

Astrophysics and Space Science Library  
Proceedings

# Upper Main Sequence Stars with Anomalous Abundances

C. R. Cowley, M. M. Dworetsky,  
and C. Mégessier  
(Editors)

# UPPER MAIN SEQUENCE STARS IN ANOMALOUS ABUNDANCES

# ASTROPHYSICS AND SPACE SCIENCE LIBRARY

A SERIES OF BOOKS ON THE RECENT DEVELOPMENTS  
OF SPACE SCIENCE AND OF GENERAL GEOPHYSICS AND ASTROPHYSICS  
PUBLISHED IN CONNECTION WITH THE JOURNAL  
SPACE SCIENCE REVIEWS

## *Editorial Board*

R.L.F. BOYD, *University College, London, England*

W. B. BURTON, *Sterrewacht, Leiden, The Netherlands*

L. GOLDBERG, *Kitt Peak National Observatory, Tucson, Ariz., U.S.A.*

C. DE JAGER, *University of Utrecht, The Netherlands*

J. KLECZEK, *Czechoslovak Academy of Sciences, Ondřejov, Czechoslovakia*

Z. KOPAL, *University of Manchester, England*

R. LÜST, *European Space Agency, Paris, France*

L. I. SEDOV, *Academy of Sciences of the U.S.S.R., Moscow, U.S.S.R.*

Z. ŠVESTKA, *Laboratory for Space Research, Utrecht, The Netherlands*

VOLUME 125

PROCEEDINGS

# UPPER MAIN SEQUENCE STARS WITH ANOMALOUS ABUNDANCES

PROCEEDINGS OF THE 90TH COLLOQUIUM  
OF THE INTERNATIONAL ASTRONOMICAL UNION,  
HELD IN CRIMEA, U.S.S.R., MAY 13–19, 1985

Edited by

C. R. COWLEY

*Department of Astronomy, The University of Michigan,  
Ann Arbor, Michigan, U.S.A.*

M. M. DWORETSKY

*Department of Physics and Astronomy,  
University College London, U.K.*

and

C. MÉGESSIER

*Observatoire de Paris, Meudon, France*

D. REIDEL PUBLISHING COMPANY

A MEMBER OF THE KLUWER  ACADEMIC PUBLISHERS GROUP

DORDRECHT / BOSTON / LANCASTER / TOKYO

**Library of Congress Cataloging in Publication Data**



**IAU Colloquium (90th : 1985 : Krymskaia oblast; Ukraine)**  
**Upper main sequence stars with anomalous abundances.**

(Astrophysics and space science library; v. 125)

Includes index.

1. Stars—Congresses. 2. Stars—Magnetic fields—Congresses. 3. Photometry, Astronomical—Congresses. 4. Astrophysics—Congresses. I. Cowley, C. R. (Charles R.), 1934-. II. Dworetsky, M. M. (Michael M.) III. Mégessier, C. (Claud) IV. Title. V. Series.

QB799.I38 1985 523.8 86-13774

ISBN 90-277-2296-X

---

Published by D. Reidel Publishing Company,  
P.O. Box 17, 3300 AA Dordrecht, Holland.

Sold and distributed in the U.S.A. and Canada  
by Kluwer Academic Publishers,  
101 Philip Drive, Assinippi Park, 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, Holland.

All Rights Reserved

© 1986 by D. Reidel Publishing Company, Dordrecht, Holland  
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 copyright owner

Printed in The Netherlands

## TABLE OF CONTENTS

Preface	xiii
<b><u>SECTION I – THEORETICAL CONSIDERATIONS</u></b>	
The Origin and Structure of the Magnetic Fields of the Chemically Peculiar Stars [Invited Review]: D. Moss .....	1
Origin of the Magnetic Field [Invited Review]: A. Z. Dolginov .....	11
Discussion: Dolginov .....	23
On the Spottedness, Magnetism and Internal Structure of Stars: R. E. Gershberg .....	25
Investigations of the Magnetic Fields of Chemically Peculiar Stars of Different Age: Yu.V. Glagolevskij, V. G. Klochkova, and I. M. Kopylov .....	29
The Magnetic Field and Other Parameters of the Chemically Peculiar Stars: Yu.V. Glagolevskij, I. I. Romanyuk, and N. M. Chunakova .....	33
On the Perturbation Technique for the Influence of Magnetic Field on Stellar Oscillations: S. V. Vorontsov .....	37
On the Magnetic Field of $\beta$ CrB: S. I. Plachinda .....	41
Estimation of Stellar Surface Magnetic Fields by the Curve-of-Growth Method: T. A. Ryabchikova and N. E. Piskunov .....	45
Discussion: Plachinda .....	49
Does $\nu$ Cep Indicate a Non-axisymmetric Dynamo?: F. Krause and G. Scholz ..	51
Discussion: Krause and Scholz .....	55
Model Atmospheres and Radiative Transfer in Chemically Peculiar Stars: Interpretational Significance of Non-LTE [Invited Review]: I. Hubený ..	57
Discussion: Hubený .....	77
Influence of the Magnetic Field on the Polarization of Radiation Scattered by Electrons in Stellar Atmospheres and Envelopes: A. Z. Dolginov, Yu. N. Gnedin, and N. A. Silant'ev .....	81
A Determination of Magnetic Fields of T Tau and Ae/Be Herbig Stars Using the Parameters of their Linear Polarization: Yu. N. Gnedin, M. A. Pogodin, and N. P. Red'kina .....	87
Practical Problems in the Analysis of CP Stars [Invited Review]: C. R. Cowley and S. Johansson .....	91

