

# Preface

Like many textbooks, this one arose out of the author's frustration. While I believe that there are many excellent journal articles, scholarly reviews, conference proceedings, and even a few advanced monographs on active galactic nuclei (AGNs), there is no single place where a beginning student can get the very basic background necessary to get the most out of the more research-oriented material. The aims of this book are thus actually twofold: first, I wanted to summarize our basic, if marginal, understanding of AGNs at what I believe is a level of familiarity that should be expected of doctoral-level students in astronomy, and second, I wanted to provide a fairly comprehensive introduction to AGNs that would serve as a gateway to the more specialized review articles and research literature for students who have research ambitions in the field. The intended audience is thus advanced undergraduate and beginning graduate students in astronomy and astrophysics. Fairly complete undergraduate preparation in physics is assumed, as is some basic understanding of extragalactic astronomy.

I have tried to focus on basic issues and avoid minutiae and arcane issues, even though some of these undoubtedly will turn out to be tremendously important in the future. I have attempted to compile the basic background material that is by-and-large familiar to researchers in AGNs, although I caution that it is by no means complete: research-level competence in the field of AGNs will require a good deal more background than is given here. As a next step for the serious research student, I would recommend the Saas-Fee course by Blandford, Netzer, and Woltjer (1990), Osterbrock's (1989) text on nebular physics and AGNs, and the more recent review articles (mostly in *Annual Reviews of Astronomy and Astrophysics*) cited in the Bibliography.

The book is obviously written from the point of view of an observer - there is more discussion about the observed properties of AGNs than there is about what physical mechanisms might be operative. Some relevant areas (e.g., radio astronomy and astrophysics, accretion-disk theory, cosmology, nebular physics) receive only a basic introduction here as they are covered in more detail elsewhere.

As will become immediately apparent, our understanding of the AGN phenomenon is still in a primitive state after over 30 years of intensive research. This means that beyond the unproven supermassive black-hole/accretion-disk paradigm, there really is no widely developed consensus about the nature of AGNs. This alone probably explains the dearth of introductory texts, and also serves to make it clear that the content of this book reflects my personal impression about what is essential in the field, and does not necessarily represent a consensus view.

The organization of the book is intended to lead the novice through the basics of the field in a coherent and reasonably self-contained fashion. I have tried to maintain a clear distinction between the things we know, the things we have reason to believe, and the things that we are not really very sure about at all. In the first two chapters, the various types of AGNs and their observed properties are introduced, as much as possible within a historical context to help clarify to the novice some of the basic phenomenology and the traditional distinctions among the various classes of AGNs. Chapters 3-8 provide an introduction to what I believe constitutes the general view of the physical properties of AGNs, with the material organized from the smallest scales to the largest. Following this description of the AGN phenomenon itself, attention is focused on how AGNs can be used to explore the structure and history of the Universe. A brief introduction is provided in Chapter 9 to the basic formalism that describes the structure and evolution of the Universe. While most of this material is certainly covered more completely and authoritatively in any number of books on cosmology, at the very least this chapter introduces the notation that will be used throughout the remainder of the book. The final three chapters discuss how QSOs are isolated in statistically meaningful ways, the luminosity function and space distribution of QSOs, and QSO absorption spectra, with particular attention paid to how these serve as cosmological probes.

In accordance with the usual standards of the astronomical literature, cgs units and appropriate astronomical units are used throughout. I have attempted to keep the notation as consistent as possible with the notation generally used in the literature (the cosmological equations generally follow the convention of Peebles), even though this has sometimes led to some possible ambiguities (e.g.,  $\gamma$  is used in various places to refer to the Lorentz factor, the damping constant, and the power-law index describing the redshift dependence of QSO absorption systems), although use of various symbols should be clear in context. One item that needs special attention is that I use  $h_0$  to denote the Hubble constant in units of  $100 \text{ kms}^{-1} \text{ Mpc}^{-1}$ ; the subscript, which is not generally used in the literature, is added to avoid any possible confusion with Planck's constant  $h$ .

As this is intended to be a general text and not a research monograph, the direct citations to the literature are incomplete. Indeed many important and outstanding journal articles have not been cited. The references given either justify directly some specific point made in the text, are of historical interest, or just happened to be articles with which I am familiar. I am certain that all astronomers who work on AGNs in the field will feel some consternation at my omission of at least some of the papers that they consider to be particularly important (many, no doubt, that they have authored themselves), and in my own defense I argue only that excessive literature citations would overburden both the reader and the author. I chose to cite only currently published works (no preprints are cited), and whenever possible the citations are to the refereed literature (which has been examined through December 1995) rather than to conference proceedings or hard-to-obtain materials. Some of the material is not attributed to any specific source, usually because the particulars are so well known

that they hardly seem to need justification. Much of the literature that shaped my own thinking on AGNs I have cited in the Bibliography. The Bibliography includes not only research review articles, which can supplement the material presented here, but also a list of more-or-less general references on AGNs which I have on one occasion or another found useful or enlightening.

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