imacsDisplay.py or: How I Learned to Stop Worrying and Love Velocity Bomb

Gregory Walth

September 7, 2007

1 Introduction

imacsDisplay.py is a spectral display tool used for diagnostics and setup for running aRedshift.py. It enables you to be able to go through individual 1d and 2d spectra in order cull out bad data, mask out bad regions, change Sloan templates, change binning, change redshift guess, display global trace, change Sloan template used, etc.

imacsDisplay.py is part of a suite of programs designed to setup, run and check redshifts for the extracted spectra from COSMOS. aRedshift.py runs the redshift cross-correlations in the real domain for the extracted spectra. It is based on Velocity but with a few extra bells and whistles to enable cross-correlations for multiple objects, templates, redshift guesses and ranges. aRedshiftDisplay.py allows you to check the cross-correlations outputed from aRedshift.py and mark good fits which can be outputted to HTML or ASCII with aRedshiftOutput.py.

In order to run imacsDisplay.py you only need to give it two command line arguments; the name of the 1d spectra file and the name of the 2d spectra file.

```
imacsDisplay.py -1d XXXX_1spec.fits -big XXXX_big.fits
```

The easiest way to use imacsDisplay is to type (once the pipeline is generated from imacsPipeline.py):

```
make stage-display
```

For more command line options all you need to type is:

```
imacsDisplay.py -h
```

A list of command line options will be printed to the terminal you are using. Once running, you can immediately press **Shift+/** in the pgplot window and it will display all of the help parameters.

2 Basics

To move back and forth between frames, type **n** for next and **p** for previous. If you want to go to the beginning frame type **b** or the final frame type **f**.

On each object you can zoom in and out in the wavelength direction for the 1d and 2d spectra and intensity directory for 1d spectra. Type **Shift+x** to zoom in the wavelength direction and type **x** to zoom out in the wavelength direction. Type **Shift+y** to zoom in the intensity direction and **y** to zoom out in the intensity direction. **Shift+z** and **z** zooms in and out in both x and y.

Note: Zoom in the 2d spectra y-direction has not been added yet.

You can change the stretch of the 2d spectra. Type **;** to sharpen the spectra and **'** to dull the spectra. Type **,** to brighten the spectra and **.** to dim the spectra. Type / to invert the gray scale.

If everything goes out of whack, you can reset the original settings by typing **r** It will reset to the original zoom and stretch.

In order to skip an object to compute a redshift for type **s** There are three options you can choose from run, skip, and done. Run and skip are self-explanatory, but done might be a little confusing. It is there for book-keeping purposes. For example if you decide to find the redshift of an object in imacsDisplay.py you will probably not want to run aRedshift.py again.

The default binning is 100 bins. This is generally adequate for galaxies with strong absorption features. For emission-line galaxies, this is too small. There is a mode called ebin which scales the binning for the resolution of emission lines according to the redshift. In order to change the binning type **e** to toggle ebin on or off.

3 Masking

More than likely you are going to have cosmic rays, bad sky-subtraction, over-saturated flat-fields or other weird things going on with your spectra. It is a good idea to mask some of this weirdness out before running the redshift software. Otherwise it will interfere with the fit, depending on how severe it is.

In order to create a mask you need to move your cursor to one side of the object you want to mask out and press **m**. Then move to the other side of the object and press **m** again. A bluish shaded region will appear representing the region being masked out.

If you discover there is a global region that needs masking out, in other words a range of the spectra that is bad throughout all of the slits, you can create a global mask. You use the same procedure as a local mask instead use **Shift+m** instead.

If you discover that your mask is too large you can make it smaller, simply repeat the same procedure inside the masked region and the mask will shrink to the new specified size.

If you discover that your mask is too small, you can make it larger by selecting outside the mask.

If you want to extend on one side. You can select anywhere inside a mask and select outside to where you want to extend the mask to.

Finally if you have made a mess of things and want to start over type **m** and then **d** to delete the masks on the spectra you are working on. If you want to delete all of masks for all slits then type **Shift+m** and then **d**.

There is an unusual case I encountered where the noise would become ridiculously large, somewhere about 10^6. So I added a feature to mask out noise (locally) above a certain level. First press **Shift+n** and then you will be prompted for a noise level and then a width (in pixels). For the noise level you can enter any number but if you use powers of ten be sure to use the following format 1e15, 1e10, 4e2,... Further examination of current IMACS spectra warranted me include masking for both positive and negative noise. There were cases where bogus negative values would throw off the fitting routines we were running. It seemed sensible to add negative noise masking as well with the same command.

Another useful command for masking spectra is **Shift+w** to mask negative spectra. When spectra tends to get noisy, it sometimes will go negative. This is just a handy time saver.

If you want to mask out spectra that are identical to zero then type **o**, or for all the spectra **Shift+o**.

Note: Two masked regions will currently not combine, you can mask over the region and aRedshift.py will still function correctly with overlapping masks.

4 Redshifts

When imacsDisplay.py is started redshift mode is off. In order to enable it, you need to Press **Shift+0**. You will notice two new things; first there will be several lines that appear with labels over the 1d plot, second in the info box on the second line a redshift guess will appear (i.e. z = 0.0000). You can move the lines around on the 1d plot to match features in your spectra by pressing [and] which will increment in redshifts of 0.01. If you want finer control on their movement you can press **Shift+**[and **Shift+**] which will increment in redshifts of 0.0001.

There are also preset redshifts you can use in order to jump to the redshift range you need.

Table 1: Preset Redshifts

keystroke	z
Shift+1	0.00
Shift+2	0.10
Shift+3	0.35
Shift+4	0.75
Shift+5	1.50
Shift+6	3.00
Shift+7	5.00

At this point there are two modes of operation; auto redshift and manual redshift.

