steps. Chapter four also contains a detailed description of Fowler's method, which is based on the poles of the transfer function. Smith advocates the use of this method for simulating linear systems with embedded nonsingularities.

The method of root matching for generating approximations to the differential equation is discussed in the next chapter. As before, the emphasis is on matching properties of the differential and difference equations. A description of Shannon's method and filtering is also included in this chapter.

In chapter six Smith discusses the extension of the previous methods based on the transfer function to nonlinear systems of differential equations. Several examples illustrate the use of the Jacobian in resolving the nonlinearities. This linearization, coupled with an explicit solution of the linear equation, is derived in detail.

Chapter seven is what Smith terms "Modern Numerical Integration Methods." He develops general algorithms and demonstrates that many of the classical formulas are special cases of this algorithm. These free parameters are then chosen so as to tone the difference scheme to the particular differential equations. In particular, parameters that minimize the variance propagation of the white noise response are presented. Phase characteristics are also discussed as to their impact on the choice of parameters.

In chapter eight so-called "classical" numerical methods are presented, both for integration and for differential equations. The presentation is straightforward and the detailed illustrations of previous chapters are no longer used. Smith presents in the last chapter some methods for speeding up evaluations based on the use of Chebyshev polynomials (sometimes known as economization).

In general the book is well written and the first part of the book especially has many examples and illustrations that make the book very readable. The lack of exercises is regrettable and might affect the choice of this book as a text for a class. The book is mainly designed for simulation engineers and real time work. Even in this case the use of precise definitions for many of the concepts would have improved the situation. The use of modern software for solving differential equations is not mentioned at all. These packages automatically choose the timestep and order of the scheme so as to (hopefully) maximize their efficiency. The formal accuracy of the schemes presented are not extensively discussed, and Smith admits that there is so far relatively little experience with the nonlinear equations. Furthermore, the concept of stiffness, now playing an increasingly important role in the modern theory, is not discussed at all.

In summary, the book is quite readable and very useful with many unusual approaches, but should only be used for a course in conjunction with more standard, modern books such as those by Lambert (Wiley, 1973), Gear, Lapidus and others.

ELI TURKEL
Magneto-Fluid Dynamics Division
Courant Institute of Mathematical Sciences
New York University
New York City

Principles and Applications of Ferroelectrics and Related Materials

M. E. Lines, A. M. Glass
680 pp. Clarendon (Oxford U.P.), Oxford, 1977. $49.50

In 1959 William Cochran pointed out the fundamental relationship between lattice dynamics and the ferroelectric phase transition. The basic idea is the so-called "soft-mode" concept, which can be described as follows: as the temperature is

decreased, certain lattice vibrational modes decrease in frequency either to zero (second-order phase transition) or to a small value (first-order phase transition) so that the crystal becomes unstable and transforms to a lower symmetry structure. Although the microscopic details responsible for the "softening" of the modes in different crystals may still be debatable, the existence of "soft modes" is firmly established. This idea has given a firm fundamental basis for the understanding of displacive transitions in ferroelectrics as well as many other structured phase transitions.

The authors of this large book, a theorist and an experimentalist who have both contributed extensively to the literature, utilize this soft-mode concept as the underlying theme. The resulting book is written with good understanding of the field and excellent summaries of many topics will be found. As stated in the preface, "the present book covers a wide range of topics right through from basic theory at the fundamental level all the way to devices," and it does it well. Any researcher or interested party will be able to find chapters or sections that will broaden their understanding or connect previously published work in a useful and thoughtful manner.

The soft-mode theme allows M. E. Lines and A. M. Glass to present the various topics in a reasonably unified way and to concentrate on archtypical systems. For example, the chapter on oxygen octahedra materials covers the ferroelectric and antiferroelectric perovskites, $LiNbO_3$ types, and the ferroelectrics with the tungsten-bronze structures. The soft-mode concept enables the connections between these materials to be emphasized and at the same time, the differences to be brought out.

The book has extensive chapters on the thermodynamics, statistical mechanics and microscopic theories of the phase transitions, as well as the other topics one would expect in a book on this subject. Additional chapters are devoted to other physics areas in which ferroelectric materials have proved to be particularly interesting, including the non-linear optics field. Ferroelectric materials have some of the largest non-linear coefficients and thus have proved to be useful, for example, as frequency doublers and modulators.

