

Dynamics and Astrometry of Natural and Artificial Celestial Bodies

Proceedings of IAU Colloquium 165

Poznań, Poland

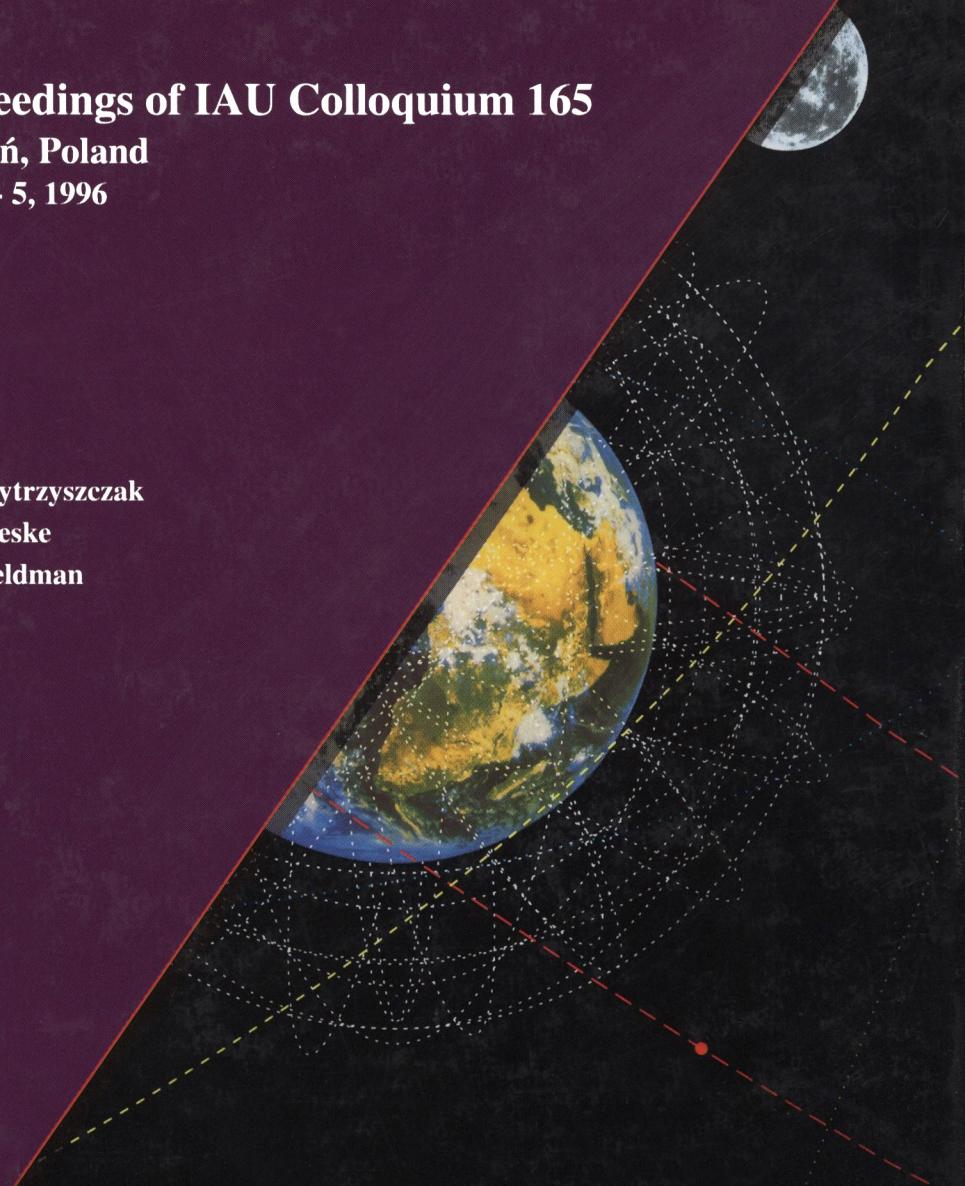
July 1 - 5, 1996

Editors:

I.M. Wytrzyszczak

J.H. Lieske

R.A. Feldman



KLUWER ACADEMIC PUBLISHERS

**DYNAMICS AND ASTROMETRY OF NATURAL
AND ARTIFICIAL CELESTIAL BODIES**



IAU Colloquium 165

Dynamics and Astrometry of Natural and Artificial Celestial Bodies

Astronomical Observatory of A. Mickiewicz University, Poznań, Poland
Observatoire de la Côte d'Azur, Grasse, France

SCIENTIFIC ORGANIZING COMMITTEE:

