AGA0414
Reduction of Spectroscopic Data

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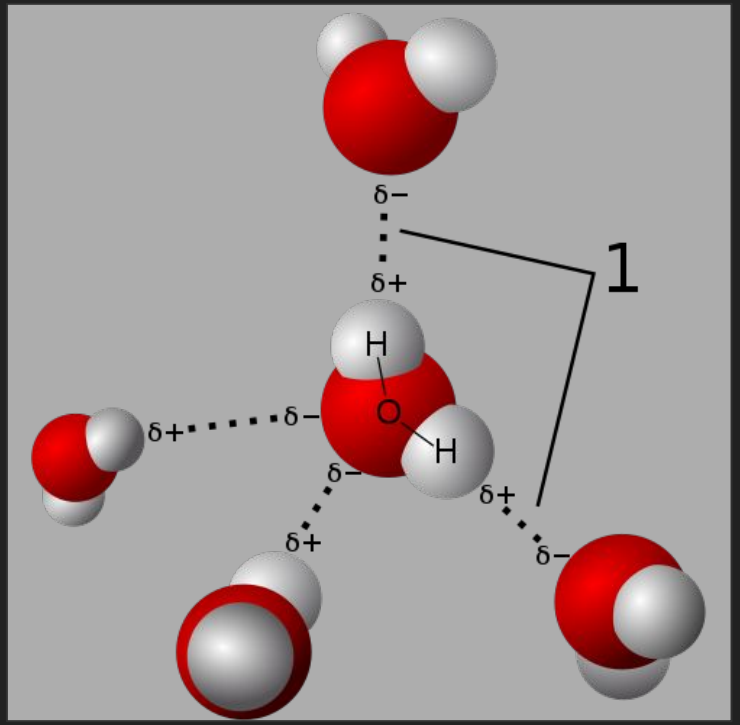
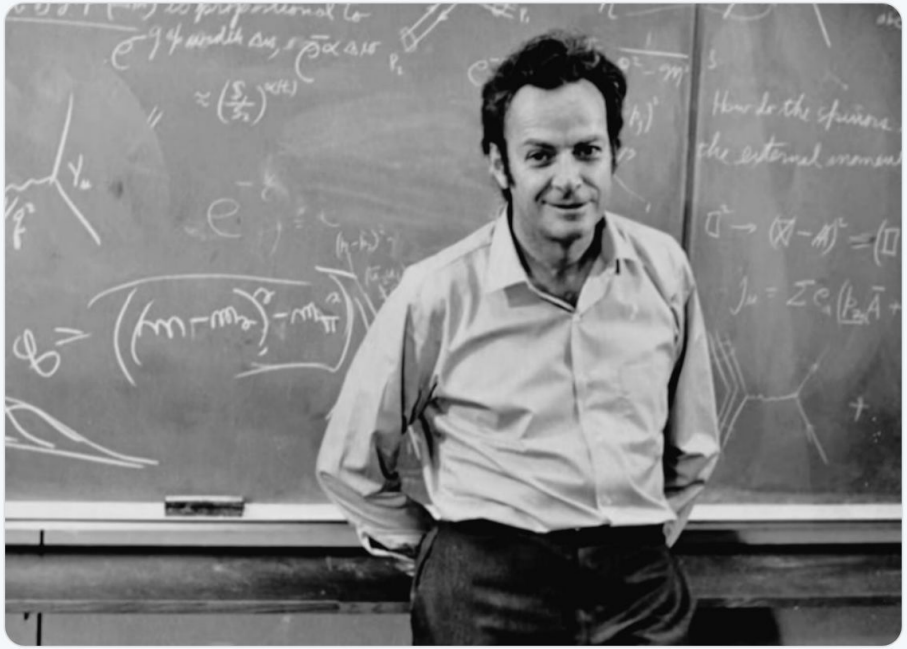
...but first: the formula of water

H_2O



Richard Feynman @ProfFeynman · May 12

Students should be made
to think,
to doubt,
to communicate,
to question,
to learn from their mistakes, and most importantly
have fun in their learning.



