Letters to the Editor.

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Light Quanta and Photo-electric Emission.

I VENTURE to think that no theory has suffered so much from the application of an arbitrary selection principle to the consideration of experimental results as the quantum theory. The treatment of the whole subject, at least so far as it is concerned with X-ray phenomena—and in no branch of study is the acquaintance with the quantum rules and with their limitation so intimate—is based upon a very inadequate knowledge of facts. It could scarcely be otherwise when experimental acquaintance with the subject is so meagre. For the present I should like to mention only one point.

The 'light-quantum' theory receives its strongest support in the phenomenon of electron emission when radiation is absorbed. It is thought by some—apparently by many—that the "light-quantum" retains its individuality between the process of emission and that of absorption. May I then record an experimental fact bearing upon the subject?

The ionisation produced by a heterogeneous beam of X-rays in a gas or the electronic emission from a metal plate (measured by ionisation outside the plate) may be abruptly and enormously increased either by (*a*) superposing on that beam a very feeble radiation of slightly shorter wave-lengths, or (*b*) by taking away from the complex radiation a very small amount of the radiation of longer wave-lengths as by filtering; that is, either by adding higher frequency radiations to, or eliminating lower frequency radiations from the beam, the same effect is produced, namely, a sudden large increase in the ionisation. The magnitude of a sudden increase may be from 100 to 150 per cent. of the original magnitude. This is the *J* ionisation produced by the *J* photo-electric emission accompanying the *J* absorption. Where then are the discrete and independent quanta?

These experimental results again show quite definitely that this *J* electron emission is an effect of the radiation as a whole. The quality of the full stream of radiation decides whether or not this shall take place. It appears (though this is much less certain) that the absorption is an absorption of all the constituents.

Such results were obtained by Miss White and myself six or seven years ago, but were withheld from publication until they could be confirmed by many experiments such as we have recently recorded (and others at present being obtained by Miss Mair), showing that these form part of a consistent whole. If then a small-angled prism of aluminium—a wedge—is placed in the path of a heterogeneous beam of X-rays, there is transmitted a spectrum of radiations varying in *average* wave-length, capable of showing both *J* absorption lines and *J* absorption edges by the ionisation method, as do homogeneous radiations. The phenomenon is now being studied photographically.

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March 6.

Eka-cæsium and a Suggestion about Radiation and the Elements.[1]

IN endeavouring to confirm the identity of the X-ray line 1·032 on Film No. 3 (see NATURE, January 30, 1926, p. 153), which would seem to correspond with the $L\alpha_1$ line of eka-cæsium (87) of calculated wave-length 1·0276, I have had this film intensified and then remeasured by Messrs. Adam Hilger, Ltd. (see *Chemical News*, February 12, 1926, p. 101).

The result is that the lines which according to the original measurement were 1·434, 1·232, and 1·032 now measure 1·434, 1·234, and 1·029, thus confirming the first values obtained, as it must be remembered we are not able to determine the lines very accurately, there being a possible error of 0·005, as previously stated.

The strong line of mercury, $L\beta_1$ of wave-length 1·0458, seems, however, to be ruled out, unless something has happened to the film originally. I understand that films on development tend to shrink rather than to stretch. This would not satisfy the suspicion that the line attributed to element 87 is the mercury one in question. There seems to be no other alternative than that the line is 87 $L\alpha_1$. More work in this field is obviously necessary.

Unfortunately, the first experiment cannot be repeated with the present apparatus, as there is now very little of the original material prepared by Dr. J. G. F. Druce.

Glass photographic plates are now being used in order to ensure greater accuracy, especially in measurement.

The question whether such elements as 85 and 87 can exist without being appreciably radioactive has been considered. There are several well-known instances of comparatively stable and even non-radioactive elements having the same atomic number as those which are very unstable; and uranium, the last-known member of the general series, is far more stable than most of those elements of somewhat lower atomic number. Therefore there is no absolute criterion as a guide in this respect.

Potassium and rubidium are feebly radioactive, but, curiously enough, no products from their radio-change seem to accumulate—at least, not so far as I know. If these common elements are contaminated with those of atomic numbers 85 and 87, and if these are radioactive, then the problem would only be partly solved. There is, however, no evidence of this kind. Both elements are mentioned on account of some statements to follow here.

Those elements of high atomic number are unstable and they emit corpuscular radiation and electromagnetic radiation; that is, α-, β-, and γ-rays, with variations according to the radio-element considered.

Conversely, one might think of the elements at the other end of the general series as having absorbed such 'radiation' at one time in their history, and thereby growing into larger and larger atoms, as are now known. Blackett's well-known experiments on the disruption of the nitrogen atom by high-speed alpha particles, as previously accomplished by Rutherford, further reveal photographically, by using the C. T. R. Wilson ionisation cloud method, that when an H-particle (proton) is ejected from the nitrogen nucleus, the bombarding alpha particle, which caused the ejection, becomes absorbed in the nitrogen nucleus. Henderson's experiments indicate that capture and loss of electrons by alpha particles is also a process which comes under the general head of *mass absorption and mass radiation.*

[1] The word radiation in this title is here used more particularly in the sense of *corpuscular* or *mass* radiation.