No attempt was made to analyse the 5·6-eV. or 7·6-eV. levels. Our values of $\sigma_0\Gamma^2$ for the first two levels are thus 50 ± 10 barns eV.^{2} and 100 ± 20 barns eV.^{2} respectively. Havens and Taylor[2] have quoted the following values for the four levels :

E_r = 1·1 eV.	$\sigma_0\Gamma^2$ = 100 barns eV.^{2}
E_r = 2·2 eV.	$\sigma_0\Gamma^2$ = 150 barns eV.^{2}
E_r = 5·6 eV.	$\sigma_0\Gamma^2$ = 200 barns eV.^{2}
E_r = 7·6 eV.	$\sigma_0\Gamma^2$ = 800 barns eV.^{2}

The contribution to the absorption cross-section at 0·025 eV. of the first two levels only, deduced from these values of $\sigma_0\Gamma^2$, is 210 barns. The measured values of the absorption cross-section are all appreciably lower. Until the publication of the experimental results from which Havens and Taylor's values of $\sigma_0\Gamma^2$ are estimated, no conclusions as to the relative reliability of these conflicting values can be made.

Note added in proof. Further chemical analysis of the hafnia sample has shown a hafnia content of 98·0 ± 0·5 per cent. Thus the above values of the hafnium cross-section are systematically 6 per cent too high.

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Atomic Nitrogen in Auroras

THE presence of atomic nitrogen[1,2] in auroras is now proved beyond doubt by the identifications of the forbidden lines λ 3466 ($^2P \rightarrow {}^4S$) and λ 5200–5198 ($^2D \rightarrow {}^4S$). No specific processes for the dissociation of the nitrogen molecules or for the excitation of the nitrogen atoms appear to have been yet suggested. It is the purpose of this communication to show that dissociative recombination of $N_2^+(X')$ ions, as shown in reaction (1), can, at the same time, cause dissociation of nitrogen molecules and excitation of the resulting nitrogen atoms to the required metastable states.

In the reaction :

$$N_2^+(X') + e \rightarrow N(^2P) + N(^2D), \qquad (1)$$

there is almost exact resonance if the dissociation energy of molecular nitrogen be that as given by Gaydon[3] (9·76 eV.). The energy supplied by the left-hand side is 15·58 eV. (first ionization potential), the $N_2^+(X')$ ion being in the lowest vibrational level ($v'' = 0$). The energy demanded by the right-hand side is 15·69 eV., being the total of those required for dissociating the nitrogen molecule (9·76 eV.), for exciting one nitrogen atom to the ^2P state (3·56 eV.) and for exciting the other atom to the ^2D state (2·37 eV.). The demand is thus slightly in excess of the supply. But, as the first negative bands in the auroral spectrum show, the excited $N_2^+(A')$ ions, from which these bands originate, are left, after emission, not only in the lowest vibrational level ($v'' = 0$) of the ground-state $N_2^+(X')$, but also in the higher levels ($v'' = 1$, 2, etc.). It is further known that the N_2^+ (X') ions in these low vibrational levels have fairly long life. The dissociative recombination thus takes place with N_2^+ (X') ions which are in the vibrational levels $v'' = 1$, 2 and loaded with energy slightly in excess of that demanded by the reaction, and has thus a very high probability. The emission of the atomic nitrogen lines from the aurora is thus explained.

There is an alternative process of neutralization of the N_2^+ ions when negative ions of atomic oxygen are present. This is by electron transfer, as in reaction (2) :

$$N_2^+ (X') + O^- \rightarrow N_2(B) + O(^1S), \qquad (2)$$

for which there is also energy balance. This process was suggested by me[4] some time ago to explain the emissions of the observed molecular nitrogen band-systems and the forbidden atomic oxygen lines in the night-sky spectrum. (The same process had also been suggested independently by Nicolet[5].) The process is not incompatible with reaction (1), because, in the quiet night sky, most of the N_2^+ (X') ions are in the lowest vibrational level. Hence, though both electrons and N_2^+ ions are present in the region where the night-sky light originates, dissociative recombination (1) does not take place on account of the slight defect in the amount of energy demanded. Instead, mutual neutralization, as in reaction (2), proceeds. It may be noted that, in this latter reaction, N_2^+ (X') molecules in low vibrational levels may also take part. But for such molecules, reaction (1) has very much higher probability than reaction (2). According to Bates[6], the probability of dissociative recombination of ionized molecules is very high, of the order 10^{-7} cm.^{3}/sec.

It is also now generally agreed that reaction (2) may, at least, be one of the processes responsible for exciting the auroral spectrum[7,8]. This is quite possible, because in the aurora many of the N_2^+ (X') ions are also in the lowest vibrational level.

The fact that dissociative recombination (1) takes place when, and only when, the N_2^+ (X') ion is *not* in the lowest vibrational level, but in some higher one, explains a number of nitrogen afterglow phenomena in accordance with the theory of active nitrogen (in which the N_2^+ (X') ion is the active substance) proposed by me[9] some time ago. This will be discussed in a separate communication. It may, however, be pointed out here that Kaplan[10] also considers that the reaction $N_2^+ + e \rightarrow$ N (excited) + N (excited) plays an important part in the auroral afterglow phenomena as studied by him extensively. He, however, takes the dissociation energy of molecular nitrogen as 7·38 eV. (Herzberg's value) and assumes that both the nitrogen atoms produced are in the ^2P state.

The possibility of dissociative recombination (1) depends, of course, on the correctness of Gaydon's value of the dissociation energy.

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