frequencies in different directions. The situation in this connection has been discussed by Bohr, Kramers and Slater,[9] who, in representing the action of the free electron, invoke a moving linear oscillator whose Doppler effect gives rise to the different frequencies, in different directions, and who, in representing scattering by an atom, invoke (presumably) a linear oscillator emitting a frequency corresponding to the primary quantum and modified now to a negligible extent by the Doppler effect. Leaving the justification of these assumptions to the arguments presented for them in the paper referred to, we may incorporate the result in a theory of quanta of the type here sketched, for the purpose of correlating the phenomena of the Compton effect and atomic scattering, by supposing that the energy of the original quantum, having been received by the system, becomes available for total or partial reemission in varied amounts, the probability of emission of a quantum from the virtual oscillator at any point of the surface of its oscillating electron in unit time being proportional to the magnitude of the Poynting vector corresponding to the irreversible radiation emitted from that point, and the magnitude of the quantum emitted being determined by the frequency of the wave emission from that point, the subsequent history of the quantum after emission being determined in its relation to gratings, prisms, etc., upon which it may fall by the same sort of considerations as those which determine the history of the primary quantum.

It is then necessary to endow the quanta with the characteristics of momentum in such a way that the energy and direction of emission of the electron associated with the scattering follows as in Compton's calculations. The feature which a view of this kind adds to the more primitive theory is first, in harmony with the view of Bohr, Kramers and Slater, its consistency with the undulatory phenomena required by the properties of the scattered radiation in relation to its analysis by a grating, and second, its formal attempt to assign definite probabilities to the scattering of quanta of different magnitudes, and in different directions, these probabilities being calculable in terms of the magnitudes of the Poynting vector at the appropriate point of emission in the sense outlined above.

Apart from its power to provide a visual picture of the passage of energy from one place to another, its power to give through the law determined by the Poynting vector a physical interpretation of the probability of a transition induced by the quantum, and a numerical magnitude to that probability, the concept of a quantum operating according to the laws above described provides the feature of an instantaneous emission of the energy, in spite of the association of that emission with a wave emission extending over a finite time. Such a feature as the last named seems essential to a satisfactory explanation of the fact that, in such a phenomenon as that of the Wien experiment above cited, the "light" emanating from any part of the track of the positive ray, no matter how small, possesses the power to produce the full Einstein photoelectric velocity in any electron which it ejects from an atom in its path.

Finally, it may again be emphasized that if we decide to talk in terms of quanta at all, and accept as an experimental fact that no quantum ever crosses a region where the classical theory predicts darkness, in other words, if we accept the classical theory as an empirical description of interference phenomena and the like, we practically constrain the quanta to follow the paths of the Poynting vector in the sense outlined above.

W. F. G. SWANN

YALE UNIVERSITY

(To be concluded)

[9] *Loc. cit.*

THE BIOLOGICAL SURVEY OF THE MOUNT DESERT ISLAND (MAINE) REGION[1]

THIS survey was undertaken in the season of 1923 at the suggestion of Mr. William Procter, a member of the board of trustees of the laboratory. The object of the survey is to gain a knowledge of the flora and fauna of the region, principally the marine forms, which will be of use to the scientific research workers who contemplate coming to work at the laboratory, as well as to present a picture of the ecology of the forms, the numbers as to kinds and individuals, their distribution with regard to season of year and over periods of years, kinds of water and bottoms that they live in, temperature conditions that influence them, their feeding habits, mating habits and seasons, habits of offense and defense and other ecological relationships.

The work may be divided into two more or less distinct parts: First, a series of intensive surveys by individual workers of restricted areas, and second, a more general and comprehensive treatment of the whole area which will take a much longer period of time but from which interesting results have already become apparent.

In the first part the following papers have already been published or are in course of preparation:

[1] By the members of the staff of the Mount Desert Island Biological Laboratory and Associated Naturalists.

The zonation of vegetation on a rocky coast: DUNCAN S. JOHNSON AND ALEXANDER F. SKUTCH.

Symbiosis between a green algae and an amphipod: ALEXANDER F. SKUTCH.

A botanical survey of North-East Creek, Mt. Desert Island: PAUL ACQUARONE.

