

Preface

This book is dedicated to *Galileo Galilei*, the Italian man who 400 years ago first pointed a telescope toward the luminous objects visible in the night sky, realizing the famous astronomical discoveries (published in the “*Sidereus Nuncius*”), which within few years prompted the first scientific revolution, today known as the “Copernican Revolution”. A new vision of the Universe was emerging at that time in the garden of Galileo in Padova. His life and scientific discoveries are so famous and important that during 2009, declared by United Nations the year of Astronomy, astronomers from all countries will celebrate his life through meetings, congresses, workshops, lectures, seminars, and a lot of other activities.

Here, in Italy, the astronomical community is working hard for the 2009 celebrations of the International Year of Astronomy. In this context, at the beginning of 2007, we proposed this book to the Springer publisher to give our personal tribute in honor of Galileo. To us, the idea of reviving the Galileo “spirit”, by engaging in a discussion with many contemporary scientists about the state-of-the-art of the present day cosmology and the role and character of this science today in our society, was very attractive. For this reason, we realized a series of interviews with many astronomers and physicists from all over the world, with the aim of summarizing the most important and significant advances made by cosmology over the past century and at the beginning of the new millennium. We have tried to interpret, as well as possible, the fighting spirit of Galileo, opening the debate to alternative ideas and strongly favoring the empirical approach to the scientific problems.

We are living in a very strange scientific epoch: theorists are pushing themselves to the limits of pure speculation in the search of a “Theory of Everything”, able to reconcile quantum mechanics, general relativity, cosmology, and particle physics. At the same time, experimental and observational projects are getting bigger and better at demonstrating the existence of the theoretically predicted dark matter and dark energy, which would constitute up to $\sim 95\%$ of the energy density, understanding the very early stages of the Universe and reconstructing its evolution. In this context, the parallelism/contrast with the situation at Galileo’s time is intriguing. At his epoch, astronomical observations prompted the Copernican Revolution through the discoveries of Jupiter’s satellites, of the phases of Venus, and so on. Today, it is the lack of a firm observational or experimental identification of nonordinary

types of matter that may trigger a profound shift of scientific paradigm. It should be recognized, in fact, that we still have to catch the essence of the unknown forms of energy and matter that fill the Universe but escape our theories and experiments, despite the great efforts of recent space missions, extensive observational programs in all frequency bands, and dedicated experiments of fundamental and astroparticle physics, and, in parallel, the great theoretical work done to explain them in a unified vision.

In general, in the simplest currently accepted standard model(s) of cosmology, there are relatively few free parameters required to fit the whole set of available data. They are linked to the density of the different forms of matter and energy, to the expansion rate of the Universe, to the kinds and statistics of primordial perturbations, and to the physical processes that occurred in the early stages of structure formation. The model works very well, but no one knows why some of these parameters have the values they do.

In addition to this, it is our aim here to discuss another important parallelism between Galileo's epoch and the present, that is enclosed in the following questions. Galileo was condemned for his ideas and several people fought against the progress of the new scientific vision of the Universe. Are we living with the same things today? How much space is there for alternative ideas that may prompt a new scientific revolution? Are we close to a deeper understanding of the current paradigm or to a new scientific revolution, or rather, are physics and astrophysics going through a profound crisis?

This book is written, as a collection of interviews, not only for all those people with a solid scientific background in cosmology and particle physics, but also for astronomers and physicists not necessarily expert in these fields of research. Here can be found the tentative answers of the scientific community to the challenges posed by cosmology to the standard physical paradigms of the last century. We hope also that it will be of some interest to readers attracted in particular by the way in which our science evolves and reflects on its principles, methods, and self-organization.

Certainly, the selection of the topics addressed by the interviews and the formulation of the posed questions reflect in same way our personal views on the most important aspects of modern cosmology. Our choice for this project, however, was that of avoiding as much as possible any comment to the single interviews, merits and responsibilities of which entirely belong to the colleagues who kindly accepted them, leaving to ourselves some general remarks for the final chapter.

We hope the reader will be satisfied by the discussion started here.

We thank all the colleagues who have kindly accepted to be involved in this project. We greatly appreciate not only their specific answers to our questions, which created a panoramic view of current cosmology, but also their efforts to enter deeply into the spirit of this book, critically discussing the various scientific aspects they addressed.

We also thank Matteo Genghini and Enrico Franceschi for their informatic assistance that helped us in the exchange of the book material during the various stages of interaction with our colleagues. We particularly thank Simone Zaggia for his help in

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Finally, we acknowledge our Springer Editor, Ramon Khanna, for having believed in this project from its beginning.

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