Preface

The high-redshift galaxies became a distinct research field during the final decade of the 20th century. At that time the Lyman-break technique made it possible to identify significant samples of such objects, and the new generation of 8 to 10-m telescopes resulted in first good spectroscopic data. Today the high-redshift galaxies have developed into one of the important topics of astrophysics, accounting for about 5–10% of the publications in the major scientific journals devoted to astronomy. Because high-redshift galaxies is a rapidly developing field and since new results are published constantly, writing a book on this topic is challenging. On the other hand, in view of the large amount of individual results now in the literature, and in view of the still growing interest in this topic, it appears worthwhile to summarize and evaluate the available data and to provide an introduction for those who wish to enter this field, or who, for various reasons, might be interested in its results.

The end of the first decade of the 21st century appears to be a good point in time to attempt such a summary. The current generation of ground-based 8 to 10-m IR-optical telescopes, the Hubble Space Telescope, and the most important large radio telescopes have by now been in operation since about one or two decades. Although these instruments will continue to produce important scientific results for some time to come, many of the initial programs exploiting their unique new possibilities have been completed. Further scientific progress with these facilities is expected to occur on a less rapid pace. Within about another decade a new generation of instruments (such as the James Web Space Telescope, the Atacama Large Millimeter Array, and new larger and innovative optical and radio telescopes) will take over the role as cutting-edge instrumentation. But these future instruments are still under construction or in advanced planning stages. Therefore, it seems timely and appropriate to take stock on what has been achieved during the past years, on what is missing, and on what has still to be done, and will be feasible in the future.

The main objective of this book is to summarize and to discuss our present knowledge of the galaxies with redshifts > 2. The light observed from these galaxies was emitted when the age of the universe was less than one quarter of the present value of 13.7 Gyr. At the epoch corresponding to a redshift of 2, galaxy formation had been completed and about a quarter of the cosmic star formation had already taken place, the cosmic star formation rate had attained its maximum, and the universe had qualitatively reached most of its present properties. The galaxies still

evolved significantly during the following $>$ 10 Gyr. But most of this evolution was of a quantitative nature.

In addition to summarizing and critically discussing the observational data and their present interpretation, the book gives a brief introduction to the observational methods, which make it possible to study these very distant and extremely faint radiation sources. This includes an assessment of the technical feasibilities and the physical limitations of the existing and of future ground-based and space-based instruments. The objective of these sections is to provide information and tools which could be of help in the planning of future observational programs and for the definition and development of new instrumentation.

As a result of major new astrophysical discoveries (such as dark matter, dark energy, and inflation) the distant universe has become a popular topic also among colleagues working in the field of fundamental physics and other related fields of science. The extreme conditions and processes in the early universe are often regarded as a particularly valuable test bench for emerging new physical concepts. The most distant galaxies were formed during the transition from the almost homogeneous very early universe to the structured universe in which we live today. Therefore, high-redshift galaxies contain important information on the physics and the properties of these early epochs.

In view of the relevance of observations of the high-redshift universe beyond astronomy, I have tried to make this book readable not only for astronomers, but for all scientists with a basic knowledge of physics. It is assumed that the reader is familiar with the basic concepts and results of modern physics, but reading the book does not require a prior knowledge of astronomy. For the readers without an astronomical background, the text includes brief descriptions of the basic concepts, terms, and notations used in the current astronomical literature. Furthermore, the first three chapters provide short overviews of our present knowledge on the main components of the local universe, and of the basic facts of cosmic evolution. The special terms, notations, and special units used in astronomy (which often appear puzzling to non-astronomers) are explained, when they appear for the first time.

These introductory sections may also be helpful for students of astronomy, who are interested in the present topic, but who have not yet completed all the basic astronomy courses. Naturally, the introductory sections can provide only short summaries of the wealth of information available in the basic astronomical textbooks. Moreover, only those facts and data are presented here, which are of interest in the context of high-redshift galaxies. Readers, who are interested in more comprehensive information on individual topics, will find references to the corresponding detailed literature.

In view of the high rate of papers published in the field of extragalactic astronomy, it is impossible to provide a complete list of references. Instead, the citations had to be restricted to the most important publications and to the most recent papers.

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