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THE PHOTOMETRIC AND RADIAL VELOCITY VARIATIONS OF THE CENTRAL STAR OF THE PLANETARY NEBULA IC 418

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RESUMEN

Presentamos un trabajo sobre la estrella central de la nebulosa planetaria IC 418, basado en espectrogramas (1979-82) y fotometría fotoeléctrica (enero 1983). Incluimos una descripción mejorada del espectro de la estrella central. Hemos encontrado que la fotosfera presenta un campo de velocidad radial variable, que implicaría fluctuaciones en el flujo de masa, al que probablemente se superpone el movimiento orbital de un sistema binario cerrado, con un período de aproximadamente 0.2 días. También hemos hallado variaciones de luz, en una escala de tiempo de una o dos horas y con una amplitud de 0.1 mag. Estas variaciones de luz no parecen ser periódicas. Nuestros datos no bastan para eliminar la posibilidad de que existan pulsaciones no radiales; sugerimos observaciones adicionales.

ABSTRACT

This paper brings spectrographic (1979-82) and photometric (January 1983) observations of the central star of the planetary nebula IC 418. We include an improved description of the stellar spectrum. We have found a variable photospheric velocity field, which would imply a fluctuating mass outflow, probably mixed with orbital motion in a close binary system with a period of about 0.2 days. We have also found light variations, on a time scale of one or two hours, with an amplitude of 0.1 mag, which do not appear to be periodic. Our observations are not yet sufficient to rule out definitely the existence of non-radial pulsations; further observations are suggested.

Key words: **PLANETARY NEBULAE-CENTRAL STARS – VARIABLE STARS-INDIVIDUAL**

I. INTRODUCTION

It is hardly necessary to emphasize the usefulness of a systematic search for photometric, spectral and radial velocity variations among central stars of planetary nebulae. We are certain to gain information about one or more of the following subjects: (a) binarity and its role in planetary nebula formation, (b) possible existence of pulsational instabilities, (c) existence and characteristics of fluctuations in the mass outflow. Up to now, most of the confirmed photometric and radial velocity variations of central stars have turned out to originate in binary systems: UU Sge (Bond, Liller, and Mannery 1978), Abell 46 (Bond 1980), Abell 41 (Grauer and Bond 1982), NGC 2346 (Méndez and Niemela 1981); Méndez, Gathier, and Niemela 1982), NGC 6826 (Noskova 1982, in Acker *et al.* 1982). Bond (1979) has suggested that the central star of K1-2 is pulsating. On the other hand, cases of spectral variations are more probably related to fluctuations in the outer atmospheric layers: e.g., He 2-131 (Méndez and Niemela 1979).

IC 418 is a very well known planetary nebula, and it has one of the few central stars brighter than 10th apparent visual magnitude, HD 35914.

Several people have published photometry of HD 35914. A useful summary is given by Acker *et al.* (1982). Two papers deserve special mention: the first one by Lasker and Hesser (1971), who observed, among other central stars, HD 35914 for 2 hours in 1968 December 29/30 and did not find evidence of periodic variations in the range from 4 seconds to approximately 25 minutes. The second one is by Gilra *et al.* (1978), who reported variations of about 15% in the ultraviolet stellar flux of HD 35914 from ANS data, on a time scale of 5 hours, suggesting that they might be related to changes in the intensity of the stellar C IV doublet at 1549 Å. As far as we know, there have been no attempts to confirm such variations on the available *IUE* spectrograms, and it would certainly be useful to do so.

Our spectrographic study of the central star of IC 418 began in 1979. Radial velocity variations were immediately found but their interpretation was not easy (Méndez 1980); Méndez and Verga 1981). New spectrograms were obtained in 1982, and a new photometric study was started in 1983. In this paper we present all our spectrographic and photometric observations, describe the variations we have found, discuss their nature and suggest further observations.

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II. SPECTROGRAMS

The calibrated spectrograms used in this work were obtained between 1979 January and 1982 March, at the Cerro Tololo Inter-American Observatory (CTIO), on IIIa-J plates baked in "forming gas". Table 1 lists the "blue" spectrograms, which extend from 3600 to 5000 Å at 45 Å/mm. The labels E and F refer to plates taken with the image-tube spectrographs of the CTIO 1-m and 4-m telescopes, respectively. Table 2 lists the "red" spectrograms,all taken with the 4-m telescope, which extend from 5000 to 6700 Å at 45 Å/mm.

All the plates in Tables 1 and 2 were taken using a skylight suppressor in order to reduce the contribution of the nebular lines. They were developed in D-19 together with intensity calibrations obtained with a spot sensitometer illuminated through a color filter selected to imitate the image-tube output. Seven "blue" and seven "red" spectrograms, all taken in 1979 January with the 4-m telescope, were traced with the PDS microphotometer of the David Dunlap Observatory. For each spectrogram the wavelength scale was reconstructed using tracings of the corresponding comparison spectrum. For each set of 7 plates the intensities were stored on mag-

TABLE 1

BLUE SPECTROGRAMS OF IC 418

Plate	Heliocentric Julian date (2440000 +)	Heliocentric radial velocities (km s^{-1})		
		He I 4471 (neb. em.)	He II 4541 (star abs.)	He II 4685 (star em.)
F1365. 3	3878. 684	72	59	68
F1368. 4	3879. 558	76	26	78
F1369. 6	3879. 665	72	46	80
F1370. 2	3879. 756	73	73	81
F1372. 6	3880. 578	66	66	37
F1379	3881. 592	69	55	71
F1380	3881. 633	58	64	82
E2491. 3	3882. 655	64	74	77
E2491. 4	3882. 664	63	75	68
E2495. 2	3883. 645	61	91	65
E2498. 2	3884. 575	63	83	57
E2500. 3	3885. 610	63	67	91
E2504. 1	3886. 612	68	68	56
E3079. 5	4142. 821	58	39	57
E3080. 6	4143. 791	58	34	89
E3344. 4	4266. 611	66	64	78
E3344. 5	4266. 614	63	43	75
E3350. 4	4269. 597	57	22	71
E3353. 6	4270. 606	53	56	68
E3374. 7	4276. 593	58	45	68
E3379. 5	4277. 594	61	28	64
E3655. 3	4535. 679	62	54	71
E3655. 7	4535. 718	63	66	74
E3656. 4	4535. 762	65	61	84
E3656. 7	4535. 798	65	57	83
E3657. 3	4535. 857	63	58	72
E3658. 3	4536. 788	61	57	76
E3658. 6	4536. 846	63	59	78
E3659. 3	4537. 769	61	64	71
E3659. 6	4537. 818	58	53	86
E3660. 3	4537. 863	61	78	55
E3661. 2	4538. 666	67	80	75
E3661. 4	4538. 739	68	81	67
E3661. 6	4538. 813	67	37	92
E3661. 8	4538. 875	61	45	71
E3662. 3	4539. 698	67	32	101
E3662. 6	4539. 762	65	35	91
E3662. 8	4539. 817	65	30	90
E3663. 4	4539. 880	--	29	78
E3841. 2	4642. 540	63	41	84
E3841. 4	4642. 552	60	47	76
E3841. 7	4642. 561	62	-1	105
E3843. 2	4643. 533	65	98	75
E3843. 3	4643. 547	64	74	82
E3843. 4	4643. 560	65	64	79
E3845. 3	4644. 575	67	104	54
E3845. 4	4644. 588	62	77	47
E3845. 5	4644. 600	67	59	49
E3845. 6	4644. 610	66	65	41

