

Spectropolarimetry of AM Herculis with ESPaDOnS/CFHT

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Abstract. We present preliminary results on spectropolarimetry of AM Herculis using ESPaDOnS/CFHT. AM Her spectra presents variations of the emission lines along the orbital cycle. The polarimetric spectra of AM Her show continuum circular polarization up to 9% in the continuum and depolarization effect in the emission lines. Polarization measurements from a unpolarized standard star remain very close to 0% with errors within $\pm 0.1\%$, showing that the instrumental polarization the instrument is very low and does not prevent measurements of the continuum polarization.

Resumo. Apresentamos os resultados preliminares de espectropolarimetria de AM Herculis e de uma estrela padrão utilizando o instrumento ESPaDOnS/CFHT. Os espectros de AM Her mostram variações das linhas de emissão ao longo do ciclo orbital. Seu espectro polarimétrico mostra depolarização nas linhas de emissão e polarização circular no contínuo de até 9%. As medidas de polarização da estrela padrão são muito próximas de 0% com erros dentro de 0,1%, mostrando que a polarização instrumental de ESPaDOnS/CFHT é muito pequena e não impede medidas de polarização no contínuo.

Keywords. Cataclysmic variables – Polarimetry

1. Introduction

Cataclysmic variables (CVs) with synchronized white dwarfs and harboring high magnetic field are called *polars*. In this type of CV, the highly magnetized white dwarf (primary) accretes material from its Roche lobe filling main sequence companion (secondary) through the inner Lagrangian point. The transferred material flows first through a stream and then is channeled via the magnetic field lines of the primary, creating an accretion column. Polarization variability is a usual characteristic in polars.

AM Her is the prototype of the polars. It has a 3.094 h orbital period (Dai et al., 2013) and a magnetic field of 14.5 MG (Bailey et al., 1991). We present flux and polarimetry spectra of AM Her, along with its radial velocity determined by the $H\alpha$ line. Furthermore, results demonstrating that ESPaDOnS can measure polarimetry by comparing observations of AM Her and a unpolarized star.

2. Data and Preliminary Results

Data were acquired on 2015 August 28, using ESPaDOnS/CFHT, located on the summit of Mauna Kea in Hawaii. They consist of 16 flux spectra of AM Her and 12 of HD 202573, a null-polarization standard star. We used the OPERA¹ pipeline to reduce the data. Each polarimetric spectrum is calculated from the combination of four flux spectra.

2.1. Flux Spectra

The 16 spectra of AM Her were obtained during a complete orbital cycle. The average spectrum is shown in Figure 1. Some of the emission lines vary with orbital phase, as shown in Figure 2 where the $H\alpha$ line presents variable profile with at least two components.

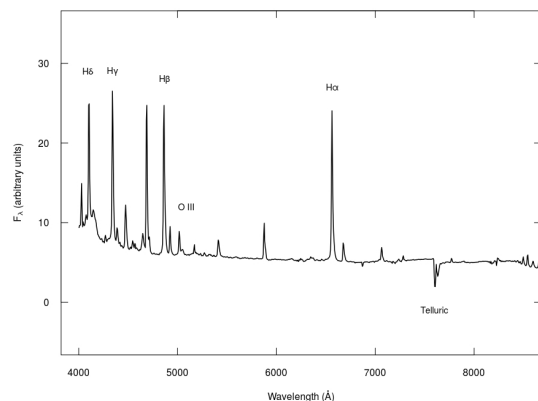


FIGURE 1. Average spectrum of AM Her, featuring some emission and telluric lines.

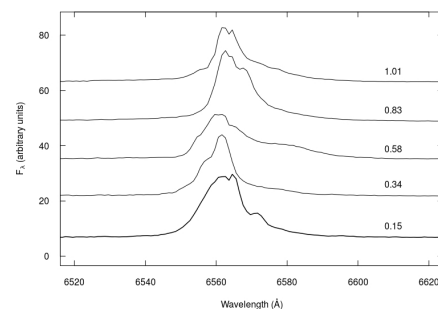


FIGURE 2. $H\alpha$ emission line for five spectra at different orbital periods. The profile is composed of at least two variable components.

Using the $H\alpha$ emission line (6563 Å), we obtained a preliminary radial velocity curve presenting a K semi-amplitude of 100 km/s (Figure 3) in good agreement with previous data (Kafka et al., 2006).

