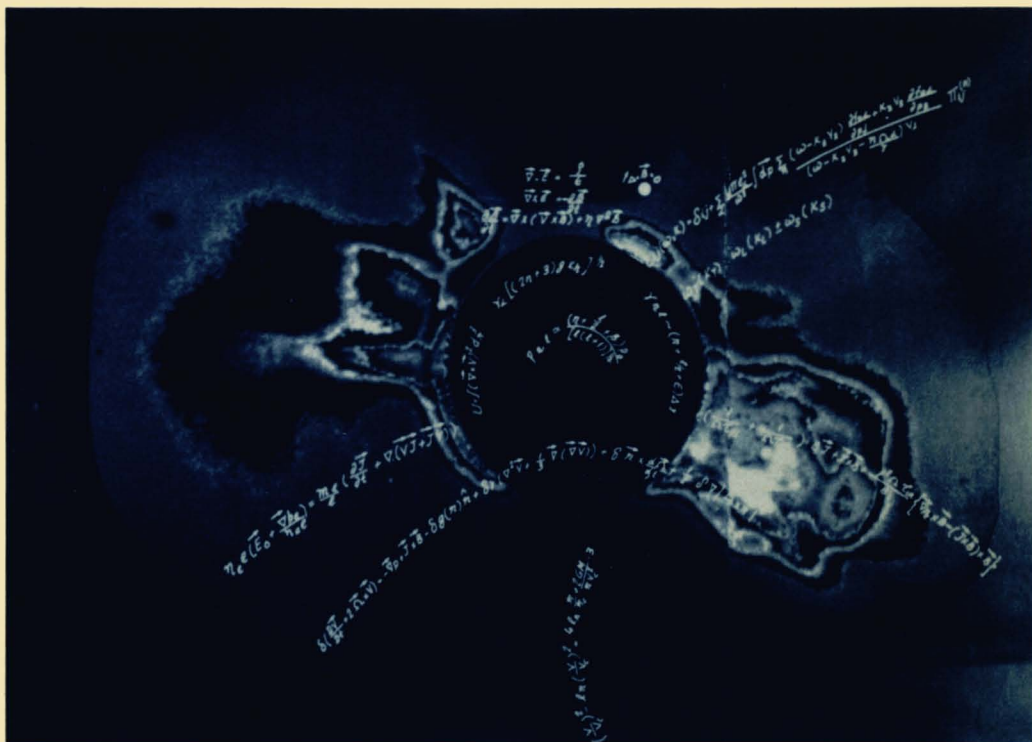


INTERNATIONAL ASTRONOMICAL UNION

SYMPOSIUM No. 142

BASIC PLASMA PROCESSES ON THE SUN

Edited by E. R. PRIEST and V. KRISHAN



INTERNATIONAL ASTRONOMICAL UNION

KLUWER ACADEMIC PUBLISHERS

BASIC PLASMA PROCESSES ON THE SUN

BASIC PLASMA PROCESSES ON THE SUN

Not yet enough!

**It is not sufficient to prove a
case, we must also tempt or
raise men to it:**

**Hence the wise man must learn to convey his wisdom;
and often in such a manner
that it may sound like foolishness!**

Nietzsche

INTERNATIONAL ASTRONOMICAL UNION
UNION ASTRONOMIQUE INTERNATIONALE

BASIC PLASMA PROCESSES ON THE SUN

PROCEEDINGS OF THE 142TH SYMPOSIUM OF THE
INTERNATIONAL ASTRONOMICAL UNION
HELD IN BANGALORE, INDIA, DECEMBER 1-5, 1989

EDITED BY

E. R. PRIEST

Mathematical Institute, University of St. Andrews, Scotland

and

V. KRISHAN

Indian Institute of Astrophysics, Bangalore, India



KLUWER ACADEMIC PUBLISHERS
DORDRECHT / BOSTON / LONDON



Library of Congress Cataloging-in-Publication Data

International Astronomical Union. Symposium (142nd : 1989 : Bangalore, India)
Basic plasma processes in the sun : proceedings of the 142nd Symposium of the International Astronomical Union, held in Bangalore, India, December 1-5, 1989 / edited by E.R. Priest, V. Krishan.

p. cm.

Includes index.

ISBN 0-7923-0879-4 (HB).

