THE 1979 ECLIPSE OF ZETA AURIGAE

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ABSTRACT

Observations of the system ζ Aurigae made around primary eclipse are described, and their significance is discussed in a preliminary fashion.

THE OBSERVATIONS

High-dispersion, long- and short-wavelength spectra of the atmospheric eclipsing binary star system ζ Aurigae (K2II + B8V) have been obtained during a total of ten observing sessions between September 15, 1979 and March 31, 1980. Dates of observations, corresponding to numbered positions in Figure 1 are: (1) Sept. 15, (2) Nov. 1, (3) Nov. 13, (4) Nov. 15, (5) Nov. 18, (6) Nov. 22, (7) Dec. 16, (8) Jan. 29, (9) Feb. 29, (10) Mar. 31. The spectrum obtained on Sept. 15 resembles the spectrum of a single late B-star (e.g. the B6V star σ Eri). Atmospheric effects are present and increasing in strength between Nov. 1 and Nov. 18. To a first approximation, the spectrum changes appear to be an increase in strength and number of absorption lines with changes in the undisturbed continuum being small. This point requires further study, however. On Nov. 22, the B star had passed second contact, and the spectrum of the system was a pure emission line spectrum. At mid-eclipse, on Dec. 16 the spectrum had changed but little from its appearance on Nov. 22. The egress spectra obtained in 1980 are not significantly different in appearance from the ingress spectra. A study of differences in detail is being undertaken now. Figure 2 shows the behavior of the Fe II resonance lines in three spectra.

Ionic spectra which are increasing in strength during the ingress atmospheric phases of the eclipse include: Al II, Al III, Cr II, Mn II, Fe I (?), Fe II, Fe III, Co II and Ni II. The Fe I identification remains in doubt since only multiplet UV7 has been identified so far.

DISCUSSION

The analysis of the ζ Aurigae spectra are still being carried out, and these remarks should be considered preliminary. The volume of data to be digested turns out to be quite large, and final conclusions will not be available for some time.

First, there is no evidence for the chromosphere of the K supergiant in our spectra--except possibly in the Mg II resonance lines. Estimates, based on observations of single late type supergiants by other IUE observers, led us to conclude that the exposure times required to obtain high dispersion spectra at mid-eclipse were in excess of 30 hours. In fact, good exposures were obtained in 2-3 hours. Furthermore, as mentioned earlier, the spectrum changed only slightly in the month from second contact to mid-eclipse, indicating that the physical conditions in the emitting plasma did not change significantly in the time period. We conclude that the emitting plasma is illuminated by the B star even at mid-eclipse. Thus, the emission probably arises in an extensive circumstellar shell which would appear as a bright "halo" around the supergiant.

In addition to the lines due to once ionized metals, both C IV and Si IV lines are present in the spectra. The C IV lines are typical of the two ions, (see Figure 3). Each of the C IV lines consist of a narrow line, near the rest wavelength, and a redward shifted broad line. The narrow line remains unchanged through the sequence of spectra, while the broad line increases in strength into the eclipse, and decreases in strength through egress, though its strength during egress is greater than during ingress. The narrow, constant component of each line is probably interstellar, while the broad component may be formed in a shock wave where the winds from the two stars interact. Highly turbulent motion in the shock wave can account for the breadth of the line profiles. We will continue to follow the system around its orbit to test this hypothesis.

