J. Astron. Space Sci. 11(1), 13-20 (1994)

THE SPECTROSCOPIC STUDIES OF THE LONG PERIOD ECLIPSING BINARY AZ CAS [1]

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(Received May 23, 1994; Accepted June 7, 1994)

ABSTRACT

Spectroscopic observations of the long period eclipsing binary AZ Cas were made using 122cm telescope/Image Tube. From the relatively sharp and strong spectral FeI lines we can calculate the mean radial velocity as −39.7 km/sec. The estimated equivalent widths of some atomic lines are well fitted to the phase of the AZ Cas.

1. INTRODUCTION

AZ Cassiopeiae is the spectroscopic binary which consists of a cool supergiant and a hot companion. It is a typical VV Cephei type eclipsing binary with the period of 3402 days(Herczeg and Bonnell 1976). However Cowley and Hutchings(1977) derived the mean period as 3404 days using the all observed data. The variation of the eclipsing duration was reported for AZ Cas(Larsson-Leander 1959, Tempesti 1975, Cowley, Hutchings and Popper 1977), which was interpreted as a change in radius of the primary star. The spectral type of primary cool star was assumed as M0Ib and the secondary as Be.

From the radial velocity survey of M supergiants in the Perseus arm measured from infrared spectra, Humphreys(1970) estimated the radial velocity of AZ Cas as −39.5 km/sec. Spectral line variations at different phases were reported by Cowley *et al.*(1977). At phase ∼ 0.98, CaII H & K, HeI, TiII, and Balmer lines appeared strong, which were interpreted as the result of the secondary B star's contribution

[1]이 논문은 교육부의 1993년도 기초과학연구소 학술연구 조성비로 수행된 것임.

through the extended outer atmosphere of the M star. The duration of the totality during eclipses varied from $\sim$ 86 days to the minimum more than 105 days(using the observed spectrograms by Cowley *et al.* 1977). From the observed spectral data, Cowley *et al.*(1977) estimated the diameter of the M supergiant as $600 \sim 700 R_{\odot}$. They estimated masses of AZ Cas as $15 M_{\odot}$ and $13 M_{\odot}$ for the M supergiant and the B main sequence star respectively. They also suggested that the initial mass of M star was $18 M_{\odot}$ and the significant amount of the mass loss by the Roche lobe overflow made the present mass of M star as $15 M_{\odot}$.

In this paper we made spectoscopic observations of the AZ Cas with the medium dispersion. The radial velocites and equivalent widths were estimated from these observed spectra.

2. OBSERVATIONS AND MEASUREMENTS

The 122cm reflecting telescope at Asiago Observatory in Italy were used for this observing runs. Image Tube was used and the linear dispersion at Hγ was 42 Å/mm. 103a-0 plates were used with the size of $4cm \times 5cm$. Comparison light source was FeI arc and the exposure time was 20 seconds. Observed materials are listed in Table 1. All plates were developed in D-19 at $20°C$ for 5 minutes, fixed in acid fixer and washed in filtered water.

Table 1. Observed spectra of AZ Cas.

Plate number	Exposure time
18250	8 min
18251	15 min

PDS microdensitometer (Perkin Elmer PDS1010 GMS) at the Korea Astronomy Observatory was used to scan spectral plates. Scanning size was $25\mu m \times 25\mu m$ with the scan speed of 100 cus(18mm/sec).

3. RADIAL VELOCITY AND EQUIVALENT WIDTH MEASUREMENTS

The 5th order transformation was used to calibrate pixels to wavelengths of the comparison arcs. The *rms* error of the wavelength is less than 0.2Å. The spectrum of AZ Cas was displayed for each wavelength region in Figure 1.

The non-linear least square fitting method was used to get the radial velocity. Fitted lines were relatively sharp FeI lines and these lines with the measured radial velocities are listed in Table 2. Figure 2 shows an example of this fitting to FeI line. The estimated mean radial velocity of AZ Cas is −39.7 km/sec. This value is very close to Humphreys'(1970) one.

