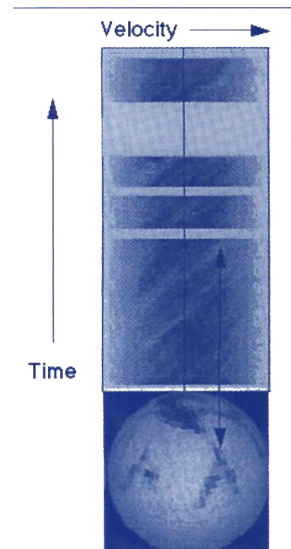
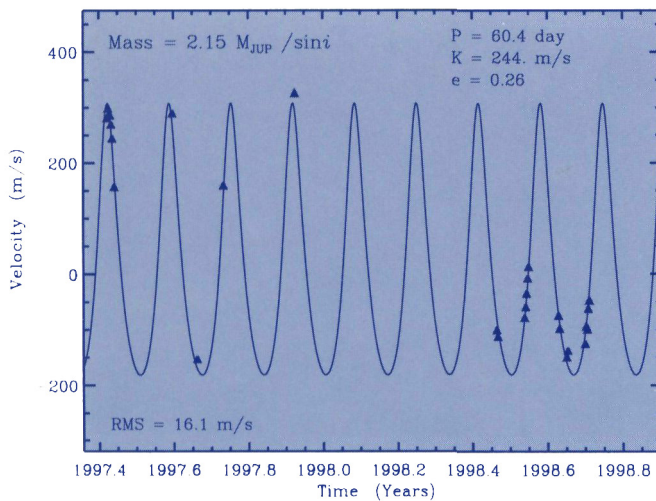




PRECISE STELLAR RADIAL VELOCITIES IAU Colloquium 170



Edited by
J. B. Hearnshaw and C. D. Scarfe

PRECISE STELLAR RADIAL VELOCITIES
IAU Colloquium 170

A SERIES OF BOOKS ON RECENT DEVELOPMENTS IN ASTRONOMY AND ASTROPHYSICS

Managing Editor, D. Harold McNamara
Production Manager, Enid L. Livingston

A.S.P. CONFERENCE SERIES PUBLICATIONS COMMITTEE

Sallie Baliunas, Chair
Carol Ambruster
Catharine Garmany
Mark S. Giampapa
Kenneth Janes

© Copyright 1999 Astronomical Society of the Pacific
390 Ashton Avenue, San Francisco, California 94112

All rights reserved

Printed by Sheridan Books, Inc.

First published 1999

Library of Congress Catalog Card Number: 99-66189
ISBN 1-58381-011-0

Please contact proper address for information on:

PUBLISHING:
Managing Editor
PO Box 24463
211 KMB
Brigham Young University
Provo, UT 84602-4463 USA

Phone: 801-378-2298
Fax: 801-378-4049
E-mail: pasp@astro.byu.edu

ORDERING BOOKS:
Astronomical Society of the Pacific
CONFERENCE SERIES
390 Ashton Avenue
San Francisco, CA 94112 - 1722 USA

Phone: 415-337-2624
Fax: 415-337-5205
E-mail: catalog@aspsky.org
Web Site: <http://www.aspsky.org>

A SERIES OF BOOKS ON RECENT DEVELOPMENTS IN ASTRONOMY AND ASTROPHYSICS

- Vol. 1-Progress and Opportunities in Southern Hemisphere Optical Astronomy: CTIO 25th Anniversary Symposium
ed. V. M. Blanco and M. M. Phillips ISBN 0-937707-18-X
- Vol. 2-Proceedings of a Workshop on Optical Surveys for Quasars
ed. P. S. Osmer, A. C. Porter, R. F. Green, and C. B. Foltz ISBN 0-937707-19-8
- Vol. 3-Fiber Optics in Astronomy
ed. S. C. Barden ISBN 0-937707-20-1
- Vol. 4-The Extragalactic Distance Scale: Proceedings of the ASP 100th Anniversary Symposium
ed. S. van den Bergh and C. J. Pritchet ISBN 0-937707-21-X
- Vol. 5-The Minnesota Lectures on Clusters of Galaxies and Large-Scale Structure
ed. J. M. Dickey ISBN 0-937707-22-8
- Vol. 6-Synthesis Imaging in Radio Astronomy: A Collection of Lectures from the Third NRAO Synthesis Imaging Summer School
ed. R. A. Perley, F. R. Schwab, and A. H. Bridle ISBN 0-937707-23-6
- Vol. 7-Properties of Hot Luminous Stars: Boulder-Munich Workshop
ed. C. D. Garmany ISBN 0-937707-24-4
- Vol. 8-CCDs in Astronomy
ed. G. H. Jacoby ISBN 0-937707-25-2
- Vol. 9-Cool Stars, Stellar Systems, and the Sun. Sixth Cambridge Workshop
ed. G. Wallerstein ISBN 0-937707-27-9
- Vol. 10-Evolution of the Universe of Galaxies: Edwin Hubble Centennial Symposium
ed. R. G. Kron ISBN 0-937707-28-7
- Vol. 11-Confrontation Between Stellar Pulsation and Evolution
ed. C. Cacciari and G. Clementini ISBN 0-937707-30-9
- Vol. 12-The Evolution of the Interstellar Medium
ed. L. Blitz ISBN 0-937707-31-7
- Vol. 13-The Formation and Evolution of Star Clusters
ed. K. Janes ISBN 0-937707-32-5
- Vol. 14-Astrophysics with Infrared Arrays
ed. R. Elston ISBN 0-937707-33-3
- Vol. 15-Large-Scale Structures and Peculiar Motions in the Universe
ed. D. W. Latham and L. A. N. da Costa ISBN 0-937707-34-1
- Vol. 16-Proceedings of the 3rd Haystack Observatory Conference on Atoms, Ions and Molecules: New Results in Spectral Line Astrophysics
ed. A. D. Haschick and P. T. P. Ho ISBN 0-937707-35-X
- Vol. 17-Light Pollution, Radio Interference, and Space Debris
ed. D. L. Crawford ISBN 0-937707-36-8
- Vol. 18-The Interpretation of Modern Synthesis Observations of Spiral Galaxies
ed. N. Duric and P. C. Crane ISBN 0-937707-37-6
- Vol. 19-Radio Interferometry: Theory, Techniques, and Applications, IAU Colloquium 131
ed. T. J. Cornwell and R. A. Perley ISBN 0-937707-38-4
- Vol. 20-Frontiers of Stellar Evolution: 50th Anniversary McDonald Observatory (1939-1989)
ed. D. L. Lambert ISBN 0-937707-39-2

