it is present in the nucleus. [O III] is strong in HD 167362, and very weak in Campbell's star.

The striking association in HD 167362 and BD + 30° 3639 of a carbon nucleus with a nitrogen envelope suggests that a comparison with NGC 6543 would be interesting, despite the higher excitation prevailing in the nuclear and nebular parts of NGC 6543.[11] This object also shows strong nebular lines of [N II], but its nucleus exhibits both N IV and C IV with similar intensities.

[1] *Astronomy and Astrophysics*, **13**, 461 (1894).

[2] Several excellent spectrograms of Campbell's star (BD + 30° 3639) have recently been secured at the McDonald Observatory and agree closely with the description of the spectrum by Wright (*Lick Obs. Pub.*, **13**, 220 (1918)); there is no trace of N II, N III, N IV or N V in the nucleus, which is a typical carbon star.

[3] *Ap. Jour.*, **2**, 354 (1895).

[4] *Harvard Ann.*, **76**, 31 (1916).

[5] *Harvard Circ.*, No. 224 (1921).

[6] Henry Draper Catalogue.

[7] *Harvard Bull.*, No. 892, 20 (1933).

[8] *Ap. Jour.*, **61**, 389 (1925); **76**, 156 (1932).

[9] "Variable Stars," *Harvard Obs. Monograph*, No. 5, 311 (1938).

[10] Beals has chosen the numbering from *WC*6 to *WC*8 so as to allow a certain latitude for new discoveries at either end of the sequence. See *Trans. I. A. U.*, **6**, 248 (1938).

[11] P. Swings, *Ap. Jour.* (in press).

THE SPECTRUM OF RW HYDRAE

BY P. SWINGS AND O. STRUVE

MCDONALD OBSERVATORY, UNIVERSITY OF TEXAS, AND YERKES OBSERVATORY, UNIVERSITY OF CHICAGO

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RW Hydrae[1] is an abnormal long-period variable having an unusually small range, of about one magnitude; the maximum photographic magnitude is 9.7 to 9.9 and the minimum 10.8 to 10.9. It has a late-type spectrum upon which are superimposed several bright lines. Miss Cannon's estimates of the spectral type range from *K*5 to *M*2; she noticed bright H_β, H_γ and H_δ.

The spectrum has been investigated by Merrill,[2] who observed, besides the late-type spectrum, several bright lines of H, He I, He II and [O III] (auroral transition λ 4363 only).

This object offers a striking similarity to AX Persei, CI Cygni, Z Andromedae, R Aquarii, T Coronae and others, consisting of a late-type star and of a companion of high excitation. In previous papers[3] we have given a new discussion of several binaries of this type, using material secured with the 82-inch reflector of the McDonald Observatory. The present note brings similar information concerning RW Hydrae, based on four spectrograms obtained between April 19 and 25, 1940; two were taken with the quartz prisms (dispersion 100 A/mm. at λ 3933) and two with the glass prisms (dispersion 50 A/mm. at λ 3933).

During the interval covered by our observations, the late-type component was of spectral class *M*0 or late *K;* compared with the bright lines, the late-type spectrum was much stronger than in AX Persei or CI Cygni, which we observed between September, 1939, and February, 1940. The red component completely obliterates the region above λ 4500, so that only strong bright lines may be detected above that wave-length.

The emission lines are collected in table 1. Besides the features observed by Merrill, our spectrograms reveal many permitted O III-transitions, weak [O II], fairly strong [Ne III], weak N_1 (nebular transition of [O III]), weak Si I and Ca II. All the emission lines are sharp.

The Balmer series is clearly seen in emission to H_{22}, and a strong Balmer continuum extends to λ 3300. Many He I lines are present. The Si I line, λ 3905, which also appears in AX Persei and CI Cygni, belongs presumably to the red-variable component; it seems rather probable that the weak Ca II lines are also excited in the atmosphere of the red star.

Besides the strong auroral transition of [O III], we observe a very weak nebular transition, N_1. Thus, the relative intensities of λ 4363 and N_1 are of the type found in planetaries of class Pd, such as IC 4997. Similar relative intensities were observed in AX Persei, CI Cygni, Z Andromedae and R Aquarii, which belong to the same group of binaries.

Fourteen permitted lines of O III are identified between λ 3265 and λ 3962. This spectrum is not excited by Bowen's fluorescence mechanism to any appreciable extent, because we find the lines of the singlet, triplet and quintet systems with the normal intensities of a recombination spectrum. The ionization potential of O^{++} is 54.6 volts, which is close to that of He^+, namely, 54.1 volts. The line He II 4686 is strong. So far as we know, no planetary nebula has been found showing such a complete recombination spectrum of O III. For example, in the extensive investigation by Bowen and Wyse[4] the only recombination line of O III which they observed is λ 5592 ($3s\,^1P^o - 3p\,^1P$); because of the blending with the red component, we are unable to discuss the region of λ 5592, but other recombination lines, such as λλ 3774, 3791 and 3962 are not found in the table by Bowen and Wyse.