42 2.7K 6.5K

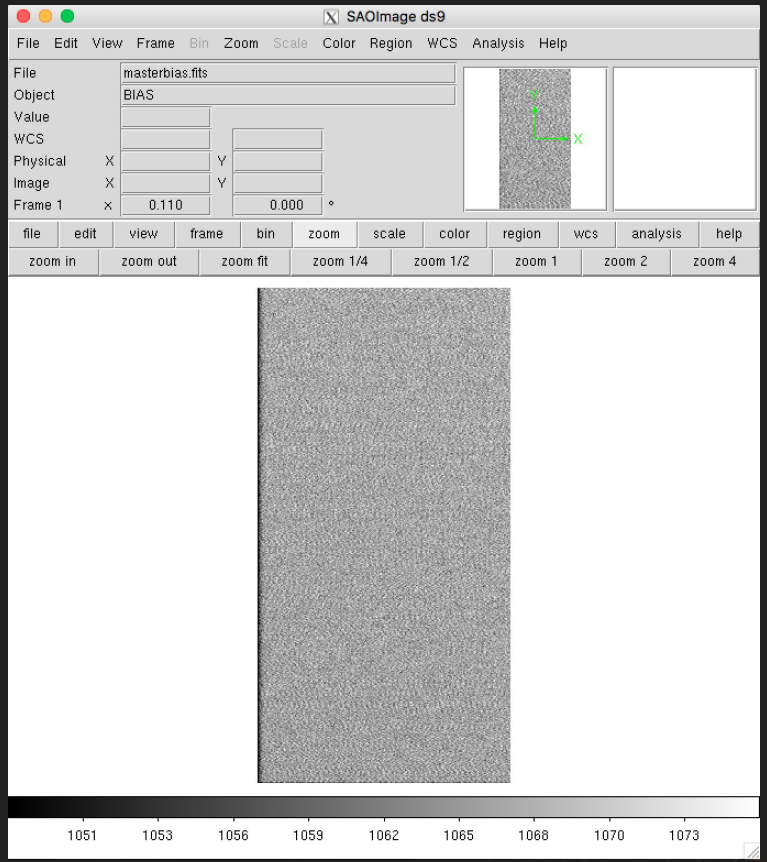
Reducing a spectrum (long slit)

- Bias or overscan subtraction
- Flat removal
- Wavelength calibration
- Flux calibration

The bias

```
ccdred> imstat bias*
#               IMAGE      NPIX      MEAN    STDDEV       MIN       MAX
          bias1.fits   2151499      1067.     36.72        0.      8648.
          bias2.fits   2151499      1067.     36.68        0.     12471.
          bias3.fits   2151499      1067.     36.71        0.      9853.
```

```
ccdred> zerocombine bias*.fits output=masterbias.fits ccdtype=""
ccdred> imstat masterbias.fits
#               IMAGE      NPIX      MEAN    STDDEV       MIN       MAX
     masterbias.fits   2151499      1065.     35.12        0.      1081.
```

