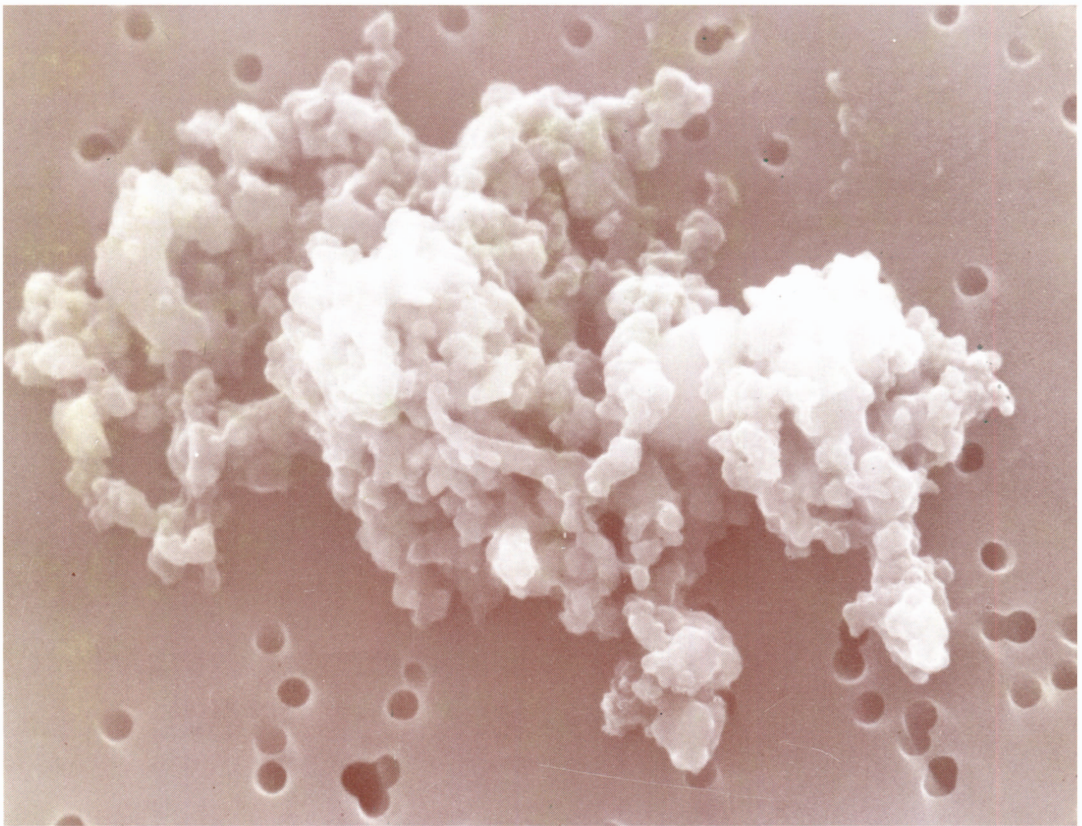


INTERNATIONAL ASTRONOMICAL UNION

SYMPOSIUM No. 90

# SOLID PARTICLES IN THE SOLAR SYSTEM

Edited by IAN HALLIDAY and BRUCE A. McINTOSH



INTERNATIONAL ASTRONOMICAL UNION

D. REIDEL PUBLISHING COMPANY / DORDRECHT : HOLLAND

BOSTON : U.S.A. / LONDON : ENGLAND



## SOLID PARTICLES IN THE SOLAR SYSTEM

SYMPOSIUM No. 90

The volume contains most of the invited and contributed papers presented at IAU Symposium No. 90 held in Ottawa, Canada during August 1979. The main subject was solid particles in the solar system whose distribution is being understood with increasing rapidity. Much of this new knowledge is due to observations from spacecraft which offer completely new locations from which to view phenomena such as zodiacal light. In combination with ground-based observations and improved theoretical models, a picture is now emerging with a clarity unattainable a few years ago. The volume contains 11 papers which survey particular areas of the overall subject and the numerous contributed papers provide more detail on specific problems. The combination of these papers will prove valuable to both the general reader interested in the current picture of the particles in interplanetary space and also to the specialist involved in research in the field.

