

---

## Contents

---

### Part I Surveys

---

|   |    |
|---|----|
| <b>Fundamental Physics, Space, Missions and Technologies</b><br><i>Claus Lämmerzahl and Hansjörg Dittus</i> . . . . .                               | 3  |
| <b>General Theory of Relativity: Will It Survive<br/>the Next Decade?</b><br><i>Orfeu Bertolami, Jorge Páramos, and Slava G. Turyshev</i> . . . . . | 27 |
| <b>Is the Physics Within the Solar System Really Understood?</b><br><i>Claus Lämmerzahl, Oliver Preuss, and Hansjörg Dittus</i> . . . . .           | 75 |

---

### Part II Theory

---

|   |     |
|---|-----|
| <b>Propagation of Light in the Gravitational Field of Binary<br/>Systems to Quadratic Order in Newton's Gravitational<br/>Constant</b><br><i>G. Schäfer and Michael H. Brügmann</i> . . . . .           | 105 |
| <b>On the Radar Method in General-Relativistic Spacetimes</b><br><i>V. Perlick</i> . . . . .  | 131 |
| <b>A Universal Tool for Determining the Time Delay<br/>and the Frequency Shift of Light: Synge's World Function</b><br><i>Pierre Teyssandier, Christophe Le Poncin-Lafitte, and Bernard Linet</i> . . . | 153 |
| <b>Unified Formula for Comparison of Clock Rates and Its<br/>Applications</b><br><i>C. Xu, X. Wu, and E. Brüning</i> . . . . .  | 181 |

VIII Contents

|  |     |
|--|-----|
| <b>Gravity Tests and the Pioneer Anomaly</b><br><i>Marc-Thierry Jaekel and Serge Reynaud</i> .....             | 193 |
| <b>Laser Ranging Delay in the Bimetric Theory of Gravity</b><br><i>Sergei M. Kopeikin and Wei-Tou Ni</i> ..... | 209 |

---

**Part III Technologies**

---

|   |     |
|---|-----|
| <b>Measurement of the Shapiro Time Delay Between Drag-Free<br/>Spacecraft</b><br><i>Neil Ashby and Peter L. Bender</i> .....  | 219 |
| <b>Laser Transponders for High-Accuracy Interplanetary Laser<br/>Ranging and Time Transfer</b><br><i>John J. Degnan</i> .....   | 231 |
| <b>Unequal-Arm Interferometry and Ranging in Space</b><br><i>Massimo Tinto</i> .....  | 243 |
| <b>Technology for Precision Gravity Measurements</b><br><i>Robert D. Reasenbergs and James D. Phillips</i> .....  | 263 |
| <b>Clocks and Accelerometers for Space Tests<br/>of Fundamental Physics</b><br><i>Lute Maleki, James M. Kohel, Nathan E. Lundblad, John D. Prestage,<br/>Robert J. Thompson, and Nan Yu</i> ..... | 285 |
| <b>Atom Interferometric Inertial Sensors<br/>for Space Applications</b><br><i>Philippe Bouyer, Franck Pereira dos Santos, Arnaud Landragin,<br/>and Christian J. Bordé</i> .....                  | 297 |
| <b>Drag-Free Satellite Control</b><br><i>Stephan Theil</i> .....  | 341 |
| <b>Drag-Free Control Design with Cubic Test Masses</b><br><i>Walter Fichter, Alexander Schleicher, and Stefano Vitale</i> .....   | 361 |
| <b>Solar Sail Propulsion: An Enabling Technology<br/>for Fundamental Physics Missions</b><br><i>Bernd Dachwald, Wolfgang Seboldt, and Claus Lämmerzahl</i> .....                                  | 379 |

---

**Part IV Missions and Projects**

---

|  |     |
|--|-----|
| <b>Testing Relativity with Space Astrometry Missions</b><br><i>Sergei A. Klioner</i> ..... | 399 |
|--|-----|

|   |     |
|---|-----|
| <b>LISA, the Laser Interferometer Space Antenna,<br/>Requires the Ultimate in Lasers, Clocks,<br/>and Drag-Free Control</b><br><i>Albrecht Rüdiger, Gerhard Heinzel, and Michael Tröbs</i> . . . . .                                | 427 |
| <b>Lunar Laser Ranging Contributions<br/>to Relativity and Geodesy</b><br><i>Jürgen Müller, James G. Williams, and Slava G. Turyshev</i> . . . . .  | 457 |
| <b>Science, Technology, and Mission Design<br/>for the Laser Astrometric Test of Relativity</b><br><i>Slava G. Turyshev, Michael Shao, and Kenneth L. Nordtvedt, Jr.</i> . . . .  | 473 |
| <b>LATOR's Measured Science Parameters<br/>and Mission Configuration</b><br><i>Kenneth Nordtvedt</i> . . . . .  | 545 |
| <b>OPTIS: High-Precision Tests of Special and General<br/>Relativity in Space</b><br><i>Claus Lämmerzahl, Hansjörg Dittus, Achim Peters, Silvia Scheithauer,<br/>and Stephan Schiller</i> . . . . .                                 | 553 |
| <b>Testing Relativistic Gravity to One Part<br/>per Billion</b><br><i>Wei-Tou Ni, Antonio Pulido Patón, and Yan Xia</i> . . . . .   | 571 |
| <b>Exploring the Pioneer Anomaly: Concept Considerations<br/>for a Deep-Space Gravity Probe Based on Laser-Controlled<br/>Free-Flying Reference Masses</b><br><i>Ulrich Johann, Hansjörg Dittus, and Claus Lämmerzahl</i> . . . . . | 577 |
| <b>Pioneer Anomaly: What Can We Learn<br/>from LISA?</b><br><i>Denis Defrère and Andreas Rathke</i> . . . . .   | 605 |
| <b>Index</b> . . . . .  | 631 |

Lasers, Clocks and Drag-Free Control

Exploration of Relativistic Gravity in Space

Dittus, H.; Lämmerzahl, C.; Turyshev, S.G. (Eds.)

2008, XX, 642 p. 179 illus., 3 illus. in color., Hardcover

ISBN: 978-3-540-34376-9