ESPaDOnS, an Echelle Spectropolarimeter for the CFHT Communities

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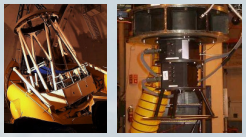
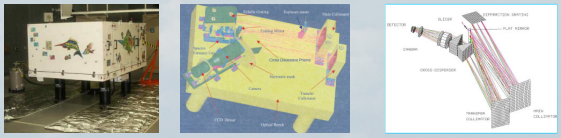
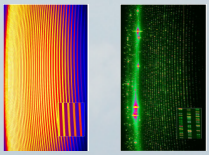
Summary: ESPaDOnS is a spectropolarimeter that has been offered at CFHT since 2005. This cross-dispersed échelle spectrograph can do spectroscopy and polarimetry, getting a complete optical spectrum from 370nm to 1.05µm in each exposure, with a spectral resolution of 68,000 in polarimetric mode. A user-friendly Graphical User Interface, an easy-to-use data reduction software, and plotting routines are also provided. ESPaDOnS, a Franco-Canadian project, was initiated by J.-F. Donati (Obs. Midi-Pyrénées/LAT), C. Catala (Obs. Paris-Meudon) and J. Landstreet (Univ. Western Ontario).



The polarimeter, installed at the f/8 Cassegrain focus of the telescope, gathers the light through a 1.6" aperture hole, and produces 2 light beams of orthogonal polarization. The 2 beams are sent to the spectrograph through 34 meters long optical fibers (one per beam).

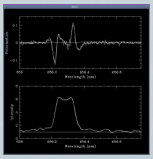


The 2 beams enter the spectrograph at the Slicer, then get collimated by the Main Collimator. The Diffraction Grating disperses the light into spectral orders that overlap. After bouncing off the Transfer Collimator, the overlapping orders are spread out by the Cross Disperser. The final 40 orders are focused by the Camera and recorded on a CCD.



Left: Flat field exposure.
Right: Thorium exposure.

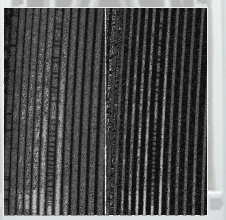
Each exposure covers 40 orders, from 370nm to 1.05µm, with a spectral resolution of 68,000 in polarimetric mode.



Data reduction is performed with Libre-ESpRIT, a package provided by J.-F. Donati and offered exclusively at CFHT. CFHT also offers simple plotting routines and *ssh* remote access to complete data reduction if needed.

What can ESPaDOnS do?

- ✓ linear or circular polarimetry of spectral lines, R=68,000
- ✓ high-resolution spectroscopy, R=80,000 [LEFT] (1 fiber, 6 slices)
- ✓ star and sky spectroscopy, R=68,000 [RIGHT] (2 fibers, 3 slices each)



- ✓ complete optical spectrum from 370nm to 1.05µm in each exposure (40 orders)
- ✓ 2 interleaved spectra (star and sky spectrum, or 2 orthogonal polarization) recorded simultaneously
- ✓ stars from magnitude 0 (Vega) down to about 13 have been observed

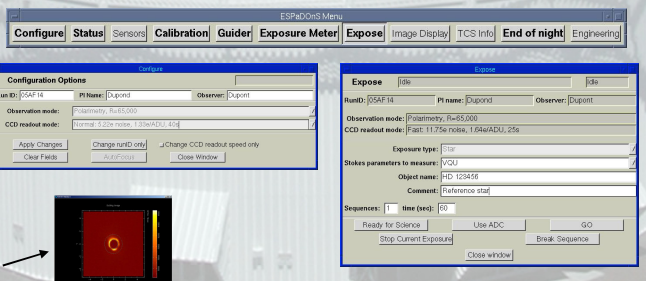
What else is offered?

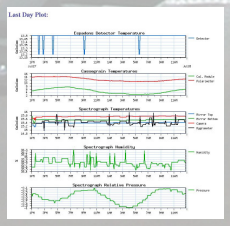
- ✓ 1.6" star pinhole, 8" sky pinhole
- ✓ 4 CCD readout modes, with different readout speed, gain and readout noise
- ✓ Exposure Meter to monitor the flux in realtime
- ✓ Fiber Agitator to avoid modal noise produced in the optical fibers
- ✓ AutoFill System to automatically fill the dewar twice a day; status of this system is available on the Web
- ✓ On-axis guiding camera to guide on the ring of light that spills out of the pinhole
- ✓ Passive thermal enclosure with temperature, hygrometry and pressure sensors
- ✓ Atmospheric Dispersion Corrector

The star hole (smaller one in the center) and sky hole (off center by 8") are drilled in a mirror, whose field of view is used by the Guiding Camera for acquiring targets and guiding.

❖ A Graphical User Interface to:

- ✓ configure the instrument
- ✓ take all necessary calibrations with one click
- ✓ take all necessary exposures to get any combination of Stokes parameters





The Bowen-Wallraven slicer (left) slices the round images coming out of the fibers in 3 slices for each of the 2 fibers (polarimetry and star+sky spectroscopy, middle) or 6 slices for the only fiber used (star only spectroscopy, right)

❖ A data reduction package written by J.-F. Donati and offered exclusively at CFHT, for:

- ✓ bias subtraction and flat fielding
- ✓ gain and readout noise calculations
- ✓ order locating and fitting
- ✓ slit model and fit
- ✓ wavelength calibration, fine tuned using telluric lines in the science spectra
- ✓ optimal spectra extraction
- ✓ polarization calculations
- ✓ sky subtraction (spectroscopy only)

❖ CFHT also offers:

- ✓ simple plotting routines
- ✓ ssh access to complete data reduction remotely if needed

http://www.cfht.hawaii.edu/Instruments/Spectroscopy/Espadons/

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