- K. Kurzyńska (Co-Chairman) Astronomical Observatory, Poznań, Poland
F. Barlier (Co-Chairman) Observatoire de la Côte d'Azur, Grasse, France
V.K. Abalakin Pulkovo Observatory, St. Petersburg, Russia
J.-E. Arlot Bureau des Longitudes, Paris, France
S. Débarbat Observatoire de Paris, Paris, France
B. Kaufman Naval Research Laboratory, Washington, USA
B. Kołaczek Space Research Center, Warszawa, Poland
J.H. Lieske Jet Propulsion Laboratory, Pasadena, USA
A. Milani University of Pisa, Pisa, Italy
X X Newhall Jet Propulsion Laboratory, Pasadena, USA
Y. Réquiem Observatoire de Bordeaux, Bordeaux, France
H. Rickman Astronomical Observatory, Uppsala, Sweden
P.K. Seidelmann US Naval Observatory, Washington, USA
M. Soffel Lohrmann Observatory, Dresden, Germany
E. Wnuk Astronomical Observatory, Poznań, Poland
M. Yoshizawa National Astronomical Observatory, Tokyo, Japan

LOCAL ORGANIZING COMMITTEE:

- I. Wytrzyszczak (Chairman), A. Kryszczyńska (Secretary),
W. Borczyk, P.A. Dybczyński, R. Feldman,
A. Gabrysiewska, A. Gąsiorowska, M. Gromadziński,
T. Kwiatkowski, P. Mazur, H. Prętka

Dynamics and Astrometry of Natural and Artificial Celestial Bodies

Proceedings of IAU Colloquium 165
Poznań, Poland
July 1 - 5, 1996

Edited by

I. M. Wytrzyszczak

*Astronomical Observatory of A. Mickiewicz University,
Poznań, Poland*

J. H. Lieske

*Jet Propulsion Laboratory,
Pasadena, USA*

R. A. Feldman

*Observatoire de la Côte d'Azur,
Grasse, France*

Partly reprinted from *Celestial Mechanics and Dynamical Astronomy*
Volume 66, No. 1, 1996/7



KLUWER ACADEMIC PUBLISHERS
DORDRECHT / BOSTON / LONDON

A C.I.P. Catalogue record for this book is available from the Library of Congress.

ISBN 0-7923-4574-6

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

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,
P.O. Box 322, 3300 AH Dordrecht, The Netherlands

Printed on acid-free paper

All rights reserved

©1997 Kluwer Academic Publishers

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 information storage and retrieval system, without written permission from the copyright owner.

Printed in the Netherlands

TABLE OF CONTENTS

PREFACE	xiii
DYNAMICS AND ASTROMETRY: PRESENT AND FUTURE	
<i>D. K. Yeomans</i>	
Comet and Asteroid Ephemerides for Spacecraft Encounters	1
<i>J. H. Lieske</i>	
Galilean Satellites and the Galileo Space Mission	13
<i>X X Newhall and J. G. Williams</i>	
Estimation of the Lunar Physical Librations	21
<i>J. Chapront and M. Chapront-Touzé</i>	
Lunar Motion: Theory and Observations	31
<i>S. Ferraz-Mello</i>	
On Hamiltonian Averaging Theories and Resonance	39
<i>F. R. Hoots and R. G. France</i>	
The Future of Artificial Satellite Theories	51
<i>S. Coffey, L. Healy and H. Neal</i>	
Applications of Parallel Processing to Astrodynamics	61
<i>E. Wnuk</i>	
Space Debris – the Short Term Orbital Evolution in the Earth's Gravity Field	71
<i>B. E. Schutz</i>	
New Observational Techniques and Precise Orbit Determination of Artificial Satellites	79

<i>S. J. Ostro</i>	
Radar Contributions to Asteroid Astrometry and Dynamics	87
<i>P. K. Seidelmann</i>	
Astrometry in the Future	97
<i>T. Fukushima</i>	
Reference Systems	107
<i>J. Vondrák, C. Ron and I. Pešek</i>	
Earth Rotation in the Hipparcos Reference Frame	115
<i>J.-E. Arlot and F. Colas</i>	
CCD Astrometry of the Solar System	123
SOLAR SYSTEM DYNAMICS	
<i>S. Débarbat</i>	
Discoveries in the Solar System	133
<i>M. Pätzold, F. M. Neubauer, A. Wennmacher, K. Aksnes, J. D. Anderson, S. W. Asmar, M. Tinto, B. T. Tsurutani, D. K. Yeomans, J.-P. Barriot, M. K. Bird, H. Boehnhardt, E. Gill, O. Montenbruck, E. Grün, B. Häusler, W. H. Ip, N. Thomas, E. A. Marouf, H. Rickman, M. K. Wallis and N. C. Wickramasinghe</i>	
Rosetta Radio Science Investigations	141
<i>P. A. Dybczyński and H. Prętka</i>	
The Galactic Disk Tidal Force: Simulating the Observed Oort Cloud Comets	149
<i>H. Prętka</i>	
Galactic Perturbations Influence on Observability of Interstellar Comets	155
<i>V. V. Emel'yanenko and M. E. Bailey</i>	
The Capture of Halley-Type and Jupiter-Family Comets from the Near-Parabolic Flux	159

