European
Solar Magnetometry
Network

TMR Network Contract No ERBFMRXCT980190

Annual Progress Report

May 1 1998 — April 30 1999

Summary

The *European Solar Magnetometry Network* (henceforth ESMN or "the network") geared up in the first year of its existence by filling most of its slots for young researchers, setting up multi-telescope campaigns, meetings, the first ESMN summer school, a website and various collaborations as proposed. A major scare during this start-up year was the temporary loss of the SOHO mission — but fortunately, SOHO is back alive and well.

Highlights

The extraordinary SOHO retrieval represents a major highlight — since otherwise SOHO's loss would have been an appreciable blow to the ESMN as well as to all solar and heliospheric physics. On June 24 SOHO ground controllers lost contact with the spacecraft. On July 23 it was located through radar techniques using the giant NAIC antenna in Arecibo, Puerto Rico, at its expected position in space but with its solar panels spinning away from the sun. A lengthy and very sophisticated procedure, including fuel thawing and battery charging, led to complete revival of the spacecraft. Some of the instruments had been baked at almost +100 C while others were subjected to deep freeze below –120 C; nevertheless, they all came back alive. Then another mishap occurred on December 21, this time in gyro control, which necessitated the design and implementation of a gyroless mode of operation. This was accomplished in forty days, in a race against fuel consumption from thruster firings. Gyroless station keeping started on February 1, with nominal North-up attitude since March 8. The happy upshot is that SOHO is expected to operate throughout the ESMN contract period and the solar activity maximum, so that the ESMN Programme items requiring new observations with SOHO remain on the list.

At the Canary Island observatories, much progress was made in instrumentation. THEMIS (the new major French-Italian solar telescope) got a new primary mirror, the DOT (Dutch Open Telescope) obtained funding for the whole ESMN period (with the ESMN contract a decisive boundary condition), the IAC group at La Laguna installed liquid-crystal polarimeters at both island sites, the AIP group yet another one at Tenerife, the KVA group (Stockholm) succesfully proposed a major upgrade of the Swedish telescope (La Palma)

and developed pioneering adaptive optics technology. Joint ground-space observing campaigns were run, one before SOHO was lost; more are coming.

At the ESMN home institutes, the young researchers funded by the contract are settling in their groups and will come to the first ESMN summer school, starting June 1.

Accomplished research

All of the ESMN objectives were addressed; most activities kept close to the projected schedule defined in section B.3 of the Project Programme. There are no difficulties in the execution of the contract so far. A brief review:

- Science objectives: (magnetic structure topology, magnetic structure dynamics, dynamo patterning): research at each partner with increasing cooperation between partners. The joint papers published during this initial ESMN year listed below result from pre-ESMN research; ongoing research covers all three topics at most partners.
- THEMIS optimisation: new primary mirror installed, much progress in telescope alignment and in adjustment of the 2D MSDP spectrograph, development of polarization measurements, adaptation of inversion codes to THEMIS data formats.
- DOT optimisation: successful negotiation by partner UU for three-year funding from various Dutch agencies to install and operate DOT instrumentation for the ESMN programme (total amount 1.4 Meuro). Optics design in cooperation with partner KVA; installation of remote pointing control from the SVST building (owned by KVA).
- Magnetometry calibration: development of Stokes profile inversion codes well underway (OP and IAC). AIP has started a new project on this topic applying neural network techniques.
- Liquid-crystal magnetometry: two new Stokes spectropolarimeters built by IAC assembled and mounted at the VTT (Tenerife) and SVST (La Palma), respectively. Another new liquid-crystal polarimeter was installed at the GCT (Tenerife, AIP).
- MOF magnetometry: change-over from sodium to potassium resonance cells accomplished; initial calibrations started (OAC, for application at UU's DOT).
- G-band magnetometry: interpretative project started by KVA and UU to calibrate this important diagnostic of photospheric fluxtubes. Continuing high-resolution observations at SVST, also during joint campaigns (KVA and others). G-band optics succesfully tested at DOT (UU).
- IPM magnetometry: not yet started awaiting THEMIS optimisation.
- Image restoration: elaborate adaptive optics programme started at the SVST showing large promise for real-time correction of atmospheric wavefront aberrations (KVA). This programme is a technology demonstration for application at the NSST (New Swedish Solar Telescope), a major upgrade of the SVST doubling its aperture, for which funding has been secured. Speckle restoration based on methodology developed at the SVST is being considered for the DOT (UU).

