OPERA: Open source Pipeline for ESPaDOnS
Reduction and Analysis

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OPERA is a Canada-France-Hawaii Telescope (CFHT) open source collaborative software project currently under development for an ESPaDOnS echelle spectro-polarimetric image reduction pipeline. OPERA is designed to be fully automated, performing calibrations and reduction, producing one-dimensional intensity and polarimetric spectra. The calibrations are performed on two-dimensional images. Spectra are extracted using the optimal extraction algorithm by Horne, K. (1986) and Marsh, T. R. (1989). While primarily designed for CFHT ESPaDOnS data, the pipeline is being written to be portable and extensible to other instruments. A primary design goal is to make use of fast, modern object-oriented technologies. Processing is controlled by a harness, which manages a set of processing modules, that make use of a collection of native OPERA software libraries and standard external software libraries. The harness and modules are completely parametrized by site configuration and instrument parameters. The software is open-ended, permitting users of OPERA to extend the pipeline capabilities. All these features have been designed to provide a portable infrastructure that facilitates collaborative development, code re-usability and extensibility. OPERA is free software with support for both GNU/Linux and MacOSX platforms. The pipeline is hosted on SourceForge under the name “opera-pipeline”.

SOFTWARE ARCHITECTURE

PIVLINE OPERATION FOR ESPaDOnS

Calibration

The calibration consists of the steps that obtain information from calibration images that will be used later in the reduction of science data.

\begin{verbatim}
  opera <location of data> mastercalibrations
\end{verbatim}

- reduction set creation
- master calibration images
- gain and noise values
- geometric calibrations
- instrument profile calibration
- extraction aperture calibration
- create badpixel mask
- create pixel-by-pixel sensitivity map
- wavelength calibration

Reduction

Reduction consists, at a high level, of intensity optimal extraction and polarimetry.

\begin{verbatim}
  opera <location of data> reduce
\end{verbatim}

- extraction and signal-to-noise calculation
- normalization
- wavelength correction based on telluric lines
- polarimetry, continuum polarization subtraction, and null polarization
- FITS product creation

SPECTROSCOPY CLASSES

Derived FITS image classes

- \texttt{operaEspadonsImage} - an extension of \texttt{operaFITSImage} that also handles mode, speed, detector, and dataset.
- \texttt{operaFITSSubImage} - a container for pixels and dimensions only (no headers), which is an arbitrary sub-window of an \texttt{operaFITSImage}.
- \texttt{operaMultiExtensionFITSImage} - a container for images stored in the FITS MEF format.
- \texttt{operaMultiExtensionsFITSImageC} - a container for the FITS Image type MEF Cube. This is the format for the CFHT Wide-field Infra-Red Camera (CameraWIRCam) instrument data.
- \texttt{operaFITSImageC} - a FITS cube that is not in MEF format.