

Imaging with *SPIRIT*

The *SPIRIT* bright star spectroscope

The *SPIRIT* bright star spectroscope provides a means to observe the spectral profile of bright stars in real time, while imaging with *SPIRIT*.

Background

The *SPIRIT* bright star spectroscope is mounted to the top of *SPIRIT II* and is used together with the *basic imaging* tools on the *SPIRIT II* web interface. The spectroscope itself, consists of an 80mm refracting telescope, a 100 lines/mm transmission grating and a video camera. It produces a real time, low resolution spectral image of bright targets with a spectral dispersion of approximately 10 Angstroms per pixel. The entire spectral image—from ultraviolet to infrared—is contained in the field of view.



Figure 1: The *SPIRIT* bright star spectroscope mounted on top of *SPIRIT II*.

Video from the spectroscope is processed in real time and presented as a spectral profile in the *Display Live Profile* window. A profile is a plot of brightness values across the spectrum from ultraviolet to infrared. Together with the live spectral profile, the original spectral image can be downloaded for calibration and analysis off-line.

How it works

The spectroscope's camera provides a real time video feed of whatever it is pointed at (during the day this will be the inside of the observatory dome). The video image produced by the transmission grating when viewing bright stars consists of two components; the target star, also known as the zero order image, and a monochromatic spectral image, where light from the star has been dispersed by the transmission grating to produce a spectrum.

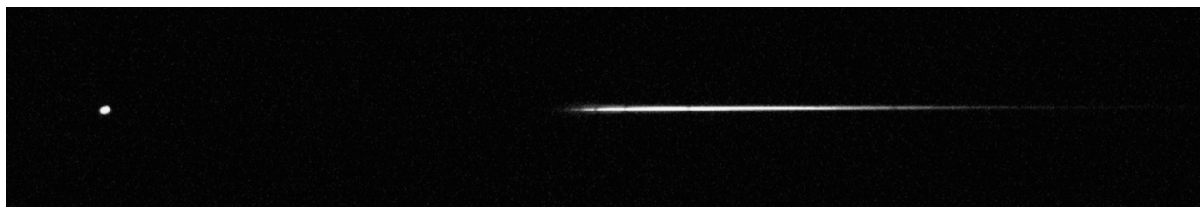


Figure 2: A spectral image showing the light of a bright star dispersed by the diffraction grating.

Software converts this image into the profile displayed on the *SPIRIT* interface. Profiles differ from star to star. Variations in the broad shape of a profile show differences in temperature. Absorption features (sudden dips in a profile) at specific wavelengths across the spectrum show chemical composition.