TABLE 1 (CONTINUED)

Plate	Heliocentric Julian date (2440000 +)	Heliocentric radial velocities (km s^{-1}) He I 4471 (neb. em.)	He II 4541 (star abs.)	He II 4685 (star em.)
E3845. 7	4644. 622	63	36	66
E3847. 3	4645. 595	64	49	70
E3847. 4	4645. 606	64	18	92
E3847. 5	4645. 617	65	48	70
F1837. 8	4648. 555	--	62	84
F1837. 12	4648. 560	--	51	94
F1837. 24	4648. 580	--	54	93
F1840. 16	4649. 540	68	79	81
F1840. 28	4649. 560	69	72	66
F1841. 12	4649. 582	64	74	69
F1844. 12	4650. 532	87	58	91
F1847. 12	4651. 544	90	16	61
E4197. 9	4834. 927	60	40	82
E4199	4835. 929	62	77	68
E4200. 8	4836. 902	61	59	71
E4200. 9	4836. 914	61	65	75
E4201	4836. 927	64	55	72
F2109. 12	5042. 571	83	71	60
F2117. 12	5044. 502	75	84	118
F2118. 12	5044. 541	94	14	89
F2118. 28	5044. 561	90	51	94
F2119. 8	5044. 570	84	55	107
AVERAGE VELOCITY		66	56	76
ROOT-MEAN-SQUARE ERROR		8	20	15

TABLE 2

RED SPECTROGRAMS OF IC 418

		Heliocentric radial velocities (km s^{-1})					
		Stellar absorptions			St. em.	Neb. em.	Int.
Plate	Heliocentric Julian date (2440000 +)	He II 5411	O III 5592	C IV 5801 5811	C III 5695	[N II] 5755	Na I 5889
F1365. 4	3878. 690	53	38	38	59	64	21
F1368. 5	3879. 562	20	22	-10	45	61	22
F1373. 1	3880. 585	69	64	66	44	58	18
F1373. 6	3880. 633	74	67	63	44	60	24
F1374. 3	3880. 662	66	61	39	48	62	24
F1375. 2	3880. 737	94	77	60	48	58	22
F1378. 6	3881. 584	3	43	15	55	64	29
F1837. 16	4648. 567	--	--	50	59	70	25
F1837. 20	4648. 576	--	--	40	72	69	27
F1837. 28	4648. 585	--	--	60	80	80	35
F1840. 8	4649. 530	86	60	14	55	56	8
F1840. 12	4649. 535	62	56	13	55	58	18
F1840. 20	4649. 546	89	60	39	61	63	24
F1840. 24	4649. 555	75	77	30	67	69	25
F1840. 32	4649. 566	109	43	70	80	81	22
F1841. 8	4649. 576	65	39	68	50	50	26
F1841. 16	4649. 588	80	84	57	55	59	24
F1841. 20	4649. 593	105	54	64	60	64	26
F1844. 8	4650. 527	17	29	15	40	60	-1
F1844. 16	4650. 537	19	41	22	51	51	14
F1847. 8	4651. 539	39	21	10	50	71	27
F1847. 16	4651. 548	17	20	7	47	65	21
F1848. 12	4651. 653	13	38	9	64	64	26
F2104. 8	5041. 502	38	34	11	55	56	7
F2104. 20	5041. 523	47	43	-9	53	61	23
F2107. 8	5042. 505	96	79	87	54	67	35

TABLE 2 (CONTINUED)

		Heliocentric radial velocities (km s^{-1})					
		Stellar absorptions			St. em.	Neb. em.	Int.
Plate	Heliocentric Julian date (2440000 +)	He II 5411	O III 5592	C IV 5801 5811	C III 5695	[N II] 5755	Na I 5889
F2107. 12	5042. 509	108	81	76	54	57	23
F2107. 16	5042. 514	90	101	75	59	68	21
F2107. 20	5042. 518	97	57	98	54	64	18
F2107. 24	5042. 523	90	78	71	51	61	5
F2107. 30	5042. 527	96	80	91	54	62	21
F2108. 10	5042. 533	90	67	82	57	61	21
F2108. 14	5042. 539	60	70	75	54	64	3
F2108. 20	5042. 542	67	53	56	60	70	9
F2108. 24	5042. 548	68	62	71	61	64	25
F2108. 28	5042. 552	60	63	83	57	62	22
F2108. 32	5042. 557	63	69	40	55	60	24
F2109. 8	5042. 567	78	57	63	54	64	21
F2109. 16	5042. 579	59	62	50	63	62	10
F2109. 20	5042. 585	56	59	51	59	64	28
F2109. 24	5042. 589	61	66	39	61	62	29
F2109. 32	5042. 603	89	60	55	59	70	20
F2110. 8	5042. 614	66	34	44	65	59	19
F2110. 12	5042. 621	65	52	55	65	68	22
F2110. 16	5042. 629	48	78	58	64	64	23
F2110. 20	5042. 638	55	49	32	66	61	27
F2113. 8	5043. 500	67	56	50	59	59	26
F2113. 12	5043. 503	76	46	47	60	68	20
F2113. 20	5043. 515	86	32	52	62	66	35
F2113. 32	5043. 550	36	30	17	57	60	21
F2114. 8	5043. 556	50	1	22	59	64	19
F2114. 12	5043. 559	46	−8	22	61	65	33
F2114. 20	5043. 580	27	36	30	55	62	28
F2114. 24	5043. 584	51	3	22	55	56	33
F2114. 32	5043. 618	49	38	18	64	63	20
F2115. 8	5043. 626	73	43	5	54	61	26
F2115. 12	5043. 633	64	46	26	63	70	32
F2117. 8	5044. 497	61	35	58	64	68	33
F2117. 16	5044. 505	45	71	67	67	66	36
F2118. 8	5044. 536	9	24	31	56	71	9
F2118. 16	5044. 544	−12	28	17	53	70	28
F2118. 20	5044. 548	36	51	37	63	65	33
F2118. 32	5044. 564	10	29	14	66	66	34
F2119. 12	5044. 575	28	39	23	64	62	28
F2119. 24	5044. 598	25	51	25	65	62	35
F2120. 8	5044. 627	56	41	32	71	65	35
AVERAGE VELOCITY		58	50	43	58	64	23
ROOT-MEAN-SQUARE ERROR		28	21	25	8	5	8

