

Preface

Allan Sandage used the term “Practical cosmology” to denote the study of the large-scale universe and the search for the world model which best describes it. In our book we, as students of practical cosmology, guide the reader through modern cosmology, with emphasis on cosmological physics within our gradually deepening sample of the universe. We have restricted this treatise to the realm of galaxies where we can measure distances to individual objects, which in itself is a classical and fundamental problem in astronomy. Therefore, our discussion of the problems of the early universe and the cosmic background radiation and its angular fluctuations, so central in modern cosmology in general, is relatively limited.

This book presents cosmology as a physical science based on observations, experiments and theoretical interpretations. We remind the reader that fundamental physics as understanding of natural phenomena, including the whole universe, is the modern *Philosophiae Naturalis* started by Galileo and Newton. We do not presuppose advanced knowledge of astronomy and do not go into detailed descriptions of observing techniques. Basic mathematical concepts used in modern cosmological models are presented in a simple way. We hope that all this will make the book useful for both astronomers and general physicists, and also for university students of physical sciences. If needed, suitable background reading on astronomy may be found in the book by Karttunen et al.: “Fundamental Astronomy” (Springer 2006), and on history of astronomy and cosmology in Teerikorpi et al.: “The Evolving Universe and the Origin of Life—The Search for Our Cosmic Roots” (Springer 2009). The development of the Cosmological Principle has been discussed by Baryshev and Teerikorpi: “Discovery of Cosmic Fractals” (World Scientific 2002).

The following subjects are close to our own experience in the study of the galaxy universe and form the main contents of the book: The cosmic distance scale and the Malmquist bias. Gravitation and world models. Observational tests of cosmological models. The large-scale structure of the universe. Conceptual problems of cosmological physics.

We emphasize those aspects which give practical cosmology its special character, due to a subtle interplay between observations, data analysis, and fundamental physics. We hope that our book will help the reader to achieve useful conceptual

understanding of some central but not so often emphasized problems in modern cosmology (such as selection effects and methods of analysis of the large-scale structure).

We underline throughout the book the essential fact that to obtain the correct picture of cosmological physics one should be aware that cosmology is—in a sense—“a science of cosmic selection effects”. The interpretations from directly observed astronomical quantities and from astronomical data in general, may be in a subtle manner distorted by physical and technical limitations of observations and by inadequate methods of data analysis.

Cosmology has not been finished yet, and many fundamental questions are still open problems. The late Edward Harrison wrote to us in a letter: “Cosmology is always in the state of triumph and crisis. It is the natural state of the art.” And this is because the initial assumptions and physical consequences are often difficult or impossible to test directly. There is the need for continuous testing of the accepted cosmological framework, which is, in the terminology of Thomas Kuhn, the working paradigm which rules and inspires contemporary cosmologists. Assumptions made by cosmologists determine the theory, its predictions and the inferred properties of deep space phenomena. At the same time the assumptions themselves are open for investigation—a constructive duality. Therefore we also wish to point out the positive role of alternative cosmological ideas which serve as a test-bench on the way towards a true world model.¹

In principle, one would like to see practical cosmology as wider based than any specific cosmological model. This is because its methods are especially aimed at testing the initial assumptions and basic predictions of different world models. It should guide cosmologists between the Scyllas of empirism and the Charybdises of pure thinking ever tempting us away from the correct route towards progressively closer approximations to the true world model and to a deeper understanding of Reality.

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We dedicate our book to the memories of Allan Sandage (1926–2010), Geoffrey Burbidge (1925–2010), and Benoit Mandelbrot (1924–2010). In the 20th century, Sandage represented the classical approach to observational cosmology, Burbidge

¹During the preparation of the book we organized the conference *Problems of Practical Cosmology* held in St.Petersburg in June 2008. The meeting offered examples of mainstream and critical views, both of which are fruitful for the advancement of cosmological physics (Proceedings at <http://ppc08.astro.spbu.ru>).

defended alternative cosmological views, and Mandelbrot introduced novel mathematical concepts for describing cosmologically distributed matter. We hope that we have been able to convey, not only their specific contributions to cosmology, but also some of their spirit of approach to science.

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Exploring the Realm of Galaxies

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