at a wavelength of 1 meter would require an antenna about two miles in length to equal the resolving power of the human eye! For a parabolic reflector antenna of diameter D, the half power beamwidth can be calculated from $60\lambda/D$ where λ is the operating wavelength. Since many sources of radio emission in the solar atmosphere are of the order of minutes of arc, very high resolution is required". The mixture of meters and miles in the first sentence does not appear necessary since kilometer is used throughout the volume. Secondly, the beamwidth turns out to be in degrees, which is not stated, although "minutes of arc" is mentioned later in the paragraph and is certainly misleading.

The book is well printed and designed to sell to individuals at $10 and to libraries at $29.75. The former price is a welcome change that should increase the volume's availability to students and research workers. The sections on particles and fields in the vicinity of the earth and in interplanetary space are excellent; there the NASA program has shown in experiment and analysis its greatest in-house capability. Some of the astronomical sections appear to me to stray beyond space physics and into the realm where texts on astronomy and astrophysics might be used although Jastrow and Rasool's article on planetary atmosphere keeps us up to date on this exciting and expanding field.

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Swinging vectors

A VECTOR APPROACH TO OSCILLATIONS. By Henry G. Booker. 149 pp. Academic, New York, 1965. Cloth $5.50, paper $2.45.

by Richard Waterhouse

The author is professor of applied electrophysics at the University of California (San Diego) and has done distinguished work in electromagnetic wave propagation. In his book he advances the thesis that the usual way of treating e.m. oscillations, involving complex numbers, is unsatisfactory. (He states that the language of pure mathematics, when used to describe rotating vectors, that is, electrical oscillations, is "peculiar to the point of being deceiving.")

To replace the complex-number treatment, Booker develops a vector treatment using real numbers only. In order to do this, he introduces several novelties, including two new terms, the "planar product" and the concept of "actance." The actance of an oscillation is defined as a vector **S**, which does not vary with time. A time varying vector is then written as e^{st} and is shown on an 'actance diagram.'

A polar notation is used for the vectors, in which a vector **A** is written

$$\mathbf{A} = A \angle \alpha,$$

where A is the length of a straight line segment, and α is the counterclockwise angle it makes with a reference direction. Then a quotient of two vectors is defined as

$$\frac{\mathbf{A}}{\mathbf{B}} = \frac{A}{B} \angle \alpha - \beta = \mathbf{C},$$

a "third vector."

The planar product is defined and writtten as

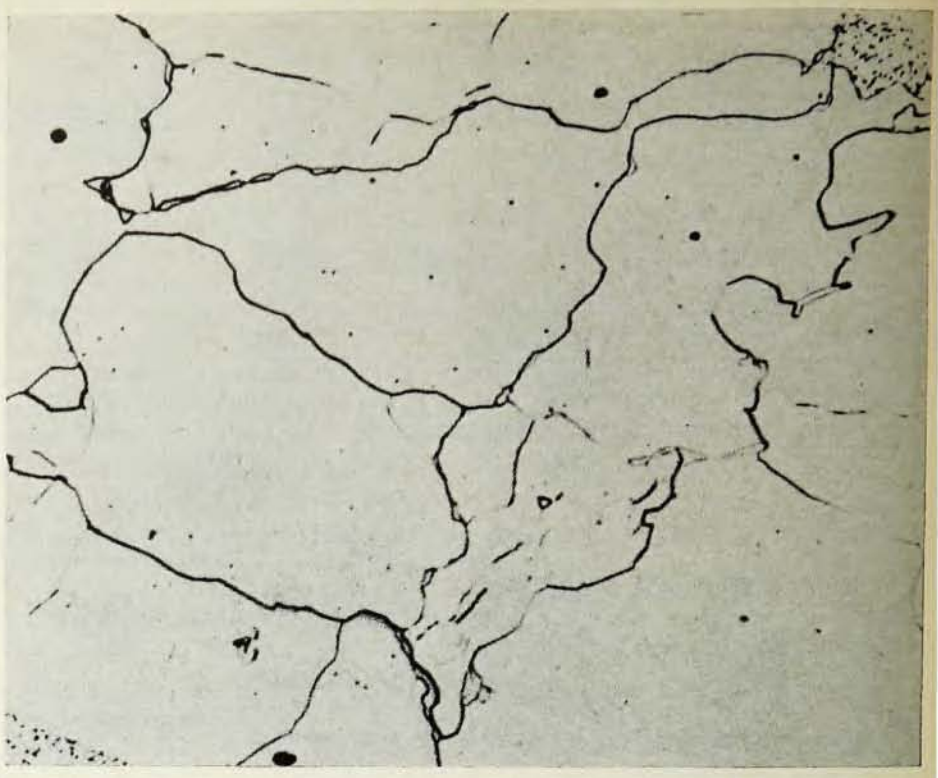
$$\mathbf{A}\,\mathbf{B} = A\,B \angle \alpha + \beta = \mathbf{D},$$

another vector which is coplanar with **A** and **B**. The planar product "undoes the quotient operation" defined above, and "is repeatedly required in using vectors to handle oscillations."

Thus to recoup the advantages of the complex notation he has rejected, the author introduces his own ad hoc type of vector analysis.

It is easy to see that Booker is no slave to convention where pure mathematics is concerned. "The accent is on the creation of vivid concepts, not on adherence to tradition," he states. However, even the impure physicist may feel that vector analysis is too important to play around with in this way. Is it sound to teach students a new type of vector analysis for use only with electrical oscillations? They may get confused when they learn that, in mathematical physics generally, the quotient of two vectors must have a tensor form.

It is clear that, indeed, a real-number treatment of rotating vectors



GRAIN BOUNDARY MIGRATION during creep of a carbon steel at 593°C under stress of 4000 psi. Micrograph 350X. (Photo courtesy U.S. Steel Corporation.) From *Fundamentals of Creep and Creep-Rupture in Metals.*

is possible, and the author has probably performed a service in working one out and presenting it, if only to exhibit the difficulties involved. Whether the new treatment will prove sufficiently advantageous to replace the old remains to be seen. For one thing, as is stated at the end of the preface, the new treatment does not remove the necessity for students of physics and engineering to understand and use complex numbers.

For another, the treatment is not short; the present exposition takes some 120 pages and is bedecked with 167 problems. Finally, although this new approach is apparently intended for teaching to students of physics and engineering, the author gives no hint that it has ever been tried out on a class. Favorable evidence from such a field trial would give much more weight to these new proposals. Pasteur's way of promoting the acceptance of a new idea remains the best.

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Metallic fracture

FUNDAMENTALS OF CREEP AND CREEP-RUPTURE IN METALS. By Frank Garofalo. 258 pp. Macmillan, New York, 1965, paper $4.50.

by Daniel B. Butrymowicz

Fundamentals of Creep and Creep-Rupture in Metals is one of the initial titles in the MacMillan Series in Materials Science—a series that attempts to provide low-cost textbooks in a wide range of topics in materials science. The author, well known for his many contributions in this area of metallurgy, has endeavored to gather, correlate and then systematically present much of the published data dealing with the fundamental aspects of creep and creep-rupture behavior of metals and alloys. At present, this being one of the more active fields of metallurgy, there is a genuine need for a review such as Garofalo's.

Intended as a textbook and reference source, the volume contains an introductory chapter supplying definitions and descriptions of deformation, creep, and creep-rupture. The next four chapters are concerned with the