SPECTRAL ANALYSIS OF THE ECLIPSING VARIABLE V471 TAURI (BD+16°516)

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Abstract. Spectroscopic observations of the white-dwarf eclipsing binary V471 Tauri are reported. The behaviour of the H and K emission lines of Ca II are investigated relative to the photoelectric observations, and the existence of a probable correlation between minimum emission line strength and the maximum wave position within the migrating wave is demonstrated.

1. Introduction

The eclipsing variable V471 Tauri was first discovered as a spectroscopic binary by Wilson (1953), from the spectra secured at the Mount Wilson Observatory. The spectral type of the star derived from the spectra obtained at the Kitt Peak Observatory, from rotationally broadened absorption lines of various elements and strong absorption lines of singly-ionized calcium (H and K), indicated that the star has a spectral type of K0V. The star has been investigated very little and those are mainly photoelectric. In 1970, the system has been observed in UBV by Nelson and Young (1970) and the light variation curve with a single deep minima was obtained, from which the binary nature of the star was discovered. In 1971, Hills using Nelson and Young's (1970) observations obtained the effective temperature to be of the order of 64 000 K for the white dwarf companion of the star and for this white dwarf companion proposed to be hottest and youngest among the known white dwarfs. The proper motion of the star was determined and discovered that its value is almost identical with that of Hyades Cluster (Van Albada, 1973). The estimated mass of the white dwarf was given as 0.79 M⊙ (Young and Nelson, 1972) and presumed to have an age of about 10⁷ yr (Sandage, 1957; Hodge and Wallerstein, 1966). The present evolutionary state of the star was attempted to be explained by mass loss and mass transfer (Hills and Dale, 1974). Later the star was observed in three colours and its geometrical elements were computed, for the changes in the light curve the ideas was adopted that either some material existed around the stars or some intrinsic variability existed in one component (Cester and Pucillo, 1976). The radial velocity of the star was obtained by Young (1976) where it was claimed that the radial velocity obtained from the absorption lines of various elements and from the Ca II (H and K) lines in emission were in good agreement within the limits of their uncertainty. It was also reported that Hα was observed in emission at 0.5

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orbital phase, suggesting some mass-transfer between the components (Lanning and Etzel, 1976). The system has also been observed at the Observatory of Ege University from 1973 to the present, and continuous changes have been observed within the light curve (Ibanoğlu, 1978; Tunca et al., 1979). In the present study, the correlation is sought between the spectroscopic and photoelectric observations. For this purpose the latest light curves were examined and probable correlation sought for between the peak position of the migrating wave and intensity of the H and K emissions of Ca II.

2. Observations

The star has been spectroscopically observed at the Astrophysical Observatory of Asiago in February and March 1980, with a 122 cm Cassegrain telescope, prism spectrograph and RCA image intensifier tube with 42 and 40 Å mm⁻¹ dispersions at 3933.66 and 3968.47 Å, respectively. The 22 spectra were obtained corresponding to different orbital phases. The exposure times of the spectra were varied according to the region wanted to be recorded and analysed. For the red part of the spectra (line width 0.1 mm in the ocular and 35 microns on the photographic plate, height of the spectra 2 mm on the plate) 7 min of exposure appeared to be most suitable for the analysis of this region, whereas for the H and K region of the spectra 22 to 30 min of exposure times were required.

3. Measurements of the Spectra and their Reductions

Each spectral line (absorption) was measured five consecutive times with respect to iron comparison lines and average (S) of the measurements were adopted and used in the calculation of the geocentric and heliocentric wavelengths, Figure 1. In the spectra 12 absorption lines could have been identified from the Stellar Spectra Atlases such as the Atlas of Cooler Stars (Keenan and McNeil, 1976) and Low-Dispersion Grating Stellar Spectra (Abt et al., 1968). The calculated geocentric, heliocentric wavelengths and their rest values, the elements they belong to and their excitation potentials are given in Table I, for the plate number 13156 obtained on March 3, 1980 at 19:00 GMT (JD 2444302.292) and orbital phase 0.320. K is defined as

\[ K = \frac{\lambda_{\text{heliocentric}}}{\lambda_{\text{geocentric}}} \]

and it was determined from the heliocentric radial velocity of the Earth relative to the Sun. In Table II, the heliocentric wavelengths, their rest values and the heliocentric radial velocities are given. The standard error made in the measurements was determined from

\[ \mu = \frac{\sigma}{\sqrt{n}}. \]