Monsters in the night

Active Galactic Nuclei
by Julian H. Krolik
Princeton University Press: 1999. 598 pp. $39.50, £23.95 (pbk)

Chris Reynolds

A significant minority of galaxies possess a monster at their centre. These objects, known as active galactic nuclei (AGN), spew out vast quantities of radiation and rapidly moving material into space. Most astronomers now accept that AGN, one of the most extreme classes of objects in our Universe, are powered by the release of energy as material falls into the gigantic black hole that resides at the centre of each galaxy.

The plethora of terminology and concepts that have arisen in the field of AGN research means there is a desperate need for a comprehensive and up-to-date text. *Active Galactic Nuclei* by Julian Krolik fulfils that role. In varying levels of detail, Krolik treats almost every aspect of the AGN phenomenon, starting with the properties of the black hole itself and working outwards to the impact of AGN on their host galaxies. This global survey of AGN physics makes Krolik's book the most useful in the field for years.

Krolik's strength is his emphasis on the well-established physical principles underlying the phenomenology. The more speculative aspects of the field, such as the exotic physics occurring in the immediate vicinity of the black hole, are (justifiably) touched upon only briefly. Thorough descriptions of the fundamental physical processes punctuate the astronomical discussion. In particular, the description of the various mechanisms that generate and influence the observed radiation will be a valuable reference to both students and active AGN researchers. Throughout the book, the reader is given a flavour of the difficulties faced by observers, some of the modern observational breakthroughs and the interplay between the observational and theoretical sides of this vibrant branch of astrophysics.

A few parts of the discussion are confusing. For example, it might be difficult for anyone without a prior knowledge of stellar dynamics to follow the book's treatment of this subject. However, such sections are rare and detract only slightly from the overall strength of the book. One word of warning — the book assumes the reader to be fluent in college-level physics. The brief tutorials in the appendices (on general relativity, magneto-hydrodynamics and other important topics) will serve only to refresh a rusty mind on these topics and may be too brief for the non-specialist.

That said, this is an excellent text and a valuable reference for anybody interested in the physics of these cosmic powerhouses. □

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The charm of the single neuron

Biophysics of Computation: Information Processing in Single Neurons
by Christof Koch
Oxford University Press: 1998. 552 pp. £45, $59.95

Erik De Schutter

The double title of this book is slightly misleading, as Koch's monograph is mostly about the biophysics of single neurons. The biophysics are put in the context of computation, but little more should be expected here than division and multiplication, and readers are referred to other books for the information-processing side.

Instead, this book reviews models of the biophysical properties that allow neurons to process synaptic input and generate spikes. It focuses on the cellular level, including the passive and active properties of dendrites, spike initiation in realistic and simplified models of neurons and the dynamics of voltage-gated channels. Some subcellular aspects are reviewed also, but in an arbitrary fashion. For example, the role of calcium in learning at the postsynaptic side is described extensively, while its role at the presynaptic side is mentioned only briefly. Synaptic plasticity and quantal release are treated rather succinctly.

As the book positions itself between the black-box approaches used for neural-code analysis at the single-cell level and those used for the analysis of neural processing at the network level, it may serve as a bridge between these two fields. Christof Koch tries to give a basic neuroscience introduction to any given topic. Unfortunately, this is not done consistently. Many technical terms are not defined or not introduced at all — for instance, the reader is presumed to be familiar with "surround receptive fields" in visual cortex, or the "negative slope conductance" of the NMDA channel.

Moreover, the author has not respected the usual structure of a primer. Even in the introductory chapters he repeatedly deviates into a high-level discussion about related controversial issues; this can be of great interest to the specialized reader but may puzzle the undergraduate. In general, a critical mind is needed, as in some instances the numbers given for equation parameters are misleading or wrong. For example, the contribution of ions to the internal resistivity of cytoplasm is discussed in three different places, but in each case the values given are valid for squid axons only, without mentioning this fact. A neuroscience background is required to assimilate most of the information in this monograph.

Unfortunately, as a primer about single-neuron biophysics it is rather unbalanced. In general, preference is given to previous work by the author and his collaborators. This leads to a detailed coverage of visual-cortex pyramidal cells and a few non-mammalian neurons, while other extensively investigated structures — such as the thalamic, auditory or olivocerebellar systems — are largely absent. Similarly, there is a separate chapter on bursting (which pyramidal neurons do), but mechanisms of oscillation (which they do not) are not treated systematically. Even in the proposed use of the pyramidal neuron as a canonical model, the book is not consistent, as realistic models of repetitive firing mechanisms are demonstrated by previous work by the author on the bullfrog sympathetic ganglion neuron.

This leads to a question that is surprisingly absent from this book: does a single canonical model suffice to describe neuronal computations, or may neurons be specialized to perform fundamentally different tasks? A chapter reviewing how differences in the morphology and expression of channels of particular neurons may correlate with their specific functions in the brain would have been a useful addition.

Although my review may seem rather critical, some of the chapters are excellent. For example, the chapter on the application of cable theory to neuronal dendrites contains the best treatment of transfer functions I have ever read. There are other gems like this in the book, which also has an excellent index. Unfortunately, it lacks the consistency and broadness to become a classic. □

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And on a higher order

An Introduction to Natural Computation
by Dana H. Ballard
MIT Press, $32.50, £19.95

Applied Neural Networks for Signal Processing
by Fa-Long Luo & Rolf Unbehauen
Cambridge University Press, £18.95, $29.95

Brain Function and Oscillations. Volume I: Brain Oscillations. Principles and Approaches
by Erol Başar
Springer, £57, $89.95

Rational Models of Cognition
edited by Mike Oaksford & Nick Chater
Oxford University Press, £60