" IUE OBSERVATIONS OF 17 Lep"*)°)

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SUMMARY

The spectrum of 17 Lep is dominated by numerous and strong shell lines of once-ionized metals. The shell shows a composite radial velocity structure which indicates the presence of multiple components with a velocity range between -50 and -250 km s^{-1}. Unlike in the visible, where these multiple components are present only during outburst, in the ultraviolet such components seem to be a permanent feature.

1. INTRODUCTION

The visual spectrum of 17 Lep has been the object of many detailed analyses, starting with Struve in the thirties (1932) and followed by Slettebak (1950), Wright (1957), Widing (1965) and Cowley (1967).

17 Lep is a binary system composed of a late B primary and an M1 giant filling its Roche lobe. The orbit is quite eccentric with e=0.132. The orbital period is about 260^d, and the inclination of the system is estimated to be around 20°÷30°.

The spectrum of the primary is composite, showing the presence of broad and diffuse absorptions of photospheric origin, corresponding to a late B spectral type, along with sharp absorptions of once-ionized metals which originate in a shell expanding at v≃ -55 km s^{-1}. These absorptions correspond to an early A spectral type.

The most spectacular feature of 17 Lep is the occurence of outbursts in the shell surrounding the primary. The outbursts, which occurr at intervals centered around 150^d, and last ≃ 20 days, are manifested by the presence of additional violet-displaced components in the shell

* Based on IUE observations obtained at the ESA Satellite Tracking Station of VILSPA (Spain)

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lines. No related variation in the luminosity is observed. A correlation has been found (Cowley, 1967) between the occurence of outbursts and the passage at the periastron, suggesting a possible mass-exchange effect.

2. THE SPECTRUM.

2 IUE high resolution images (SWP 4790 and LWR 4144) covering the range 1175 - 3200 Å have been obtained at VILSPA in March 1979. Moreover, 2 LWR high resolution images (LWR 5104 and LWR 6808) taken by other observers some months later and available from the VILSPA data-bank have been used to investigate possible spectral variations.

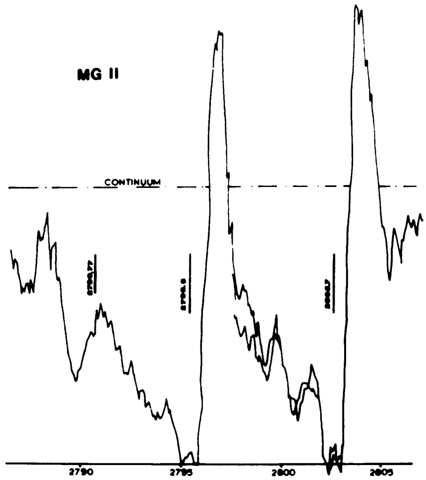

Figure 1. - The MgII resonance doublet.

Besides the strong emissions in the P Cyg profiles of the MgII resonance doublet (Fig. 1), the UV spectrum is characterized by a very large number of strong "shell" absorption lines shortward displaced with respect to the nominal wavelength. Almost the totality of the absorptions show a typically quasi-rectangular profile with FWHM$\gg$ 1 Å and central intensity close to zero (Fig. 2). A composite structure is clearly evident in the shell lines. They show a well marked absorption peak in the least displaced component (v$\simeq$ -55 km s^{-1}) and additional less marked

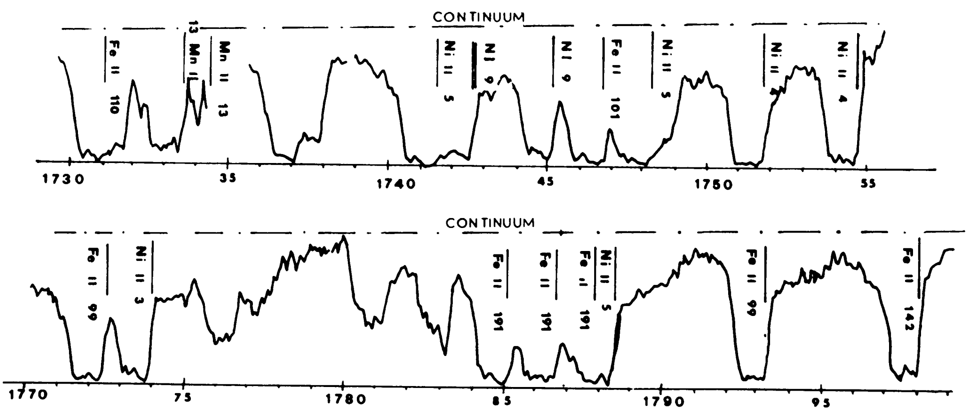

Figure 2. - A portion of the spectrum of 17 Lep.

peaks shortward displaced up to -250 km s^{-1}. It is notable that this structure is present in the visible only during outbursts.

