The Quantum Theory of Radiation. By W. Heitler. Oxford, Clarendon Press, 1936. xi+252 pp.

This is the eleventh in The International Series of Monographs on Physics which is published under the editorship of R. H. Fowler and P. Kapitza and it may be fairly said to maintain the very high standard set by the preceding numbers of the series. The first chapter, about one-fifth of the book, is devoted to the classical theory of radiation (Maxwell's equations, electromagnetic potential, field of a moving electron, scattering and absorption of light) and ends with the Hamiltonian form of treatment which is based on the wave equation governing the vector potential and a consequent expansion of the vector potential in a Fourier series (after the time variable has been separated from the space variables). The second chapter treats the quantum theory of the field in free space (the field being regarded as the result of a superposition of plane waves and each of the plane waves having the same Hamiltonian as a linear oscillator). The third chapter discusses the interaction of radiation with matter (emission and absorption, breadth of spectrum lines, photo-electric effect, dispersion and Raman effect, resonance fluorescence, Compton effect). Chapter 4 is devoted to the positive electron and the book closes with a discussion of the penetrating power of high-energy radiation and a summary account of the Born-Infeld non-linear theory of the electromagnetic field.

It may well be imagined from the indication given above of the variety of topics treated that the reading of the book under review is not easy. The boldness of speculation and imagination which is so characteristic of the physical theories of the past decade is continually in evidence and a mathematician, who cannot ride with a carefree heart in the vanguard of attack but must have an ever present anxiety about his lines of communication, may have his moments of discouragement. For instance, the author introduces (p. 71) as a "relativistic analogue of Dirac's well-known δ function" the function

$$\Delta = \lim_{\kappa\to\infty} \frac{1}{\pi r}\left[\frac{\sin \kappa(r+ct)}{r+ct} - \frac{\sin \kappa(r-ct)}{r-ct}\right]$$

and an old-fashioned conscience is worried by a limit which does not exist. But the whole work carries the stamp of authority and one may surmise that these twinges of conscience are caused by nothing more important than matters of elegance which, in the words of Boltzmann, may safely be left to the tailor and the cobbler.

F. D. MURNAGHAN

Les Involutions Cycliques Appartenant à une Surface Algébrique. By Lucien Godeaux. (Actualités Scientifiques et Industrielles, No. 270.) Paris, Hermann, 1935. 44 pp.

The same scheme is used in the present pamphlet as in the preceding ones, namely, to present a brief and fairly popular account of the status of a problem, but accurate and including a suggestion for the direction of most probable further development. Proofs are not given, but the bibliography of fifty-eight titles is cited as occasion arises. This is fairly full, but a number of important recent contributions are not included.

The problem is very clearly stated; it is the study of rational or irrational (1, p) correspondences between the points of two algebraic surfaces, the p points being the successive images of a given one in a birational correspondence of period p. A projective model of each surface is constructed in hyperspace, such that the birational correspondence becomes a collineation. Involutions are then classified according to the number of invariant points. An isolated invariant point may be perfect or imperfect, according as every direction through it does or does not remain fixed. In the case of imperfect points the two invariant directions are examined further. This process is continued until the form of contact at each point is completely accounted for. The procedure is illustrated by a detailed discussion of a plane cyclic collineation.

A regular surface can not have irregular involutions, but the converse is not true. Each combination is discussed, and the criterion obtained in order that a surface shall represent an involution. Finally the theory is applied to surfaces having a canonical curve of order zero.

The booklet is excellently printed on stiff paper, making an attractive page. It furnishes a welcome resumé of this interesting theory.

VIRGIL SNYDER

Gesammelte Werke. By David Hilbert. Volume 3. *Analysis, Grundlagen der Mathematik, Physik, Verschiedenes. Nebst einer Lebensgeschichte.* Berlin, Springer, 1935. 435 pp.

This third volume completes the edition of Hilbert's collected mathematical papers. The last volume spans over a wide range and reminds one again of Hilbert's outstanding contributions to our mathematical knowledge. It contains the papers on Dirichlet's principle, on the calculus of variations, on Hilbert space, and all his papers on physical problems. The series of investigations on the foundation of mathematics has also been reserved for this volume.

One rereads with pleasure Hilbert's famous talk on mathematical problems at the Paris congress in 1900 and one cannot avoid realizing the tremendous strides of the mathematical sciences in the past third of a century. A majority of his problems have been solved as precisely as they were formulated, and for almost all of them one can say that important contributions have been made. One should not forget to mention in this last volume the necrologues on Weierstrass, Darboux, and Hilbert's long-time friends and associates, Minkowski and Hurwitz. They reveal to us more than anything else Hilbert's human qualities and his unusual ability as a writer.

It should be mentioned that some of Hilbert's papers are not to be found in this edition, most of them papers which have been published in similar versions in several periodicals. His books have also been omitted. Through this expedient it was possible to reduce the number of volumes to three instead of the four originally scheduled. One finds, however, a list of all publications, lectures, and dissertations completed under his supervision.

Hellinger has contributed an account of Hilbert's work on integral equations, and Bernays gives an appreciation of his work on the foundation of mathematics. They are both excellent, clearly and well written, but one has a feeling, particularly in regard to the papers on the foundation of mathematics,