# PRACTICAL GUIDE TO MODERN LABORATORY INSTRUMENTATION

## Experimental Physics: Modern Methods

**R. A. Dunlap**
*Oxford U. P., New York, 1988. 377 pp. $49.00 hc ISBN 0-19-504949-7*

*Reviewed by Howard H. Sample*

R. A. Dunlap has attempted to write a self-contained text suitable for a one- or two-term junior-level laboratory course in physics. He has succeeded admirably; it is an excellent book. Moreover the book will be useful to beginning graduate research students, as a concise and easily understood reference source on instrumentation and measurement techniques in condensed matter physics, nuclear physics and optics.

The book begins with a discussion of the electronic properties of solids, from the one-dimensional Schrödinger equation for electrons to the physics of doped semiconductors—all in 25 pages. While junior physics majors (or graduate students for that matter) cannot gain a full understanding of the material from this whirlwind treatment, they certainly will come away with an appreciation of the important parameters for electrical conduction: electron concentration, bandgaps, Fermi level and scattering time. Dunlap uses hand-waving arguments rather than complex mathematics to get across the important physical ideas. And he lists suitable and readily available references for those students who want a more in-depth treatment.

Today's laboratory instrumentation is almost exclusively solid state and, more often than not, computer controlled. Most physics undergraduates have not had the training in electronics to enable them to understand how these instruments work. For them, Dunlap includes extensive material on the operation of discrete semiconductor devices and integrated electronics, and on interfacing instruments to computers. While the main thrust is toward a basic understanding of the physics of the devices (depletion layers, band bending, biased junctions), a great deal of specific device information is also included. For example, typical circuits utilizing JFETs, MOSFETs and op-amps are explained. CMOS and TTL implementations of common logic gates are discussed. An excellent description of the RS232 and IEEE-488 interfaces is given, including logic levels, baud rates, ASCII code and standard connector pin designations. (Anyone who has tried to obtain this information from computer manuals or instrument instruction manuals will love this section—it alone is worth the price of the book.)

The remainder of the book deals with commonly used measuring instruments and techniques in experimental physics: thermometry, vacuum systems, cryogenic technology, optics (sources, detectors, electronics), x-ray diffraction and magnetic measurements. The book does not attempt to be a laboratory manual of specific experiments, in the spirit of A. C. Melissinos's *Experiments in Modern Physics* (Academic Press, New York, 1966). Nor does it contain the exhaustive tabulations of data for the specialist, found in various topical books, such as G. K. White's *Experimental Techniques in Low Temperature Physics*, (Oxford U. P., Oxford, 1959). Rather, it is a "what it is and how it works" treatise. Physics undergraduates who want to know about a lock-in amplifier or a flux gate magnetometer or a NaI (Tl) scintillation detector, can probably get all they need simply by reading a few relevant pages in Dunlap's book, without having to wade through a lot of theoretical material.

The book does have shortcomings. Most of these are attributable to Dunlap's effort to cover so much material in a reasonable number of pages. Sometimes his discussion of a topic is so brief as to be of little practical value. One example of this is the 14-page chapter on crystal structure and x-ray diffraction. In the thermometry chapter, he unnecessarily confuses the reader by failing to use the integral form for the voltage produced by a thermocouple, instead writing $\Delta V = [S_2(T) - S_1(T)]\,\Delta T$ throughout. The chapter on magnetic phenomena contains confusing statements regarding cgs and SI units. For example, an equation in this chapter gives the magnetic susceptibility of a paramagnet as $\chi = M/H$; immediately below this equation is a graph that says that $(\chi/\mu_0) = \mathrm{M/H}$ (with $\mu_0$ undefined). For me the most jarring omission is Dunlap's failure to allude anywhere to the fact that most common low-temperature thermometers undergo significant changes in even modest magnetic fields.

But these complaints are minor in the context of what Dunlap is trying to do. On the whole, his book is a concise, accurate and very readable description of modern methods in experimental physics. It is at just the right level for physics undergraduates and can be used as at least a "first source" instrumentation reference by graduate students and by professional physicists.

**Howard H. Sample** is a professor of physics at Tufts University. His research interests include thermal, electrical and optical properties of solids at low temperatures. He has had a long-term interest in the effects of high magnetic fields on common low-temperature thermometers.

## Archaeometry: An Introduction to Physical Methods in Archaeology and the History of Art

**Ulrich Leute**
*VCH, New York, 1987. 176 pp. $25.00 hc ISBN 0-89573-612-8*

In writing this book, Ulrich Leute explains in his preface, he aimed to