THE N IV λ5820 MULTIPLET IN WN STARS

by

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ABSTRACT

Evaluating transition probabilities of N IV 2p3d $^3P^0$ to 2s4s ^3S and 2p3p ^3P and an emission feature at λ7410 it is shown that a disputed emission at λ5810 in WN stars may not be attributed to N IV.

Key words: HD 192163 WN6, N IV transition probabilities.

The interpretation of stellar spectra assumes the knowledge of atomic data, energy differences for identification, oscillator strengths and cross sections for explaining the spectral intensities.

A group under the direction of M. J. Seaton at University College, London, has completed programs for the calculation of atomic structures, oscillator strengths and collision cross sections for complex atoms. The atomic structure program is essentially based on the work of Condon and Shortley (1935) but the inclusion of configuration interaction is built in as an essential feature. I shall apply some of our first results to solve a puzzle in the spectra of Wolf-Rayet WN stars. If any of you have some particularly pressing needs for oscillator strengths or collision cross sections we shall do our best to provide them.

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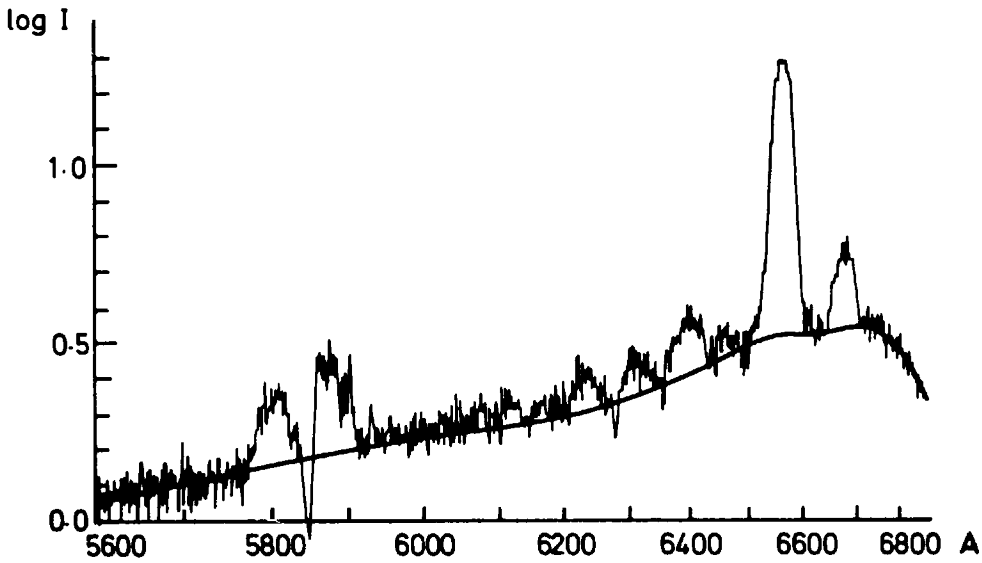

Log I tracing of the spectrum of·H.D. 192 163 WN 6

Figure 1.

Figure 1 shows part of the spectrum of HD 192163 WN6, taken by Underhill (1959). The emission feature at λ5810 is usually attributed to C IV. But the case in favor of the attribution to N IV $2p3p\,^3P-2p3d\,^3P^0$ has again been argued by Hiltner and Schild (1966); this transition gives a line centered at λ5820. Laboratory investigations of N IV by Hallin (1966) have failed to produce that line. Figure 2 shows the allowed transitions from $2p3d\,^3P^0$ with the corresponding transition probabilities. They are from Table 3 of Nussbaumer (1969) where gf values for all the transitions between the 34 lowest levels of N IV have been calculated. The level $2p3d\,^3P^0$ will be depopulated mainly to $2p^2\ ^3P$. But in an extended atmosphere that radiation might be reabsorbed and the relative intensities of $2p^2\ ^3P-2p3d\,^3P^0$ λ298 and $2p3p\,^3P-2p3d\,^3P^0$ λ5820 need therefore not be the same in laboratory experiments and in astronomical observations. For this reason the absence of N IV λ5820 in the laboratory cannot be invoked to ban that line from the Wolf-Rayet spectrum.