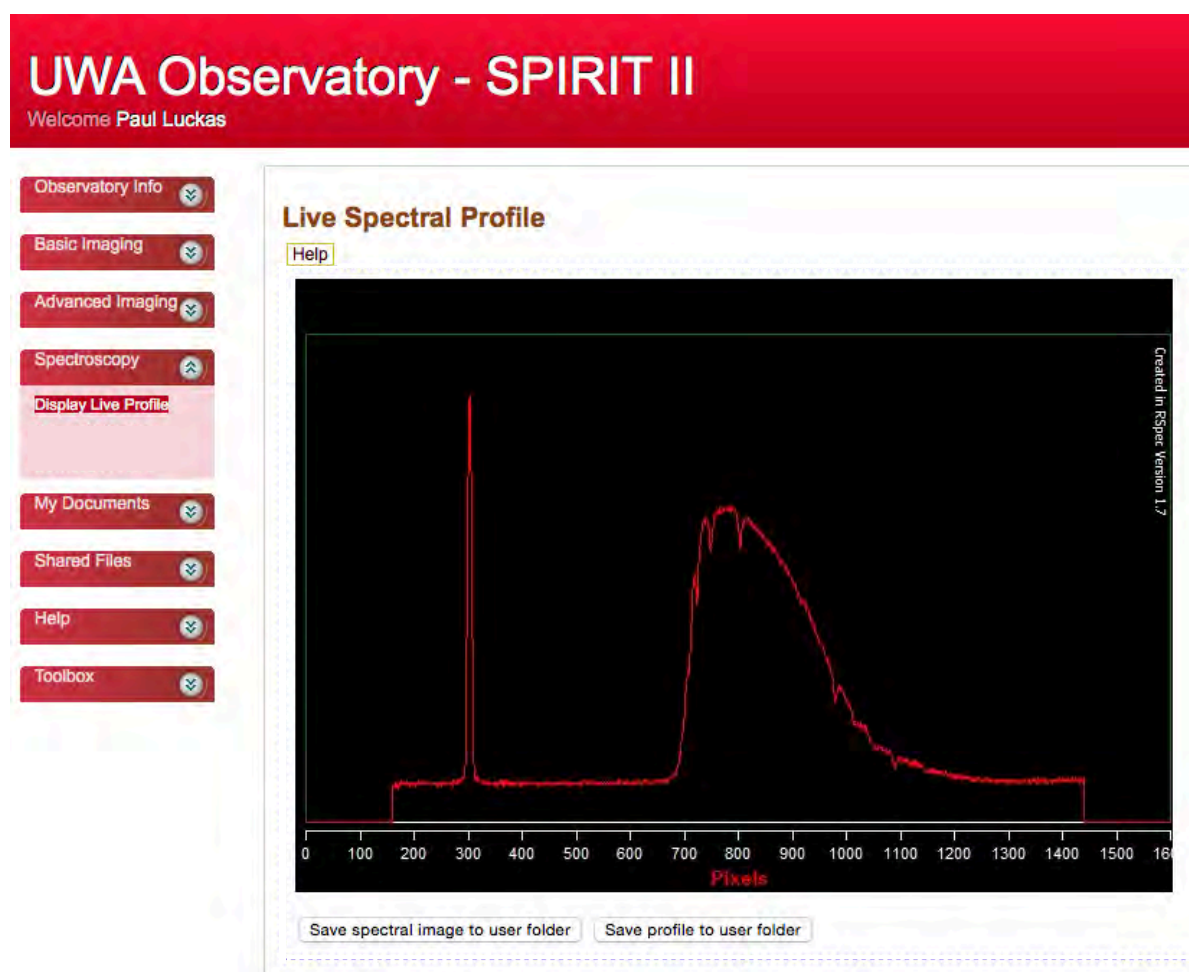


Figure 3: The appearance of a bright star's spectral profile in the SPIRIT II interface. The profile includes the 'zero order' image (the spike at left) and the spectrum of dispersed light (right).

Because the spectroscope produces a 'real time' image, a spectral profile can only be generated during the time *SPIRIT* takes an exposure. For this reason, target exposures are usually in the order of 30-60 seconds, which allows enough time to interact with the spectral profile window. Once an exposure is complete, *SPIRIT* will stop tracking the star and the live profile will quickly disappear as the target moves out of the field of view. The entire process can be repeated if necessary to enable more 'viewing time'.

The profile and spectral image can be downloaded to *my images* during image acquisition by selecting the 'save' buttons. Saved spectral images can be calibrated and analysed off-line using applications such as *RSpec*¹.

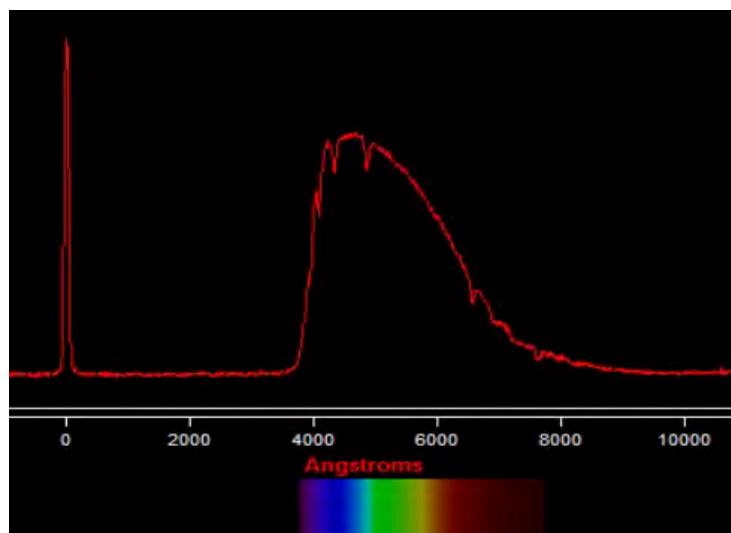


Figure 4: A calibrated spectral profile of a bright type A star, showing hydrogen Balmer absorption features.

