Physics. — "*On the light emitted by gases in the solid state and the spectrum of the northern light*". By L. VEGARD, H. KAMERLINGH ONNES and W. H. KEESOM. (Communication from the physical laboratory at Leyden) [1]).

(Communicated at the meeting of March 28, 1925).

This paper contains the results we obtained in the Leyden laboratory in cooperation with Mr. I. BERGE, and which form a continuation of the researches described by one of us in preceding communications [2]) on the light emitted by gases in the solid state.

After a series of investigations made at the temperature of liquid hydrogen, we observed the luminescence of different gases and gaseous mixtures at the temperature of liquid helium. We shall describe here especially the investigations on the light emitted when solid nitrogen and mixtures of nitrogen and neon at the temperature of *liquid helium* are bombarded by swift cathode rays.

From the light emitted by pure nitrogen at the temperature of liquid helium we obtained several spectra of high dispersion, which show, that the band N_1 doubtlessly has the same structure and place as at the temperature of liquid hydrogen. In this case there is a principal maximum (5555) with two secundary maxima. This result is in correspondance with former observations made with liquid hydrogen under reduced pressure and shows that the *band N_1 does not become narrower at lower temperatures*. The band N_2 is strong, but is split up now into two components (5236, 5222).

Besides the bands N_1 and N_2 a *regular series of bands* is most prominent in this spectrum. Each band consists of a double line and a diffuse edge towards the red. In this respect they are different from the bands emitted by gaseous nitrogen. With the glass spectrograph used we obtained 7 bands on the plate, but doubtlessly these extend into the ultraviolet region.

The wavelengths are the following:

	1°.	2°.	3°.	4°.	5°.	6°.	7°.
strong	5770	5490	5116	4784	4490	4223	3986
weak		5502	5127	4795	4499	4231	3994.

[1]) A more detailed description will appear in one of the next "Communications" from the physical laboratory at Leyden.

[2]) L. VEGARD. These Proceedings **27**, p. 113. Comm. from the phys. lab. at Leyden N⁰. 168*d*, C. R. t. 176 p. 974, t. 176 p. 1488, 1923, t. 178 p. 1153, t. 179 p. 35, t. 179 p. 151, 1924.

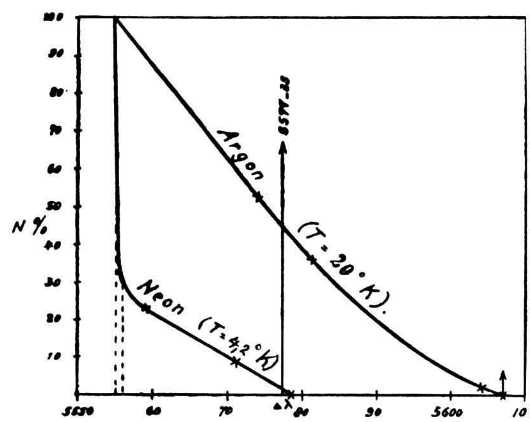
Undoubtedly we have here a state of development of the same bands that have already been observed at the temperature of liquid hydrogen and which became very strong with canal rays [1]). At lower temperatures these bands, which at higher temperatures are very broad and diffuse, are contracted to narrow lines with a diffuse edge towards the read.

In argon containing traces of nitrogen and at the temperature of liquid hydrogen the bands are also contracted into two lines, but these lines have another position. The two strongest bands, corresponding to the fifth and the sixth band of the table, have the wavelengths: (4523, 4473) and (4231, 4211).

In a former communication one of us has remarked [2]), that doubtlessly these two bands correspond with the bands observed by Lord RAYLEIGH in the diffuse light of the night sky, but as long as the wavelengths of the bands of Lord RAYLEIGH have not been determined more accurately we cannot say to which form of contraction they belong.

At the same temperature of liquid helium, nitrogen emits also three or four weak lines in the region of the great wavelengths viz. (5914, 5952, 6399) (6417?), which probably correspond to weak lines of the northern light spectrum.

The *experiments with solid neon* containing nitrogen in different proportions have shown that the band N_1 changes in a way similar to that found earlier for mixtures of nitrogen and argon [3]).



A decrease of the concentration of the nitrogen brings the principal maximum to move towards greater wavelenghts, while the secundary maxima finally disappear. This behaviour of nitrogen-neon mixtures is similar to that of nitrogen-argon-mixtures, but as regards the magnitude of the displacement and the law it follows, the two kinds of mixtures show a very interesting and typical difference, which is illustrated by the figure. Here the wavelength of the principal maximum has been plotted as a function of the nitrogen concentration for the two mixtures. The shift of the principal maximum is caused by a specific action of the admixed gas on one side and by a decrease of the dimensions of the nitrogen particles on the other side.

For the argon mixtures at the temperature of liquid hydrogen the two

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[1]) L. VEGARD. C.R. 179 p. 36.

[2]) loc. cit.

[3]) loc. cit.

influences are of the same order of magnitude. The specific action of the argon is evident from the fact that small argon concentrations cause a considerable shift of the principal maximum even when they cannot exert perceptible influence on the magnitude of the nitrogen particles.

For the nitrogen-neon-mixtures however the specific influence of the inert gas is very small. For neon concentrations varying from 0 % up to 70 % the position of the principal maximum remains nearly constant.

At this concentration the maximum begins to move quickly on account of the diminution of the nitrogen particles.

In correspondance with the interpretation of the northern light spectrum formerly published by one of us, we see that when the nitrogen concentration approaches zero, the band N_1 *changes into a line with wavelength 5578.6 which nearly coincides with the green line of the northern light. According to this interpretation, this small difference* $\triangle \lambda = 1.2$ Å *should be accounted for by the specific influence of the neon.*

In neon containing traces of nitrogen the band N_2 is split up into three components (5229—5220—5203) the first of which is the stronger one.

At increasing concentration of the nitrogen, the band N_2 changes into a double line. Moreover the spectrum shows a number of lines perhaps belonging to the neon spectrum.