Searching for companions in CRIRES spectra and slit-viewer images of telluric standards

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Introduction

It is thought that the majority of O and B-type stars are members of spectroscopic binary systems (e.g. Hoffmeister et al. 2011). The presence of such companions may influence the evolution of early-type stars and in some cases the systems may be the progenitors of core-collapse supernovae. This poster describes a project whose aims are to set limits on the multiplicity of massive stars for comparison with previous work (especially wide-separation systems), and to produce an atlas of high-resolution spectra of these objects using CRIRES, which is the near to- mid-infrared high-resolution spectrometer on the VLT.

Our sample comprises 300+ telluric standards observed between 2006 and 2011. Figure 1 shows a histogramme of their spectral types. Eighty percent of the objects are O- or B- type stars.

Results - possible close companions

CRIRES slit-viewer images have a plate scale of around 0.05 arcsec and, due to the adaptive optics system in CRIRES, have a spatial resolution of typically less than 0.2 arcseconds. Although they are shallow (integration times typically of a few seconds), the high spatial resolution infra-red nature of the observations makes them useful for detecting unknown companions. Observations are typically taken in the J,H and/or K bands, with a number of objects observed in the $H\times5e^{-2}$ filter, which lets through $\sim$20 times less light than H. We plan to obtain approximate colours of some systems and hence a handle on the spectral type in the cases that more than 1 filter was observed.

Figure 2 shows four tellurics where possible companions have been detected with CRIRES, with separations from 0.8 to 2.0 arcseconds. These are just a sample chosen at random and determination of the companion magnitudes and statistical analysis of the detection frequency against stellar type and magnitude is still pending. Note that due to the properties of speckle, the putative faint companions would have to be followed up to determine (1) if they are really stellar objects and (2) if the proper motions are the same as the main target in order to confirm if they are companions or just background objects (e.g. Muller et al. 2011).

Results - infrared spectra

Examples of infrared spectra for three CRIRES telluric standards are shown in Figures 3 and 4; only one of the four detectors being shown. CRIRES probes the wavelength region from $\sim$1 to 5 microns, has wavelength coverage of typically λ/70 and resolution of 50,000 to 100,000 depending on the slit employed. Our aim is to produce an atlas of all 300+ telluric spectra that will be used for a variety of scientific and technical purposes, for example (1) Searching for features in the B-star spectra that are caused by companions (2) searching for warm CO in the disks of early-type stars (Goto et al. 2012), (3) searching for H2 around Herbig-Haro stars (Carmona et al. 2011), (4) spectral analysis of B type stars in H, He, C, N, O, Mg and Si to act as templates for stars that suffer from strong optical extinction (Nieva et al. 2011) and (5) avoiding tellurics that show emission-line features.

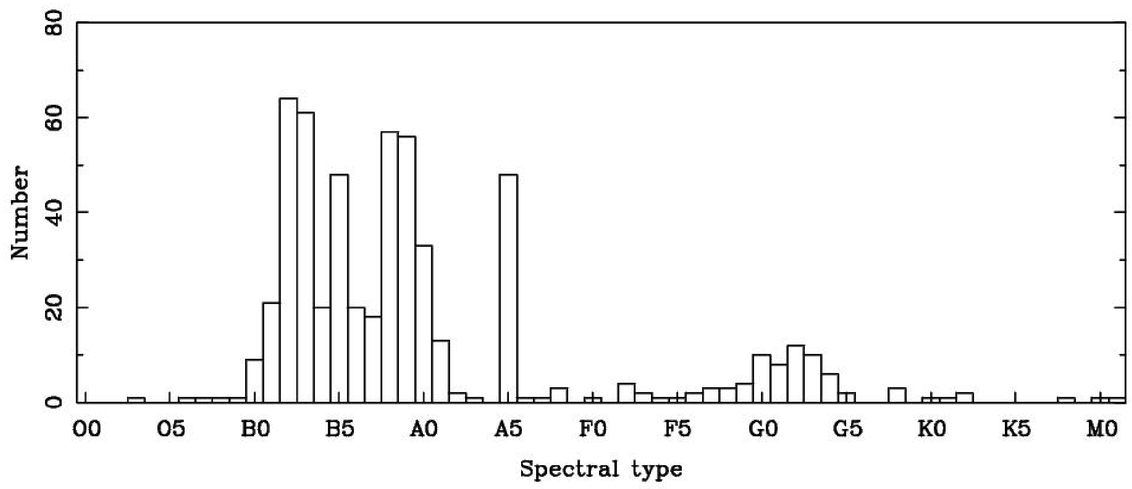

Figure 1: Histogram of spectral types of HIP telluric standards observed with CRIRES observed between 2006 and 2011.

