 0253

- Vogt: *ESMN Fellow at OAC*
- Hénoux, Sahal-Bréchet: *OP*
- Objective (b)

Haugan, S. V. H., Brekke, P., Fredvik, T., Kjeldseth-Moe, O., Wilhelm, K., and Gurman, J. B.: 2000, “Observed Variability and Dynamics of Active Region Loops”, in *AAS/Solar Physics Division Meeting*, Vol. 32, 0205+

- Brekke: *ESA*, Fredvik, Kjeldseth-Moe: *UIO*
- Objective (b)

McIntosh, S. W., Bogdan, T. J., Cally, P. S., Carlsson, M., Hansteen, V. H., Judge, P. G., Lites, B. W., Peter, H., Rosenthal, C. S., and Tarbell, T. D.: 2001, “An Observational Manifestation of Magnetoatmospheric Waves in Internetwork Regions of the Chromosphere and Transition Region”, *Astrophysical Journal Letters* **548**, L237–L241

- Rosenthal, Carlsson, Hansteen: *UiO*
- Rosenthal: *ESMN Fellow at UiO*
- Objective (b)
- *Refereed journal*
- *Abstract*: We discuss an observational signature of magnetoatmospheric waves in the chromosphere and transition region away from network magnetic fields. We demonstrate that when the observed quantity, line or continuum emission, is formed under high- β conditions, where β is the ratio of the plasma and magnetic pressures, we see fluctuations in intensity and line-of-sight (LOS) Doppler velocity consistent with the passage of the magnetoatmospheric waves. Conversely, if the observations form under low- β conditions, the intensity fluctuation is suppressed, but we retain the LOS Doppler velocity fluctuations. We speculate that mode conversion in the $\beta \sim 1$ region is responsible for this change in the observational manifestation of the magnetoatmospheric waves.

Nordlund, Å., Dorch, B., and Stein, R.: 2000, “Magnetoconvection and the solar dynamo”, in *Cyclical evolution of solar magnetic fields: Advances in theory and observations*, IAU Colloquium 179 (Eds. P. Venkatakrishnan, O. Engvold and A.R. Choudhuri), Journal of Astrophysics and Astronomy 21, Indian Institute of Astrophysics, Kodaikanal, India, 307–313

- Dorch: *ESMN Fellow*
- Objective (b), (c), (f)

O’Shea, E., Banerjee, D., Doyle, J. G., Fleck, B., and Murtagh, F.: 2001a, “Active Region Oscillations”, *Astronomy and Astrophysics* **368**, 1095–1107

- O’Shea: ESMN Fellow at ESA; Fleck: ESA

- Objective (b)

- Refereed journal, pre-ESMN research

- Abstract: We report here on an investigation of high frequency oscillations in active regions, carried out using high cadence observations of O V 629 Å, Mg IX 368 Å and Fe XVI 325 Å, with the Coronal Diagnostic Spectrometer (cds) on soho. Using the techniques of wavelet analysis on various temporal series datasets, we find that certain oscillation frequencies are favoured for each line. We find furthermore that a ~ 5 min oscillation signature is commonly present in all lines, suggesting a coupling of the photospheric driver with the transition region and coronal loop modes. We report on the tendency for higher frequency oscillations to be present at lower intensity values, suggesting that higher frequency oscillations occur in interloop regions or at loop boundaries, possibly as a result of some resonant absorption process. In addition, we find that the coronal lines of Fe XVI and Mg IX show more significant oscillations in the velocity than in the intensity, which suggests that in the velocity we measure additional non-compressive wave modes not visible in the intensity. As this effect is not seen in the transition region line of O V it would seem that these additional non-compressive modes are produced in and limited to the corona. We suggest that there are two main mechanisms responsible for the observed oscillations; either resonant Alfvén and/or fast kink waves or propagating slow magnetoacoustic waves, both present in coronal loops.