- On-line imagery: largely realized at various websites collected in browsers[1] [2] which include daily images from OP and in the ARTHEMIS archive (OAC).
- Data archiving: partially realized, through the ARTHEMIS archive[3] (OAC) and the BASS2000 archive[4] (OP), to be combined into the Whole Sun Catalog meta-catalog[5] (ESA).
- Data reduction: extensive development of calibration and inversion codes for THEMIS polarimetry, liquid-crystal magnetometry and standard Stokes polarimetry (IAC, OP, AIP).
- Boundary conditions: AIP has worked out a SOHO Joint Observing Campaign combining AIP, UU, KVA, IAC observing at the Canary Island telescopes with the SOHO (ESA/NASA) and TRACE (NASA/LMSAL) missions. Formulation of the microstructured magnetic atmosphere concept posing important constraints of solar polarimetry (IAC). UiO has largely reduced SOHO data sets that will permit numerical emulation of upward wave propagation.
- Comparisons with modelling: efforts started, in particular at UiO concerning detailed numerical simulation of the above SOHO observations as well as starting a magnetohydrodynamic simulation code.
- Training programme: started by introducing the ESMN appointees to the local expertise and familiarizing them with the ESMN research programme. The upcoming ESMN school brings them together at Oslo (UiO), a good occasion to set up collaborations and exchanges.
- Public outreach: numerous popular lectures held, popular science articles written, sunspot posters resulting from the JOP72 campaign mailed to many public observatories and planetaria.

Principal networking activities

- Start of the ESMN website[6].
- Multi-telescope campaigns:
  - chromospheric dynamics, May 1998, combining SOHO and SVST, partners ESA, KVA, UU (SOHO Joint Observing Program 72);
  - filaments and arch filament systems, September 1998, combining TRACE, YOHKOH (US and Japanese satellites) with VTT, GCT, THEMIS and SVST
  - scheduling of campaigns in May and September 1999.
- ESMN meetings: Potsdam, October 1998, all partners.

[1] `http://sohowww.nascom.nasa.gov/cgi-bin/synop_image/`
[2] `http://umbra.nascom.nasa.gov/images/latest.html`
[3] `http://arthemis.na.astro.it/`
[4] `http://mesola.obspm.fr/`
[5] `http://wholesun.nascom.nasa.gov/WSC/`
[6] `http://www.astro.uu.nl/~rutten/tmr/`

– ESMN schools: organisation of the first school[7] on "Radiative Transfer and Radiation Hydrodynamics" at Oslo, June 1–11 1999. It is booked to capacity (35 young researchers).

Appointments of young researchers

The major ESMN accomplishment of the past year is the successful staffing of all three-year ESMN slots with highly qualified young researchers. The ESMN purposely elected four year duration while funded for three in order to permit careful and selective candidate screening, after advertising the posts widely through newsletters and websites as well as leaflets and posters mailed to many institutes.

Many inquiries were received, leading to over 30 formal applications from qualifying researchers of which the ESMN picked the best. Partners UiO, IAC, KVA, AIP and OAC (one of two 2-year slots) did so during the report year, UU per May 1, OP per June 1. The ESMN is very happy with the high standard of its young researchers. There are three years to go for the remaining two-year slots, enabling similarly cautious recruiting.

The young researchers are integrated into the ESMN by participating in the ESMN schools, in the multi-telescope campaigns, and in ESMN meetings. Their first network-wide get-together is at the Oslo school in June.

Interactions with industry

KVA continued its intensive cooperation with Compaq Europe's designer (M. Shand of Digital System Research Center) of fast PCI architecture interfaces ("Pamette") that permit fast throughput of multi-megabyte images in Alpha workstations[8]. Both KVA and UU continued their intensive collaboration with Lockheed-Martin including joint observing at the SVST and young-researcher exchange. Other technology interactions (on liquid crystal, CCD, fiber technology) are being pursued.

