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Notes on the Spectrum of γ UMi

by

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ABSTRACT

High dispersion spectrograms of γ UMi taken on August 31, 1969, show only rotationally broadened absorption lines with no shell component. The Hγ profile is consistent with effective temperature about 8500 K, log$g$ — about 2.5, and $v\sin i$ — about 175 km/s. The star seems not to be a δ Scuti variable, however its type of variability is not yet clear.

1. Introduction

γ UMi (HR 5735) is an interesting object with variable radial velocity and brightness, but undefined as yet type of variability. As a suspected spectroscopic binary it was observed spectroscopically by Struve (1923, 1950). His 200 radial velocity measurements could be combined with a period of $0\overset{d}{.}108449$; the shape and range of the velocity curve, however, varied markedly from cycle to cycle. The average half-amplitude from all lines was about 14 km/s. The star was classified as β Canis Majoris variable and observed later by Henroteau (1950) and by Sahade and Frieboes-Conde (1963). Their radial velocity observations confirmed the Struve's period and the highly irregular character of variability.

Light changes of γ UMi were observed by Baker (1926) and by Meyer (1936). Both these authors found the period of light variations different from the spectroscopic period and equal to $0\overset{d}{.}14335$. More recent V and B photoelectric observations by Joshi *et al.* (1969) yielded the period of $0\overset{d}{.}143009$; the amplitude of light variations was very small, 0.03 - 0.05 mag. in V, and the light curves were very irregular.

Using the 10 A/mm spectra Weaver (1952) was first to suggest the temporary presence of a tenuous shell around γ UMi. The MgII 4481 line in the spectrum of γ UMi is broad and shallow indicating the value of $v \sin i$ of the order of 200 km/s. On the spectrograms reproduced by Weaver (1952) the profiles of TiII and FeII lines are too much V-shaped and asymmetric to be purely rotational and can be best explained as composed of rotational contours formed in the atmoshpere proper and much narrower (and possibly asymmetric) profiles arising from the shell. The shell characteristics in the spectrum of γ UMi were present in 1911-1912 and absent in 1952 (Weaver 1952), they were also probably present in 1956 (Sahade and Frieboes-Conde 1963) and in 1963 (Leushin 1969).

γ UMi is a standard in MKK classification scheme where its spectrum is designated as A3II - III. The assignement to the luminosity class II - III was questioned by Weaver (1952) and Sahade and Frieboes-Conde (1963) on the basis that the enhancement of TiII and FeII lines as compared to FeI lines is in this case a shell effect rather than the luminosity indicator.

2. Spectroscopic Observations

Eleven coude spectra of γ UMi were obtained on Kodak IIa-O emulsion at the Lick Observatory on August 31, 1969: eight spectra with dispersion 5.4 A/mm in wavelength range 3600-4600 A, and three spectra with dispersion 2.7 A/mm in the range 3850-4400 A. The positions of MgII 4481, CaII K, and several hydrogen lines (Hγ, H8-H12, H14) on 5.4 A/mm plates were measured on the Grant machine of the Lick Observatory yielding the radial velocities shown in Fig. 1. The result of radial velocity measurements as shown in this figure can be summarized as follows:

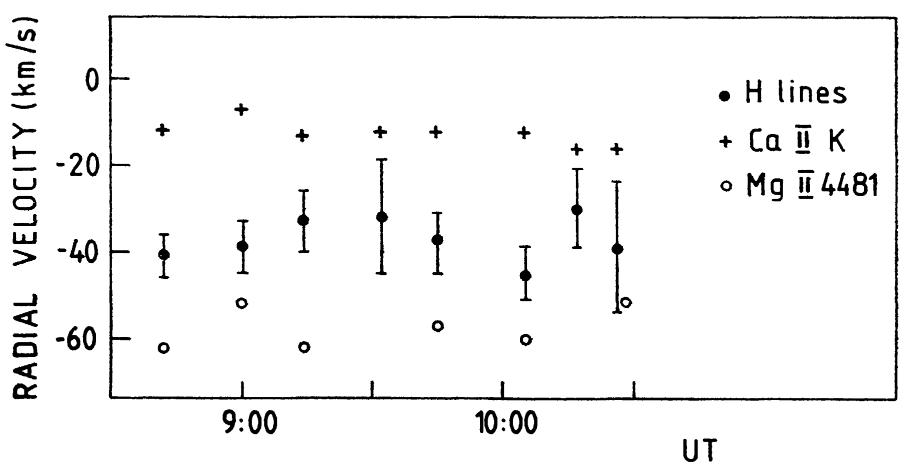

Fig. 1. Heliocentric radial velocities of γ UMi on August 31, 1969. Vertical bars at the points corresponding to means from the hydrogen lines represent the dispersion of values obtained from individual lines.

