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 organized[1] 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-do-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.

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