Fundamental Theories of Physics

Volume 179

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Dirk Puetzfeld · Claus Lämmerzahl
Bernard Schutz
Editors

Equations of Motion in Relativistic Gravity

Editors

Dirk Puetzfeld
ZARM
University of Bremen
Bremen
Germany

Bernard Schutz
Max-Planck-Institut für Gravitationsphysik
Golm, Brandenburg
Germany

Claus Lämmerzahl
ZARM
University of Bremen
Bremen
Germany

Fundamental Theories of Physics
ISBN 978-3-319-18334-3 ISBN 978-3-319-18335-0 (eBook)
DOI 10.1007/978-3-319-18335-0

Library of Congress Control Number: 2015938091

Springer Cham Heidelberg New York Dordrecht London
© Springer International Publishing Switzerland 2015

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Printed on acid-free paper

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Preface

The derivation of the equations of motion for extended bodies represents a fundamental problem in relativistic gravitational physics. Since the early days of Einstein's theory of General Relativity, a wide spectrum of methods has been proposed to allow for the derivation in different physical settings. Without having such equations of motion at hand it is impossible to correctly describe, for example, the motion of binary systems, or to calculate the form of gravitational waves emitted by such systems. These equations are also crucial for astrometry and for high precision satellite missions.

In 2013 we organized¹ an international conference in Bad Honnef (Germany) on the "Equations of Motion in Relativistic Gravity". The conference brought together the leading experts in their respective fields, and was very well received by the speakers as well as by the audience. We would like to thank the WE-Heraeus Foundation for the generous support of this conference. Our thanks also go to the Physikzentrum Bad Honnef where the conference took place.

The very positive reception and the feedback after the conference made clear that there is a strong demand for an up-to-date textbook, covering the wide spectrum of methods employed in current research in the context of the relativistic problem of motion. This book intends to give a broad and up-to-date status report on this issue. It hopefully is of value for the experts working in this field and may also serve as a guideline for students with a background in General Relativity, who would like to enter the field.

The present volume is based on the lectures given at the conference, and gives an overview of the following topics:

- Derivation of the equations of motion in General Relativity (GR) and in alternative gravity theories for
 - Spinning and extended test bodies
 - Self-force effects

¹<http://puetzfeld.org/eom2013.html>.

- Self-gravitating/heavy bodies
 - Microstructured bodies with internal degrees of freedom
- Approximation methods linked to the derivation of the equations of motion
 - Multipolar methods
 - Post-Newtonian and post-Minkowskian methods
- Current and future observations
 - Binary systems, in particular binary pulsars
 - Gravitational waves
 - Celestial mechanics and astrometry
 - Satellite experiments

The contributions in this book roughly follow the order of presentations at the conference, i.e. there are contributions on test bodies, self-force effects, the dynamics of self-gravitating bodies, as well as on current and future observations.

We as editors are deeply indebted to the contributors to this volume, who made great efforts to present their respective areas of research in an accessible way to a broader audience. We hope that the material presented here will prove to be useful as a reference for experienced researchers, as well as serve as an inspiration for younger researchers who want to enter this exciting field of gravitational physics.

Dirk Puetzfeld
Claus Lämmerzahl
Bernard Schutz

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Contributors

A. Alberdi Instituto de Astrofísica de Andalucía (CSIC), Glorieta de la Astronomía s/n, Granada, Spain

Lars Andersson Albert Einstein Institute, Potsdam, Germany

Stanislav Babak Albert Einstein Institute, Golm, Germany

S. Britzen Max-Planck-Institut für Radioastronomie, Bonn, Germany

Carla Cederbaum Mathematisches Institut, Universität Tübingen, Tübingen, Germany

Robert H. Cole Institute of Astronomy, University of Cambridge, Cambridge, UK

L. Filipe O. Costa CAMGSD, Instituto Superior Técnico, Universidade de Lisboa, Lisbon, Portugal; Departamento de Física e Astronomia, Centro de Física do Porto – CFP, Universidade do Porto, Porto, Portugal

W.G. Dixon Churchill College, University of Cambridge, Cambridge, England

A. Eckart I. Physikalisches Institut, Universität zu Köln, Cologne, Germany; Max-Planck-Institut für Radioastronomie, Bonn, Germany

