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HD 121276: AN ECLIPSING MAGNETIC Ap STAR AT LAST?

Magnetic Ap stars have a peculiar distribution of orbital periods when they belong to binary systems: no magnetic Ap star is known for sure in systems with periods shorter than 3 days (Gerbaldi et al. 1985; see, however, the possible exception found by North 1994a). This is probably why it is so difficult to find a single eclipsing binary among them: indeed, in spite of some early claims (North 1984; Renson & Mathys 1984; Renson 1984, 1990), a close examination tends to make these alleged eclipsing Ap stars normal (North 1994a,b; Ziznovsky 1994).

We present here a new possible candidate: the southern star HD 121276 = CP $-51°6430$ was classified Ap SiCr(pec) by Houk (1978) with a quality 1, i.e. the best. Interestingly, Houk gives a remark saying "He 4026 is fairly strong, with Ca K being even stronger (yld. A1). Magnesium may also be strong; 4471 = 4481". Since Ap stars are helium-poor, the strength of He 4026 appears rather strange and implies that this star is unusual, even among the Ap stars.

The large amplitude photometric variability was noticed in mid-1993 by one of us (CR) during the reduction of early data. These were gathered at the European Southern Observatory, La Silla, Chile, with the double-beam "P7" photometer attached to the 0.7m Swiss telescope in 1989, 1991, 1993 and systematic monitoring took place in June 1993 and July 1994. The resulting lightcurves are shown in Figure 1, for the [U], [B], [V] magnitudes and [U−B], [B−V] colour indices of the Geneva photometric system, according to the ephemeris

$$\mathrm{HJD(Min.I)} = 2\ 449\ 343.774 + 6.514628 \times \mathrm{E}$$

There is a deep primary minimum, while the secondary minimum is very shallow and a bit ill-defined. In V, there is a large variation (0.08 mag.) outside the eclipses, which is also present in the [B] band but is less definite in the [U] band. This out-of-eclipse variation resembles the effect due to the non-sphericity of a component nearly filling its Roche lobe, but such an effect is not expected to be so wavelength dependent. Moreover, the period is rather long and the primary minimum is short (about 12.5 hours), suggesting that the system is well-detached. Therefore, one is tempted to attribute the out-of-eclipse variations to the intrinsic variability of the primary, which is indeed expected to vary according to its Ap SiCr classification. But the large scatter in the [U] band is much larger than that expected from the measurement errors alone (0.009 mag.) and suggests that some irregular phenomena occur in this system.

