Letters to the Editor.

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The Coherence of Superposed X-Radiations.

WHAT is probably the most remarkable conclusion from the investigation of the *J* phenomenon is that two superposed X-radiations produce effects which are not the sum of those of the two constituent radiations, but are due to the compound radiation as a whole. It is not merely that a constituent of one radiation produces effects in atoms traversed when those atoms are exposed to the action of one or more constituents of the other beam; it is much more than that. The compound radiation, so far as the *J* phenomenon is concerned, behaves as an entity with properties of its own dependent upon (average) penetrating power and not on constituent wave-lengths. This follows as a necessary consequence of the laws which we have found, and have already stated ("The *J* Phenomenon in X-rays," *Phil. Mag.*, May 1925). We have, however, just obtained the most direct and convincing proof of this.

The absorption of an X-radiation scattered from a plate of aluminium was studied by placing an increasing number of thin aluminium sheets in its path to an electroscope. It was found that at a thickness of 0·05 cm. of absorbing aluminium the intensity as measured in the electroscope suddenly dropped by about 7·5 per cent. This was the J_2 discontinuity, as it occurred when the average absorption coefficient $(\mu/\rho)_{Al}$ was about 2·0. Thick plates of aluminium were then placed behind the first scattering plate so that while the original radiation studied was unchanged, there was superposed upon it the more penetrating radiation from a much thicker layer, making the combined radiation (on the average) more penetrating. On filtering this combined radiation by aluminium as before, no discontinuity was observed at the stage found in the first experiment—that is, the discontinuity no longer occurred even in the absorption of that part of the radiation from the first scattering plate. Instead of this a discontinuity of the same magnitude (relative) occurred when the filtering sheets had a thickness 0·02 cm. which was the appropriate position for the discontinuity in the *radiation as a whole*. By "appropriate position" we mean the thickness of aluminium at which the beam as a whole reached the critical absorption coefficient characteristic of the absorber.

Thus two beams which, because of differing penetrating powers, exhibit the discontinuity at differing filtering thicknesses of aluminium, when superposed exhibit not two discontinuities at these thicknesses, but one discontinuity of double magnitude (*i.e.* unaltered relative magnitude) at a thickness between the two shown by its constituents. All this is perfectly consistent with our results from scores of experiments; the discontinuity occurs not at a certain wave-length but at a definite "absorption coefficient" for the whole beam—an absorption coefficient with which we are now perfectly familiar.

The phenomenon may perhaps be more clearly described as one dependent on something analogous to temperature of the X-radiation as a whole, though it is impossible as yet to see how far the analogy will take us. For "absorption coefficient" is more precisely the fractional rate of diminution of ionisation in air (or other gas) with the mass per unit area of aluminium traversed. This again is approximately the rate (fractional) of transfer of energy from the radiation to the matter through which it passes. (In the case of a fluid flowing with constant speed through a substance, this would be governed by temperature of the fluid.)

Indeed, all our experiments on the *J* phenomenon show detachment from mere wave-length and dependence on this absorption coefficient of radiation. The analogy goes further, however, for there is very strong evidence indeed that the *J* absorption discontinuities we have observed are of such a magnitude as just to compensate for a deficiency of absorption which under slightly different conditions takes place continuously. (Such discontinuities occur of course when a liquid is superheated or a vapour supersaturated: there takes place suddenly what would under favourable conditions have been a more gradual change of state.) Correspondingly, when the X-radiation is transmitted through matter, absorption does not take place at the rate which appears under slightly different conditions; but when the discontinuity does occur, the deficiency in absorption occurring previously appears quite suddenly. It is as though there were a sudden evaporation (or condensation) of the energy of radiation, when this is in an unstable state so far as its relation with the surrounding matter is concerned, the energy of the radiation being transferred to electrons in the matter traversed.

It ought not to be necessary to say that in the above experiment the whole process can be repeated in inverse order, any feature of it can be repeated, the discontinuities may be displaced,—in fact, the whole of the phenomenon is under perfect control. The magnitude of these discontinuities, too, is remarkably constant, a long series of experiments giving a drop of $(7{\cdot}7 \pm 0{\cdot}5)$ per cent. consistently. Again, we should emphasise that this experiment, though particularly controllable, accurate, and striking, only verifies what, in this laboratory, has been observed less directly in a hundred experiments. The conditions for this "coherence" and its limitations are at present being further studied.

We take this opportunity, too, of announcing that we are now able to show the three discontinuities J_1, J_2 and J_3 one after the other by progressive filtering of a selected X-radiation. Each is indicated by a drop of about 10 per cent. in the intensity of the radiation as usually measured. J_1 was first observed in a scattered radiation; J_2 in a characteristic radiation (*K* series); J_3 in a primary radiation. We now have them all exhibited in one radiation.

We shall describe elsewhere the application of the *J* phenomenon to scattered X-rays.

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Radio Transmission Round the Earth.

A THEORY which would explain the facts of long-distance radio transmission must take into account the differences between day and night transmission, long- and short-wave transmission, etc., and must connect these with a plausible assumption with regard to the constitution of the upper conducting or refracting layer, which is believed to function as the chief agency in bending the rays round the earth.

The effect on transmission of such a layer, which has been shown by many eminent scientific men to account in an adequate way for the *bending* of the rays