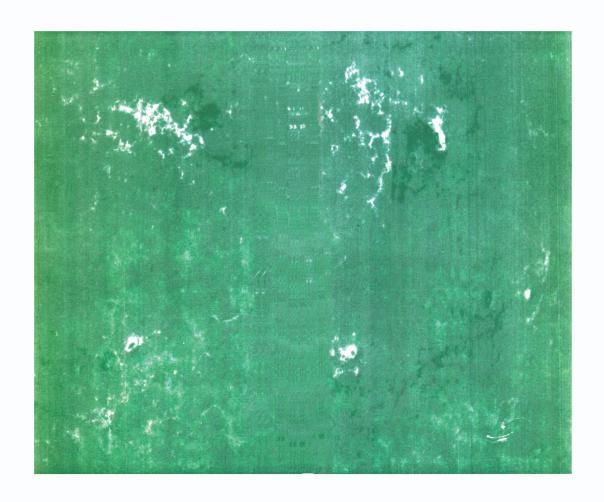
SYMPOSIUM No. 43

SOLAR MAGNETIC FIELDS

Edited by ROBERT HOWARD





INTERNATIONAL ASTRONOMICAL UNION

D. REIDEL PUBLISHING COMPANY/DORDRECHT-HOLLAND

SOLAR MAGNETIC FIELDS

SYMPOSIUM No. 43

This volume contains the proceedings of IAU Symposium No. 43 and presents the state of our knowledge of the morphology and the physics of magnetic fields in the solar atmosphere. Among the topics discussed are: problems and interpretation concerning measurement; structure and evolution of small-scale magnetic fields; the relation to transient phenomena in solar active regions; large-scale manifestations of solar activity; and the relationship of the large-scale magnetic fields to the 11-year activity cycle.

The discussion extends from subsurface layers through the photosphere, chromosphere, and the corona to interplanetary space; both radio and optical measurements of magnetic fields are presented and analyzed.

Participants in the symposium represent universities and solar observatories throughout the world.

D. REIDEL PUBLISHING COMPANY DORDRECHT-HOLLAND

SOLAR MAGNETIC FIELDS

INTERNATIONAL ASTRONOMICAL UNION UNION ASTRONOMIQUE INTERNATIONALE

SYMPOSIUM No. 43

HELD AT THE COLLÈGE DE FRANCE, PARIS, FRANCE AUGUST 31 TO SEPTEMBER 4,1970

SOLAR MAGNETIC FIELDS

EDITED BY

ROBERT HOWARD

Hale Observatories, Carnegie Institution of Washington, California Institute of Technology, Pasadena, Calif., U.S.A.



D. REIDEL PUBLISHING COMPANY DORDRECHT-HOLLAND 1971

Published on behalf of the International Astronomical Union by D. Reidel Publishing Company, Dordrecht, Holland

All Rights Reserved

Copyright © 1971 by the International Astronomical Union

Library of Congress Catalog Card Number 78-159656 ISBN 90 277 0201 2

No part of this book may be reproduced in any form, by print, photoprint, microfilm, or any other means, without written permission from the publisher

