In Table I are listed the results of our various measurements. The column marked I_C represents the ionization in air at atmospheric pressure expressed in ions per cc per second due to the cosmic rays traversing our 7.5 cm filter. I_L represents the ionization due to the local rays passing through this filter expressed in the same units. Measurements 1 to 4 were made with different apparatus, using compressed air instead of compressed argon in the chamber, and lead and copper shields of different shape. These results are thus not strictly comparable with the later ones, though the difference is probably not more than 2 percent.

In Fig. 1 these results are shown graphically, and are compared with those of Millikan and his collaborators (Phys. Rev. **37**, 235 1931) as shown in the dotted line. It will be noted that for corresponding barometric pressures our measurements show consistently more intense radiation at the higher latitudes. The high altitude measurements in Hawaii are of especial interest as indicating that the difference with latitude is greater for the less penetrating rays.

Millikan's measurements were made at latitudes varying from 34°N to 59°N, most of them being at about 40°N. Our measurements near this latitude are in satisfactory agreement with his considering the slight differences in experimental arrangement. We do not however confirm the independence of the intensity of latitude which he reports.

The variation of the cosmic rays with atitude which these measurements show is of ust the kind to be expected if the rays consist of electrically charged particles which are deflected by the earth's magnetic field, the less penetrating rays being the more strongly affected.

This letter is the first report of an extensive program involving similar measurements by many physicists in widely distributed parts of the world. The design and construction of the instruments are due chiefly to Professor R. D. Bennett of Massachusetts Institute of Technology, with L. N. Ridenour, Dr. J. A. Hopfield and Dr. E. O. Wollan. Professor J. C. Stearns of the University of Denver with J. A. Longman, L. N. Ridenour and W. Overbeck made the measurements at Denver and Mt. Evans. Dr. Marcel Schein and Dr. Bernhard Frey of the University of Zürich cooperated in the measurements at the Jungfraujoch. Professor Harry Kirkpatrick of the University of Hawaii made the local arrangements in Hawaii, and with Professor W. H. Eller and Mr. I. Miyake assisted in the measurements. In New Zealand, Professor P. W. Burbidge of Auckland University College organized the various expeditions, and with Dr. C. M. Focken of the University of Otago helped with the observations. Valuable assistance has also been given by A. A. Compton and others. Without the cordial cooperation of the various universities where the work has taken us, the measurements would have been much more difficult.

Arthur H. Compton

University of Chicago,
The Tasman Sea,
May 7, 1932.

On the Production of Ultra-Short Electromagnetic Waves

In a note published in this journal, Mr. G. Potapenko gave an account of his interesting investigations in the field of the ultra-short electromagnetic waves.

The tubes that the author used in his experiments had pure tungsten filaments, as it was impossible to observe ultra-short waves with tubes having other kinds of filaments.[1]

As a result of some experiments I carried out recently, I found that, under particular conditions, oscillations of very high frequency may be obtained by using tubes with a heater element and a cathode coated with oxides.

Different tubes have been tested, namely, tubes of the type: −27 R.C.A. (American); E. 424 Philips (Dutch); R.E.N.S. 1104 Telefunken (German).

Although the common Barkhausen-Kurz arrangement may be used, that of Tank and Schiltneck[2] was found to be more suitable, the only modification being to connect the cathode to the negative terminal of the filament. The heating current must have a value which is only 80 percent−90 percent of its normal rated value.

Although unnecessary if the latter experimental arrangement is used, a slight positive

[1] Phys. Rev. **39**, 630 (1932).

[2] Helv. Phys. Acta. **1**, 100 (1928).

plate potential (0.5 to 2 volts) increases the amplitude of oscillations. Under these conditions a plate current is present even when the tube is not oscillating; this current being obviously increased when oscillations set up. This increase of current may vary (in accordance with the particular tube, etc.) between 10 and 200 microamperes. As the grid potential runs between 20 and 100 volts, a band of wave-lengths between 180 and 50 cm can be obtained.

AMEDEO GIACOMINI

Istituto di Fisica della Regia Università,
Milano, Italy,
June 1, 1932.

Predissociation in Nitrogen

Predissociation in nitrogen is best illustrated by the first positive bands $B_{13}\rightarrow A_9$, $B_{14}\rightarrow A_{10}$, $B_{15}\rightarrow A_{11}$ and by the bands $B_{13}\rightarrow A_8$, $B_{14}\rightarrow A_9$ and $B_{15}\rightarrow A_{10}$.[1] On small dispersion spectograms most of the bands of the first positive group possess three fairly strong heads, which correspond to transitions from the three components of the $^3\pi$ initial state of these bands to the $^3\Sigma$ state. In the above-mentioned bands however, two of the heads are almost completely missing. About a year ago, I reported the excitation of these missing heads in mixtures of nitrogen and oxygen,[2] in which the concentration of nitrogen was relatively small compared with that of the oxygen. At that time, the explanation of this effect was proposed to be the prevention of the normally occurring predissociation by electric fields, which were introduced during collisions. There is an obvious alternative explanation in which electric fields play no direct role, namely, the effect of increasing the number of molecules in the normally predissociating levels by collisions which give rise to transition from the non-predissociating component of the $^3\pi$ state to the two predissociating ones. The energy differences between the components of the $^3\pi$ state are very small and such transfers should take place without difficulty. The effect of pressure on predissociation has been discussed for AlH by Stenvinkel[3] and others, and this effect in nitrogen is in some respects, similar to the one in AlH. There is a difference, however, for in nitrogen the collision transfers are between components of an electronic state, whereas in AlH they are between rotational levels.

The occurrence of this effect in nitrogen suggests a similar explanation for the enhancement of predissociation in iodine by argon.[4] Mulliken's assignments of $^3\pi_0{}^+$ to the upper state of the visible halogen bands, makes this state a triplet state and hence provides the two other components, $^3\pi_1$ and $^3\pi_2$, which are necessary in order that the iodine problem be similar to the one in N_2. In iodine, the two levels $^3\pi_1$ and $^3\pi_2$ may themselves be unstable or they may combine with a third unstable level as in nitrogen.

Before the appearance of Van Vleck's[5] paper on the theory of the magnetic quenching of iodine fluorescence, I had proposed to myself the problem of studying the effect of magnetic fields on the predissociation in nitrogen, in order to observe the effect of magnetic fields on collisions. It was thought at the time that the magnetic field might be able to enhance collision transitions from the non-predissociating $^3\pi$ state to the two predissociating ones, and thus be able to quench the fluorescence. I am not aware of any theoretical reason for believing that this explanation has any value, but in view of the effect of collisions on predissociation both in iodine and in nitrogen, it seems worth while to suggest that the effect of magnetic fields on collisions may be of some significance.

JOSEPH KAPLAN

University of California
at Los Angeles,
June 3, 1932.

[1] J. Kaplan, Phys. Rev. **38**, 373 (1931).
[2] J. Kaplan, Phys. Rev. **38**, 1079 (1931).
[3] Stenvinkel, Zeits. f. Physik. **62**, 201 (1930).
[4] Turner, Phys. Rev. **38**, 574 (1931).
[5] Van Vleck, Phys. Rev. **40**, 544 (1932).