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model, the experimental determination and application of configuration coordinate curves, optical transitions in a crystalline photoconductor, electron traps, their thermal and optical activation, extinction phenomena, energy transfer, sensibilization, and many other subjects. The author skillfully blends experimental and theoretical information into a unified whole. Both are condensed to an absolute minimum. If I had to voice any criticism, it is that I would have welcomed a few more references. Many names are given in the text without any indication where to find the complete information, and the bibliography is essentially limited to review papers or books on the subject. However, the book can be very much recommended to those interested in crystalline luminescence.

X-Ray Spectrochemical Analysis. Vol. 11 of Chemical Analysis. By L. S. Birks. 137 pp. Interscience Publishers, Inc., New York, 1959. \$5.75. *Reviewed by I. Fankuchen, Polytechnic Institute of Brooklyn.*

DR. Birks has written a small, unpretentious book which will be frequently referred to by everyone doing spectrochemical analysis. It is indeed true that x-ray spectra have been used to identify atoms for almost forty years. But it is only in the last ten years or so that suitable apparatus has been commercially available so that routine chemical analysis in an average analytical laboratory could be so attempted. Hundreds of papers on the subject have appeared in the last ten years and these are for the most part in quite readily available journals. However, Dr. Birks has done a very useful thing; he has digested these papers and resubmitted their essence in a most readable and accurate form. The writing is economical, perhaps too much so; there is no stuffing in the book. As a result, some things suffer. Thus, the author index is remarkably incomplete. Only names specifically mentioned in the text are listed. Although each chapter concludes with a list of references to which Birks repeatedly refers in the text, these references are not given in the author index. This makes hunting up someone's work not too easy. The price per page seems somewhat high. This first modern book on an increasingly important subject is to be recommended.

Biographical Memoirs of Fellows of the Royal Society, Vol. 5, 1959. 280 pp. The Royal Society, London, 1960. 30s. *Reviewed by R. Bruce Lindsay, Brown University.*

THE Royal Society continues to confer a boon on all who are interested in the history of contemporary science by publishing the fifth volume of a series, begun in 1955, of biographical memoirs of recently deceased fellows. It contains brief biographies of nineteen fellows, most of whom died in 1958 or 1959 and whose scientific activities were for the most part associated with the first half of the twentieth century. Of these men who achieved distinction in their chosen

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EXAMPLE

Determination of the Spin-Lattice Relaxation Time (T_1) of F Centers in KCl

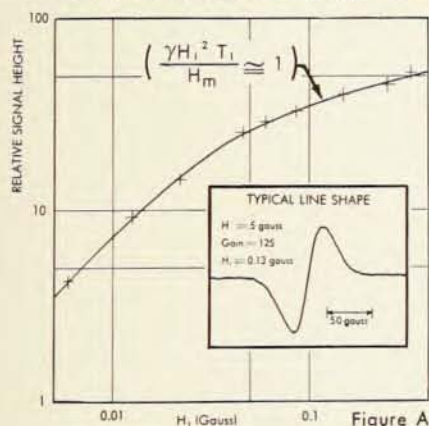


Figure A

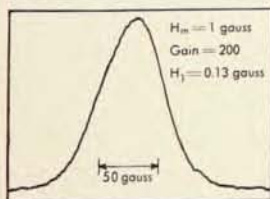
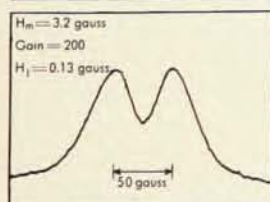
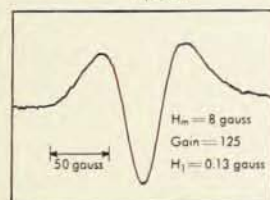


Figure B

Structure defects involving unpaired electrons in crystalline solids generally exhibit a resonance response characteristic of spins immersed in a continuous distribution of magnetic fields. Each electron spin interacts with many neighboring nuclei. The orientation of the nuclear magnetic moments with or against the electron spin, together with the strength of the interactions, determines the local magnetic field, which will be different for every electron. The F center in an alkali halide (an electron occupying a vacant halogen ion site) is a prototype of such a system. In KCl the electron interacts with its nearest neighbor, potassium nuclei, as well as with more distant nuclei to give a line of Gaussian shape of 50 gauss width with no observable structure.