Printed in The Netherlands by D. Reidel, Dordrecht

TABLE OF CONTENTS

PR	EFACE AND INTRODUCTION	v
LIS	ST OF PARTICIPANTS	XIII
	PART I/INSTRUMENTATION - MEASUREMENT OF MAGNETIC FIELDS IN THE SOLAR ATMOSPHERE	
	J. M. BECKERS / The Measurement of Solar Magnetic Fields J. V. RAMSAY, R. G. GIOVANELLI, and H. R. GILLETT / The Culgoora	3
	Magnetograph	24
3.	F. Q. ORRALL / A Complete Stokes Vector Polarimeter	30
	M. SEMEL / Measurements of Magnetic Fields	37
5.	T. J. JANSSENS and N. K. BAKER / Digital Videomagnetograms in Real	
	Time	44
	W. LIVINGSTON and J. HARVEY / The Kitt Peak Magnetograph. IV: 40-Channel Probe and the Detection of Weak Photospheric Fields	51
7.	T. D. FAY and A. A. WYLLER / A Pressure Scanning Fabry-Pérot	
	Magnetometer	62
	R. B. DUNN / Sacramento Peak Magnetograph	65
	V. A. KOTOV / Systematic Errors of the Crimean Vector Magnetograph (presented by A. Severny)	71
10.	R. C. SMITHSON and R. B. LEIGHTON / Analog Video Magnetograms in Real Time	76
	G. E. BRUECKNER / A New Completely Digitized Filter Magnetograph E. WIEHR / Difficulties in the Simultaneous Measurement of all Stokes	84
	Parameters	89
13.	N. A. ESEPKINA, V. Y. PETRUNKIN, N. S. SOBOLEVA, G. M. TIMOFEEVA, and A. V. REINER / Reduction of the Parasitical Signal of Circular Polarization on an Antenna of Variable Profile	
	with the Help of a Grating	91
14.	A. CACCIANI, M. CIMINO, and M. FOFI / A Short Report on the Magnetic	
	Beam Absorption Filter Research at the Rome Astronomical Observatory	94
	PART II / THE INTERPRETATION OF MAGNETOGRAPH RESULTS - THE FORMATION OF ABSORPTION LINES IN A MAGNETIC FIELD	
15.	J. O. STENFLO / The Interpretation of Magnetograph Results: The Formation of Absorption Lines in a Magnetic Field	101

16.	L. L. HOUSE / Coherence Properties of Polarized Radiation in Weak	
	Magnetic Fields	130
	P. MALTBY / Paschen-Back Effect of the Lithium Resonance Doublet in Sunspots	141
18.	V. M. GRIGORYEV and J. M. KATZ / The Crossover and Magneto-Optical	
	Effects in Sunspot Spectra	148
	F. K. LAMB / The Effect of Collisions on Spectral Line Formation in Solar Magnetic Regions	149
20.	R. GÖHRING / Line Formation in Inhomogeneous Magnetic Fields (presented by W. Mattig)	162
	PART III / OBSERVATIONS OF SUNSPOT AND ACTIVE REGION MAGNETIC FIELDS	
21.	E. H. SCHRÖTER / On Magnetic Fields in Sunspots and Active Regions	167
22.	J. RAYROLE / Magnetic Field and Turbulence in Sunspots	181
23.	FL. DEUBNER and R. GÖHRING / Photoelectric Measurements of Sunspot	
	Magnetic Fields	190
24.	E. TANDBERG-HANSSEN / Observations of Magnetic Fields in	
	Quiescent Prominences	192
25.	V. BUMBA and J. SUDA / Some Remarks on the Statics and Dynamics of	
	Magnetic Field Structure Development in Active Regions	201
26.	V. A. KOTOV / On the Structure of Magnetic Field and Electric Currents	
	of a Unipolar Sunspot (presented by A. Severny)	212
27.	C. ZWAAN and J. BUURMAN / Magnetic Field Strengths Derived from	
	Various Lines in the Umbral Spectrum	220
28.	T. T. TSAP / The Magnetic Fields at Different Levels in the Active Regions	
	of the Solar Atmosphere (presented by N. V. Steshenko)	223
29.	H. I. ABDUSSAMATOV / Observations of the Two-Level Structure of	
	Sunspot Magnetic Fields (presented by N. S. Soboleva)	231
	E. WIEHR / On the Circular Polarization in Active Regions	235
31.	H. ZIRIN / Application of the Chromospheric Magnetograph to Active	
	Regions (presented by P. Foukal)	237
32.	D. L. SCHATZ / Evolution of the Magnetic Field Configuration in an	
	Active Region	243
33.	F. RODDIER / Line Profiles in Sunspot Umbrae and Penumbrae by	
	Atomic Beam Spectroscopy	249
34.	V. M. GRIGORYEV and G. V. KUKLIN / On the Fine Structure of the	
	Magnetic Field in the Undisturbed Photosphere	252
	E. N. FRAZIER / Supergranulation at the Center of the Disk	260
36.	C. J. DURRANT / Magnetographic and Spectrographic Observations of	
	Weakly Active Regions	268
37.	S. I. GOPASYUK and T. T. TSAP / The Magnetic and Velocity Fields and	

