

# PHYSICS, CHEMISTRY, AND DYNAMICS OF INTERPLANETARY DUST

On the cover is mosaic images of Comet Hyakutake, taken at the University of Florida Rosmary Hill Observatory on 25 March 1996 when the comet passed 0.1 AU from the Earth. The images were taken using a CCD camera without any filter; the mosaic covers  $8 \times 10^6$  km along the plasma tail. The coma surrounding the nucleus is visible at the right hand edge of the mosaic. Also of interest is the disconnection event in the plasma tail of the comet to the left. These disconnection events are thought to be associated with magnetic sector boundaries in the solar wind. At the bottom of the picture is the face-on spiral galaxy M101. The bright knots in the arms of the galaxy are HII regions. This image is part of a larger mosaic shown below which depicts the coma and 29 degrees of the tail.

Credit: Photo by James M. De Buizer and James T. Radomski, University of Florida, Department of Astronomy. Copyright by the University of Florida.

# **A SERIES OF BOOKS ON RECENT DEVELOPMENTS IN ASTRONOMY AND ASTROPHYSICS**

---

**A.S.P. CONFERENCE SERIES  
PUBLICATIONS COMMITTEE**

**Dr. Sallie L. Baliunas, Chair  
Dr. John P. Huchra  
Dr. Roberta M. Humphreys  
Dr. Catherine A. Pilachowski**

**© Copyright 1996 Astronomical Society of the Pacific  
390 Ashton Avenue, San Francisco, California 94112**

**All rights reserved**

**Printed by BookCrafters, Inc.**

**First published 1996**

**Library of Congress Catalog Card Number: 96-85542  
ISBN 1-886733-24-4**

**D. Harold McNamara, Managing Editor of Conference Series  
206 KMB  
Brigham Young University  
Provo, UT 84602-4463  
801-378-2298**

**pasp@astro.byu.edu  
Fax 801-378-2265**

# A SERIES OF BOOKS ON RECENT DEVELOPMENTS IN ASTRONOMY AND ASTROPHYSICS

---

- Vol. 1-Progress and Opportunities in Southern Hemisphere Optical Astronomy: The 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-The Evolution of the Universe of Galaxies. The 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-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 Application, IAU Colloquium 131  
ed. T. J. Cornwell and R. A. Perley ISBN 0-937707-38-4
- Vol. 20-Frontiers of Stellar Evolution, celebrating the 50th Anniversary of McDonald Observatory  
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 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-Workshop on Cataclysmic Variable Stars ed. N. Vogt	ISBN 0-937707-48-1
Vol. 30-Variable Stars and Galaxies, in honor of M. S. Feast on his retirement 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 Collouquium 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 and 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 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  
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, 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  
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  
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. R. Binzel, Y. Kozai, 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  
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,  
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 Systems 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  
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. K. 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, Vicent Martinez, and Maria-Jesus Pons-Borderia ISBN 1-886733-15-5
- Vol. 95-Solar Drivers of Interplanetary and Terrestrial Disturbances  
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  
ed. Stephen S. Holt and George 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 Å. S. Gustafson and Martha S. Hanner ISBN 1-886733-24-4

Inquiries concerning these volumes should be directed to the:  
Astronomical Society of the Pacific  
CONFERENCE SERIES  
390 Ashton Avenue  
San Francisco, CA 94112-1722  
415-337-1100

ASTRONOMICAL SOCIETY OF THE PACIFIC  
CONFERENCE SERIES



**Volume 104**

**PHYSICS, CHEMISTRY, AND DYNAMICS OF  
INTERPLANETARY DUST**

**Proceedings of the 150th Colloquium of the  
International Astronomical Union held in  
Gainesville, Florida, USA, 14-18 August 1995**

