Letters to the Editor.

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The Nature of Radiation.

BOTHE and Geiger have recently performed an experiment on the Compton effect (*Die Naturwissenschaften*, 13, p. 440, May 15, 1925; *Zs. f. Phys.*, 32, p. 639, 1925) indicating that the recoil electron, and the photoelectron emitted by the scattered radiation, appear simultaneously. Prof. A. H. Compton has made another experiment (Proc. Nat. Acad. Sci., 11, p. 303, 1925), showing that the direction in which the scattered radiation acts in producing ionisation, and the direction of the recoil electron, are related. The natural interpretation of these experiments is in terms of a corpuscular theory of radiation, in which a corpuscular quantum, glancing off a scattering atom with emission of a recoil electron, very soon hits another atom and emits a photoelectron. This contradicts the suggestion, discussed by Bohr, Kramers, and the writer (*Phil. Mag.*, 47, p. 785, 1924), that there was a virtual field, like the ordinary fields of optical theory, emitted during the stationary states of the atom, the function of which was to induce a probability of transition; for on that view the probabilities of ejection of electrons by the scattering and absorbing atoms would be independent, both being induced by a radiation field existing continuously, and the two electrons would be in general ejected at different times and in unrelated directions. I wish to point out, however, that a corpuscular theory still is not in conflict with the main part of the idea of virtual fields.

The possibility of harmony between a virtual radiation field and a corpuscular structure of light was discussed with great penetration by Prof. Swann, in his address at the meeting of the American Association for the Advancement of Science last Christmas (*Science*, 61, p. 425, 1925). Prof. Swann suggested the existence of a field, obeying Maxwell's equations, the function of which should be to guide corpuscular quanta, which might travel along Poynting's vector. This was also the idea on which the writer was working when he first considered a field emitted during the stationary states, although Prof. Swann was not aware of this. (NATURE, 113, p. 307, 1924; *Phys. Rev.*, 25, p. 397, 1925.)

The theory in this form was developed in England, under the guidance of Mr. R. H. Fowler, to whom my sincerest thanks are due. The essential feature was the emission of the field before the ejection of the corpuscle; that is, during the stationary state before the transition. By this device were avoided the difficulties of explaining coherence, of the "size of quanta," of the presence of interference phenomena in weak light. When this view was presented to Prof. Bohr and Dr. Kramers, they pointed out that the advantages of this essential feature would be kept, although rejecting the corpuscular theory, by using the field to induce a probability of transition rather than by guiding corpuscular quanta. On reflection, it appeared that no phenomena at that time known demanded the existence of corpuscles. Under their suggestion, I became persuaded that the simplicity of mechanism obtained by rejecting a corpuscular theory more than made up for the loss involved in discarding conservation of energy and rational causation, and the paper already quoted was written. The changes made in adopting this view were thus not fundamental; it might be mentioned that they were not new, the failure of conservation having been suggested by D. L. Webster and others, and the idea of a field to induce a probability of transition being due to Jeans.

The present experiments, however, seem to show definitely the characteristic properties of corpuscles: the localisation of the active power of a light wave in space (Compton) and in time (Bothe and Geiger), although of course the evidence is as yet meagre. The simplest solution of the radiation problem then seems to be to return to the view of a virtual field to guide corpuscular quanta. One slight difficulty in the way of carrying this out should be mentioned: the velocity of a corpuscle should transform under the Lorentz transformation as a velocity, and Poynting's vector does not so transform. There are other difficulties as well, but one may hope that none of them are insurmountable.

It seems to me of particular value to realise that the facts of optics are, in general, satisfactorily described by theories of the electromagnetic field; that it is highly improbable that any essentially different theory could also explain such an extended set of facts; and that consequently we must expect to find this theory appearing in some form or other in our final description of radiation, whatever that may be, and whether it include corpuscular quanta or not. Some physicists have been tempted to throw away the great work of Maxwell and Lorentz, because there are phenomena which suggest light corpuscles. This seems to me a very doubtful policy; for a corpuscular theory of the kind now indicated would by no means take the place of the electromagnetic theory, but would rather supplement and extend it. Some of the material for this extension must naturally come from such experiments as those of Bothe and Geiger and of Compton.

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The Effect of Diluents on the Initial Stages of Catalytic Action.

IT has been long known that the presence of diluent vapours in the reactants depresses the reaction velocity at a catalyst surface. The following quantitative treatment has been confirmed by experiments on the effect of water vapour on the initial stages of the dehydrogenation of alcohol by copper. Let p = the fractional partial pressure of the reactant A, hence $1-p$ = the fractional partial pressure of the diluent B. Then the rate at which the reactant molecules arrive at the surface is proportional to $p/\sqrt{2\pi MRT}=\mu_A p$, say. Thus the probability that a reactant molecule should bombard a given portion of a catalyst at a given instant is

$$\frac{\mu_A p}{\mu_A p+\mu_B(1-p)};$$

i.e. the fraction of A molecules in the impinging stream of A and B molecules. According to the conception of Langmuir and Frenkel, a molecule that hits another adsorbed molecule is immediately reflected, whereas when it strikes the bare surface it remains for the short period of time τ. It is also known that chemical action occurs on definite centres on the catalyst surface.

Let n be the number of times one of these centres becomes momentarily vacant in t units of time, then $\mu_A \cdot p \cdot n/\{\mu_A p+\mu_B(1-p)\}$ molecules of the reactant are adsorbed, and they occupy the centre of activity for a fraction of the total time $=\mu_A\tau_A pn/\{\mu_A p+\mu_B(1-p)\}$.