	TABLE OF CONTENTS	IX
38.	Brightness in the Solar Atmosphere (presented by N. V. Steshenko) J. HARVEY and D. HALL / Magnetic Fields Measured with the 10830 Å	274
	He I Line	279
	s. MUSMAN / Observations and Interpretation of Supergranule Velocity and Magnetic Fields	289
	R. G. GIOVANELLI and J. V. RAMSAY / Vertical Velocities Associated with Plage Region Magnetic Fields	293
	A. M. TITLE and J. P. ANDELIN, JR. / Spectra-Spectroheliograph Observations	298
42.	N. R. SHEELEY, JR. / The Time Dependence of Magnetic, Velocity, and Intensity Fields in the Solar Atmosphere	310
43.	C. SAWYER / On the Reality of Magnetic Fine Structure	316
44.	s. F. SMITH / Ha Structures and Small-Scale Magnetic Field Configurations D. VRABEC / Magnetic Field Spectroheliograms from The San Fernando	323
	Observatory	329
46.	A. SEVERNY / On the Time Fluctuations of Magnetic Fields	340
47.	A. S. TANENBAUM, J. M. WILCOX, and R. HOWARD / Five-Minute	240
10	Oscillations in the Solar Magnetic Field	348
40.	N. V. STESHENKO / The Fine Structure of Magnetic Fields and Velocities	
40	in Sunspots. (No text nor summary was communicated by the author.)	
49.	Y. D. ŽHUGŽDA / The Oscillatory Convection in Penumbrae. (No text nor	
	summary was communicated by the author.)	
	PART IV / OBSERVATIONS OF MAGNETIC FIELDS	
	ASSOCIATED WITH FLARES AND OTHER TRANSITORY PHENOMENA	
50.	R. MICHARD / Solar Magnetic Fields in Association with Flares	359
51.	G. DAIGNE / On Coronal Instability and Moving Radio Features	
	Associated with a Flare Spray	367
52.	E. B. MAYFIELD / Magnetic Fields Associated with Solar Flares	376
53.	T. TAKAKURA / Sunspot Magnetic Fields and High Energy Electrons	
	in Flares	390
54.	A. S. KRIEGER, G. S. VAIANA, and L. P. VAN SPEYBROECK / The X-Ray	
	Corona and the Photospheric Magnetic Field	397
55.	s. ÉNOMÉ and H. TANAKA / Magnetic Fields in the Lower Corona	
	Associated with the Expanding Limb Burst on March 30th 1969	
	Inferred from the Microwave High-Resolution Observations	413
56.	A. B. SEVERNY / Electric Currents Connected with the Proton Flares of	
	7 July and 2 September, 1966	417
57.	K. L. HARVEY, W. C. LIVINGSTON, J. W. HARVEY and C. D. SLAUGHTER /	16.5
50	Observations of Magnetic Field Changes in Active Regions	422
Jō.	N. ERUSHEV, A. B. SEVERNY, and T. TSAP / The Magnetic Fields and the	

