Letters to the Editor.

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Luminescence of Solid Nitrogen and the Auroral Spectrum.

IN a paper recently published in Proc. Roy. Soc. A. 106, p. 138, Prof. McLennan and Dr. Shrum give results showing that they have been able to produce the same luminescence effect in solid nitrogen which I discovered in January last and foretold in my earlier papers on the auroral spectrum. In their discussion of the results, however, they come to the conclusion that this effect is not applicable to the auroral spectrum.

In order to meet the argument put forward it would indeed be sufficient to refer to my previous publications,[1] from which it appears that the conclusions drawn by McLennan and Shrum are contrary to observed facts; but as their paper might give the impression that they had found new facts which disproves my interpretation of the auroral spectrum, and as their paper also, in my view, contains some other errors, a few comments upon it seem to be necessary.

First of all, it should be made clear that our difference of opinion does not originate from a difference with regard to experimental facts. As already mentioned in my previous papers, the luminescence of solid nitrogen shows two bands in the green, called N_1 and N_2. While N_2 has the appearance of a single diffuse line, N_1 has the form of a band showing three maxima, one strong ($\lambda = 5555$) and two weak ($\lambda\lambda = 5611$, 5649). McLennan and Shrum find the same two bands and with the same structure. For the three maxima of N_1 they give the wave-lengths 5556, 5617, 5654, in good agreement of my own values. The band N_1 extends on both sides of the auroral line (5577); but this line does not coincide with any of the maxima of the band N_1.

Now McLennan and Shrum *regard the three maxima of the band N_1 as ordinary spectral lines with a definite wave-length*, and, as the auroral line does not coincide with any of them, they regard it as proved that the band N_1 has nothing to do with the auroral line. The matter, however, is not so simple, and these two investigators do not seem to have realised that we are dealing with a light effect of a peculiar type. Their conclusion, which usually would hold for spectral lines originating from a gaseous source, is not valid for the light effect in question, which is emitted from matter in the solid state.

As a matter of fact, I have been able to show that this light effect is attached to some special crystal structure of nitrogen and that *the maxima of the band N_1 have no definite positions, and hence they cannot, as is done by McLennan and Shrum, be treated as ordinary spectral lines*.

My view is that the band N_1 is a manifestation of the same effect as that which is responsible for the auroral line, which is to be regarded as the limiting aspect of this band when the particles are reduced to molecular order of magnitude. The correctness of this view is strongly supported by the results of my experiments with mixtures of nitrogen and argon.

So long as we are unable to reproduce the conditions of the upper atmosphere, we cannot apply to the band N_1 the ordinary spectroscopic method of identification by means of exact wave-length measurements. It is possible, however, to test the correctness of my view by taking into account the whole auroral spectrum and by drawing evidence from the various cosmic phenomena connected with the upper atmosphere, and—as will be seen from my papers—my conviction of the correctness of my interpretation of the auroral spectrum is gained in this way.

In dealing with the auroral spectrum we must, above all, take into account the type and the intensity distribution of the lines. The error which we find in so many earlier attempts at interpretation is that due attention has not been paid to the *spectrum as a whole*. In spectral tables a number of lines were found, which, within the limits of possible errors, coincided with auroral lines, regardless of the question as to whether the lines so picked out formed a connected physical system and could exist as a light effect from one single source. We should not only consider the lines which actually appear in the auroral spectrum, but also regard those, often equally important, which *are not present*. Now solid nitrogen bombarded with cathode rays constitutes a simple physical system which just gives the most singular type of spectrum which is found for the auroræ, and also explains the predominance of the auroral line. McLennan and Shrum suggest that the experiments show that N_2 ought to come out stronger in the auroral spectrum than it actually does. This, however, is not so, for, as my experiments show, N_1 may be made to dominate the whole spectrum, and, under the conditions existing in the upper atmosphere, we should from my experiments expect the auroral line 5577 to be quite predominant as compared with 5230.

McLennan and Shrum are also mistaken in regard to their interpretation of the luminescence from solid argon. Thus their statement that they have found a phosphorescence with an afterglow in pure argon is not in accordance with my experiments. The green afterglow usually observed was shown to be due to minute traces of nitrogen, and the phosphorescence line was identical with N_2. Further, they regard the strong diffuse line 5607 as an argon line; but this line is no doubt the same as 5604 of my experiments, and this line was shown to be the N_1 band of nitrogen in a somewhat different position and in a transformed state. The correctness of my view was evident from the analysis of the light effect from mixtures of argon and nitrogen of varying concentrations.

Also the view taken by McLennan and Shrum with regard to the physical conditions for producing the N_1 band is contrary to my observations, details of which will be found in my papers.

In conclusion, it is perhaps worth while to suggest that differences between McLennan and Shrum's observations and my own may be partly due to the fact that their experimental material was very limited, and that their arrangements made it difficult to overlook the experimental conditions and to vary them in a known way. Instead of bombarding a layer of solidified gas with a well-defined bundle of electric rays—as was done in my experiments—they have formed the layer on the walls of the discharge tube itself, which was wholly surrounded with the cooling liquid.

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October 15.

[1] Proc. Roy. Akad. Amsterdam, 27 *C.R.* 178, p. 1153; 179, p. 35, and p. 157. NATURE, vol. 113, No. 2846, p. 716, and vol. 114, No. 2862, p. 357.