both have had some graduate work). The number of doctoral advisees per adviser is also given. There are 1.8 doctorate recipients per major adviser per 3-year period in physics and in mathematics, 2.5 in chemistry, and 3.0 in education (where it is highest).

Next, the areas of first-postdoctoral employment are analyzed. In the period 1964–66, 55% of the physics PhD's went to work in colleges and universities (in research and teaching), 9% went to work directly for the government and 18% went to industry. These figures represent an appreciable change from the period 1958–60 when the college–university influx was 47% and industry took 32% of the PhD's. The survey also describes the PhD background of people in various postdoctoral fields. For instance, out of 1894 PhD's whose first postdoctoral work was in solid-state physics, only 46 had received a PhD in solid-state physics (1388 came from other subfields of physics, 318 held PhD's in chemistry and 109 in engineering).

The number of foreign students coming to the US for doctoral education is increasing rapidly. They now account for approximately 15% of all PhD's awarded. During the period 1960–66, approximately 5000 PhD's were awarded to foreign students in the physical sciences and engineering; 13.4% of these students came from Canada, 11.7% from northwest and central Europe, 11.7% from the Near East, 21.3% from India and 16.3% from Taiwan. A relatively small number of foreign institutions contribute these students. Among the foremost schools are National Taiwan University, Cairo University, the Universities of Toronto, Bombay and Madras, Seoul University and the Israel Institute of Technology. The time-lapse distribution for foreign PhD's is the same as for US PhD's. 51% of all foreign PhD's take their first postdoctoral employment in the US. This number is very area dependent: 90% of the PhD's from Taiwan and 78% from Korea work here; the number is low for PhD's from Mexico and Central America, Pakistan, and Africa (except Egypt).

The next minority group considered is women doctorate recipients. Women receive 40% of all the baccalaureate degrees (the percentage is increasing) and about 11% of all PhD's. Over the 1958–66 period, the percentage of all women PhD's in physics and astronomy has remained constant at about 1% (the 1964–66 figures for chemistry and mathematics were 5.2% and 2.4%). The time-lapse distribution for the physics and astronomy PhD for women is closely the same as for men, and the fields for first-postdoctoral employment are roughly the same. (60% go to colleges and universities, 4% work for the government, and 17% are hired by industry.) 2% of the physics PhD's in 1966 were women.

This important book provides not only detailed information on the background and training of physicists (see also *Physics Manpower–1966*, AIP Publication R-196, edited by Susanne D. Ellis), but also places this information in the context of what is happening in other fields. It is not the kind of book you would curl up with on a rainy day, but there is no question that the report will be required reading for all people trying to prove a point and become better informed.

* * *

The reviewer is professor of physics and acting chairman of the Department of Physics at Haverford College. She is a former member of the AIP Manpower Advisory Committee.

A spectroscopic renaissance

TECHNIQUES OF VACUUM ULTRAVIOLET SPECTROSCOPY. By James A. R. Samson. 348 pp. Wiley, New York, 1967. $13.95

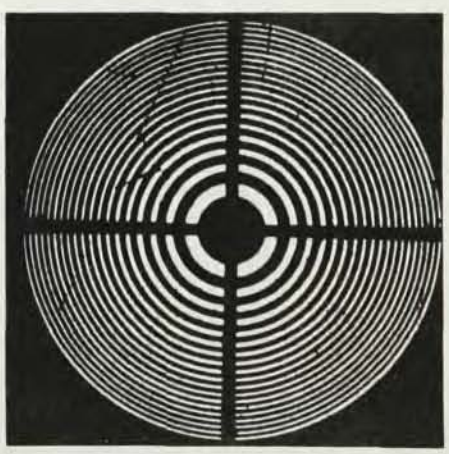
by Stanley S. Ballard

Vacuum-ultraviolet spectroscopy is a field in which American physicists have played important roles. Theodore Lyman of Harvard University was one of the earliest workers, around the turn of the century. He improved on the pioneer work of Viktor Schumann of Germany by using a concave grating rather than a fluorite prism as a dispersing device and hence was able to push down to wavelengths considerably shorter than the oxygen absorption onset, where air ceases to be transparent: about 186 nanometers. Robert A. Millikan and his collaborators, first at the University of Chicago and later at California Institute of Technology, introduced the condensed-vacuum-spark-discharge source and photographed emission lines down to 14 nm.