netic tape, and were later added together, in order to improve the signal-to-noise ratio. The resulting intensity tracings are shown in Figures 1, 2 and 3. They reveal more details than reported in previous descriptions (Swings and Struve 1941; Aller and Wilson 1954; Andrillat 1957; Aller and Kaler 1964). For completeness, we list here the new findings, already included in a preliminary report (Méndez and Verga 1981).

a) Weak, previously undetected C III emissions are visible at 4056, 4186, 4516, 5270 and 5826 Å. We also find the famous unidentified emissions at 4485 and 4503 Å.

b) The He I absorptions at 4471 and 5875 Å are blue-shifted relative to the nebular emissions. The same happens with Hδ and Hγ, although in this case the shift can be at least partly attributed to blends with the strong He II absorptions, which we estimate to contribute about one half of the equivalent width at Hδ and Hγ.

c) We also find O III 5592 and C IV 5801, 5811 in absorption.

III. THE RADIAL VELOCITY VARIATIONS

All the radial velocity measurements were made by RHM and ADV with the Grant comparator-microphotometer of the IAFE. Several plates were measured by both, and no systematic differences were found. The heliocentric Julian dates and the heliocentric radial

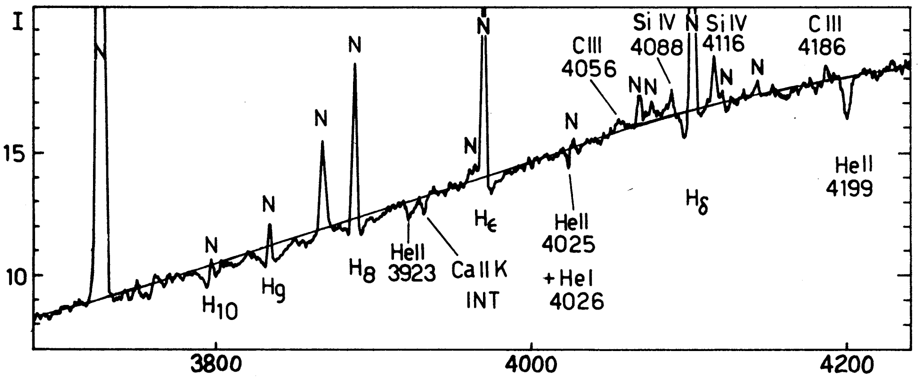

Fig. 1. Intensity tracing of the spectrum of HD 35914, the central star of IC 418, from 3700 to 4200 A. Addition of 7 spectrograms. The nebular lines are labeled with N, the interstellar features with INT.

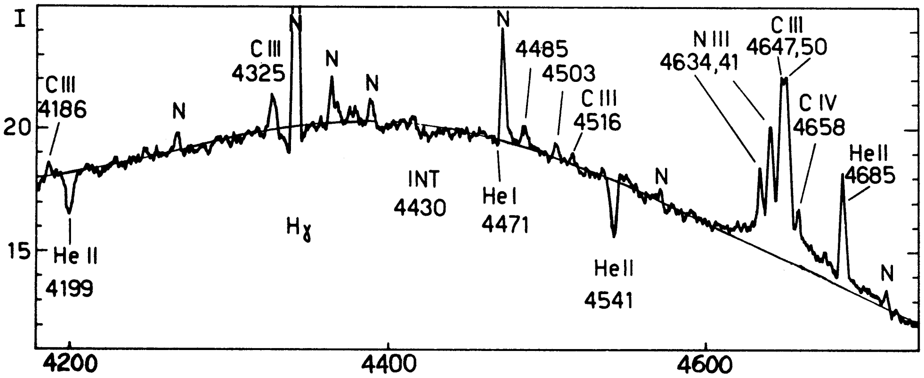

Fig. 2. The same as Figure 1, from 4180 to 4720 A.

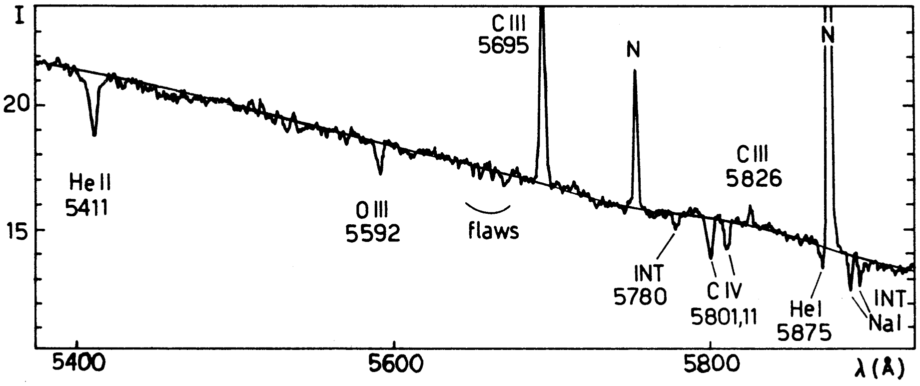

Fig. 3. The same as Figure 1, from 5400 to 5900 A

velocities of several absorption and emission features are listed in Tables 1 and 2, followed by the corresponding averages and root-mean-square errors for each feature. The adopted rest wavelengths are listed in Table 3.