1. Solar wind--Congresses. 2. Space plasmas--Congresses.

3. Astrophysics--Congresses. I. Priest, E. R. (Eric Ronald), 1943-. II. Krishan, V. (Vinod) III. Title.

QB529.I57 1989

523.7--dc20

90-41849

ISBN 0-7923-0879-4 (HB)

ISBN 0-7923-0880-8 (PB)

*Published on behalf of
the International Astronomical Union
by*

Kluwer Academic Publishers, P.O. Box 17, 3300 AA Dordrecht, The Netherlands.

*Kluwer Academic Publishers incorporates
the publishing programmes of
D. Reidel, Martinus Nijhoff, Dr W. Junk and MTP Press.*

*Sold and distributed in the U.S.A. and Canada
by Kluwer Academic Publishers,
101 Philip Drive, Norwell, MA 02061, U.S.A.*

*In all other countries, sold and distributed
by Kluwer Academic Publishers Group,
P.O. Box 322, 3300 AH Dordrecht, The Netherlands.*

Printed on acid-free paper

All Rights Reserved

© 1990 International Astronomical Union

No part of the material protected by this copyright notice may be reproduced or utilized in any form or by any means, electronic or mechanical including photocopying, recording or by any information storage and retrieval system, without written permission from the publisher.

Printed in the Netherlands

TABLE OF CONTENTS

FOREWORD		xi
I.	INTRODUCTION	1
	Good Morning	3
	V. Krishan	
	Welcome	5
	J.C. Bhattacharyya	
	The Plasma Universe	9
	C.G. Falthammar (Invited Review)	
II.	THE SOLAR INTERIOR	21
	Interior Structure of the Sun	23
	J.C-Dalsgaard (Invited Review)	
	The Electrodynamics of Neutrinos in Dispersive Media	35
	V.N. Oraevsky and V.B. Semikoz	
	Problems of Solar Convection	39
	W. Unno (Invited Review)	
	Mechanisms for Dynamo Mode Excitation	45
	P. Hoyng (Invited Review)	
	Locating the Seat of the Solar Dynamo	51
	A. Rai Choudhuri	
	Helioseismological Determination of Stratification and Dynamic Processes in the Solar Core	56
	A.G. Kosovichev	
	Internal Large-Scale Toroidal Magnetic Field of the Sun	57
	V.N. Krivodubskij	
	Magnetic Buoyancy with Viscosity and Ohmic Dissipation and Flux Tube Formation	58
	V.D. Kuznetsov	
	Effect of Turbulence on Emerging Magnetic Flux Tubes in the Convection Zone	60
	S. D'Silva and A.R. Choudhuri	
	Plasma Damping of Gravitational Waves	62
	C. Sivaram	
	Propagation and Oscillation of Neutrinos with Magnetic Moment inside the Sun	63
	C. Sivaram	

III.	STELLAR PLASMAS	65
	Magnetic Braking	67
	L. Mestel (Invited Review)	
	Energy Release in Stellar Flares	77
	R. Pallavicini (Invited Review)	
	Stokes Parameters for Thomson Scattering in Magnetized Plasma	93
	C-K. Chou and H-H. Chen	
	Classical Treatment of the Compton Collision in General Relativity	95
	P. Paillere	
	Chromospheric and Coronal Heating Mechanisms	97
	P. Ulmschneider and U. Narain	
IV.	PHOTOSPHERIC FLOWS and MAGNETIC FIELDS	99
	Large-Scale Flow Patterns in the Solar Atmosphere	101
	K.R. Sivaraman	
	Sunspot Motions from a Study of Kodaikanal and Mount Wilson Observations	107
	R. F. Howard, K. R. Sivaraman, S. S. Gupta and P. I. Gilman	
	Observations of Magnetic Features with the German Solar Telescopes at the Observatorio del Teide/Tenerife	113
	F. Kneer, D. Soltau, E. Wiehr	
	Interpretation of the "Third Harmonic" of the Solar Magnetic Cycle	119
	M.H. Gokhale and J. Javaraiah	
	Self-Organization Processes on the Sun : The Heliosynergetics	125
	V. Krishan and E.I. Mogilevskij	
	Linear and Nonlinear Convection with an Aligned Magnetic Field	135
	N. Rudraiah, I. S. Shivakumara and P. Geetavani	
V.	PHOTOSPHERIC FLUX TUBES	137
	Magnetohydrodynamics of Sunspots	139
	N.O. Weiss (Invited Review)	
	Sunspot Seismology Theory	149
	J.M. Davila (Invited Review)	
	Waves in Magnetic Flux Tubes	159
	B. Roberts (Invited Review)	
	Nonlinear Waves in Flux Tubes	175
	M. Ryutova (Invited Review)	
	Resonant Absorption of P-Modes by Sunspots	187
	S.M. Chitre and J.M. Davila	
	Wave Propagation in Sunspots	189
	S.S. Hasan	
	On the Location of Footpoints of Sub-Arc-Second Magnetic Structures in the Quiet Solar Photosphere	193
	K.R. Sivaraman, S.P. Bagare and L.J. November	

