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Evidence for the spin of the photon from light-scattering

It is well known that in the encounters between molecules and photons, exchanges of energy occur which are rendered evident by the observed changes in frequency of the scattered light. Whenever in such an encounter a molecule gains or loses spin-energy, there is a corresponding change in its angular momentum, which can only be explained on the assumption that there is an equal and opposite change in the spin-moment of the photon. This involves definite consequences for the state of polarisation of the scattered light, and opens up the possibility of demonstrating experimentally the existence of angular momentum in radiation.

The general principle involved is sufficiently illustrated by considering the case of a photon which is circularly polarised and is scattered without change of direction by a molecule the axis of spin of which coincides with the axis of circular polarisation. If the spin of the molecule is unaffected by the encounter, the scattered photon retains its original character. On the other hand, if the molecule gains two additional units of angular momentum, the photon will alter in frequency and at the same time *change over from right-handed to left-handed circular polarisation* or *vice versa*. The considerations are naturally not so simple in the general case in which the molecule is arbitrarily orientated and the photon is scattered in a direction not coinciding with the primary ray. It may be shown that besides the reversal of the sign of circular polarisation in the forward direction, there would also result a depolarisation of the scattered light, which would be specially evident in directions transverse to the primary rays.

It may be remarked that similar phenomena should also be observed when, as the result of an encounter with the photon, a change in spin-energy of the molecule is superimposed on a change in its vibrational state. On the other hand, a change in vibrational state alone would not give rise to the effects indicated.

It may be noted that certain interesting observations recently reported by Hanle and by Bar[1] find a natural explanation in the considerations set out above. In support of the view that the scattered radiations exhibiting strong depolarisation or reversal of circular polarisation involve rotational transitions, it may be

[1] *Die Naturwissenschaften* (1931) **19**, pp. 375 and 463.

mentioned that the lines exhibiting such effects are usually diffuse, while lines which are well polarised are usually sharp and intense.

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