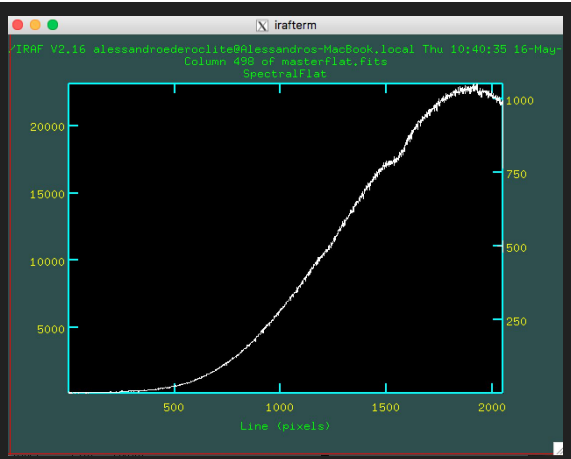


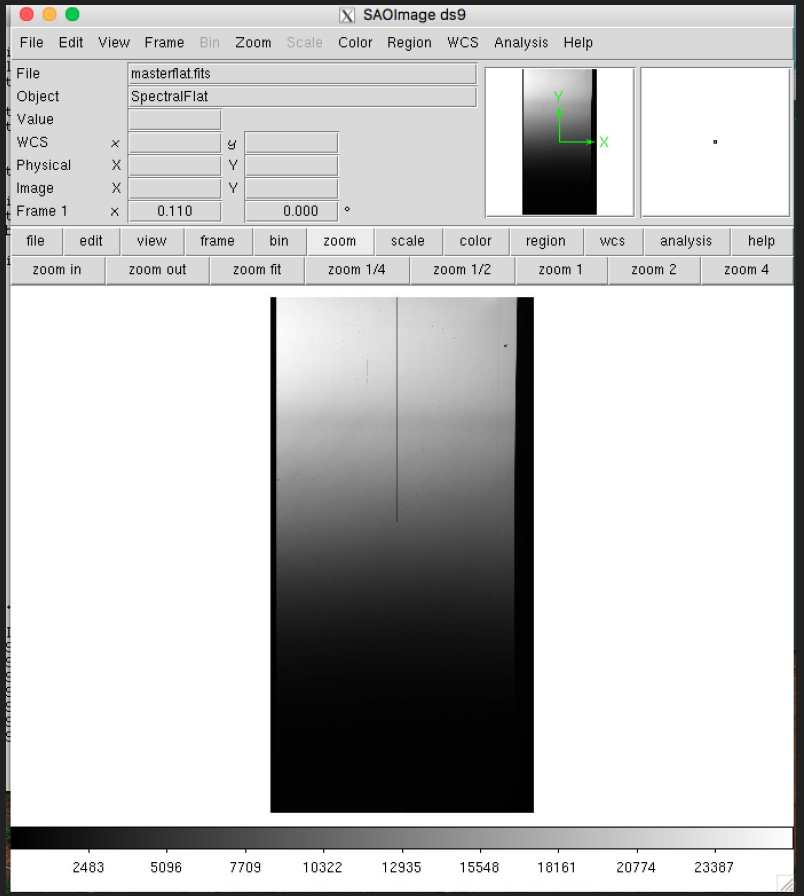
The flat field

```
ccdred> ccdproc @flats.lis output=b//@flats.lis ccdtype="" fixpix- overscan- trim- zerocor+ \
darkcor- flatcor- zero=masterbias.fits
```

```
ccdred> flatcombine b//@flats.lis output=masterflat.fits ccdtype="" process- subsets-
```

```
ccdred> imstat *lat*fits
#               IMAGE      NPIX      MEAN    STDDEV       MIN       MAX
          bflat1.fits   2151499    8433.    8568.      -26.    28985.
          bflat2.fits   2151499    8337.    8482.    -24.5     28546.
          bflat3.fits   2151499    8292.    8443.    -17.5     28384.
           flat1.fits   2151499    9498.    8570.        0.    30057.
           flat2.fits   2151499    9401.    8484.        0.    29618.
           flat3.fits   2151499    9357.    8445.        0.    29456.
     masterflat.fits   2151499    8354.    8498.   -16.46     28638.
```





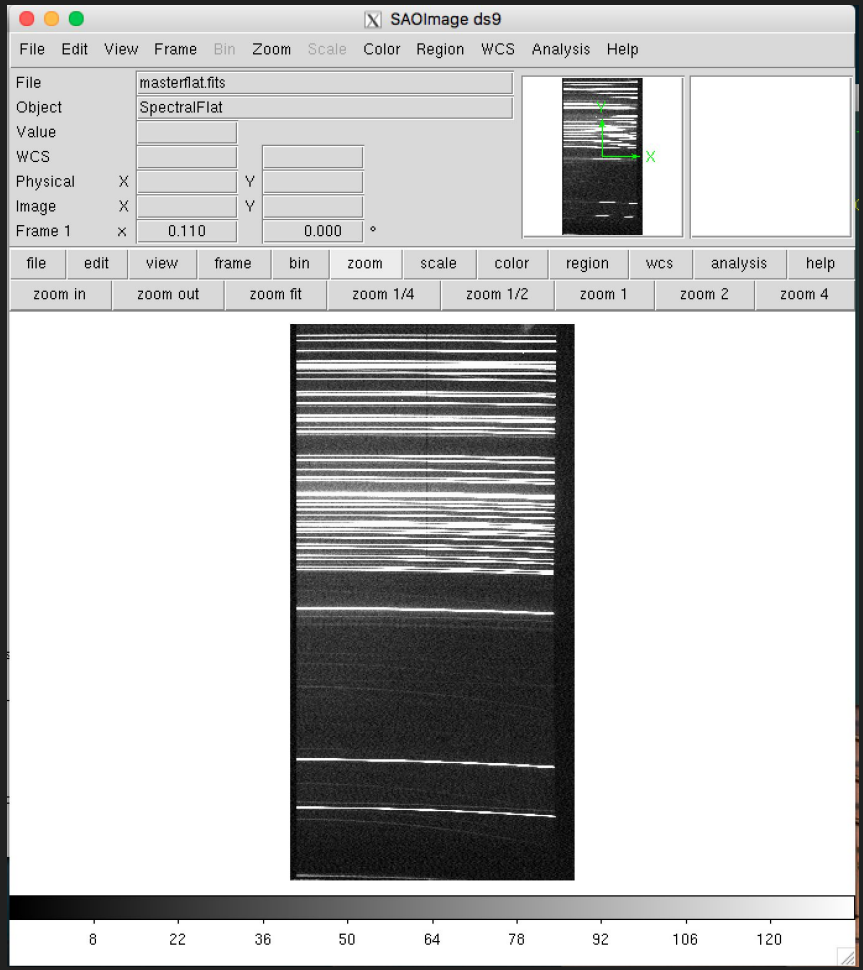
The “arc”

```
ccdred> ccdproc @arcs.lis output=b//@arcs.lis ccdtype="" fixpix- overscan- trim- zerocor+ \
darkcor- flatcor- zero=masterbias.fits
```

```
ccdred> imcombine b//@arcs.lis arc.fits

May 16 10:47: IMCOMBINE
  combine = average, scale = none, zero = none, weight = none
  blank = 0.
                Images
             barc1.fits
             barc2.fits

  Output image = arc.fits, ncombine = 2
```



