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GTC OBSERVATIONS OF ULTRACOMPACT AM CVN BINARIES

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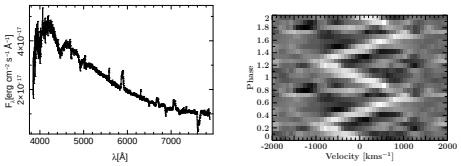
AM CVn systems are a small group of mass-transferring ultracompact binaries consisting of a white dwarf primary and a degenerated or semi-degenerated secondary. They are the endpoints of binary stellar evolution, having survived two common-envelope phases and showing orbital periods between 5.4–65 min (Solheim 2010). They are the only *known* sources of gravitational waves in the LISA regime and will act as LISA verification sources.

Over the last year we have used GTC+Osiris to obtain high speed phase-resolved spectroscopy of four AM CVn systems to determine the orbital period. Here we present the results of the first three systems.

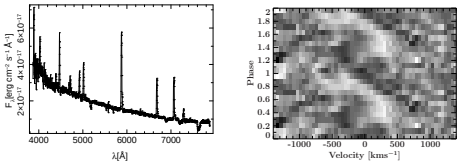
All systems were observed using the R1000B grism in 2 × 2 binning mode over 3–4 nights, in total of 6 hours per source with integration times per spectrum ranged between 120s and 180s, resulting in a velocity resolution of 120 km s^{-1}, sufficient to resolve the expected radial velocity variations of 800–1200 km s^{-1}. All spectra were extracted using IRAF's implementation of optimal extraction and subsequently wavelength and flux calibrated. A total of 123, 70 and 80 spectra, respectively for SDSS J0129, SDSS J1525 and SDSS J1642 were obtained. Violet-over-red line-flux ratio time series (Nather et al. 1981) were constructed and through a Lomb-Scargle periodogram the orbital period was determined.

SDSS J1525+3600 shows a surprisingly long period of 44.28 min, compared to the overall shape of the average spectrum, which is more indicative of shorter period systems in the 20–35 minute range. The accretor is still clearly visible in the pressure broadened absorption lines most likely indicating a hot donor star and/or a high mass accretor (Figure 1a).

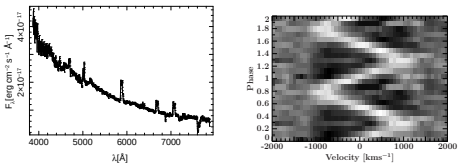
SDSS J1642+1934 displays an orbital period of 54.20 min with a close alias at 56.34 min. It has the one-but-longest period of the known AM CVn star. The average spectrum also shows strong Mg b absorption lines, most likely from the accretor's atmosphere. The phase resolved spectroscopy shows unusual 'black-outs' in the S-wave emission strengths that require further investigation (Figure 1b).



(a) SDSS J152509.57+360054.5



(b) SDSS J164228.06+193410.0



(c) SDSS J012940.05+384210.4

Fig. 1. Left panel: The grand average GTC spectra. Right panel: The phase resolved, trailed spectra of the combination of several helium lines showing the S-wave variation due to the anisotropic hot-spot emission.

SDSS J0129+3842 shows an orbital period of 37.55 min and the average spectrum shows the Stark broadened absorption lines of the DB white dwarf accretor (Figure 1c). The orbital period is close to the superhump period of 37.9 min determined by Shears et al. (2011) and results in a period excess $\epsilon = 0.009$.

A few hours of observations per object using GTC+Osiris are very well suited to determine the orbital period and the velocity amplitude of the bright spot emission in AM CVn stars. The high quality data unveil additional unexpected and unknown features, like absorption lines and black-out phases.

REFERENCES

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