We have checked the behavior of both image-tube spectrographs using the nebular and interstellar lines as "standards". In Figures 4 to 6 we have plotted the radial velocities of the "standard" lines as a function of the velocity of some stellar absorptions. We find the stability of both spectrographs to be acceptable. We estimate that the uncertainty in the radial velocity of a single line of good quality is below 10 km s^{-1}. The average velocities

TABLE 3

NEBULAR, STELLAR AND INTERSTELLAR LINES MEASURED FOR RADIAL VELOCITIES

λ (Å)	Identification	
4471.479	neb. em	He I
4541.59	st. abs.	He II
4685.682	st. em	He II
5411.524	st. abs.	He II
5592.37	st. abs.	O III
5695.92	st. em.	C III
5754.57	neb. em.	[N II]
5801.33	st. abs.	C IV
5811.98	st. abs.	C IV
5889.95	Interst. abs.	Na I

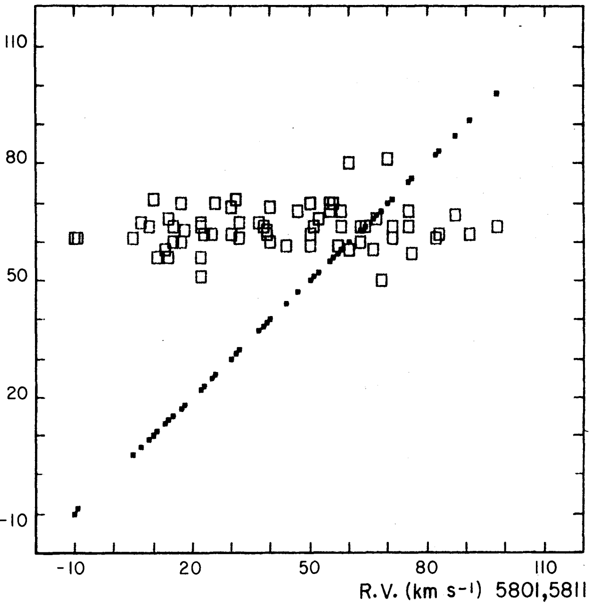

Fig. 4. The radial velocity of the nebular [N II] emission 5754 plotted as a function of the radial velocity of the C IV absorptions 5801, 5811. For comparison, the filled squares represent the C IV velocities as a function of themselves.

of the He I 4471 and [N II] 5754 nebular emissions are, from Tables 1 and 2 respectively, 66 and 64 km s^{-1}, in good agreement with other determinations.

Now let us consider the behavior of the C IV stellar absorptions at 5801 and 5811 Å. All the C IV values listed in Table 2 are averages of the corresponding velocities for these two lines. Both profiles are of good quality, and we do not expect individual errors larger than, at most, 15 km s^{-1}. In fact, we have eliminated from Table 2 three spectrograms which yielded for 5811 velocities differing more than 30 km s^{-1} from that of 5801.

We immediately notice substantial variations, far exceeding the expected errors. The frequency distribution of velocities shows two peaks, as expected for periodic or quasi-periodic variations (see e.g., Schlesinger 1915). In Figure 4 we see that the average C IV velocity falls substantially below the nebular velocity (see also Table 2).

Now let us consider other absorption lines; Figures 7 and 8 show that, although their profiles are not as good

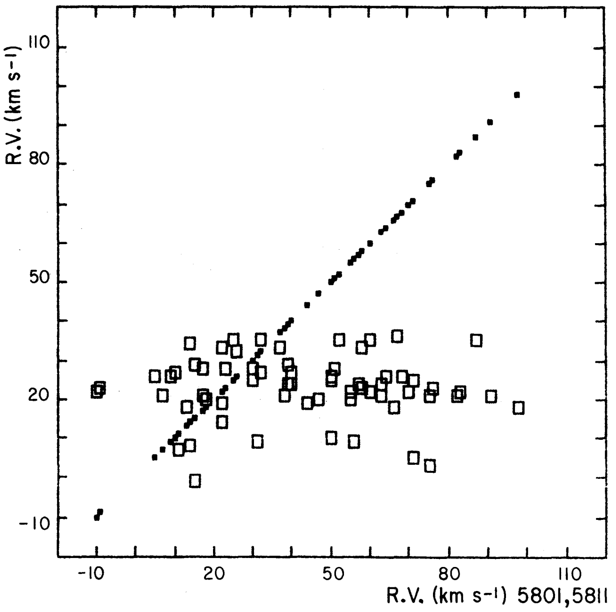

Fig. 5. The radial velocity of the interstellar Na I absorption 5889 as a function of the radial velocity of C IV. Filled squares as in Figure 4.

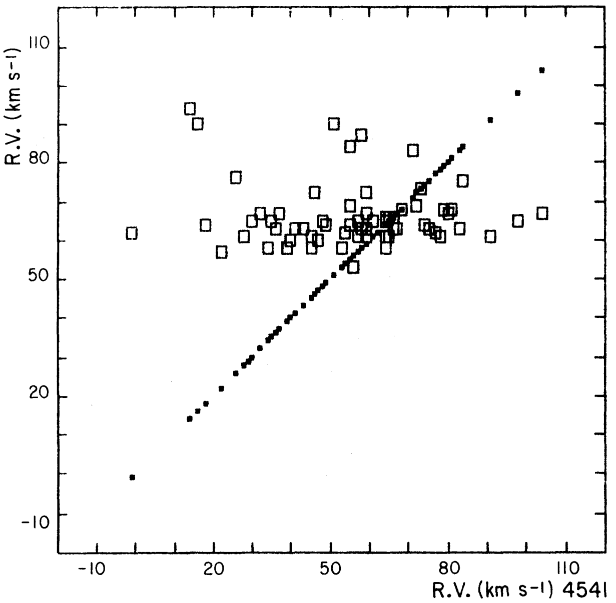

Fig. 6. The radial velocity of the nebular He I emission 4471 as a function of the radial velocity of the He II absorption 4541. For comparison, the filled squares represent the velocities of 4541 as a function of themselves.