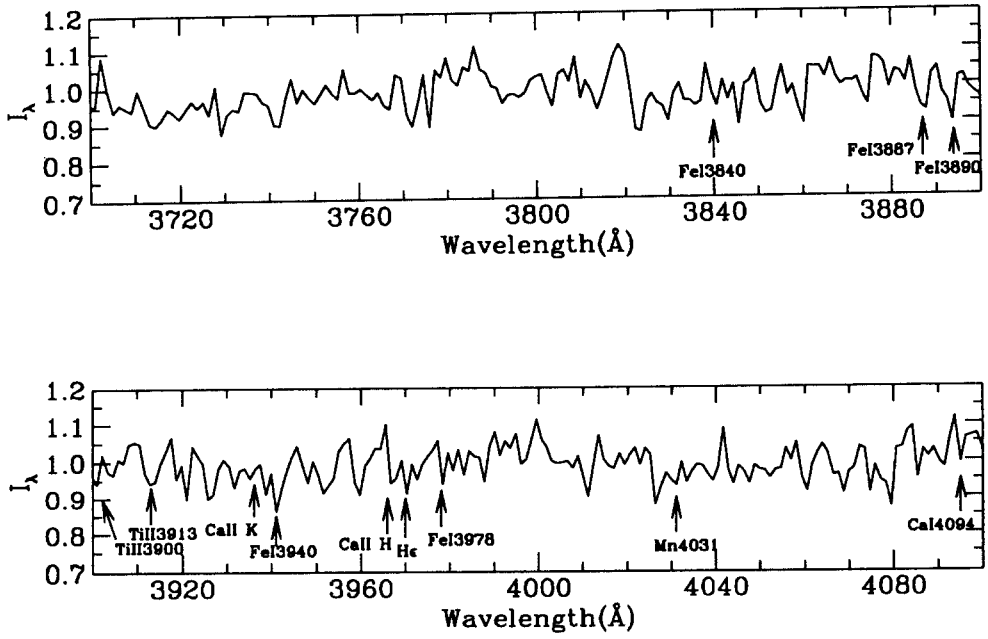

Figure 1. The spectrum of AZ Cas to the wavelength region. Balmer lines and TiII lines are strong feature while CaII K line is very weak.