**Edited by  
Bo Å. S. Gustafson and Martha S. Hanner**



## TABLE OF CONTENTS

<b>PREFACE</b> . . . . .	xix
<b>ACKNOWLEDGEMENTS</b> . . . . .	xxi
<b>PHOTOGRAPH OF COLLOQUIUM PARTICIPANTS</b> . . . . .	xxii
<b>LIST OF PARTICIPANTS</b> . . . . .	xxiv
<b>ORGANIZING COMMITTEES</b> . . . . .	xxix
 <b>I. DYNAMICS OF THE INTERPLANETARY DUST CLOUD</b>	
 <b>DYNAMIC POPULATIONS OF DUST IN INTERPLANETARY SPACE</b>	
(Invited review) . . . . .	3
E. Grün and P. Staubach . . . . .	
<b>A REFORMULATION OF DIVINE'S INTERPLANETARY MODEL</b> . . . . .	15
M.J. Matney and D.J. Kessler . . . . .	
<b>ANALYSIS OF ULYSSES DUST MEASUREMENTS WITHIN THE</b>	
<b>ASTEROID BELT</b> . . . . .	19
I. Mann, M. Wilck and E. Grün . . . . .	
<b>JOVIAN DUST BURSTS</b> . . . . .	23
H.A. Zook, E. Grün, M. Baguhl, D. Hamilton, G. Linkert,	
J.-C. Liou, R. Forsyth and J.L. Phillips . . . . .	
<b>DETECTION OF POSSIBLE INTERSTELLAR PARTICLES BY</b>	
<b>THE HITEN SPACECRAFT</b> . . . . .	27
H. Svedhem, R. Münzenmayer and H. Iglseider . . . . .	
<b>ELECTROMAGNETIC ESCAPE OF DUST FROM THE SOLAR SYSTEM</b>	31
D.P. Hamilton, E. Grün and M. Baguhl . . . . .	
<b>INTERSTELLAR GRAIN FLOW THROUGH THE SOLAR WIND CAVITY</b>	
<b>AROUND 1992</b> . . . . .	35
B.Å.S. Gustafson and S.M. Lederer . . . . .	
<b>TRAPPING OF DUST PARTICLES INTO INTERNAL RESONANCES</b>	
<b>WITH THE INNER PLANETS</b> . . . . .	39
R.S. Gomes . . . . .	
<b>DYNAMICAL EVOLUTION OF INTERPLANETARY DUST DUE TO GRAV-</b>	
<b>ITATIONAL SCATTERING BY JUPITER AND THE INNER PLANETS</b>	43
N.N. Gor'kavyi, L.M. Ozernoy and J.C. Mather . . . . .	
<b>ORBITAL EVOLUTION OF THE LUNAR EJECTA</b> . . . . .	47
S. Yamamoto and T. Mukai . . . . .	
 <b>II. METEORS</b>	
<b>THE PHYSICS OF METEORS (Invited review)</b> . . . . .	53
Z. Ceplecha . . . . .	
<b>THE METEOROID ORBIT FACILITY AMOR: RECENT DEVELOPMENTS</b>	
<b>(Invited contribution)</b> . . . . .	65
J.W. Baggaley and R.G.T. Bennett . . . . .	

