

Book review: *Fundamental Questions of Practical Cosmology*,  
by Baryshev and Teerikorpi

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*Fundamental Questions of Practical Cosmology. Exploring the Realm of Galaxies*, by Yuri Baryshev, & Pekka Teerikorpi (Springer, Dordrecht), 2012. ISBN 978-94-007-2378-8. 332 pages.

This is a book about cosmology, a text which may be read by both students and novice researchers in the field, but cosmologists of longer standing can also use it either for reference or also to sample opinions not usually covered in other books of this kind. Indeed, one might well question the need for a new reference work on cosmology, given that plenty of them have already been published. In my opinion, there is a need to offer a complete overview of the subject taking on board a wider range of opinions than is at present the case with typical reference works on cosmology. A student can easily get the impression that everything is now well known, and that only a few minor conceptual details or finer measurements of parameters remain to be worked out. Only standard viewpoints are usually offered in some detail, all others being entirely neglected. There are also books by heterodox authors who present their own alternative theories, but most of these are sectarian, aiming to press home a particular view, rather than representing all current knowledge of the subject. There is a dearth of books on cosmology with well-balanced content that present the fundamentals and current knowledge of this area with rigor while at the same time covering controversial observations and discussions that might cast doubt on the science which is being built. This book stands out as an attempt to cover both goals. It offers “Fundamental Questions” rather than “definitive answers”; in this sense, it may be a good tutor for those wanting to immerse themselves for the first time in the turbid waters of cosmology, a science of cosmic selection effects—as said in the prelude of this book. It will also serve to help those wishing to unlearn their prejudices and learn how to think scientifically about cosmology.

The volume is divided into a prelude, twelve chapters and a long list of references.

Chapter one contains a good historical introduction and a description of some of the basic concepts of cosmology. Extra attention is paid to the subject of fractal distribution of galaxies. Already in this first

chapter certain fundamental questions arise: changes in physical constants, tests of general relativity, the accurate measurement of cosmological parameters and understanding the new physics implicit in them (dark matter, dark energy, etc.), how observed power-law correlations (megafractality) have emerged from the tiny initial fluctuations, physics at high redshift, geometry and the expansion of the space.

Chapter two is dedicated to distance measurement methods in cosmology, and the different geometries in which these distance can be interpreted.

As I have already mentioned, the authors consider selection effects to be very important in cosmology, and chapter three is dedicated to emphasizing the importance of biases due to selection effects, the treatment of errors in distance determination, patchy extinction and reddening.

Topics covered in chapter four include the expansion of the Universe and the Hubble diagram. There is a good historical introduction and a thorough analysis of the recent measurements of the Hubble Constant. I find interesting the explanation given that the value measured by Sandage & Tammann might be better than that derived by the HST key project (the standard value adopted by most cosmologists). Other methods of deriving the Hubble constant are also explained.

Chapter five covers general relativity and other theories of gravity. Emphasis is placed on the problems involved in their use in cosmology; also dealt are the problems in unifying general relativity and quantum physics. The authors mention the anomalies with the Pioneer 10 and 11 spacecraft, which led some physicists think a few years ago that there was an extra acceleration needed to be explained by a new theory of gravity, but the problems arising from the Pioneer spacecraft have now been solved by other means than the variation of gravity laws. A remarkable difference between this book and other reference works on gravitation theories in cosmology is its inclusion of an extended presentation of the Poincaré–Feynman’s field approach, consisting of the exchange of gravitons.

Further ideas and tests of gravity theories are given in chapter six. Attention is paid to strong fields, which make field approach predictions different from those of general relativity. I like the mention of Mitra’s hypothesis that a black hole should have zero mass, and that, instead of black holes, Einstein’s equations have as a solution an “eternally collapsing object” (ECO). In the approach of field gravity, there are no black holes either. As stated by the authors, there is not yet any proof that black holes exist, for which it would be necessary to establish the existence of an event horizon.

As is obligatory in any serious book on cosmology, the standard Friedmann model is presented in chapter seven. Newtonian cosmology is first presented and discussed. Of course, Newtonian cosmology was abandoned a long time ago because of caveats needed to explain certain facts. Nonetheless, possible solutions for these caveats were discussed for many decades, and one might still pause to rethink them, as suggested in this chapter.

Chapter eight deals with observational tests to discriminate between different cosmological scenarios; for example, tests on the expansion of the Universe. While some may consider that the expansion of the Universe is an untouchable fundamental dogma of physical cosmology, and that to persist in testing it is a waste of time, the authors are nevertheless not writing this book to preach any dogma, but to provide a scientific analysis of the fundamentals of cosmology.

The next chapter emphasizes the need to consider alternative cosmologies. Certain ideas and facts are discussed, such as the fractal Universe and hierarchical cosmologies, changes in the physical constants and non-cosmological redshifts. This chapter gives an excellent review of heterodox ideas and facts not to be found in standard works on cosmology. Also admirable is the neutrality adopted by the authors when explaining the different interpretations, a refreshing change from the usual self-assured arrogant declarations of what is right and wrong.

Chapter ten is dedicated to the large-scale structure of the Universe, with special attention given to fractal structures and non-homogeneity. This is followed in chapter eleven by a discussion of observations pointing towards non-homogeneity and fractal structure. Arguments for and against homogeneity are described and an historical perspective given.

In the final chapter, the authors review some of the unsolved problems of cosmology. Has the scale to homogeneity already been found? Does the presence of very large structures up to 1000 Mpc cast doubt on the existence of such a regime of homogeneity? How certain is the detection of baryonic acoustic oscillations on the 100 Mpc scale in the distribution of galaxies? Can dark energy, initially detected on 1000 Mpc scales, also be observed on small scales in the local universe? The authors conclude the book with a description of interesting conceptual problems arising in the ideal Friedmann model related to the physics of space expansion.

The authors of this book are cosmologists of long standing in their fields and they offer us here a compilation of their seasoned thoughts on the subject. Baryshev is a leading specialist on the fractal distribution of galaxies, non-homogeneity, conceptual problems of the expansion, etc. Teerikorpi has produced important papers on selection effects in cosmology, dark energy on small scales, etc. Certainly, this work is not an absolute point of view about cosmology. No book is that. Indeed the contents are biased towards the preferred topics of the authors; for instance, there is an excess of discussion on the question of non-homogeneity on large scales. Then there are topics not treated with sufficient extension in the book: inflation, the early Universe, the main ideas of some alternative models such as the Quasi-Steady State Model, Plasma Cosmology, simulations of Lambda-CDM models, etc. Nonetheless, the book is relatively well balanced and covers practically all the important points in observational/practical cosmology, as well as the main theoretical ideas. An outstanding work that should find a place on the shelves of any good astrophysics library.