It is possible that the permitted O III lines do not belong to a nebula, but rather to the exciting nucleus. Both the O III and the N III lines, and perhaps also those of He II and partly those of H and He I may belong to a nucleus of type *WN* possessing abnormally sharp lines; such a *WN* nucleus

TABLE 1

BRIGHT LINES IN RW HYDRAE

STAR		IDENTIFICATION		
λ	Int.	Element	λ	Int.
3266.	1	O III	3265.45	10
3312.4	0	O III	3312.30	5
3341.1	1	O III	3340.74	6
3383.0	1	O III	3382.69	3
		O III	3383.85	2
		O III	3384.95	4
3429.3	1–2	O III	3428.67	3
		O III	3430.60	4
3444.0	3	O III	3444.10	5
3676.01	1	H_{22}	3676.36	
3679.41	2	H_{21}	3679.35	
3682.55	2	H_{20}	3682.81	
3686.57	2	H_{19}	3686.83	
3691.38	2	H_{18}	3691.56	
3696.91	2	H_{17}	3697.15	
3703.77	2–3*n*	H_{16}	3703.85	
		O III	3702.75	5
		O III	3703.37	5
3707.13	0–1	O III	3707.24	6
3711.80	3	H_{15}	3711.97	
3714.60	0	O III	3715.08	6
3721.75	3	H_{14}	3721.94	
3724.90	1	[O II]	3726.1	
3734.36	4	H_{13}	3734.37	
3750.14	4	H_{12}	3750.15	
3753.98	2–3	O III	3754.67	7
		N III	3754.62	6
3759.97	2–3	O III	3759.87	9
3770.72	4	H_{11}	3770.63	
3773.87	1	O III	3774.00	6
3790.82	1	O III	3791.26	6
3798.09	5	H_{10}	3797.90	
3819.71	2–3	HeI	3819.61	4
3835.54	5	H_9	3835.39	
3868.74	4	[Ne III]	3868.7	
3889.05	7*	H_8	3889.05	
		He I	3888.65	10
3905.26	1	Si I	3905.53	10
3926.0	1	He I	3926.53	1
3933.0	2	Ca II	3933.68	200
3961.58	1–2	O III	3961.59	8
3965.04	2–3	He I	3964.73	4
3968.0	1	[Ne III]	3967.5	
		Ca II	3968.49	150
3970.10	7	H_ϵ	3970.08	
4009.43	2	He I	4009.27	1
4026.25	2	He I	4026.19	5

4097.33	2	N III	4097.31	10
4101.79	10	H_δ	4101.75	
4121.03	1–2	He I	4120.81	3
4143.88	1–2	He I	4143.77	2
4340.49	12	H_γ	4340.48	
4363.17	4	[O III]	4363.2	
4387.82	4	He I	4387.93	3
4471.63	3	He I	4471.48	6
4685.72	6	He II	4685.81	
4861.4	15	H_β	4861.34	
4922.	3	He I	4921.93	4
5007.	1	[O III]	5006.84	
5876.	5	He I	5875.62	10
6563.	20	H_α	6562.82	

* The violet wing is weaker than the red wing.
NOTE: Identifications in square brackets designate forbidden transitions.

would be surrounded by a nebulosity giving rise to strong auroral [O III], fairly strong nebular [Ne III], weak nebular [O II] and very weak nebular [O III].

In HD 167362, which contains a late *WC* nucleus exciting a surrounding nebula, we found[5] that the nuclear lines are sharper than is usually observed in Wolf-Rayet stars.

Because of the presence of the strong red component, we cannot settle the question of the excitation of N III; neither is there any information regarding the continuous spectrum of the exciting nucleus. No line of carbon was found.

From 20 bright lines, the radial velocity was found to be +14 km./sec. From three absorption lines (Cr I 4289.72, Fe I 4299.24 and Fe I 4325.76), the radial velocity of the late-type star was found to be +15 km./sec. The two components have practically the same radial velocity.

RW Hydrae belongs to the same group of binaries as AX Persei, CI Cygni, T. Coronae, Z Andromedae, R Aquarii, etc. The excitation of its nebular part is lower than in AX Persei and CI Cygni and is rather similar to R Aquarii; but the intensity ratio of the auroral and nebular transitions is larger in RW Hydrae than in R Aquarii.

[1] $\alpha(1900) = 13^h 28^m.8$; δ (1900) = −24°53′; HD 117970; BD −24° 10977.

[2] *Ap. J.*, **77**, 44 (1933).

[3] *Ap. J.*, **91**, 546 (1940); also Swings, Elvey and Struve, *Pub. A. S. P.*, (in press).

[4] *Lick Obs. Bull.*, **19**, No. 495 (1939).

[5] *Proc. Nat. Acad. Sci.*, **26**, 458 (1940).