objects appears to find its explanation in these experiments. More interesting for the physics of the upper atmosphere is the conclusion from these results that the Vegard-Kaplan bands, the 3471 line, and possibly other radiations in the light of the night sky, are emitted in the lower rather than in the higher regions of the upper atmosphere, perhaps so low as 50 km. This conclusion is based on the presence in the light of the night sky of a strong line at 3471 and of the Vegard-Kaplan bands. In fact, the spectrum reproduced here is an excellent reproduction of the light of the night sky.

The tube from which this plate was photographed is now rapidly approaching a pure nitrogen stage. The next two or three photographs should give us valuable information regarding the relationship between this line and the Vegard-Kaplan bands, as well as further proof that the line is characteristic of pure nitrogen.

JOSEPH KAPLAN.

Departments of Astronomy and Physics,
University of California at Los Angeles.
May 16.

[1] Kaplan, NATURE, 141, 645 (1938).

## Possible Presence of Metastable Atoms of Nitrogen ($^2P$) in the High Atmosphere

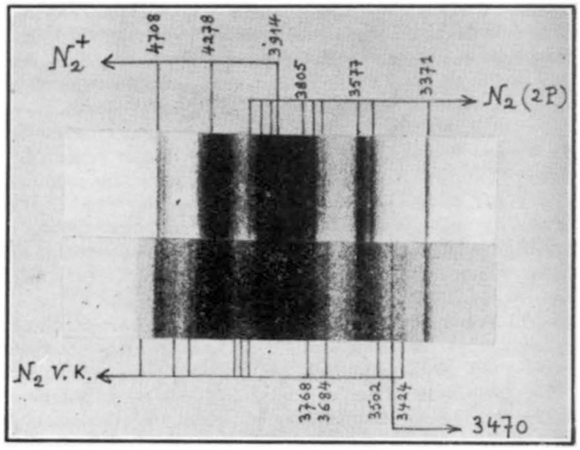
DURING a stay at the Tromsø Observatory, I studied systematically the spectrum of different forms of auroras (arcs, draperies, clouds, corona, etc.). One hundred spectrograms were thus obtained in the autumn of 1937. The analysis of these data is now being carried out, but some important facts are already apparent.

The spectrum of the bright region of an intense aurora (arc, draperies, corona) always offers the same general aspect. Outside the red and green lines of O I, the bands of the three systems of nitrogen, $N_2^+$, $N_2(1P)$ and $N_2(2P)$ only are observed (see upper spectrum, photographed on a Guilleminot Superfulgur plate having no sensitivity in the green). A very great over-exposure discloses practically no new radiation. The luminescence can be reproduced by submitting nitrogen to an electronic bombardment with a proper accelerating potential[1].

Some diffuse auroras behave in a completely different way. If the exposure is sufficient, their spectrum contains, with the lines and bands previously mentioned, a relatively great number of other radiations, generally weak and difficult to identify. However, these radiations may show so large an increase in intensity that their study becomes easy. It may be ascertained that they are the nitrogen bands $A \rightarrow X$, known as Vegard-Kaplan bands. The heads located at 3424, 3502, 3684, 3768, 4045, 4073, 4171, 4425 and 4535 A. are particularly distinct; these bands are plainly degraded toward the longer wavelengths (see lower spectrum).

With the Vegard-Kaplan bands, and evolving in the same way, an intense and sharp line always appears near 3470 A. (3470·3 A., according to the best measurements). Its appearance is such that it is easily distinguished from the neighbouring bands, and that any trial of identification with the 3469 $N_2(2P)$ band is impossible. As no other plausible interpretation comes to the mind, it seems reasonable to admit the presence of the atomic nitrogen line $^2P \rightarrow {}^4S$, the computed position of which is also 3470 A. This attribution is in perfect agreement with the recent observation by Prof. Kaplan[2] of a high-pressure afterglow in nitrogen, giving near 3470 A. a strong line associated with the Vegard-Kaplan bands.

As Prof. Kaplan suggests, the radiation reported at 3471 A. in the night sky light (Dufay, Gauzit) is perhaps also the nitrogen line $^2P \rightarrow {}^4S$. But the spectrum of the sky is so complex that it is difficult to give weight to this attribution. On the contrary, the simultaneous presence of the 3470 line and of the Vegard-Kaplan bands in the aurora and in the afterglow, with a similar evolution, seems to prove that the radiations emitted in both cases have the same origin. The fact is obvious for the Vegard-Kaplan bands; it is highly probable for the 3470 line. If we consider that active nitrogen is doubtless a mixture of metastable nitrogen molecules and atoms, the attribution of the 3470 line to the transition $^2P \rightarrow {}^4S$ becomes quite normal.




SPECTRA OF BRIGHT AURORA (*above*), DIFFUSE AURORA (*below*).

The presence of nitrogen atoms ($^2P$) in the auroral region must then be taken into consideration, and we may expect to find also the lines corresponding to the transitions $^2P \rightarrow {}^2D$ ($\lambda = 10{,}400$ A.) and $^2D \rightarrow {}^4S$ ($\lambda = 5206$ A.). The first one occurs in a part of the spectrum which has not yet been explored. The other, which is much less probable, was not recognized in the aurora or the light of the night sky. A more complete and thorough analysis of the two spectra and, above all, the study of the 3470 line by the interference method, should give the definitive solution of the problem.

The actual state of our knowledge, however, permits us to conclude that, in the aurora, the mechanism of excitation includes probably the two following stages:

(1) An electronic bombardment, which is the primary phenomenon and produces the permanent radiations of the spectrum.

(2) An afterglow, similar to that of Kaplan, giving rise to the nitrogen bands $A \rightarrow X$ and to the 3470 (NI, $^2P \rightarrow {}^4S$) radiation. This second process seems very important in certain diffuse auroras.

RENÉ BERNARD.

Institut de Physique générale,
Université de Lyon.
May 23.

[1] Vegard, L., *Geofys. Pub. Oslo*, (10), **4**, 53 (1933). Bernard, R., *C.R.*, **204**, 993 (1937).

[2] Kaplan, J., NATURE, **141**, 645 (1938).