- Vol. 21-The Space Distribution of Quasars
ed. D. Crampton ISBN 0-937707-40-6
- Vol. 22-Nonisotropic and Variable Outflows from Stars
ed. L. Drissen, C. Leitherer, and A. Nota ISBN 0-937707-41-4
- Vol. 23-Astronomical CCD Observing and Reduction Techniques
ed. S. B. Howell ISBN 0-937707-42-4
- Vol. 24-Cosmology and Large-Scale Structure in the Universe
ed. R. R. de Carvalho ISBN 0-937707-43-0
- Vol. 25-Astronomical Data Analysis Software and Systems I
ed. D. M. Worrall, C. Biemesderfer, and J. Barnes ISBN 0-937707-44-9
- Vol. 26-Cool Stars, Stellar Systems, and the Sun, Seventh Cambridge Workshop
ed. M. S. Giampapa and J. A. Bookbinder ISBN 0-937707-45-7
- Vol. 27-The Solar Cycle: Proceedings of the National Solar Observatory/Sacramento Peak
12th Summer Workshop
ed. K. L. Harvey ISBN 0-937707-46-5
- Vol. 28-Automated Telescopes for Photometry and Imaging
ed. S. J. Adelman, R. J. Dukes, Jr., and C. J. Adelman ISBN 0-937707-47-3
- Vol. 29-Viña Del Mar Workshop on Cataclysmic Variable Stars
ed. N. Vogt ISBN 0-937707-48-1
- Vol. 30-Variable Stars and Galaxies
ed. B. Warner ISBN 0-937707-49-X
- Vol. 31-Relationships Between Active Galactic Nuclei and Starburst Galaxies
ed. A. V. Filippenko ISBN 0-937707-50-3
- Vol. 32-Complementary Approaches to Double and Multiple Star Research, IAU Colloquium
135
ed. H. A. McAlister and W. I. Hartkopf ISBN 0-937707-51-1
- Vol. 33-Research Amateur Astronomy
ed. S. J. Edberg ISBN 0-937707-52-X
- Vol. 34-Robotic Telescopes in the 1990s
ed. A. V. Filippenko ISBN 0-937707-53-8
- Vol. 35-Massive Stars: Their Lives in the Interstellar Medium
ed. J. P. Cassinelli and E. B. Churchwell ISBN 0-937707-54-6
- Vol. 36-Planets Around Pulsars
ed. J. A. Phillips, S. E. Thorsett, and S. R. Kulkarni ISBN 0-937707-55-4
- Vol. 37-Fiber Optics in Astronomy II
ed. P. M. Gray ISBN 0-937707-56-2
- Vol. 38-New Frontiers in Binary Star Research: Pacific Rim Colloquium
ed. K. C. Leung and I.-S. Nha ISBN 0-937707-57-0
- Vol. 39-The Minnesota Lectures on the Structure and Dynamics of the Milky Way
ed. Roberta M. Humphreys ISBN 0-937707-58-9
- Vol. 40-Inside the Stars, IAU Colloquium 137
ed. Werner W. Weiss and Annie Baglin ISBN 0-937707-59-7
- Vol. 41-Astronomical Infrared Spectroscopy: Future Observational Directions
ed. Sun Kwok ISBN 0-937707-60-0
- Vol. 42-GONG 1992: Seismic Investigation of the Sun and Stars
ed. Timothy M. Brown ISBN 0-937707-61-9

- Vol. 43-Sky Surveys: Protostars to Protogalaxies
ed. B. T. Soifer ISBN 0-937707-62-7
- Vol. 44-Peculiar Versus Normal Phenomena in A-Type and Related Stars, IAU Colloquium 138
ed. M. M. Dworetsky, F. Castelli, and R. Faraggiana ISBN 0-937707-63-5
- Vol. 45-Luminous High-Latitude Stars
ed. D. D. Sasselov ISBN 0-937707-64-3
- Vol. 46-The Magnetic and Velocity Fields of Solar Active Regions, IAU Colloquium 141
ed. H. Zirin, G. Ai, and H. Wang ISBN 0-937707-65-1
- Vol. 47-Third Decennial US-USSR Conference on SETI
ed. G. Seth Shostak ISBN 0-937707-66-X
- Vol. 48-The Globular Cluster-Galaxy Connection
ed. Graeme H. Smith and Jean P. Brodie ISBN 0-937707-67-8
- Vol. 49-Galaxy Evolution: The Milky Way Perspective
ed. Steven R. Majewski ISBN 0-937707-68-6
- Vol. 50-Structure and Dynamics of Globular Clusters
ed. S. G. Djorgovski and G. Meylan ISBN 0-937707-69-4
- Vol. 51-Observational Cosmology
ed. G. Chincarini, A. Iovino, T. Maccacaro, and D. Maccagni ISBN 0-937707-70-8
- Vol. 52-Astronomical Data Analysis Software and Systems II
ed. R. J. Hanisch, R. J. V. Brissenden, and Jeannette Barnes ISBN 0-937707-71-6
- Vol. 53-Blue Stragglers
ed. Rex A. Saffer ISBN 0-937707-72-4
- Vol. 54-The First Stromlo Symposium: The Physics of Active Galaxies
ed. Geoffrey V. Bicknell, Michael A. Dopita, and Peter J. Quinn ISBN 0-937707-73-2
- Vol. 55-Optical Astronomy from the Earth and Moon
ed. Diane M. Pyper and Ronald J. Angione ISBN 0-937707-74-0
- Vol. 56-Interacting Binary Stars
ed. Allen W. Shafter ISBN 0-937707-75-9
- Vol. 57-Stellar and Circumstellar Astrophysics
ed. George Wallerstein and Alberto Noriega-Crespo ISBN 0-937707-76-7
- Vol. 58-The First Symposium on the Infrared Cirrus and Diffuse Interstellar Clouds
ed. Roc M. Cutri and William B. Latter ISBN 0-937707-77-5
- Vol. 59-Astronomy with Millimeter and Submillimeter Wave Interferometry, IAU Colloquium 140
ed. M. Ishiguro and Wm. J. Welch ISBN 0-937707-78-3
- Vol. 60-The MK Process at 50 Years: A Powerful Tool for Astrophysical Insight: A Workshop of the Vatican Observatory
ed. C. J. Corbally, R. O. Gray, and R. F. Garrison ISBN 0-937707-79-1
- Vol. 61-Astronomical Data Analysis Software and Systems III
ed. Dennis R. Crabtree, R. J. Hanisch, and Jeannette Barnes ISBN 0-937707-80-5
- Vol. 62-The Nature and Evolutionary Status of Herbig Ae / Be Stars
ed. P. S. Thé, M. R. Pérez, and E. P. J. van den Heuvel ISBN 0-937707-81-3
- Vol. 63-Seventy-Five Years of Hirayama Asteroid Families: The Role of Collisions in the Solar System History
ed. Y. Kozai, R. P. Binzel, and T. Hirayama ISBN 0-937707-82-1
- Vol. 64-Cool Stars, Stellar Systems, and the Sun, Eighth Cambridge Workshop
ed. Jean-Pierre Caillault ISBN 0-937707-83-X

