Reprinted: P L Knight & L. Allen Concepts of Quantum Optics (Pergamon Press, Oxford 1983)

Dear Dick, This is supposed to be the first observation of a photon

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Interference Fringes with Feeble Light

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The phenomena of ionisation by light and by Röntgen rays have led to a theory according to which energy is distributed unevenly over the wave-front (J.J. Thomson, *Proc. Camb. Phil. Soc.* XIV. p.417, 1907). There are regions of maximum energy widely separated by large undisturbed areas. When the intensity of light is reduced these regions become more widely separated, but the amount of energy in any one of them does not change, that is, they are indivisible units.

So far all the evidence brought forward in support of the theory has been of an indirect nature; for all ordinary optical phenomena are average effects, and are therefore incapable of differentiating between the usual electromagnetic theory and the modification of it that we are considering. Sir J.J. Thomson however suggested that if the intensity of light in a diffraction pattern were so greatly reduced that only a few of these indivisible units of energy should occur on a Huygens zone at once the ordinary phenomena of diffraction would be modified. Photographs were taken of the shadow of a needle, the source of light being a narrow slit placed in front of a gas flame The intensity of the light was reduced by means of smoked glass screens.

Before making any exposures it was necessary to find out what proportion of the light was cut off by these screens. A plate was exposed to direct gas light for a certain time. The gas flame was then shaded by the various screens that were to be used, and other plates of the same kind were exposed till they came out as black as the first plate on being completely developed. The times of exposure necessary to produce this result were taken as inversely proportional to the intensities. Experiments made to test the truth of this assumption shewed it to be true if the light was not very feeble.

Five diffraction photographs were then taken, the first with direct light and the others with the various screens inserted between the gas flame and the slit. The time of exposure for the first photograph was obtained by trial, a certain standard of blackness being attained by the plate when fully developed. The remaining times of exposure were taken from the first in the inverse ratio of the corresponding intensities. The longest time was 2000 hours or about 3 months. In no case was there any diminution in the sharpness of the pattern although the plates did not all reach the standard blackness of the first photograph.

In order to get some idea of the energy of the light falling on the plates in these experiments a plate of the same kind was exposed at a distance of two metres from a standard candle till complete development brought it up to the standard of blackness. Ten seconds sufficed for this. A simple calculation will shew that the amount of energy falling on the plate during the longest exposure was the same as that due to a standard candle burning at a distance slightly exceeding a mile. Taking the value given by Drude for the energy in the visible part of the spectrum of a standard candle, the amount of energy falling on 1 square centimetre of the plate is 5×10^{-6} ergs per sec. and the amount of energy per cubic centimetre of this radiation is 1.6×10^{-16} ergs.

According to Sir J.J. Thomson this value sets an upper limit to the amount of energy contained in one of the indivisible units mentioned above.

$1,8\ eV \times 1,6 \times 10^{-12} \sim 3 \times 10^{-12}$ ergs

On the Quan
Radi

A. EI

The formal similarity of the curve o
body radiation and the Maxwell veloc
hidden for long. Indeed, already W
in which he derived his displacement

$$\rho = \nu^3 f(\nu/T)$$

was led by this similarity to a furt
It is well known that he then found

$$\rho = \alpha\nu^3\ e^{-h\nu/kT},$$

which is also nowadays accepted as b
values of ν/T (Wien's radiation law)
based on classical mechanics and ele
formula, and that classical theory n

$$\rho = \frac{k\alpha}{h}\ \nu^2 T\ .$$

As soon as Planck in his classical i

$$\rho = \alpha\nu^3\ \frac{1}{e^{h\nu/kT} - 1}$$

on the assumption of discrete elemen
quantum theory developed, it was nat
equation (2) became forgotten.

Recently[1†] I found a derivation of P
upon the basic assumption of quantum

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†The considerations given in that pa