On the other hand, if your interest is in ferroelectrics in the form of thin films, ceramics or glasses, a look at the table of contents or the index will point you to pages where the work in these areas are well reviewed with a good range of references to the original literature. This should make the book useful to those scientists who might be interested in the possible application of ferroelectrics. In fact, the last 60 pages treat specific applications of ferroelectrics such as their use as pyroelectric detectors, memory or display elements, and electro-optic modulators.

I should think solid-state physicists in general would enjoy thumbing through this welcome addition covering such a wide range of topics. The book may open new vistas for many such people. The dedicated specialists in the ferroelectric field will certainly enjoy reading this book.

GERALD BURNS
IBM Watson Research Center
Yorktown Heights, N.Y.

The Physical Principles of Diagnostic Radiology

P. Sprawls Jr
365 pp. University Park, Baltimore, 1977. $24.50

An increasingly popular diversion for physics professors is to simplify their subject enough so that it can be absorbed by a nonspecialist. Witness the proliferation of "Physics for Music Majors" or "Physics for People Who Hate Science" courses on many campuses. The difficult task undertaken by Perry Sprawls in this book is to create a "Physics for Radiologists." To appreciate the magnitude of this undertaking, at least as Sprawls perceives it, we need only observe his starting point. He assumes no previous knowledge of physics and virtually none in mathematics. Indeed, he includes an appendix that painstakingly explains the most elementary algebraic manipulations, things like determining the value of Y when given the relation $Y = X/WZ$ and values for X, W, and Z. He dispenses with elementary physics, from a definition of energy through a discussion of electrons and the structure of matter, in two short chapters covering a dozen pages each. He also gives the whole field of electronics equally short shrift.

From such humble beginnings, Sprawls proceeds to cover, or at least touch on, the whole gamut of physical principles important in diagnostic radiology. The topics include production of x rays, interaction of x rays with matter, radiographic image formation, scattered radiation, film characteristics, image blur and resolution, fluorescent screens, image intensifiers and fluoroscopy, tomography, image noise, patient dose and ultrasound. (The latter topic may seem anomalous, but ultrasonic imaging is an important diagnostic tool in most radiology departments today.)

By and large, the choice of topics is excellent, the level of presentation is appropriate to the intended audience (radiological residents and technologists), the illustrations are profuse and well done, and the exposition is clear. The book, however, has one major flaw. In his zeal to simplify complicated subjects, Sprawls has often glossed over important points and has allowed some serious errors to creep in.

The reader can find several examples of this problem in the discussion of image blur and resolution in chapter 15. Figure 18 alone illustrates two gross misconceptions. The first is that an object having a sinusoidal thickness variation would produce a sinusoidal exposure variation on the radiograph. The second is that an object consisting of a *single cycle* of a sinusoid can be used to get a direct measure of MTF—the modulation transfer function.

An additional error concerning MTF shows up in figure 5 of chapter 15 and in the associated text. In that figure he plots the MTF associated with "receptor blur" (apparently a gaussian) and that associated with the x-ray tube focal spot. The latter curve is evidently a sine function, since the author states that "*most* focal spots" have a rectangular profile. Sprawls makes a considerable point of the fact that the focal-spot MTF goes to zero at one point. Yet, inexplicably, he does not plot the curve beyond this zero point. He thus does not mention the interesting phenomenon of contrast reversal, clearly evident in figure 7 of chapter 16, and leads the student to believe that the system has no response at all for spatial frequencies beyond the first zero of the MTF.

A most egregious error of omission occurs in the section on computed tomography. The author states, correctly enough, that many systems use the procedure of back-projection. He does not point out, however, that back-projection alone is totally inadequate and that some spatial filtering operation is also required. Basically he has described a method of reconstruction known since about 1940, and not the exciting new method of computed tomography.

The discussion of ultrasonic beam intensity also leaves much to be desired. The author starts by introducing the "amplitude of the ultrasound pulse," which is undefined except to say that it is "related to the energy content or 'loudness' of the ultrasound pulse." A brief paragraph on intensity ends with the following totally misleading sentence: "Since the pulse rate is fixed in most systems the intensity of the beam is proportional to pulse amplitude when the amplitude is expressed in decibels." Sprawls nowhere explains the simple notion that intensity is proportional to the square of the amplitude.

I could cite several other examples of oversimplification or outright error. If, as the dust jacket proclaims, this was indeed the "only comprehensive textbook on the Physics of Diagnostic Radiology," we could ignore these problems. However the field has long had an excellent text, *The Physical Aspects of Diagnostic Radiology* by Michel Ter Pogossian (Harper and Row, 1967). Except for the