COMMISSIONS 27 AND 42 OF THE IAU
INFORMATION BULLETIN ON VARIABLE STARS

Number 5587

Konkoly Observatory
Budapest
4 January 2005

HU ISSN 0374 – 0676

FIRST OPTICAL SPECTRA OF AD MENSAE

TAPPERT, C.[1]; SCHMIDTOBREICK, L.[2]

[1] Departamento de Astronomía y Astrofísica, Pontificia Universidad Católica, Casilla 306, Santiago 22, Chile

[2] European Southern Observatory, Casilla 19001, Santiago 19, Chile

The object has first been mentioned as a possible SS Cyg type star by Payne-Gaposchkin (1971), while she was investigating variable stars in the Large Magellanic Cloud. It was thus included as AD Men in the 69th name–list of variable stars (Kholopov et al. 1989). The first spectroscopic observation was performed by Zwitter & Munari (1995), who found the star about $1^{\rm m}$ brighter than previously catalogued and concluded that AD Men might thus be a CV in outburst, probably a dwarf nova of SS Cyg subtype. This was in agreement with the A-type absorption spectrum without emission lines which they observed. Unfortunately, checking the coordinates, one realises, that they actually did not observe AD Men itself but a brighter star about 40 arcsec southwest of AD Men (Downes at al. 2001).

Since the object therefore still lacks spectroscopic confirmation of its classification as a CV, we performed new spectroscopic observations using the ESO Faint Object Spectrograph and Camera (EFOSC2) at the 3.6 m telescope on La Silla, Chile. Six spectra, each of 5 min exposure time, have been obtained on 2004-11-14 starting at 07:21 UT using grism #6 and a $1''$slit.

Standard reduction has been performed with IRAF. The BIAS has been subtracted and the data have been divided by a flat field, which was normalised by fitting Chebyshev functions of high order to remove the detector specific spectral response. The six spectra have been optimally extracted (Horne, 1986). Wavelength calibration yielded a final FWHM resolution of 1.2 nm and a spectral range of 390 nm to 790 nm. The individual spectra have then been averaged, the continuum of the final spectrum has been normalised to one.

The resulting spectrum is plotted in Fig. 1. It is dominated by the Balmer lines and some He I lines in emission. Also present is Fe II at 516.9 nm, but no indication for any high excitation lines like He II are found. The properties of the identified emission lines are listed in Table 1.

In order to derive information on the possible temperature range of the disc of AD Men, we have measured the Balmer decrement, which is defined as ratio of line intensities $\mathrm{H}_\alpha : \mathrm{H}_\beta : \mathrm{H}_\gamma$. For the ratios of the equivalent widths we find $\mathrm{H}_\alpha/\mathrm{H}_\beta = 2.32$ and $\mathrm{H}_\gamma/\mathrm{H}_\beta = 0.59$. A comparison of the equivalent widths and their ratios with the model data from Williams (1991) yields moderately high temperatures and densities. Due to the rather low values of the equivalent widths, a high inclination has to be assumed for the system to get an agreement in all three lines. The best correspondence is found for $T = 8000$K, $\log N_0 = 12.5$, and an inclination of 80°, but a somewhat higher temperature and lower density ($T = 10000$K, $\log N_0 = 12.0$) is still in agreement with the data.

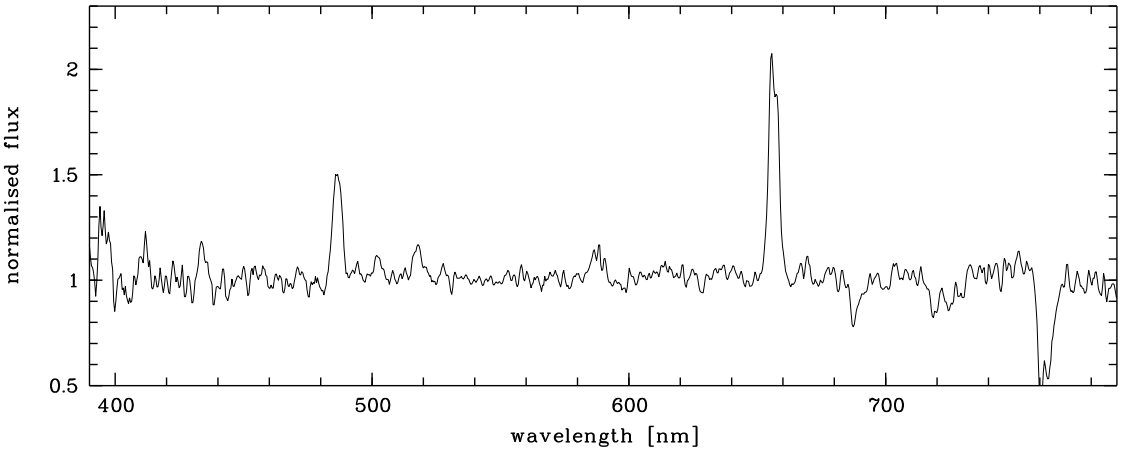

Figure 1. The normalised optical spectrum of AD Men, shows the system to be a cataclysmic variable of probably low mass transfer rate.

Table 1: Measured line width, computed velocity, and measured equivalent widths are given for all identified lines in the spectrum of AD Men.

