Active OB stars: structure, evolution, mass loss, and critical limits
Proceedings IAU Symposium No. 272, 2010
C. Neiner, G. Wade, G. Meynet & G. Peters, eds.

doi:10.1017/S1743921311011306

Optical spectroscopy of DPVs and the case of LP Ara

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Abstract. We present preliminary results of our spectroscopic campaign of a group of intermediate mass interacting binaries dubbed "Double Periodic Variables" (DPVs), characterized by orbital light curves and additional long photometric cycles recurring roughly after 33 orbital periods (Mennickent *et al.* 2003, 2005). They have been interpreted as interacting, semi-detached binaries showing cycles of mass loss into the interstellar medium (Mennickent *et al.* 2008, Mennickent & Kołaczkowski 2009). High resolution Balmer and helium line profiles of DPVs can be interpreted in terms of mass flows in these systems. A system solution is given for LP Ara, based on modeling of the ASAS V-band orbital light curve and the radial velocity of the donor star.

Keywords. stars: binaries, stars: early-type

1. Spectra of Galactic DPVs and report on the analysis of LP Ara

During recent years we have monitored a sample of Galactic DPVs with high resolution optical spectrographs. From the inspection of the spectral region around Hα and He I 5875 we find in all cases evidence for blended emission or absorption profiles of complex morphology (Fig. 1). The He I 5875 profiles are usually broad and shallow, being the AU Mon He I 5875 profile exceptionally deep among Galactic DPVs.

LP Ara (HD 328568, 2MASS J16400178-4639348, B = 10.48, B-V = 0.28) is classified as an eclipsing binary of β Lyr type in SIMBAD (simbad.u-strasbg.fr/simbad/). Spectral types B8+[A8] and mass ratio $q = 0.090$ were given by Svechnikov & Kuznetsova (1990). From modeling of photometric observations made with the INTEGRAL/OMC camera, Zasche (2010) found a semidetached system with orbital period $P_o = 8.53282038$ d, $i = 77.1^o$, $q = 0.2$, ratio between stellar temperatures and radii $T_1/T_2 = 1.143$ and $R_1/R_2 = 1.135$ and no third light. The above authors did not correct their observations for the additional long photometric cycle $P_l = 273$ days reported by Michalska *et al.* (2009).

We compared the spectrum taken near the long cycle maximum at $\Phi_o = 0.96$ with a grid of synthetic model spectra in a region deployed of H I and He I lines. We find the best fit for the secondary star with the model $T_{eff} = 9500$ K, log g = 3.0 and v_2 sini = 65 km/s. We modeled the ASAS-3 light curve and radial velocity of LP Ara with a Wilson-Devinney code obtaining $P_o = 8.53295$ d, $T_1 = 16400$ K, $q = 0.30$, $i = 83.9^o$, orbital separation $a = 41.1\ R_\odot$, mass funtion $f(m) = 5.70 \pm 0.36$, $M_1 = 9.84\ M_\odot$, $M_2 = 2.98\ M_\odot$, $R_1 = 5.3\ R_\odot$, $R_2 = 11.6\ R_\odot$, $\log g_1 = 4.0$, $\log g_2 = 2.8$ and V-band luminosity ratio $k = L_1/L_2 = 1.50$. Typical errors of derived physical parameters are $\approx$ 10–20%. LP Ara is a double lined spectroscopic binary, however according to the present state of our analysis, only lines from the secondary component strictly follow the orbital motion. The use of ASAS-3 photometry corrected for long period changes yields a model free from systematic effects within 5% accuracy. If third light or additional structures do exist they contribute below 5% to the total orbital light.

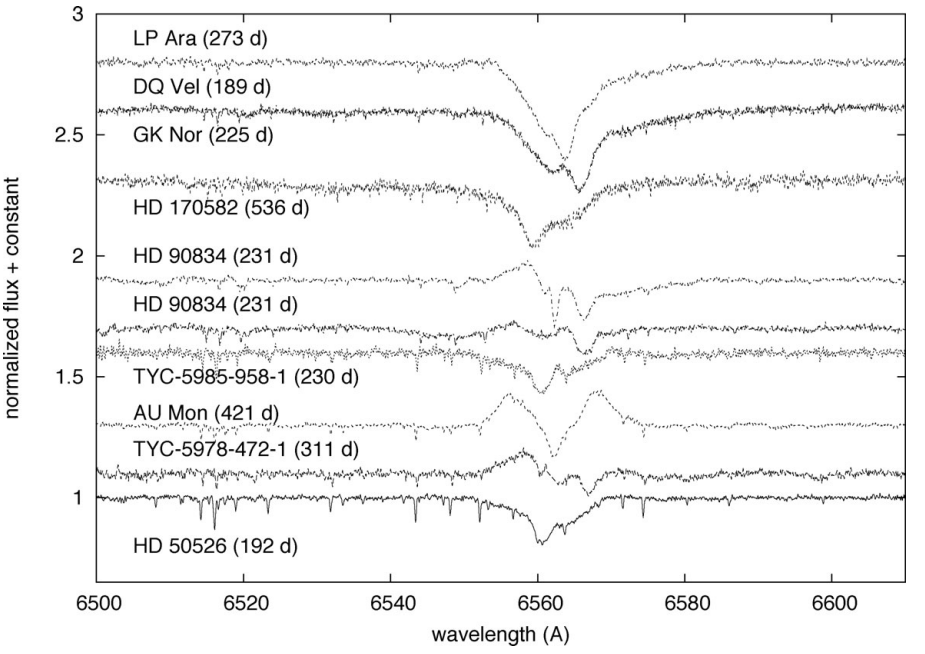

Figure 1. Spectra of Galactic DPVs around Hα at randomly selected orbital phases. The long period, found by us from a study of ASAS-3 ligth curves, is given in parenthesis. Two spectra of HD 90834 illustrate line profile variability. Sharp absorption features are telluric lines.

2. Conclusions

DPV Hα profiles are complex and usually show asymmetric absorption/emission features varying with the orbital period as well as with the long cycle. This fact suggests that *often* the line emission region is not disc-like, but more as an irregular structure, a fact already noted for V 393 Sco (Mennickent *et al.* 2010). The photometric regularity of DPVs (Michalska *et al.* 2009) place them apart from active Algols (W Serpentids). The rotational velocities of emitting material in some DPVs are much larger than expected for Keplerian orbits around B-type primaries. The system parameters for LP Ara fit the global scheme of low mass ratios found in other DPVs, e.g. OGLE LMC-SC8-125836 and V 393 Scorpii (Mennickent *et al.* 2008, 2010) and AU Mon (Desmet *et al.* 2010).

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https://doi.org/10.1017/S1743921311011306 Published online by Cambridge University Press