(*a*) At the time of observations the radial velocity variations in γ UMi were small.

(*b*) Radial velocities of individual hydrogen lines show a remarkable scatter. This is only partly due to observational errors resulting from the difficulties in locating the minima of broad hydrogen lines: the MgII 4481 line, which is broad and shallow and therefore even more difficult to measure, gives the scatter of individual points not much larger than that of the radial velocities obtained from the sharp and symmetric calcium line.

(*c*) The scatter of individual values around the means for particular phases is completly random, *i.e.* no systematic shifts or lags were observed.

(*d*) Lines of different elements give different values of systemic velocity. The mean from all hydrogen lines is −36 km/s, *i.e.* is more negative than the value of about −20 km/s observed by Sahade and Frieboes-Conde (1963). The Ca K line gives the mean velocity equal to −12 km/s. Radial velocities of the calcium line were obtained from the same comparison lines as the hydrogen lines, so that any systematic error is improbable. Systemic velocity obtained from MgII 4481 line is equal to −56 km/s.

The inspection of density tracings of particular spectrograms did not reveal any noticeable changes in line profiles or other spectral characteristics. Some of the hydrogen lines were converted into intensities and their equivalent widths were measured; they remained constant in time within the accuracy of measurements, in contrast to the results by Leushin (1969) and Kumajgorodskaya and Chunakova (1976).

A part of density tracing of the spectrum of γ UMi is shown in Fig. 2. As can be seen, at the time of observations the absorption lines were symmetric and did not contain any noticeable shell component. There were also no traces of emission in the observed wavelength region. However, the only earlier report on the presence of emission lines in the spectrum of γ UMi (Mannino 1952) seems to be the result of improper identification of absorption lines.

3. Discussion

The position of γ UMi on $C_1-(b-y)$ diagram (Fig. 3) as calibrated by Breger (1974), corresponds to a star with photometric characteristics of a giant. Similar conclusion can be drawn from the shape of hydrogen Hγ line. Fig. 4 shows the comparison of the observed Hγ line with theoretical profiles calculated by Kurucz *et al.* (1974) for effective temperature 8500 K and two values of $\log g$, 2.5 and 3.5, and broadened rotationally

