based, show a maximum after being multiplied with x. Thereupon he bases a method of analysis, forming the "deformed curve" $x \cdot J(x)$ by multiplying the measured values J by the absorbing depth. In the case of a band structure of the radiation this curve includes various maxima and so may be decomposed into deformed elementary functions. By the relations above mentioned a totally new significance is given to this proceeding. This is seen at once by writing Eq. (3) in the form

$$\rho(x) = \mu^2 x J(x)/J_0. \tag{6}$$

This is exactly the deformed intensity curve. In the case of an exponential depth-ionization curve (or one representable by a sum of exponential functions) it is seen that the method of Lenz[4] signifies physically a decomposition into different range groups. In the depth-ionization curve—the part above 80 m—may be considered to be formed by two exponential functions. Thus the application of the Lenz-method means a decomposition into two range groups, the harder one we have treated above more rigorously.

With great pleasure I acknowledge my indebtedness to Professor Dr. E. L. da Fonseca Costa for his helpful advice.

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October 28, 1936.

[1] B. Gross, Zeits. f. Physik **92**, 755 (1934).
[2] F. Weischedel, Zeits. f. Physik **101**, 732 (1936).
[3] B. Gross, Zeits. f. Physik **83**, 217 (1933).
[4] E. Lenz, Zeits. f. Physik **83**, 193 (1933).

Direct Effects of Particular Solar Eruptions on Terrestrial Phenomena

In this journal previously, I[1] called attention to the occurrence of widespread sudden fadeouts of high frequency radio transmission, and suggested that study be undertaken to determine possible relations of the effect to solar, earth-current, terrestrial magnetic, and other phenomena. This led to effective cooperation in such study, which has been rewarded by the observation of simultaneous happenings on numerous occasions in each of the four fields named. The work has corroborated the hypothesis advanced in the 1935 article that a radio fadeout is due to a sudden solar emanation lasting only a few minutes.

In the two years from July 1934 to June 1936 there were 94 reported radio fadeouts; 39 of these are known to have been accompanied by a simultaneous visible eruption on the sun; 15 of them are known to have been accompanied by simultaneous fluctuations of terrestrial magnetic elements; and for 4 of them simultaneous fluctuations of earth currents have been reported. The fluctuations in terrestrial magnetism and earth currents are abrupt pulses of about the same duration as the radio fadeouts, not similar to the fluctuations characteristic of magnetic storms. In none of these fields has there been an opportunity to make a comprehensive study of world-wide data, and there is good reason to suppose that the number of coincidences has been greater than is known at this time.

The occurrence of visible effects in the causative solar eruptions is probably more or less fortuitous. The cause of the terrestrial phenomena is a sudden outburst of highly penetrating solar radiation of ultraviolet (i.e., ultra-visible) frequencies. This produces sudden ionization of the atmosphere below (or possibly in) the E-layer of the ionosphere, where the air density is great enough to insure numerous collisions of moving ions and hence rapid absorption of the radio wave energy during the few minutes it lasts. The degree of absorption is less for the higher radiofrequencies than for lower ones. The ionization density of the F_2-layer is not affected. With the sudden ionization below (or in) the E-layer, sudden changes occur in the currents flowing there, currents which are the cause of a certain part of the earth's magnetism. The changes in these currents directly cause the special magnetic fluctuations which are observed, and also inductively produce changes in earth currents.

The absorbing ionization and the radio fadeouts are produced on the illuminated side of the earth and do not occur on the dark side. They are most intense where the sun's radiation is perpendicular (i.e., around noon and at low latitudes). This distribution is also true of the terrestrial magnetic variations, and probably of the earth current and other phenomena if any. The effect is thus quite distinct from ordinary magnetically disturbed periods, sometimes called magnetic storms, whose effects are much more marked at high than low latitudes. Ordinary magnetic disturbances and the special effect here reported have no necessary connection with each other, except for a general tendency to occur more frequently when sunspots are more numerous. Ordinary magnetic disturbances occur simultaneously with lowered ionization density in the F_2-layer, as shown by my colleagues.[2] Thus magnetic storms and the special magnetic effects simultaneous with radio fadeouts are associated with different levels in the atmosphere. It is believed that certain rare observations reported in the past by astronomers, of magnetic pulses simultaneous with visible solar effects, such as the coincidence reported by Professor C. A. Young as occurring on August 3 and 5, 1872, were the special type of magnetic effect now found to be associated with radio fadeouts.

The radio fadeouts reached an extraordinary climax in May and June, 1936. In the three months, April to June, there were 54 reported fadeouts, more than the total number reported previously (in the two years the phenomenon has been known). Then in the following three months, July to September, there were only 16 fadeouts. Of the 54 fadeouts in April to June, 21 were accompanied by solar eruptions, and 10 were accompanied by the special magnetic effect. As there is reason to suppose that radio fadeouts (and the associated magnetic and other phenomena) are caused by one type of ultraviolet (i.e., ultra-visible) solar radiation, and that ordinary magnetic disturbances, auroras, etc., are caused by a solar emanation of different character, these phenomena present powerful means of keeping track of two different and very interesting types of events on and in the sun. They deal with emanations which are not only invisible but probably do not reach the earth's surface at all.

J. H. Dellinger

National Bureau of Standards,
November 24, 1936.

[1] Dellinger, Phys. Rev. **48**, 705 (1935).
[2] Kirby, Gilliland, Judson, Smith, Reymer, Phys. Rev. **48**, 849 (1935) and **50**, 258 (1936).