[7] `http://www.astro.uio.no/school-99/`

[8] `http://www.research.digital.com/SRC/pamette/`

Joint Publications

Andretta, V., Jordan, S. D., Muglach, K., Garcia, A., Jones, H. P., Penn, M. J., and Soltau, D.: 1999, "The Helium Spectrum in the Quiet Sun: The January 16/17 and May 7–13, 1997 Coordinated SOHO/Ground-based Observational Campaigns", in C. E. Alissandrakis and B. Schmieder (Eds.), *Second Advances in Solar Physics Euroconference: Three-Dimensional Structure of Solar Active Regions*, Astron. Soc. Pac. Conf. Ser. 155, 336,
Andretta = OAC, Muglach = AIP

Andretta, V., Jordan, S. D., Muglach, K., Garcia, A., Jones, H. P., and Soltau, D.: 1998, "Investigating the Formation of the Helium Spectrum in the Solar Atmosphere", in R. A. Donahue and J. A. Bookbinder (Eds.), *Workshop on Cool Stars, Stellar Systems and the Sun*, Astron. Soc. Pac. Conf. Ser. 154, 559–667,
Andretta = OAC, Muglach = AIP

Balthasar, H., Martínez Pillet, V., Schleicher, H., and Wöhl, H.: 1998, "Velocity Oscillations in Active Sunspot Groups", *Solar Phys.* **182**, 65–72,
Refereed journal; Balthasar = AIP, Martínez Pillet = IAC; copy added

Foing, B. H., Muglach, K., Wiik, J.-E., Beaufort, T., Orlando, S., Duvet, L., and Desteve, C.: 1998, "Polar Plumes and Streamers from 1994 and 1998 Eclipses", in *Solar Jets and Coronal Plumes*, ESA SP-421,
Foing = ESA, Muglach = AIP, Wiik = UiO

Li, K. J., Schmieder, B., Malherbe, J.-M., Roudier, T., and Wiik, J.-E.: 1998, "Physical properties of the quiescent prominence of 5 June 1996, from Halpha observations", *Solar Phys.* **183**, 323–338,
Refereed journal; Schmieder, Malherbe = OP, Wiik = UiO; copy added

Martens, P. C. H. and Muglach, K.: 1999, "Scientific Highlights from the Solar & Heliospheric Observatory", in K. N. Nagendra and J. O. Stenflo (Eds.), *Proceedings of the 2nd Solar Polarization Workshop*, Kluwer Academic Publishers, Dordrecht, 325,
Martens = ESA, Muglach = AIP

Mein, P., Schmieder, B., Malherbe, J.-M., Wiik, J. E., Engvold, O., Brekke, P., Zirker, J. B., Poland, A. I., Delaboudiniere, J. P., and Staiger, J.: 1998, "Velocity Fields of a Filament Region Observed with Ground-Based Telescopes and from SOHO", in *New Perspectives on Solar Prominences*, IAU Symp. 167, Astron. Soc. Pac. Conf. Ser. 150, 135,
Mein, Schmieder, Malherbe, Delaboudiniere = OP, Wiik, Engvold, Brekke = UiO

Muglach, B. F. K., Beaufort, T., Orlando, S., Martens, P., and Desteve, C.: 1998, "Coordinated Eclipse and SOHO Observations on 26 February 1998", in *A Cross-Roads for European Solar and Heliospheric Physics*, ESA SP-417, 337,
Martens = ESA, Muglach = AIP

Muglach, K. and Sütterlin, P.: 1998, "Simultaneous Observations with the GCT and SoHO: High Velocity Events in the Upper Chromosphere", in C. E. Alissandrakis and B. Schmieder (Eds.), *Second Advances in Solar Physics Euroconference: Three-Dimensional Structure of Solar Active Regions*, Astron. Soc. Pac. Conf. Ser. 155, 341,

Muglach = AIP, Sütterlin = UU

Muglach, K. and Sütterlin, P.: 1999, "Simultaneous Observations with the GCT and SOHO: High Velocity Events in the Upper Chromosphere", in *Three Dimensional Structure of Solar Active Regions*, Astron. Soc. Pac. Conf. Ser. 155, 341,
Muglach = AIP, Sütterlin = UU

