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BOOK REVIEW
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Book review: "Extragalactic astronomy and cosmology—an introduction"

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A book review on
Extragalactic Astronomy and Cosmology—An Introduction, 2nd Edn.
Edited by Peter Schneider, Berlin; Heidelberg: Springer-Verlag, 2015. ISBN: 978-3-642-54082-0; ISBN: 978-3-642-54083-7

This is the second edition of a textbook conceived to be used in an introductory course on extragalactic astronomy and cosmology (the author is professor at Bonn University and a well-known specialist in gravitational lensing). A new edition is fully justified because, as Schneider (2015) explains in the preface, the field has been evolving rapidly during the years which have passed since the first edition (published in 2006), with the advent of new observational facilities and new surveys.

The first characteristic of the book is apparent from its title: it covers both extragalactic astronomy and cosmology. It is not the only textbook to deal with both subjects; there have been other examples, such as Combes et al. (2002) or Jones et al. (2015) with a new edition published this year; however, most introductory textbooks focus either on galaxies (e.g., Spark and Gallagher, 2006) or on cosmology (e.g., Liddle, 2015; Roos, 2015), or give a general introduction to astronomy at a very simple technical level (e.g., Unsöld and Baschek, 2005).

The treatment of both subjects at the same level is a very good choice, as a lot of research in extragalactic astronomy, such as structure formation, weak lensing or galaxy evolution, has implications for cosmology and vice-versa. Obviously the price to be paid is the size of the book, which in this case is about 600 pages long, and a teacher will have to carefully select parts of the text depending on the length of his or her course.

On the other hand I have to stress that part of the large size of this book is due to one of its qualities, i.e., the large number of illustrations. There are many graphs but also nice color images, which undoubtedly have an aesthetic value and should help to kindle the interest of students.

The mathematical level of the book is accessible to readers who have a basic knowledge of calculus. Formulae and mathematical derivations are frequent (more advanced or detailed subsections are printed in smaller characters), allowing the student to go beyond pure notions and to grasp the nature of astrophysical phenomena and processes in a quantitative way.

Moreover, every important sub-field of research in extragalactic astronomy and cosmology is introduced and discussed, with a good balance between theory and observations, and the text is fully uptodate.

Not surprisingly, the first chapter is a general introduction to the subject, but for its length (more than 40 pages) and content it could stand by itself as an accessible review. It is divided into two main parts: the first one gives a synthesis of the scientific theme of the book, while the second one describes the present main observational facilities on Earth and in space at different wavelengths.

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The second chapter is devoted to the Milky Way as a galaxy: it includes classical themes such as the measurement of star distances, the structure and kinematics of the Milky Way, but also microlensing and the search for dark matter in the Milky Way, and the evidence showing the presence of a black hole in its center.

The following chapter is devoted to the world of galaxies: their classification, their morphologies and colors, the dynamics of ellipticals and the rotation curves of spirals, the scaling relations (Faber-Jackson, Tully-Fisher, the Fundamental Plane), the Population Synthesis models, the chemical evolution, the supermassive black holes in their center, the estimate of distances and the luminosity function, and the role of galaxies as gravitational lenses (note that this is not an exhaustive list of the many properties of galaxies discussed by the author).

The fourth chapter, the first devoted to cosmology, presents the homogeneous world models, describing the standard Big Bang model with the main theoretical framework and the supporting observational evidence. The author presents a classical Newtonian derivation of the Friedmann equations, discusses the primordial nucleosynthesis, the link with particle physics, the implications for the existence of dark matter, and explains the problems of the standard model which led to the introduction of inflation.

These first four chapters constitute what I would define the basic foundations of extragalactic astronomy and cosmology following a logical and didactic path, starting from our galaxy and arriving at the relativistic description of the universe as a whole.

In the second part of the book, each chapter is instead devoted to a different and specific sub-field, reflecting the most active areas of present research in the domain of extragalactic astronomy and cosmology.

The fifth chapter discusses Active Galactic Nuclei, with an historical introduction, a classification of the different types and the unified models and the central engine. Every important aspect, theoretical and observational, concerning supermassive black holes in the center of galaxies is discussed at some length (among others, Eddington luminosity, superluminal motion, reverberation mapping).

The sixth chapter is devoted to clusters and groups of galaxies, the galaxy distribution, the luminosity function, the galaxy dynamics and cluster mass, the hot gas component, the Sunyaev-Zeldovich effect, the cluster scaling relations, the weak and strong lensing.

The seventh and eigth chapters are predominantly cosmological, the former treating the development of inhomogeneities in the Universe (linear perturbation theory, non-linear evolution of density fluctuations, the Press-Schechter model, the masses of clusters and the substructure of halos), the latter presenting the determination of the cosmological parameters with different approaches (among others, the baryonic oscillations, the abundance of galaxy clusters, the Lyα forest, the Cosmic Background Radiation, the cosmic shear).

The ninth and tenth chapters come back to galaxy properties: they present the Universe at high redshift (with all the zoology of objects, from Lyman–break galaxies to Extremely Red Objects, the cosmic star-formation history and the Madau plot) and galaxy evolution, which has been added to this new edition and includes the main themes addressed by current research. For example, together with observational results, the author offers a good introduction to hydrodynamical simulations and semi-analytic models (dark matter simulations are presented in chapter 7, devoted to the inhomogeneities in the Universe).

The final chapter offers a perspective on future projects and open problems.

Following the suggestions of some reviewers to the first edition, Schneider has added a few problems at the end of each chapter. I think that this is a welcome addition, even if the number of problems remains limited, five per chapter on average, with the exception of the chapter on cosmological models, with 13 problems, while chapters 9 and 10 have no problem at all. Problems, even simple ones, allow students to digest the abundant material of the course, and I believe that a larger number would not have been useless, even if it is obvious that teachers can provide them. In any case, students will appreciate that the solutions are given in an appendix at the end of the book.

Two appendixes are devoted to the blackbody radiation and to the properties of the stars. They should help students who did not attend (or did not yet complete) a specific course on stars and stellar evolution.

Other appendices include the list of acronyms, a bibliography and a detailed index. In the bibliography there is a list of general and technical textbooks, as well as a description of the main sites where the student can access the technical literature, but not a list of articles. Given the vast range of topics covered by the book, this is an unavoidable choice.

In conclusion, I think that Peter Schneider has found the right balance between completeness, depth, difficulty and length, and from this point of view is presently the best textbook on the subject I am aware of. It offers a wide, exhaustive and uptodate introduction to extragalactic astronomy and cosmology at a mathematical level which is simple but sufficient to go beyond pure notions. After having assimilated its content, I think that the students will have a good basis to start reading and understanding the technical literature.

Therefore, Schneider's textbook can be strongly recommended for any introductory course; moreover, it will be also useful to a wider number of readers (astronomers working in other fields or physicists) who are interested in the subject.

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