ON THE DETERMINATION OF VELOCITIES OF RADAR METEORS . . . . .	71
P. Pecina	
A NEW TECHNIQUE FOR RADAR METEOR SPEED DETERMINATION: INTER-PULSE PHASE CHANGES FROM HEAD ECHOES . . . . .	75
A.D. Taylor, M.A. Cervera, W.G. Elford and D.I. Steel	
FRAGMENTING PARTICLES DURING 1989-1994 PERSEID RADAR OBSERVATIONS . . . . .	79
M. Šimek	
OPTICAL SEARCH FOR HIGH METEORS IN HYPERBOLIC ORBITS . . . . .	83
S.C. Woodworth and R.L. Hawkes	
 <b>III. METEOROID STREAMS</b>	
THE EVOLUTION OF METEOROID STREAMS (Invited review) . . . . .	89
I.P. Williams	
THE FORMATION AND EVOLUTION OF THE PERSEID METEOROID STREAM . . . . .	101
N.W. Harris	
MODELLING THE ORBITAL EVOLUTION OF THE PERSEID METEORIDS . . . . .	105
J. Jones and P. Brown	
ACTIVITY OF THE NEW FILAMENT IN THE PERSEID METEOR STREAM . . . . .	109
M. Šimek and P. Pecina	
DYNAMICS OF THE LEONID METEOROID STREAM: A NUMERICAL APPROACH . . . . .	113
P. Brown and J. Jones	
THE FIRST IN A NEW SERIES OF LEONID OUTBURSTS . . . . .	117
P. Jenniskens	
REGULAR AND STOCHASTIC MOTION OF METEOROID STREAMS IN HALLEY-TYPE ORBITS . . . . .	121
V.V. Emel'yanenko and M.E. Bailey	
WHEN MIGHT 2P/ENCKE HAVE PRODUCED METEOR STORMS? . . . . .	125
D.I. Steel and D.J. Asher	
NO METEOR STORMS EXPECTED FROM P/MACHHOLZ 2 . . . . .	129
D.J. Asher and D.I. Steel	
DYNAMIC AND PROBABILISTIC RELATION BETWEEN METEORIDS AND THEIR PARENT BODIES . . . . .	133
L.G. Adolfsson and B.Å.S. Gustafson	
MODELLING THE EJECTION OF METEORIDS FROM COMETS . . . . .	137
J. Jones and P. Brown	

#### IV. ORIGIN OF THE INTERPLANETARY DUST CLOUD

SOURCES OF INTERPLANETARY DUST (Invited review) . . . . .	143
S.F. Dermott, K. Grogan, B.Å.S. Gustafson, S. Jayaraman, S.J. Kortenkamp and Y.L. Xu	
ESTIMATING THE ASTEROIDAL COMPONENT OF THE ZODIACAL CLOUD USING THE EARTH'S RESONANT RING . . . . .	155
S. Jayaraman and S.F. Dermott	
SIRTF: A UNIQUE OPPORTUNITY FOR PROBING THE ZODIACAL CLOUD . . . . .	159
S. Jayaraman, S.F. Dermott and M. Werner	
THE CONTRIBUTION OF KUIPER BELT DUST GRAINS TO THE INNER SOLAR SYSTEM . . . . .	163
J.-C. Liou, H.A. Zook and S.F. Dermott	
NATURALLY OCCURRING SELECTION EFFECTS ON THE TERREST- RIAL ACCRETION OF INTERPLANETARY DUST PARTICLES . . . . .	167
S.J. Kortenkamp, S.F. Dermott and J.C. Liou	
SOURCES OF 10 MICRON INTERPLANETARY DUST: THE CONTRIBUTION FROM THE KUIPER BELT . . . . .	171
G.J. Flynn	

#### V. DUSTY PLANETARY RINGS

THE CONTAMINATION OF IAPETUS BY PHOEBE DUST . . . . .	179
J.A. Burns, D.P. Hamilton, F. Mignard and S. Soter	
ORBITAL EVOLUTION OF SMALL PARTICLES EJECTED FROM MARTIAN SATELLITES . . . . .	183
H. Ishimoto	
MARTIAN SELF-SUSTAINING DUST TORUS . . . . .	187
S. Sasaki	

#### VI. DUST MEASUREMENTS FROM EARTH ORBIT

RECENT NEAR EARTH SATELLITE FLUX DATA: CONTRIBUTIONS IN THE DEFINITION OF THE INTERPLANETARY FLUX AT 1 AU HELIOCENTRIC DISTANCE (Invited review) . . . . .	193
J.A.M. McDonnell, D.J. Gardner and N. McBride	
SPACE DEBRIS (Invited contribution) . . . . .	201
D.J. Kessler, P.D. Anz-Meador and M.J. Matney	
ARCHIVING IMPACT DATA: THE LDEF IDE DATABASE . . . . .	209
K.G. Paul	
MICROPARTICLE IMPACTS OBSERVED ON THE HUBBLE SPACE TELESCOPE SOLAR ARRAY . . . . .	213
L. Berthoud and K. Paul	