¹ <http://wiki.lna.br/wiki/espectro>

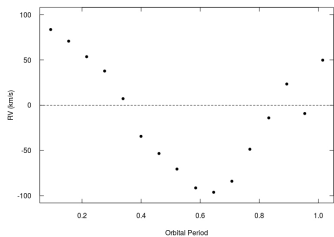


FIGURE 3. Radial velocity of the $H\alpha$ emission line of AM Her.

2.2. Spectropolarimetry

Using a set of four flux spectra, we calculate 16 polarization spectra. Figure 4 presents four polarization spectra of AM Her, showing the variation of the continuum polarization at different orbital phases. Figure 5 shows nine polarimetric spectra around the $H\alpha$ and HeI emission lines, where both present variable levels of depolarization for different orbital phases.

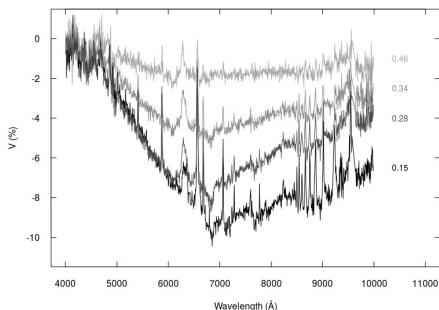


FIGURE 4. Polarization from AM Her in different orbital periods. Maximum polarization modulus in the continuum is 9%.

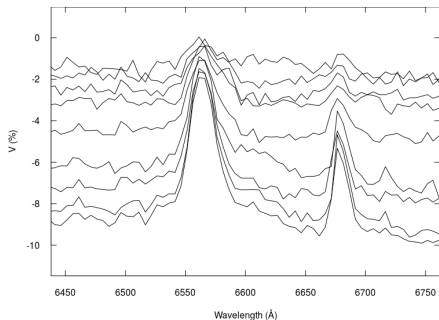


FIGURE 5. AM Her polarization in the spectral region containing $H\alpha$ and HeI emission lines.

2.3. Standard Star

We also acquired data from a null polarization standard star, HD 202573. Figure 6 shows the spectrum of HD 202573 and a model spectrum for a G5 III star. It is striking the resemblance of the spectra, attesting the quality of the differential flux calibration of ESPaDOnS data using OPERA software.

ESPaDOnS data confirm null V polarization for HD202573 (Oudmaier et al., 2005). Figure 7 shows circular polarization spectra for both the standard star HD202573 and AM Her. The instrumental polarization of ESPaDOnS is very low, as can be

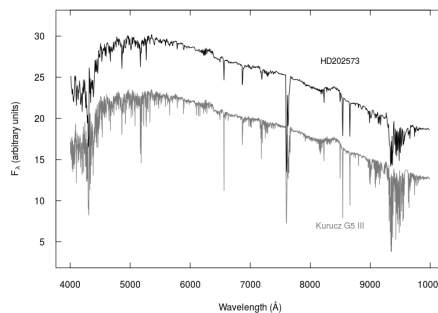


FIGURE 6. Black: flux spectrum of HD 202573 shifted by 10 units. Gray: a G5 III model from the Kurucz Atlas (2013)³.

seen from the polarization spectrum of the standard star, confirming the results from Pereyra et al. (2015).

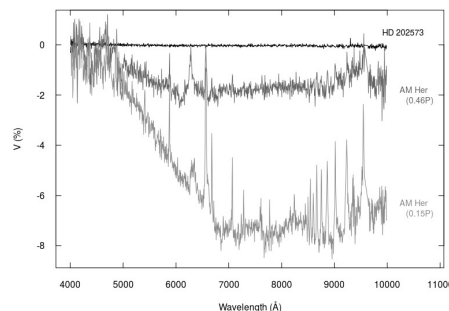


FIGURE 7. Circular polarization spectra for the standard star HD 202573 (black) which presents $V \approx 0\%$, in comparison with AM Her spectra on 0.15 and 0.46 of the orbital phases. These results show that the instrumental polarization is small and do not present measurements of the circular continuum polarization.

3. Conclusions

AM Her spectra show different profiles for emission lines depending on its orbital phase. The k semi-amplitude ≈ 100 km/s is consistent with previous results. The polarimetric spectra of AM Her show circular polarization up to 9% and depolarization in the $H\alpha$ emission lines.

Furthermore, instrumental polarization of ESPaDOnS/CFHT is very low, therefore, continuum polarimetric measures are not significantly affected by the instrumental polarization.

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