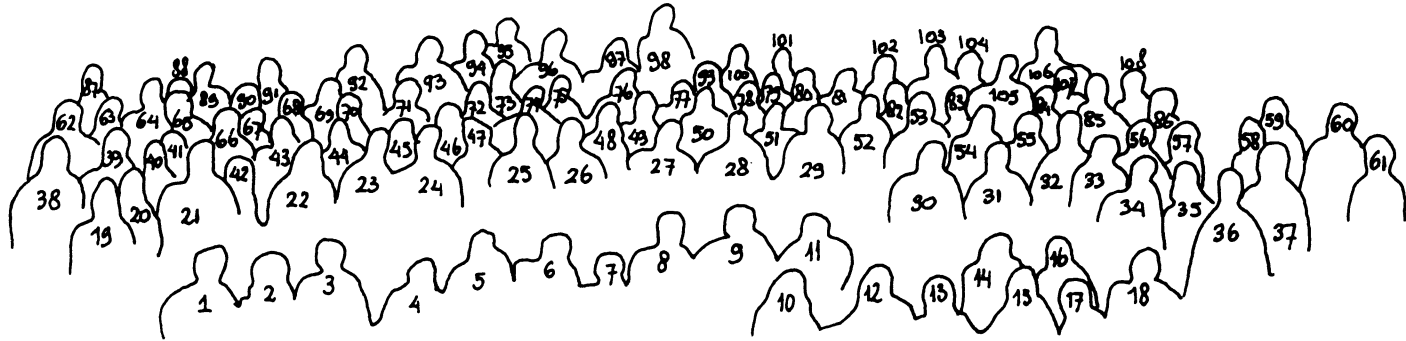
VI.	CHROMOSPHERIC and CORONAL HEATING	195
	The Heating of the Quiet Solar Chromosphere	197
	W. Kalkofen (Invited Review)	
	Coronal Heating by DC Currents	207
	J. Heyvaerts (Invited Review)	
	Relaxed States of MHD Turbulence : Minimum Dissipation or Minimum Energy?	215
	D. Montgomery (Invited Review)	
	A Case for Alfvén Wave Heating	223
	F. Califano, C. Chiuderi and G. Einaudi (Invited Review)	
	Recent Advances in Acoustic Heating	231
	P. Ulmschneider	
	Nonlinear Surface Alfvén Wave Propagation in the Solar Atmosphere	237
	M.S. Ruderman	
	Interaction of Flux Tubes with Sound Waves	239
	C. Uberoi	
	Resonant Absorption of Alfvén Waves and the Associated Phenomenon of Magnetic Reconnection	245
	C. Uberoi	
	Fabry-Perot Interferogram Profiles in $\lambda 5303$ in Relation to Coronal Structures: 1980 and 1983 Eclipses	251
	J.N. Desai, K.P. Raju, T. Chandrasekhar, N.M. Ashok, J.M. Pasachoff	
	Density Irregularity of the Inner Corona determined from Simultaneous Measurements of the XUV and the K Coronal Brightness	253
	M. Guhathakurta, G.J. Rottmann, F.Q. Orrall, R.R. Fisher	
	Simultaneous Organisation of (V,B): The Spicules	255
	V. Krishan	
	Magnetic Helicity of Oscillating Coronal Loops	256
	V. Krishan and E.R. Priest	
	Nonlinear Alfvén Waves with Large Larmor Radius Effect	258
	N. Kumar and K.M. Srivastava	
	Cosmic Ray Signatures of Different Types of Solar Wind Streams	259
	P.K. Shrivastava and S.P. Agrawal	
	Calcium K Line Profiles as a Function of Latitude and Solar Cycle Phase	261
	J. Singh	
	On the Existence of Hydromagnetic Interface Waves in a Structured Atmosphere	262
	K. Somasundaram, S. Manthiramoorathi, A.S. Narayanan	
	Acoustic Wave Generation in Vertical Magnetic Fields	264
	H.S. Yun and J.W. Lee	
	Wave Energy Dissipation in the Solar Atmosphere	266
	Z. Aihua	
VII.	MAGNETIC RECONNECTION and CORONAL EVOLUTION	269
	Magnetic Reconnection on the Sun	271
	E.R. Priest (Invited Review)	