EMPIRICAL SCALING LAWS FOR CRATER DIMENSIONS FOR IMPACTS INTO SOLAR CELLS . . . . .	217
K.G. Paul and L. Berthoud	

## VII. INSTRUMENTATION

STARDUST: COMET AND INTERSTELLAR DUST SAMPLE RETURN MISSION . . . . .	223
D.E. Brownlee, D. Burnett, B. Clark, M.S. Hanner, F. Horz, J. Kissel, R. Newburn, S. Sandford, Z. Sekanina, P. Tsou and M. Zolensky	

THE COSMIC DUST ANALYZER FOR THE CASSINI MISSION TO SATURN . . . . .	227
R. Srama, E. Grün, The CASSINI-Dust-Science Team	

MARS DUST COUNTER ON BOARD ISAS PLANET-B . . . . .	233
E. Igenbergs, S. Sasaki, G. Färber, F. Fisher, R. Münzenmayer, A. Fujiwara, H. Iglseider, A. Glasmachers, E. Grün, T. Mukai, K.-i. Nogami, H. Ohashi, G. Schwehm, H. Svedhem and K. Yamakoshi	

HYPERVELOCITY CAPTURE OF METEOROIDS IN AEROGEL . . . . .	237
P. Tsou	

A COLLECTOR FOR INTERPLANETARY DUST PARTICLES AND SPACE DEBRIS . . . . .	243
Y.-L. Xu, H.Q. Zhang, N. Zhang, M. Yu, P. Xie and C.Y. Fan	

AN OPTICAL INSTRUMENT TO CHARACTERIZE INDIVIDUAL DUST PARTICLES . . . . .	247
F. Giovane, B.Å.S. Gustafson and Ph.L. Lamy	

ACCURACY OF A VELOCITY/TRAJECTORY SENSOR FOR CHARGED DUST PARTICLES . . . . .	251
S. Auer	

CONCEPTS FOR DUST VELOCITY MEASUREMENTS ON A COMETARY ORBITER . . . . .	255
S. Perruchot, Ph.L. Lamy, F. Giovane and B.Å.S. Gustafson	

## VIII. CHEMISTRY OF THE INTERPLANETARY DUST

THE ELEMENTAL COMPOSITION OF INTERPLANETARY DUST (Invited review) . . . . .	261
D.E. Brownlee	

COLLECTION AND MICROANALYSIS OF ANTARCTIC MICRO-METEORITES (Invited contribution) . . . . .	265
M. Maurette, C. Engrand and G. Kurat	

THE SEARCH FOR INTERSTELLAR COMPONENTS IN INTERPLANETARY DUST PARTICLES (Invited contribution) . . . . .	275
J. Bradley and T. Ireland	

