Systematic uncertainties in the characterisation of He-dominated metal-polluted white dwarfs

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The two most employed methods to obtain the photospheric parameters of white dwarfs fit spectroscopic or photometric data, respectively. These two techniques do not always lead to consistent parameters, but the discrepancies are alarmingly large for helium-dominated white dwarfs. Independent studies usually claim the differences arise from the use of distinct methodologies, versions of the synthetic spectra or to the observed data. However, the published uncertainties just quote, typically, the statistical errors, which underestimate the actual values, which should take into account the dramatic effect of the systematics. We have tackled this situation by characterising a sample of 13 helium-dominated white dwarfs with the spectroscopic and photometric technique, using up to three different spectroscopic and photometric data for each star. We arrived at mean absolute differences of $\simeq 570\,\mathrm{K}$, $\simeq 0.27\,\mathrm{dex}$ and $\simeq 0.23\,\mathrm{dex}$ for $T_{\rm eff}$, $\log g$ and log(H/He), respectively, when fitting model spectra to diverse spectroscopic data. The photometric fits provide mean absolute differences up to $\langle \Delta T_{\rm eff} \rangle = 930\,\mathrm{K}$ and $\langle \Delta \log g \rangle = 0.10\,\mathrm{dex}$. We suggest these values to be adopted as the minimum uncertainties when publishing atmospheric parameters from spectroscopic and photometric fits, respectively. Besides, with the aim of investigating the effect of the assumed and often unrealistic chemical composition on the best-fit atmospheric parameters, we carried out the data modelling using synthetic spectra of three different chemical compositions: (1) pure helium, (2) helium-dominated atmospheric models with traces of hydrogen and (3) hydrogen plus metals in helium-dominated photospheres. In general, pure helium model spectra result in larger $T_{\rm eff}$ than those derived from DBA, while the $\log g$ differences are also notable but change from spectroscopic to photometric data. The addition of metals does also affect the best-fit parameters, but the change is less dramatic than in the previous case.