- Vol. 65-Clouds, Cores, and Low Mass Stars
ed. Dan P. Clemens and Richard Barvainis ISBN 0-937707-84-8
- Vol. 66- Physics of the Gaseous and Stellar Disks of the Galaxy
ed. Ivan R. King ISBN 0-937707-85-6
- Vol. 67-Unveiling Large-Scale Structures Behind the Milky Way
ed. C. Balkowski and R. C. Kraan-Korteweg ISBN 0-937707-86-4
- Vol. 68-Solar Active Region Evolution: Comparing Models with Observations
ed. K. S. Balasubramaniam and George W. Simon ISBN 0-937707-87-2
- Vol. 69-Reverberation Mapping of the Broad-Line Region in Active Galactic Nuclei
ed. P. M. Gondhalekar, K. Horne, and B. M. Peterson ISBN 0-937707-88-0
- Vol. 70-Groups of Galaxies
ed. Otto G. Richter and Kirk Borne ISBN 0-937707-89-9
- Vol. 71-Tridimensional Optical Spectroscopic Methods in Astrophysics, IAU Colloquium 149
ed. G. Comte and M. Marcelin ISBN 0-937707-90-2
- Vol. 72-Millisecond Pulsars: A Decade of Surprise.
ed. A. A. Fruchter, M. Tavani, and D. C. Backer ISBN 0-937707-91-0
- Vol. 73-Airborne Astronomy Symposium on the Galactic Ecosystem: From Gas to Stars to Dust
ed. M. R. Haas, J. A. Davidson, and E. F. Erickson ISBN 0-937707-92-9
- Vol. 74-Progress in the Search for Extraterrestrial Life: 1993 Bioastronomy Symposium
ed. G. Seth Shostak ISBN 0-937707-93-7
- Vol. 75-Multi-Feed Systems for Radio Telescopes
ed. D. T. Emerson and J. M. Payne ISBN 0-937707-94-5
- Vol. 76-GONG '94: Helio- and Astero-Seismology from the Earth and Space
ed. Roger K. Ulrich, Edward J. Rhodes, Jr., and Werner Däppen ISBN 0-937707-95-3
- Vol. 77-Astronomical Data Analysis Software and System IV
ed. R. A. Shaw, H. E. Payne, and J. J. E. Hayes ISBN 0-937707-96-1
- Vol. 78-Astrophysical Applications of Powerful New Databases: Joint Discussion No. 16 of the
22nd General Assembly of the IAU
ed. S. J. Adelman and W. L. Wiese ISBN 0-937707-97-X
- Vol. 79-Robotic Telescopes: Current Capabilities, Present Developments, and Future
Prospects for Automated Astronomy
ed. Gregory W. Henry and Joel A. Eaton ISBN 0-937707-98-8
- Vol. 80-The Physics of the Interstellar Medium and Intergalactic Medium
ed. A. Ferrara, C. F. McKee, C. Heiles, and P. R. Shapiro ISBN 0-937707-99-6
- Vol. 81-Laboratory and Astronomical High Resolution Spectra
ed. A. J. Sauval, R. Blomme, and N. Grevesse ISBN 1-886733-01-5
- Vol. 82-Very Long Baseline Interferometry and the VLBA
ed. J. A. Zensus, P. J. Diamond, and P. J. Napier ISBN 1-886733-02-3
- Vol. 83-Astrophysical Applications of Stellar Pulsation. IAU Colloquium 155
ed. R. S. Stobie and P. A. Whitelock ISBN 1-886733-03-1
- Vol. 84-The Future Utilisation of Schmidt Telescopes, IAU Colloquium 148
ed. Jessica Chapman, Russell Cannon, Sandra Harrison, and Bambang Hidayat ISBN 1-886733-05-8
- Vol. 85-Cape Workshop on Magnetic Cataclysmic Variables
ed. D. A. H. Buckley and B. Warner ISBN 1-886733-06-6
- Vol. 86-Fresh Views of Elliptical Galaxies
ed. Alberto Buzzoni, Alvio Renzini, and Alfonso Serrano ISBN 1-886733-07-4

- Vol. 87-New Observing Modes for the Next Century
ed. Todd Boroson, John Davies, and Ian Robson ISBN 1-886733-08-2
- Vol. 88- Clusters, Lensing, and the Future of the Universe
ed. Virginia Trimble and Andreas Reisenegger ISBN 1-886733-09-0
- Vol. 89-Astronomy Education: Current Developments, Future Coordination
ed. John R. Percy ISBN 1-886733-10-4
- Vol. 90-The Origins, Evolution, and Destinies of Binary Stars in Clusters
ed. E. F. Milone and J. C. Mermilliod ISBN 1-886733-11-2
- Vol. 91-Barred Galaxies, IAU Colloquium 157
ed. R. Buta, D. A. Crocker, and B. G. Elmegreen ISBN 1-886733-12-0
- Vol. 92-Formation of the Galactic Halo–Inside and Out
ed. H. L. Morrison and A. Sarajedini ISBN 1-886733-13-9
- Vol. 93-Radio Emission from the Stars and the Sun
ed. A. R. Taylor and J. M. Paredes ISBN 1-886733-14-7
- Vol. 94-Mapping, Measuring, and Modelling the Universe
ed. Peter Coles, Vincent Martinez, and Maria-Jesus Pons-Borderia ISBN 1-886733-15-5
- Vol. 95-Solar Drivers of Interplanetary and Terrestrial Disturbances: Proceedings of 16th
International Workshop, National Solar Observatory/Sacramento Peak
ed. K. S. Balasubramaniam, S. L. Keil, and R. N. Smartt ISBN 1-886733-16-3
- Vol. 96- Hydrogen-Deficient Stars
ed. C. S. Jeffery and U. Heber ISBN 1-886733-17-1
- Vol. 97-Polarimetry of the Interstellar Medium
ed. W. G. Roberge and D. C. B. Whittet ISBN 1-886733-18-X
- Vol. 98-From Stars to Galaxies: The Impact of Stellar Physics on Galaxy Evolution
ed. Claus Leitherer, Uta Fritze-von Alvensleben, and John Huchra ISBN 1-886733-19-8
- Vol. 99-Cosmic Abundances: Proceedings of the 6th Annual October Astrophysics Conference
ed. Stephen S. Holt and Geroge Sonneborn ISBN 1-886733-20-1
- Vol. 100-Energy Transport in Radio Galaxies and Quasars
ed. P. E. Hardee, A. H. Bridle, and J. A. Zensus ISBN 1-886733-21-X
- Vol. 101-Astronomical Data Analysis Software and Systems V
ed. George H. Jacoby and Jeannette Barnes ISSN 1080-7926
- Vol. 102-The Galactic Center, 4th ESO/CTIO Workshop
ed. Roland Gredel ISBN 1-886733-22-8
- Vol. 103-The Physics of Liners in View of Recent Observations
ed. M. Eracleous, A. Koratkar, C. Leitherer, and L. Ho ISBN 1-886733-23-6
- Vol. 104-Physics, Chemistry, and Dynamics of Interplanetary Dust, IAU Colloquium 150
ed. Bo A. S. Gustafson and Martha S. Hanner ISBN 1-886733-24-4
- Vol. 105-Pulsars: Problems and Progress, IAU Colloquium 160
ed. M. Bailes, S. Johnston, and M. A. Walker ISBN 1-886733-25-2
- Vol. 106-Minnesota Lectures on Extragalactic Neutral Hydrogen
ed. Evan D. Skillman ISBN 1-886733-26-0
- Vol. 107-Completing the Inventory of the Solar System: A Symposium held in conjunction with
the 106th Annual Meeting of the ASP
ed. Terrence W. Rettig and Joseph M. Hahn ISBN 1-886733-27-9