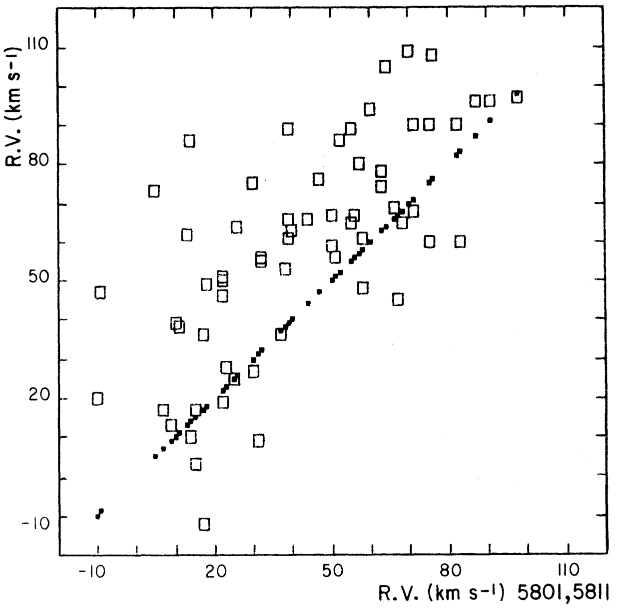

Fig. 7. The radial velocity of the stellar He II absorption 5411 as a function of the radial velocity of C IV. Filled squares as in Figure 4.

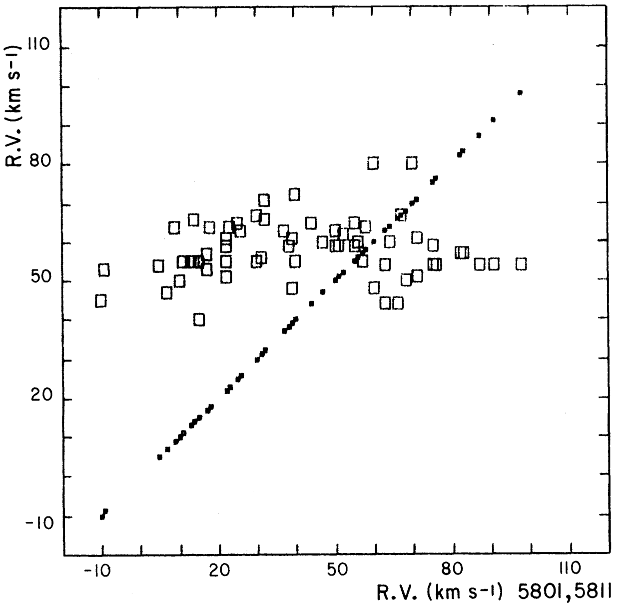

Fig. 9. The radial velocity of the stellar C III emission 5695 as a function of the radial velocity of C IV. Filled squares as in Figure 4.

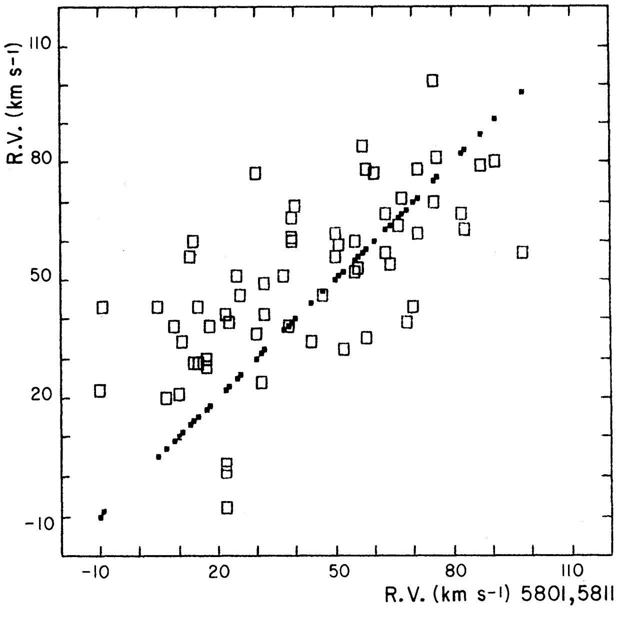

Fig. 8. The radial velocity of the stellar O III absorption 5592 as a function of the radial velocity of C IV. Filled squares as in Figure 4.

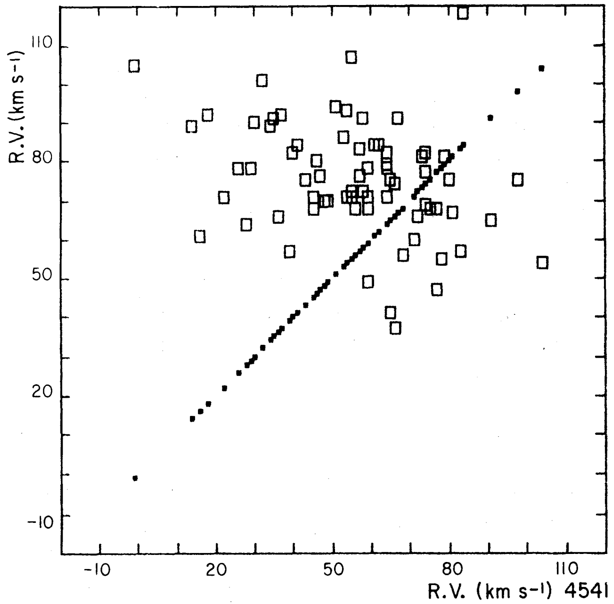

Fig. 10. The radial velocity of the stellar He II emission 4685 as a function of the radial velocity of the He II absorption 4541. Filled squares as in Figure 6.

as those of C IV, there is a clear positive correlation of He II 5411 and O III 5592 with the C IV absorptions; that is to say, all the absorptions move in phase. It is also clear that both He II and O III are not as blueshifted as C IV, this indicates the existence of a velocity field in the region where these absorptions are formed.

