Optical Data Reduction in Python

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ccdproc

Insert snappy graphic here

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In [20]:
```
import numpy as np
from ccdproc import CCDData
import glob
import os
from astropy.table import Table, Column
from astropy import units as u

#list of keywords to include in the observing log
keywords = ['NAME', 'OBJECT', 'FILTERS', 'EXPTIME', 'SECZ', 'GAIN', 'RDNOISE']
key_dtype = ['a14', 'a8', int, float,  float, float, float]
observation_table = Table(names=keywords, dtype=key_dtype)

#glob.glob creates a list of all files that match 'a*.fits'
img_list = glob.glob('data/raw/a*fits')
```

```
ccd_dict={}
#now loop through each file, open it, and read in the
information about
#the file
for img in img_list:
    ccd = CCDData.read(img, unit=u.adu)
    table_row=[os.path.basename(img)]
    for k in keywords[1:]: table_row.append(ccd.heade
r[k])
    observation_table.add_row(table_row)

print(observation_table)
```

```
     NAME      OBJECT  FILTERS EXPTIME  SECZ GAIN RDNO
ISE
------------ -------- ------- ------- ----- ---- ----
---
a8280001.fits PG1545+0      28   5.039  1.26  1.9
5.0
a8280004.fits PG1545+0      28  10.039 1.249  1.9
5.0
a8280005.fits PG1545+0      28  10.039 1.248  1.9
5.0
a8280006.fits PG1545+0      28  10.039 1.248  1.9
5.0
a8280007.fits PG1545+0      28  10.039 1.247  1.9
5.0
a8280008.fits PG1545+0      28  10.039 1.246  1.9
5.0
a8280009.fits PG1545+0      28  10.038 1.246  1.9
5.0
a8280010.fits PG1545+0      38  10.039 1.244  1.9
5.0
a8280011.fits PG1545+0      38  10.039 1.244  1.9
5.0
a8280012.fits PG1545+0      28  10.039 1.243  1.9
5.0
          ...      ...     ...     ...   ...  ...
...
a8280424.fits   rs0037      84 120.039 1.229  1.9
```

```
5.0
a8280425.fits     BIAS      28     0.0 1.289  1.9
5.0
a8280426.fits     BIAS      28     0.0 1.289  1.9
5.0
a8280427.fits     BIAS      28     0.0 1.289  1.9
5.0
a8280428.fits     BIAS      28     0.0 1.289  1.9
5.0
a8280429.fits     BIAS      28     0.0 1.289  1.9
5.0
a8280430.fits     BIAS      28     0.0 1.289  1.9
5.0
a8280431.fits     BIAS      28     0.0 1.289  1.9
5.0
a8280432.fits     BIAS      28     0.0 1.289  1.9
5.0
a8280433.fits     BIAS      28     0.0 1.289  1.9
5.0
a8280434.fits     BIAS      28     0.0 1.289  1.9
5.0
Length = 432 rows
```

In [40]:

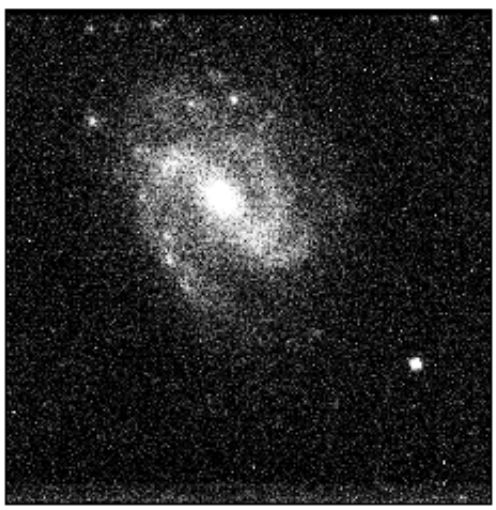
```
import ccdproc
bias_mask = (observation_table['OBJECT']=='BIAS')
bias_list = []
#read in each of the data files
for img in observation_table['NAME'][bias_mask]:
    ccd = CCDData.read('data/raw/'+img, unit=u.adu)
    ccd = ccdproc.subtract_overscan(ccd, fits_sectio
n=ccd.header['BIASSEC'])
    ccd = ccdproc.trim_image(ccd, fits_section=ccd.hea
der['TRIMSEC'])
    bias_list.append(ccd)
```

