medusa *Aurelia aurita* is acclimatised to different latitudes: in Florida its optimum temperature for pulsation is 29°, whereas this temperature is fatal to members of the same species in Nova Scotia.

The results summarised here will be published in the *Proceedings of the Zoological Society*.

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A. G. Mayer, *Pap. Tortugas Lab.*, **6**, 3 (1914).

Interpretation of Shankland's Experiment

THE experimental results of Shankland[1] are in contradiction with the accepted theory of the Compton effect, in particular with the idea of detailed conservation of energy and momentum. If we accept his evidence, and if we assume that, in this process, energy and momentum are not given out in some unknown form, we have to conclude that energy and momentum are not conserved. As Dirac pointed out recently[2], Shankland's result would be compatible with the point of view of Bohr, Kramers and Slater. I would like, however, to direct attention to the fact that this point of view by no means affords the only plausible interpretation of the experiment.

To make this clear, it is useful to divide the predictions of the current theory into the following statements:

(*a*) Supposing the frequency and direction of the incident radiation to be given, the radiation scattered through an angle θ will have a definite frequency $\nu(\theta)$. The recoil electrons emitted at an angle φ with the incident beam will have a definite energy, $E(\varphi)$.

(*b*) Simultaneously with each recoil electron, there appears one quantum of the scattered radiation, and vice versa.

(*c*) Between the direction of emission of a recoil electron and the simultaneous quantum of scattered radiation there is, again for given direction and frequency of the incident radiation, an unambiguous connexion: the two directions lie in one plane through the direction of incidence, and their angles θ and φ are definite functions of each other.

Statement (*a*) is very accurately confirmed in the X-ray region, but I am not aware of an equally exact confirmation for energies as high as those used by Shankland. This point is of importance, as the fact (*a*) is the only reason for assuming that no energy is given out in a form unknown at present.

Statement (*b*) was, for X-rays, subject to a test by Bothe and Geiger[3], who found a positive result.

Shankland's experiment is a test for (*b*) and (*c*) together, for, as distinct from Bothe-Geiger, his counters subtend small solid angles with the scatterer, and if (*b*) would hold but not (*c*), the number of coinciding pairs that would happen to pass his counters would be too small to be detected. If we accept his evidence, we are then forced to abandon either (*c*), or (*b*) and (*c*) together. (One cannot, of course, retain (*c*) without (*b*), as without (*b*) recoil electrons and secondary quanta are not connected in pairs.)

(i) The point of view of Bohr-Kramers-Slater and Dirac would imply that (*b*) and (*c*) have to be abandoned. This would necessarily imply that the Bothe-Geiger experiment was erroneous. On that view, the photon does not exist in the corpuscular sense of the current theory.

An alternative—and, it seems to me, equally plausible possibility—is that (*b*) still holds; that is, that there *is* a secondary photon for each recoil electron, but that their directions do not obey the relations required by the conservation laws.

(ii) One may either believe that (*c*) breaks down for *any* frequency of the incident radiation, just as Bohr-Kramers-Slater require (*b*) to break down for all frequencies.

(iii) Alternatively, one may believe that (*c*) holds, at least approximately, for small frequencies, and that deviations from it become appreciable only for photon energies of the order of a million volts. The latter alternative would, on the existing evidence, give us the freedom to abandon also the exact validity of (*a*) for high frequencies. This would, in many ways, seem more satisfactory, for (*a*) is the very direct result of applying the conservation laws. It seems therefore artificial to maintain it where the conservation laws fail. Together with (*a*), the statistical conservation of energy would fall. That, too, seems satisfactory, once detailed conservation has been abandoned.

Again, if we abandon both (*a*) and (*c*) for high energies, there would be a close analogy between the two phenomena in which an apparent non-conservation has been observed, namely, the Compton effect and the continuous β-spectrum, while on the point of view of Bohr-Kramers-Slater or on the assumption (ii) above, these must be widely different phenomena.

A decision between (i), (ii) and (iii) (and possibly other interpretations) can, of course, only be made by further experiments, and a theoretical discussion of advantages and disadvantages of (ii) and (iii) as compared to (i) would, at the present stage, be idle. But their possibility should be kept in mind in order to carry out and discuss such experiments without being biased by one particular non-conservation theory.

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[1] *Phys. Rev.*, **49**, 8 (1936).
[2] NATURE, **137**, 298 (Feb. 22, 1936).
[3] *Z. Phys.*, **32**, 639 (1925).

Colour of the Luminous Background of the Extra-Galactic Nebulæ

ACCORDING to Milne, the multitude of the distant galaxies form a continuous luminous background. It is interesting to investigate what its colour should be. By Hubble's law, the spectra of the galaxies are shifted towards the red. It is easy to calculate the integral colour of the background if we adopt Milne's view that the galaxies are really receding. Then the light of a galaxy is shifted towards the red according to Doppler's law. The intensity from a receding nebula is less than it would be if the nebula were motionless at the same distance. Indeed, a quantum of light if shifted to the red has less energy than the original quantum; in addition, when a source of light is receding, its quanta fall upon the observer less frequently than they would if the source were motionless. Under the combined action of both causes the intensity is diminished doubly.