Missing Levels and Lines of Astrophysical Importance: S. Johansson and C. R. Cowley .....	99
Combined Discussion: Cowley and Johansson - Johansson and Cowley .....	103
Characteristic Absorption Features in the Spectra of Ap -Si Stars Between 1250 and 1850 Å: M.-C. Artru and T. Lanz .....	105
Space Observations of Chemically Peculiar and Related Normal Stars [Invited Review]: D. S. Leckrone .....	109
Combined Discussion: Artru and Lanz - Leckrone .....	121
Study of Inhomogeneities on the Surface of Magnetic CP Stars [Invited Review]: V. L. Khokhlova .....	125
Discussion: Khokhlova .....	133
Inverse Problems in Astrophysics: A. M. Cherepaschuk, A. V. Goncharski, and A. G. Yagola .....	135
The Distribution of Fe, Cr, and Si over the Surface of θ Aur: V. L. Khokhlova, J. B. Rice, and W. H. Wehlau .....	137
Application of Deutsch's Method for 53 Cam: I. Vincze .....	141
The Nonhomogeneous Distribution of Abundances and the Magnetic Field Measurements in CP Stars: F. A. Catalano .....	149

#### SECTION II - SYSTEMATICS, PHOTOMETRY

Systematics of CP Stars [Invited Review]: H. Hensberge and W. Van Rensbergen .....	151
Spectroscopy of CP Stars in the Groups of Different Age: V. G. Klochkova, and I. M. Kopylov .....	159
Combined Discussion: Hensberge and Van Rensbergen - Klochkova and Kopylov .....	163
Rotation, Variability and Age of Ap Stars: P. North .....	167
Light Curve Analysis of Rotating Variable Stars: A. Hempelmann and W. Schöneich .....	171
A Search for Long-Term Photometric Variability in CP2-Stars: H. Hensberge ..	175
The Nature of Balmer Line Variability in Chemically Peculiar Stars: B. Musielok .....	179
Combined Discussion: North - Musielok .....	181
The Variability of the λ5200 Feature in CP2 Stars: H. M. Maitzen and H. Hensberge .....	183

Short Time Light Variations of Ap-Stars: G. Hildebrandt, W. Schöneich, D. Lange, E. Źelwanowa, and A. Hempelmann . . . . .	189
CP-Stars in the Near Infrared: Normal: R. Kroll, H. Schneider, H. H. Voigt, and F. A. Catalano . . . . .	191
H $\alpha$ and OI Photometry of Upper Main Sequence Stars with Anomalous Abundances: E. E. Mendoza V. . . . .	195
A Photometric Investigation of the Magnetic Star 53 Camelopardalis: M. Muciek, P. North, F. Rufener, and J. Gertner . . . . .	199
Spectrophotometry of the Broad Continuum Features in Magnetic Ap Stars: D. M. Pyper and S. J. Adelman . . . . .	201
On the Duplicity of CP3 Stars: H. Schneider . . . . .	205
Investigations of CP and Normal Stars With Coadded Dominion Astrophysical Observatory Spectrograms: G. Hill and S. J. Adelman . . . . .	209
Discussion: Hill and Adelman . . . . .	217
Rapid Oscillations of CP2-Stars [Invited Review]: W. W. Weiss . . . . .	219
Discussion: Weiss . . . . .	233
Computed Spectral Line Variations for Oblique Nonradial Pulsators: D. Baade and W. W. Weiss . . . . .	234
Short-Periodic Radial Velocity Variations of the B9p Star ET And: E. Gerth .	235
Frequency Analysis of the Rapidly Oscillating Ap Star HD 60435: J. M. Matthews, D. W. Kurtz, and W. H. Wehlau . . . . .	239
Investigations of the Magnetic Star 53 Cam Variations Using the Spectra of High Time Resolution: N. S. Polosukhina, V. P. Malanushenko, I. Tuominen, H. Karttunen, and H. Virtanen . . . . .	243
HD 24975: A New Delta Scuti Star? (or a Mild Ap Star with Short Photometric Variations?): C. Mégessier, P. North, and M. Burnet . . . . .	253
<b><u>SECTION III - MAGNETIC CP STARS</u></b>	
Hot Magnetic Stars: Abundances, Spectroscopy, Photometry, Systematics [Invited Review]: K. Hunger . . . . .	257
On the Ultraviolet Photometric Variability of the Helium-Weak B Stars (from ANS Data): E. I. Źelwanowa and W. Schöneich . . . . .	271
Intermediate Peculiar Stars: The Bp-Ap Si Stars [Invited Review]: C. Mégessier	275
Combined Discussion: Źelwanowa and Schöneich - Mégessier . . . . .	287

