Preface

This is the second edition of my book *Galaxy Formation*. Many people liked the first edition which appeared in 1998, just before the explosion of magnificent new data which have completely changed the face of astrophysical cosmology. Many of the agonies which had to be gone through in the first edition have disappeared and, to many people's amazement, including mine, there is now a *concordance model* for cosmology, the cosmologist's equivalent of the particle physicist's *standard model*. Just like the standard model, however, the concordance model creates as many problems as it solves. This is not a cause for concern, but rather one for celebration because we are now able to ask much better and deeper questions than in the past. These questions indicate clearly the need for physics and astrophysics 'Beyond the Concordance Model'.

The object of this new edition is to bring this amazing story up-to-date, very much in the spirit of the first edition. To recapitulate some of the points made in the previous preface about the origin of the book, I was asked by Springer-Verlag to expand the set of lecture notes that I prepared in 1988 for the First Astrophysics School organised by the European Astrophysics Doctoral Network into a full-length book. The set of notes was entitled *Galaxy Formation* and was published as a chapter of the volume *Evolution of Galaxies: Astronomical Observations* (eds. I. Appenzeller, H.J. Habing and P. Lena, pages 1 to 93, Springer-Verlag Berlin, Heidelberg, 1989). In that chapter, I attempted to bridge the gap between elementary cosmology and the technical papers appearing in the literature which can seem quite daunting on first encounter. The objective was to present the physical ideas and key results as clearly as possible as an introduction and guide to the technical literature.

In 1993, more lecture notes on *The Physics of Background Radiation* were prepared for the 23rd Advanced Course of the Swiss Society of Astrophysics and Astronomy, the topic being *The Deep Universe* (A.R. Sandage, R.G. Kron and M.S. Longair, Springer-Verlag Berlin, Heidelberg, 1995). Then, also in 1993, I completed a history of twentieth century astrophysics and cosmology, which was published as Chap. 23 of a three-volume work entitled *Twentieth Century Physics* (eds. L.M. Brown, A. Pais and A.B. Pippard, IOP Publications, AIP Press Bristol, and New York 1995). A much enlarged full-length book on this topic entitled *The Cosmic Century: A History of Astrophysics and Cosmology* was published by Cambridge University Press in 2006. That book brought the story of the origin of

galaxies and the large-scale structure of the Universe up-to-date as of October 2005 and it has been further updated and expanded in the present book. Just as in the first edition, the present volume is much more than a recycled and concatenated version of previously published works. I have rewritten and rethought the original versions, expanded some parts, brought everything up-to-date and included new material.

I often find that I understand things best, and present them most clearly, when I have to prepare them for students, at either the undergraduate or the post-graduate level, and so I have adopted the same form of presentation here. I have intentionally presented the material in an informal, pedagogical manner, and attempted to avoid getting bogged down in formalities and technicalities. If the material becomes too difficult, I simply summarise the key points, give some appropriate references and pass on. My approach is to reduce the problems to their simplest form and rationalise from these examples the results of more complete analyses. Wherever it is feasible without excessive effort, we will attempt to derive exact results. The level of presentation is intended to be appropriate for a final-year undergraduate or first-year post-graduate course of lectures. In other words, it is assumed that the reader has a good grasp of basic physics but does not necessarily have the appropriate background in astronomy, astrophysics or cosmology. My aim has been to write a user-friendly book, taking particular care to expound carefully areas where I have found students have difficulty.

When I wrote the original set of lecture notes on galaxy formation, my objective was to tell the story of modern astrophysical cosmology from the perspective of one of its most important and fundamental problems of cosmology – how did the galaxies come about? I enjoy this approach to the exposition of modern cosmology because, to do the problem justice, it is essential to introduce the whole of what I call *classical cosmology*, as the framework for the discussion. This approach has, for me, the great advantage of concentrating upon a crucial problem of astrophysical cosmology rather than regarding the objective of cosmology as being simply the delineation of a preferred cosmological model, however interesting that is in its own right. As we will show, the origin of galaxies and larger-scale structures in the Universe is one of the great cosmological problems and has provided us with unique and direct information about the physics of the very early Universe.

This new understanding brings with it the question of whether or not the old structure of the book is really appropriate – do we really need to grind through all the old story in order to understand the problems raised by the concordance model? My decision has been to maintain much of the original structure of the book, largely because the approach was very strongly physics-motivated and the old story reveals much of the essential physics of the concordance model.

One final warning is in order. I make no claim that this presentation is complete, unbiased or objective. You should regard the book as my own impressions and opinions of what I consider to be the important issues of modern astrophysical cosmology. Others would tell the story in a completely different way and put

emphasis upon different parts of what is unquestionably a multi-dimensional story. I will endeavour to include as wide a spectrum of ideas and opinions as possible, but the text will inevitably be incomplete. I do not worry about this – it should encourage you to read as widely as possible in order to neutralise my prejudices and biases.

Good Luck!

Venice and Cambridge,
July 2007 *Malcolm Longair*

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