- Vol. 108-M. A. S. S. Model Atmospheres and Spectrum Synthesis: 5th Vienna Workshop
ed. S. J. Adelman, F. Kupka, and W. W. Weiss ISBN 1-886733-28-7
- Vol. 109-Cool Stars, Stellar Systems, and the Sun, Ninth Cambridge Workshop
ed. Roberto Pallavicini and Andrea K. Dupree ISBN 1-886733-29-5
- Vol. 110-Blazar Continuum Variability
ed. H. R. Miller, J. R. Webb, and J. C. Noble ISBN 1-886733-30-9
- Vol. 111-Magnetic Reconnection in the Solar Atmosphere: Proceedings of a Yohkoh Conference
ed. R. D. Bentley and J. T. Mariska ISBN 1-886733-31-7
- Vol. 112-The History of the Milky Way and Its Satellite System
ed. A. Burkert, D. H. Hartmann, and S. R. Majewski ISBN 1-886733-32-5
- Vol. 113-Emission Lines in Active Galaxies: New Methods and Techniques, IAU Colloquium 159
ed. B. M. Peterson, F. Z. Cheng, and A. S. Wilson ISBN 1-886733-33-3
- Vol. 114-Young Galaxies and QSO Absorption-Line Systems
ed. Sueli M. Viegas, Ruth Gruenwald, and Reinaldo R. de Carvalho ISBN 1-886733-34-1
- Vol. 115-Galactic and Cluster Cooling Flows
ed. Noam Soker ISBN 1-886733-35-X
- Vol. 116-The Second Stromlo Symposium: The Nature of Elliptical Galaxies
ed. M. Arnaboldi, G. S. Da Costa, and P. Saha ISBN 1-886733-36-8
- Vol. 117- Dark and Visible Matter in Galaxies
ed. Massimo Persic and Paolo Salucci ISBN 1-886733-37-6
- Vol. 118-First Advances in Solar Physics Euroconference: Advances in the Physics of Sunspots
ed. B. Schmieder, J. C. del Toro Iniesta, and M. Vázquez ISBN 1-886733-38-4
- Vol. 119-Planets Beyond the Solar System and the Next Generation of Space Missions
ed. David R. Soderblom ISBN 1-886733-39-2
- Vol. 120-Luminous Blue Variables: Massive Stars in Transition
ed. Antonella Nota and Henny J. G. L. M. Lamers ISBN 1-886733-40-6
- Vol. 121-Accretion Phenomena and Related Outflows, IAU Colloquium 163
ed. D. T. Wickramasinghe, G. V. Bicknell and L. Ferrario ISBN 1-886733-41-4
- Vol. 122-From Stardust to Planetesimals: Symposium held as part of the 108th Annual Meeting of the ASP
ed. Yvonne J. Pendleton and A. G. G. M. Tielens ISBN 1-886733-42-2
- Vol. 123-The 12th 'Kingston Meeting': Computational Astrophysics
ed. David A. Clarke and Michael J. West ISBN 1-886733-43-0
- Vol. 124-Diffuse Infrared Radiation and the IRTS
ed. Haruyuki Okuda, Toshio Matsumoto, and Thomas L. Roellig ISBN 1-886733-44-9
- Vol. 125- Astronomical Data Analysis Software and Systems VI
ed. Gareth Hunt and H. E. Payne ISBN 1-886733-45-7
- Vol. 126-From Quantum Fluctuations to Cosmological Structures
ed. D. Vallis-Gabaud, M. A. Hendry, P. Molaro, and K. Chamcham ISBN 1-886733-46-5
- Vol. 127-Proper Motions and Galactic Astronomy
ed. Roberta M. Humphreys ISBN 1-886733-47-3

- Vol. 128- Mass Ejection from AGN (Active Galactic Nuclei)
ed. N. Arav, I. Shlosman, and R. J. Weymann ISBN 1-886733-48-1
- Vol. 129-The George Gamow Symposium
ed. E. Harper, W. C. Parke, and G. D. Anderson ISBN 1-886733-49-X
- Vol. 130-The Third Pacific Rim Conference on Recent Development on Binary Star Research
ed. Kam-Ching Leung ISBN 1-886733-50-3
- Vol. 131-Boulder-Munich II: Properties of Hot, Luminous Stars
ed. Ian D. Howarth ISBN 1-886733-51-1
- Vol. 132-Star Formation with the Infrared Space Observatory (ISO)
ed. João L. Yun and René Liseau ISBN 1-886733-53-X
- Vol. 133-Science with the NGST
ed. Eric P. Smith and Anuradha Koratkar ISBN 1-886733-53-8
- Vol. 134-Brown Dwarfs and Extrasolar Planets
ed. Rafael Rebolo, Eduardo L. Martin,
and Maria Rosa Zapatero Osorio ISBN 1-886733-54-6
- Vol. 135-A Half Century of Stellar Pulsation Interpretations: A Tribute to Arthur N. Cox
ed. P. A Bradley and J. A. Guzik ISBN 1-886733-55-4
- Vol. 136- Galactic Halos: A UC Santa Cruz Workshop
ed. Dennis Zaritsky ISBN 1-886733-56-2
- Vol. 137-Wild Stars in the Old West: Proceedings of the 13th North American Workshop
on Cataclysmic Variables and Related Objects
ed. S. Howell, E.Kuulkers, and C. Woodward ISBN 1-886733-57-0
- Vol. 138-1997 Pacific Rim Conference on Stellar Astrophysics
ed. Kwing L. Chan, K. S. Cheng, and Harinder P. Singh ISBN 1-886733-58-9
- Vol. 139-Preserving the Astronomical Windows, Proceedings of Joint Discussion
No. 5 of the 23rd General Assembly of the IAU
ed. Syuzo Isobe and Tomohiro Hirayama ISBN 1-886733-59-7
- Vol. 140-Synoptic Solar Physics – 18th NSO/Sacramento Peak Summer Workshop
ed. K. S. Balasubramaniam, J. W. Harvey, and D. M. Rabin ISBN 1-886733-60-0
- Vol. 141-Astrophysics from Antarctica
A Symposium held as part of the 109th Annual Meeting of the ASP
ed. Giles Novak and Randall H. Landsberg ISBN 1-886733-61-9
- Vol. 142-The Stellar Initial Mass Function, 38th Herstmonceux Conference
ed. Gerry Gilmore and Debbie Howell ISBN 1-886733-62-7
- Vol. 143-The Scientific Impact of the Goddard High Resolution Spectrograph
ed. John C. Brandt, Thomas B. Ake III, and Carolyn Collins Petersen ISBN 1-886733-63-5
- Vol. 144- Radio Emission from Galactic and Extragalactic Compact Sources,
IAU Colloquium 164
ed. J. Anton Zensus, G. B. Taylor, and J. M. Wrobel ISBN 1-886733-64-3
- Vol. 145-Astronomical Data Analysis Software and Systems VII
ed. Rudolf Albrecht, Richard N. Hook, and Howard A. Bushouse ISBN 1-886733-65-1
- Vol. 146-The Young Universe: Galaxy Formation and Evolution at
Intermediate and High Redshift
ed. S. D'Odorico, A. Fontana, and E. Giallongo ISBN 1-886733-66-X
- Vol. 147-Abundance Profiles: Diagnostic Tools for Galaxy History
ed. Daniel Friedli, Mike Edmunds, Carmelle Robert,
and Laurent Drissen ISBN 1-886733-67-8

