Kodaikanal Obs Bull Ser A (1978) 2, 164-167

THE He II 5411Å VELOCITY CURVE OF THE WOLF-RAYET ECLIPSING SYSTEM HD 214419

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ABSTRACT

A velocity curve of the Wolf Rayet eclipsing system HD 214419 is obtained from measures on prismatic spectra of the He II 5411 emission line The shape of the velocity curve is unlike that obtained for He II 4686 The emission line exhibits some phase dependent changes

Key Words Wolf-Rayet stars - eclipsing binary—velocity curve

1 Introduction

Mclaughlin and Hiltner (1941) discovered the star to be a spectroscopic binary The eclipsing nature was found by Gaposchkin (1944) and it was further studied by Hiltner (1944) A recent velocity curve of this system has been measured for the N IV 4058 line and He II 4686 by Bappu and Viswanadham (1977) Photoelectric observations were first made by Hiltner (1950) at wavelengths of 5300 Å and 3550 Å Hiltner also derived a monochromatic light curve for the He II 4686 line Bappu and Sinvhal (1959) have derived similar light curves for He II 5411 and 4860 by the techniques of interference filter photometry In this paper, the velocity curve of this system is derived for He II 5411, and the orbital parameters calculated Phase dependendent changes in the profile of He II 5411 are also studied The aim of this investigation is to compare the velocity curve and other aspects of the He II 5411 line with similar characteristics studied for He II 4686 and N IV 4058Å

2 The Observations

The spectrogram used in this analysis were obtained in 1951-52 by Dr Bappu with the single prism glass spectrograph on the Mount Wilson 60-inch reflector The spectra have a dispersion of 160Å mm^{-1} at 5500Å The radial velocities measured for the emission line He II 5411 as well as the violet absorption edge, whenever seen, are given in Table 1. The phases are calculated on the basis of the photoelectric period and epoch of primary minimum

Table 1 Radial Velocities of He II 5411

Sl No	Phase (days)	V_E km s^{-1}	V_A km s
1	0 024	− 69	
2	0 102	− 116	
3	0 138	46	
4	0 142	− 119	
5	0 170	− 107	
6	0 202	− 107	
7	0 203	− 138	
8	0 287	16	280 0
9	0 327	16	238 0
10	0 370	64	242 0
11	0 381	01	
12	0 400	46	
13	0 446	02	220 0
14	0 66	− 78	
15	0 622	+ 30	
16	0 700	− 39	
17	0 774	− 147	
18	0 84	+ 282	
19	0 864	− 286	
20	0 924	− 364	+ 80 0
21	0 996	− 372	+100 0
22	1 06	+ 336	− 118 0
23.	1 127	− 369	
24	1 316	− 371	
25	1 609	− 182	
26	1 669	− 185	
27	1 823	+ 149	

V_E Velocity for the centre of emission line

V_A Velocity for the centre of absorption edge

as given by Hiltner (1960) The velocity curve provides a value of K of 230 km s^{-1} with the systemic velocity as 176 km s^{-1} The eccentricity derived is 0.95 The He II 5411 line, thus does not exhibit the eccentricity shown by the velocity curve of He II 4686 The eccentricity is closer to that shown by N IV 4058 There are, however, some major differences between the velocity curves of 4058 Å and 5411 Å One principal aspect is of course the value of K A partial contribution to the difference can be explained by the fact that a violet absorption edge is visible for 5411 Å for a good portion of the period while it is absent for 4058 Å Figure 1 is a plot of