Turning now to the stellar C III emission, we see in Figure 9 that it does not vary significantly. A slight tendency towards negative correlation, previously suggested by Méndez and Verga (1981), has not been confirmed by the new material. On the other hand, it has been possible to confirm (see Figures 10 and 11) that the radial velocity of the stellar He II 4685 emission tends to change in antiphase with the velocity of the

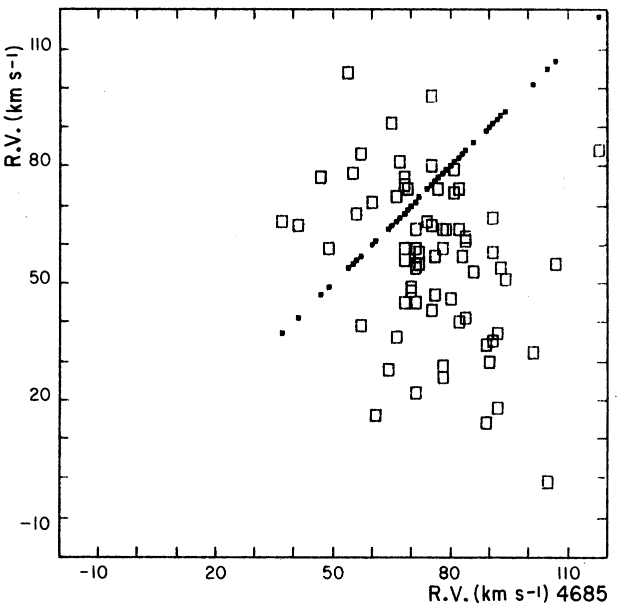

Fig. 11. The radial velocity of the stellar He II absorption 4541 as a function of the radial velocity of the stellar He II emission 4685. For comparison, the filled squares represent the velocities of 4685 as a function of themselves.

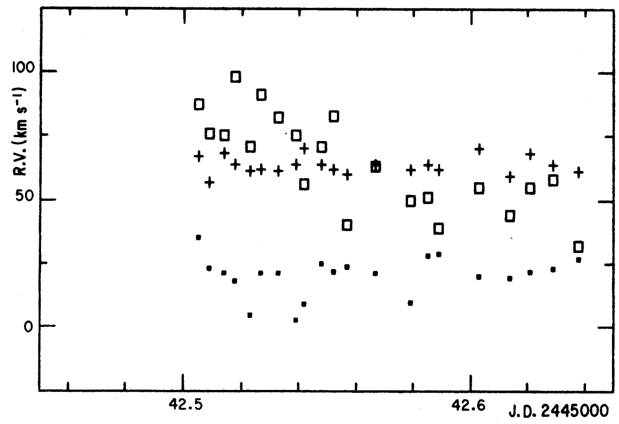

Fig. 12. The radial velocities of C IV 5801, 5811 (open squares), [N II] 5754 (plus signs) and Na I 5889 (filled squares) plotted as function of time on JD 2445042.

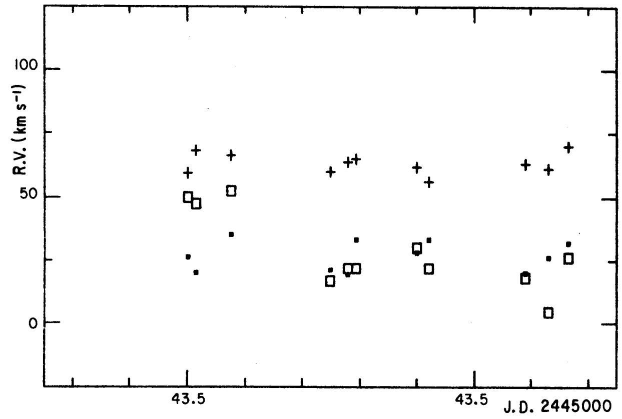

Fig. 13. The same as in Figure 12 for JD 2445043.

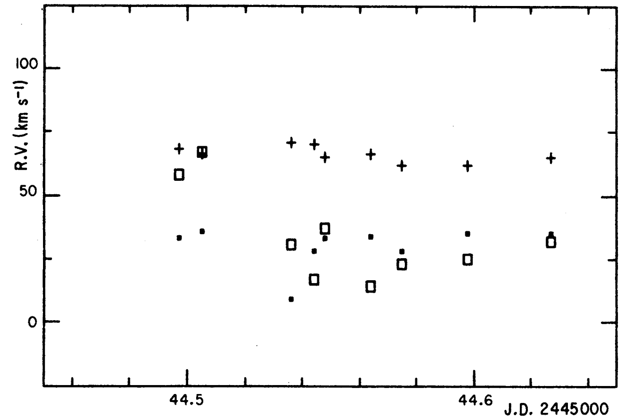

Fig. 14. The same as in Figure 12 for JD 2445044.

He II absorptions. We also note in Tables 1 and 2 that the mean radial velocities of the C III 5695 and the He II 4685 stellar emissions turn out to be slightly smaller and larger, respectively, than the nebular velocity.

Having established the reality of the radial velocity variations, we now consider if they are periodic.

IV. A SEARCH FOR PERIODS

We shall initially restrict our attention to the 66 C IV absorption velocities, which are more reliable. We have made an extensive period search using the method of Lafler and Kinman (1965). We have tested all significantly different periods between 0.05 and 2.5 days, with negative results.

However, we are reluctant to conclude that the radial velocity variations are not periodic. Figures 12, 13 and 14 show the behavior in time of the C IV absorption velocities, on three consecutive nights, compared with nebular and interstellar velocities. We see what appear to be three pieces of radial velocity curve, all compatible with a period of the order of 0.2 days, but with a different gamma velocity; sometimes near the nebular velocity (JD 5042), and more frequently blueshifted by about 30 km s^{-1} (JD 5043 and 5044; also JD 4649, which we have not plotted for brevity).

We have therefore investigated if there can be an orbital motion partially masked by a variable velocity field. For that purpose we selected from Table 2 the 49 C IV radial velocities corresponding to the 4 nights mentioned above, which are the only ones that can be used to reconstruct a piece of radial velocity curve. Starting with JD 5043 and 5044 only, we found several possible periods. Next, we subtracted 28 km s^{-1} from all the velocities of JD

5042, and combined all four nights. The corresponding search produced more or less the same possible periods as before. The three best ones are:

0.165170 days, with $\theta = 0.400$,
0.247859 days, with $\theta = 0.421$,
0.198237 days, with $\theta = 0.424$,

where θ is the test parameter defined by Lafler and Kinman.

Figure 15 shows the 49 C IV velocities plotted as a function of phase, for each of the possible periods. None of them can be rejected. Plots of the radial velocities of He II 5411 and O III 5592 are similarly inconclusive; additional full-night observations will be necessary to reach a more definite conclusion.

