LETTERS TO THE EDITOR

Prompt publication of brief reports of important discoveries in physics may be secured by addressing them to this department. Closing dates for this department are, for the first issue of the month, the twentieth of the preceding month; for the second issue, the fifth of the month. The Board of Editors does not hold itself responsible for the opinions expressed by the correspondents.

Recent Measurements of Upper-Atmospheric Ionization

This letter is in the nature of an addendum to Dr. E. O. Hulbert's communication in the issue of this journal for November 1, 1934.

(1) In his brief account of the historical sequence of the identification of the various ionospheric regions it would appear that Dr. Hulbert has confused the main Region F_2 and the subsidiary "shelf" Region F_1. The identification of Region F_2 as a separate stratum existing above the well-known Kennelly-Heaviside layer (Region E) was made in nocturnal experiments in 1926–7.[1] In such experiments we know that Region F_1, which is of day-time occurrence only, could not have been detected. Evidence of the day-time formation of this region and of the symmetrical trend of its electron content relative to noon was first published in 1933.[2]

Since the maximum electron density in Region F_2 is always much greater than that in Region F_1, we must seek an explanation of radio skipped distances, if an electron-limitation hypothesis is accepted, in terms of Region F_2 ionization and not in terms of Region F_1 ionization, as Dr. Hulbert proposes to do. Support for such a view is found in the fact that the skipped distance has the same type of diurnal trend (asymmetry with respect to noon) as the temporal ionization variation in Region F_2 would lead one to expect. It does not follow the symmetrical variation of Region F_1 ionization relative to noon.

(2) There is substantial evidence conflicting with Dr. Hulbert's theory that the effective electrical carriers in the Kennelly-Heaviside layer are of molecular (and not electronic) mass. Effects of double refraction (echo-doubling)[3] and differential absorption of the ordinary and extraordinary reflected wave components,[4] due to the influence of the earth's magnetic field, are found for Region E as for Region F, and it may be shown that these phenomena can only be expected to occur if the effective electric charges are associated with electronic mass.

(3) The interpretation of the diurnal and seasonal trends of the critical penetration frequency for Region F_2 presents considerable difficulties. One view, urged by Kirby, Berkner and Stuart,[5] is that the measurements made when the sun is high (e.g., at summer noon) are entirely vitiated by absorption and that the ionization maximum really is greater on a summer noon than on a winter noon although the critical frequency measured in summer is not greater than that measured in winter. An alternative theory, which I put forward at a meeting of the International Scientific Radio Union in London (September, 1934) at which a world survey of ionospheric results was discussed, is that the critical frequency measurements, even allowing for a certain amount of absorptive effect, really do indicate an abnormal depression of the value of maximum ionization when the sun is high and that the occurrence of this abnormality is due to the increased temperature (and thus lower ion-production) and consequent expansion (and thus reduced *maximum* ionization content) of the outermost layers of the atmosphere.

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[1] Appleton, Nature **120**, 330 (1927).
[2] Appleton, Nature **131**, 872 (1933) and Proc. Phys. Soc. **45**, 673 (1933); see also Schafer and Goodall, Nature **131**, 804 (1933).
[3] White, Proc. Phys. Soc. **46**, 91 (1934).
[4] Appleton and Ratcliffe, Proc. Roy. Soc. **A117**, 576 (1928).
[5] Kirby, Berkner and Stuart, Bur. Standards J. Research **12**, 16 (1934).

Natural Width of the $K\alpha$-Lines

The purpose of this note is to give a simple theoretical interpretation of some of the experiments dealing with the natural widths of x-ray lines. The results of Allison,[1] which exhibit an interesting variation of the widths of the $K\alpha$-doublet lines with atomic number, will be the main object of the present considerations; we hope to discuss quantitative refinements and extensions to other experimental situations in a later publication.

The widths of the $K\alpha$-lines arise almost entirely from the finite lifetimes of the energy states involved in the emission of the lines. Other effects, such as Doppler effects and perturbations due to the crystal potential, play a subordinate rôle. These lifetimes, in turn, are closely related to the probabilities of transition from the state whose lifetime is to be calculated, to energetically lower states. Under conditions[2] which are very nearly satisfied for a $K\alpha$-line, the energy width, ΔE, of such a line is the sum of the widths of two atomic states, that in which the K-electron is missing, and that in which the L-electron is removed from the atom. Subject to this interpretation, we write

$$\Delta E = \Delta E_K + \Delta E_L. \qquad (1)$$

We shall ignore the doublet structure of the lines in our present consideration.

When one K-electron is missing from the atom, the probability that an (n, l, m)-electron will fill the vacancy is given by

$$A_{K;\, n,\, l,\, m} = (64\pi^4/3)(e^2\nu^3/hc^3)\,|r_{K;\, n,\, l,\, m}|^2, \qquad (2)$$