On the determination of fundamental parameters of accreting white dwarfs

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Cataclysmic variable stars (CVs) are semidetached binary systems consisting of an accreting white dwarf and a low-mass donor transferring matter to the compact object via the inner Lagrangian point. The knowledge of physical parameters of accreting white dwarfs, such as effective temperature T_{eff} and surface gravity g, is crucially important for the further development of the theory of CV evolution. In particular, the temperature of the white dwarf allows for estimating the mass accretion rate which is a function of system age, while the surface gravity, a function of the mass, is needed to evaluate other system parameters of the binary. The traditional methodology of the parameter determination of *isolated* white dwarfs is fitting the model spectra to observed absorption lines. Spectra of CVs with relatively low mass-transfer rate also often exhibit the clear presence of broad Balmer absorption lines, suggesting using the same approach for measuring the parameters of the white dwarf. However, optical spectra of the *accreting* white dwarfs are contaminated by an accretion disc, the contribution of which is unknown. For this reason, there is a common opinion that optical spectra of the accreting white dwarfs do not allow for accurate constraining T_{eff} and $\log g$ and that instead ultraviolet spectroscopy is necessary. Indeed, the contamination from the accretion disc at these wavelengths is much smaller compared to its contribution at optical wavelengths and therefore can be neglected. Unfortunately, most of the accreting white dwarfs with a low mass-transfer rate are quite dim and only a few of them were observed with Hubble Space Telescope while optical spectra of many such objects were already obtained with large ground-based telescopes.

Here we show that by adopting a simple model for the disc contribution it is possible to constrain T_{eff} and $\log g$ of the accreting white dwarf using optical spectroscopy. We performed extensive testing of our technique by simulating various spectra which consist of synthetic spectra of white dwarfs covering a range of $\log g/T_{\text{eff}}$ plus a power-law with the differing contributions of the latter and adding random noise of different levels. We have found that even for a relatively large disc contribution (200%), and a relatively low signal-to-noise ratio SNR$\sim$30, uncertainty estimates of parameters were within our model grid. (ΔT_{eff} = 250 K and $\Delta \log g$ = 0.25). We then fitted the spectra of several CVs for which both optical and UV spectroscopy is available. We found a good agreement in the measured parameters of the accreting white dwarfs using our method with those obtained by Pala et al. (2022) from the analysis of UV spectra.

Following our procedure, we have studied more than 15 accreting white dwarfs, including post-period-minimum candidates. We found that the white dwarfs in most of them have a temperature in the range of 10000–15000 K.