- Vol. 148-Origins
ed. Charles E. Woodward, J. Michael Shull,
and Harley A. Thronson, Jr. ISBN 1-886733-68-6
- Vol. 149-Solar System Formation and Evolution
ed. D. Lazzaro, R. Vieira Martins, S. Ferraz-Mello,
J. Fernández, and C. Beaugé ISBN 1-886733-69-4
- Vol. 150-New Perspectives on Solar Prominences, IAU Colloquium 167
ed. David Webb, David Rust, and Brigitte Schmieder ISBN 1-886733-70-8
- Vol. 151-Cosmic Microwave Background and Large Scale Structure of the Universe
ed. Yong-Ik Byun and Kin-Wang Ng ISBN 1-886733-71-6
- Vol. 152-Fiber Optics in Astronomy III
ed. S. Arribas, E. Mediavilla, and F. Watson ISBN 1-886733-72-4
- Vol. 153-Library and Information Services in Astronomy III, (LISA III)
ed. Uta Grothkopf, Heinz Andernach, Sarah Stevens-Rayburn,
and Monique Gomez ISBN 1-886733-73-2
- Vol. 154-Cool Stars, Stellar Systems, and the Sun, Tenth Cambridge Workshop
ed. Robert A. Donahue and Jay A. Bookbinder ISBN 1-886733-74-0
- Vol. 155-Second Advances in Solar Physics Euroconference:
Three-Dimensional Structure of Solar Active Regions
ed. Costas E. Alissandrakis and Brigitte Schmieder ISBN 1-886733-75-9
- Vol. 156-Highly Redshifted Radio Lines
ed. C. L. Carilli, S. J. E. Radford, K. M. Menten and
G. I. Langston ISBN 1-886733-76-7
- Vol. 157-Annapolis Workshop on Magnetic Cataclysmic Variables
ed. Coel Hellier and Koji Mukai ISBN 1-886733-77-5
- Vol. 158-Solar and Stellar Activity: Similarities and Differences
ed. C. J. Butler and J. G. Doyle ISBN 1-886733-78-3
- Vol. 159-BL Lac Phenomenon
ed. Leo O. Takalo and Aimo Sillanpää ISBN 1-886733-79-1
- Vol. 160-Astrophysical Discs, An EC Summer School
ed. J. A. Sellwood and Jeremy Goodman ISBN 1-886733-80-5
- Vol. 161-High Energy Processes in Accreting Black Holes
ed. Juri Poutanen and Roland Svensson ISBN 1-886733-81-3
- Vol. 162-Quasars and Cosmology
ed. Gary Ferland and Jack Baldwin ISBN 1-886733-83-X
- Vol. 163-Star Formation in Early Type Galaxies
ed. Jordi Cepa and Patricia Carral ISBN 1-886733-84-8
- Vol. 164-Ultraviolet-Optical Space Astronomy Beyond HST
ed. Jon A. Morse, J. Michael Shull and Anne L. Kinney ISBN 1-886733-85-6
- Vol. 165-The Third Stromlo Symposium: The Galactic Halo
ed. Brad K. Gibson, Tim S. Axelrod, and Mary E. Putman ISBN 1-886733-86-4
- Vol. 166-Stromlo Workshop on High-Velocity Clouds
ed. Brad K. Gibson and Mary E. Putman ISBN 1-886733-87-2
- Vol. 167-Harmonizing Cosmic Distance Scales in a Post-HIPPARCOS Era
ed. Daniel Egret and André Heck ISBN 1-886733-88-0

- Vol. 168-New Perspectives on the Interstellar Medium
ed. A. R. Taylor, T. L. Landecker, and G. Joncas ISBN 1-886733-89-9
- Vol. 169-11th European Workshop on White Dwarfs
ed. J.-E. Solheim and E. G. Meistas ISBN 1-886733-91-0
- Vol. 170-The Low Surface Brightness Universe, IAU Colloquium 171
ed. J. I. Davies, C. Impey, and S. Phillipps ISBN 1-886733-92-9
- Vol. 171-LiBeB, Cosmic Rays, and Related X-and Gamma-Rays
ed. Reuven Ramaty, Elisabeth Vangioni-Flam,
Michel Cassé, and Keith Olive ISBN 1-886733-93-7
- Vol. 172-Astronomical Data Analysis Software and Systems VIII
ed. David M. Mehringer, Raymond L. Plante, and
Douglas A. Roberts ISBN 1-886733-94-5
- Vol. 173-Theory and Tests of Convection In Stellar Structure
ed. Álvaro Giménez, Edward F. Guinan, and Benjamín Montesinos ISBN 1-886733-95-3
- Vol. 174-Catching the Perfect Wave: Adaptive Optics and Interferometry for the 21st
Century, A Symposium held as a part of the 110th Annual Meeting of the ASP
ed. Sergio R. Restaino, William Junor, and Nebojsa Duric ISBN 1-886733-96-1
- Vol. 175-Structure and Kinematics of Quasar Broad Line Regions
ed. C.M. Gaskell, W. N. Brandt, M. Dietrich, D. Dultzin-Hacyan,
and M. Eracleous ISBN 1-886733-97-X
- Vol. 176-Observational Cosmology: The Development of Galaxy Systems
ed. Giuliano Giuricin, Marino Mezzetti, and Paolo Salucci ISBN 1-58381-000-5
- Vol. 177-Astrophysics with Infrared Surveys: A Prelude to SIRT
ed. Michael D. Bica, Chas A. Beichman, Roc M. Cutri,
and Barry F. Madore ISBN 1-58381-001-3
- Vol. 178-Stellar Dynamos: Nonlinearity and Chaotic Flows
ed. Manuel Núñez and Antonio Ferriz-Mas ISBN 1-58381-002-1
- Vol. 179-Eta Carinae At The Millennium
ed. Jon A. Morse, Roberta M. Humphreys, and Augusto Damineli ISBN 1-58381-003-X
- Vol. 180-Synthesis Imaging in Radio Astronomy II
ed. G. B. Taylor, C. L. Carilli, and R. A. Perley ISBN 1-58381-005-6
- Vol. 181-Microwave Foregrounds
ed. Angelica de Oliveira-Costa and Max Tegmark ISBN 1-58381-006-4
- Vol. 182-Galaxy Dynamics, A Rutgers Symposium
ed. David Merritt, J. A. Sellwood, and Monica Valluri ISBN 1-58381-007-2
- Vol. 183-High Resolution Solar Physics: Theory, Observations and Techniques
ed. T. R. Rimmele, K. S. Balasubramaniam, and R. R. Radick ISBN 1-58381-009-9
- Vol. 184-Third Advances in Solar Physics Euroconference: Magnetic Fields and Oscillations
ed. B. Schmieder, A. Hofmann, and J. Staude ISBN 1-58381-010-2
- Vol. 185-Precise Stellar Radial Velocities, IAU Colloquium 170
ed. J. B. Hearnshaw and C. D. Scarfe ISBN 1-58381-011-0