59.	Polarization of Radio Emission in the Active Center of October 1968 v. v. Kasinsky / The Position Regularities of Flares Related to the Field	428
	Maximum in Sunspot Groups (presented by G. V. Kuklin) M. J. MARTRES, I. SORU-ESCAUT, and J. RAYROLE / An Attempt to Associate Observed Photospheric Motions with the Magnetic Field	432
	Structure and Flare Occurrence in an Active Region	435
61.	L. KŘIVSKÝ / Volume Characteristics of Magnetic-Channel Flares	443
	D. A. KUZNETSOV and A. A. SHPITALNAYA / The Relation Between Dashes and Flares (Physical Nature of the Dash Phenomena) (presented by N. S. Soboleva)	450
	by 14. B. Boooleva)	450
	PART V/THEORIES OF SMALL SCALE MAGNETIC FIELI	os
63.	P. A. SWEET / Theories of Small-Scale Magnetic Fields	457
	P. R. WILSON / Sunspot Magnetic Fields and Umbral Dots	475
	E. I. MOGILEVSKY / Statistical Model of Small Scale Discrete Structure	
	of Magnetoplasma in Active Regions of the Sun	480
66.	S. NAGARAJAN / Evolution of Turbulent Magnetic Fields – Approach to a Steady State	487
67.	J. JAKIMIEC / Distribution of the Magnetic Force in the Surface Layers	
	of Sunspots	505
68.	W. H. BOSTICK, V. NARDI, L. GRUNBERGER, and W. PRIOR /	
	Observation of Solar Flare Type Processes in the Laboratory	512
69.	G. W. PNEUMAN and R. A. KOPP / Interaction of Coronal Material with	
	Magnetic Fields	526
70.	M. KOPECKÝ and G. V. KUKLIN / The Possibility of Magnetic Field	
	Origin in Fine Structure Elements of Solar Features	534
71.	M. KOPECKÝ and V. KOPECKÝ / Anisotropy of Electric Conductivity and	
	Dissipation of Magnetic Fields	542
	PART VI/OPTICAL AND RADIO OBSERVATIONS OF LARGE SCALE MAGNETIC FIELDS ON THE SUN	
72.	G. NEWKIRK, JR. / Large Scale Solar Magnetic Fields and Their	5.45
72	Consequences	547
	D. M. RUST and JR. ROY / Coronal Magnetic Fields Above Active Regions	560
	P. CHARVIN / Experimental Study of the Orientation of Magnetic Fields	569
	in the Corona	580
	M. D. ALTSCHULER, G. NEWKIRK, JR., D. E. TROTTER, and R. HOWARD /	200
	Time Evolution of the Large-Scale Solar Magnetic Field	588
	K. H. SCHATTEN / The Magnetic Field Structure in the Active Solar	200
	Corona	595

	TABLE OF CONTENTS	XI
77.	G. DAIGNE, M. F. LANTOS-JARRY, and M. PICK / Optical and Radio	
	Observations of Large Scale Magnetic Fields on the Sun	609
78.	S. F. SMERD and G. A. DULK / 80 MHz Radioheliograph Evidence on	
	Moving Type IV Bursts and Coronal Magnetic Fields	616
79.	M. R. KUNDU / Active Regions at Millimeter Wavelengths and the	
	Measurement of Magnetic Fields	642
80.	H. ROSENBERG / Radio-Astronomical Evidence for Magneto-	
	Hydrodynamical Pulsations in the Corona	652
81.	U. ANZER and E. TANDBERG-HANSSEN / On the Orientation of Magnetic	
	Fields in Quiescent Prominences	656
	G. W. SIMON and R. W. NOYES / Observations of the Coronal Network	663
83.	v. E. STEPANOV and N. F. TJAGUN / Preliminary Results of Spectroscopic	
	Determination of the Coronal Rotation	667
	PART VII/THE POLAR FIELDS OF THE SUN AND	
	THE MAGNETIC ACTIVITY CYCLE	
	THE MAGNETIC ACTIVITY CYCLE	
84.	A. B. SEVERNY / The Polar Fields and Time Fluctuations of the General	
	Magnetic Field of the Sun	675
85.	P. AMBROŽ, V. BUMBA, R. HOWARD, and J. SÝKORA / Opposite	
	Polarities in the Development of Some Regularities in the Distribution	
	of Large-Scale Magnetic Fields	696
86.	G. Y. SMOLKOV / Magnetic Fields in Polar Prominences (presented by	
	G. V. Kuklin)	710
	J. O. STENFLO / Observations of the Polar Magnetic Fields	714
	Y. NAKAGAWA / A Numerical Study of the Solar Cycle	725
	G. V. KUKLIN / Dynamics of Large-Scale Magnetic Fields	737
	J. M. WILCOX / Sector Structure of the Solar Magnetic Field	744
91.	J. TUOMINEN / The Sun as a Magnetic Rotator	754
	PART VIII / THEORIES OF LARGE SCALE FIELDS AND	
	THE ACTIVITY CYCLE	
	THE ACTIVITY CICLE	
92.	N. O. WEISS / Theories of Large Scale Fields and the Magnetic Active Cycle	757
93.	F. KRAUSE and KH. RÄDLER / Dynamo Theory of the Sun's General	
	Magnetic Field on the Basis of a Mean-Field Magnetohydrodynamics	770

94. I. K. CSADA / A Dynamo Model for the Large Scale Fields

780