Normalize flat #1

```
ccdred> imcopy masterbias.fits[100:400,*] t_masterbias.fits
masterbias.fits[100:400,*] -> t_masterbias.fits
ccdred> imcopy masterflat.fits[100:400,*] t_masterflat.fits
masterflat.fits[100:400,*] -> t_masterflat.fits
ccdred> imcopy arc.fits[100:400,*] t_arc.fits
arc.fits[100:400,*] -> t_arc.fits
ccdred> imcopy std.fits[100:400,*] t_std.fits
std.fits[100:400,*] -> t_std.fits
```

Normalize flat

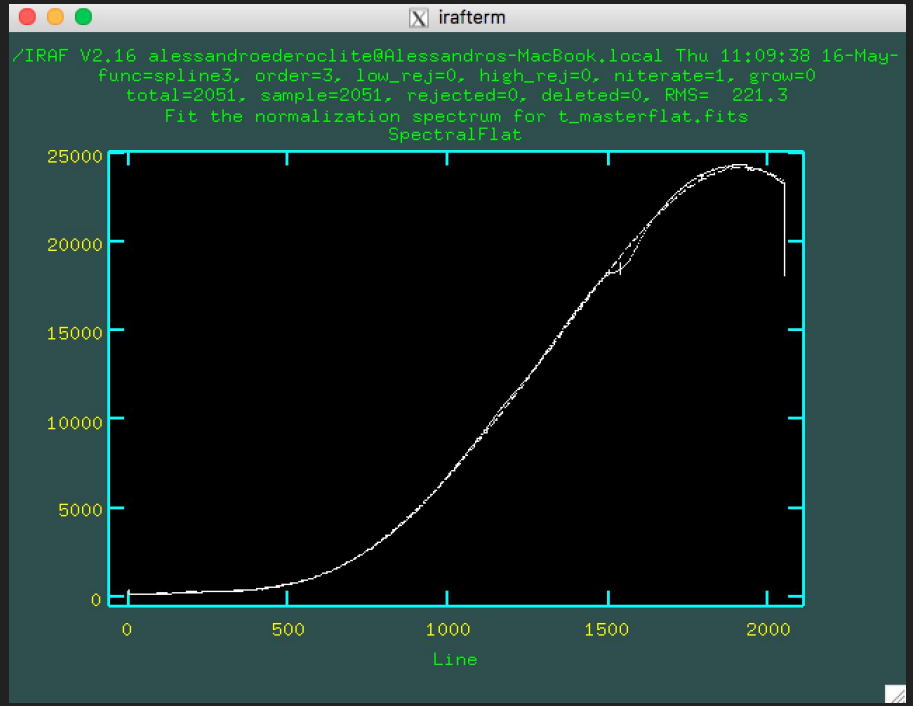
```
ccdred> twod
      apextract.  longslit.

twodspec> longsli
      aidpars@        demos           fitcoords       lscombine       sensfunc        specshift
      autoidentify    deredden        fluxcalib       reidentify      setairmass      splot
      background      dopcor          identify        response        setjd           standard
      bplot           extinction      illumination    sarith          sflip           transform
      calibrate       fceval          lcalib          scopy           specplot
```

```
longslit> longslit.dispaxis=2
longslit> lpar longslit
     dispaxis = 2               Dispersion axis (1=along lines, 2=along columns, 3=along z)
        (nsum = "1")            Number of lines/columns to sum
 (observatory = "observatory")  Observatory of data
  (extinction = "onedstds$kpnoextinct.dat") Extinction file
      (caldir = "onedstds$spec50cal/") Standard star calibration directory
      (interp = "poly5")        Interpolation type
     (records = "")             Record number extensions
     (version = "February 1993")
        (mode = "ql")
      ($nargs = 0)
```

