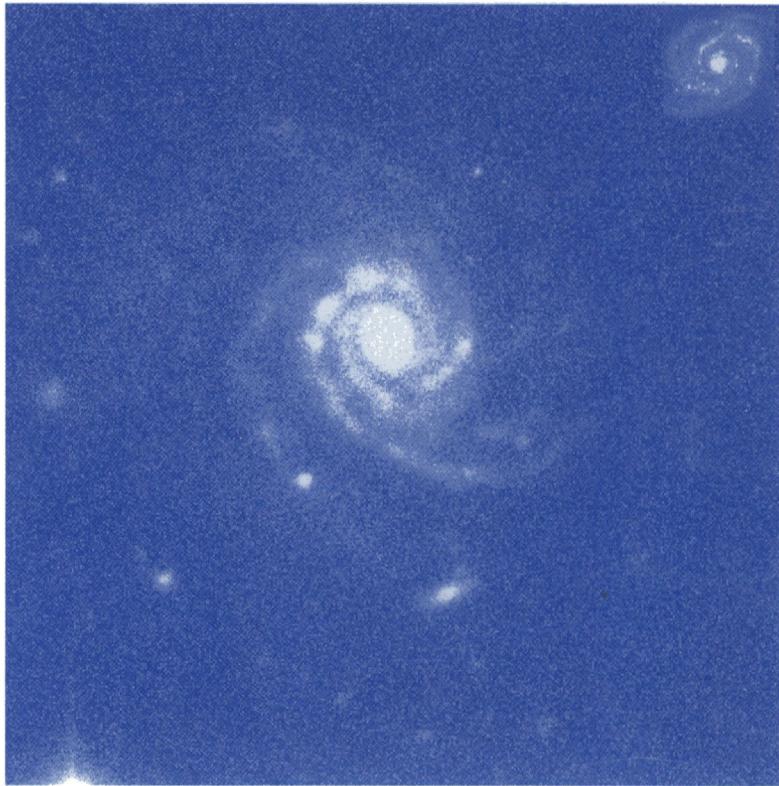




**THE LOW SURFACE BRIGHTNESS UNIVERSE
IAU Colloquium 171**



**Edited by
J. I. Davies, C. Impey, and S. Phillipps**

THE LOW SURFACE BRIGHTNESS UNIVERSE
IAU Colloquium 171

COVER ILLUSTRATION:

The picture on the front cover is of the giant Low Surface Brightness Galaxy Malin 3. Inset is M51 shown on the same scale. The image of Malin 3 has been contrast enhanced.

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 BookCrafters, Inc.

First published 1999

**Library of Congress Catalog Card Number: 99-62757
ISBN 1-886733-92-9**

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. Pritchett 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. Marcellin	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 conjuunction 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 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

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@aspky.org
Web Site: <http://www.aspky.org>

ASTRONOMICAL SOCIETY OF THE PACIFIC
CONFERENCE SERIES



Volume 170
THE LOW SURFACE BRIGHTNESS UNIVERSE
IAU Colloquium 171

**Proceedings of an IAU Colloquium held at
Cardiff, Wales
5-10 July, 1998**

Edited by
J. I. Davies, C. Impey, and S. Phillipps

Contents

<i>Preface</i>	xx
Observational selection effects	
Historical Introduction	
<i>K. C. Freeman</i>	3
Is there a Low Surface Brightness Universe ?	
<i>M. J. Disney</i>	9
Optical Galaxy Selection	
<i>S. McGaugh</i>	19
Selection effects at 21cm	
<i>F. H. Briggs</i>	27
Constraints on the unseen galaxy population from the Ly α forest	
<i>K. M. Lanzetta, Hsiao-Wen Chen, J. K. Webb and X. Barcons</i>	35
Luminosity and surface brightness distributions	
Low luminosity galaxies in large surveys	
<i>J. P. Huchra</i>	45
The space density of spiral galaxies as a function of their luminosity, surface brightness and scalesize	
<i>R. S. de Jong and C. Lacey</i>	52
The faint end of the galaxy luminosity function in rich clusters	
<i>R. M. Smith, S. Phillipps, S. P. Driver and W. J. Couch</i>	60
Optical and near-IR field luminosity functions	
<i>J. Loveday</i>	68
Low surface brightness galaxies in deep surveys	
<i>H. C. Ferguson</i>	76
Low surface brightness dwarf galaxies in the Bristol-Anglo-Australian Observatory Virgo cluster survey	
<i>J. B. Jones, S. Phillipps, J. M. Schwartzenberg and Q. A. Parker</i>	84
A dichotomy between HSB and LSB galaxies	
<i>M. Verheijen and B. Tully</i>	92

