Python NIRSPEC Pipeline Cheat Sheet

Initial setup

1. On hobbes the source code is located in the directory /opt/python/2.7.5/lib/python2.7/site-packages/

    A. pynirspec/ — The actual pipeline. Converts raw FITS images into reduced 1-D spectra

    B. atmopt/ — Contains code that computes atmospheric models using the RFM line-by-line code (rfm_tools.py) used for the wavelength calibration.

    C. pyspec/ — Tools for dealing with fully reduced 1D spectra (I haven't used this)

2. Within your working directory create the following directories: CAL1D/, L1FILES/, SA1D/, SPEC1D/, SPEC2D/, and WAVE/.

3. If you plan to edit the code you should get a bitbucket account and follow pontoppi/pynirspec, pontoppi/atmopt, and pontoppi/pyspec.

    A. It's a mercurial repository. Email Klaus Pontoppidan (pontoppi@stsci.edu) for access.

Reduction

1. Inputs

    1. nirspec.ini file — contains spectral setups (echelle/cross disperser angles), number of orders, location of orders, and initial guesses for wavelength calibration,
    2. Driver script — see example

2. Level 1 - Each step is performed on a science and standard target

    A. FDark and ODark — median combined dark frames for the flats and science frames, respectively. Also creates a bad pixel mask.

    B. OFlat — Median combined, normalized flat field.

    C. Nod — Stack of A-B images

        i. Based on coordinates from the headers, images are assigned as A or B (Errors occur at this step sometimes).

        ii. A-B subtraction, flat field and bad pixel corrections are applied.

        iii. An image of just the sky is also created.

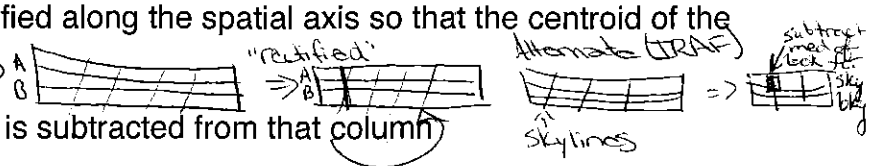
        iv. Uncertainties are propagated as a separate image

D. Order — Average combined A-B image

i. Offsets along the spatial axis are computed independently for A and B nods

ii. Shifts are applied and the images are averaged together.

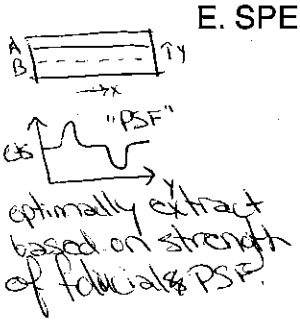
iii. The combined image is rectified along the spatial axis so that the centroid of the PSF follows a single row.



iv. The median of each column is subtracted from that column

v. Final image is printed to the SPEC2D/ directory which includes the target image with uncertainties and the sky image with uncertainties.

E. SPEC1D — 1D spectrum with a rough wavelength calibration



i. 1-D spectrum is extracted based on an optimal extraction method.

ii. An initial wavelength calibration is applied based on the initial guesses from the nirspec.ini file.

iii. The final spectrum is printed to the SPEC1D/ directory. Includes arrays for: wavelength, source flux, uncertainty in source flux, sky flux, and uncertainty in sky flux for both the A and B positions.

F. WaveCal — Wavelength calibrated 1-D spectra for A and B nods

if problematic divide spectrum into four parts and fit wv soln individually

i. Atmospheric model in computed by RFM (atmopt) based on wavelength regions given in nirspec.ini

ii. Cross-correlation between model and observed sky yields the wavelength calibration which is a 4th order polynomial. The optimization happens in rfm_tools.py (atmopt) within the Optimize() class.

iii. The final spectrum is printed to WAVE/. The format is the same as SPEC1D/ except the wavelength calibration is updated.

λ is not regularly spaced
Flux evenly spaced over 1024 pixels

3. Level 2

A. CalSpec — A/B averaged, telluric corrected (from standard) 1-D spectrum

i. A and B nod spectra are normalized to median

$\frac{A_{sci}}{A_{std}}$, $\frac{B_{sci}}{B_{std}}$, combine.

ii. Optional Beers law correction is applied to the standard

iii. Science spectra are divided by the telluric standard

iv. The final spectrum is printed to CAL1D/. Includes arrays for: wavelength, telluric divided flux, and uncertainty in flux.