TABLE OF CONTENTS

vii

<i>J. Q. Zheng, M. J. Valtonen and H. Rickman</i>	
Orbital Changes in Planet–Comet Encounters	165
<i>M. Banaszkiewicz and A. V. Krivov</i>	
Hyperion as a Dust Source in the Saturnian System	171
<i>L. Duriez and A. Vienne</i>	
Comparison Between Present Representations of the Motions of the Eight Major Satellites of Saturn	177
<i>A. S. Hope, B. Kaufman, R. Dasenbrock and D. Bakeris</i>	
A Clementine II Mission to the Asteroids	183
<i>K. Muinonen, A. Milani and E. Bowell</i>	
Determination of Initial Eigenorbits for Asteroids	191
<i>A. López García, Yu. D. Medvedev and J. A. Moraño Fernández</i>	
Using Close Encounters of Minor Planets for the Improvement of their Masses	199
<i>K. Nordtvedt and D. Vokrouhlický</i>	
Recent Progress in Analytical Modeling of Relativistic Effects in the Lunar Motion	205
<i>A. Gusev</i>	
Gravitational Capture to Resonance Rotation of the Early Moon in General Relativity and Gravitation	215
<i>W. J. Jin and J. L. Li</i>	
Determination of some Physical Parameters of the Moon with Lunar Laser Ranging Data	221
<i>E. Yu. Aleshkina, G. A. Krasinsky and M. V. Vasilyev</i>	
Analysis of LLR Data by the Program System ERA	227
<i>X. Moisson</i>	
Construction of Relativistic Ephemerides and Applications	233
<i>G. A. Krasinsky and M. V. Vasilyev</i>	
ERA: Knowledge Base for Ephemeris and Dynamical Astronomy	239

<i>G. I. Eroshkin, N. I. Glebova, M. A. Fursenko and A. A. Trubitsina</i>	
Some Aspects of Constructing Long Ephemerides of the Sun, Major Planets and the Moon: Ephemeris AE95	245
<i>E. V. Pitjeva</i>	
The Ephemerides of the Inner Planets from Spacecraft Range Data and Radar Observations 1961–1995	251
<i>C. H. Acton</i>	
NASA's SPICE System Models the Solar System	257
ROTATION OF SOLAR SYSTEM OBJECTS	
<i>A. W. Harris and W. Z. Wisniewski</i>	
Asteroid Spins: From the Very Fast to the Very Slow	265
<i>K. Goździewski</i>	
Rotational Dynamics of Janus and Epimetheus	269
<i>G. I. Eroshkin and V. V. Pashkevich</i>	
Numerical Simulation of the Rotational Motion of the Earth and Moon	275
<i>N. Petrova</i>	
Lunar Libration Tables and Determination of Crater Coordinates	281
<i>T. Hartmann and M. Soffel</i>	
A New Nutation Series for a Rigid Earth Model	287
<i>P. Bretagnon</i>	
Rotation of the Rigid Earth	295
<i>V. A. Brumberg and T. V. Ivanova</i>	
New Approach to the Earth's Rotation Problem Consistent with the General Planetary Theory	301
<i>R. Molina and A. Vigueras</i>	
An Analytical Theory for a Gyrostatic Earth	307

<i>V. V. Sidorenko</i>	
Evolution of the Rotational Motion of a Planet with a Liquid Core	313
<i>J. Souchay</i>	
Agreements and Disagreements between Theories of Rigid Earth Nutation	319
<i>S. Bouquillon and J. Souchay</i>	
Precession and Nutation of Mars Calculated with Kinoshita's Model	325
DYNAMICS OF ARTIFICIAL SATELLITES AND SPACE DEBRIS	
<i>P. Exertier, G. Métris, S. Bruinsma and F. Barlier</i>	
Mean Orbital Motion of Geodetic Satellites and its Applications	333
<i>D. Currie, K. Kissell, P. Avizonis and D. Wellnitz</i>	
On the Dynamics of the LAGEOS Spin Vector High-Precision and Comparisons to Theoretical Modeling	341
<i>A. Drożdżner</i>	
Orbits of Geostationary TV Satellites	347
<i>S. Rudenko</i>	
Geosynchronous Satellite Orbit Determination	351
<i>U. Hugentobler, T. Schildknecht and G. Beutler</i>	
Determination of Resonance Terms Using Optical Observations of Two METEOSAT Satellites	355
<i>A. V. Krivov, L. L. Sokolov and J. Getino</i>	
Orbital Instability Zones of Space Balloons	361
<i>A. Rossi</i>	
Long Term Evolution of Earth Orbiting Debris	367
<i>C. Calvo, B. Melendo and M. Palacios</i>	
Ideal Frame and Multi-Revolution Methods for Space Debris Dynamics	375