The Role of Magnetic Reconnection in Flares and Prominence Equations	293
T.G. Forbes (Invited Review)	
Structure and Equilibrium of Coronal Magnetic Fields	303
A.A. Van Ballegooijen	
The Evolution of a Sheared Potential Magnetic Field in the Solar Corona	309
J.T. Karpen, S.K. Antiochos, C.R. DeVore	
Storage and Release of Magnetic Energy in a Force-Free Field	313
J.J. Aly	
Magnetic Shear and Flares	319
P. Venkatakrishnan	
Implications of Tension-Free Equilibria for Pre-Flare Energy Build-Up	323
P. Venkatakrishnan	
Energy Balance in Prominence-Corona Transition Regions	325
C. Chiuderi and F. Chiuderi Drago	
Numerical Simulations of Solar Disturbances and their Interplanetary Consequences	331
M. Dryer, S.T. Wu and T.R. Detman (Invited Review)	
Stability of a Massive Current Sheet Supported by a Two-Dimensional Potential Magnetic Field	341
J.J. Aly and S. Colombi	
Nature of Large-Scale Magnetic Field and Complexity of HCS as observed in Interplanetary Plasma	343
T.E. Girish and S.R. Prabhakaran Nayar	
The Quasi-Static Evolution of Magnetic Structures on the Sun and Their Topological Reconstruction	345
Yu.G. Matyukin and V.M. Tomozov	
Slight Disappearance of Prominence Plasma to the Solar Corona	347
V. Rusin, V. Dermendjiev, M. Rybansky, G. Buyukliev	
Coronal Loop Interaction	350
R.N. Smartt and Z. Zhang	
VIII. SOLAR FLARES	353
Plasma Processes in Solar Flares	355
V.M. Tomozov (Invited Review)	
Coherent Radiation from Electrostatic Double Layers	365
J. Kuijpers (Invited Review)	
Fast Solar Flare Proton Acceleration by MHD Turbulence	375
D.F. Smith (Invited Review)	
Super-Alfvénic Beam-Plasma Instabilities in Solar Flares	383
F. Verheest	
Acceleration, Transport of and Radiation by Electrons in Impulsive Phase of Flares	391
V. Petrosian	
Diagnosing Solar Plasmas From EUV and X-Ray Emission Lines	403
B.N. Dwivedi	

Electrons and X-Ray Emission of Solar Flares V.G. Kurt	409
Relationship between Solar Flares and Solar Cosmic Rays M.N. Vahia	415
Energetic Particles in a Flare Loop : Spectra and Radiation Signatures P.A. Bespalov, V.V. Zaitsev, A.V. Stepanov	421
The Interaction of Cometary Plasma with Interplanetary Medium - A Post-Halley View D. Prasad	429
Magnetic Field Chromospheric Plasma Interaction and the Problem of the Braking Force in Surge Dynamics V. Dermendjiev	435
Observations of Energetic Electrons in Solar Flares B. Lokanadham	438
Role of Beam Foil Spectroscopy in Understanding Basic Plasma Processes on the Sun G. Krishnamurty, P.M.R. Rao, P. Sarswathy and B.N.R. Sekhar	439
Role of Plasma Spectroscopy in Understanding Plasma Processes on the Sun P.M.R. Rao, P. Sarswathy, B.N.R. Sekhar and G. Krishnamurty	441
Density Diagnostics of Solar Emission Lines from the Nitrogen-like Mg VI Ion P.K. Raju and R. Vasundhara	443
Analysis of Prognostic 9 Solar Flare Hard X-ray Data Support for the Non-Thermal Thick Target Model R.R. Rausaria, R. Bakaya and P.N. Khosa	445
Stochastic Dynamics of Protons in Solar Magnetic Loops V.N. Senatorov and V.M. Tomozov	448
Relationship of Coronal Mass Ejection Events with Solar Flares and Coronal Holes V.K. Verma	450
Ion Cyclotron Instability and Electron Acceleration in Coronal Magnetic Flux Tubes M. Xu, D. Li, D. Wang, S. Tsai	452
Modelling a Solar Flare from XUV and Radio Observations F. Chiuderi Drago and B.C.M. Fossi	454
IX. SOLAR RADIO EMISSION	455
Millimeter and Microwave Activity of the Sun M.R. Kundu and S.M. White (Invited Review)	457
Electron Beams and Langmuir Turbulence in Solar Type III Radio Bursts Observed in the Interplanetary Medium R.P. Lin (Invited Review)	467
Diagnostics of the Solar Plasma Using Radio Observations with the RATAN-600 G.B. Gelfreikh	483
Dual Frequency Variability Study of an Active Region R.K. Shevgaonkar and M.R. Kundu	489