Book orders or inquiries concerning these volumes should be directed to the:

Astronomical Society of the Pacific Conference Series
390 Ashton Avenue
San Francisco, CA 94112-1722 USA

Phone: 415-337-2126
Fax: 415-337-5205

E-mail: catalog@aspsky.org
Web Site: <http://www.aspsky.org>

ASTRONOMICAL SOCIETY OF THE PACIFIC
CONFERENCE SERIES



Volume 185

PRECISE STELLAR RADIAL VELOCITIES
IAU Colloquium 170

Proceedings of a meeting held at
Victoria, B.C., Canada
21-26 June, 1998

Edited by

J. B. Hearnshaw
*Department of Physics & Astronomy, University of Canterbury,
Christchurch, New Zealand*

and

C. D Scarfe
*Department of Physics & Astronomy, University of Victoria,
Victoria, B. C., Canada*

Table of Contents

Preface	xx
Conference photograph	xxii
Photograph identification key	xxiii
Conference participants	xxiv

Part 1. Instruments

Spectrographs for the Measurement of Radial Velocities (invited paper)	1
<i>A. Baranne</i>	
The Fiber-Fed Spectrograph, a Tool to Detect Planets (invited paper)	13
<i>D. Queloz, M. Casse and M. Mayor</i>	
A New Spectrograph Dedicated to Precise Stellar Radial Velocities	22
<i>F. Bouchy, P. Connes and J. L. Bertaux</i>	
Some Comments on the Design of Échelle Spectrographs Using R2 or R4 Gratings for Precise Radial Velocity Measurements	29
<i>J. Hearnshaw, N. Rumsey and G. Nankivell</i>	
A New Multichannel Fourier Transform Spectrometer	36
<i>T. E. Nordgren and A. R. Hajian</i>	

Part 2. Fundamental Concepts and Techniques

Astrometric versus Spectroscopic Radial Velocities	41
<i>D. Dravins, D. Gullberg, L. Lindgren and S. Madsen</i>	
Application of the Telluric-Line Technique to Study Late-Type Stars for Radial-Velocity Variations	48
<i>R. Greimel and S. L. S. Yang</i>	
Precision versus Accuracy: Some Astrophysical and Operational Limitations	52
<i>R. E. M. Griffin</i>	
Steps toward Absolute Accuracy in Radial Velocities	58
<i>D. Gullberg</i>	
Precise Radial-Velocity Measurements with a Cassegrain Spectrograph, I: Wavelength Calibration	63
<i>I. V. Ilyin and R. Duemmler</i>	

Precise Radial-Velocity Measurements with a Cassegrain Spectrograph, II: Radial-Velocity Determination and Applications	68
<i>I. V. Ilyin and R. Duemmler</i>	
Exactly What Is Stellar ‘Radial Velocity’?	73
<i>L. Lindegren, D. Dravins and S. Madsen</i>	
Radial Velocities without Spectroscopy	77
<i>S. Madsen, L. Lindegren and D. Dravins</i>	
Determination of Broadening Functions Using the Singular-Value Decom- position (SVD) Technique	82
<i>S. Rucinski</i>	
Absolute Radial Velocities by Cross-Correlation with Synthetic Spectra	91
<i>J. Skuljan, J. B. Hearnshaw and P. L. Cottrell</i>	
Using the Radial-Velocity Spectrometer at the Dominion Astrophysical Observatory	98
<i>J. Skuljan, J. B. Hearnshaw and P. L. Cottrell</i>	
Characterizing the Nearby Solar-Type Stars	102
<i>D. R. Soderblom and J. R. King</i>	
Minimizing Radial-Velocity Errors Caused by Spectral-Type Mismatch in Early-Type Stars	108
<i>W. Verschueren, M. David and M. Vrancken</i>	
Part 3. Extrasolar Planets	
The Texas High-Precision Radial-Velocity Program (invited paper) . . .	113
<i>W. D. Cochran and A. P. Hatzes</i>	
Doppler Detection of Extra-Solar Planets (invited paper)	121
<i>G. W. Marcy, R. P. Butler and D.A. Fischer</i>	
Distinction between Extra-Solar Planets and Low-Mass Secondaries (in- vited paper)	131
<i>T. Mazeh</i>	
The Advanced Fiber-Optic Echelle (AFOE) and Extra-Solar Planet Searches (invited paper)	143
<i>P. Nisenson, A. Contos, S. Korzennik, R. Noyes and T. Brown</i>	
The ESO Precise Radial-Velocity Survey for Extra-Solar Planets: Results from the First Five Years	154
<i>M. Kürster, A. P. Hatzes, W. D. Cochran, K. Dennerl, S. Döbereiner and M. Endl</i>	
The Planet Orbiting ρ Coronae Borealis	162
<i>R. W. Noyes, A. R. Contos, S. G. Korzennik, P. Nisenson, T. M. Brown and S. D. Horner</i>	

Part 4. Asteroseismology

Radial-Velocity Observations of Non-Radially Pulsating Stars (invited paper)	166
<i>A. P. Hatzes, A. Kanaan and D. Mkrtychian</i>	
Possible Detection of P-Mode Oscillations on Procyon	177
<i>C. Barban, E. Michel, M. Martić, J. Schmitt, F. Bouchy, J. C. Lebrun, P. Connes, J. L. Bertaux and A. Baglin</i>	
Radial-Velocity Variations of the Rapidly Oscillating Ap Star 33 Lib . .	183
<i>A. P. Hatzes, A. Kanaan and D. Mkrtychian</i>	
Precise Velocity Observation of K-Giants: Evidence for Solar-Like Oscillations in Arcturus	187
<i>W. J. Merline</i>	

Part 5. Variable Stars

The Puzzling K and Early-M Giants: A Summary of Precise Radial-Velocity Results for 15 Stars(invited paper)	193
<i>A. M. Larson, S. L. S. Yang and G. A. H. Walker</i>	
High-Precision Radial-Velocity Measurements of Late-Type Evolved Stars	204
<i>I. N. Cummings, J. B. Hearnshaw, F. M. Kilmartin and A.C. Gilmore</i>	
Importance of Precise Radial Velocities for Cepheid Binaries	211
<i>L. Szabados</i>	
How Could Precise Stellar Radial Velocities Help to Understand Field and Cluster-Member Flare Stars	218
<i>G. Szécsényi-Nagy</i>	
Limitations of Precise Radial-Velocity Measurements in Pulsating Stellar Atmospheres	223
<i>J. Vinkó, G. Kaszás and L. L. Kiss</i>	
Radial-Velocity Variations of Late-Type Variables	228
<i>S. L. S. Yang, G. A. H. Walker and A. M. Larson</i>	

Part 6. Stellar Rotation, Doppler Imaging

Doppler Imaging of Stars with Surface Inhomogeneities (invited paper)	233
<i>A. Collier Cameron</i>	
Stellar Rotation and Precise Radial Velocities (invited paper)	243
<i>D. F. Gray</i>	
The Problem of Uniqueness in Doppler Imaging	255
<i>M. Al-Malki and Z. Eker</i>	
Radial-Velocity Variations from Starspots	259
<i>A. P. Hatzes</i>	

