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THE PHOTON-SOLITON

by

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Einstein's explanation of the photoelectric effect on the basis of quantum theory has thrown overboard the physical concept of spreading waves underlying Maxwell's electromagnetic wave equations. The spreading wave concept is, therefore, a pure mathematical fiction although it Precisely predicts the behaviour of light in phenomena such as diffraction, interference, polarisation, etc. In this context it is interesting to recall a Paper by M. Sachs [6]. On the basis of this theory, a wave started at a star four light years away which would expand over no area of about 10^{38} cm^2 (assuming a hemispherical spreading) would have to reconcentrate to activate a detector on earth. Whereas there is no difficulty in accepting such a concept in mathematics or philosophy,it would not be useful to understand physics. As Feynman et al. [2, p. 2-1] have stated "a physical understanding is a completely unmathematical, imprecise and inexact thing, but absolutely necessary for a Physicist". Often important discoveries are nucleated by physical concepts by causing right insight into the nature of obscure phenomena. The present author has described how C. V. Raman used it to discover the theory of diffraction light waves by ultrasonic radiation [1]. From this point of view "light without spreading waves" is a more useful concept.

The possibility of a disturbance propagating without spreading was postulated by Russell (cf. [5]), on the basis of a hydrodynamic phenomenon. This has been called the soliton. The soliton is pictured as a non-linear elementary excitation and has been used in charge density wave theories of linear conductors, in crystal lattices, and in areas of low temperature physics. It can be a crystal dislocation, a non-linear plasma excitation, a fluxon or elementary particle. It appears obvious to the present author that one of the simplest solitons is the photon.

It would be of great interest to deduce from the general theory of solitons, the particular equations controlling the behaviour of photon-solitons (can we call them pholitons) during transmission in material media, reflection, refraction, scattering and polarisation phenomena, as well as the creation of the photon-soliton [3, p. 4-7]. Such an approach may throw new light on the nature of the Planck's constant.

It is of interest to examine the possible size of the photon-soliton (i. e. range of influence to cause certain phenomena), from the spatial and temporal range of coherence of radiation.

The joint work of the present auther[7]on depolarisation of light scattered by silver iodide sols is also of interest from this point of view. It is found that the degree of depolarisation is independent of concentration of sols in very dilute solutions but a conspicuous change takes place at higher concentrations. This transition occurs (see Table 1)when the average distance between the particles is of the order of 3 wavelengths. This is perhaps the magnitude that can be given to the size of photon-solitons, in visible radiation. Since scattering is affected both by the process of absorption as well as of re-emission, it is difficult to conclude as to whether this gives the lateral or longitudinal dimension. Experiments can be devised to explore the effect of each of these proces
ssses. It is of interest in this connection to note that the coherence

length for visible light is found to be 3 to 4 wavelengths [4, p. 283].

The photon-solitons incident on narrow slits would get absorbed and get re-emitted by the slit edges at different angles resulting in a monstrous distribution of light intensity instead of a simple image of the slit dictated by the rectilinear propagation of photon-solitons. In view of the large dimension (range of influence) of the photon-solitons, the two slit interference phenomenon can be pictured in terms of the photon-soliton getting absorbed and energising an extensive electron cloud encompassing both the nearby slits and the emission would take place at one or the other slit, depending on the disposition of the photon-solitons.

A similar explanation can be given to electron diffraction taking the range of influence of incident electron on the electron cloud of the material of the slit. The electron cloud in matter gets affected by the incident electron over a relatively large distance due to dispersion type mutual interaction between the electrons in the material. The scattering of an electron by the edges of a slit can, therefore, be influenced by the presence of another slit within the range of influence. This give a picture for the results of the thought experiment [3, p. 1-4] on the two-slit interference of electrons which are normally interperted on the basis of the uncertainty principle.

The very long base coherence of light is, however, a different phenomenon. This is obviously caused by slightly divergent coherent photon-soliton beams caused by stimulated emission, during the passage of primary photon-soliton through the extensive high temperature stellar atmosphere.

Dirac has stated "I understand what an equation means, if I have a way of figuring out the characterisations of its solution without actually solving it" (see [2]). From this point of view it is desirable to work out the theory of electromagnetic radiations entirely on the basis of "photon-solitons" by a concerted effort of the physicists and mathematicians. This would be a great help not only to teach electromagnetic theory in a more realistic way, but also to stimulate the discovery of new and unsuspected features in the interaction of matter and radiation.

TABLE

Depolarisation of white light scattered by silver iodide sols.

Size of the particles: 1050A

Number of particles per cm³ per ml $\times 10^{-10}$	Average distance (A) between particles and particle	Depolarisation
2.3	35000	0.052
4.6	28000	0.052
9.2	22000	0.052
1.83	17000	0.066
3.66	14000	0.085
7.32	11000	0.133

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