Transition	λ [nm]	FWHM [nm]	$v_{\rm rot} \sin i$ [km s^{-1}]	$-W$ [nm]
Hα	656.2	4.55(4)	2080	5.1(2)
Hβ	486.1	3.96(3)	2440	2.2(1)
Hγ	434.0	3.49(8)	2410	1.3(4)
Hδ	410.2	3.54(8)	2590	0.8(2)
Hϵ	397.0	2.93(5)	2210	0.4(3)
He I	667.8	4.0(3)	1800	0.5(1)
He I	587.6	6.6(6)	3400	0.8(2)
He I	501.5	3.4(2)	2000	0.4(1)
Fe II	516.9	3.8(2)	2200	0.69(5)

The high Balmer decrement, the presence of HI and HeI emission lines and the absence of high excitation lines suggest that AD Men is a cataclysmic variable with rather low mass transfer rate. Our spectrum hence confirms the classification of AD Men as dwarf nova and does not contradict the SS Cyg subtype designation. The confirmation of the subtype has to come from long term photometric monitoring. Although the object is relatively bright (B $\approx 15\overset{\rm m}{.}5$), to our knowledge no such monitoring has been performed so far.

In average we find a projected rotation velocity of 2350 km/s. From this high value, we conclude that AD Men is seen at rather high inclination. This agrees with the relatively low values of the equivalent widths. The Balmer lines seem to be slightly broader than the He I or Fe II lines, thus indicating that the lines might origin in different regions of the accretion disc. However, the difference is not significant enough for any convincing conclusion, especially regarding the low S/N of the He I lines.

To check for variability, we analysed the individual spectra. We have six spectra covering about 0.6 h in total. Plotting the region around Hα for each individual spectrum (see Fig. 2) visualises the variability in the line. The line seems to consist of three peaks, indicating the presence of isolated emission sources in addition to the general disc emission. We measured the radial velocities of Hα by fitting a broad Gaussian and derive a variation between $-150\,{\rm km\,s^{-1}}$ and $+100\,{\rm km\,s^{-1}}$ (Fig. 2). Due to the short time–coverage only, we cannot make any assumptions on the orbital period. However, for the semi-amplitude of

the radial velocities we find a lower limit of $K_1 > 120\,\mathrm{km\,s^{-1}}$. This variation is very high and thus again points toward the high inclination of the system.

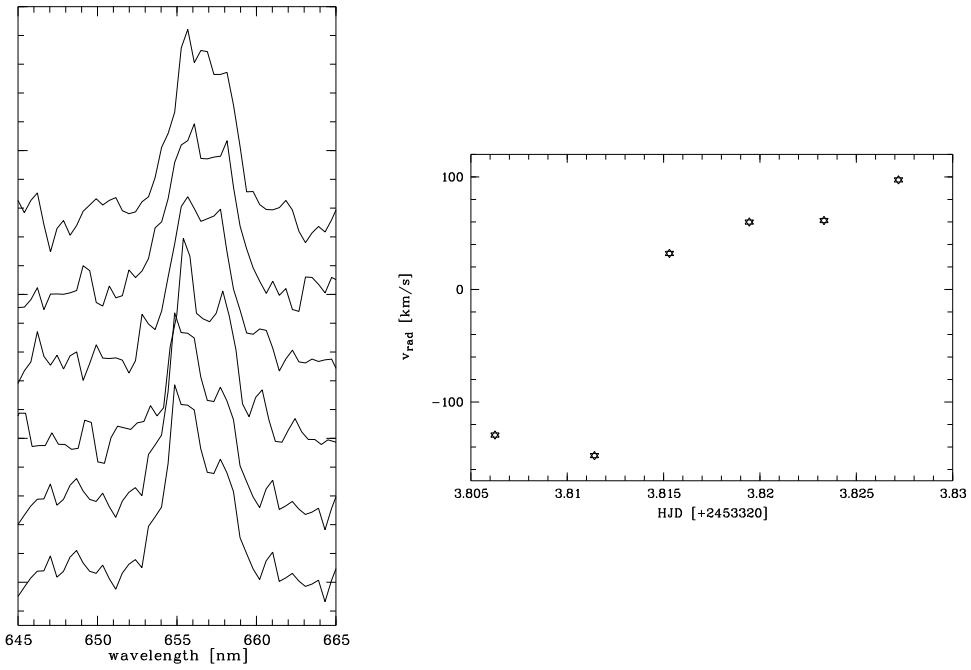

Figure 2. On the left side, the variation of Hα is visualised. The spectra with the continuum normalised to 1, are arbitrarily shifted up with increasing time. On the right side, the radial velocities as measured by fitting a broad Gaussian to the line are plotted against time.

We expect the system to have a period below the period gap for the following reasons: (1) for a system above the period gap, K_1 would reach values of $350\,\mathrm{km\,s^{-1}}$ or more. Such high values are rather unlikely, even eclipsing dwarf nova tend to have values between 90 and $200\,\mathrm{km\,s^{-1}}$ only. (2) The system is of low mass transfer rate, but no signs of the secondary are found in the spectrum. Hence, the secondary should be of rather low mass which results in a low orbital period. On the other hand, we do not see any absorption features of the white dwarf, thus excluding very low mass transfer rates, such as for WZ Sge type CVs. We therefore tentatively conclude that AD Men is a high inclination, possibly eclipsing SU UMa type dwarf nova with an orbital period below 2 h, making it an interesting target for followup time-resolved observations.

References:

Downes R.A., Webbink R.F., Shara M.M., Ritter H., Kolb U., Duerbeck H.W., 2001, *PASP*, **113**, 764, online

Horne K., 1986, *PASP*, **98**, 609

Kholopov P.N., Samus N.N., Kazarovets B.V., Frolov M.S., Kireeva N.N., 1989, *IBVS*, 3323

Payne-Gaposchkin, C. H., 1971, *The variable stars of the Large Magellanic Cloud*, Smithsonian Contributions to Astrophysics, Washington, Smithsonian Institution Press

Williams G.A., 1991, *AJ*, 101, 1929

Zwitter T., Munari U., 1995, *A&AS*, **114**, 575