- Doppler Imaging of Stellar Oscillations: Multi-Site Observations of Epsilon Cephei 264
E. J. Kennelly, T. M. Brown, P. Ehrenfreund, B. Foing, J. Hao, S. Horner, S. Korzennik, P. Nisenson, R. Noyes and P. Sonnentrucker

Part 7. Convection, Line Asymmetry

- Stellar Surface Convection, Line Asymmetries, and Wavelength Shifts (invited paper) 268
D. Dravins
- The Value of Fabry-Perot Interferometry in Studying Long-Term Convective Line Shifts (invited paper) 278
R. S. McMillan, T. H. Bressi, J. L. Montani, T. L. Moore, M. L. Perry and A. F. Tubbiolo
- Differential Fe I Line Shifts as Convective Signatures in R = 40 000 Échelle Spectra 286
D. Gullberg
- Convective Lineshifts in the Infrared Region of the Solar Spectrum . . . 291
D. Hamilton and J. B. Lester

Part 8. Binary Stars

- A Program for the Analysis of Long-Period Binaries: The Case of γ Delphini (invited paper) 297
A. W. Irwin, D. A. Vandenberg and A. M. Larson
- Radial Velocities of Visual and Interferometric Binaries (invited paper) 308
C. D. Scarfe and D. J. Barlow
- A Method of Measuring Gamma-Velocities of Contact Binary Stars . . . 321
G. Kaszás, J. Vinkó and G. Fürész
- Spectroscopic Orbit of the Eclipsing Binary BD +52°2009 325
B. Khalessheh
- On the Binarity of the F0p Magnetic Stars γ Equ and 49 Cam 331
D. E. Mkrtychian, N. N. Samus, N. A. Gorynya, P. North and A. P. Hatzes
- Upward Revision of the Individual Masses in Alpha Cen: Implications for the Evolutionary State of the System 335
C. Neuforge, D. Pourbaix, A. Noels and R. Scuflaire
- α Centauri Revisited: When the Spectroscopic and the Astrometric Mass Ratios Become Consistent 340
D. Pourbaix
- Discovering New Spectroscopic Components in Visual Multiple Stars . . 347
A. A. Tokovinin

Part 9. Radial-Velocity Standards

Radial-Velocity Standard Stars (invited paper)	354
<i>R. P. Stefanik, D. W. Latham and G. Torres</i>	
Towards a New Set of High-Precision Radial-Velocity Standard Stars (invited paper)	367
<i>S. Udry, M. Mayor and D. Queloz</i>	
The Status of Early-Type Radial-Velocity Standards	378
<i>F. C. Fekel</i>	
20 Years of CORAVEL Monitoring of Radial-Velocity Standard Stars	383
<i>S. Udry, M. Mayor, E. Maurice, J. Andersen, M. Imbert, H. Lindgren, J.-C. Mermilliod, B. Nordström and L. Prévot</i>	

Part 10. Radial Velocities, Interferometry and Space Missions

Combining High Angular-Resolution Interferometry and Spectroscopy in Studies of Stars and Stellar Systems (invited paper)	390
<i>J. Davis</i>	
Future Directions for Radial-Velocity Research (invited paper)	401
<i>D. W. Latham</i>	
Derivation of Orbital Parameters of Very Low-Mass Companions in Double Stars from Radial Velocities and Observations of Space-Astrometry Missions like HIPPARCOS, DIVA and GAIA	410
<i>H.-H. Bernstein</i>	
Imaging and Modeling of Double Stars with the Navy Prototype Optical Interferometer; a Continuation of the Mark III Double-Star Program	416
<i>C. A. Hummel</i>	

Part 11. Conclusions

Retrospect (invited paper)	422
<i>G. A. H. Walker</i>	
Author index	429

Preface

IAU Colloquium 170, on Precise Stellar Radial Velocities, was sponsored by IAU Commission 30 (Radial Velocities), with the support of Commissions 9, 26, 27, 29, 36 and 42; Division IX was the coordinating division. The scientific organizing committee was chaired by John Hearnshaw (New Zealand), with David Latham (U.S.A.) as deputy chairman, and included Gilbert Burki (Switzerland), Paul Butler (U.S.A. - Australia), William Cochran (U.S.A.), Dainis Dravins (Sweden), David Gray (Canada), Roger Griffin (U.K.), Alan Irwin (Canada), Michel Mayor (Switzerland), Tsevi Mazeh (Israel), Robert McMillan (U.S.A.), Larry Ramsey (U.S.A.), Colin Scarfe (Canada) and Robert Stefanik (U.S.A.)

Fourteen years of rapid progress had elapsed since the last IAU meeting on stellar radial velocities (Colloquium 88), and hence this meeting was timely. In particular, the previous three years had seen the first detection of extrasolar planets, as a result of the substantially higher precision of radial velocities achieved by the use of CCDs.

The scope of the Colloquium was deliberately broad, and included all effects on stellar spectral lines which involve the Doppler effect, and give rise to line broadening and line asymmetry, as well as a discussion of gravitational redshifts. Thus stellar rotation, stellar convection, binary star orbits, pulsating variable stars, spotted stars and asteroseismology were all discussed at Colloquium 170.

The meeting took place between Sunday June 21 and Friday June 26, 1998, at Victoria, B.C., Canada. Its venue was Dunsmuir Lodge, a conference center of the University of Victoria, located on a wooded hillside some 20 km from the university campus, but overlooking the Victoria airport. Almost all the participants from outside Victoria were housed at the Lodge, which provided much opportunity for informal discussion away from sessions. Seventy people from nineteen countries participated in the Colloquium.

The local organizing committee was chaired by Colin Scarfe, with Alison Marchant, administrative officer of the university's Physics and Astronomy Department, as its treasurer. Other members were Russell Robb, Stephenson Yang and Alan Irwin from the university, and Murray Fletcher and Alan Batten from the Dominion Astrophysical Observatory (DAO), part of the Herzberg Institute of Astrophysics of the National Research Council of Canada. Lorraine Charron served briefly as the committee's secretary, and Ann Scarfe, assisted by Margaret Robb, organized a program of activities for the companions of participants.

The meeting was structured around a series of about 20 invited talks, with contributed papers related to them presented either orally or as posters. It proved to be possible to allow each poster paper to be discussed briefly orally as well. The discussion was often quite lively, but with controversial topics treated in a good-humored fashion. The difficult task of summing things up was ably handled by Gordon Walker.

Subsequent to the meeting, a few papers were published elsewhere, or were merged by agreement between their authors. Three of the invited talks, however, had not been submitted to the editors after more than a year, despite

repeated reminders and entreaties. They were “Searching for Giant Planets at the Haute Provence Observatory”, by Michel Mayor et al., “Radial Velocities: Other Planetary Systems, Solar and Stellar Seismology”, by George Isaak, and “Asteroseismology of Sun-like Stars with the Advanced Fiber Optic Echelle”, by Tim Brown. To avoid further delay, the editors reluctantly decided to proceed without those contributions, although aware that this volume would be the poorer as a result.

