SCIENTIFIC BOOKS

Photoelectricity. By H. STANLEY ALLEN. 2nd Edition. New York: Longmans Green Co.

THE principal experimental facts of photoelectricity were practically all known before the publication of the first edition of Professor Allen's "Photoelectricity." It had been known for a decade, thanks to the work of Lenard, that under illumination, metal plates in vacuo give off electrons whose number varies directly with the intensity, but whose energy of emission depends only on the frequency of the light. The existence of long wave length limits—beyond which no amount of illumination would eject electrons—characteristic of the substance, and falling for different elements in an order clearly related to their positions in the periodic table was already well established. The striking differences in the amount and in wave-length distribution of the emission from specular surfaces of the alkali metals when the plane of polarization of the incident light is changed, had been discussed and extensively studied by Elster and Geitel and by Pohl and Pringsheim.

The problems raised by these phenomena were clearly recognized as being incapable of solution by "classical" theories of radiation, or by reference to any of the known optical properties of matter. The non-dependence of the energy of emission on the intensity of the light, coupled with the instantaneity of photoelectric response, called apparently for an absorption of energy from an area of wave front enormously greater than an atom could command, or for some form of trigger action which seemed ruled out by other well-established phenomena. Einstein had boldly faced this dilemma by proposing his photoelectric equation, based on the assumption that radiant energy travels through space in bundles or "quanta," but his equation lacked experimental verification.

Comparatively little work has been done in the past dozen years leading to the knowledge of new experimental facts. The conditions under which the "normal" and "selective" effects of Pohl and Pringsheim occur have been probed more closely. It has been found that photoelectric emission is not in all cases independent of temperature, as was formerly considered to be the case. The establishment of photoelectric emission as the initial process occurring in typical light sensitive resistances, *e.g.,* crystals, has followed from the work of Gudden and Pohl. Investigation of photoelectric phenomena, in the broad sense of the word "photoelectric," has been much more active in the realm of X-rays, where the influence of surface "work functions" is avoided. DeBroglie has shown that under X-ray excitation the velocities of the "photo" electrons exactly correspond to the various electron rings postulated by the Bohr theory. It is in fact in the correlation of photoelectric phenomena with the quantum theory that the real progress in the subject has been made. Foremost in this direction is the classical work of Millikan, who has verified Einstein's photoelectric equation with such accuracy as to derive from the "stopping potentials" for various wave lengths one of the most accurate determinations of the quantum constant "h." Quite recently (since the book under review was published) Foote and his associates have definitely proved the existence of photoelectric emission from alkali metal vapors due to absorption at the wave lengths indicated by the Bohr theory from spectroscopic considerations—an experimental result which has been sought with indifferent success by many investigators and was finally made possible by utilizing the effect of released positive ions on the space charge around a glowing filament, due to Kingdon.

Thus, although the lines of work which were most actively followed in 1913 have been somewhat neglected, the explanation of certain of the phenomena has been found by collateral work—where by "explanation" we mean that the problems of photoelectricity have been brought within the field of the quantum theory. The process of electron emission by radiation is just as mysterious as ever, but it is the same mystery as the emission of spectrum lines, and the radiation of the black body. With the clearing up of the contradictions presented by the well-established wave theory of radiation in space and the quantum theory of radiation and absorption of energy by matter, the chief problems of photoelectricity may be expected to find their solution.

The second edition of Allen's "Photoelectricity" takes its form from the frankly expressed belief of the author that no change in arrangement has been made necessary by developments since the first. The chapter headings are practically the same. The chief experimental facts are first treated, a discussion and review of theories is given and finally a very interesting and stimulating series of chapters dealing with photography, fluorescence and phosphorescence, photochemical reactions and physiological effects—allied subjects in which it is more and more apparent that photoelectricity plays an important rôle. The book is open to the criticism that it has in fact followed the first edition too closely. The original illustrations have been retained almost throughout, thus exhibiting experimental results which have often been superseded in important details, even though the main phenomena illustrated are the same. Few new illustrations have been added and the description of later work is in consequence less detailed and critical than is the case with the early work, so that the book inevitably suffers in perspective. The necessity "to overcome the difficulty of including some references to this work without materially increasing the size of the book" is an unfortunate condition for a scientific writer to have to bow to. The book will, however, be found to be exceptionally complete in its references, and an extensive bibliography of all articles since 1913 opens the way for any one to inform himself in detail on any aspect of the subject.