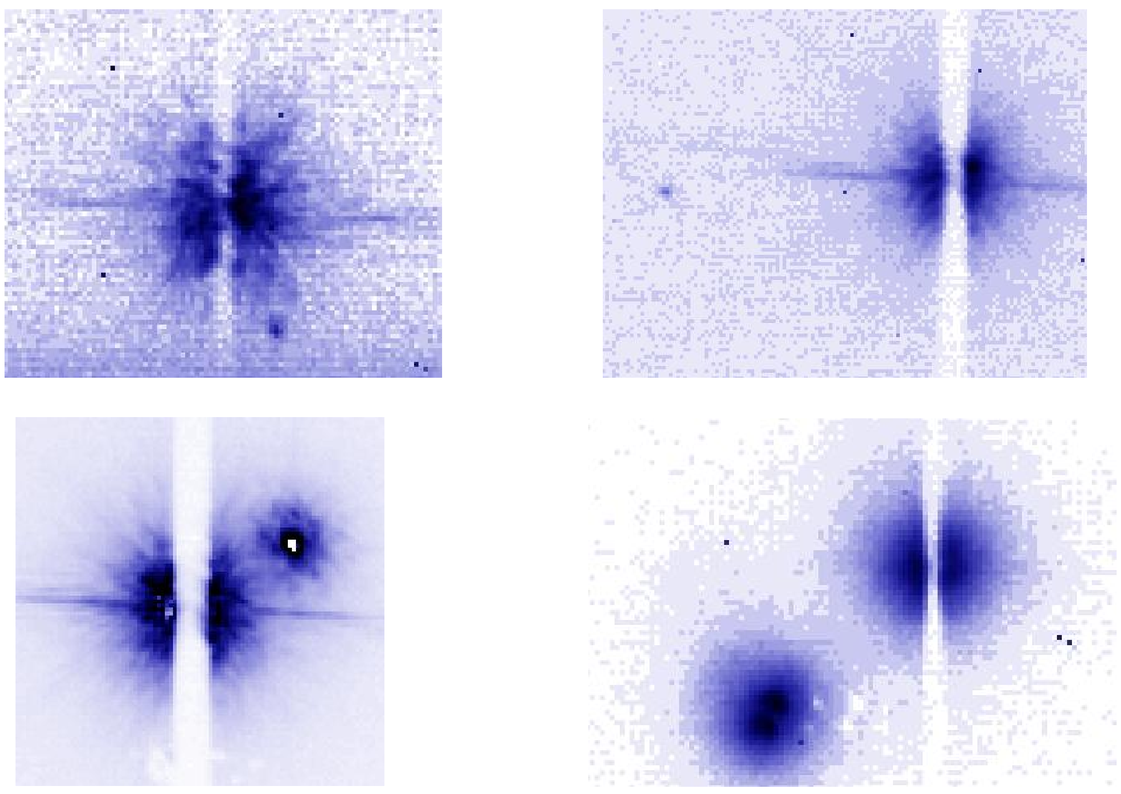

Figure 2: Examples of CRIRES slit viewer images that show possible companions. Separations range from 0.8 arcsec for the top left image to 2.0 arcs-seconds for the top right image. The slit width is 0.2 or 0.4 arcsec.

Figure 3: Example telluric spectra for three different Hip telluric stars, taken with CRIRES between 2006 and 2008. One detector only is shown for the three objects.

References

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Future work

Future work will involve statistical analysis of the current sample and the production of an atlas of all the slit viewer images and their corresponding spectra.