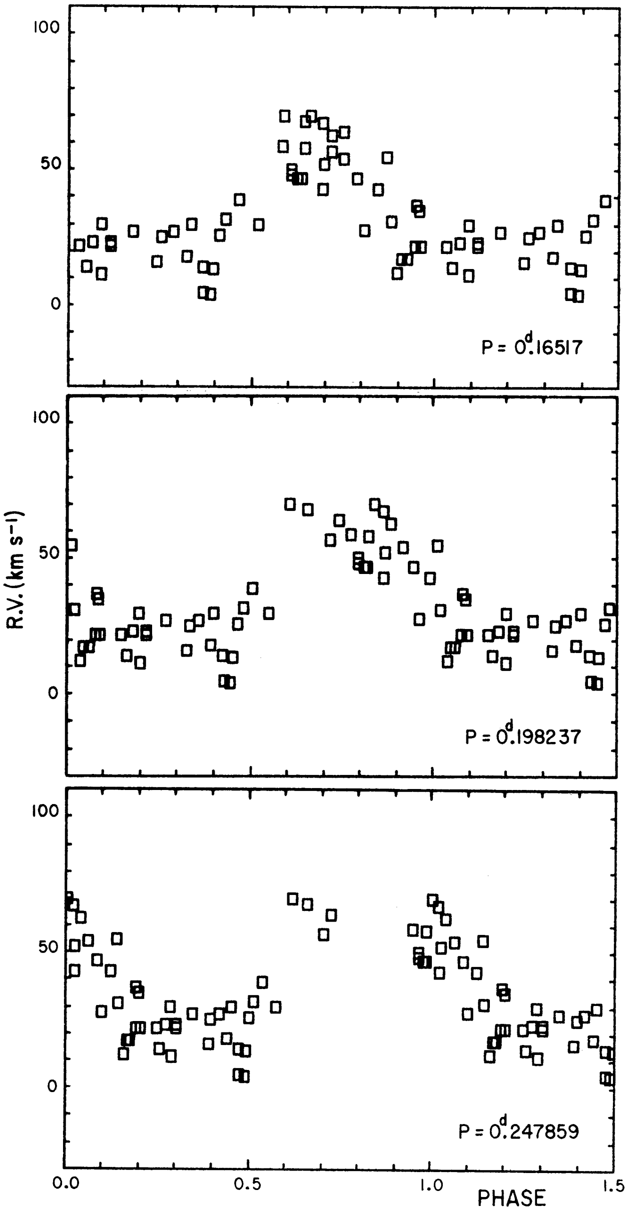

Fig. 15. 49 C IV absorption velocities plotted as a function of phase for each of the three best possible periods. An arbitrary $t_0 = 2443800.0$ was adopted.

In summary, at the present time we can say that a velocity field is present, is variable, and shows hints of a cyclical behavior. We are not yet able to decide if a suitable model to explain these phenomena has to include orbital motions or not; the first alternative is not incompatible with the available data, but it still needs confirmation.

V. PHOTOELECTRIC PHOTOMETRY

The photoelectric photometry of HD 35914 was performed with the CTIO 91-cm telescope in 1983 January 4-8. The measurements were made relative to the 9th magnitude star HD 35734, using the *y* filter of the Strömgren *uvby* system (CTIO set No. 4) and cold box No. 57 with an ITT FW 130 (S 20) photomultiplier. The sky measurements were always made 30 arc seconds south of each star. The selected diaphragm had a diameter of 24 arc seconds on the sky, in order to include the whole nebula and minimize the influence of seeing and guiding. The contribution of nebular light was not important, because the *y* filter does not transmit strong nebular emissions. Of course, a small contribution from the nebular continuum and some weak nebular emissions must be present, but it is not expected to have any effect on our conclusions.

A mean value of 0.17 was adopted for the atmospheric extinction coefficient. Since the comparison star HD 35734 is not known to be variable, and its instrumental magnitudes have not shown any evidence of variability (see Figure 16), we have plotted in Figure 17 the *y* magnitude differences, (HD 35914 – HD 35734).

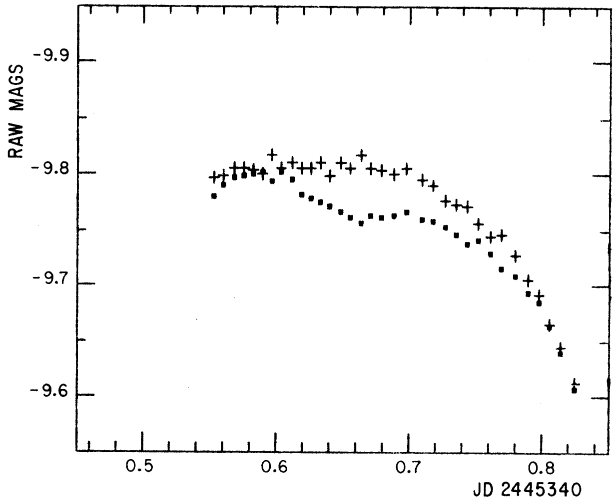

Fig. 16. Raw instrumental *y* magnitudes, not corrected for the effects of atmospheric extinction, of HD 35914 (filled squares) and the comparison star HD 35734 (plus signs), corresponding to JD 2445340. For an easier comparison, we have added 0.55 mag to the magnitudes of HD 35734.

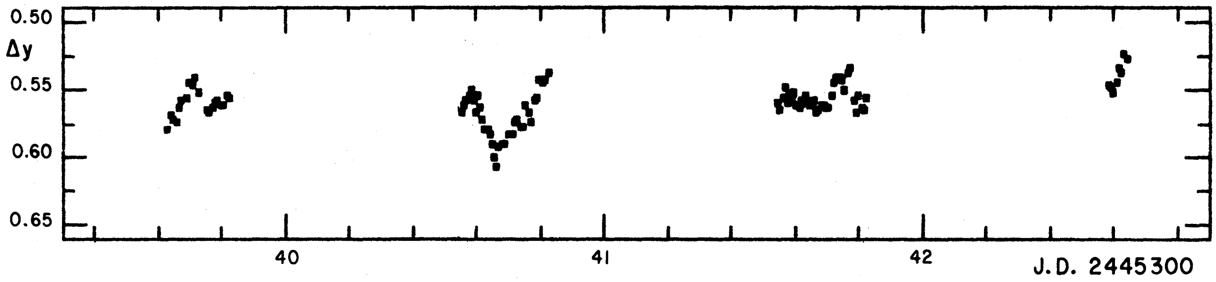

Fig. 17. The *y* magnitude differences, HD 35914 – HD 35734, plotted as a function of time.

