OPTICAL OBSERVATIONS OF CI CYGNI

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ABSTRACT

We report optical emission line variations in CI Cygni during the 1980 eclipse.

I. OBSERVATIONS

We have obtained high (H-alpha) and low resolution spectra of CI Cygni during and after the 1980 photometric minima. The high resolution program at Washburn Observatory is described in Anderson, Oliversen and Nordsieck (1980), while the low resolution program is desribed in Oliversen (1981).

The balmer decrement was used to correct the emission line intensities for reddening due to interstellar extinction. The case B recombination balmer line ratio of I(4340)/I(4861) is .47, while the observed line ratio was .40±.03. Comparison of the observed to the case B line ratio implies a total visual extinction of A_V=1.1±.5.

		I(5007+4959)/I(λ)				
JD	PHASE	λ 3869	λ 4363	λ 4686	λ 4861	λ 5876
2444375	.97	2.1	2.8	4.7	1.2	3.7
2444399	.01	3.2	2.6	5.5	1.3	3.5
2444463	.08	4.6	3.1	1.4	.75	2.4
2444485	.10	3.8	2.9	1.3	.67	1.5
2444721	.38	2.7	2.6	.83	.55	1.6
2444823	.50	1.9	2.6	.80	.40	1.5

Table 1. CI Cyg Observed Emission Line Intensity Ratio's

M. Friedjung and R. Viotti (eds.), The Nature of Symbiotic Stars, 153–156.

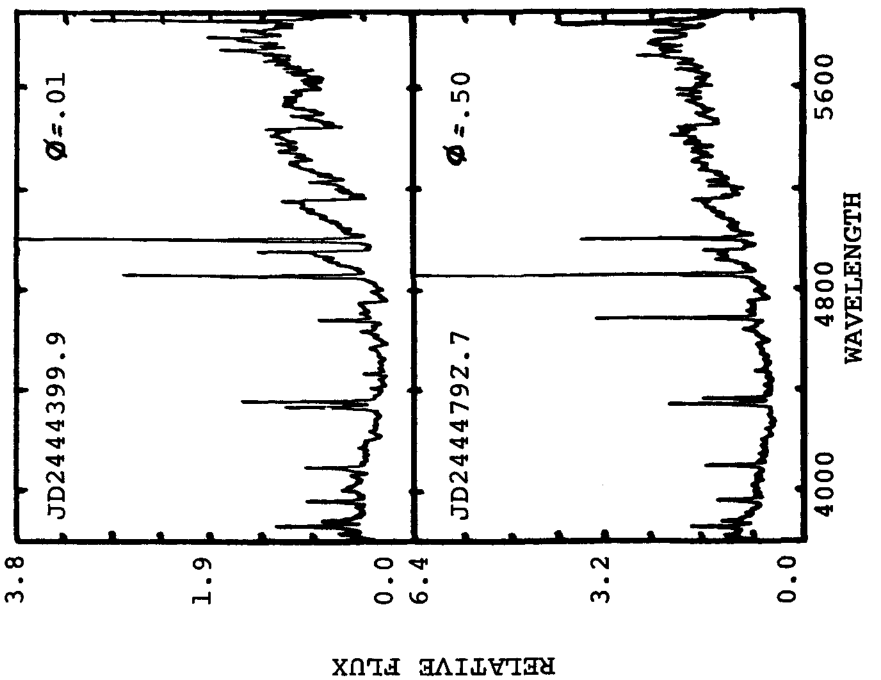

Figure 1. Low resolution spectra of CI Cygni.