THEORY OF MOTION

S. A. Klioner

- On the Problem of Post–Newtonian Rotational Motion 383

A. Elipe

- Gyrostats in Free Rotation 391

E. A. Grebenikov

- Concerning New Perturbation Methods
in Solar System Dynamics 399

L. Floria

- Orbital Arc Length as a Universal Independent Variable 405

S. Breiter

- Semi-Analytical and Semi-Numerical Methods
in Celestial Mechanics 411

R. Barrio and A. Elipe

- Integration of Orbital Motions with Chebyshev Polynomials .. 419

*S. Ferrer, A. Viartola, J. Palacián,**P. Yanguas and J. F. San Juan*

- Models of Elliptical Galaxies in 1–1–1 Resonance
and their Normalization: The 3D Hénon and Heiles System 425

M. H. Youssef and M. K. Ahmed

- Analytical Effects of Gravitational Waves
on the Motion of an Artificial Satellite 431

REFERENCE SYSTEMS AND ASTRONOMICAL STANDARDS

V. A. Brumberg

- Ephemeris Astronomy Definitions
and Constants in General Relativity 439

J. Kovalevsky

- Optical–Radio Reference Ties 447

S. Puliaev and A. H. Andrei

- Investigations on Optical and Radio Reference Frames 449

<i>T. Corbin</i>	
Contributions of the USNO to the Optical Reference Frame	453
<i>V. V. Vityazev</i>	
The ROTOR: Rotation of Frames via Representation of Systematic Differences in Terms of Spherical Functions	463
<i>D. Gambis</i>	
Monitoring Earth Orientation Using Various Techniques: Current Results and Future Prospects	475
<i>C. Bizouard, N. Capitaine, C. Ron and J. Vondrák</i>	
Principal Term of Nutation from the Combination of VLBI Observations and Optical Astrometry	481
<i>O. V. Kotreleva and V. A. Naumov</i>	
Determination of Nutation and Precession Based on Observations with the Pulkovo Polar Tube	487

OBSERVATIONAL TECHNIQUES AND CATALOGUES

<i>S. E. Urban</i>	
New Reductions of the Astrographic Catalogue	493
<i>L. G. Taff, V. V. Tel'nyuk-Adamchuk and O. A. Molotaj</i>	
NPC, a New Combined Position Catalogue of Stars in the Northern Pole Region	499
<i>I. Kumkova and A. Kolomiets</i>	
Catalogues of Intermediate Stars in the Vicinity of Radio Sources	505
<i>L. I. Yagudin</i>	
Star Cross-Identification in Big Catalogues with Significant Epoch Difference and without Proper Motions .	511
<i>D. Pascu, J. R. Rhode, P. K. Seidelmann, E. N. Wells, C. T. Kowal, B. H. Zellner, A. Storrs, D. G. Currie and D. M. Dowling</i>	
Astrometry of Faint Planetary Satellites with WFPC2 of Hubble Space Telescope	517

<i>F. Poulet, B. Sicardy, J. L. Beuzit and P. Prado</i>	
Observations of Saturn's Inner Satellites	
During the August 1995 Ring-Plane Crossing	525
<i>J.-E. Arlot, W. Thuillot, F. Colas, D. T. Vu, J. Berthier, P. Descamps and Ch. Ruatti</i>	
First Results of the PHESAT95 Campaign	
of Observation of the Phenomena of the Satellites of Saturn	531
<i>R. C. Stone</i>	
CCD Observations of Planets and Asteroids	
in the Extragalactic Reference Frame	535
<i>L. V. Morrison and M. E. Buontempo</i>	
Carlsberg Positions of Planets Compared with JPL DE403	541
<i>M. Assafin, R. Vieira Martins and A. H. Andrei</i>	
Astrometric Positions of Quasars by CCD Observations	547
<i>M. Yoshizawa</i>	
Solar-Radius Variations over a Solar Cycle	
Observed with the Tokyo Photoelectric Meridian Circle	551
<i>K. Kurzyńska, R. Baranowski, P. A. Dybczyński, A. Gabryszecka and M. Lehmann</i>	
One-Image Poznań Astrolabe: Project and Prospects	557
<i>M. Yoshizawa, K. Sato, J. Nishikawa, T. Fukushima and M. Miyamoto</i>	
Two Astrometric Projects: LIGHT (Light Interferometer Satellite for Studies of Galactic Halo Tracers) and MIRA (Mitaka/Mauna Kea/Maui) Optical and Infra-Red Interferometer Array	561
<i>N. S. Chernykh and A. G. Sokolsky</i>	
ITA-CrAO Minor Planet Survey: Results and Prospects	567
LIST OF PARTICIPANTS	571
INDEX	583