

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 ex-

tension 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 tune 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



Give your PDP-11 a Calendar.

When you equip your computer with a TCU-100, you'll automatically have the date and time available when you power up.

It's an easy way to keep track of downtime, too. Furthermore, you can use the unit like an alarm clock. Set it to interrupt at preset times—or at intervals as short as 1/2048 second.

TCUs are shipped preset to your local time, but can be set to any time you want by a simple software routine. The built-in battery back-up is good for months with out computer power.

For the LSI-11 user, we offer the TCU-50 — the same reliable timekeeper without the interrupt capability. With either unit, time is cheap. The TCU-100 is just \$495. And the TCU-50 is only \$325.

Time is only one way we can help you upgrade your PDP-11 or LSI-11 system. We'd also like to tell you about the others.

So contact Digital Pathways if you're into -11's. We are too.

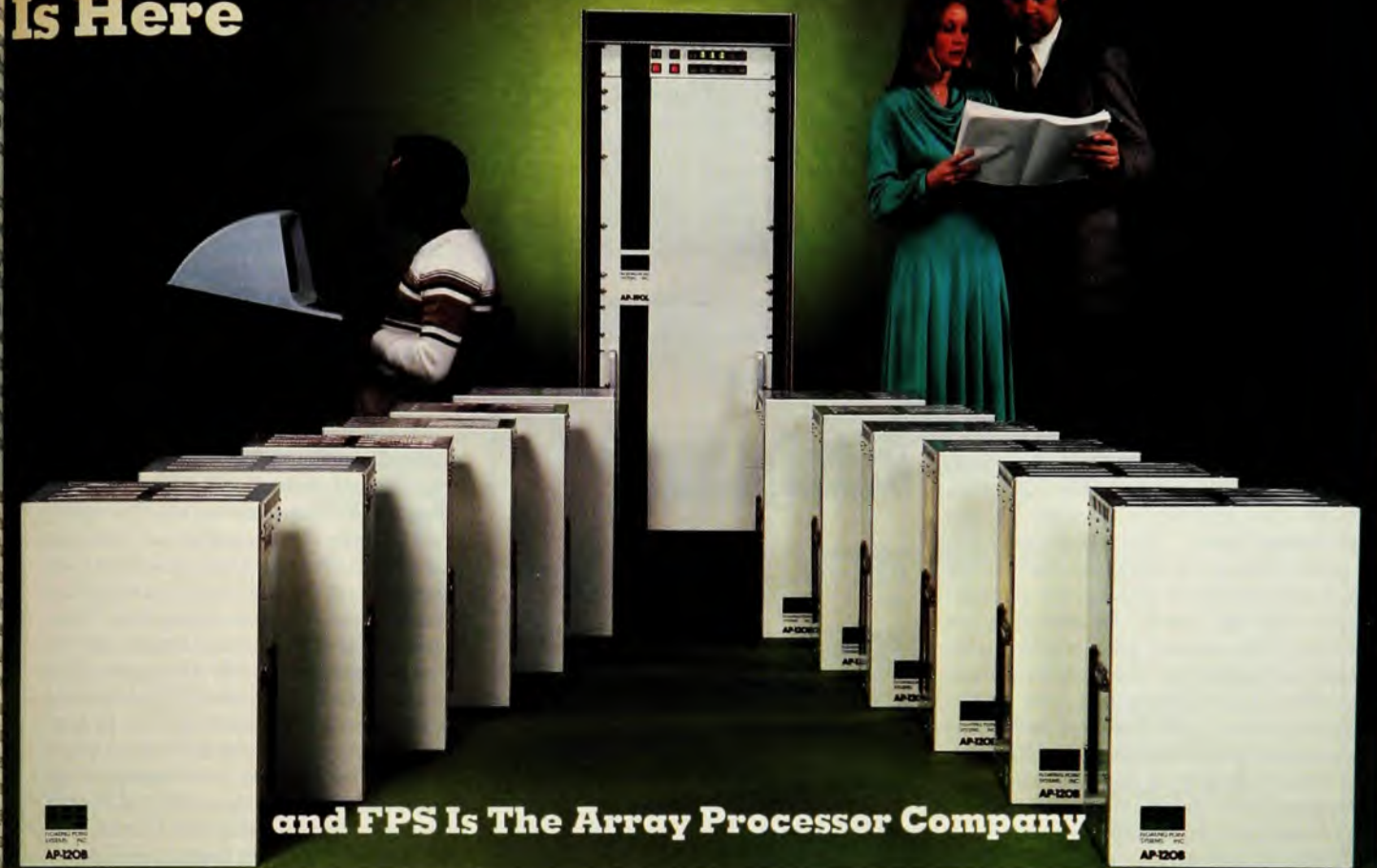


DIGITAL PATHWAYS INC.