Clark Lake Radio Observations of Coronal Mass Ejections N. Gopalswamy	495
VLA Observations of the Coronal Plasma K.R. Lang	501
Type III Bursts Traced from the Solar Surface to 1 AU Y. Leblanc	509
Observations of Solar Continuum Emission at Decameter Wavelengths Ch. V. Sastry	513
Behaviour of Whistlers in Coronal Magnetic Traps and Its Relevance to a New Fine Structure in Solar Type IV Radio Bursts G.P. Chernov	515
Higher Harmonic Plasma Radiation in Solar Type II Radio Bursts V.V. Fomichev, I.M. Chertok, R.V. Gorgutsa, A.K. Markeev, B. Kliem, H. Aurass, A. Kruger, J. Kurts, H. Urbarz	517
Absorption of Electromagnetic Waves in Astrophysical Plasmas R.T. Gangadhara and V. Krishan	519
Microbursts at Meter-Decameter Wavelengths G. Thejappa, N. Gopalswamy, M.R. Kundu	521
The Sun at the VLA's Metric and Decimetric Wavelengths S.M. White, M.R. Kundu, N. Gopalswamy, E.J. Schmahl	523
VLA-Phoenix Observations of a Narrow-Band Decimetric Burst R.F. Willson and A.O. Benz	525
 SUMMARY LECTURE N.O. Weiss	 527
 LIST OF PARTICIPANTS	 533
 INDEX	 537





1. Li Jianke 2. Guha Thakurtha M 3. E Ebenezer 4. MH Gokhale 5. A Taktakishvili 6. A Paranjpye 7. D F Smith
8. P K Manoharan 9. A V Stepanova 10. V Krishan 11. V V Zaitsev 12. M Ryutova 13. F Chiuderi 14. M Dryer
15. Xu Min Jian 16. E R Priest 17. Zhou Aihua 18. S K Saha 19. Y Leblanc 20. C Oberoi 21. Chou Chih-Kang
22. V K Verma 23. A K Gupta 24. Hari Om Vats 25. C Debi Prasad 26. K B Ramesh 27. C Sivaram 28. R V Bhonsle
29. Ch V Sastry 30. B Buti 31. Ranu Kundu 32. S Hasan 33. L Mestel 34. S K Bose 35. E I Mogilevsky 36.
37. J Javaraiah 38. 39. K R Bondal 40. G C Joshi 41. E Ya Zlotnik 42. Anita Joshi 43. H M Hiremath
44. L N Kotcherlakota 45. 46. K Sasidharan 47. 48. B R Madhava Rao 49. N D N Prasad
50. 51. G B Gelfreikh 52. K R Lang 53. J V Hollweg 54. T G Forbes 55. M R Kundu 56. Hong Sik Yun
57. B N Dwivedi 58. F Verheest 59. R R Rausaria 60. J Kuijpers 61. C T Vanajakshi 62. B Roberts 63. Udit Narain
64. J N Desi 65. V D Kuznetsov 66. W Kalkofen 67. 68. Nagendra Kumar 69. J Heyvaerts 70. Zdenka Smith
71. W Unno 72. P Venkatakrishnan 73. R T Gangadhara 74. C Chowdappa 75. R P Lin 76. P Hoyng 77. A R Choudhuri
78. R Kariyappa 79. R Vasundhara 80. K Sundara Raman 81. V G Kurt 82. B Lokanadham 83. R K Varma 84. K Sinha
85. 86. R Steinitz 87. R C Kapoor 88. 89. V P Gaur 90. 91. P K Raju
92. R Pallavicini 93. Franz Kneer 94. R K Shevgaonkar 95. M N Vahia 96. N O Weiss 97. D Montgomery 98. S P Bagare
99. Sydney D'Silva 100. M Anamma 101. M N Leony 102. 103. D Mohan Rao 104. K E Rangarajan
105. P S M Aleem 106. V B Semikoz 107. B S Nagabhushana 108. R S Narayanan.