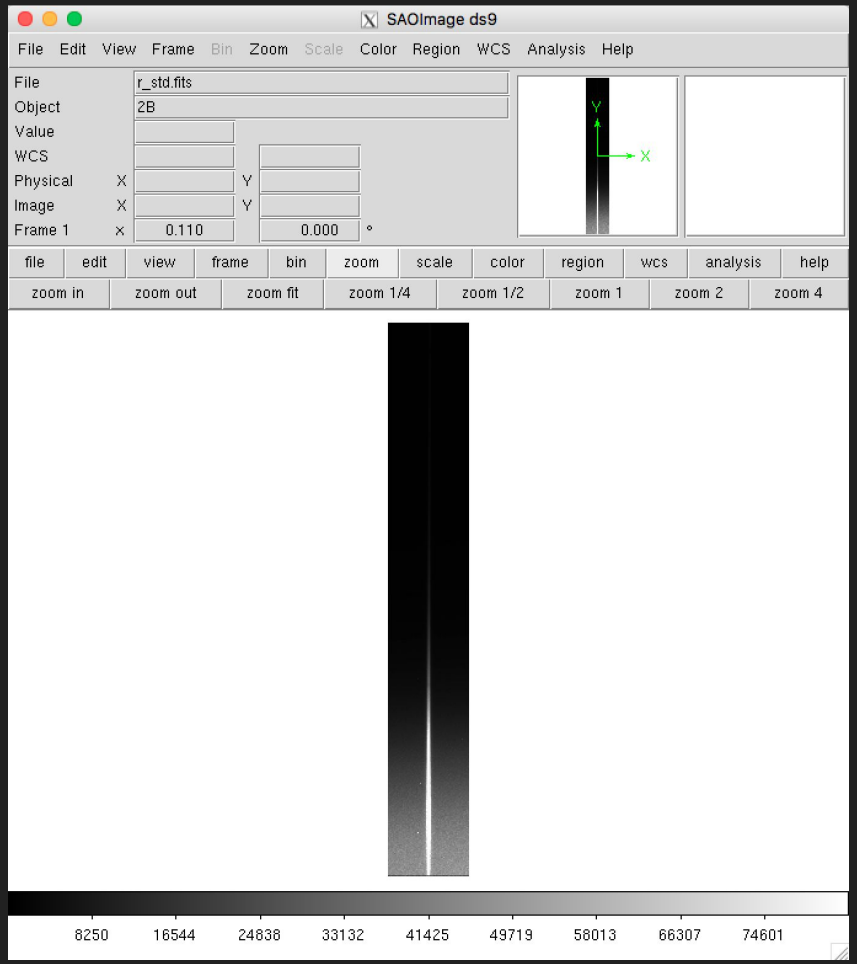
Normalize flat #2

```
longslit> lpar response
  calibration =                 Longslit calibration images
 normalizatio =                 Normalization spectrum images
     response =                 Response function images
 (interactive = yes)            Fit normalization spectrum interactively?
   (threshold = INDEF)          Response threshold
      (sample = "*")            Sample of points to use in fit
    (naverage = 1)              Number of points in sample averaging
    (function = "spline3")      Fitting function
       (order = 3)              Order of fitting function
  (low_reject = 0.)             Low rejection in sigma of fit
 (high_reject = 0.)             High rejection in sigma of fit
    (niterate = 1)              Number of rejection iterations
        (grow = 0.)             Rejection growing radius
    (graphics = "stdgraph")     Graphics output device
      (cursor = "")             Graphics cursor input
        (mode = "al")
longslit> response t_masterflat.fits t_masterflat.fits n_t_masterflat.fits
Fit the normalization spectrum for t_masterflat.fits interactively (yes):
Dispersion axis (1=along lines, 2=along columns, 3=along z) (1:3) (2):
```