4151 Middlefield Road • Palo Alto,
California 94306 • Telephone (415) 493-5544

Circle No. 27 on Reader Service Card

The Age of Array Processing Is Here



and FPS Is The Array Processor Company

The AP-120B
ARRAY PROCESSOR COMPUTER
Interfaces to all popular minicomputers . . . a typical AP-120B complete is less than \$50K.

The AP-190L
ARRAY PROCESSOR COMPUTER
Interfaces to IBM 360/370, UNIVAC 1100, Sigma 5-9, and DEC System 10 . . . a typical AP-190L System is less than \$97K.

Simulation: Mechanical Systems, Flight, Theoretical Physics & Chemistry, Electric Power Distribution • Image Processing: Satellite Imagery, X-Ray Tomography & Ultrasonics • Graphic Research • Finite Element Analysis • Meteorology • Signal Processing: Speech, Vibration Analysis, Geophysical and Seismological.

More than 500 FPS Array Processor computers are in use worldwide, providing their users with the computational power of large, mega-dollar scientific computers at greater reliability, greater applicability, easier programmability, and at a small fraction of the cost.

A typical minicomputer/FPS Array Processor system (such as a PDP 11/34 and AP-120B) provides a computational throughput

for scientific and signal processing algorithms that is on the order of **two hundred times greater** than the throughput of the mini alone.

A large computer/FPS Array Processor system allows heavy data processing, which would severely load the host CPU, to be **off-loaded to the AP-190L for efficient processing** while the host CPU is utilized for tasks more appropriate to its architecture and operating system.

The unique, efficient instruction set and complementary architecture of FPS Array Processor computers are **specifically designed to accommodate the vector and matrix algorithms** for scientific data processing. High processing speeds result from the **seven independent data paths** that move operands synchronously to and from the **38-bit floating-point arithmetic units, accumulators, and multiple memories**. This inherent simplicity allows FPS Array Processors to be readily simulated on the host or front-end computers for program development. It allows FPS to provide you with a large volume **Scientific Math Library** (more than 200 functions) and additional volumes for **Signal Processing** and **other special operations**. And it allows you to **program FPS Array Processors** so you can create your own special, unique, or proprietary functions.

FPS Array Processor computers offer high reliability (much more than your present computer) and compactness (only slightly larger than minicomputers). They are found in research, shipboard, airborne, and mobile installations, as well as computer rooms throughout the world.

FAST

167 nanosecond multiply/add
The following algorithms are memory to memory
2.7ms 1024 pt real FFT
26.1ms 8192 pt real FFT
1.55s 512 x 512 real 2D FFT
10.2ms 20 x 20 matrix inverse

EASY PROGRAMMING

The power of FPS Array Processors is easily called through FORTRAN subroutines resident in the host or front-end minicomputer. A Vector Function Chainer permits routines to be chained together for a single call, reducing host overhead. Extensive documentation and a simulator/debugger help you create new routines.

HIGH CAPACITY

Data memory to 512K words (2-million bytes)

PRECISION

38-bit floating point arithmetic

FPS can bring new power to your computer system. Find out how FPS Array Processor technology can benefit your application. For more information and an FPS Array Processor brochure, **use the reader response number or coupon below**. For immediate consultation, **contact Floating Point Systems directly**.

Circle No. 28 on Reader Service Card



CALL TOLL FREE 800-547-9677
P.O. Box 23489, Portland, OR 97223
TLX: 360470 FLOATPOINT PTL
In Europe & UK: Floating Point Systems, SA Ltd.
7 Rue du Marche, 1204 Geneva, Switzerland
022-280453, TLX: 28870 FPSE CH

Floating Point Systems, Inc.

FPS Sales and Service Worldwide: Boston, Chicago, Dallas, Detroit, Houston, Huntsville, Los Angeles, New York, Orlando, Ottawa, Philadelphia, Phoenix, Portland, San Francisco, Washington, D.C. International offices: Geneva, London, Munich, Paris, Tel Aviv (Eastronix, Ltd.), Tokyo (Hakuto Co. Ltd.)

☐ I have an immediate need. Please have a technical consultant contact me.

☐ Please send me an FPS Array Processor brochure.

Name _____ Title _____

Company _____ Phone _____

Address _____

City _____ State _____ Zip _____

My Computer System is _____ My application 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 archetypical 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