D. REIDEL PUBLISHING COMPANY  
DORDRECHT : HOLLAND / BOSTON : U.S.A.  
LONDON : ENGLAND

# SOLID PARTICLES IN THE SOLAR SYSTEM

INTERNATIONAL ASTRONOMICAL UNION  
UNION ASTRONOMIQUE INTERNATIONALE

SYMPOSIUM No. 90

ORGANIZED BY THE IAU IN COOPERATION WITH COSPAR  
HELD AT OTTAWA, CANADA, AUGUST 27 – 30, 1979

# SOLID PARTICLES IN THE SOLAR SYSTEM

EDITED BY

IAN HALLIDAY

and

BRUCE A. McINTOSH

*Herzberg Institute of Astrophysics,  
National Research Council of Canada,  
Ottawa, Canada*



D. REIDEL PUBLISHING COMPANY

DORDRECHT : HOLLAND / BOSTON : U.S.A. / LONDON : ENGLAND



Library of Congress Cataloging in Publication Data  
Main entry under title:

**CIP**

Solid particles in the solar system.

(Symposium – International Astronomical Union ; no. 90)

Includes index.

1. Interstellar matter—Congresses. I. Halliday, Ian. II. McIntosh, Bruce A. III. International Astronomical Union. IV. International Council of Scientific Unions. Committee on Space Research. V. Series: International Astronomical Union. Symposium ; no. 90.

QB790.S64 523.1'12 80-23993

ISBN 90-277-1164-X

ISBN 90-277-1165-8 (pbk.)

---

*Published on behalf of  
the International Astronomical Union  
by*

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

*All Rights Reserved  
Copyright © 1980 by the International Astronomical Union*

*Sold and distributed in the U.S.A. and Canada  
by Kluwer Boston Inc.,  
190 Old Derby Street, Hingham, MA 02043, U.S.A.*

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

*D. Reidel Publishing Company is a member of the Kluwer Group*

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

*Printed in The Netherlands*

## TABLE OF CONTENTS

Preface	ix
List of Participants	xi
Dedication	xv
Organizing Committees	xvi
I ZODIACAL LIGHT - MEASUREMENTS AND MODELS	
R.H. GIESE: Optical Investigation of Dust in the Solar System (INVITED)	1
C. LEINERT, I. RICHTER, E. PITZ, M.S. HANNER: Four Years of Zodiacal Light Observations from the Helios Space Probes	15
J.L. WEINBERG, R.C. HAHN: Brightness and Polarization of the Zodiacal Light: Results of Fixed-position Observations from Skylab	19
G.H. SCHWEHM: The ISPM Zodiacal Light - Background Starlight Experiment	23
J.L. WEINBERG, R.C. HAHN, F. GIOVANE, D.W. SCHUERMAN: Planned Observations of the Diffuse Sky Radiation During Shuttle Mission STS-4	25
E. PITZ: An Attempt to Observe Zodiacal Light at 5 $\mu$ with a Balloon Experiment	29
R. ROBLEY: Change in the Zodiacal Light with Solar Activity	33
P.L. LAMY, A. LLEBARIA, S. KOUTCHMY: Two-dimensional Photographic Photometry of the Zodiacal Light from Spatial Observations	37
R.C. HENRY, R.C. ANDERSON, W.G. FASTIE: Far-ultraviolet Studies. VIII. Apollo 17 Search for Zodiacal Light	41
H. TANABE, A. TAKECHI, A. MIYASHITA: Photometric Axis Measurements of the Zodiacal Light at Large Elongations	45
N.Y. MISCONI: The Symmetry Plane of the Zodiacal Cloud Near 1 AU	49
A. MUJICA, G. LOPEZ, F. SANCHEZ: Method for the Determination of Density and Phase Functions of Interplanetary Dust	55
J. BUITRAGO, P. ALVAREZ, G. LOPEZ, A. MUJICA, F. SANCHEZ: Method of Scattering Plane Scanning	61
R. DUMONT, A.-C. LEVASSEUR-REGOURD: Inversion of the Zodiacal Brightness Integral: a new Geometric Approach	67
D.W. SCHUERMAN: Evidence that the Properties of Interplanetary Dust Beyond 1 AU are Not Homogeneous	71
P.L. LAMY, J.M. PERRIN: Zodiacal Light Models with a Bimodal Population	75
H.J. STAUDE, S. RÖSER: Wavelength Dependent Models of the Zodiacal Light	81