In [41]:

```
#median combine the data
cb = ccdproc.Combiner(bias_list)
master_bias = cb.median_combine(median_func=np.median)
master_bias.write('MASTER_BIAS.fits', clobber=True)
```

In [24]:
```
img = 'data/raw/a8280415.fits'
ccd = CCDData.read(img, unit=u.adu)
from astropy import modeling as mod
m_init = mod.models.Legendre1D(5)
ccd = ccdproc.subtract_overscan(ccd, fits_section=cc
d.header['BIASSEC'], model=m_init)
ccd = ccdproc.trim_image(ccd, fits_section=ccd.heade
r['TRIMSEC'])
ccd = ccdproc.subtract_bias(ccd, master=master_bias)
g = ccd.header['GAIN'] * u.electron/u.adu
rd = ccd.header['RDNOISE'] * u.electron
ccd = ccdproc.create_deviation(ccd, gain=g, readnois
e=rd)
```

In [38]:
```
import pylab as pl
import matplotlib.cm as cm
pl.figure()
ax = pl.axes([0.1, 0.1,0.8,0.8])
ax.imshow(ccd.data, origin='lower', vmin = 20, vmax=4
0, cmap = cm.Greys_r)
ax.set_xticks([])
ax.set_yticks([])
pl.show()
```



specreduce

In [56]:
```
import sys
```

```
import numpy as np
from astropy.io import fits

from PySpectrograph.Models import RSSModel

import specreduce

from specreduce.interidentify import InterIdentify
from specreduce import spectools as st
from specreduce import WavelengthSolution
```

In [57]:

```
function='poly'
order=3
rstep=1
nrows=1
mdiff=20
thresh=3
niter=5
dc=3
ndstep=50
dsigma=5
method='Zeropoint'
res=2
dres=0.2
filename=None
smooth=3
inter=True
subback=0
textcolor='green'
log = None

linelist='Xe.salt'
slines, sfluxes = st.readlinelist(linelist)

hdu = fits.open('mfxgbpP201411210026.fits')
data = hdu[1].data
xarr = np.arange(data.shape[1])
```

In [58]:

```
grating = hdu[0].header['GRATING']
slitname = hdu[0].header['MASKID']
```

```
slit = st.getslitsize(slitname)
grang = hdu[0].header['GR-ANGLE']
arang = hdu[0].header['AR-ANGLE']

xbin, ybin = hdu[0].header['CCDSUM'].split()
xbin = int(xbin)
ybin = int(ybin)
xpos = -0.2666
ypos = 0.0117
objid = None


rss = RSSModel.RSSModel(grating_name=grating.strip(),
gratang=grang,
                        camang=arang, slit=slit, xbi
n=xbin, ybin=ybin,
                        xpos=xpos, ypos=ypos)

rss.gamma = 0

res = 1e7 * rss.calc_resolelement(rss.alpha(), -rss.be
ta())
dres = res / 10.0
wcen = 1e7 * rss.calc_centralwavelength()
R = rss.calc_resolution(wcen / 1e7, rss.alpha(), -rs
s.beta())

ws = st.useRSSModel(xarr, rss, function=function, orde
r=order, gamma=rss.gamma)
```

In [59]:

```
istart = int(data.shape[0]/2)
InterIdentify(xarr, data, slines, sfluxes, ws, mdiff=m
diff, rstep=rstep,
              function=function, order=order, sigma=th
resh, niter=niter,
              res=res, dres=dres, dc=dc, ndstep=ndste
p, istart=istart,
              method=method, smooth=smooth, filename=f
ilename,
              subback=subback, textcolor=textcolor, lo
```

```
g=log, verbose=True)
```

Out[59]: {}

In [ ]:
```
specreduce sample with links to data is available her
e:
    https://gist.github.com/crawfordsm/a4941cd8e8daebc
6d9e3
```

What Else?

