Solar Surface Magnetism

NATO ASI Series

Advanced Science Institutes Series

A Series presenting the results of activities sponsored by the NATO Science Committ which aims at the dissemination of advanced scientific and technological knowledge, with a view to strengthening links between scientific communities.

The Series is published by an international board of publishers in conjunction with the NATO Scientific Affairs Division

A Life Sciences **B Physics**	Plenum Publishing Corporation London and New York
C Mathematical and Physical Sciences **D Behavioural and Social Sciences** **E Applied Sciences**	Kluwer Academic Publishers Dordrecht, Boston and London
F Computer and Systems Sciences **G Ecological Sciences** **H Cell Biology** **I Global Environmental Change**	Springer-Verlag Berlin, Heidelberg, New York, London, Paris and Tokyo

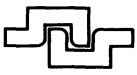
NATO-PCO-DATA BASE

The electronic index to the NATO ASI Series provides full bibliographical references (with keywords and/or abstracts) to more than 30000 contributions from international scientists published in all sections of the NATO ASI Series.
Access to the NATO-PCO-DATA BASE is possible in two ways:

– via online FILE 128 (NATO-PCO-DATA BASE) hosted by ESRIN, Via Galileo Galilei, I-00044 Frascati, Italy.

– via CD-ROM "NATO-PCO-DATA BASE" with user-friendly retrieval software in English, French and German (© WTV GmbH and DATAWARE Technologies Inc. 1989).

The CD-ROM can be ordered through any member of the Board of Publishers or through NATO-PCO, Overijse, Belgium.



Series C: Mathematical and Physical Sciences - Vol. 433

Solar Surface Magnetism

edited by

Robert J. Rutten

and

Carolus J. Schrijver

Sterrekundig Instituut,
Utrecht, The Netherlands

Springer-Science+Business Media, B.V.

Proceedings of the NATO Advanced Research Workshop on
Solar Surface Magnetism
Soesterberg, The Netherlands
November 1–5, 1993

A C.I.P. Catalogue record for this book is available from the Library of Congress.

ISBN 978-94-010-4519-3 ISBN 978-94-011-1188-1 (eBook)
DOI 10.1007/978-94-011-1188-1

Printed on acid-free paper

TABLE OF CONTENTS

IV. Magnetic patterns

V. Theory of magnetoconvection

VI. Prospects

LIST OF PARTICIPANTS

Australia	
C.J. Durrant	Dept. of Applied Mathematics, University of Sydney
Canada	
V. Gaizauskas	Herzberg Institute of Astrophysics, Ottawa
Denmark	
Å. Nordlund	University Observatory, Copenhagen
France	
P. Mein	Observatoire de Paris, Meudon
R. Muller	Observatoire du Pic du Midi, Bagnères de Bigorre
B. Schmieder	Observatoire de Paris, Meudon
M. Semel	Observatoire de Paris, Meudon
Germany	
P. Caligari	Kiepenheuer-Institut für Sonnenphysik, Freiburg
F.-L. Deubner	Inst. für Astronomie und Astrophysik, Würzburg
A. Hofmann	Sonnenobservatorium Einsteinturm, Potsdam
W. Schmidt	Kiepenheuer-Institut für Sonnenphysik, Freiburg
M. Schüssler	Kiepenheuer-Institut für Sonnenphysik, Freiburg
H.C. Spruit	MPI für Physik und Astrophysik, Garching
J. Staude	Sonnenobservatorium Einsteinturm, Potsdam
Hungary	
K. Petrovay	Dept. Astronomy, Eötvös Loránd University, Budapest
Italy	
R. Falciani	Astronomy Department, University of Florence
E. Landi degl' Innocenti	Astronomy Department, University of Florence
G. Severino	Osservatorio Astronomico di Capodimonte, Napoli
The Netherlands	
B. Fleck	Space Science Department, ESTEC, Noordwijk
N.M. Hoekzema	Sterrekundig Instituut, Utrecht University
P. Hoyng	SRON Space Research Laboratory, Utrecht
P.C. Martens	Space Science Department, ESTEC, Noordwijk
R.J. Rutten	Sterrekundig Instituut, Utrecht University
C.J. Schrijver	Sterrekundig Instituut, Utrecht University
L.H. Strous	Sterrekundig Instituut, Utrecht University

