Letters to the Editor.

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The Origin of the Nebulium Spectrum.

IN the spectra of the gaseous nebulæ several very strong lines are found which have not been duplicated in any terrestrial source. Many lines of evidence point to the fact that the lines are emitted by an element of low atomic weight. Since the spectra of the light elements, as excited in terrestrial sources, are well known, this leads to the conclusion that there must be some condition, presumably low density, which exists in the nebulæ, that causes additional lines to be emitted.

A type of line, which one would expect to be affected by density in this manner, is that caused by a jump from a metastable state to a lower level. Such a metastable state is usually considered to be one from which jumps are very improbable, that is, one of which the average life is very long. Consequently, under terrestrial conditions, where the time between impacts is a very small fraction of a second, the metastable atom, in general, will be dropped down to a lower state by collisions of the second kind or by impact with the walls long before the return would take place spontaneously with the emission of radiation. Under conditions in the nebulæ, however, the time between impacts is very long, and many of these atoms will have a chance to return to lower states with the emission of radiation corresponding to the difference in energy between these metastable states.

Since the nebulæ are known to emit the well-known spectra of highly ionised nitrogen and oxygen, these ions at once suggest themselves as possible sources of the unknown lines as well.

In a four-electron system such as N_{II} and O_{III} the lowest energy levels are due to the configuration of 2 ($2s$) and 2 ($2p$) electrons. According to the Hund theory, this configuration gives rise to ^3P, ^1D, and ^1S terms. All but the lowest of these are metastable, since any jump between them involves a zero change in the azimuthal quantum number. In a five-electron system such as O_{II}, the normal configuration of 2 ($2s$) and 3 ($2p$) electrons forms ^4S, ^2D, and ^2P terms. These are likewise metastable.

The frequency of lines due to jumps between these terms can be calculated accurately in only two cases, namely, ^1D-^1S of O_{III} and ^2D-^2P of O_{II}. The calculated frequencies, if unresolved, are 22916 and 13646, which correspond to wave-lengths of 4362·54 Å.U. and 7326·2 Å.U. respectively. Two of the strongest nebulium lines are found at 4363·21 Å.U. and 7325 Å.U. These deviations are well within the rather large experimental errors arising from the fact that the values are calculated from the difference in frequency of lines in the 500 Å.U. region.

Another group of which the position can be predicted roughly is ^4S-^2D of O_{II}. Both terms have been calculated from series relationships, but as no intercombinations between quartets and doublets have been found, the predicted frequency is only approximate. The predicted frequencies of the two components are 27157 and 27175, which correspond to wave-lengths of 3681·25 Å.U. and 3678·81 Å.U. respectively. The strongest two nebulium lines in the ultra-violet are at 3728·91 Å.U. and 3726·16 Å.U. The doublet separation checks well and uncertainties in the adjustment of series limits for either the quartets or the doublets can account for the deviation in wave-lengths.

The strongest lines in the whole nebulium spectrum are the pair at 5006·84 Å.U. and 4958·91 Å.U. These have a separation of 193 frequency units, which is in almost exact agreement with the separation of 192 units observed for $^3P_1$-$^3P_2$ in O_{III}. This at once suggests that these two lines are $^3P_2$-$^1D_2$ and $^3P_1$-$^1D_2$ respectively. The relative intensity of these two lines is just what would be expected.

Another strong pair occurs at 6583·6 Å.U. and 6548·1 Å.U., showing a separation of 82·3 frequency units. This agrees very well with the known separation of 82·7 for $^3P_1$-$^3P_2$ in N_{II}. If these lines are identified as $^3P_2$-$^1D_2$ and $^3P_1$-$^1D_2$ of N_{II}, one can calculate at once the term value of $^1D_2$, since those of ^3P are already known. This ^1D term should combine strongly with the ^1P term of the $s^2p{\cdot}s$ configuration and the ^1D term of the $s^2p{\cdot}d$ configuration. The term values of these singlet terms have already been determined accurately by Fowler. The calculated positions of the lines arising from these combinations, obtained with the use of the above nebulium lines, are 746·98 Å.U. and 582·15 Å.U. Strong lines are observed in the nitrogen spectrum at 746·97 Å.U. and 582·16 Å.U. This furnishes almost certain proof of the identification of this pair of nebulium lines.

The other lines to be expected, on the above hypothesis, from N_{II}, N_{III}, O_{II}, and O_{III}, fall outside the range of wave-lengths easily observable in nebulæ. The above identifications account for all but two or three of the strong nebulium lines. It should be noted that in every case where it has been possible to make an exact prediction, a strong nebulium line has been observed at the calculated place. Furthermore, the above identifications are entirely in accord with the behaviour of these lines in the nebulæ as observed by Wright.

The nebulium lines thus far identified are collected in Table I.

TABLE I.

λ.	Source.	Series Designation.
7325·0	O_{II}	^2D-^2P
6583·6	N_{II}	$^3P_2$-^1D
6548·1	N_{II}	$^3P_1$-^1D
5006·84	O_{III}	$^3P_2$-^1D
4958·91	O_{III}	$^3P_1$-^1D
4363·21	O_{III}	^1D-^1S
3728·91	O_{II}	^4S-$^2D_3$
3726·16	O_{II}	^4S-$^2D_2$

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The Function of Water Vapour in the Photosynthesis of Hydrogen Chloride.

EVIDENCE was presented (B. Lewis and E. K. Rideal, *J. Chem. Soc.*, **129**, 583 and 596; 1926) for the view that the photo-expansion of bromine and other halogens in the presence of water vapour (Budde effect) is due to heat liberated by the recombination of halogen atoms set free by the absorption of light quanta. Although absorption of radiation occurs in the dry gas, no Budde effect is observable (J. W. Mellor, *J. Chem. Soc.*, **81**, 1280; 1902; Lewis and Rideal, *loc. cit.*) even when the gas is subjected to an intense source of ultra-violet radiation (E. B. Ludlam, *Proc. Roy. Soc. Edinburgh*, **44**, 197; 1924). This is interpreted to mean that the halogen does not dissociate in the dry state; that the radiation absorbed