Letters to the Editor.

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Luminescence from Solid Nitrogen, and the Auroral Spectrum.

IN NATURE of September 18 and 25, McLennan and his collaborators have published statements regarding the origin of the auroral spectrum which call for some remarks. Dealing with the N_2-band from solid nitrogen, they confirm the result which I published in June 1925, showing that N_2 consists of a number of components. Applying this to the auroral problem they say (p. 409) :

" Since no band of anything like this character has ever been shown to be a feature of the spectrum of the aurora, in the neighbourhood of λ 5230, it would appear that Vegard's theory that finely divided solid nitrogen exists in that portion of the upper atmosphere where auroral displays originate is not tenable."

Now according to my experiments the structure of the N_2 band varies considerably with experimental conditions, and we cannot yet tell which structure corresponds to the conditions which, according to my view, exist in the auroral region. But even if we had experimented under comparable conditions, we cannot make any comparison with the auroral spectrum for the simple reason that we do not know anything about the structure of the auroral line (or group of lines) at λ 5230 Å.U. This line has never been obtained on spectrograms, although I have tried with spectrographs of small dispersion and very high illuminating power, but has merely been observed with spectroscopes of small dispersion and by using a broad slit. *Under these conditions also the N_2 band would appear as a line.*

Thus our present knowledge of the auroral line 5230, as well as the present state of the experimental conditions for obtaining N_2, do not enable us to compare the structure of N_2 with that of the auroral line 5230.

The identification of the auroral line with an oxygen line observed by McLennan under certain special conditions seems to be in contradiction to observed facts. Thus :

(1) The line is a spark line, while the auroral spectrum from blue to ultraviolet is a nitrogen *band* spectrum.

(2) The density required to obtain the line is 10,000-100,000 times greater than that present in the auroral region.

(3) The excess of inert gases necessary to enhance the line does not exist in the auroral region.

(4) No other oxygen lines, or lines of the inert gases, are observed in the auroral spectrum.

(5) If light gases are dominant in the upper atmosphere, nitrogen must also dominate greatly over oxygen ; and at altitudes of 500-600 km. the amount of oxygen should be negligible. All the experimental evidence we have at present shows that all oxygen lines are greatly suppressed by the presence of nitrogen.

(6) McLennan obtains approximate coincidence of wave-length of a single line, but fails to interpret the whole type of spectrum shown by the aurora, *and his interpretations would involve a spectrum quite different from that of auroræ.*

On the other hand, my continued experiments with solid nitrogen have shown that solid nitrogen gives

the whole typical auroral spectrum from red to ultra-violet. Regarding the auroral line 5577, I have been able to show that the band N_1—in accordance with the consequences of my theory—is contracted and displaced when the nitrogen particles are diminished. A neon layer is found to have no specific influence on N_1, and if the nitrogen particles are diffused into neon, the N_1 band by diminution of the nitrogen concentration approaches a position which within the limit of experimental error coincides with the auroral line. For small concentration (c) the position is given by the following expression determined by the method of least squares :

$$\lambda = 5577 \cdot 56 - 0 \cdot 8754c.$$

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    October 29.

Properties of High Frequency Radiations.

IT is impossible to state accurately the properties of high frequency radiation (wave-length $<$0·02 Å.U.), for we have no exact knowledge of the variation, with wave-length, of the intensity and distribution of scattered radiation. We have good reason for believing that the intensity of the radiation scattered by an atom is, on an average, proportional to its atomic number, and that the distribution becomes more and more asymmetrical as the frequency increases. I have found that a formula of Dirac's (*Roy. Soc. Proc.*, A, **3**, p. 405, 1926) fits some of the results obtained by Mr. H. M. Cave and myself in a series of experiments on the γ-rays of radium better than any other so far put forward. It may be stated that the best way to test this formula will be to examine the distribution of scattered radiation.

Owing to scattering, there is a tendency for γ-rays to become less penetrating as they pass through matter (see Gray, *Phil. Mag.*, **26**, p. 611, 1913, and Oba, *Phil. Mag.*, p. 601, 1914). This is shown by the following experiment. γ-rays from radium, initially filtered through 2·2 cm. of lead, passed through a conical hole in a lead block, the hole having an average diameter of 1·9 cm. and a length of 20 cm. These rays were examined by absorption plates of brass and lead. An electroscope was placed one inch above the lead block. From the readings, what may be called the apparent mass absorption coefficient μ'/ρ (to distinguish it from the true coefficient μ/ρ) could be obtained. μ'/ρ was not constant but, owing to scattered rays having a greater wave-length, increased in 2·28 cm. of brass from 0·0208 to 0·0287, and in 2·06 cm. of lead from 0·034 to 0·041. The true coefficients were (μ/ρ) brass = 0·0470 and (μ/ρ) lead = 0·0560; μ'/ρ is greater for lead, mainly because of the greater fluorescent absorption. As the thickness of absorbing material is increased, in each substance a state will be reached after which (μ'/ρ) will have a constant value which will be about 0·037 for brass and 0·043 for lead. If the rays for which (μ'/ρ) brass = 0·037 were examined by lead 4·8 cm. thick and water of corresponding thickness, it would be found that the respective values of μ'/ρ were about 0·046 and 0·040. These values have been obtained by rough calculations from known data. It will be seen that there is not a great deal of difference between the absorption in brass, lead, and water.

The most penetrating γ-rays we could use were obtained by filtration through lead plates placed at appropriate distances in the conical hole. For these rays (μ/ρ) copper was equal to 0·0443 and (μ/ρ) lead 0·0472, so it is not possible to obtain much further information in this way about the effect of scattering on apparent absorption coefficients. It seems certain, however,