Preface

Over the past 20 years, cosmology has emerged as a mature research field, in which it is possible to perform precise measurements and test fundamental physics. Its significance in relation to the other areas of research in physics has grown substantially. To wit, two out of ten Nobel Prizes in physics awarded during the past 10 years were conferred for studies related to cosmology (in 2006 and in 2011). Among the preceding more than 100 awards, only one-half of one Nobel Prize (in 1978) was for cosmology.

The number of researchers working in cosmology is increasing, and students taking introductory courses on cosmology include not only those who plan to work in this field, but also those with different interests, seeking to get at least a basic understanding of the subject.

The aim of this book is to provide an introduction to modern cosmology for senior undergraduate and graduate physics students, without necessarily requiring a strong background in theoretical high energy physics. Students in astronomy/astrophysics, in experimental high energy physics, or in other areas of research as well may be interested to learn some fundamental concepts of the structure and evolution of the Universe. Typically, these students are not closely familiar with General Relativity and quantum field theory, and therefore they may find it difficult to digest the existing cosmology books on the market.

This book describes the so-called Standard Cosmological Model. The model's theoretical aspects are based on General Relativity and on the Standard Model of particle physics, with the addition of the inflationary paradigm. This scenario is very successful in explaining a large amount of observational data including, in particular, the description of the Universe expansion, the primordial abundances of the light elements, and the origin and the properties of the cosmic microwave background radiation. However, there is also a plethora of observed phenomena that does not fit the frameworks of the Minimal Standard Model of particle physics and cosmology, and represents clear indications for new physics. To name just a few examples, the minimal model cannot explain the cosmological matter-antimatter asymmetry, the observed accelerated expansion of the contemporary Universe, and does not have any candidate for dark matter. The cosmological inflation is still at the level of a hypothesis. Its realization demands some new field or fields, which have not yet been discovered.

These subjects are presented here within a rather heuristic approach, which includes a needed description of observational data, and a reduction of mathematical technicalities as much as possible. Chapters 6 and 7, dealing, respectively, with inflation and baryogenesis, are more advanced and require some knowledge of quantum field theory, but students who are not familiar with those concepts can skip these chapters without affecting their comprehension of the rest of the book. The content of this book is partially based on the cosmology class given at Fudan University by one of the authors and on lectures given at a number of universities by the other.

The work of C.B. was supported by the NSFC grant No. 11305038, the Shanghai Municipal Education Commission grant No. 14ZZ001, the Thousand Young Talents Program, and Fudan University. The work of A.D.D. was supported by the grant of the Russian Federation Government 11.G34.31.0047.

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May 2015

Springer

http://www.springer.com/978-3-662-48077-9

Introduction to Particle Cosmology
The Standard Model of Cosmology and its Open Problems
Bambi, C.; Dolgov, A.D.
2016, XI, 251 p. 30 illus., 21 illus. in color., Hardcover
ISBN: 978-3-662-48077-9