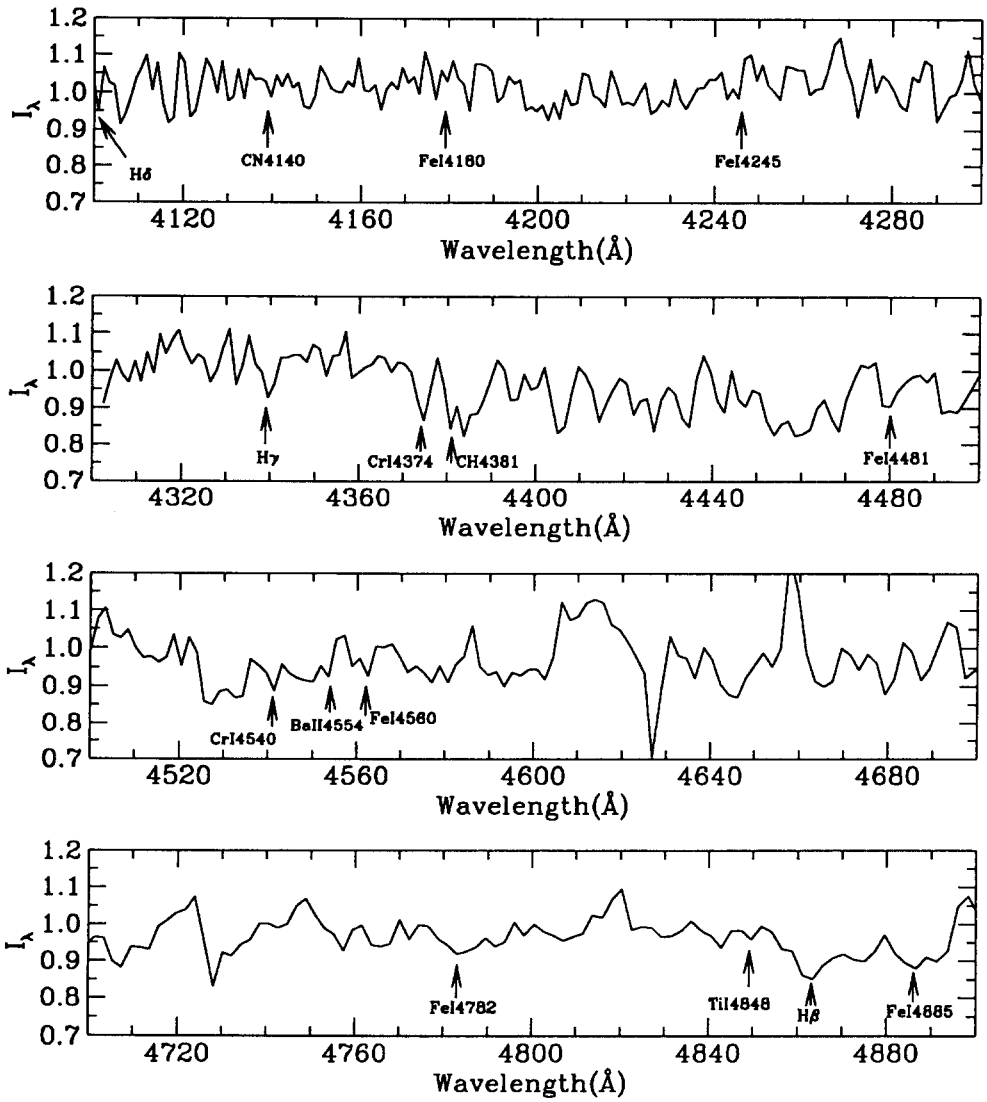

Figure 1. (continued)

Table 2. The radial velocities of FeI lines.

Reference(Å)	Observation(Å)	Radial Vel.(km/sec)
3843.71	3843.23	-13.5
3887.05	3886.99	19.3
3927.61	3926.28	-77.5
3972.92	3972.56	-3.2
3927.61	3926.28	-77.5
4031.72	4030.44	-71.2
4180.40	4179.31	-54.2
		mean -39.7

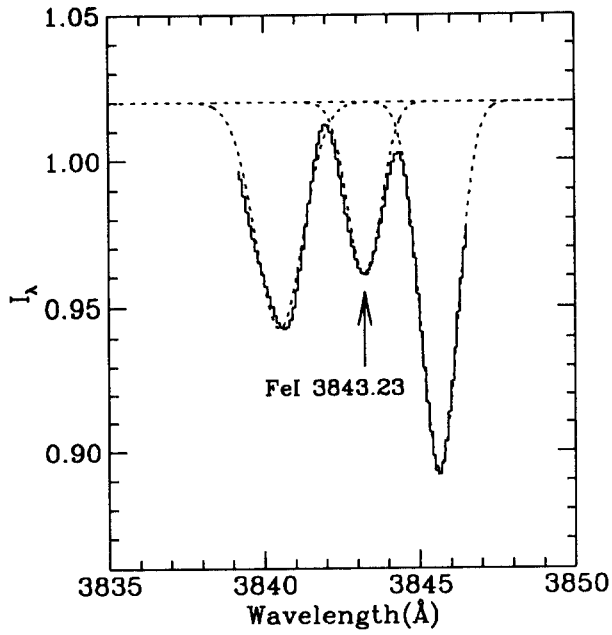

Figure 2. Non-linear least square fitting method was used to get the radial velocity. FeI line was used to this fitting.

Table 3. Equivalent widths of some FeI and Balmer lines.

References(Å)	-Log(W/λ)
FeI 3843.71	4.42
FeI 3887.05	4.25
FeI 3927.61	5.15
FeI 3972.92	5.37
FeI 4020.48	4.96
FeI 4031.72	4.63
FeI 4180.40	4.96
H 4861	3.61
H 4340	3.82
H 4101	4.25
H 3970	4.30

We measured equivalent widths of FeI and Balmer lines to get the curve of growth. The resulted equivalent widths are listed in Table 3.

4. DISCUSSIONS

To find the possible intensity variations of Balmer lines, we tried to measure the equivalent widths of some Balmer lines as Hβ, Hγ, Hδ, and Hϵ. Fitting to estimate these values are displayed in Figure 3. The mean equivalent width of these Balmer lines is 4.0 ± 0.3, which is very close to the phase. We plotted our calculated value with the data of Cowley *et al.* (1977) in Figure 4.

We also confirm the strong absorption feature of TiII bands. Specially TiII3913 is very strong. However CaII K is quite weak while CaII H line is moderate. The estimated radial velocity is very close to the phase.