In such a system, with about 10^{17} centers per cc, dipole-dipole interaction is weak and the corresponding relaxation time, T_2 , is replaced with T_1 in theoretical treatments. Portis investigated the saturation response of this system* and determined T_1 at room temperature using a spectrometer employing amplitude modulation of the klystron output. He found that the observed EPR absorption signal $\chi'' H_1$ became independent of the microwave field amplitude, H_1 , at saturation, and found a value for T_1 of 8×10^{-5} sec. at room temperature.

We were interested in studying the saturation behavior of this system with the Varian EPR spectrometer employing field modulation at a frequency $\omega_m = 2\pi \times 10^5$. If $\omega_m T_1$ is greater than 1, the modulation amplitude, H_m , appears in the saturation parameter. Saturation was expected to occur when $\frac{\gamma H_1^2 T_1}{H_m} \approx 1$. Figure A shows an experimental saturation curve, in which the amplitude of the absorption $\chi'' H_1$, is plotted vs H_1 . It is possible to produce a theory to account for the observed behavior, but the break at saturation is not sharp and at best many measurements are required to determine T_1 .

One may obtain a value of T_1 much more quickly by observing the dispersion (χ'). Upon saturation, the line shape passes from the typical derivative of the dispersion to the rapid passage shape observed in inhomogeneous systems.** This line shape is the actual distribution of spins in the local magnetic fields. It arises from a summation of the rapid passage responses of the spin packets which compose the line as the modulation field sweeps back and forth sinusoidally. One may vary either H_1 or H_m to bring about saturation; Figure B shows three curves obtained by varying only the modulation amplitude H_m . They illustrate intermediate cases as one is passing into the saturation region. If one solves for T_1 for those values of H_m and H_1 which produce the central curve shown, one obtains a value of 1×10^{-5} sec., which is in good agreement with the value obtained by Portis.

*A. M. Portis, *Phys. Rev.* **91**, 1071 (1953), *Phys. Rev.* **104**, 584 (1956).

**J. S. Hyde, *Phys. Rev.* (to be published).

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fields fifteen were physical scientists or engineers. Of particular interest to physicists are the notices of W. Pauli, O. W. Richardson, M. Saha, and L. Prandtl, who, in addition to being internationally famous, were personally well known in the United States and had many friends here.

Each biography is accompanied by a photograph and a complete bibliography. For the most part the notices have been prepared with care and sincere dedication. In general the emphasis is on the professional accomplishments of the subject, but nearly all articles provide some insight into the personal and social characteristics as well. One can often learn a good deal from the hobbies of famous scientists.

Some vital statistics may be of interest. The average age of the subjects of these memoirs was 77. Eight of them attained the age of 80 or over, and one lived to be 100, the third fellow of the Royal Society in its whole history to have achieved this distinction. This rugged individual was the engineer, Sir James Swinburne, whose active career spanned much of the development of the electrical industry of Great Britain.

The reading of these memoirs should prove a great stimulus to the preparation of full-scale scientific biographies of many whose names will live forever in the annals of science.

Space Flight. Vol. 1, Environment and Celestial Mechanics. By Krafft A. Ehricke. A volume of the Principles of Guided Missile Design series, edited by Grayson Merrill. 513 pages. D. Van Nostrand Co., Inc., Princeton, N. J. \$14.50. Reviewed by R. E. Street, University of Washington.

THIS volume, together with forthcoming Vol. 2 on dynamics and Vol. 3 on operations, covers within the broad field of space flight what is essentially the mechanics of flight under central force fields. It is a combination of astronomy and celestial mechanics text intended for the astronautical scientist and engineer. For these students, its motivation is better than the classical books written for physicists and astronomers.

After a brief, but very interesting, discussion of the history of the development of the rocket engine, a short chapter on the utility of space flight is devoted to the reasons why we should develop space flight. Anyone who knows the author, has heard him speak, or read his papers, knows, of course, that he is an avid proponent of man's exploration of space. It is good to have his views interestingly presented in this permanent form.

With Chapter 3, the author figuratively gets to work. This chapter is a thorough discussion of the solar system in which all of the known facts of the sun, the planets, their moons and other bodies are succinctly presented. The treatment is quantitative with innumerable references. Similarly, Chapters 4, 5, and 6 on the central force field, orbits in space, and perturbations, respectively, serve as an excellent introduction to the mathematical aspects of celestial and planetary mechanics. All of the many numerous equivalent forms of