prehensive exposition on electron-microscope imaging theory or on image processing. The introductory chapter on image formation is a condensed and directed treatment with inaccuracies in only a few details. (The somewhat confused statements on inelastic scattering reflect the general confusion in the literature on this subject.) The optical-analogue methods of image processing are dismissed briefly. The concentration of interest, suggested by the title, reflects a restricted, personal point of view that has value because of the depth and completeness of Saxton's involvement in the subject.

For those directly concerned in the image-processing game this book is a must. The interested nonspecialist may prefer to wait for some future, popularized version.

JOHN M. COWLEY
Department of Physics
Arizona State University
Tempe

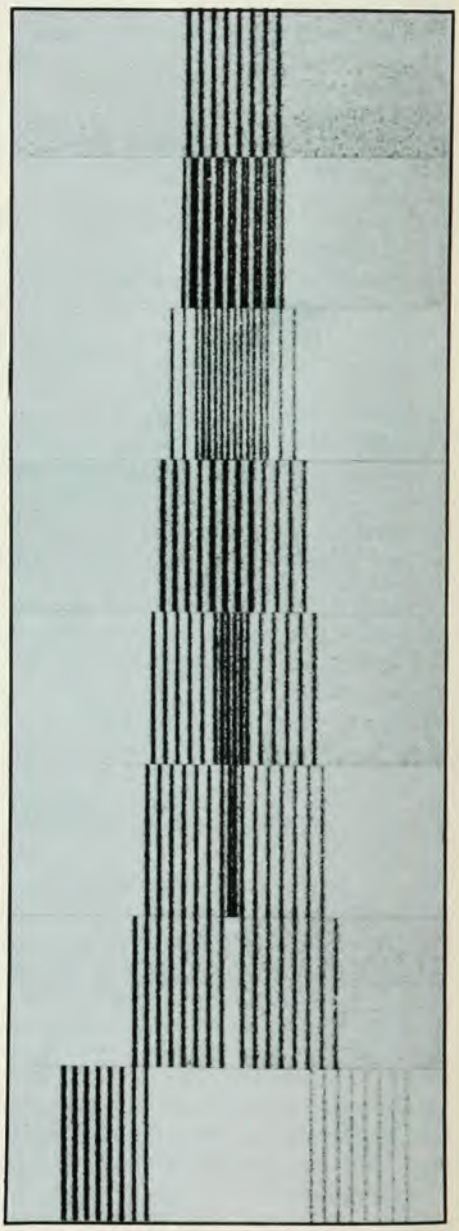
Optical Spectra of Transparent Rare Earth Compounds

S. Hüfner
237 pp. Academic, New York, 1978.
$24.00.

One feature above all others determines the character of the spectra of rare-earth ions in solids: the internal nature of the 4f electrons. The rare earths are thus the delight of theoretical physicists, who can treat the effect of the crystal lattice by means of perturbation theory. It is therefore rather hard to understand why it took so long to interpret the spectra. John van Vleck wrote about the "puzzle of rare-earth spectra in solids" as long ago as 1937. Even in the 1950's there was still some question as to the nature of the absorption line of the praseodymium ion in the yellow. Only by understanding this transition could parameters relevant to other rare-earth ions be inferred. Karl Heinz Hellwege settled the matter by careful polarization work carried out in Darmstadt. His laboratory was the training ground of Stefan Hüfner, who is thus admirably poised to survey the present status of the field.

One of the problems facing the writer of a broad review is how to cope with the elaborate theoretical apparatus that has grown up like ivy over the experimental edifice. Hüfner prunes it to a bare minimum. He directs his attention first at the physics and second at the mathematics. This makes the book ideal for a graduate student, or anyone interested in getting a sound introduction to the field. Group theorists should envy the skill of the author in compressing the corpus of their subject to five printed pages.

Hüfner treats the splittings induced in the free-ion levels by the crystal field from a thoroughly modern point of view, beginning with the point-charge model and including a discussion of Douglas Newman's superposition model. The transitions between states of the 4f shell, which give the optical spectra their characteristically sharp fine structures, receive a detailed treatment. Hüfner's conclusion that several mechanisms may contribute to the so-called hypersensitive transitions (pseudoquadrupolar transitions with intensities particularly sensitive to the environment) is probably more apt than some of the workers in the field would admit. The book contains a section on satellite lines, which have long been of



Absorption lines of the rare-earth ion Ho^{3+} in crystalline $LaCl_3$ in magnetic fields of strengths ranging from 0 (top) to 4637 gauss (bottom). Stefan Hüfner discusses the optical spectra of transparent rare-earth compounds in his book, reviewed here. (Photo: Dieke and Pandey)

special interest to members of the Darmstadt school.

The effect of the crystal lattice is not merely to perturb and mix the states of the free ion. Hüfner gives a good account of acoustic and optical phonons, their effect in inducing the non-radiative decay of excited states, and the role they play in the transfer of energy between rare-earth ions embedded in the lattice. The specific example of $TmVO_4$ illustrates the Jahn–Teller effect. Hüfner describes magnetic interactions between neighboring ions in considerable detail, including spin-wave sidebands. He concludes his book with a discussion of divalent rare-earth compounds and rare-earth lasers.

Throughout, the style is lucid and to the point. It is apparent that Hüfner has reworked much of the material and not merely transferred it from the literature. However, it is ironic that the connection between the Slater parameters F_6 and F^6, which so bedevilled the early spectroscopic term analyses, would be an example of one of the very few typographical errors. Fortunately, no misinterpretation is likely. The printing of the book is excellent and its price modest.

BRIAN R. JUDD
Department of Physics
The Johns Hopkins University
Baltimore

Frequency and Time

P. Kartaschoff
260 pp. Academic, New York, 1978. $24.50

During the last few decades a major revolution in the science and practice of measurement has occurred. One major component in this revolution was the change from astronomical time and the astronomical definition of *time interval* to atomic time and the definition of the *second* based on the cesium-resonance frequency at 9 192 631 770 Hz. Peter Kartaschoff has been active in the field with notable contributions to the development of cesium atomic clocks and the characterization of frequency and time stability.

Kartaschoff begins his introduction by stating: "Measurements in frequency and time are of fundamental importance for all experimental work in science and engineering. This is easily demonstrated by the fact that time as a parameter is present in most equations describing natural phenomena." I agree very much with this statement; however, Kartaschoff's attempt to cover frequency and time as a "field" in textbook fashion had to meet with difficulties. I believe that this task is not possible, because time and frequency is a topic whose *application* gives it coherence, not its *physical or technical* background. This fundamental difficulty is possibly the reason why *Frequency and Time* is, to the best of my knowledge, the first textbook attempt on this subject. The disciplines that feed into time and frequency range from fundamental quantum physics, via basic metrology, mathematical statistics, spectroscopy, circuit theory and telecommunications, to astronomy and astrophysics. The book therefore is a compendium of some of the contributions of these disciplines to the application of time and frequency.

As a textbook, *Frequency and Time* aims at the engineering student rather than the physicist. Kartaschoff thus emphasizes statistical data analysis, time dissemination and coordination via radio signals, and electronic-measurement methods and principles. He does not focus on the underlying atomic and molecular physics, quantum mechanics and the fantastic opportunities in atomic and molecular spectroscopy opened up by and connected with atomic-frequency standards.

The most serious shortcoming of Kartaschoff's is the near-total lack of references after the year 1974, which means that its content stops at the state-of-the-