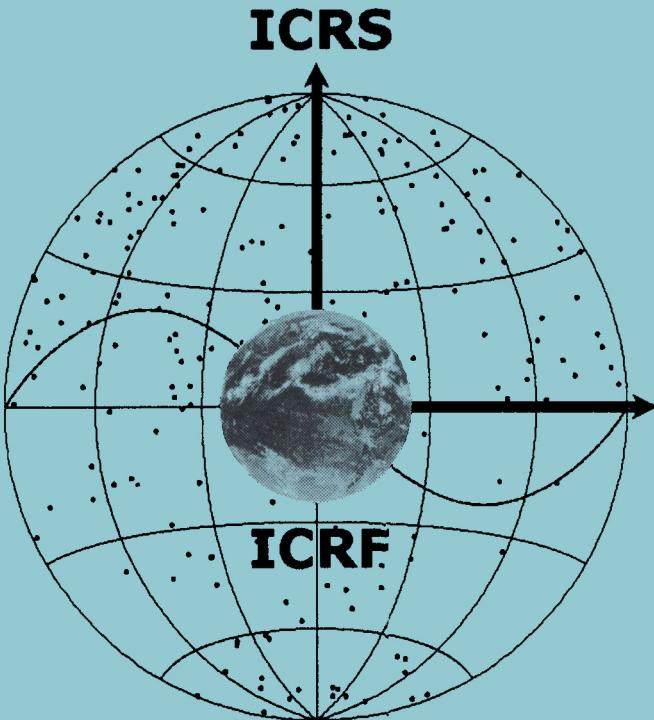


# **Proceedings of IAU Colloquium 180**



## **Towards Models and Constants for Sub-Microarcsecond Astrometry**

Edited by

Kenneth J. Johnston

Dennis D. McCarthy

Brian J. Luzum

George H. Kaplan



International Astronomical Union  
International Earth Rotation Service

# Towards Models and Constants for Sub-Microarcsecond Astrometry

Proceedings of IAU Colloquium 180

Held at the U.S. Naval Observatory  
Washington, DC, USA  
27–30 March 2000

*Edited by*  
Kenneth J. Johnston  
Dennis D. McCarthy  
Brian J. Luzum  
George H. Kaplan

---

U.S. Naval Observatory  
Washington, DC, USA  
2000

Printed in the United States of America  
2000

For further information, contact:

Astronomical Applications Department  
U.S. Naval Observatory  
3450 Massachusetts Avenue NW  
Washington, DC 20392-5420  
USA  
[help@aa.usno.navy.mil](mailto:help@aa.usno.navy.mil)

Or see <http://aa.usno.navy.mil/AA/publications/>

# IAU Colloquium 180

## Towards Models and Constants for Sub-Microarcsecond Astrometry

March 2000

### Scientific Organizing Committee

Kenneth J. Johnston ( <i>chair</i> )	Dennis D. McCarthy
Victor Brumberg	Francois Mignard
Nicole Capitaine	Gerard Petit
Veronique Dehant	P. Kenneth Seidelmann
Toshio Fukushima	Michael Soffel
Wenjing Jin	E. Myles Standish
Jean Kovalevsky	Jan Vondrak

### Local Organizing Committee

George H. Kaplan ( <i>chair</i> )	Nancy Oliverson
F. Stephen Gauss	Jane Russell
William E. Howard III	Lynn Treadway
Brian J. Luzum	Sean Urban
Chopo Ma	

### Proceedings Editors

Kenneth J. Johnston	Brian J. Luzum
Dennis D. McCarthy	George H. Kaplan

# Table of Contents

Conference Participants ..... xi

Conference Photograph ..... xx

## CELESTIAL REFERENCE SYSTEM AND FRAME

---

**Celestial Reference Systems — an Overview ..... 3**

*J. Kovalevsky*

**Report of the IAU Working Group on ICRS ..... 10**

*F. Mignard*

**Limits on Astrometric Accuracy ..... 20**

*A. Fey*

**Models for Source Structure Corrections ..... 29**

*P. Charlot*

**Improving the Accuracy of Radio Astrometry ..... 40**

*A. Fey*

**The Accuracy of Ground-based Optical Interferometry  
Observations ..... 47**

*D. Hutter*

**Determination of Optical Positions for Extragalactic Radio  
Sources under the Collaboration between SHAO and NAO ..... 57**

*Z. Tang, W. Jin, S. Wang, G. Pinigin, A. Shulga, N. Magurova, and  
Yu. Protsyuk*

**Densification of ICRS in the Optical by use of Old Pulkova  
Observation Sets ..... 61**

*I. Kumkova, V. Bobylev, and N. Bronnikova*

<b>Optical Positions of Extragalactic Radio Sources Using the UCAC1 .....</b>	68
<i>M. Assafin, N. Zacharias, A. Andrei, and R. Vieira Martins</i>	
<b>Densifying the Optical Reference Frame: The Tycho-2 Catalog of 2.5 Million Stars .....</b>	75
<i>S. Urban and G. Wycoff</i>	
<b>The UCAC as Input Catalog for FAME .....</b>	80
<i>N. Zacharias, T. Rafferty, S. Urban, M. Zacharias, and G. Wycoff</i>	
<b>A New Optical Realization of the ICRS .....</b>	85
<i>G. Gontcharov, A. Andronova, E. Kornilov, and O. Titov</i>	
<b>Intermediate Stars in Extragalactic Radiosource Fields: Astrometric Measurements .....</b>	92
<i>M. Birlan and G. Bosca</i>	
<b>Problems of Using Hipparcos Astrometry of Double Stars .....</b>	97
<i>S. Urban, T. Corbin, G. Wycoff, and B. Mason</i>	
<b>Comparison of Hipparcos Proper-Motion System to the FK5 ....</b>	104
<i>Z. Zhu and W. Jin</i>	
<b>Stellar Kinematics from Hipparcos Proper Motions .....</b>	110
<i>Z. Zhu and W. Jin</i>	
<b>Examination of the Hipparcos Proper Motion System from Lunar Occultation Analysis .....</b>	115
<i>M. Sôma</i>	
<b>Dynamical Reference Frame — Current Relevance and Future Prospects .....</b>	120
<i>M. Standish</i>	
<b>Global Astrometric Solutions with Sparse Matrix Techniques ....</b>	127
<i>R. Branham</i>	