Spectrum reduction

```
longslit> ccdproc t_std.fits output=r_std.fits ccdtype="" fixpix- overscan- trim- zerocor- \
>>> darkcor- flatcor+ zero=t_masterbias.fits flat=t_masterflat.fits
```

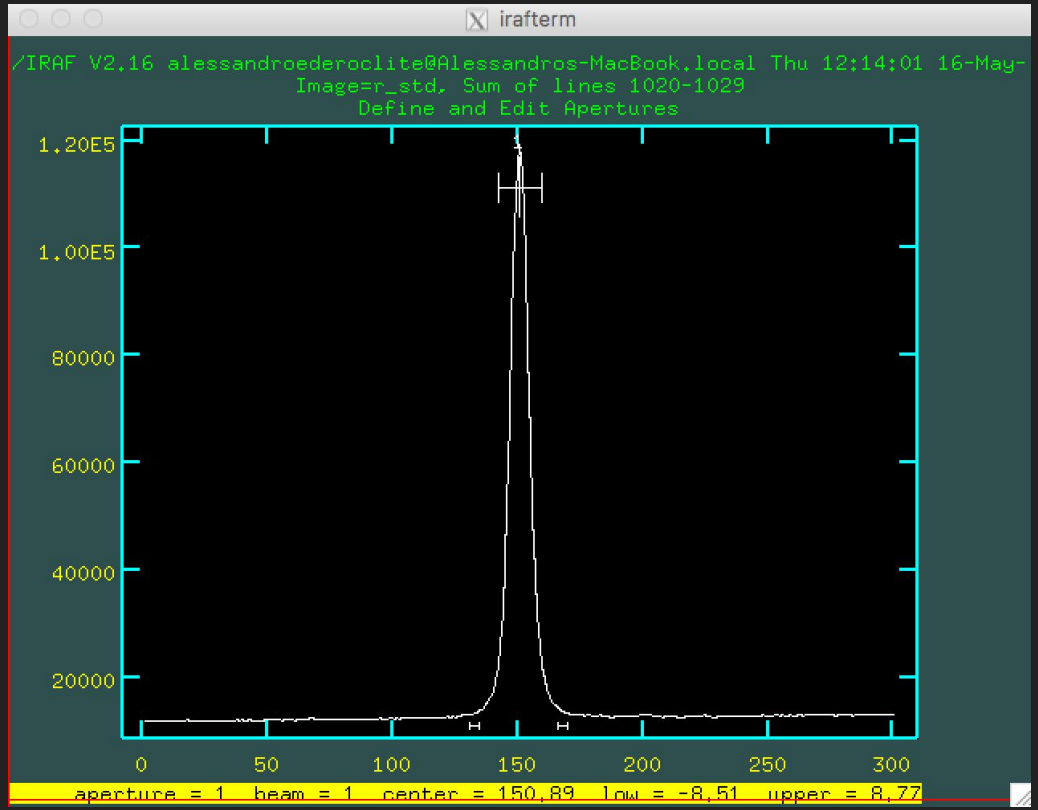


Extract the spectrum

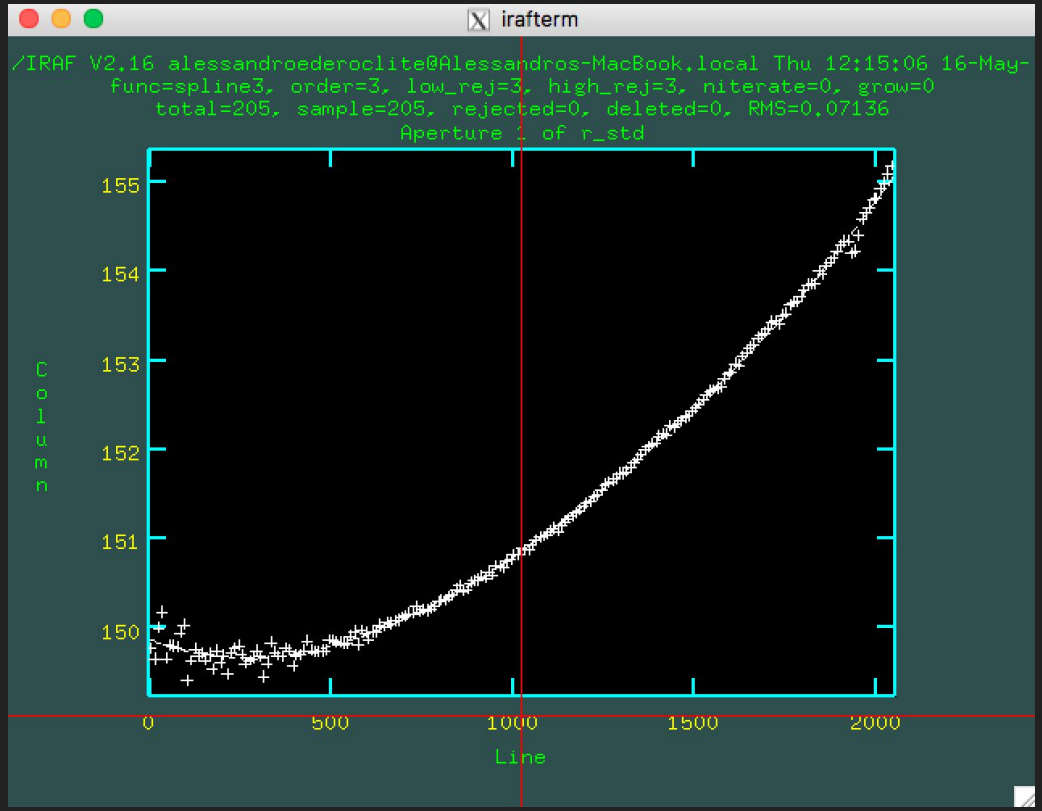
```
longslit> specred
      aidpars@        aprecenter      continuum       lscombine       scopy           specplot
      apall           apresize        deredden        msresp1d        sensfunc        specshift
      apdefault@      apscatter       dispcor         odcombine       setairmass      splot
      apedit          apsum           dofibers        refspectra      setjd           standard