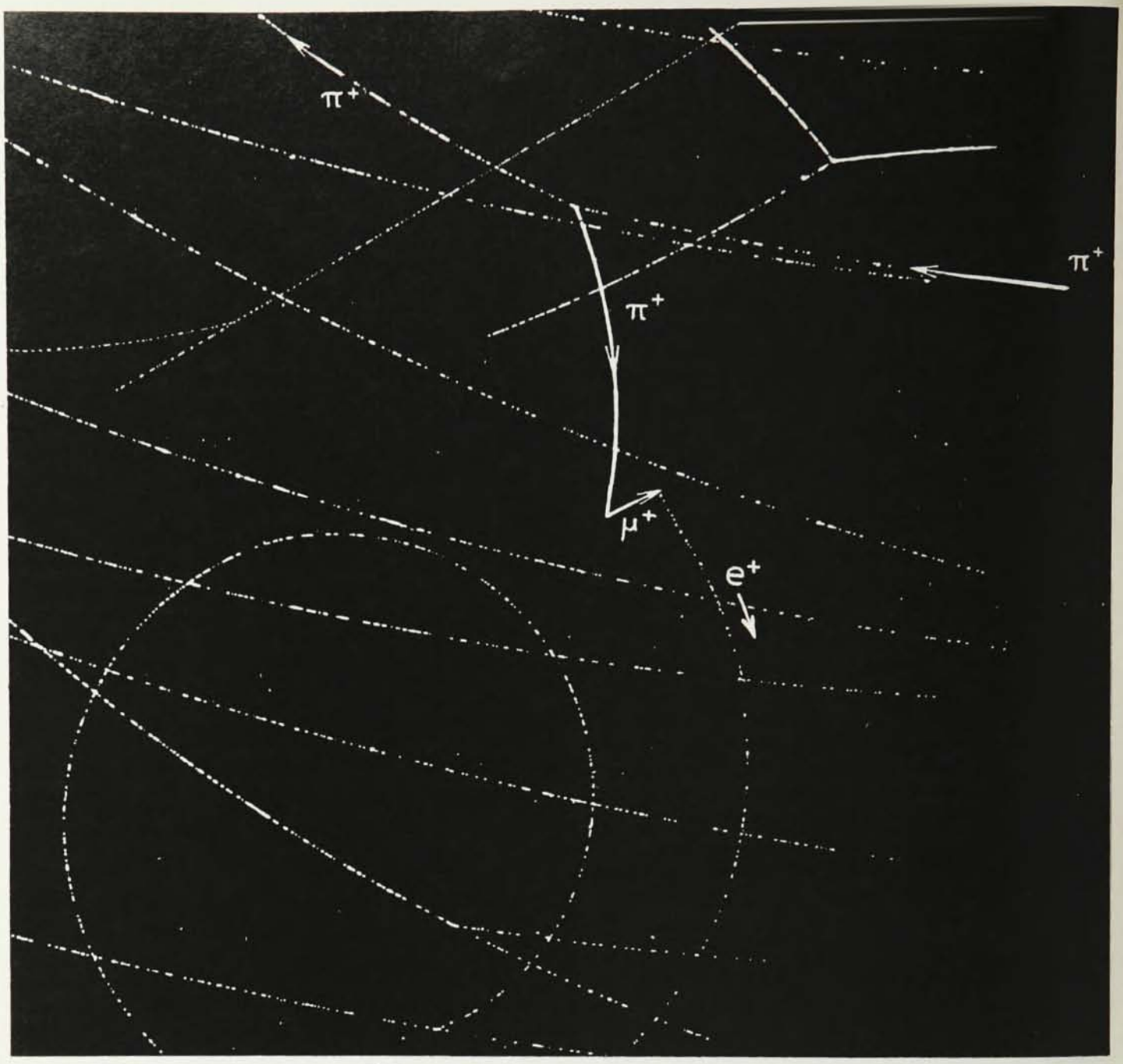
Until the present book appeared the only authoritative reference source in English was *The Spectroscopy of the Extreme Ultraviolet* by Lyman. The second edition of his book was published by Longmans, Green in 1928. In view of the many instrumental improvements that have been made in the intervening years, and the renaissance of interest in the type of data given by vacuum spectroscopy, it is indeed timely that a new book has been written on this subject.

The author, James Samson, was born in Scotland and received the bachelor's degree at the University of Glasgow. He came to the US and finished his graduate training at the University of Southern California where he worked with Gerhard L. Weissler, a man well known in spectroscopic circles. Since 1961 Samson has been director of the experimental physics laboratory with the GCA Corporation of Bedford, Massachusetts. He has published extensively on the instrumentation and applications of vacuum-ultraviolet spectroscopy; he is a most appropriate person to have written the present volume.

This book is self-contained to a remarkable degree. There is a chapter on the concave diffraction grating that is complete enough that an interested reader need not turn to one of the standard references or textbooks on spectroscopic instruments. The detailed chapter on vacuum spectrographs and monochromators contains much useful information. The chapter on vacuum techniques is short because this information is now well known, and appropriate pumps and accessories are readily available commercially. (This development is per-



SELF-SUPPORTED GOLD PLATE, constructed by A. Baez. For zone plate to be useful in vacuum ultraviolet, transparent zones are fully open. (From *Techniques of Vacuum Ultraviolet Spectroscopy*).