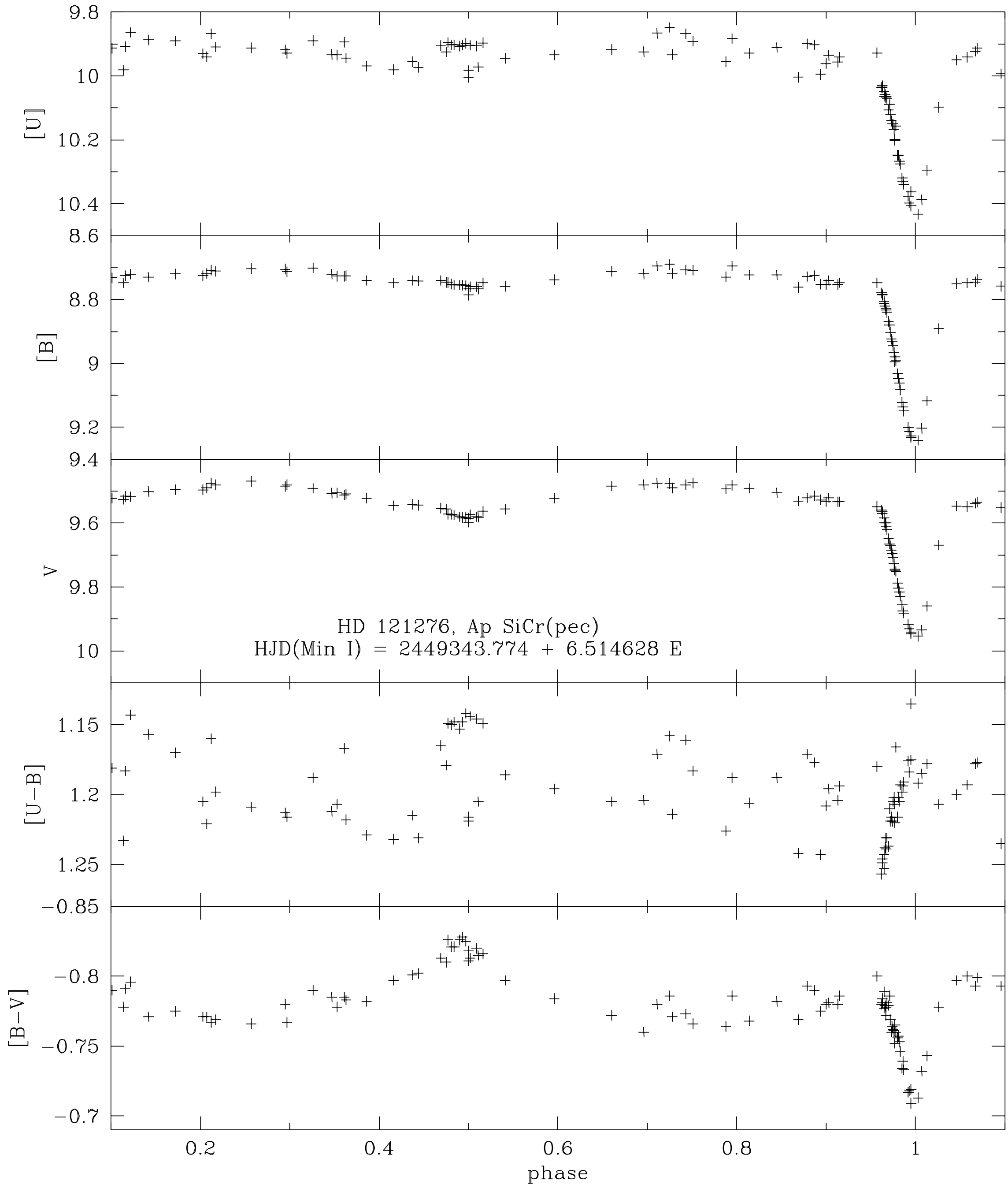

Figure 1. Geneva [U], [B] and V lightcurves of the eclipsing binary HD 121276, phased according to our ephemeris. Notice the large scatter in the[U] passband. The [U−B] and [B−V] indices are shown as well.

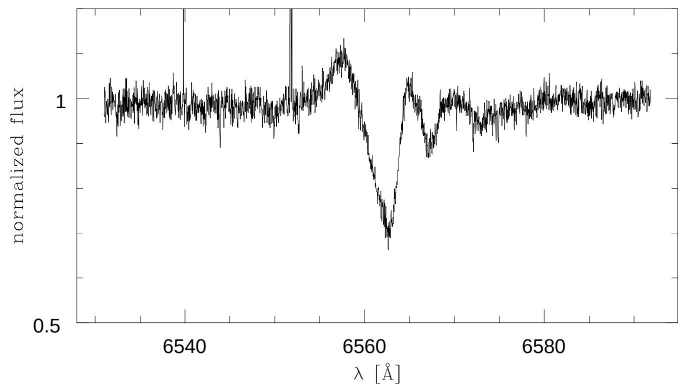

Figure 2. High-resolution spectrum of HD 121276 taken at orbital phase 0.249, i.e. at quadrature, and showing the star as a double-lined system. Notice the asymmetry of the H_α line of the primary and the emission on its blue side, showing the presence of circumstellar gas.

This is confirmed by the [U−B] and [B−V] indices. Both minima are clearly visible, showing the secondary to be redder in [B−V]. The behaviour of [U−B] in the primary minimum is quite unexpected in that the system is becoming *bluer* as the eclipse proceeds, while one would expect the reverse from the secondary eclipse where the system is at minimum [U−B]. Since the mean values of the reddening-free X and Y parameters (Cramer & Maeder 1979) are 1.07 and 0.01 respectively, we probably have a system composed of a mid-B primary and of a late B or early A secondary. The mean value of the reddening-free peculiarity parameter, Z, is −0.020, which suggests that one or both component(s) may have the Si peculiarity type, since this parameter is negative for Bp and Ap stars and null for normal B and A stars. However, the mean value of the $\Delta(V1-G)$ index, which is also a peculiarity parameter (see e.g. Hauck & North 1982), is only about 0.001, indicating a very marginal peculiarity at most.

One of us (PN) has taken a spectrum of this system with the 1.4m CAT telescope of the European Southern Observatory, equipped with the CES spectrograph, the Long Camera and the FA 2048 CCD detector (ESO CCD # 30). The resolving power was R = 60000. The spectrum was taken in the H_α region on the night of May 15-16, 1994 at HJD = 2449488.715, i.e. at phase $\phi = 0.249$ according to our ephemeris. Since this is exactly at quadrature, we can estimate the total mass of the system from the relative velocity at that phase. The spectrum displayed in Figure 2 shows, however, a very peculiar profile of the primary's H_α line: the profile is not only asymmetric, but also shows a blue emission component. Circumstellar gas is therefore certainly present in this system, which may explain the unusual features of the lightcurves.

To estimate the relative velocity, we first fit a gaussian to the core of the H_α line of each component. For the primary, a large uncertainty results from the asymmetry of the H_α line, but some confidence interval can be guessed by fitting a gaussian to the whole profile on the one hand, and to the very core and red side only on the other hand.In the first case we have $\lambda_{p1} = 6562.297$Å, in the second case $\lambda_{p2} = 6562.594$Å. The secondary's line is much more symmetrical, and two fits with a slightly different fitting range give $\lambda_{s1} = 6567.277$Å and $\lambda_{s2} = 6567.288$Å. The range in wavelength difference is thus $\Delta\lambda = 4.683$ to 4.991 Å, corresponding to a relative velocity $\Delta V_r = 213.9$ to 228.0 km s^{-1}.

Since the eclipses are separated by half a period, the assumption of a circular orbit appears realistic, and we obtain then a semi-major axis in the range (the inclination i of the orbital plane being close to 90°, sin$i$ is approximated by 1):

$$a = 0.128 \ - \ 0.137 \text{ AU}$$

This implies the following range for the total mass:

$$M_p + M_s = 6.6 \ - \ 8.1 \ M_\odot$$

which is consistent with the spectral types estimated above for each component on the basis of the reddening-free X and Y parameters.

This system might well be yet another case of spurious classification due to the peculiar appearance of an unrecognized composite spectrum. The plate used by Houk for her classification of HD 121276 was taken in the night of May 18-19, 1968, i.e. around JD 2439995.6, which corresponds to $\phi \approx 0.049$, just after the primary minimum. But in view of the uncertainty of the period, which is about 0.0002 days at most, the plate could have been taken right in the middle of the primary eclipse, and the apparent spectrum would have been more similar to the intrinsic spectrum of the secondary.

A complete spectroscopic and photometric study would be needed to clarify the true nature of this binary.

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