burning the lamp at a higher voltage or by increasing the pressure of the mercury vapor in the lamp by external heating.

When the temperature of the mercury is increased, the mercury vapor absorption bands appear. The band at 2540A, first described by R. W. Wood (Astrophys. J., vol. 26), is approximately 0.1A wide at a mercury temperature of 220°C (corresponding to a vapor pressure of 32 mm), and spreads toward longer wave-lengths until it reaches about 2576A at 407°C and 2652A at 426°C, (corresponding to a vapor pressure of 2316 mm). Wood found that this band did not extend beyond the resonance line on the short wave side. Our work with this arc, however, shows the resonance line disappearing at approximately 350°C and two narrow absorption bands appearing at approximately 2534A and 2532A. With further increase in the temperature of the mercury these bands merge with the 2540 band until at 426°C there is continuous absorption between 2530A and 2652A, with evidence of further absorption beyond 2652A.

The five fluted bands around 2345A appear between 320°C and 340°C and broaden as the temperature is increased until they extend over a range of about 16A at 420°C. The broadest of the bands is about 3A wide. The increased pressure also affects certain lines in the region between 3500A and 2100A, some of the lines disappearing entirely at the higher temperatures.

Mercury in a separate quartz absorption cell shows a somewhat different absorption spectrum. The band at 2540A spreads toward the long wave-lengths as the vapor pressure increases until at a temperature of 456°C there is strong absorption of the radiation to 2652A and partial absorption to 2850A, and at 492°C (corresponding to a vapor pressure of 5420 mm) there is strong absorption to 2753A. The band does not extend beyond the resonance line on the short wave side. The fluted bands at 2345A appear at about 340°C and spread to either side until at 460°C the line at 2345A disappears and at 517° (corresponding to a vapor pressure of 7430 mm) the absorption between 2301A and 2350A appears to be continuous.

Further investigation of the absorption bands of both the excited and the unexcited mercury vapor is being made.

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Experimental Evidence for the Existence of Quadrupole Radiation

Rubinowicz (Zeits. f. Physik **53,** 267 (1929)) has shown that spectral lines which violate the transition rule for l or j cannot be explained as dipole radiation, but must be attributed to multipole radiation.

Besides the nebular lines identified by Bowen, the best known line of this type is the green auroral line 5577A. According to McLennan the auroral line is the forbidden combination between the low metastable O I terms $^1S_0$ and $^1D_2$. (The values of these terms have been accurately determined as $^1S_0=76037$ and $^1D_2=93962$ by one of the authors (F.) and will appear shortly in the Phys. Rev.)

Assuming that the auroral line is quadrupole radiation, Rubinowicz (Zeits. f. Physik **61,** 338 (1930)) pointed out that not only those Zeeman components may be observed which correspond to the usual transition $\Delta m=\pm 1$, 0, but also components which correspond to the transitions $\Delta m=\pm 2$. The latter have zero intensity when viewed longitudinally and were therefore not observed by McLennan and Sommer. According to Rubinowicz all of the above transitions show the same intensity when viewed perpendicularly to the field, with the exception of $\Delta m=0$, which can only be observed at oblique angles with the field. Measurements of the transversal Zeeman effect thus make possible an experimental test for the existence of quadrupole radiation.

We have photographed the transversal Zeeman effect of the auroral line. The magnetic field was produced by a large solenoid previously constructed and calibrated by one of us (C.) for a precision determination of e/m by the Zeeman effect. With this solenoid it is possible to maintain a field of 7000 gauss continuously. The auroral line was produced by a d.c. discharge of 0.6 amperes through a mixture of argon and oxygen in a tube 30 mm in diameter. The tube

was silvered over the central portion to increase the intensity by multiple reflection. The light leaving the tube transversally through a slit in the silvering was reflected out of the solenoid by a 45° prism. The Zeeman pattern was photographed with a Fabry-Perot interferometer crossed with a prism spectrograph. By placing a thin calcite plate with proper orientation behind the spectrograph slit, each spectral line appeared separated into its π and σ components.

At a field of 2580 gauss and an interferometer separation of 0.6159 cm, the auroral line was resolved into four components. The displacement of the inner components was $0.92\Delta\nu_{\text{norm}}$, that of the outer components was $1.96\Delta\nu_{\text{norm}}$. The theoretical factors are 1 and 2, respectively. As was predicted the undisplaced line did not appear. We found that the outer components were polarized perpendicular to the field, and that the components displaced by $\Delta\nu_{\text{norm}}$, which in the normal effect are polarized perpendicular to the field, are in this case polarized parallel. This is in complete agreement with the theory of Rubinowicz.

We intend to investigate the Zeeman effect of other forbidden lines.

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Mobility of Na^+ Ions in H_2

The results of studies of mobilities of ions in mixtures showing the great importance of traces of impurities on mobilities,[1] the studies of Erikson[2] on the change of mobilities of positive ions with age at atmospheric pressures including the effects of impurities, and the prominence recently given the change of charge of initially ionized atoms and molecules in gases reported by Kallman and Rosen,[3] indicating as previously emphasized the total ignorance as to the nature of the ionized carrier,[4,1] led to the present investigations the first results of which it is desired to report at this time.

It seemed essential by as nearly an absolute a method as possible to measure the mobilities of a type of initially ionized carrier which would only reluctantly alter its charge in gases of reasonable purity over very short time intervals. To this end it was attempted to measure the mobilities of positive Na^+ ions from a Kunsman[5] source, using a high frequency square wave form oscillator in fairly pure gases at low pressures. From the nature of the Kunsman sources the gas chosen was hydrogen purified by a process previously used by the writer.* A Kunsman source of positive ions with a square wave form oscillator, using the original Rutherford A.C. method with positive ions instead of negative ions, should: (1) give absolute values of the mobilities with no disturbing effects of gauzes as encountered in other A.C. methods,[6] and with ions definitely emerging from one plane of the parallel plate electrode system; (2) give ions which retain their positive charge in H_2 because of their low ionization potential; and (3) be capable of extension to very short time intervals. The chamber used was a brass one of a type previously described[7] with electrodes altered to suit the Kunsman source. The source was a coating of Na catalyst, kindly sent the writer by Dr. Kunsman, on a thin Pt foil, spot welded onto a small oven of Ni containing a Pt spiral heating element insulated from it by "Insolute" cement. In practice it was heated to about 700°C and gave a copious supply of + ions. It was mounted in the center of the upper plate of a parallel plate condenser in the gas, the lower plate going to ground through an electrometer system. The plate distance was 1.2 cm. By means of an oscillator first designed by J. L. Bowman,[8] built here by Mr. J. E. McVay and adapted by the writer, good square wave form alternating potentials of from 10 to 150 volts with frequencies varying from 500 to 25,000 cycles per second have been achieved. It is probable that the upper frequency limit can be considerably extended. The first results covered a range of pressures from 0.5 to 7 cm of Hg and appeared of sufficient importance to report at this time, as the work will be interrupted for the period of a month or two by external demands on the writer.

Mobilities in H_2 were observed, beginning

* The H_2 was passed over hot Cu, NaOH, $CaCl_2$, two meter long tubes of P_2O_5 and a special double liquid air trap immersed in liquid air.