About 75% of the strongest spectral features have been identified; lines of CI, CII, NI, MgII, SIII, CrII, MnII, FeII, CoII and NiII are definitely present. About 95% of the identified features belong to the once-ionized metals, and principally to FeII, which is the main contributor to the line opacity. It is remarkable, however, that in the far UV range there are various regions, mainly below λ 1500, showing strong unidentified absorption blends which reach zero intensity. There is no positive evidence of the presence either of doubly ionized species such as SiIII, TiIII, CrIII, FeIII etc, which are common in the spectra of B stars, or of the "superionized" species such as SiIV, CIV and NV which are found in the B supergiants. No photospheric line, i.e. centered around the nominal wavelength and with a rotationally broadened profile, have been definitely detected. The sole candidates are the two resonance doublets of CII λ 1335 and SiII λ 1530 which fall in regions affected by severe blends.

No significant changes are present in the two additional LWR spectra. The overall multiple-shell structure of the absorption profiles has remained essentially the same. The chance that all the three LWR spectra have been taken during the outbursts phase is very low ($\simeq 10^{-3}$). This means, therefore, that the UV spectrum, unlike the visible, shows the constant presence of multiple-shell structure. However, the possibility remains that 17 Lep has recently undergone a permanent outburst phase also in the visible, where no recent spectra are available.

3. THE RADIAL VELOCITIES.

RV's have been measured for all reasonably unblended lines. As reported above, the <u>red</u> component of the absorption profile falls, on an average, around -55 km s^{-1}, a value which is very close to that found in the visible for the sharp absorption component formed in the expanding shell. There are, however, small but definite deviations for different elements around the mean value. CrII and TiII fall around -42 km s^{-1}, NiII around -66 km s^{-1}, while the MgII doublet falls around -80 km s^{-1}. For the line-rich FeII spectrum we have also tried to

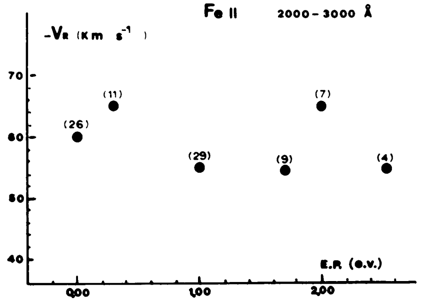

Figure 3. - The relation between the RV of the main shell component and the excitation potential; in brackets, the number of lines used.

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ascertain whether there is any dependence of the RV's on the excitation potential. We have found no such dependence (Fig. 3).

The fairly good but not ideal resolution of the IUE spectrograph and the scarcity of lines definitely free from blending in the UV range set serious limits to accurate RV analysis of the secondary components of the multiple shell structure of 17 Lep. Nonetheless, using the most reasonably unblended lines, we have found a clustering of the secondary absorption peaks around -180 and -230 km s^{-1}, with other less important contributions up to $\simeq$ -300 km s^{-1}.

An attempt has also been made to measure the "edge velocity" for all the unblended lines. A value of around -300 km s^{-1} has been found for most of the lines, except for the MgII doublet which reaches -700 km s^{-1}. There is a definite relation between v_{edge} and the excitation potential, with the resonance lines having the highest v_{edge} (Fig. 4).