Blanketing Hypothesis and Light Variations of HD 27309: I. Kh. Iliev . . . . .	291
A Spectroscopic Study of the Bp-Star $\theta$ Aur: D. Kolev and E. Georgeva . . . . .	295
The Ultraviolet Spectral Energy Distribution of the Magnetic Ap Star HD 170000 Inside and Outside of the Spots: W. Schöneich, A. Hempelmann, and E. I. Źelwanowa . . . . .	299
Cool Magnetic CP Stars [Invited Review]: S. J. Adelman and C. R. Cowley . . . . .	305
Discussion: Adelman and Cowley . . . . .	315
Abundance Analysis of Three Ap Stars: HD 2453, HD 8441, and HD 192913: T. A. Ryabchikova and D. A. Ptitsyn . . . . .	319
Absorption Lines of Ca II and H in the Near IR Region of the Magnetic Star HD 152107 : T. N. Kuznetsova . . . . .	323
A Search for Heavy Elements in the Ultraviolet Spectra of Ap Stars: A. B. Severny and L. S. Lyubimkov . . . . .	327
The Investigations of Variations in the Depression $\lambda$ 4200, $\lambda$ 5200 of the Magnetic Stars 53 Cam and Beta CrB.: V. I. Burnashev, V. P. Malanushenko, and N. S. Polosukhina . . . . .	341
Discussion: Severny and Lyubimkov . . . . .	345
The Age of $\epsilon$ UMa: S. Hubrig . . . . .	347
Line Spectrum Variations in the Ap Star HD 51418: I. Kh. Iliev and I. S. Barzova	351
$\beta$ CrB - a Rosetta Stone?: L. Oetken . . . . .	355
Some Structural Features of Magnetic Fields of the Chemically Peculiar Stars $\beta$ CrB and $\alpha^2$ CVn: I. I. Romanyuk . . . . .	359
$\beta$ Lyrae - A Binary System with Anomalous Abundances and Magnetic Field: M. Yu. Skul'skij . . . . .	365

#### SECTION IV - NON-MAGNETIC CP AND RELATED STARS

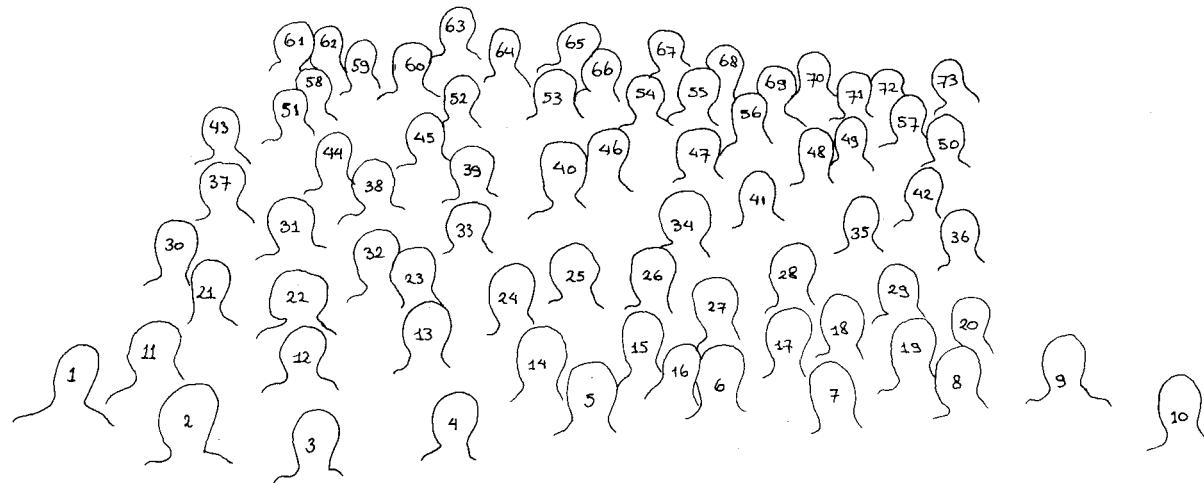
Spectroscopic Analyses of Hot Main Sequence Stars [Invited Review]: K. Sadakane . . . . .	369
Diffusion Processes and Chemical Peculiarities in Magnetic Stars [Invited Review]: G. Alecian . . . . .	381
Combined Discussion: Sadakane - Alecian . . . . .	391
Chemical and Temperature Inhomogeneities on Stellar Surfaces as a Result of an Instability: A. Z. Dolginov . . . . .	395
Non-Magnetic Intermediate-Temperature Stars: A Review [Invited Review]: M. M. Dworetsky . . . . .	397