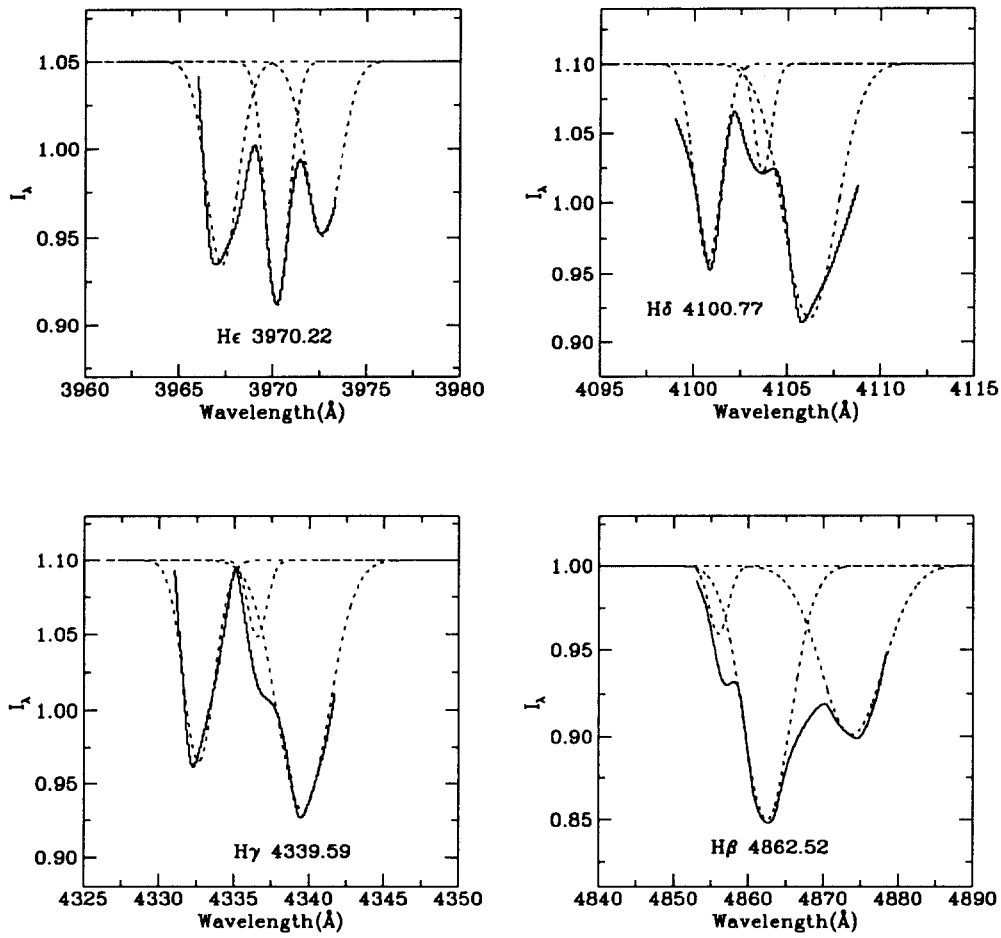

Figure 3. Fitting was made to estimate equivalent widths of Balmer lines.

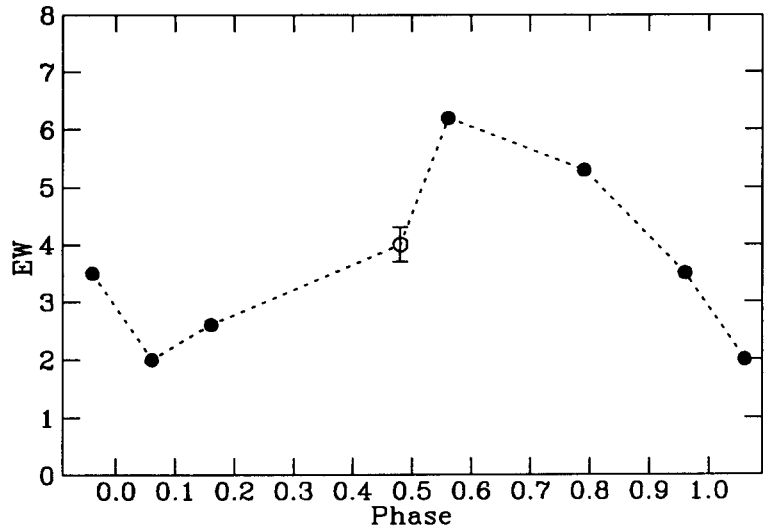

Figure 4. The estimated mean equivalent width of Balmer lines (open circle) is well fitted to the phase of AZ Cas (Cowley *et al.* 1977).

ACKNOWLEDGEMENTS: Observations were made at the Asiago Observatory and the measurements were made at the Korea Astronomy Observatory. We are grateful for the generosity of directors of both observatories. This work was financially surpported by the Ministry of Education, and we are grateful for this support.

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