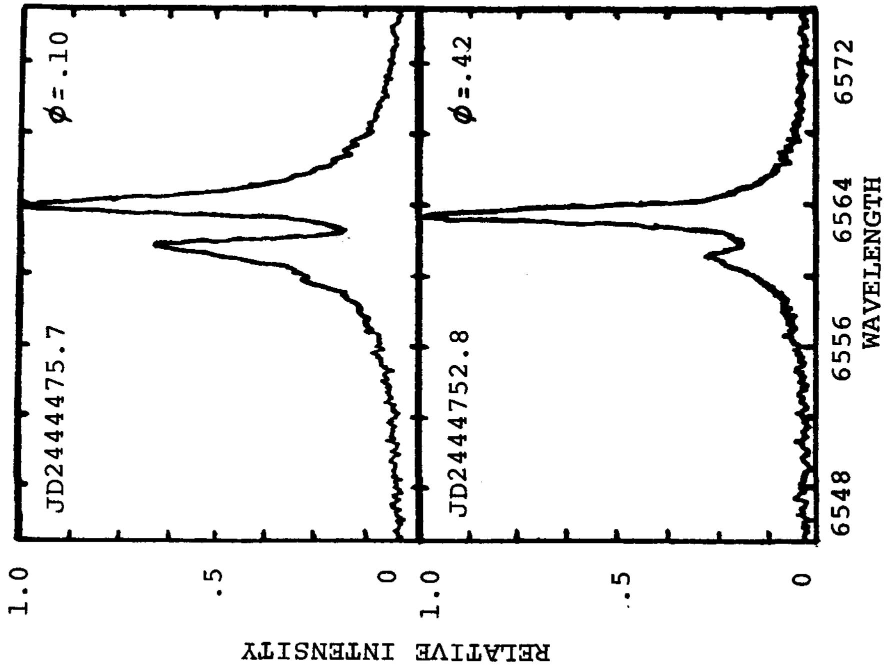

Figure 2. H-alpha profiles in CI Cygni.

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The observed line ratios of I(5007+4959)/I(λ) are given in table 1. The [OIII] λ4959 line occurs on top of a band head of TiO. The two features could not be resolved on our spectra. The line ratios quoted in table 1 assume a value of 2.93/1, which is the ratio of the spontaneous emission probabilities of 5007 and 4959A. Sample low resolution spectra (3800- 5900A) both in and out of eclipse are given in figure 1.

II. EMISSION LINE RATIO'S

The observed [OIII] line ratio varys irregularily where, I(5007+4959)/I(4363)=2.6±.3. Under conditions of high density (N_e>10^8 cm^{-3}) the [OIII] line ratio becomes insensitive to density changes. This places a lower limit on the temperature of about 10000K based upon the [OIII] emissivities as given by Nussbaumer and Storey (1981), and Keyes (1981).

The emission line ratio's of I(5007+4959)/I(λ) all correlated with the optical eclipse. The [OIII] emission comes from a more extended region than the emission lines of [NeIII] λ3869A, He I λ5876, He II λ4686 or H-beta, confirming Stencel's (1981) result. The spectra record relative flux, therefore we can not distinguish between no change in the [OIII] emission versus a slower decline compared to the other emission lines. The [NeIII] λ3869 emission reached its minimum slightly after the optical eclipse at phase .08.

III H-ALPHA EMISSION LINE PROFILES

Sample H-alpha profiles both in and out of eclipse are shown in figure 2. CI Cyg exhibits the usual asymetrical profile along with a blue shifted reversal. During the eclipse the blue-shifted absorption feature became deeper. The deepest reversal occured slightly after the optical eclipse at phase .08. The absorption feature's heliocentric velocity also appears to correlate with phase. At phase 0 the velocity of the central reversal was about -15 km/s and at phase .5 the velocity is about -31 km/s. At phases 0 and .5 the radial velocity due to binary motion of the hot source should be zero. Perhaps these velocity shifts arise in absorbing matter streaming from the red giant to the hot object.

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Stencel, R.E., Kafatos, M., Michalitsianos, A.G., and Boyarchuk, A.A. 1981, ApJ. In press.

DISCUSSION ON CI CYGNI

Boyarchuk: I would like to call your attention to the fact that CI Cyg is always brighter at mid of the eclipse than just after second contact or before the third one.

Slovak: A comment on the eclipse in CI Cyg as compared to the eclipse in AR Pav. CI Cyg appears to reach the same minimum light at mid-eclipse, whereas AR Pav varies by approximately 0.5 mag from "bright" eclipses to quiescent eclipses. Thus the accretion disk in CI Cyg appears very small and with no visible hot spot. The accretion disk in AR Pav, however, varies significantly from eclipse to eclipse.

Mikolajewska: HeII λ4686 was not visible in 1971 and 72, but was very wide and strong in 1976. These variations are not related to the eclipses.

Rudak: I would like to ask Dr. Michalitsianos to briefly summarize the main parameters of CI Cyg, and to mention those observational facts for which an accretion disk geometry of matter around the hot component is necessary.

Michalistianos: For a 3 to 7 $M_\odot$ system the semi-major axis for the orbit is $a \approx 3.8$ to $5.0\ 10^{13}$cm. The duration of the eclipse is approximately 0.2 of the orbital period ($\sim$880 days). Thus the radius of the primary is $\sim$0.38a. The Balmer continuum absolute flux that we assume arises from a disk is f_λ(2500-3646A) $\approx 8\ 10^{-11}$ erg cm^{-2}s^{-1}A^{-1} after correcting for E(B-V)=0.5. This gives L(disk) $\approx$ 67 $L_\odot$. About 1/3 of the observed luminosity arises from the disk. The primary may just fill its Roche lobe.

Kafatos: We have found from the duration of the eclipse that if the mass ratio between the two stars is 1:1, then the red giant is just filling its Roche lobe, but if the mass ratio is larger than that, it does not. Very probably, during quiescence the red giant does not fill its Roche lobe.

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