Mykola Fenyk Pidstryhach Institute for APMM, Ukrainian National Academy of Sciences, Lviv, Ukraine

Toshifumi Futamase Astronomical Institute, Tohoku University, Sendai, Japan

Jonathan R. Gair Institute of Astronomy, University of Cambridge, Cambridge, UK

Domenico Giulini Riemann Center for Geometry and Physics, Institute for Theoretical Physics, Leibniz University Hannover, Hannover, Germany; Center for Applied Space Technology and Microgravity, University of Bremen, Bremen, Germany

Achamveedu Gopakumar Department of Astronomy and Astrophysics, Tata Institute of Fundamental Research, Mumbai, India

Arne Grenzebach ZARM, University of Bremen, Bremen, Germany

Anuradha Gupta Department of Astronomy and Astrophysics, Tata Institute of Fundamental Research, Mumbai, India

Abraham I. Harte Albert-Einstein-Institut, Max-Planck-Institut für Gravitationsphysik, Golm, Germany

Peter A. Hogan School of Physics, University College Dublin, Dublin 4, Ireland

Y. Itin Institute of Mathematics, Hebrew University of Jerusalem and Jerusalem College of Technology, Jerusalem, Israel

V. Karas Astronomical Institute, Academy of Sciences, Prague, Czech Republic

Sergei M. Kopeikin Department of Physics & Astronomy, University of Missouri, Columbia, MO, USA

D. Kunneriath Astronomical Institute, Academy of Sciences, Prague, Czech Republic

José Natário CAMGSD, Instituto Superior Técnico, Universidade de Lisboa, Lisbon, Portugal

R.F. O'Connell Department of Physics and Astronomy, Louisiana State University, Baton Rouge, LA, USA

Yuri N. Obukhov Theoretical Physics Laboratory, Nuclear Safety Institute, Russian Academy of Sciences, Moscow, Russia

Volker Perlick ZARM, University of Bremen, Bremen, Germany

Alexander N. Petrov Sternberg Astronomical Institute, Lomonosov Moscow State University, Moscow, Russia

Roman Plyatsko Pidstryhach Institute for APMM, Ukrainian National Academy of Sciences, Lviv, Ukraine

Adam Pound Mathematical Sciences, University of Southampton, Southampton, UK

Dirk Puetzfeld ZARM, University of Bremen, Bremen, Germany

N. Sabha I. Physikalisches Institut, Universität zu Köln, Cologne, Germany

Gerhard Schäfer Theoretisch-Physikalisches Institut, Friedrich-Schiller-Universität Jena, Jena, Germany

R. Schödel Instituto de Astrofísica de Andalucía (CSIC), Glorieta de la Astronomía s/n, Granada, Spain

O. Semerák Institute of Theoretical Physics, Faculty of Mathematics and Physics, Charles University in Prague, Prague, Czech Republic

Alexander J. Silenko Research Institute for Nuclear Problems, Belarusian State University, Minsk, Belarus; Bogoliubov Laboratory of Theoretical Physics, Joint Institute for Nuclear Research, Dubna, Russia

Dinesh Singh Department of Physics, University of Regina, Regina, SK, Canada

Oleksandr Stefanyshyn Pidstryhach Institute for APMM, Ukrainian National Academy of Sciences, Lviv, Ukraine

Jan Steinhoff Centro Multidisciplinar de Astrofísica (CENTRA), Instituto Superior Técnico (IST), Lisbon, Portugal

C. Straubmeier I. Physikalisches Institut, Universität zu Köln, Cologne, Germany

P. Suková Center for Theoretical Physics, Polish Academy of Sciences, Warsaw, Poland

M. Valencia-S. I. Physikalisches Institut, Universität zu Köln, Cologne, Germany

Barry Wardell Department of Astronomy, Cornell University, Ithaca, NY, USA

Norbert Wex Max-Planck-Institut für Radioastronomie, Bonn, Germany

J.A. Zensus I. Physikalisches Institut, Universität zu Köln, Cologne, Germany; Max-Planck-Institut für Radioastronomie, Bonn, Germany