C. Zwaan	Sterrekundig Instituut, Utrecht University
Norway	
P.E. Maltby	Inst. of Theoretical Astrophysics, University of Oslo
Spain	
F. Moreno Insertis	Instituto de Astrofisica de Canarias, La Laguna
J. Sanchez Almeida	Instituto de Astrofisica de Canarias, La Laguna
Switzerland	
C.U. Keller	Institut für Astronomie, ETH Zürich
S.K. Solanki	Institut für Astronomie, ETH Zürich
J.O. Stenflo	Institut für Astronomie, ETH Zürich
Ukraine	
E.A. Gurtovenko (deceased January 20, 1994)	Main Astronomical Observatory, Kiev
United Kingdom	
N.O. Weiss	Dept. Applied Math. Theor. Physics, Cambridge
USA	
A.A. van Ballegooijen	Center for Astrophysics, Cambridge MA
J.M. Beckers	National Solar Observatory, Tucson AZ
J.W. Harvey	National Solar Observatory, Tucson AZ
K.L. Harvey	Solar Physics Research Corp., Tucson AZ
R.F. Howard	National Solar Observatory, Tucson AZ
J.K. Lawrence	Dept. Physics & Astronomy, CSU, Northridge CA
S.F. Martin	Solar Astronomy, Caltech, Pasadena CA
E.N. Parker	Laboratory for Astrophysics, University of Chigaco IL
D. Rabin	National Solar Observatory, Tucson AZ
N.R. Sheeley	Naval Research Laboratory, Washington DC
R.A. Shine	Lockheed Palo Alto Research Labs., Palo Alto CA
G.W. Simon	Phillips Lab., National Solar Observatory, Sunspot NM
A. Skumanich	High Altitude Observatory, NCAR, Boulder CO
J.H. Thomas	Dept. Physics and Astronomy, University of Rochester,
A.M. Title	Lockheed Palo Alto Research Labs., Palo Alto CA
H. Uitenbroek	Center for Astrophysics, Cambridge MA

Electronic mail addresses for these and for hundreds of other solar physicists are furnished by the Stanford SolarMail forwarding service. Information is obtained by sending an empty message to solarmail@stanford.solar.edu. An address list is obtained by sending an empty message to maildir@solar.stanford.edu.

Preface

Observations of the solar magnetic field are largely confined to the radiation emitted from the photosphere, the thin layer of the solar atmosphere which we call "the solar surface". It is from solar surface observations that we must infer the internal structure and the internal magnetohydrodynamic processes that lead to the multitude of fascinating phenomena of solar magnetic activity, and from solar surface observations we must also infer the interplay of convection and magnetism that regulates field dispersal, drives the heating of the outer-atmospheric plasma, and generates the solar wind.

There is much to be learned from solar surface magnetism in physics and astrophysics; currently, there are rapid developments in this exciting field. The workshop of which this volume contains the proceedings aimed at a synthesis between observers and theorists, both with regard to the discrete elements that are the building blocks of solar magnetism and with regard to the larger-scale spatial and temporal patterns in which the magnetic elements emerge and disappear.

The workshop was held during November 1–5, 1993 in Soesterberg, The Netherlands. The fifty participants took a very active part in making the workshop quite a lively one. The articles in these proceedings cover most of the oral and poster presentations, excepting a dozen soon to be published elsewhere.

The organisation of this workshop and the editing of this volume has been a pleasure, thanks to wholehearted cooperation of many colleagues. Specifically, we thank our mentor in solar astrophysics, C. Zwaan, whose retirement shortly before the workshop, while an incentive to us, has fortunately not kept him from active research. J.W. Harvey and N.O. Weiss were valued members of the scientific organising committee. N.M.H. Hoekzema, L.H. Strous, E.B.J. van der Zalm and particularly Mrs. M. Wijburg have helped with the local organization, while Mrs. B. Gaizauskas, F.-L. Deubner, P. Mein, C. de Jager, M. Kuperus, R.H. Hammerschlag, C. Zwaan and (last but not least) Mrs. P.H.D. Zwaan-van Diggelen have provided entertainment of various sorts.

Finally, we are very grateful to NATO for funding this workshop. Its success demonstrates that NATO's decision to terminate the general ARW programme, making this workshop its swansong in solar physics, is to be deplored indeed.

Robert J. Rutten and Carolus J. Schrijver
Sterrekundig Instituut Utrecht, February 1994