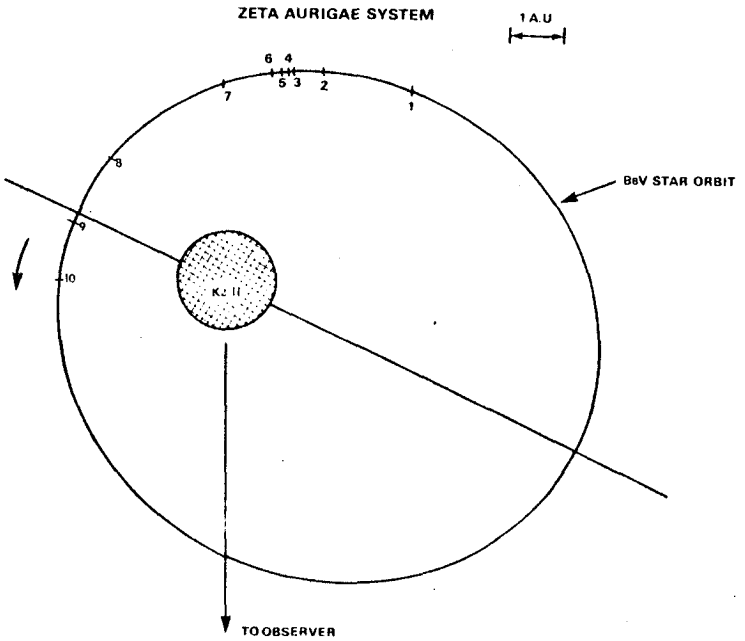

Figure 1

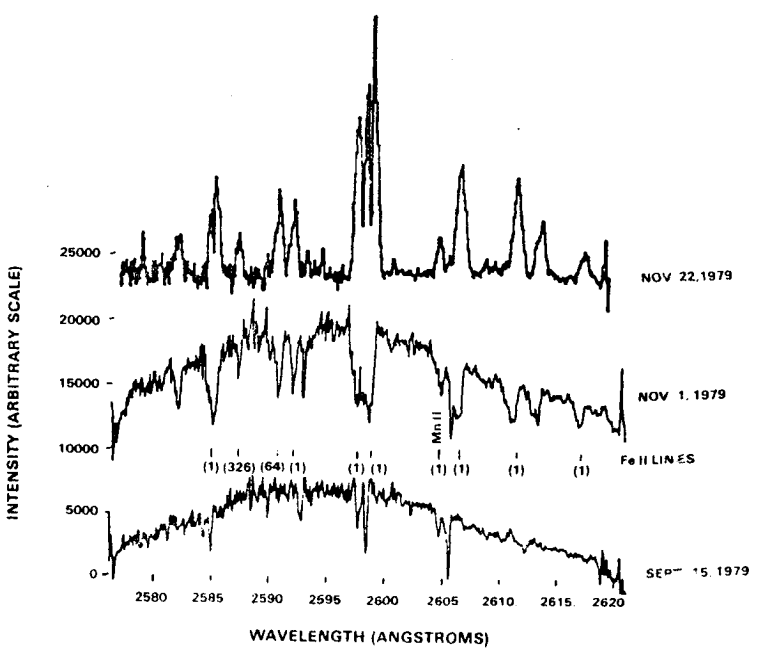

Figure 2

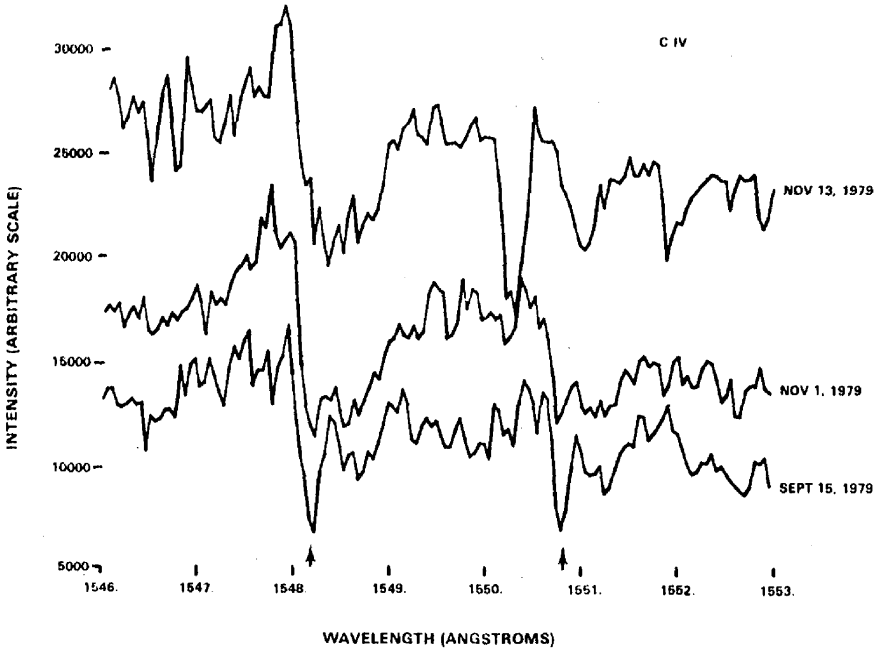
C IV
30000
25000
20000
15000
10000
5000
INTENSITY (ARBITRARY SCALE)
NOV 13, 1979
NOV 1, 1979
SEPT 15, 1979
1546.
1547.
1548.
1549.
1550.
1551.
1552.
1553.
WAVELENGTH (ANGSTROMS)

Figure 3