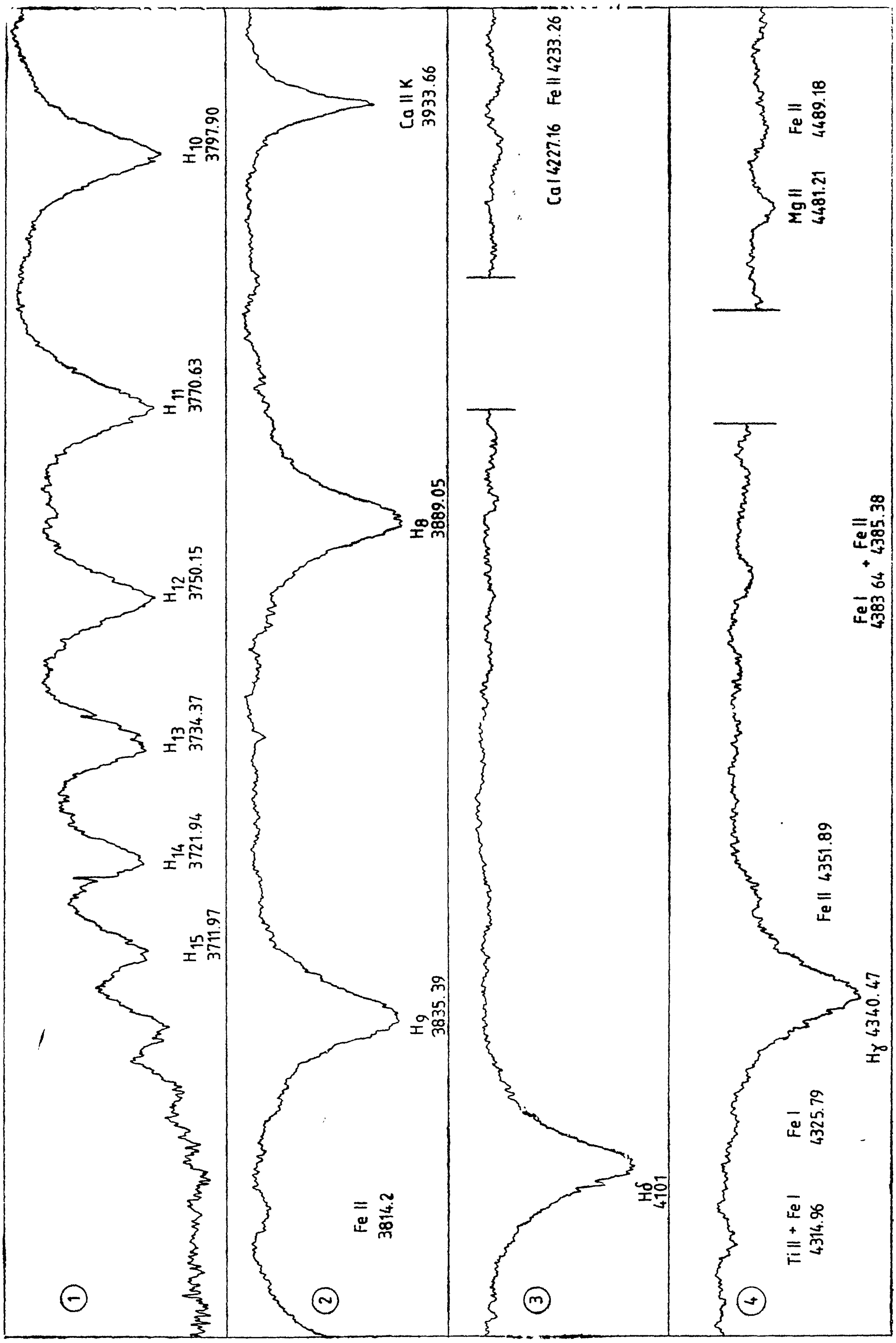

Fig. 2. Parts of density tracing of a spectrogram with dispersion 5.4 A/mm.