      apfind          aptrace         dopcor          reidentify      sfit            telluric
      apfit           autoidentify    doslit          response        sflip           transform
      apflatten       background      fitprofs        sapertures      skysub
      apmask          bplot           identify        sarith          skytweak
      apnormalize     calibrate       illumination    scombine        slist
```

```
specred> apall r_std.fits
Find apertures for r_std?  (yes):
Number of apertures to be found automatically (1):
Resize apertures for r_std?  (yes):
Edit apertures for r_std?  (yes):
```

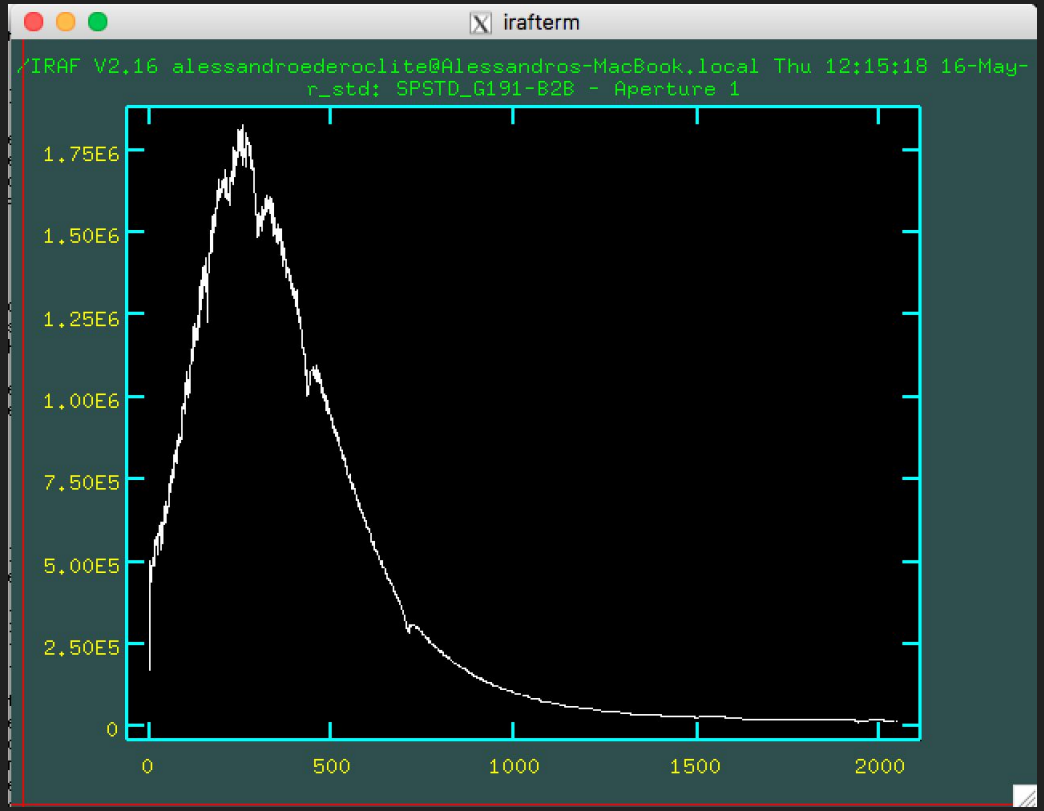
Identify spectrum (“aperture”)