A COMPREHENSIVE STUDY OF MAJOR, MINOR AND LIGHT ELEMENT ABUNDANCES IN OVER 100 INTERPLANETARY DUST PARTICLES	283
K.L. Thomas, L.P. Keller and D.S. McKay	
ISOTOPIC ANOMALIES IN INTERPLANETARY DUST PARTICLES	287
S. Messenger and R.M. Walker	
THE ABUNDANCE PATTERN OF ELEMENTS HAVING LOW NEBULAR CONDENSATION TEMPERATURES IN INTERPLANETARY DUST PAR- TICLES: EVIDENCE FOR A NEW CHEMICAL TYPE OF CHONDRITIC MATERIAL	291
G.J. Flynn, S. Bajt, S.R. Sutton, M.E. Zolensky, K.L. Thomas, and L.P. Keller	
MINERALOGICAL CHANGES IN IDPS RESULTING FROM ATMOSPHERIC ENTRY HEATING	295
L.P. Keller, K.L. Thomas and D.S. McKay	
 <b>IX. ZODIACAL LIGHT AND THERMAL EMISSION</b>	
OPTICAL AND THERMAL PROPERTIES OF ZODIACAL DUST (Invited review)	301
A.C. Levasseur-Regourd	
COBE OBSERVATIONS OF ZODIACAL EMISSION (Invited contribution)	309
M.G. Hauser	
DUST NEAR THE SUN (Invited contribution)	315
I. Mann	
COBE/DIRBE STUDIES OF SCATTERING BY INTERPLANETARY DUST	321
G.B. Berriman, J.L. Weiland, C.M. Lisse, W.T. Reach, M.G. Hauser and T. Kelsall	
SEARCH FOR THE SIGNATURE OF INTERSTELLAR DUST IN THE COBE DATA	325
K. Grogan, S.F. Dermott, B.Å.S. Gustafson, S. Jayaraman, Y.L. Xu and D. Hamilton	
CLUES IN ZODIACAL LIGHT OBSERVATIONS FOR A DUST RING ALONG THE EARTH'S ORBIT	329
J.B. Renard, R. Dumont, A.C. Levasseur-Regourd and E. Hadamcik	
CLEMENTINE PHOTOGRAPHS OF THE INNER ZODIACAL LIGHT	333
B.L. Cooper, H.A. Zook and A.E. Potter	
ZODIACAL LIGHT - SCATTERED FRAUNHOFER LINE PROFILES	337
D. Clarke	
RADIAL VELOCITIES OF DUST PARTICLES IN THE F-CORONA	341
L.I. Shestakova, A.K. Aimanov and G.K. Aimanova	

INFRARED SPECTROSCOPIC OBSERVATIONS OF NEUTRAL HELIUM DURING THE 1994 ECLIPSE . . . . .	345
I. Mann, J.R. Kuhn and M.J. Penn	
THE ROLE OF PARTICLE SIZE IN PRODUCING THE F-CORONAL SCATTERED BRIGHTNESS . . . . .	349
R.M. MacQueen, W.C. Davidson and I. Mann	
TIME VARIATION OF THE SOLAR DUST CLOUD . . . . .	353
H. Kimura	
MODEL CALCULATIONS OF NEAR SOLAR DUST PROPERTIES . . . . .	357
I. Mann, H. Ishimoto, H. Okamoto and T. Mukai	
DUST PARTICLES NEAR THE SUN . . . . .	361
L.I. Shestakova and L.V. Tambovtseva	

## X. COMETARY DUST

COMPOSITION AND OPTICAL PROPERTIES OF COMETARY DUST (Invited review) . . . . .	367
M.S. Hanner	
MORPHOLOGY OF COMETARY DUST COMA AND TAIL (Invited contribution) . . . . .	377
Z. Sekanina	
FRAGMENTATION OF COMET SHOEMAKER-LEVY 9'S NUCLEI DURING FLIGHT THROUGH THE JOVIAN ATMOSPHERE . . . . .	383
Z. Sekanina	
A FRAGMENTATION MODEL OF DUST GRAINS IN THE INNER COMA OF HALLEY. A POSSIBLE EXPLANATION OF THE COLOR EFFECT . . . . .	387
B. Goidet-Devel, J. Clairemidi, G. Moreels and P. Rousselot	
POLARIMETRIC MEASUREMENTS OF SCATTERED LIGHT BY DUST GRAINS IN EARTH AND MICROGRAVITY CONDITIONS. TENTATIVE INTERPRETATION OF THE DICHOTOMY BETWEEN COMETS . . . . .	391
E. Hadamcik, A.C. Levasseur-Regourd, J.C. Worms and J.B. Renard	
METEORITES FROM COMETS? RECENT OBSERVATIONAL DEVELOPMENTS . . . . .	395
H. Campins	