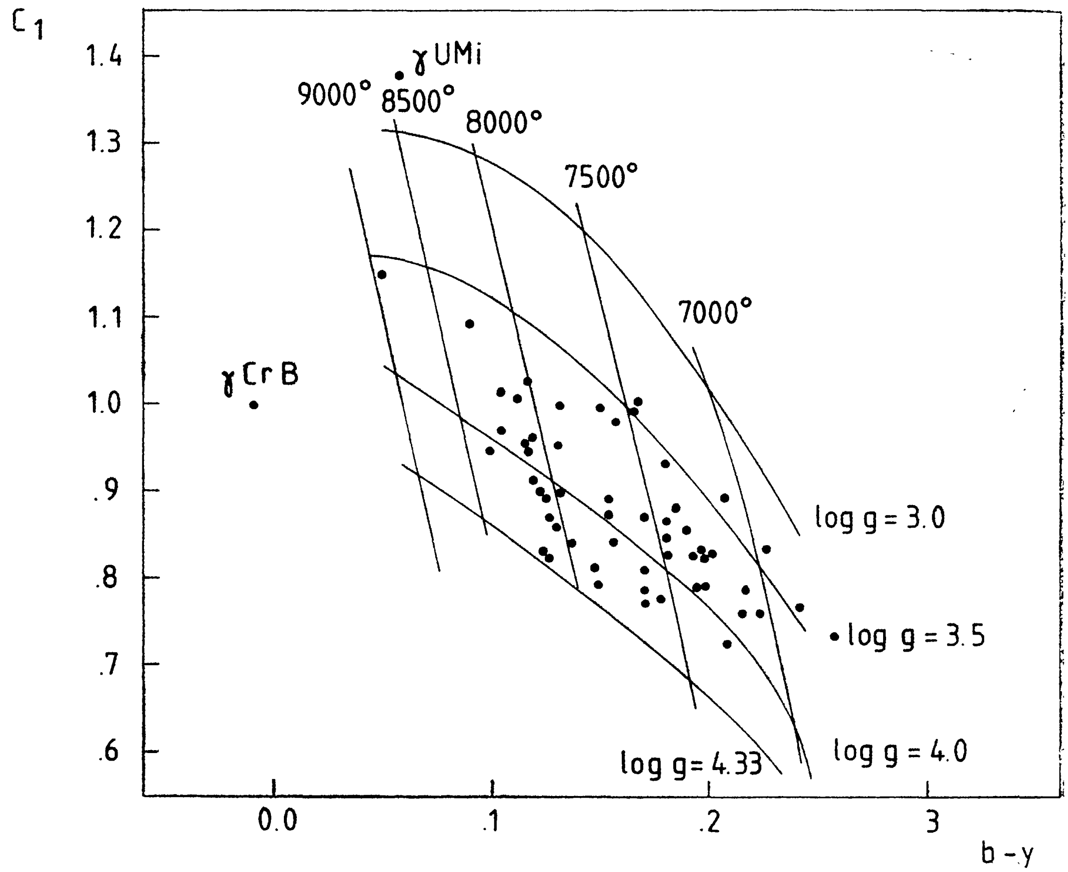

Fig. 3. $C_1-(b-y)$ diagram as calibrated by Breger (1974). Points represent the well established δ Scuti variables.

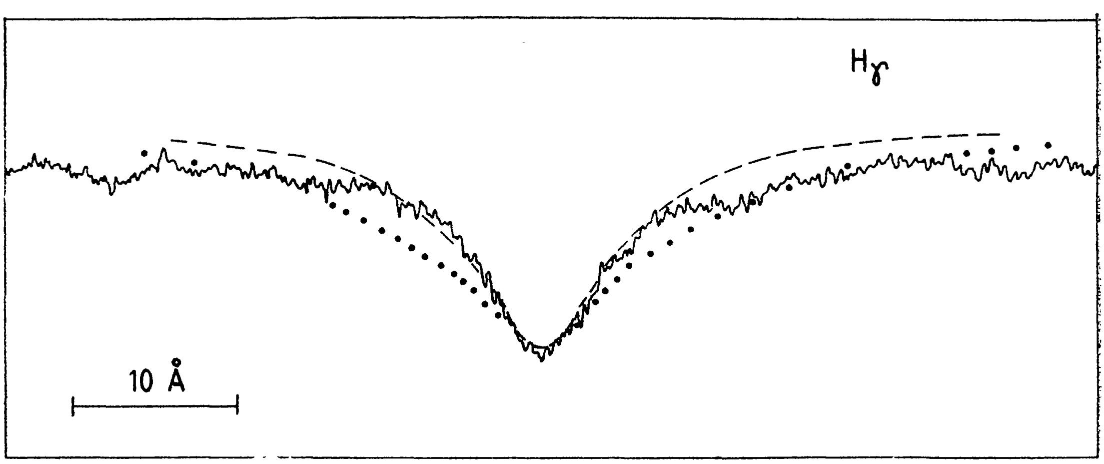

Fig. 4. Observed Hγ profile (dispersion 2.7 A/mm) compared with theoretical profiles for effective temperature 8500 K and two values of log$g$: 2.5 – broken line, and 3.5 – dots. Both profiles are broadened by $v \sin i$ = 175 km/s.

by $v \sin i = 175$ km/s. Thus the assignement of γ UMi to the luminosity class II - III has a real physical meaning.

As can also be seen from Fig. 3, γ UMi lies well outside the region occupied by δ Scuti variables. Hence, the classification of γ UMi as a δ Scuti star (Baglin *et al.* 1972) seems to be incorrect. The more complete data on light variations are needed before any positive classification of the type of variability is possible, including the revival of Struve's hypothesis of Maia variables (Breger 1979).

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