The editors would like to thank all the other participants for providing their manuscripts, many of them promptly and a few somewhat more tardily. The organizers would like to thank the IAU Executive Committee for its support, as well as the University of Victoria administration, primarily Dean of Science John Weaver and Acting Associate Vice-President for Research Howard Brunt. Many members of the Physics and Astronomy Department, and several members of the staff of the DAO, in addition to those named above, provided material assistance with the arrangements. In particular, Russell Robb, Rob Cardinal and Chris Aikman set up and maintained the audio-visual equipment and recorded the discussion, Gerry Justice arranged Internet links to Dunsmuir Lodge, and Don Moffatt and Frank Younger conducted an evening tour of the DAO. Another evening was enlivened by a concert of the marimba music of Graham Hargrove and Nicholas Coulter. The entire staff of Dunsmuir Lodge, led by its manager, Robin Cameron, and its conference officer, Leslie Solojuk, worked hard to ensure a pleasant and comfortable environment for the meeting. To all, we express our gratitude on behalf of all the participants.

1999 July

John Hearnshaw
Colin Scarfe

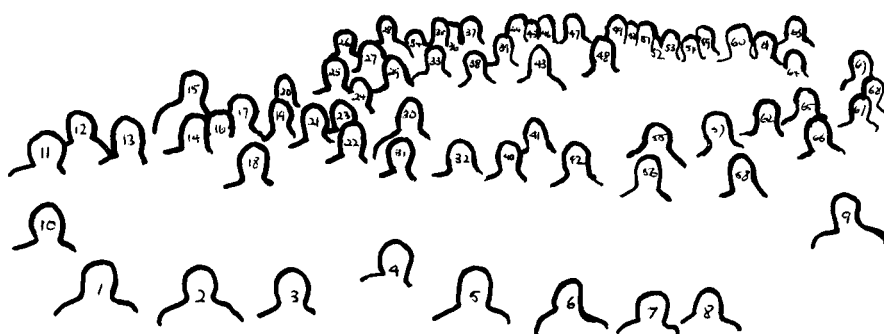
Cover illustration: Two of the themes of this meeting are represented in the cover picture, which juxtaposes a schematic view of the principles of Doppler imaging of spotted stars (see Collier Cameron, page 233) and a plot of the measured velocities for Gliese 876, from which the existence of an accompanying planet was deduced (see Marcy et al., page 121).

Conference Photo



Identification Key to Conference Photograph

- | | | |
|-------------------|----------------------|--------------------|
| 1. R. McMillan | 2. J. Lester | 3. J. Davis |
| 4. C. Hummel | 5. G. Szécsényi-Nagy | 6. D. Gullberg |
| 7. T. Mazeh | 8. R. Noyes | 9. M. Al-Malki |
| 10. S. Yang | 11. C. Scarfe | 12. D. Popper |
| 13. H. Bernstein | 14. M. Kürster | 15. G. Walker |
| 16. D. Hamilton | 17. S. Rucinski | 18. B. Khalessheh |
| 19. G. Kaszás | 20. D. Queloz | 21. J. Vinkó |
| 22. D. Dravins | 23. L. Szabados | 24. T. Brown |
| 25. S. Desidera | 26. G. Ecker | 27. I. Cummings |
| 28. L. Ramsey | 29. J. Skuljan | 30. D. Soderblom |
| 31. W. Cochran | 32. A. Cochran | 33. A. Cameron |
| 34. D. Pourbaix | 35. D. Stickland | 36. D. Gray |
| 37. C. Aikman | 38. G. Marcy | 39. W. Verschueren |
| 40. R. Robb | 41. R. Cardinal | 42. A. Larson |
| 43. D. Fischer | 44. S. Horner | 45. P. Nisenson |
| 46. I. Ilyin | 47. D. Richardson | 48. A. Tokovinin |
| 49. D. Mkrtychian | 50. F. Bouchy | 51. J. Hearnshaw |
| 52. P. Lampens | 53. A. Hatzes | 54. A. Batten |
| 55. M. Mayor | 56. A. Baranne | 57. D. Latham |
| 58. A. Contos | 59. F. Fekel | 60. A. Irwin |
| 61. G. Isaak | 62. T. Nordgren | 63. M. Fletcher |
| 64. C. Barban | 65. S. Udry | 66. A. Hajian |
| 67. R. Stefanik | 68. C. McCarthy | 69. E. Griffin |
- Missing: W. Merline



List of Participants – IAU Colloquium 170

Name	Country	Name	Country
Aikman, Chris	Canada	Al-Malki, Mohammed	Saudi Arabia
Baranne, Andre	France	Barban, Caroline	France
Batten, Alan	Canada	Bernstein, Hans-Heinrich	Germany
Bouchy, Francois	France	Brown, Tim	U.S.A.
Cameron, Andrew	U.K.	Cardinal, Rob	Canada
Cochran, Anita	U.S.A.	Cochran, William	U.S.A.
Contos, Adam	U.S.A.	Cummings, Irene	New Zealand
Davis, John	Australia	Desidera, Silvano	Italy
Dravins, Dainis	Sweden	Ecker, George	Israel
Fekel, Frank	U.S.A.	Fischer, Debra	U.S.A.
Fletcher, Murray	Canada	Gray, David	Canada
Griffin, Elizabeth	U.K.	Gullberg, Dag	Sweden
Hajian, Arsen	U.S.A.	Hamilton, Devon	Canada
Hatzes, Artie	U.S.A.	Hearnshaw, John	New Zealand
Horner, Scott	U.S.A.	Hummel, Christian	U.S.A.
Ilyin, Ilya	Finland	Irwin, Alan	Canada
Isaak, George	U.K.	Kaszás, Gabor	Hungary
Khalesseh, Bahram	Iran	Kürster, Martin	Chile
Lampens, Patricia	Belgium	Larson, Ana	U.S.A.
Latham, David	U.S.A.	Lester, John	Canada
Marcy, Geoff	U.S.A.	Mayor, Michel	Switzerland
Mazeh, Tsevi	Israel	McCarthy, Chris	U.S.A.
McMillan, Robert	U.S.A.	Merline, William	U.S.A.
Mkrtichian, David	Ukraine	Nisenson, Peter	U.S.A.
Nordgren, Tyler	U.S.A.	Noyes, Robert	U.S.A.
Popper, Dan	U.S.A.	Pourbaix, Dimitri	Belgium
Queloz, Didier	U.S.A.	Ramsey, Larry	U.S.A.
Richardson, Derek	U.S.A.	Robb, Russell	Canada
Rucinski, Slavek	Canada	Scarfe, Colin	Canada
Skuljan, Jovan	New Zealand	Soderblom, David	U.S.A.
Stefanik, Robert	U.S.A.	Stickland, David	U.K.
Szabados, Laszlo	Hungary	Szécsényi-Nagy, Gabor	Hungary
Tokovinin, Andrei	Russia	Udry, Stephane	Switzerland
Verschueren, Werner	Belgium	Vinkó, Jozsef	Hungary
Walker, Gordon	Canada	Yang, Stephenson	Canada