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haps one of the most striking changes since the early days when vacuum problems were vexing and highly time consuming to the experimentalist. I recall my work in this field some 35 years ago, when vacuum problems were still the most difficult ones that the deep-ultraviolet spectroscopist had to solve.)

The subject of light sources is an important one for any spectroscopic technique, but is particularly so in the vacuum ultraviolet where large photon energies are involved and hence very energetic sources are needed to give lines of the desired short wavelength. The problem of obtaining good continuous spectra for absorption work in this wavelength range is particularly stringent.

In conventional spectroscopy, filters can be employed to isolate particular spectral regions, and window materials are readily available. However, in the vacuum-ultraviolet region synthetic calcium fluoride transmits to about 125 nm and selected pieces of lithium fluoride to 104 nm—beyond that, either very thin pellicles of organic compounds must be used as windows, or the entire apparatus, from source to photographic plate or detector, must be in a common vacuum chamber. And of course bandpass filters are substantially nonexistent, although thin films of some metals and semiconductors have found limited use.

Photographic plates are useful from the visible to the x-ray region, thanks to fluorescent treatment or to removal of the absorbing gelatin in the so-called Schumann plates. Photoelectric detectors are used in the deep ultraviolet as well as in other parts of the spectrum, and a good discussion of these newer detectors is given.

Absolute intensity measurements are discussed, as are polarization techniques at the short wavelengths. Finally, there is a chapter listing currently applicable wavelength standards and strong atomic lines in the region 199–1.8 nm. Here the pioneer work of the Swedish investigators, especially Bengt Edlén, is given its just due.

There are literature references at the end of each chapter, in numbers ranging from 2 to 154 per chapter. There is a total of over 550 such references, but this figure includes a certain amount of duplication. The author index, seven and a half double-column pages, includes references to journal articles referred to at chapter end. The subject index, nine double-column pages, appears entirely adequate. The book contains many well conceived and well executed line-drawing illustrations and a few half-tone photographs. The text shows evidences of careful preparation and painstaking editing.

The spectroscopy of the region from around 200 nm to soft x rays was primarily of academic interest for the first 50 years of its investigation. Credit is due those academic physicists who kept the field alive and introduced improvements during the decades when spectroscopy was far from the central focus of interest in experimental physics. With the birth of the "space age" in the early 1950's it was realized that the techniques of vacuum spectroscopy could produce laboratory data important to the understanding of upper-atmosphere and planetary-atmosphere physics. This application caused the renaissance of interest in the field and accounts for the fact that it is so vigorous today. Thus an enthusiastic reception and a useful life are predicted for this book.

* * *

The reviewer, who is now professor of physics and department chairman at the University of Florida, was introduced to the field of vacuum-ultraviolet spectroscopy by H. E. White and F. A. Jenkins at the University of California, Berkeley, during his graduate-student days.

Reflecting interfaces

INTERNAL REFLECTION SPECTROSCOPY. By N. J. Harrick. 327 pp. Interscience, New York, 1967. $16.50.

by Joseph G. Hoffman

Total internal reflection at a glass-to-air interface certainly seems to support Newton's notion that rays of light are attracted by the glass body. Chapter 1 opens with the quotation from Newton's *Optiks* on the phenomenon in which light goes out of the glass but is returned into it. Although this book is about applications the author points out basic features that are not yet understood, and his descriptions of the construction of internal reflection elements for the numerous different uses of internal reflection are most instructive concerning properties of the evanescent wave.

This is one of only two books available on the subject (the other is *Modern Aspects of Reflectance Spectroscopy*, Wesley W. Wendlandt, ed., Plenum Press, 1968). There were about 450 published papers at the time Harrick's book was sent to the publishers. Spectroscopy of very minute amounts of material, of strongly absorbing liquids, and of semiconductor-surface-states is greatly enhanced. Internal reflection provided a breakthrough in many formerly difficult if not impossible phases of spectroscopy, and the possibilities are indicated in three of the seven chapters. This book leaves one with the belief that more research on the evanescent wave will lead to even wider fields of application.

The excellent text makes the reader wish for more theory and visualization of the "light rays" at the reflecting interface. Classical Maxwell theory was developed by Schaeffer and Gros in Ann. d. Physik, NF, **32**, 648 (1910). They gave elaborate schematic sketches of the electric and magnetic fields at the interface. These sketches would enhance the basic physics of any text on internal reflection. The quantum theory of the evanescent wave would be a desirable addition to the elucidation of the subject.

Entirely aside from the remarkable and intriguing applications, this is a highly commendable book for the experimental insight it provides into the

TYPICAL FINGERPRINT recorded with an inkless instrument. Dark lines are the ridges in the skin pattern and dots are the pores in the ridges. (From *Internal Reflection Spectroscopy*).