- Acknowledgement: Research at Armagh Observatory is grant-aided by the Dept. of Education for N. Ireland while partial support for software and hardware is provided by the STARLINK project which is funded by the UK PPARC. Information on the wavelet filtering program, MR/1, may be found at www.multiresolution.com. Wavelet software was provided by C. Torrence and G. Compo, and is available at URL: <http://paos.colorado.edu/research/wavelets/>. This work was supported by PPARC grant GR/K43315 plus a short-term fellowship to DB from Armagh Observatory. EOS and BF are members of the European Solar Magnetometry Network (www.astro.su.se/~dorch/esmn/). We would like to thank the CDS team at Goddard Space Flight Center for their help in obtaining the present data. CDS is part of SOHO, the Solar and Heliospheric Observatory, which is a mission of international cooperation between ESA and NASA.

O’Shea, E., Banerjee, D., Doyle, J. G., Fleck, B., and Murtagh, F.: 2001b, “Active Region Oscillations”, in A. Wilson (Ed.), *Helio- and Asteroseismology at the Dawn of the Millenium*, Procs. SOHO 10/GONG 2000 Workshop, ESA SP-464, ESA Publ. Div., ESTEC, Noordwijk, 223–226

- O’Shea: ESMN Fellow at ESA; Fleck: ESA

- Objective (b)

Rosenthal, C. S. and Julien, K. A.: 2000, “Numerical Modeling of the Absorption and Scattering of Acoustic Radiation by Sunspots”, *The Astrophysical Journal* **532**, 1230–1239

- *Rosenthal: ESMN Fellow at UiO*
- *Objective (f2)*
- *Refereed journal*
- *Abstract:* We present numerical calculations of the scattering of acoustic-gravity waves by a model sunspot consisting of an inhomogeneous, vertically magnetized region embedded in a polytropically stratified layer. The calculations show the transformation of incoming f-mode and p-mode power into downward-propagating, slow magnetoacoustic waves resulting in substantial absorption of incident f-modes and first-order p-modes and indicating that the slow-mode transformation model is a viable explanation for the observed absorption. In addition to absorption, we find large scattering phase shifts for the f-modes. Phase shifts are small for all p-modes. Coupling between modes of different radial order is generally small. The remaining differences between our results and the observations may constitute evidence that, if the mode transformation picture is correct, real sunspots must deviate significantly from the simple unidirectional field geometry we use here. In particular, we suggest that a sunspot consisting of a bundle of fibrils, in each of which the magnetic flux density increases rapidly with depth, would reproduce more closely the measured strong absorption and scattering of p-modes.
- *Acknowledgement:* C. S. R. acknowledges support from SOI/MDI NASA grant NAG 5-3077 and from the European Commission Training and Mobility of Researchers Programme through the establishment of the European Solar Magnetometry Network (contract FMRX-CT98-0190 DG12MIHT).

Rutten, R. J., Hammerschlag, R. H., Bettonvil, F. M., and Suetterlin, P.: 2000, “Dutch Open Telescope: Status and Prospects”, in *AAS/Solar Physics Division Meeting*, Vol. 32, 02107

- *Sütterlin: ESMN Fellow at UU*
- *Objective (d)*

Rutten, R. J., Hammerschlag, R. H., Sütterlin, P., Bettonvil, F. C. M., and van der Zalm, E. B. J.: 2001, “Solar magnetometry with the Dutch Open Telescope”, in A. Wilson (Ed.), *The Solar Cycle and Terrestrial Climate*, Procs. 1st Solar & Space Weather Euroconference, ESA Special Publication SP-463, Estec, Noordwijk, 611–616

- *Sütterlin: ESMN Fellow at UU*
- *Objective (d)*
- *Acknowledgement:* The DOT project is funded by Utrecht University, the Netherlands Graduate School for Astronomy NOVA and the Netherlands Organization for Scientific Research NWO. The DOT team enjoys hospitality at the Swedish solar telescope building in close cooperation within the European Solar Magnetometry Network funded by the EC under TMR contract ERBFMRXCT98019. The DOT was built by the workshops of the Sterrekundig Instituut Utrecht and the Faculty of Physics and Astronomy of Utrecht University and the Central Workshop of Delft University. The new DOT data acquisition system is built by the Instrumentele Groep Fysica at Utrecht.