## II METEORS AND METEORITES

W.J. BAGGALEY: Meteors and Atmospheres (INVITED)	85
W.G. ELFORD: The Influence of the Atmosphere on Radar Meteor Rates	101
B.A. LINDBLAD: Serial Correlation of Meteor Radar Rates	105
W.J. BAGGALEY: Analysis of Meteor Data	109
P.B. BABADZHANOV, V.S. GETMAN: Orbit, Chemical Composition and Atmospheric Fragmentation of a Meteoroid from Instantaneous Photographs	111
R.L. HAWKES, J. JONES: Two Station Television Meteor Studies	117
P.M. MILLMAN: One Hundred and Fifteen Years of Meteor Spectroscopy	121
J.A. RUSSELL: Correlation of Height and Forbidden Oxygen Line Strength for Perseid Meteors	129
J. DELCOURT: Experimental and Theoretical Study of Radiometeors	133
*D.J. KESSLER, P.M. LANDRY, J.R. GABBARD, J.L.T. MORAN: Ground Radar Detection of Meteoroids in Space	137
J. ŠTOHL: On Time-dependent Models of the Meteoric Background Complex	141
*I.V. GALIBINA, A.K. TEREŇJEVA: Evolution of Meteoroid Orbits Over Millenia	145
A. HAJDUK: The Core of the Meteor Stream Associated with Comet Halley	149
D.W. HUGHES, I.P. WILLIAMS, C.D. MURRAY: The Quadrantid Meteor Stream: Past, Present and Future	153
*P.B. BABADZHANOV, Y.V. OBRUBOV: Evolution of Orbits and Intersection Conditions with the Earth of the Geminid and Quadrantid Meteor Streams	157
B. LOKANADHAM: The Structure of the Taurid, Geminid and Quadrantid Meteor Streams	163
T. SARMA, J. JONES: Television Observations of the Delta-Aquarid Shower	167
Z. CEPLECHA: Observational and Theoretical Aspects of Fireballs (INVITED)	171
D.O. REVELLE: Interaction of Large Bodies with the Earth's Atmosphere (INVITED)	185
*E.N. KRAMER, V.I. MUSIY, E.A. TIMCHENKO-OSTROVERKHOVA, I.S. SHESTAKA: Probability of Collision with the Earth and Orbital Life-Time of Bodies of Asteroidal and Cometary Origin	199
*V.V. FEDYNSKY, A.I. DABIZHA, I.T. ZOTKIN: The Stream of Crater Forming Meteorites on the Earth	205
D.W. HUGHES: On the Mass Distribution of Meteorites and Their Influx Rate	207

\*Note: Not presented at the Symposium.