“Trace”

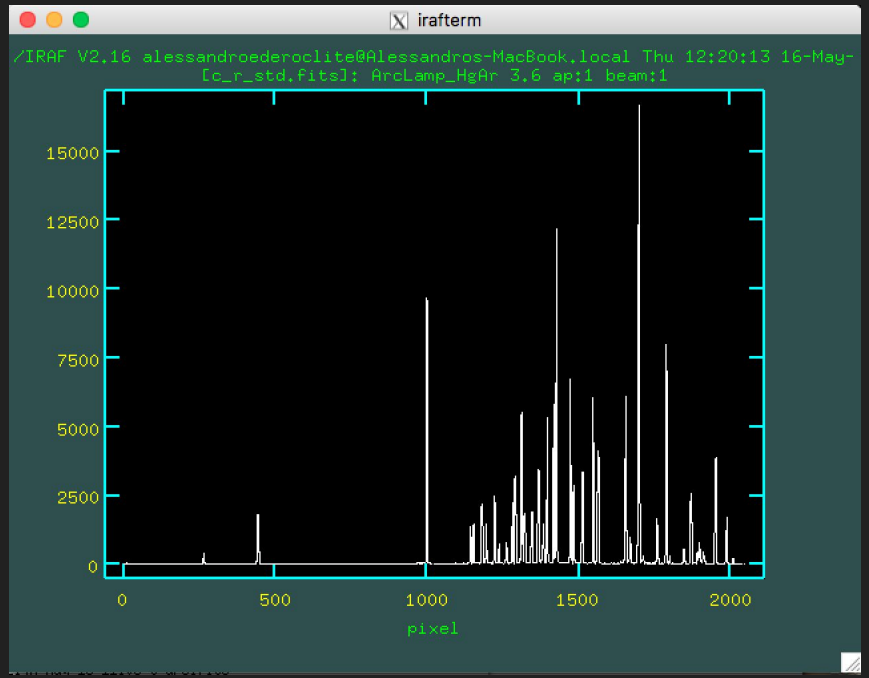

irafterm
/IRAF V2.16 alessandroederoclite@Alessandros-MacBook.local Thu 12:15:06 16-May-
func=spline3, order=3, low_rej=3, high_rej=3, niterate=0, grow=0
total=205, sample=205, rejected=0, deleted=0, RMS=0.07136
Aperture 1 of r_std
155
154
153
152
151
150
Column
0
500
1000
1500
2000
Line

Preview


irafterm
/IRAF V2.16 alessandroederoclite@Alessandros-MacBook.local Thu 12:15:18 16-May-
r_std: SPSTD_G191-B2B - Aperture 1
1.75E6
1.50E6
1.25E6
1.00E6
7.50E5
5.00E5
2.50E5
0
0
500
1000
1500
2000

Extract the “arc”

```
specred> apall t_arc.fits output=c_r_std  ref=r_std  recenter- trace- back- interactive-
Warning: Coordinate system ignored (rotated?). Using pixel coordinates.
```



Calibrate in wavelength

Test #2

Excited?

You have time until May28 (at 14:00).

I expect a pdf.

If you have doubts, ask.

Be smart: help each other and google!

Mind you: google may not give you the exact answer because of different software versions.