The auto redshift is setup in such a way where depending on the type of template (i.e. star, galaxy or agn) there are preset redshift guesses and ranges. The auto redshift is under the assumption that you know what type of template to use but you cannot identify the redshift. In order for this mode to work, the user must set the redshift guess to 0 (**Shift+1**).

Table 2: Auto Redshift Default Values

template type	redshift guess	redshift range
galaxy	0.10, 0.35, 0.55, 0.80, 1.50	0.20, 0.40, 0.40, 0.40, 1.20
agn	0.75, 1.50, 3.00, 5.00	0.50, 1.20, 2.00, 2.50
star	0.00	0.05

The manual redshift is setup in such a way that when the user marks a redshift guess that it will supersede the auto redshift mode and run with a smaller redshift range of 0.10 since the redshift is roughly known.

For the redshifts we use the Sloan Spectral Templates which can be found at http://www.sdss.org/dr2/algorithms/spectemplates/

If the presets are not what you need type **t** to select your own templates. In the terminal there will be a prompt asking you which template to use. You can simply type in the templates you want to use. The Sloan Template choices are from 0-32. To correctly enter in a set, start with an opening bracket [followed by the template number you wish to use followed by a closing bracket]. If you use more than one template, separate the template numbers with commas.

```
e.g.
Enter a list of new templates? [23,24,25]
```

There are two ways you can use imacsDisplay.py to find redshifts.

Table 3: Template Presets

keystroke	type	templates
1	galaxy	23, 27
2	galaxy	23
3	galaxy	27
4	galaxy	24, 25, 26, 27
5	galaxy	23, 24, 25, 26, 27, 28
6	agn	29, 30, 31, 32
7	star	4, 10, 12

The first method (single spectra):

Navigate to the spectra you want to find a redshift for. Find a starting redshift (if possible). Mask out bad pixels, cosmic rays or bad sky-subtracted regions if necessary. Set the templates and binning you wish to use. Press **Shift+v**, this will run aRedshift.py in the background on the spectra you choose. Depending whether you have a starting spectra and the number of templates you use will determine how long this process will take. When it is finished, a message will display in the terminal letting you know it is done computing the redshift.

The second method (multiple spectra):

Go through all of the spectra. Change the status to **skip** for objects you wish to skip. Find the starting redshifts for objects you wish to compute (if possible). Mask out bad pixels, cosmic rays or bad sky-subtracted regions if necessary. Set the templates and binning you wish to use. Type **q** to exit out of imacsDisplay.py. Type the following in the terminal to run the redshift software:

```
make stage-redshift
```

Depending on how many objects you have, and how many templates you are using and how many objects you were able to find a starting redshift for will determine how long it takes. Typically it can take anywhere from 2 to 3 hours on up to finish.

5 Other Options

Trace

Before the 1d spectra is created, the pipeline task imacsSpec1d.py fits a global polynomial to the spectra y-dispersion. This is to ensure that when the spectra are being extracted that the extraction aperture is in the correct place. We call this the trace. There is also an output of the trace once imacsSpec1d.py is finished. In order to display the trace of the global spectra, type **Shift+t**.

Chip Overlay

To overlay the chip regions on top of the 2d spectra, type **c**. A map file must be loaded when imacsDisplay.py is started.

Smoothing

At this point the only smoothing available is Gaussian smoothing. To use type **Shift+g** and then a number to select the amount of smoothing. To turn the feature off type **Shift+g** and then **0**.

Comments

Another useful feature is being able to add comments while you are going through the spectra, **Shift+c**.

Status

In order to check the status of all the spectra and read the comments type **Shift+‘**.

6 Keystrokes

Keystroke	Command
Basic	
e	emission binning toggle
q	quit
r	reset zoom and stretch
s	status toggle
Space	display cursor position
Shift+/	help
Shift+t	trace display toggle
c	overlay chip regions
Shift+c	add comments
Shift+‘	display spectra status
Shift+s	save to file
Shift+l	reload fits files
Shift+,	smaller pgplot window
Shift+.	larger pgplot window
Shift+;	python command
Frame	
n	next object
p	previous object
b	beginning frame
f	ending frame
Zoom	
x	zoom out in x
y	zoom out in y
z	zoom out in x and y
Shift+x	zoom in x
Shift+y	zoom in y
Shift+z	zoom in x and y
h	pan to -x
j	pan to -y
k	pan to +y
l	pan to +x
Stretch	
;	sharper
'	duller
,	brighter
.	fainter
/	invert
Smoothing	
Shift+g	Gaussian smoothing

Keystroke	Command
Mask	
Shift+m	global mask
Shift+m+d	delete masks for all objects
m	mask
m+d	delete masks for a single object
Shift+n	mask noise
Shift+w	mask negative spectra
o	mask spectra = 0.0
Shift+o	global mask spectra = 0.0
Redshift	
Shift+0	redshift display toggle
[	increment in z -0.01
]	increment in z +0.01
Shift+[	fine increment in z -0.0001
Shift+]	fine increment in z +0.0001
Shift+1	z set to 0.00
Shift+2	z set to 0.10
Shift+3	z set to 0.35
Shift+4	z set to 0.75
Shift+5	z set to 1.50
Shift+6	z set to 3.00
Shift+7	z set to 5.00
Shift+r	manual redshift, value set by user
Shift+v	run aRedshift.py on spectra
Template	
t	create template set
1	galaxy1 template set [23,27]
2	galaxy2 template set [23]
3	galaxy3 template set [27]
4	galaxy4 template set [24,25,26,27]
5	galaxy5 template set [23,24,25,26,27,28]
6	agn template set [29,30,31,32]
7	star template set [4,10,12]