The first three nights were of good photometric quality; the observations during the last one were interrupted by clouds. The data acquisition was computer-controlled via "People's Photometry II" (see details in the CTIO Facilities Manual). The integration times were as long as necessary (normally less than 30 seconds) to ensure a theoretical precision of 0.3%. An inspection of the raw instrumental magnitudes of the comparison star (see Figure 16) indicates that the uncertainty of an individual measurement is certainly not larger than 0.01 mag. This is enough to ensure that the reality of the variations shown in Figure 17 is out of question.

A period search using the *y* magnitude differences has not been successful. In particular, none of the three possible periods discussed in Section 4 produces a light curve (see Figure 18). Therefore, the light variations do not appear to be periodic; although we should remark that from such a limited amount of data we cannot exclude the existence of two or more superposed periods, as in the case of Beta Cephei stars (see Section 6).

VI. DISCUSSION

We would like to start the discussion by pointing out that orbital motion alone is not enough to explain the observed radial velocity variations; a careful analysis is necessary.

There are clear evidences of mass outflow in the atmosphere of HD 35914: In the visible spectrum, the presence of many emissions, and the blueshifts of absorption lines relative to the nebular velocity; in the ultraviolet, the P Cygni profile of the C IV resonance doublet at 1549 Å (Harrington *et al.* 1980). In Section 3 we have shown that the velocity field in the photosphere is variable: sometimes (e.g., J.D. 5042) the average photospheric outflow velocity in the region where the C IV absorptions 5801, 5811 are formed, which is usually of the order of 30 km s^{-1}, decreases to essentially zero. This seems to happen without any substantial change in the appearance of the stellar spectrum.

At the present time we do not want to risk an interpretation of these outflow fluctuations, because there are a few important questions we cannot answer yet. What is the real time scale of the velocity fluctuations, one day or a few hous? Is there sometimes mass inflow

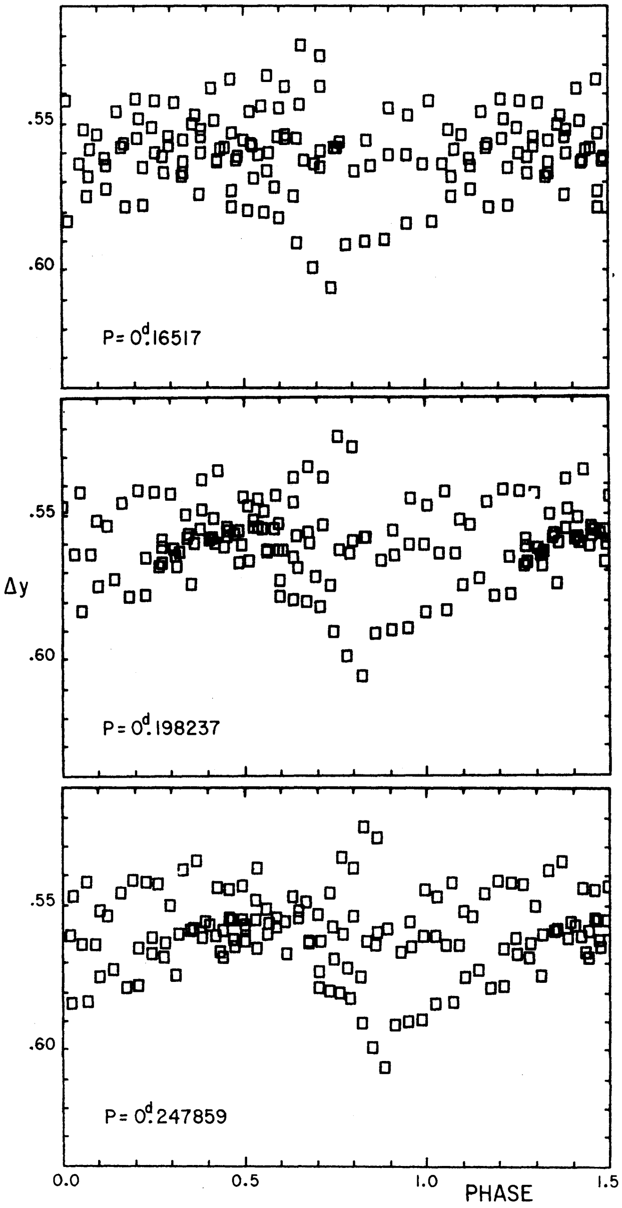

Fig. 18. The *y* magnitude differences plotted as a function of phase for each of the three best possible periods mentioned in Section 4. We adopted the same arbitrary t_0 = 2443800.0 as in Figure 15.

or not? The answers to these two questions depend on the existence or not of orbital motion in a binary system, or of pulsations.

Although we are inclined to believe that we are dealing with a close binary, we cannot definitely rule out the alternative of non-radial pulsations. The variable objects which are nearest to IC 418 in the HR diagram are the Beta Cephei and 53 Persei variables (see e.g. Smith 1980), and one might conceivably suggest that HD 35914 is doing something similar. We consider this alternative to be unlikely; in fact, we can safely exclude a radial pulsation as the dominant phenomenon, because there is no hint of periodicity in the photometric data. Besides, the visible light amplitude would not appear to be much smaller than that reported by Gilra *et al.* (1978) in the ultraviolet; although the observations were not simultaneous, this would tentatively speak against significant variations of the surface temperature.

However, from our limited photometric data we cannot completely exclude the possibility of multiperiodic phenomena associated with non-radial pulsations; the periods and amplitudes of the variations would not be inconsistent with what we have observed. A higher spectral resolution would be necessary to search for the absorption line profile variations usually associated with non-radial pulsators. Another check would be to obtain simultaneous information about light-and radial velocity variations. We prefer to delay further discussions until such observations are made. We hope to have shown that more observations of the central star of IC 418 will be rewarding.

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