Comets in the Post-Halley Era

Volume 1

R. L. Newburn, Jr.
M. Neugebauer
J. Rahe
(editors)

Kluwer Academic Publishers

COMETS IN THE POST-HALLEY ERA

VOLUME 1

IN PART BASED ON REVIEWS PRESENTED AT THE
121ST COLLOQUIUM OF THE
INTERNATIONAL ASTRONOMICAL UNION,
HELD IN BAMBERG, GERMANY, APRIL 24–28, 1989

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KLUWER ACADEMIC PUBLISHERS
DORDRECHT / BOSTON / LONDON

Library of Congress Cataloging-in-Publication Data

Comets in the post-Halley era / scientific editors, Ray L. Newburn, Jr., Marcia Neugebauer, Jürgen Rahe ; production editor, Lori Fry ; with 96 contributing authors.
p. cm. -- (Astrophysics and space science library ; v. 167)
"A book based in part upon the colloquium of the same name held in Bamberg, Federal Repuolic of Germany, April 24-28, 1989."
Includes index.
ISBN 0-7923-1164-7 (hb : acid-free paper)
1. Comets. 2. Comets--Observations. 3. Astrometry. I. Newburn, Ray L. II. Neugebauer, Marcia. III. Rahe, Jürgen. IV. Series.
QB721.C6494 1991
523.6--dc20 91-7245
CIP

ISBN 0-7923-1164-7 (HB)
ISBN 0-7923-1165-5 (PB)

Published by Kluwer Academic Publishers,
P.O. Box 17, 3300 AA Dordrecht, The Netherlands.

Kluwer Academic Publishers incorporates
the publishing programmes of
D. Reidel, Martinus Nijhoff, Dr W. Junk and MTP Press.

Sold and distributed in the U.S.A. and Canada
by Kluwer Academic Publishers,
101 Philip Drive, Norwell, MA 02061, U.S.A.

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

This publication was prepared by the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.

Printed on acid-free paper

Printed in the Netherlands

COMETS IN THE POST-HALLEY ERA

VOLUME 2

IN PART BASED ON REVIEWS PRESENTED AT THE
21ST COLLOQUIUM OF THE
INTERNATIONAL ASTRONOMICAL UNION,
HELD IN BAMBERG, GERMANY, APRIL 24–28, 1989

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VOLUME 167

We dedicate these volumes to Fred L. Whipple
("Fred" to everyone in the field),
Grand Young Man of cometary science,
who led us all to the right path

The Editors

PREFACE

In the early 1980s, it became clear that the 1986 apparition of P/Halley would likely result in a considerable advance in our knowledge of comets, especially if some of the spacecraft being planned were successful. It also became clear that, after a reasonable period, during which the new observations could be analyzed and mentally digested, a conference and a book should review the new discoveries.

Following up on that idea, two of the undersigned began planning just such a conference. The conference was held in Bamberg, Federal Republic of Germany, on April 24–28, 1989—more than three years after Halley perihelion and the mission encounters, giving the investigators time to reduce and analyze their data. The reviews presented at that conference became the basis of this book.

Rather to everyone's amazement, all of the cometary spacecraft—ESA's Giotto, NASA's ICE, IKI's VEGA-1 and VEGA-2, and ISAS' Sakigake and Suisei—were successful. So, too, was the IHW, which coordinated much of the ground-based observing of the comet. In excess of 20 gigabytes of ground-based Halley data and much of the spacecraft data will appear later this year in *The Comet Halley Archive*. P/Halley itself apparently has retained some residual activity at heliocentric distances beyond that of Saturn! As a result, although the 1986 apparition is nearly over, the data still are being reduced and ideas still are developing rapidly. This healthy continuing development in our field made it important to the editors to produce this book as rapidly as was consistent with thorough reviews and editing. It appears that about 21 months will have been the interval required.

We originally intended that every paper would be reviewed by two external reviewers, as well as by at least one of the technical editors and by the production editor. In this, we were largely successful, and we wish to extend our sincere and heartfelt thanks to all of those who helped with the critical reviewing work. Their names are listed in the acknowledgments.

This book has been produced from camera-ready manuscripts. As a result, it contains some inevitable nonuniformities that could have been avoided only by completely retyping it entirely at one location. That probably would have resulted in new errors in the manuscripts, as well as requiring both additional time and additional resources. We chose not to retype it.

There has been perhaps a tendency in some places to think of Halley as a sort of divide, providing many answers and marking a peak in research activity on comets. However, as is usual in research, Halley provided more questions than answers. Just since the Bamberg conference, three moderately bright and exciting comets—P/Brorsen-Metcalf, Austin, and Levy—have received considerable ground-based study. Further, most experiments on the Giotto spacecraft survived their 70-km/s flyby 600 km from the nucleus of Halley in sufficiently good health to justify at least consideration of an encounter with P/Grigg-Skjellerup in 1992. Also, the U.S. Congress has approved funding for the Comet Rendezvous Asteroid Flyby (CRAF) mission. Therefore, this book provides one more interim report on our attempts to understand the nature, origin, and evolution of those enigmatic solar system members called comets.

Ray L. Newburn, Jr.
Marcia Neugebauer
Jürgen Rahe

August 1990

ACKNOWLEDGMENTS

We particularly wish to acknowledge the help of our many reviewers, who are listed below. Most reviewed two papers, and a few even read three. Without these reviewers' help in this thankless task, the book would not have achieved the level of technical quality that it now has.

Ray L. Newburn, Jr.
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Jürgen Rahe

M. A'Hearn
M.J.S. Belton
J. Brandt
H. Campins
A. Cochran
J. Conel
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M. Delitsky
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D. Yeomans

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COMETARY ORBITAL DYNAMICS AND ASTROMETRY

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ABSTRACT. Comets are the only large solar system bodies where nongravitational forces directly affect their dynamic motions. Their approach to within a few AU of the Sun initiates the vaporization of nucleus ices, and the resulting rocket-like effects either add to or subtract from the comet's orbital energy; the sign of the energy change depends upon the comet's rotation direction and its spin pole orientation. The cometary outgassing phenomena have generally been modeled by assuming a rapidly rotating nucleus of water ice that outgasses symmetrically with respect to perihelion. Although this nongravitational acceleration model has been quite successful in providing accurate orbits and ephemerides, several comets exhibit water production rates and visual light curves that are noticeably asymmetric with respect to perihelion. New asymmetric models are being developed that attempt to represent more closely the cometary outgassing phenomena. For the same comet, derived nongravitational parameters can differ widely, depending upon which model is used to fit the astrometric data. The uncertainties in the data and in the nongravitational acceleration model prevent realistic extrapolations of these objects' motion beyond a few hundred years, particularly if close planetary encounters are involved. Accurate orbits, ephemerides and efforts to model the nongravitational effects ultimately depend upon the quality of the astrometric data. Using a combination of long-focus telescopes, charge coupled device (CCD) detectors, microdensitometer reductions and modern star catalogs, cometary astrometric data can be generated that are accurate to the sub arcsecond level. While occultation, spacecraft, and radar observations can provide powerful astrometric data when available, it is still the ground-based optical observations that must provide the vast majority of data for cometary astrometry in the foreseeable future.

R. L. Newburn, Jr. et al. (eds.), Comets in the Post-Halley Era, Vol. 1, 3–17.