Straus, T., Deubner, F.-L., Fleck, B., Marmolino, C., Severino, G., and Tarbell, T.: 1998a, "Phase spectra seen from space", in F.-L. Deubner, J. Christensen-Dalsgaard, and D. Kurtz (Eds.), *New Eyes to See inside the Sun and Stars*, IAU Symp. 185, Kluwer, Dordrecht, 455,
Straus, Severino = OAC, Fleck = ESA

Straus, T., Fleck, B., Severino, G., Deubner, F., Marmolino, C., and Tarbell, T.: 1998b, "k-ω Phase Spectra Obtained from Space", in *A Crossroads for European Solar and Heliospheric Physics*, ESA SP-417, 293,
Straus, Severino = OAC, Fleck = ESA

ESMN Team Constitutions

UU (Utrecht)

Name	Position	Funding	Comment
Felix Bettonvil	Scientist/Engineer	UU	
Robert Hammerschlag	Scientist/Engineer	UU	
Max Kuperus	Professor	UU	
Thijs Krijger	Graduate Student	NWO	from Sep 1 1998
Robert Rutten	Senior Scientist	UU	
Jan Kuijpers	Senior Scientist	UU/KUN	0.8 UU, 0.2 KUN
Cornelis Zwaan	Emeritus Professor	(UU)	retired but active

NWO = The Netherlands Organization for Scientific Research
KUN = Catholic University Nijmegen

IAC (La Laguna)

Name	Position	Funding	Comment
Javier Trujillo Bueno	Cientifico Titular	CSI	
Manolo Collados Vera	Profesor Titular	ULL	
Jorge Sanchez Almeida	Research Scientist	IAC	
Valentin Martinez Pillet	Research Scientist	IAC	
Olaf Dittmann	Post Doc	ESMN	from Mar 15 1998

CSI = Consejo Superior de Investigaciones
ULL = University of La Laguna

OAC (Naples)

Name	Position	Funding	Comment
Giuseppe Severino	Associate Astronomer	OAC	
Maurizio Oliviero	Post Doc	OAC	Apr 1998 – Apr 1999
Etienne Vogt	Post Doc	ESMN	from Jan 11 1999
Thomas Straus	Post Doc	OAC	Dec 1995 – Jan 1999
Kevin Reardon	Graduate Researcher	OAC	

UiO (Oslo)

Name	Position	Funding	Comment
C. Rosenthal	Post Doc	ESMN	from Dec 12 1998
M. Carlsson	Professor	UiO	
O. Engvold	Professor	UiO	
R. Skartlien	Post Doc	NRC	until Sep 1998
V. Hansteen	Professor	UiO	
P. Maltby	Professor	UiO	

NRC = Norwegian Research Council

KVA (Stockholm)

Name	Position	Funding	Comment
Henrik Blomberg	MSc student	SU + KTH	to March 1 1999
Bertil Dorch	Post Doc	ESMN	from Jan 1 1999
Dan Kiselman	Research Associate	KVA	
Mats Löfdahl	Research Associate	KVA	75%
Luc Rouppe van der Voort	PhD student	KVA	
Göran Scharmer	Professor	KVA	
Wang Wei	Science Engineer	KVA	

SU = Stockholm University
KTH = Royal Swedish Technical University

AIP (Potsdam)

Name	Position	Funding	Comment
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Axel Hofmann	Scientist	AIP	
Karin Muglach	Post Doc	ESMN	
Axel Settele	PhD student	DFG	
Jürgen Staude	Professor	AIP	

DFG = Deutsche Forschungsgemeinschaft

OP (Paris)

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Pascal Demoulin	Astronome Adjoint	MEN	
Nicole Mein	Maitre de Conferences	MEN	
Meir Semel	Directeur de Recherche	CNRS	
Veronique Bommier	Chargé de Recherches	CNRS	

MEN = Ministere de l'Education Nationale
CNRS = Centre National de la Recherche Scientifique

ESA (Noordwijk)

Name	Position	Funding	Comment
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Paal Brekke	Staff member	ESA	
Bernard Foing	Staff member	ESA	
Stein Haugan	Staff member	ESA	
Luis Sanchez	Staff member	ESA	