High Resolution Spectroscopy

High precision Radial Velocity Measurement

Robin Leadbeater

www.threehillsobservatory.co.uk
Convento group BRITE project

- The Canadian BRITE Constellation is a network of 6 Nano-Satellites measuring brightness variations in bright stars with high precision.

- Amateur RV and H alpha line profile measurements coordinated with BRITE measurements of Deneb and P Cygni during summer 2014.

- Objective is to better understand the relationship between the pulsations, the variations in the stellar wind and the brightness variations.

  (Alpha-Cygni variables could potentially be used as “standard candles” for distance measurement)

http://spektroskopieforum.vdsastro.de/viewtopic.php?t=4163
Measure the RV of Deneb from night to night over several months. Using the Si II 6347, 6371 Å absorption lines.

~10 km/s range so need long term repeatability ~1 km/s RV (0.02 Å at 6000 Å).

LHIRES III (2400 l/mm) = ~ 15 Å/mm (~0.09 Å/pixel ATK314L) measure the line with a precision and long term repeatability of ~1/5 pixel.

Observers’ data will be combined to give continuous coverage so reproduceability between observers needs to be of the same order.

Flexure in LHIRES will potentially exceed this during an observation. Internal lamp spectra taken before and after star spectra is usual solution. Lamp spectrum superimposed directly on the star spectrum for better precision.

Also measure an RV reference star (Vega) to verify the precision and accuracy and allow data from different observers to be combined.
LHIRES III Installation Three Hills Observatory

Celestron C11

Guider Camera

Imaging Camera

R ~ 15000 (0.4Å) with 2400 l/mm grating
Habitat “Filly Dot” lamp mounted in front of aperture in line with slit

Calibration lines superimposed on star spectrum
Deneb spectrum image

Si III star lines

Ne lamp lines
Wavelength Calibration using ISIS “file mode”
Mean of all star+lamp exposures used for calibration image

ISIS calculates Heliocentric RV correction using SIMBAD coordinates, fits header time and obs coordinates. Note instrument correction not required for this project.
“File mode” file (4 Ne lines 2\textsuperscript{nd} order)

order of fit
dispersion A/pix
line wavelengths
Set binning and sky background zones

Correct tilt and slant and enter wavelength and coordinate of first lamp line
Run the calibration and check the quality of the fit

Residual errors well within target 0.02Å precision
Final spectrum without background subtraction
Final spectrum with background subtraction

Some sign of small residual features from the lamp lines but these do not interfere with the star lines to be measured.
The fits header which includes the heliocentric correction
Removal of Telluric lines using template
Measure the line wavelength to 0.005Å ~1/20 pixel precision

Using Barycentre or Gaussian fit gives a much higher precision than the pixel size or line width might suggest possible.
Observations on ~50% of nights June – Sept
(bright target made observing possible in thin cloud and short breaks)
Deneb H alpha line profile evolution
2014-07-23 - 2014-12-28

Generated from 48 observations