Low Surface Brightness galaxy surveys

Multi-Wavelength Surveys for Galaxies Hidden by the Milky Way <i>R. C. Kraan-Korteweg</i>	103
A survey for low surface brightness dwarf galaxies around M31 <i>T. E. Armandroff, J. E. Davies and G. H. Jacoby</i>	111
The Fornax spectroscopic survey - Low Surface Brightness galaxies in Fornax <i>M. J. Drinkwater, S. Phillipps and J. B. Jones</i>	120
Found: High Surface Brightness compact galaxies <i>M. J. Drinkwater, S. Phillipps, J. B. Jones, M. D. Gregg Q. A. Parker, R. M. Smith, J. I. Davies and E. M. Sadler</i>	128
Counting the ghosts: optical field surveys for Low Surface Brightness galaxies <i>J. J. Dalcanton</i>	131
The radial extent of the Fornax cluster Low Surface Brightness galaxy population <i>J. I. Davies, A. Kambas, Z. Morshidi-Esslinger and R. Smith</i>	138
The discovery of red Low Surface brightness galaxies <i>K. O'Neil</i>	145
Dwarf galaxies in nearby groups <i>T. Bremnes, B. Binggeli and P. Prugniel</i>	154
Low Surface Brightness Dwarf Galaxies in Nearby Clusters <i>K. Chiboucas and M. Mateo</i>	157
Properties of Low Surface Brightness galaxies	
The interstellar medium in Low Surface Brightness galaxies <i>W. J. G. de Blok</i>	161
Dwarf galaxies as Low Surface Brightness galaxies <i>E. D. Skillman</i>	169
Low Surface Brightness galaxies beyond z=0.5: existence, detection and properties <i>G. Bothun</i>	177
Environmental effects on the faint end of the luminosity function <i>S. Phillipps, J. B. Jones, R. M. Smith, W. J. Couch and S. P. Driver</i>	183

Morphology and stellar populations in the gas-rich, giant Low Surface Brightness galaxies <i>P. Knezeck</i>	191
The extreme outer regions of disk galaxies: star formation and metal abundances <i>A. Ferguson, R. Wyse and J. Gallagher</i>	196
The Low Surface Brightness galaxy HIPASS1126-72 <i>V. Kilborn, E. de Blok, L. Stavely-Smith and R. Webster</i>	204
The structure of the super thin spiral galaxy UGC7321 <i>L. D. Matthews, J. S. Gallagher and W. van Driel</i>	207
HST WFC-2 imaging of four nearby Low Surface Brightness galaxies <i>K. O'Neil</i>	210
Kinematics of giant Low Surface Brightness galaxies <i>T. E. Pickering</i>	214
What causes the HI holes in gas-rich Low Surface Brightness dwarfs ? <i>K. L. Rhode, J. J. Salzer and D. J. Westpfahl</i>	221
VLA HI imaging of the Low Surface Brightness dwarf galaxy DDO47 <i>F. Walter and E. Brinks</i>	224
The evolution of Low Surface Brightness galaxies	
The fate of Low Surface Brightness galaxies in clusters and the origin of the diffuse intra-cluster light <i>B. Moore, G. Lake, J. Stadel and T. Quinn</i>	229
The structure of the multi-phase ISM in Low Surface Brightness galaxies <i>M. Spaans</i>	237
The star formation histories of Low Surface Brightness galaxies <i>E. F. Bell, R. G. Bower, R. S. de Jong, B. J. Rauscher, D. Barnaby, D. A. Harper, M. Hereld and R. F. Loewenstein</i>	245
Gas rich Low Surface Brightness galaxies - progenitors of blue compact dwarfs ? <i>J. J. Salzer and S. A. Norton</i>	253

Morphological aspects of star formation in dwarf galaxies <i>N. Brosch, A. Heller and E. Almoznino</i>	261
The connection between dE and dI galaxies <i>B. W. Miller</i>	271
Star formation thresholds in Low Surface Brightness dwarf galaxies <i>L. van Zee</i>	274
Testing environmental influences on star formation with a sample of Low Surface Brightness dwarf galaxies in the Vigo cluster <i>A. Heller, E. Almoznino and N. Brosch</i>	282
HI and QSO absorption lines	
The Parkes Multi-beam blind HI survey <i>R. L. Webster, V. Kilborn, J. C. O'Brien, L. Stavely-Smith, M. E. Putman and G. Banks</i>	291
HI in Karachentsev objects: properties of new nearby dwarf galaxies <i>W. K. Huchtmeier</i>	299
An HI survey of Low Surface Brightness galaxies selected from the APM survey <i>S. Côté, T. Broadhurst, J. Loveday and S. Kolind</i>	307
Using weak MgII lines to chart Low Surface Brightness galaxies <i>V. Le Brun and C. W. Churchill</i>	315
Simulations of Ly α absorption from Low Surface Brightness galaxies <i>S. W. Linder</i>	323
First results from the HI Parkes zone of avoidance survey <i>P. A. Henning, L. Stavely-Smith, R. C. Kraan-Korteweg and E. M. Sadler</i>	331
Results from the Dwingeloo obscured galaxies survey <i>A. J. Rivers, P. A. Henning, R. C. Kraan-Korteweg, O. Lahav and W. B. Burton</i>	334
HI properties of Low Surface Brightness dwarf and blue compact dwarf galaxies <i>C. L. Taylor, E. Brinks and E. D. Skillman</i>	337

Extra-galactic background light

The HST/LCO measurement of the optical extra-galactic
background light

R. A. Bernstein

341

Optical diffuse light in clusters of galaxies

R. Vilchez-Gómez

349

Diffuse ultraviolet background radiation

R. C. Henry

357

Detecting the Low Surface Brightness Universe: the extra-galactic
background light and LSB galaxies

P. Väisänen and E. V. Tollestrup

365

The baryonic mass content of the Universe

Cosmic baryon density from primordial nucleosynthesis and
other evidence

B. E. J. Pagel

375

Chemical constraints, baryonic mass and the chemical
evolution of Low Surface Brightness galaxies

M. G. Edmunds

383

Helium abundances in the most metal-deficient dwarf galaxies

Y. I. Izotov

390

What we don't know about the Universe

C. Impey

393