Choosing targets

The *SPIRIT* bright star spectroscope is a low resolution instrument, designed to provide a basic profile of bright targets. It is ideally suited for exploring the broad spectral characteristics of bright stars and best results are achieved when targeting stars located high in the sky with magnitudes brighter than 3.5. Stars must be specified using accurate J2000 RA and DEC coordinates. These can be obtained using the on-line SIMBAD database: <http://simbad.u-strasbg.fr/simbad/sim-fbasic> (see appendix A).

Using the bright star spectroscope

To view the spectral profile of a bright star:

1. Select *Take a single image* from the *basic imaging* menu in *SPIRIT*.
2. Enter accurate J2000 RA and DEC coordinates for the target star (see Appendix A).
3. Set an exposure time of 30-60 seconds and press *acquire image*.
4. Choose *Display Profile* from the *Spectroscopy* menu (you may be prompted for your *SPIRIT* login).

¹ More information on *RSpec* can be found at <http://www.rspec-astro.com>
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SPIRIT will slew to the target, take a pointing exposure, re-centre and then commence imaging. During this time, the spectral profile will appear in the profile window.

Progress can be monitored under *System Status* while viewing the profile window.

5. Save the profile and/or spectral image before the main exposure completes. Images and profiles can be found in *my images*.

Appendix A: Finding accurate coordinates

It is important to ensure that the target is accurately centred in order to display a profile. In order to ensure a very high level of accuracy, stars need to be specified using J2000 RA and DEC coordinates.

Target coordinates can be found in most planetarium software, including *Stellarium*. Ensure you use the J2000 coordinates to maximise the accuracy of targeting with *SPIRIT*. The online SIMBAD database available at <http://simbad.u-strasbg.fr/simbad/sim-fbasic> can also be used to obtain accurate coordinates during imaging. RA and Dec coordinates can be copied and pasted directly into the *SPIRIT* imaging window.

The screenshot shows the SIMBAD database interface for the star Sirius. The page title is "Sirius". Below the title, there are several tabs: "other query", "Identifier query", "Coordinate query", "Criteria query", "Reference query", "Basic query", "Script submission", "Output options", and "Help". The "Coordinate query" tab is selected. The query is "Sirius". Below the query, there are several links: "Available data", "Basic data", "Identifiers", "Plot & images", "Bibliography", "Measurements", "External archives", "Notes", and "Annotations". The "Basic data" section is expanded, showing the star's name "* alf CMa -- Double or multiple star" and other object types. The ICRS coordinates (06 45 08.91728 -16 42 58.0171) are highlighted in yellow. Other data fields include FK5 coord., FK4 coord., Gal coord., Proper motions, Radial velocity / Redshift / cz, Parallax, and Spectral type.

Field	Value
ICRS coord. (ep=J2000)	06 45 08.91728 -16 42 58.0171 (Optical) [11.70 10.90 90] A 2007A&A...474..653V
FK5 coord. (ep=J2000 eq=2000)	06 45 08.917 -16 42 58.02 (Optical) [11.70 10.90 90] A 2007A&A...474..653V
FK4 coord. (ep=B1950 eq=1950)	06 42 56.72 -16 38 45.4 (Optical) [67.39 63.09 0] A 2007A&A...474..653V
Gal coord. (ep=J2000)	227.2303 -08.8903 (Optical) [11.70 10.90 90] A 2007A&A...474..653V
Proper motions mas/yr [error ellipse]	-546.01 -1223.07 [1.33 1.24 0] A 2007A&A...474..653V
Radial velocity / Redshift / cz	V(km/s) -5.50 [0.4] / z(-) -0.000018 [0.000001] / cz -5.50 [0.40] (-) A 2006AstL...32..759G
Parallax mas	379.21 [1.58] A 2007A&A...474..653V
Spectral type	A1V+DA C 2013yCat....1.2023S

Figure 5: The RA and Dec coordinates (highlighted) of the star 'Sirius' found using SIMBAD.