Triangulation Measurements in the Solar System .....	132
--	-----

*V. Abalakin, M. Chubey, G. Eroshkin, and I. Kopylov*

## IMPROVED DEFINITIONS AND MODELS

---

Definition of the Celestial Ephemeris Pole and the Celestial Ephemeris Origin .....	153
--	-----

*N. Capitaine*

On the Reference Pole for Earth Orientation and UT1 .....	164
---	-----

*P. Mathews and T. Herring*

Diurnal and Sub-Diurnal Terms of Nutation .....	171
---	-----

*A. Brzeziński*

Geodetic and Geophysical Applications of High-precision Astrometry .....	182
---	-----

*C. Wilson*

Rigid-Earth Nutation Models .....	190
-----------------------------------	-----

*J. Souchay*

Towards Sub-microarcsecond Rigid-Earth Nutation Series in the Hamiltonian Theory .....	196
---	-----

*J. Souchay and M. Folgueira*

Report of the IAU Working Group on ‘Nonrigid-Earth Nutation Theory’ .....	201
--	-----

*V. Dehant*

Improved Models for Precession and Nutations .....	212
--	-----

*P. Mathews*

Improvement of Nonrigid-Earth Nutation Series by Adding a Model Free Core Nutation Term .....	223
--	-----

*T. Shirai and T. Fukushima*

<b>Nonrigid Earth Rotation Solution .....</b>	230
<i>P. Bretagnon, P. Rocher, and J.-L. Simon</i>	
<b>Advances in the Unified Theory of the Rotation of the Nonrigid Earth .....</b>	236
<i>J. Getino and J. M. Ferrández</i>	
<b>A New Nutation Model of Nonrigid Earth with Ocean and Atmosphere .....</b>	242
<i>C. Huang, W. Jin, and X. Liao</i>	
<b>Precession-Nutation Estimates from Optical Astrometry 1899.7–19920.0 and Comparison with VLBI Results .....</b>	248
<i>J. Vondrák and C. Ron</i>	
<b>Estimation of EOP from VLBI: Direct Approach .....</b>	254
<i>L. Petrov</i>	
<b>Influence of Adopted Nutation Model on VLBI NEOS-Intensives Data Analysis .....</b>	259
<i>O. Titov</i>	

## RELATIVISTIC CONSIDERATIONS

---

<b>Relativity in Modern Astrometry and Celestial Mechanics — Overview .....</b>	265
<i>S. Klioner</i>	
<b>Report of the BIPM/IAU Joint Committee on Relativity for Space-Time Reference Systems and Metrology .....</b>	275
<i>G. Petit</i>	
<b>Report of the Working Group ‘Relativity for Celestial Mechanics and Astrometry’ .....</b>	283
<i>M. Soffel</i>	

<b>Kinematical Relativistic Corrections for Earth's Rotation Parameters .....</b>	<b>293</b>
<i>V. Brumberg and P. Bretagnon</i>	
<b>Sub-Microarcsecond Astrometry and New Horizons in Relativistic Gravitational Physics .....</b>	<b>303</b>
<i>S. Kopeikin and C. Gwinn</i>	
<b>Possible Relativistic Definitions of Parallax, Proper Motion and Radial Velocity .....</b>	<b>308</b>
<i>S. Klioner</i>	
<b>General Relativistic Models for a GAIA-like Astrometry Mission</b>	<b>314</b>
<i>F. de Felice, A. Vecchiato, B. Bucciarelli, M. Lattanzi, and M. Crosta</i>	
<b>Numerical Data Processing Simulation of Microarcsecond Classical and Relativistic Effects in Space Astrometry .....</b>	<b>320</b>
<i>S. Kopeikin, N. Shuygina, M. Vasiliev, E. Yagudina, and L. Yagudin</i>	

## TIME AND STANDARDS

---

<b>Time and Standards — An Overview .....</b>	<b>329</b>
<i>B. Guinot</i>	
<b>Report on Astronomical Constants .....</b>	<b>417</b>
<i>T. Fukushima</i>	
<b>Report of Special Commission 3 of IAG .....</b>	<b>337</b>
<i>E. Groten</i>	
<b>SOFA Software Progress Report .....</b>	<b>353</b>
<i>P. Wallace</i>	
<b>Future Definition of UTC .....</b>	<b>363</b>
<i>D. McCarthy</i>	

## OBSERVATIONAL PROJECTS

---

<b>Observational Model for Precision Astrometry with the Space Interferometry Mission .....</b>	<b>375</b>
<i>S. Turyshев and M. Milman</i>	
<b>SIM Grid Star Observations: Astrometry with a New High Dynamic Range Imaging Device .....</b>	<b>380</b>
<i>L. Winter</i>	
<b>The Effect of Companions on the SIM Reference Frame .....</b>	<b>386</b>
<i>C. Jacobs and S. Turyshев</i>	
<b>The Future of Space Astrometry .....</b>	<b>392</b>
<i>K. Johnston</i>	
<b>Summary and Recommendations .....</b>	<b>398</b>
<i>P. K. Seidelmann</i>	