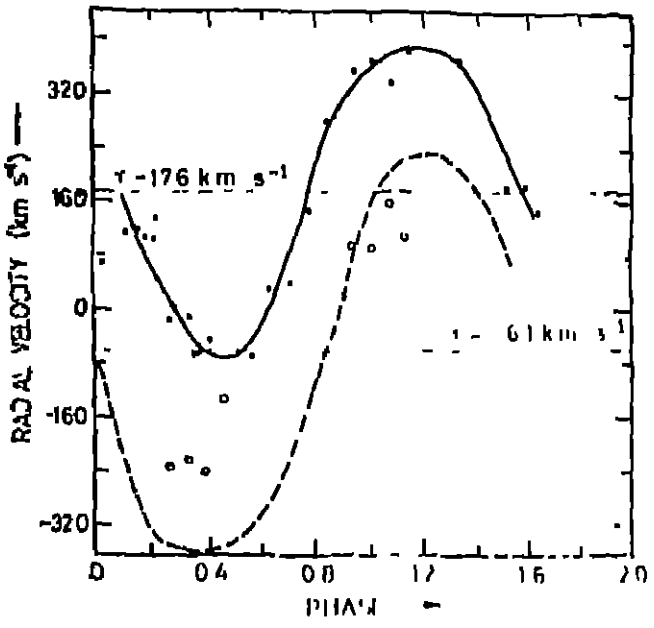

Fig 1 Upper curve is the velocity curve of HD 214419 from He II 5411 Filled circles represent emission and open circles, the violet absorption edge Lower one is the velocity curve of HD 214419 from N IV 4058 obtained by Bappu and Viswanadham (1977)

the two velocity curves The most striking feature is the difference in values of the γ-axis Also plotted in this curve are the absorption edge velocities of 5411 Å which are observable in the vicinity of the two elongations, when the values of velocity are largest, both of approach and of recession A curious aspect is the fact that, the most negative of the 5411 violet-absorption edge velocity values, are still more positive than the velocities exhibited at the same phases by the N IV emission line 4058 Å This shows that the γ-axis as determined for 5411 Å must have an intrinsically more positive value than that of 4058 Å, and is a clear indication that the region of emission of the 5411 Å line has dynamical characteristics different from the region that contributes to most of the 4058 Å radiation The striking difference in value of eccentricity between the 5411 Å and 4686 Å velocity curves can be explained by invoking peculiar fluorescence phenomena in the excitation of 4686 Å, in certain regions, that become visible at some phases and which disturb the appearance of the normal He II velocity curve Possible support for this conjuncture comes also from a study of the monochromatic light curves of Hiltner (1960) and of Bappu and Sinvhal (1959) which show the similarity in the abnormal behaviour of the emission line intensity Once again it becomes obvious that monochromatic light curves obtained in 4058 Å from the N IV line would be of the greatest interest

Table 2 Orbital elements obtained from different lines

	(1) HeII 4686	(2) NIV 4058	(3) HeII 5411
K	148 2 km s^{-1}	312 7 km s^{-1}	230 km s^{-1}
γ	117 5 km s^{-1}	−60 8 km s^{-1}	176 0 km s^{-1}
e	0 309	0 035	0 096
w	323°	98 7°	336° 28
I	–	0 010 days	1 5 days
a sin I	3 2 x 10^{6} km	7 1 x 10^{6} km	5 1 x 10^{6} km

Observers

1) Bappu & Viswanadham 1977
2) Bappu & Viswanadham 1977
3) Present work

3. Phase dependent changes in the line profile of He II 5411

Figure 2 shows a set of profiles of the emission line 5411 Å reduced to the intensity of the continuum Near phases close to the primary minimum, the line profile has a symmetrical appearance Similar to what has been found by Bappu and Viswanadham (1977), for members of the Pickering series in the blue region of the spectrum between phases 0.24 and 2.56, not only are the central intensities reduced considerably, but an asymmetry towards longer wavelength is caused by the absorption effects on the violet edge The profiles at the secondary minimum corresponding to the phase when the Wolf-Rayet star eclipses the companion also shows enhanced intensity in 5411 Å, and very soon after there is the effect of violet absorption that produces an asymmetry in the overall profile While these profiles have not been corrected for eclipse effects

