Reducing GNIRS Cross-Dispersed Data

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What we’ll cover

• What do the raw data look like?
• What are the steps in the reduction?
  – Using the Gemini IRAF package
• How do the data change at each stage?
• All based on public spectra of M81 (NGC 3031)
This talk is complemented by:

- Raw data and file containing all commands used to reduce spectra
  - drforum.gemini.edu/topic/material-for-noao-workshop/
- Web page with more explanation of points not covered here (“XD reduction page”)  
- XDGNIRS script – does everything in the above file, and then some (more later)
More Help: The Science User Support Department

- New group led by Joanna Thomas-Osip

- What post-observing support do you want?
- What post-observing support do you want to contribute??
What is (are?) XD data?

- The popular configuration that gives 0.85 – 2.5 um coverage at R~1200
  - 32 l/mm, “short blue” (0.15”/pix) camera

- Basic steps also applicable to other XD configurations, e.g.
  - 0.05” pixel scale with AO
  - 111 l/mm grating
What constitutes a data set?

Science target spectra
Flats: IR lamp
Flats: QH lamp
Arc spectra
Standard star spectra
Daytime pinhole flats
Raw data: the science target

- Bad pixels
- $\alpha$-particle hits (worst prior to mid-2012)
Raw data: the science target*

“Tachyon”

Electronic striping and quadrant offsets (can be removed)

Persistence from acq. image

(*Example data from 3 different programs)
Raw data: the standard star

- Bright target, shorter exposures
  - Sky emission less obvious
  - Fewer radiation events
- Compact target
  - Nod along slit

Different program; striping example
The reduction steps

1. Set up lists and environment
2. Remove electronic pattern
3. “Prepare” and “cut” the files
4. Make the master flatfield
5. Clean radiation events from data
6. Flatfield and sky subtract
7. Combine individual files
8. Straighten and wavelength calibrate
9. Extract spectra
10. Remove telluric absorption
11. Flux calibrate
12. Combine orders
Where to start?

• *Highly* recommend using Ureka
  – Easy-to-install package containing IRAF, Gemini IRAF, python, ...
  – ssb.stsci.edu/ureka/

• Get to know your data: decide which files to include
  – See the XDGNIRS reduction page
Getting set up

- Start pyraf/IRAF, load packages, identify data types, create lists, ...
Remove electronic pattern

- Use “cleanir.py” script to “clean” files that need it
“Prepare” and “cut” the data

- **nsprepare** flags saturated pixels, locates spectral orders, ...
- **nsreduce** extracts orders into 6 separate extensions
Make the flatfield

• Flats taken with IR blackbody and quartz halogen lamps
  – Use ext 1 of IR flats, ext 2-6 of QH flats
  – Others can be ignored

• **nsflat** used to combine frames and normalise
Remove spikes from science data

- E.g. identify spikes in median or minimum image, interpolate using **fixpix**
Cut, flatfield and sky subtract

- Run **nsreduce** on science target and standard star data, then combine individual files with **nscombine**
Wavelength calibrate

• Done with **nswavelength**. Automatic solution usually fine; if not, check arcs.
Rectify the orders

- **nssdist** (pinholes), **nsfitcoords**, **nstransform** (galaxy & standard star)
Rectify the orders

- See the XD reduction page for examples of bad results and what to do about them
Extract spectra

- `nsextract` calls `apall` or simply extracts columns
Remove lines from standard star

- Intrinsic H absorption lines in A-type stars
- Use (ns)telluric + Vega spectrum, and/or
- Use `splot` to fit and subtract Lorentz profiles
Divide out telluric lines

- Use (ns)telluric to divide by standard star. Check shift/scale are sensible.
Flux calibrate

• For each order, use mk1dspec to make a blackbody spectrum with the same temperature as the standard star
• Multiply each galaxy order by the blackbody
• If absolute flux calibration needed, scale the order 3 (extension 1) blackbody to the star’s 2MASS Ks magnitude
Combine orders

- Use `specplot` to check order overlap and decide which pixels to include; `odcombine` to combine.
“XDGNIRS” reduction code

- List of raw files → flux calibrated spectrum...
- ...usually...
- No “official” support, but will try to answer questions on forum
“Fast Turnaround” at Gemini

- Submit proposals every month
- People review each other’s proposals
- Successful programs made ready within a month of the deadline
- Observations executed on 3 nights/month dedicated to the program
- Trial just launched at Gemini North: deadline Jan 31!
Gemini’s Fast Turnaround Program


Proposal deadline

We got time!

Phase II deadline

Data!!

Bloggs et al. 2017
Importa
tResult

Paper??

Gemini Observatory: AURA, The Johns Hopkins University, California Institute of Technology, National Optical Astronomy Observatory, National Science Foundation, National Aeronautics and Space Administration, and The Spanish Observatorio del Henry Overby y University of Hawaii at Maunakea Foundation.