Sütterlin, P. and Wiehr, E.: 2000, “Applying speckle masking to spectra”, *Solar Physics* **194**, 35–42

- *Sütterlin: ESMN Fellow at SIU*

- Objective (d)
- Refereed journal, pre-ESMN research

Schmidt, W., Muglach, K., and Knölker, M.: 2000, “Free-fall Downflow Observed in He I 1083.0 nm and H β ”, *Astrophysical Journal* **544**, 567–571

- Muglach: ESMN Fellow at AIP
- Objective (b)
- Refereed journal
- Abstract: In a short time-sequence of simultaneously observed slit spectra of He I 1083.0 nm and H beta we find the signature of material flowing toward the solar surface with up to 42 km/s, in addition to material which is almost at rest. The constant acceleration of the moving material is about 200 m/s. These multiple velocities occur in a small region of about 5 arcs in a plage region. We observe a highly dynamical phenomenon which lasts a few minutes. The duration and constant acceleration suggest free fall of matter unobstructed by magnetic structures or along vertical field lines.

Schmieder, B., Deng, Y., Mandrini, C. H., Rudawy, P., Nitta, N., Mason, H., Fletcher, L., Martens, P., and Brynildsen, N.: 2000, “Dynamics in Restructuring Active Regions Observed During Soho/Yohkoh/Gbo Campaigns”, *Advances in Space Research* **25**, 1879–1882

- Schmieder: OP, Brynildsen: UIO
- Refereed journal
- Objectives (a), (b)

Tziotziou, K., Heinzl, P., Mein, P., and Mein, N.: 2000, “Study of chromospheric CaII cloud-like features”, in *The Solar Cycle and Terrestrial Climate*, Procs. of 1st Solar & Space Weather Euroconference, ESA SP-463, ESA Publ. Div., ESTEC, Noordwijk, 443–446

- Tziotziou: ESMN Fellow at OP
- Objective (f)

Tziotziou, K., Heinzl, P., Mein, P., and Mein, N.: 2001, “Non-LTE inversion of chromospheric CaII cloud-like features”, *Astronomy and Astrophysics* **366**, 686–698

- Tziotziou: ESMN Fellow at OP
- Objectives (a),(f)
- Refereed journal
- Abstract: A chromospheric cloud like feature observed in the 8542 Å CaII line is studied by a two step inversion procedure which provides estimates of its temperature, electronic density, microturbulence, geometrical thickness and bulk velocity. The first step involves the computation of a large grid of models by a multi-level non-LTE transfer code which gives the CaII line depth-dependent mean intensity inside an isolated, isothermal cloud lying above the chromosphere. The second step involves the inversion of the observed profiles with the grid of computed synthetic CaII profiles. A searching and matching χ^2 algorithm is implemented followed by an interpolation algorithm which permits a more accurate determination of the parameters on which the profiles depend. The five grid parameters are reduced to four by defining the emission measure from the geometrical thickness and electronic density. We show that this

inversion procedure gives accurate results for some of our inversion parameters when dealing with solar filaments and is complementary to a previous study of the same object in the $H\alpha$ line. The main advantages, problems and future extension of the inversion approach are also discussed.

• *Acknowledgement:* MSDP observations were obtained in the framework of the International Observing Time offered by the CCI of the Canarian Observatories and supported by the European Commission through the Access to Large-Scale Facility “Activity of the Human Capital and Mobility Program”. The Vakuu-Turm-Teleskop (VTT) is operated on the island of Tenerife by the Kiepenheuer-Institut für Sonnenphysik at the Spanish Observatorio del Teide of the Instituto de Astrofísica de Canarias. PH was supported by the CNRS and by the project K1-003-601 of the Academy of Sciences of the Czech Republic. This research is part of the European Solar Magnetometry Network supported by the EC through the TMR programme. The authors are grateful to the referee, Dr. J.Bruls for his comments and suggestions.