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The NI (5200 Å) emissions in the tropical atmosphere

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The afterglow of nitrogen in a discharge tube was first observed in 1884 and up to 1946 attempts were made at intervals to explain it. It is generally agreed that the earliest photographic observations of the night sky spectrum were made by Slipher (1915-19197.5 these were followed by other spectrographic researches (e.g. Lord Rayleigh, 1920–1921(4) and 1922-1932; (5) Dufay, 1922–1923(6)7. An attempt to identify the atomic nitrogen spectral lines was made by McLennan, Ireton and Thompson (19267.' In this attempt, solid nitrogen was made luminescent by bombardment with energetic electrons. Among the lines recognized then were 5192.4 Å and 5204.4 Å. The chances of observing exactly the 5200 Å line were brightened after the observation of the atomic nitrogen? P's line at 3466.4 Å by means of experiments incorporating high pressure. When the experiments were repeated, using panchromatic plates, the relatively weaker nebular line at approximately 5200 X was observed /J. Kaplan, 19397. The transition that leads to this line is forbidden. The excitation of such forbidden atomic lines which involves a change of electron spin cannot be accounted for by direct proton impact; it is necessary to consider secondary excitation mechanisms. In fact, as far back as 1954, there was little doubt /Seaton, 19537 that most of the forbidden atomic emissions arise from various secondary excitation processes and not from excitation of the main atmospheric constituents by direct proton impact. Although the existence of what is now termed "airglow" was established photometrical in 1909 /by Yntema7,9 the weak NI doublet: 5198 $ (453/2 - 2D5/2, 3/2) was first detected in the twilight several years later by Courtes (19507.(10) Subsequent observations of the same emission have been made (n. Dufay, 1951, 1952, 1953; Nicolet and Pastiels, (11) 19527. The NI 5200 Å line was later detected in the nightglow N. Dufay, 1959; Krassovskii, 1958; Blackwell et al., 19607.(12)(13) (14) Ttwa It was found to be an integral part of the Polar Auroral Spectrum (Evifte, 19597(15) although (surprisingly) no other NI lines between 5200 & and 6650 & were observed. Courtes T9507 (16) and Dufay /79507(17) reported that NI 2D - 4s 5198.5-5200.7 Å might be present in the nightglow spectrum, Besides, Courtes 7795071o detected some twilight line emissions "in the neighborhood" of 5199 Å which he attributed to? D - 4s 15198.5 - 5200.7 Å of NI. Gartlein and Spherman /19527 reported the appearance of 5199 | late in the display, and persisting when the rest of the spectrum dies away, thus hinting at a relatively longer lifetime of the N (CD). Seaton 7795371) estimated that I (5199) rarely exceed 14R. At about the same time, Hunten confirmed to Seaton (in a private communication) that while I (5199) is comparable to I (5228) (N, Negative Group; 0, 3) on photographic plates with exposures of an hour or two, it had not (by then) been detected using a high-speed photomultiplier. On further investigations, Dufay (1950, 1952, 1953718) discovered that this line emission forms an integral part of the early sunrise atmospheric airglow, though much feebler. Dufay observed that although it always appeared during twilight and early part of the night in summer, its appearance during winter was less frequent. Among its other properties as noted by

Dufay are: - (i) Its average photon intensity along the zenith was about 2 x 107 cm-2 sec-1. (ii) Its height of emission was noted to be equal to or greater than 100 km. It exhibits no correlation with magnetic activity. Dufay (19507 proposed that the presence of 5199 line emissions results partly from the process N (As) + hy (5199 X) — 1(2) and especially the process N (4s) + hy (3466) -N (??) which is then followed by the process N (? P) > N (2D) + hr. (10,400 8). Owing to the fact that 1(2D) has a natural radiative life time of about 26 hours /Garstang, 19567(19) it was proposed that the 5199 Å emission proceeds after sunset, but this proposal received criticism from Bates /19527 because if allowance is made for collisional deactivation, the number of free nitrogen atoms required to account for the observed intensity is incredibly high (e.g. Seaton, 1955 (20) estimated such a number to be 2 x 10 cm). The role played by deactivation processes on N (D) is not to be under-estimated. Seaton (19537 obtained the value of the ratio I (5199)/1(3467) with and without consideration of deactivation processes. With the assumption that deactivation is absent, I (5199)/ (3467) is greater than 9.4 while the same ratio drops to within the range 0.0125 - 0.5 if deactivation processes are taken into account. These deactivation processes have been found to be responsible for the fact that the lifetime of N("D) in the upper atmosphere is less than the natural value of about 26 hours (e.g. it is about 15 min. at 175 km, 200 lm and 300 km). (21) Bates (79527(22) suggested that the source of the excited nitrogen atoms could be the dissociative recombination process 1+ (x) + 1 + n (?). Prior to this, Bates, Massey and Pearse /19487 had suggested as of importance the secondary excitation process N,* + e + N' whereby the energy available for excitation of the two atoms is the difference between the dissociation energy and the ionization potential of the neutral molecule. More than one value of the energy available for excitation has been obtained: 5.82 eV using the dissociation energy advocated by Gaydon (19527 (9.752 eV); 8.20 eV using the dissociation energy advocated by Herzberg (T9507 (7.373 eV). Other possible reactions which involve N (D) were suggested by Seaton (T9537, and they are 1 (?) + 0(3p) -> N (48) + O (')) + 0.41 eV and N (2p) + 1, 1(?) + ,'. In their conclusions, Bates (19527 and Seaton (T9537 seem to concur that the NI lines are excited by dissociative