Figure 2 shows that at λ7413 there is a line with a transition probability three times higher than for N IV λ5820. Swings and Jose (1950) find a faint emission feature at λ7410 of intensity 1 against an intensity of 20 for Hα λ6563. They attribute λ7410 to N III $2s2p3s\,^4P^0-2s^2\ 4s\ ^2S$. But even if we attribute that emission to the two-elec-

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TRANSITIONS FROM N IV 2p 3d $^3P^0$

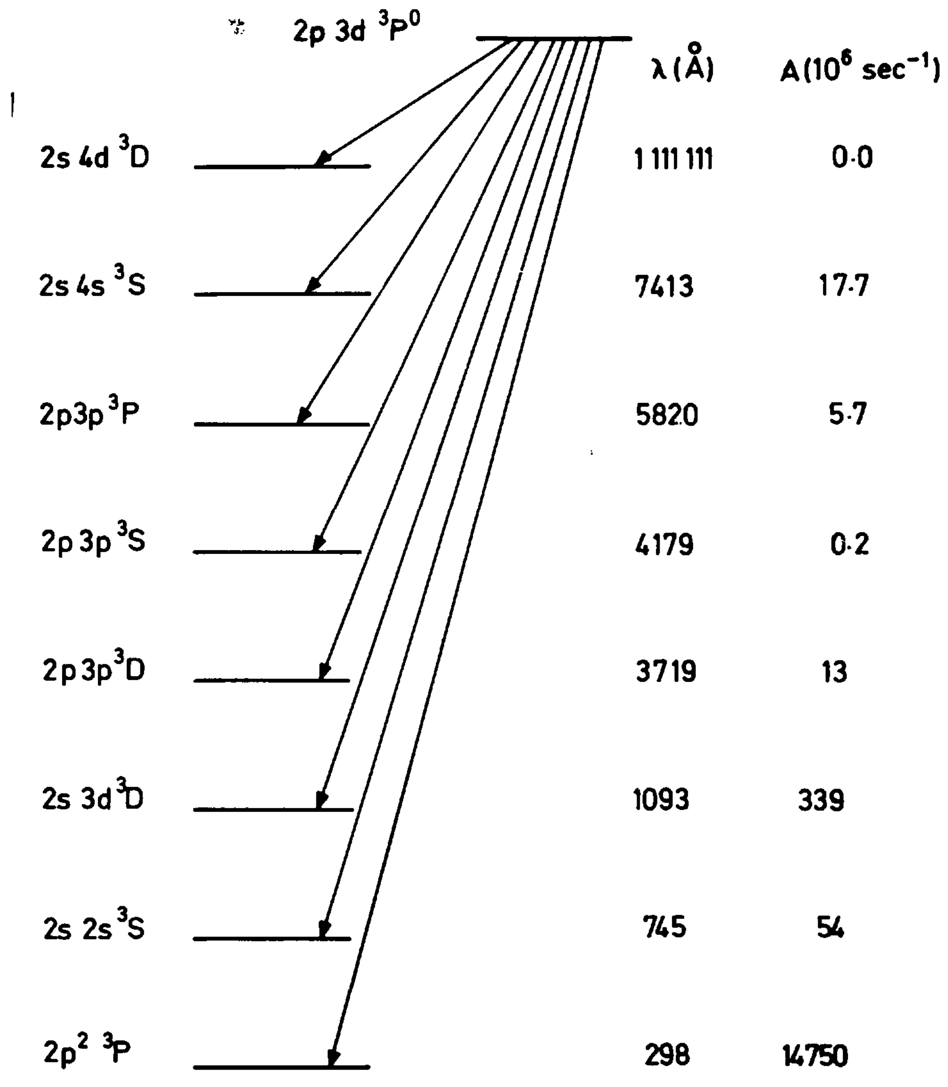

Figure 2.

tron transition 2s4s ^3S-2p3d $^3P^0$ it is obvious from the data of Figure 2 that the emission at λ5810 is far too strong to be attributed to N IV 2p3p ^3P-2p3d $^3P^0$. I think these arguments based on transitions from a common upper level will finally dispose of the temptation to attribute the emission feature at λ5810 to N IV.

The transition 2s4s ^3S-2p3d $^3P^0$ is an example of a two-electron jump; such transitions are naturally accommodated in our approach based on the idea of configuration interaction.

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DISCUSSION

Trefftz: We have made the same calculation and it would be interesting to compare the results. For Si II we were able to compare our values with those of other authors and we found very large differences for weak and strong lines. The result does depend on the number of transitions, which are included in the calculations.

Nussbaumer: In our calculation all known transitions are included.

Wellmann: May I remind you, that Dr. Nussbaumer asked to know which transition probabilities of astrophysical interest should be calculated. I would like to remind you that the exact calculations of collision cross sections for forbidden lines by Seaton and his group were very important for the determination of electron densities and temperatures in diffuse nebulae. They should be continued.

Underhill: Observations show that the N IV line at λ6200A, which should be much stronger than the λ5820A line, is only a very weak feature. This also leads to the conclusion that the observed emission at λ5810 is not due to N IV.

Swings: Could you calculate gf-values for Fe II lines?

Nussbaumer: I am not sure because Fe II is a very complicated ion.

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