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SPECIAL ARTICLES

REMARKS ON SURFACE DISTRIBUTION OF MARINE PLANKTON DIATOMS IN THE EAST PACIFIC

THESE remarks are almost entirely based on information obtained by study of material collected mainly in the years 1920, 1921, 1922 and partly in 1923 and 1924. A similar amount of material is on hand awaiting study at the Scripps Institution, but its content is unknown.

Some of the collecting of this material was done from boats and some from piers, but in all cases a measured amount of water, dipped from the surface of the sea, was passed through a small filtration net of No. 25 bolting silk. The material retained by the silk was then preserved in formaldehyde. This method was placed in operation at the Scripps Institution pier in 1919, at Pt. Hueneme pier in 1920, and at Oceanside pier in 1921, where daily catches from seven gallons of water were made throughout succeeding years.

In 1921 a small boat was chartered for the summer which was used for making daily collections from five gallons of water at points five and ten miles seaward from the Scripps Institution pier. A similar series was taken in 1922. In 1920 Dr. McEwen, Scripps Institution hydrographer, made collections from the passenger steamer *Queen* between San Diego and Seattle in daytime running. Following this, Mr. Mortensen, second officer on the *Queen,* made a few catches on each of several round trips between San Diego and Seattle. Earlier in 1920 Mr. Crandall and Mr. Michael, members of the staff of the Scripps Institution, had taken a series of collections on a voyage from Jacksonville, Florida, through the Panama Canal to San Diego on the yacht *Kemah,* belonging to Mr. E. W. Scripps. Most of the aforementioned steamer catches were taken from two and one half to three gallons of water. In 1921 the California Academy of Sciences conducted an expedition into the Gulf of California, on which Dr. Fred Baker, of San Diego, made a series of catches, each taken from three gallons of water.

In 1922 Mr. Barnhart, of the Scripps Institution, obtained a series of catches off the coast of Lower California while a guest on a scientific expedition by the Mexican government. In 1923 the U. S. Coast and Geodetic Survey steamer *Pioneer* took a series of catches seaward from San Diego, and then a fairly continuous (geographically) series while running from San Diego to Alaska and the Aleutian Islands. This series was interrupted for considerable periods of time in certain localities. Early in 1924 Mr. E. W. Scripps, in his yacht *Ohio,* obtained a series between the Canal Zone and Callao, Peru. All these later steamer catches were made by filtering five gallons of water.

From the various sources a total of some thousands of catches was obtained and studied. Since a known volume of water was filtered in each case, the diatom production was uniformly estimated in numbers of cells per liter, thus rendering each catch numerically comparable with any other. Unfortunately, many catches could not be made comparable in any additional feature, except that they were all taken at the surface level.

The geographic area represented in the combination of all these various series is over seven thousand miles in extent in coastal waters of the East Pacific. It comprises more than seventy degrees of latitude and more than ninety degrees of longitude.

The temperature of the water from which collections were taken ranged from 39.4° F. to 84.5° F.

The size of the catches ranged from zero to a total of nearly seven million cells per liter. Largest catches were found in Alaskan waters, but very small catches were also taken there, while catches running into millions of cells per liter have often been taken off the coast of California. Surface catches taken far from land (eighty miles or more) in all latitudes (tropic, sub-tropic and sub-arctic) have all been very small, few reaching the number of one thousand cells to the liter. The available evidence indicates that a certain nearness to land is necessary for good production of diatoms in the East Pacific.

In some cases, in all regions and any season, heavy (also light) production seems to be strongly localized. Some highly productive localities seem to be recurrently (and perhaps permanently) so, while others appear to be more sporadic in such showing. Some localities have always shown small numbers, so far as yet observed.

In all regions, production seems to be usually best in the spring, poorest in late summer and early