Abstract: We present a new NLTE grid of optical (3200–7200 Å) synthetic spectra calculated with Tlusty/Synspec. Our model atmospheres include the most recent hydrogen Stark broadening profiles; were calculated in opacity sampling but limited to pure H/He composition. The grid covers the observed parameter space of (He-)sdB and (He-)sdO stars, making it suitable for the homogeneous spectral analyses of such evolved stars.

Introduction

Hot subdwarfs are very important objects to understand the late stages of stellar evolution. These He burning stars connect the red giant branch to the white dwarf sequence and suffer a strong mass-loss before they settle on the extreme horizontal branch for about a 100 Myr. This hot subdwarfs also give insight into the horizontal branch morphology. The conditions and reasons of the extreme mass-loss are not easy to decipher, in particular for single stars. Current formation theories can explain the observed subdwarf populations, but extensive spectral libraries that include all types of hot subdwarfs would be welcome to separate the observed populations and find the relative contributions of the various formation channels.

Model calculation

We used Tlusty 204 and Synspec 49 (Hubeny & Lanz 1995, Lanz & Hubeny 1995) in our work, which calculate plane-parallel, horizontally homogeneous, static stellar atmospheres in radiative and hydrostatic equilibrium treating metal line blanketing by means of opacity sampling. The most detailed model atmospheres of H and He were included from the BSTAR database (Lanz & Hubeny, 2007) giving altogether 61 explicit gravity (upper-levels and 330 radiative transitions. The grid was calculated in about 1400 CPU hours and consists of 11 396 grid points to which we were able to converge 10 887 spectra.

The spectral energy distributions were calculated at 16 000–18 000 frequency points using 70 depth points in opacity sampling. The micro-turbulent velocity was set to zero and all models were converged to a relative change of 0.1% of the structural parameters. Synthetic spectra were then calculated in the range of 3200–7200 Å with 0.1 Å step size, ensuring that both the continuum and the line profiles are sampled well. Because the abundances were limited to H/He our models do not address the Balmer line problem. Due to this shortcoming the derived atmospheric parameters are not expected to be consistent with the more accurate photometric or asteroseismic constraints.

A sample of synthetic spectra near the HJ line are shown in Figure 1. Effective temperature increases from bottom to top in the figure as well as the He abundance in each sequence. The shift in emission balance is marked by the gradual decrease of the He I/He II line strength ratio towards higher temperatures. Also remarkable is the weakening of the HJ line at higher temperatures and He abundance, while in the most extreme cases the He II Pickering series dominates the spectra.

Line profiles

The new version of Tlusty makes it possible to include detailed H line profiles directly in the atmosphere structure calculations. We added the Stark broadening tables for the first ten lines of the Lyman and Balmer series of H from Tremblay & Bergeron (2009). A systematic line profile difference towards the high members of the Balmer series has been observed in white dwarfs and also notable for subdwarfs, in particular for the Hα – Hδ lines in Figure 2. The differences in the line profiles are relatively small. However, because the surface gravity is constrained by the upper Balmer series, even such small differences can be responsible for about half of the discrepancy observed between spectroscopic and photometric surface gravities, also known as the log g problem (Rauch, 2012). We expect that the new profiles will increase the internal consistency of temperature and gravity determinations from various Balmer lines. Surprisingly, we found a deeper He line core. Although the new line profiles modify the atmospheric structure and the level populations, this change was unexpected and needs further investigations.

Before the final publication of our grid further efforts will be made to converge the mixing model atmospheres and the continuum sampling will be increased to at least a few Ångströms in order to reduce the size of the database below 1 Gb.

References

Rauch, T. 2012, Fifth Meeting on Hot Subdwarf Stars and Related Objects, ASP Conf. Ser., 452, 111