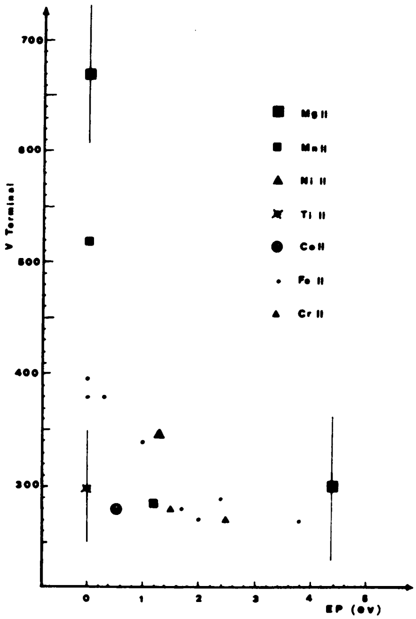

Figure 4. - The relation between v_{edge} and the excitation potential.

4. CONTINUUM-TEMPERATURE-COLUMN DENSITIES.

The very severe line blocking makes the tracing of the continuum very uncertain. Using the few "windows" which are present in the spectrum, a "pseudo-continuum" has been derived and compared with the Kurucz models, after having determined the flux using the method described by Cassatella et al. (1981). The best fit with the models gives a value of $\simeq$ 8000°K for the temperature. This value is lower than that of a B9 star (visible) and could be explained either by the uncertainties in the continuum determination, or, from a quite different viewpoint, by assuming that the observed UV continuum is not formed in the photosphere of the primary but in the optically thick shell that surrounds it.

The curve of growth method applied to the FeII lines yields a value of $\simeq$ 7700°K for the excitation temperature.

Column densities have been calculated for the once-ionized metals on the assumption that all the atoms of these elements appear in the first ionization state. The results are reported in Table 1.

5. THE MgII RESONANCE DOUBLET.

These lines are the only undoubted emissions in the UV spectrum of 17 Lep. The profile is a typical P Cyg, with the emission intensity reaching a peak height of about 60% of the continuum intensity.

The absorption have a minimum around v= -215 km s^{-1}. The emission component, although strong, is weaker than the absorption component, as in common P Cyg profiles produced by resonant scattering. This indicates the absence of additional excitation mechanisms in the shell itself, such as collisions, and confirms the low value found for the temperature. The emission width obeys the relation found by Kondo et al.(1976) for the supergiants. The value derived (M_V = 2.1) is in satisfactorely agreement with that derived by the trigonometric parallax (1.7±1.2).

TABLE 1.

ION	lg N
FeII	16.8±0.5
NiII	16.0±0.5
MnII	16.3±0.5
CrII	15.4±0.5

CONCLUSIONS.

a). The UV line spectrum of 17 Lep is entirely produced in the optically thick shell fully covering the primary.

b). The once-ionized metals are the main contributors to the shell spectrum. There is no evidence either of "photospheric" lines or of lines of higly-ionized species.

c). The shell shows a constant presence of multiple components (with velocity range between -40 and -200 km s^{-1}), which in the visible are present only during the outburst phase.

d). The presence of P Cyg profiles for the MgII resonance doublet, and the strength of its emission component are quite uncommon in Be and B-shell stars (Dachs 1980), where the emissions are very weak and the absorption sharp.

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DISCUSSION

Paterson-Beekmans: There are in the UV and the visible Fe II lines arising from the same unstable level (vis. 42, UV 191, 192, 193). In KX And, for ex., all these lines are strong. Do you see a different behaviour of these lines in 17 Lep?

Selvelli: We don't have visual tracings for comparing the behaviour of visual and UV Fe II lines. The lines of m = 191, 192, 193 are very strong in 17 Lep.

Koubsky: What is the phase coverage of your UV observations?

Selvelli: We would like to know it, but unfortunately there are no simultaneous visible and UV observations. Our three LWR observations are seperated by 120 and 180 days, while the frequency of the outburst in the visible is near 150 days, so we can exclude that all 3 spectra correspond to an abnormal phase.

Andrillat: Have you compared the P Cyg H_α profile with the P Cyg Mg II profile? In April 1980 we have observed the P Cyg H_α profile with a good resolution.

Selvelli: No, we do not have visual informations.

Harmanec:Is there some similarity between the UV spectrum of 17 Lep and the UV spectrum of some symbiotic stars?

Selvelli: No.

de Groot: You said the spectral "outbursts" are not reflected in increases in the stars luminosity. How well, then, is the visual light curve known?

Selvelli: UBV photometric observations of Widing (1967) exclude variations greater than .1 mag. in coincidence with visible outbursts.