these final two parts would have dominated the coverage; now they are reduced almost to an afterthought, so far has the field of acoustics come in the last half century.

The level of all of the articles is close to uniform, and there appears to be a minimum of duplication, which is often the bane of multiauthored volumes.

In his 1879 review in *Nature* of volume 2 of Rayleigh's book on sound, Herman von Helmholtz expressed the hope that there would be a third volume, taking up a number of topics that von Helmholtz found lacking in the first two volumes. So I would hope for the later appearance of a volume 5 to the *Encyclopedia of Acoustics* to include such topics as cochlear implants, concert-hall acoustics, speech perception in the young and voice identification, as well as more material on signal processing. But for what is here, the book is a magnificent compendium of acoustical knowledge.

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Electronic Imaging in Astronomy: Detectors and Instrumentation

Ian S. McLean
Wiley, New York, 1997. 472 pp. $82.95 hc ($44.95 pb)
ISBN 0-471-96971-0 hc
(0-471-96972-9 pb)

Until the 1970s, optical astronomers had to make do with two imperfect detectors: the photographic plate and the photomultiplier. The former could cover large focal-plane areas, but detected less than 1% of the incident starlight and were quickly saturated by background skylight. Photomultipliers were two orders of magnitude more sensitive, but only single-channel and bulky.

In the late 1960s and early 1970s, several groups married the panoramic and sensitivity advantages of television cameras to the emerging power of digital technology for space probes and ground-based telescopes. The Voyager images are perhaps among the best remembered. Then, in the 1970s, arrays of solid-state sensors based on doped silicon technology began to appear. In these, electrons released by photons accumulate at photo sites (pixels) until sensed by an on-chip amplifier and converted to a digital signal. Self-scanned diode arrays came first, followed by CCD's (charge-coupled devices).

Over the years, CCDs have grown from a few hundred pixels to several million on a single chip. Coupled with innovations in thinning and ultra-low-noise amplification, the stable format, large charge-storage capacity, high conversion efficiency of photons to charge (quantum efficiency) and panchromatic response make them almost perfect astronomical detectors. CCDs on four-meter and other optical telescopes have increased precision and sensitivity a thousandfold and, with the Hubble Space Telescope, have ushered in an exciting new era for observational astronomy. Even more dramatic has been the improvement in low-noise infrared arrays.

The remarkable, parallel development of CCDs and infrared arrays is celebrated by Ian McLean in *Electronic Imaging in Astronomy*, in which he provides an informal history and a veritable gold mine of basic information on all of these solid-state devices and the powerful auxiliary instruments into which they have been incorporated. McLean has played an important part in this story. He was involved in building infrared instrumentation at the Royal Observatory in Edinburgh for the United Kingdom Infrared Telescope, and more recently, as a professor at UCLA, he has built CCD cameras and is helping develop infrared instruments for the two ten-meter Keck telescopes.

This is more of a how-to book than a scientific monograph. McLean gives us the benefit of his considerable experience, with extensive and invaluable discussions of such things as cryogenics, data acquisition and image processing. He also knows most of the key players in the field, and there is a liberal sprinkling of anecdotes, with occasional sermons on how to run an instrumentation team. In addition, there are important chapters on detection techniques at other wavelengths, from ultraviolet to radio, and McLean finishes with a summary of the new, very large optical–infrared telescopes, now complete or under construction, which, with their carefully engineered auxiliary instruments and the emerging technology of adaptive optics, will provide unprecedented precision and sensitivity for astronomers by the year 2000. One caution: You might be left with the impression that large, scientific-grade CCDs and infrared arrays are available off the shelf at reasonable cost. In fact, their fabrication is still a fragile art, and the best devices are expensive and their delivery uncertain.

There are useful references and suggestions for further reading (not all readily available) at the end of each chapter. The sets of exercises and their answers didn't seem really necessary to me, but that may be personal taste. The only real shortcoming is an inadequate index. Important topics appear in several different places in the book, but most don't appear at all in the index. For example, try to find such fundamentals as cold stops or thermal emission from the sky and the telescope.

The book will be an invaluable resource for engineers and other groups building instruments. Parts of it will be vital reading for graduate and other students who need to understand fully the idiosyncrasies of detectors, reduction software and observing routines. It could well form an important part of an undergraduate or graduate course in astronomical techniques. Certainly no astronomical institution should be without a copy.

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Relativity and Gravitation

Philippe Tourrenc
Translated by Andrew King
Cambridge U. P., New York, 1997. 242 pp. $64.95 hc ($29.95 pb)
ISBN 0-521-45075-6 hc
(0-521-45685-1 pb)

I am frequently on the lookout for a slim, straightforward, no-frills text on relativity. Not to teach my graduate-level course in general relativity. For that I rely upon some combination of Bernard Schutz's *A First Course in General Relativity* (Cambridge U. P., 1985) and the "telephone book": Charles Misner, Kip Thorne and John Wheeler's *Gravitation* (Freeman, 1973). For teachers who are of a more field-theoretical bent, there's Steven Weinberg's *Gravitation and Cosmology* (Wiley, 1972), while for the more mathematically oriented, there's Robert Wald's *General Relativity* (U. Chicago, P., 1984). But sometimes you just need a book to assign to a good undergraduate who wants to do a one-semester or one-quarter reading course for credit. The book should not be so encyclopedic that the student makes no noticeable progress. It should also avoid overlong development of formalism (such as tensor calculus or differential geometry), so that the student soon gets into the stuff that really interests him or her.

Philippe Tourrenc's *Relativity and Gravitation* nicely fills the bill. The author, a professor of physics at the Université Pierre et Marie Curie in Paris, has produced a condensed accounting of special and general relativity rather than a full textbook, yet he packs a remarkable amount into its 240 pages. The absence of problems