The zoological grouping of forms on the sea-bottom on Cod-Ledge off Mount Desert Island: ROY MINER. To be reconstructed in models as a group in the American Museum of Natural History, N. Y.

The rotifers of Mount Desert Island: FRANK J. MYERS AND H. K. HARRING. To be published in the Trans. Wis. Acad. of Science.

The primitive luminous organisms of Maine: ULRIC DAHLGREN. *The Maine Naturalist,* Vol. IV, Nr. 1, 1924.

The fireflies of Maine: ULRIC DAHLGREN. *The Maine Naturalist,* Vol. II, Nos. 3 and 4, 1922.

The larval distributive habits of some Pelecypod mollusks of the waters surrounding Mount Desert Island: THURLOW NELSON.

The insect fauna of Mount Desert Island: CHAS. W. JOHNSON.

In the general work some 50 collecting trips have resulted in the recording of about 250 forms of marine animals on form cards, with notes as to their location, abundance, breeding, food, enemies, parasites, migrations, etc. This work has been pursued mostly in the neighborhoods nearest the laboratory and a lesser part in the deeper water south of Otter Creek and around Egg-Rock. Some of the more interesting facts that have emerged, for further study as to causes, are as follows:

Yearly variation in the abundance of *Aurelia aurita.* This jellyfish was very abundant in Frenchman's Bay in 1921. In 1922 it disappeared to such an extent that but two specimens were seen at Southwest Harbor. In 1923 some few specimens were noted and recorded in the bay. In 1924 it appeared in moderate abundance. It is evidently coming back to its normal abundance and it seems very probable that in 1925 it will be found in large numbers again. The cause of this variation is unknown, but a possible solution of the question is that the heavy ice may mechanically kill the attached hydroid stages or hyphae. Year by year this question will be studied in search of an explanation.

In the same way in 1921 and 1922 the tubularian hydroids, especially *Tubularia crocea,* were very abundant, covering the spiles of docks with huge masses. In 1922 the nudibranch mollusk *Dendronotus frondosa,* which was only moderately abundant in 1921 and which lives principally on tubularian hydroids, had become extremely numerous and was found all over the hydroids and crawling everywhere. By 1923 the hydroids were so scarce that a few specimens were found with difficulty and in that summer *Dendronotus* had also declined in numbers. In 1924 but six small specimens of *Dendronotus* were found. The relationship here was that of food supply and suppression of the hydroids by overeating by *Dendronotus,* followed by suppression of *Dendronotus* by starvation in the absence of the hydroids.

The question of yearly temperature relationship was well exemplified by the localization of the pelagic shrimp *Nyctiphanes norvegica.* In 1921–1922 this shrimp was rarely seen in the bay, although known to be a common inhabitant of the cold outside waters, where it lives in great schools near the bottom.

The winter of 1922–1923 was very cold and the spring very late so that in June, 1923, the waters of Frenchman's Bay were far below the normal in temperature. This resulted in the invasion of the bay by myriads of *Nyctiphanes* which swarmed on the surface at night and swam in the mid-depths of the lower bay around Bald-Rock in the daytime. This was repeated in the summer of 1924 after a cold late spring.

An interesting and undescribed breeding habit of a marine annelid worm has been observed and recorded for several years and further study is necessary. This form is a tube builder living in moderately deep water near the entrance of the bay. It breeds several times each summer, these periods being about a month apart and thus showing the periodicity that is so characteristic of the *Palolo* worm, *Odontosyllis, Nereis* and many other marine annelids. On the day when it breeds the red eggs are cast in untold numbers into the bottom waters and during a rapid development rise to the surface at about the middle of the day. The water becomes blood red and as the day lengthens, toward evening, the active little trochophore larvae suddenly become negatively heliotropic and move toward the bottom, leaving the water of natural color again.

The breeding, seasonal succession and migrations of several of our important food fishes have been observed but not as yet seriously studied. This important feature must wait until the laboratory can secure a better boat than it now owns.

Numbers of interesting animal associations have been recorded and lists made, and the work increases in value year by year. The papers written are published in various journals until the laboratory is able to publish its own work.

ULRIC DAHLGREN

PRINCETON UNIVERSITY