III THE INTERPLANETARY DUST COMPLEX 1. SOURCES, EVOLUTION,  
AND DYNAMICS

Ľ. KRESAK: Sources of Interplanetary Dust (INVITED)	211
M.S. HANNER: Physical Characteristics of Cometary Dust from Optical Studies (INVITED)	223
Z. SEKANINA: Physical Characteristics of Cometary Dust from Dynamical Studies: A Review (INVITED)	237
Z. SEKANINA: On the Particle-Size Distribution Function of Cometary Dust	251
R. HELLMICH, H.U. KELLER: On the Dust Production Rates of Comets	255
*O.V. DOBROVOLSKY, N.N. KISELEV, G.P. CHERNOVA, F.A. TUPIEVA, N.V. NARIZHNAJA: Nature of Dust Grains in the Atmosphere of Comet Ashbrook	259
P.D. FELDMAN: Ultraviolet Albedo of Comet West (1976 VI)	263
Z. SEKANINA, J.A. FARRELL: Evidence for Fragmentation of Strongly Nonspherical Dust Particles in the Tail of Comet West 1976 VI	267
J. KISSEL, B.C. CLARK, D. CLAIR: Experiments on Dust Collection for a Cometary Mission	271
B.K. DALMANN, D. BAHR, H. FECHTIG, J. KISSEL: Dust Experiment for a Rendezvous Cometary Mission	273
G. BRAUN, E. GRUN, J. KISSEL, N. PAILER: An Impact Mass-Spectrometer for the Halley Probe	275
E. GRUN: In Situ Measurements of Interplanetary Dust in the Inner Solar System (INVITED)	277
*A.N. SIMONENKO, B.J. LEVIN: Circumsolar Motion of Dust Particles at the Stage of Increasing Solar Luminosity	279
J.A. BURNS, S. SOTER: A Simple Derivation of the Radiation Forces Felt by Scattering Particles	281
D.W. SCHUERMAN: Effect of Radiation Pressure on the Restricted Three-body Problem	285
L.B. LE SERGEANT, P.L. LAMY: Collisions Among Interplanetary Dust Grains	289
E. GRUN, H.A. ZOOK: Dynamics of Micrometeoroids	293
J. TRULSEN, A. WIKAN: Poynting-Robertson Effect and Collisions in the Interplanetary Dust Cloud	299
J.P.J. LAFON, P.L. LAMY, J.M. MILLET: The Electrostatic Potential of Interplanetary Grains	303
G.E. MORFILL, E. GRUN: Motion of Charged Dust Particles in Interplanetary Dust	309
E. GRUN, G.E. MORFILL: Electromagnetic Effects on the Zodiacal Dust Cloud	311
G.E. MORFILL, E. GRUN: Electromagnetic Effects on Hyperbolic Cosmic Dust Particles	313
O. HAVNES: A Two-Stream Instability in Streams of Charged Grains	315
G.H. SCHWEHM: Trajectories of Sublimating Interplanetary Dust Grains	319
K.D. SCHMIDT, E. GRUN: Orbital Elements of Micrometeoroids Detected by the Helios 1 Space Probe in the Inner Solar System	321
P.A. DANIELS, D.W. HUGHES: A Monte Carlo Simulation of the Mass Distribution in an Accreting System of Dust Particles	325
S.F. SINGER, J.E. STANLEY: Submicron Particles in Meteor Streams	329



IV	THE INTERPLANETARY DUST COMPLEX 2. PHYSICAL PROPERTIES	
	D.E. BROWNLEE, L. PILACHOWSKI, E. OLSZEWSKI, P.W. HODGE: Analysis of Interplanetary Dust Collections. (INVITED)	333
	J.M. GREENBERG: From Interstellar Dust to Comets to the Zodiacal Light (INVITED)	343
	W. KRATSCHMER: Laboratory Measurements on the Infrared Features of Interstellar Silicate Grains	351
	B.N. KHARE, C. SAGAN: Cosmic Dust Synthesized in Reducing Environments	355
	H. FECHTIG, K. NAGEL, N. PAILER, E. SCHNEIDER: Collisional Processes of Iron and Steel Projectiles on Targets of Different Densities	357
	N. PAILER, E. GRUN: Determination of Particle Densities by Penetration Studies	365
	B. LANG, N. PEKALA, E. KROL, A. NOWAKOWSKI, P. MARTIN, YU. STAKHEEV, G. BARYSHIKOVA: Thermomagnetic Study of Chondrules	371
	H. ZOOK: Evidence for Ice Meteoroids Beyond 2 AU	375
	*R. SMOLUCHOWSKI: Existence and Role of Amorphous Grains in the Solar System	381
	T. MUKAI: Grain Disruption by Collisions with Solar Energetic Particles	385
	K.F. RATCLIFF, N.Y. MISCONI, S.J. PADDACK: Radiation Induced Rotation of Interplanetary Dust Particles; a Feasibility Study for a Space Experiment	391
	J.C. MANDEVILLE, J.A.M. MCDONNELL: Micrometeoroid Multiple Foil Penetration and Particle Recovery Experiments on Board Space Shuttle's Long Duration Exposure Facility (LDEF)	395
V	PARTICLES AND PLANETS	
	A.F. COOK: Planetary Rings (INVITED)	401
	J.R. HILL, D.A. MENDIS: Charged Dust Rings in the Outer Planetary Magnetospheres	417
	J.D. CHAMBERLAIN, W.M. ALEXANDER, J.D. CORBIN: Orbits of Submicron Lunar Ejecta in the Earth-Moon System	421
	W.M. ALEXANDER, J.D. CORBIN: Interaction of Lunar Ejecta and the Magnetosphere of the Earth	425
VI	SUMMARY BY P.M. MILLMAN	429
	Index	433