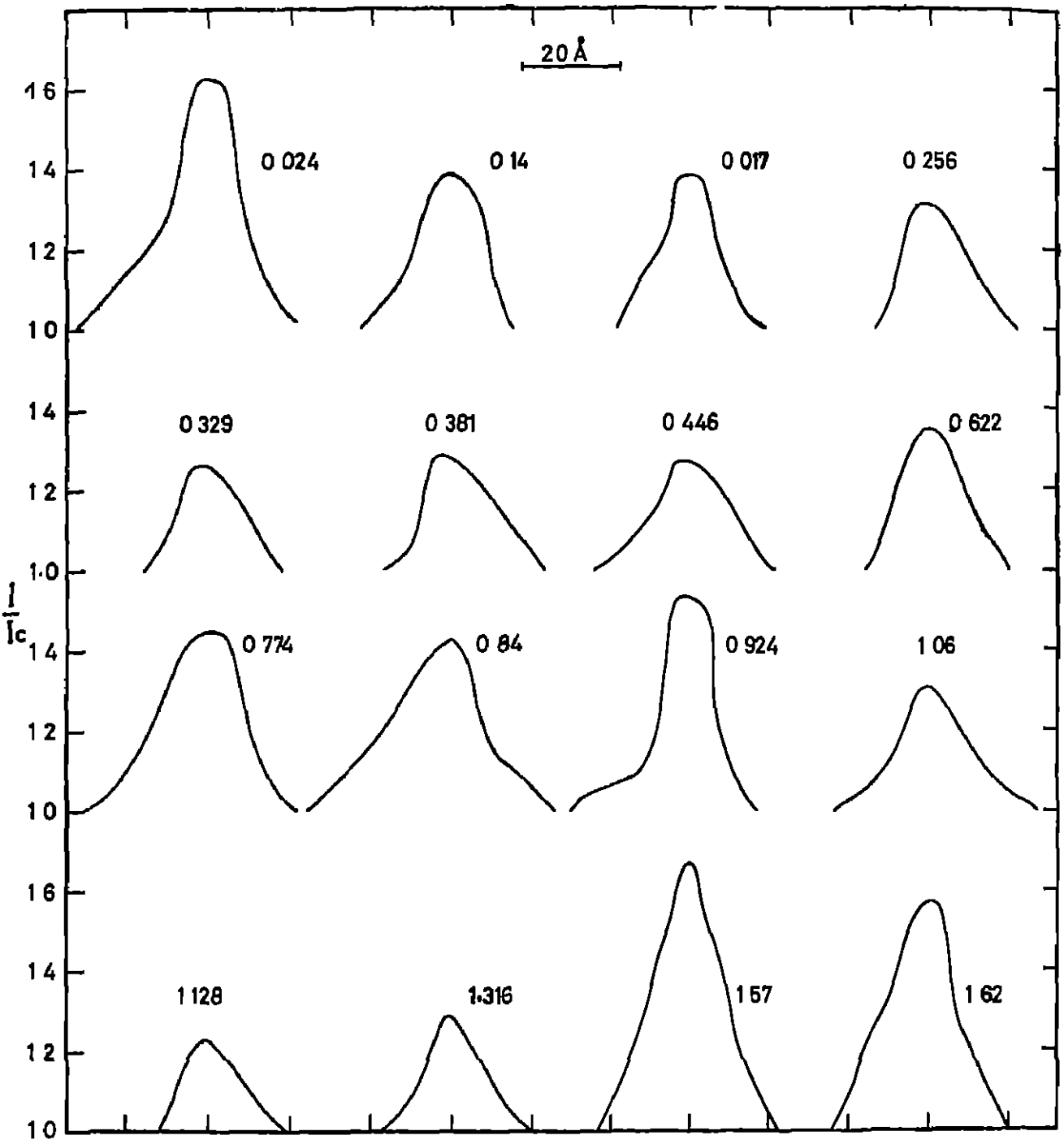

Fig 2 Line profiles of He II 6411 in CQ Cephei

in the continuum, it is still obvious that the intensity of the line is considerably more enhanced, at times of primary minimum and secondary minimum, than they are at phases outside these two points of conjunction. This finding provides qualitative support to the photoelectric results of Bappu and Sinvhal (1959)

Discussion

This investigation was undertaken in a search for dissimilarities, if any, in the performance of the helium lines, both as regards velocity and intensity. It is seen that the velocity curve obtained, even though the results are based on low dispersion

naterial, is sufficient to demonstrate the fact that he velocity of 5411 Å is different from that seen for 4686 Å. This conclusion establishes the need to postulate an anomalous behaviour of 4686 Å. This esult emerges principally from the fact that the shapes of the velocity curves are dissimilar. However, photometrically, the monochromatic light curves of hese two lines show some degree of similarity, and hence we need to postulate that the helium emission n this system comes from a region which differs from hat which produces most of the N IV 4058 Å radiation. One can therefore hardly exaggerate the need for a comprehensive monochromatic study of this system, in the light of several lines.

Acknowledgement

I wish to express my gratitude to Dr M K V Bappu for providing the spectra and also for many helpful discussions.

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