## TABLE OF CONTENTS

ix

Discussion: Dworetsky . . . . .	417
The Abundance of Gallium in B-type Chemically Peculiar Stars: M. Takada-Hidai, K. Sadakane, and J. Jugaku . . . . .	420
Gallium Overabundance in the Ap-Si Star HD 25823: M.-C. Artru and R. Freire Ferrero . . . . .	421
The Most Iron-Deficient Manganese Star HR 562: D. A. Ptitsyn and T. A. Ryabchikova . . . . .	425
The Light and Spectrum Variable CP2 Star HR 6127: J. Žižňovský . . . . .	429
The Analysis of Chemical Composition of Am Star Atmospheres [Invited Review]: A. A. Boyarchuk and I. S. Savanov . . . . .	433
Discussion: Boyarchuk and Savanov . . . . .	443
Lithium in Am and δ Del Stars: C. Burkhart, M. Lunel, M. F. Coupry, and C. Van 't Veer . . . . .	447
The Li I 6708 Feature in CP Stars: R. Faraggiana, F. Castelli, M. Gerbaldi, and M. Floquet . . . . .	451
The Metallic-Lined Star 32 Aquarii: D. Kocer, C. Bolcal, and S. J. Adelman . . . . .	455
Particle Transport in Non-Magnetic Stars [Invited Review]: G. Michaud . . . . .	459
The Planetoid-Impact Hypothesis of CP, F, A, and B Star Formation: Possibilities and Perspectives: E. M. Drobyshevski . . . . .	473
Combined Discussion: Michaud – Drobyshevski . . . . .	477
General Index . . . . .	479





- |                  |                  |                    |                  |                       |
|------------------|------------------|--------------------|------------------|-----------------------|
| 1. Cowley        | 17. Rice         | 33. Pogodin        | 49. Kolev        | 64. Hensberge         |
| 2. Polosukhina   | 18. Hubený       | 34. Musielok       | 50. Bitchkov     | 65. Schneider         |
| 3. Engberg(son)  | 19. Adelman      | 35. Boyarchuk      | 51. Pamyatnykh   | 66. student of Crimea |
| 4. Mona Engberg  | 20. Pyper-Smith  | 36. Kipper         | 52. Udovichenko  | 67. Schöneich         |
| 5. Catalano      | 21. Johansson    | 37. Kumagarodskoya | 53. Skul'skij    | 68. Mikulashek        |
| 6. Wehlau        | 22. Vincze       | 38. North          | 54. Romanov      | 69. Hempelmann        |
| 7. Michaud       | 23. Zverko       | 39. Jugaku         | 55. Miskevich    | 70. Glagolevskij      |
| 8. Krause        | 24. Dworetsky    | 40. Kuznetsov      | 56. Ryabchikova  | 71. Gershberg         |
| 9. Mendoza       | 25. unidentified | 41. Alecian        | 57. Kopylov      | 72. Romanyuk          |
| 10. Schachovskoi | 26. Takada-Hidai | 42. Iliev          | 58. Savanov      | 73. Plachinda         |
| 11. Ziznovsky    | 27. Sadakane     | 43. Kuznetsova     | 59. Artru        |                       |
| 12. Dr. Engberg  | 28.              | 44. Stepien        | 60. Franzman     |                       |
| 13. Yagola       | 29. Muciek       | 45. Van Rensbergen | 61. Drobyshevski |                       |
| 14. Khokhlova    | 30. Weiss        | 46. Ruuzalepp      | 62. Vornt        |                       |
| 15. Mégessier    | 31. Dolginov     | 47. Zelwanowa      | 62. Vorontsov    |                       |
| 16. Gertner      | 32. Silant'ev    | 48. Ptitsyn        | 63. Kroll        |                       |