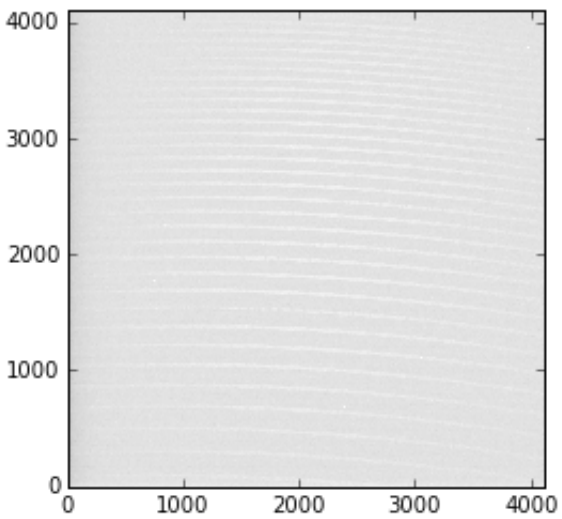
PySALT

http://pysalt.salt.ac.za/
ccd reduction, high speed photometry, spectral reduction, fabry-perot

pyhrs
http://pyhrs.readthedocs.org/en/latest/

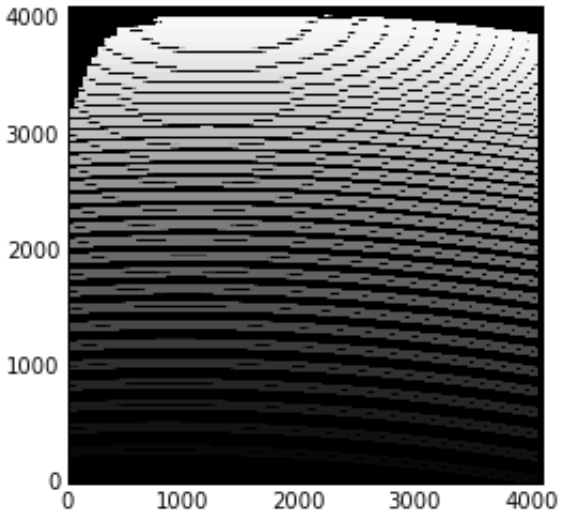
In [44]:
```
ccd   = CCDData.read('R201404280081.fits', unit=u.elect
ron)
order = CCDData.read('RORDER.fits', unit=u.electron)
wave = CCDData.read('RWAVE.fits', unit=u.angstrom)
```

In [47]:
```
pl.imshow(ccd.data, origin='lower', vmin=400, vmax=50
0, cmap = cm.Greys_r)
pl.show()
```

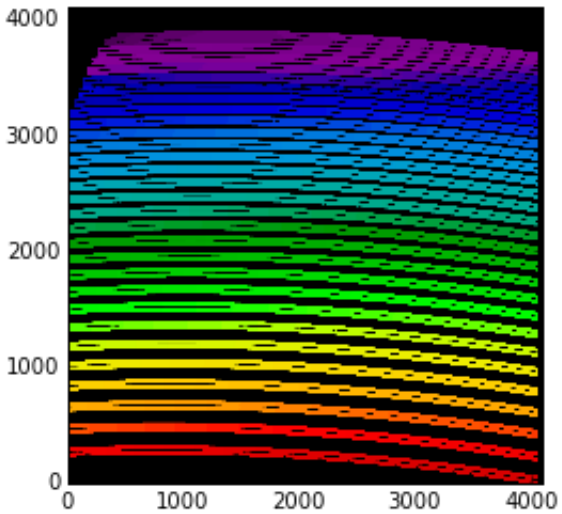


In [55]:

In [55]:
```
pl.imshow(order.data, origin='lower', vmin=53, vmax=8
5,cmap = cm.Greys_r )
pl.show()
```



In [51]:
```
pl.imshow(wave.data, origin='lower', vmin=5500, vmax=9
000,cmap = cm.spectral )
pl.show()
```



But are we doing it right?

Acknowledgements

Huge thank you to the astronomy python community!

National Research Foundation of South Africa, Southern African Large Telescope Foundation

github, Lorentz Center, LCOGT, numfocus, python software foundation

Acknowledgement:
This talk made use of Astropy, a community-developed core Python package for Astronomy (Astropy Collaboration, 2013.