

"Paradoxically, physicists claim that gravity is the weakest of the fundamental forces."

Prof. Hallstein Høgåsen— after having fallen from a ladder and breaking both his arms

Preface

Many of us have experienced the same, fallen and broken something. Yet, supposedly, gravity is the weakest of the fundamental forces. It is claimed to be 10^{-15} times weaker than electromagnetism. But still, every one of us have more or less a personal relationship with gravity. Gravity is something which we have to consider every day. Whenever we loose something on the floor and whenever we pour something in a cup, gravity is an active participant. Had it not been for gravity, we could not have done anything of the above. Thus gravity is part of our everyday life.

This is basically what this book is about: gravity. We will try to convey the concepts of gravity to the reader as Albert Einstein saw it. Einstein saw upon gravity as nobody else before him had seen it. He saw upon gravity as curved spaces, four-dimensional manifolds and geodesics. All of these concepts will be presented in this book.

The book offers a rigorous introduction to Einstein's general theory of relativity. We start out from the first principles of relativity and present Einstein's theory in a self-contained way. For the readers convenience, we have included a rough flowchart of chapter dependencies in Appendix D. Such a flowchart is particularly useful if this book is used as a textbook for a course in General Relativity.

After introducing Einstein's field equations, we go onto the most important chapter in this book which contains the three classical tests of the theory and introduces the notion of black holes. Recently, cosmology has also proven to be a very important testing arena for the general theory of relativity. We have thus devoted a large part to this subject. We introduce the simplest models decribing an evolving universe, which in spite of their simpleness, can say quite a lot about the universe we live in. We include the cosmological constant and explain in detail the "standard model" in cosmology. After the main issues have been presented we introduce an anisotropic and an inhomogeneous universe model and explain some of their features. Unless one just accepts the cosmological principles as a fact, one is unavoidably led to the study of such anisotropic and inhomogeneous universe models. As an introductory course in general relativity, it is suitable to stop after finishing the chapters with cosmology.

For the more experienced reader, or for people eager to learn more, we have included a part called "Advanced Topics". These topics have been chosen by the authors because they present topics that are important and that have not been highlighted elsewhere in textbooks. Some of them are on the very edge of research, others are older ideas and topics. In particular, the last two chapters deal with Einstein gravity in five dimensions which has been a hot topic of research in recent years.

All of the ideas and matters presented in this book have one thing in common: they are all based on Einstein's classical idea of gravity. We have not considered any quantum mechanics in our presentation, with one exception:

black hole thermodynamics. Black hole thermodynamics is a quantum feature of black holes, but we chose to include it because the study of black holes would have been incomplete without it.

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