## XI. LIGHT SCATTERING

OPTICAL PROPERTIES OF DUST FROM LABORATORY SCATTERING MEASUREMENTS (Invited contribution) . . . . .	401
B.Å.S. Gustafson	
LABORATORY MEASUREMENTS OF LIGHT SCATTERING BY DUST PARTICLES . . . . .	409
P.P. Combet and Ph.L. Lamy	

SCATTERING PROPERTIES OF DUST PARTICLES IN WEIGHTLESSNESS . . . . .	415
J.C. Worms, A.C. Levasseur-Regourd, E. Hadamcik, D. Bourras, and J.B. Renard	
A COMPLETE AND EFFICIENT MULTISPHERE SCATTERING THEORY FOR MODELING THE OPTICAL PROPERTIES OF INTERPLANETARY DUST . . . . .	419
Y.-l. Xu and B.Å.S. Gustafson	
APPLICABILITY OF A1-TERM METHOD TO THE SCATTERING BY IRREGULARLY SHAPED INTERPLANETARY DUST GRAINS . . . . .	423
H. Okamoto	
OPTICAL PROPERTIES OF FLUFFY PARTICLES . . . . .	427
R. Stognienko, Th. Henning and V. Ossenkopf	
SCATTERING PROPERTIES OF COMETARY GRAINS . . . . .	433
D.B. Vaidya and J.N. Desai	
MODELLING THE TEMPERATURE OF COMETARY PARTICLES . . . . .	437
Z. Xing and M.S. Hanner	
COHERENT BACKSCATTER OPPOSITION EFFECT FROM SATURN RING PARTICLES AND THEIR REGOLITHS . . . . .	443
L.J. Horn, R.M. Nelson, W.D. Smythe and B.W. Hapke	
ON THE DIELECTRIC FUNCTION OF PARTIALLY AMORPHOUS OLIVINE DUST . . . . .	447
D.K. Lynch and S. Mazuk	
<b>XII. PHYSICAL PROCESSES AND LABORATORY ANALYSES</b>	
SUBLIMATION OF INTERPLANETARY DUST (Invited review) . . . . .	453
T. Mukai	
LABORATORY EXPERIMENTS ON CARBONACEOUS AND SILICATE MATERIALS (Invited contribution) . . . . .	463
L. Colangeli, V. Mennella, A. Rotundi, E. Bussoletti and P. Palumbo	
THE MOBILITY OF A HYDROGEN ATOM ON AN ICY MANTLE . . . . .	469
K. Masuda	
SIZE DISTRIBUTIONS OF ASTEROIDAL DUST: POSSIBLE CONSTRAINTS ON IMPACT STRENGTHS . . . . .	473
D.D. Durda and S.F. Dermott	
FREE MOLECULAR GAS DRAG ON FLUFFY AGGREGATES . . . . .	477
R. Nakamura	
MEASUREMENT OF DUST ELECTRIC CHARGES BY THE ULYSSES AND GALILEO DUST DETECTORS . . . . .	481
J. Svestka, S. Auer, M. Baguhl and E. Grün	

### XIII. RELATIONSHIPS TO INTERSTELLAR DUST

PROPERTIES OF INTERSTELLAR DUST (Invited review) . . . . .	487
J. Dorschner	
ON THE CRYSTALLINE SILICATE COMPONENT OF COMET DUST (Invited contribution) . . . . .	497
J.M. Greenberg, A. Li, T. Yamamoto and T. Kozasa	
THE DUST IN $\beta$ PICTORIS SYSTEMS (Invited contribution) . . . . .	507
S.B. Fajardo-Acosta	
DUST EVOLUTION IN PROTOPLANETARY DISKS . . . . .	513
T. Henning, W. Schmitt, H. Klahr and R. Mucha	
CHEMICAL REACTIONS AND DUST DESTRUCTION IN PROTO- PLANETARY ACCRETION DISKS . . . . .	517
F. Finocchi, H.-P. Gail, W.J. Duschl and W.M. Tscharnuter	
SUMMARY REMARKS (Invited review) . . . . .	527
Ph.L. Lamy	
AUTHOR INDEX . . . . .	537