

imexam Documentation

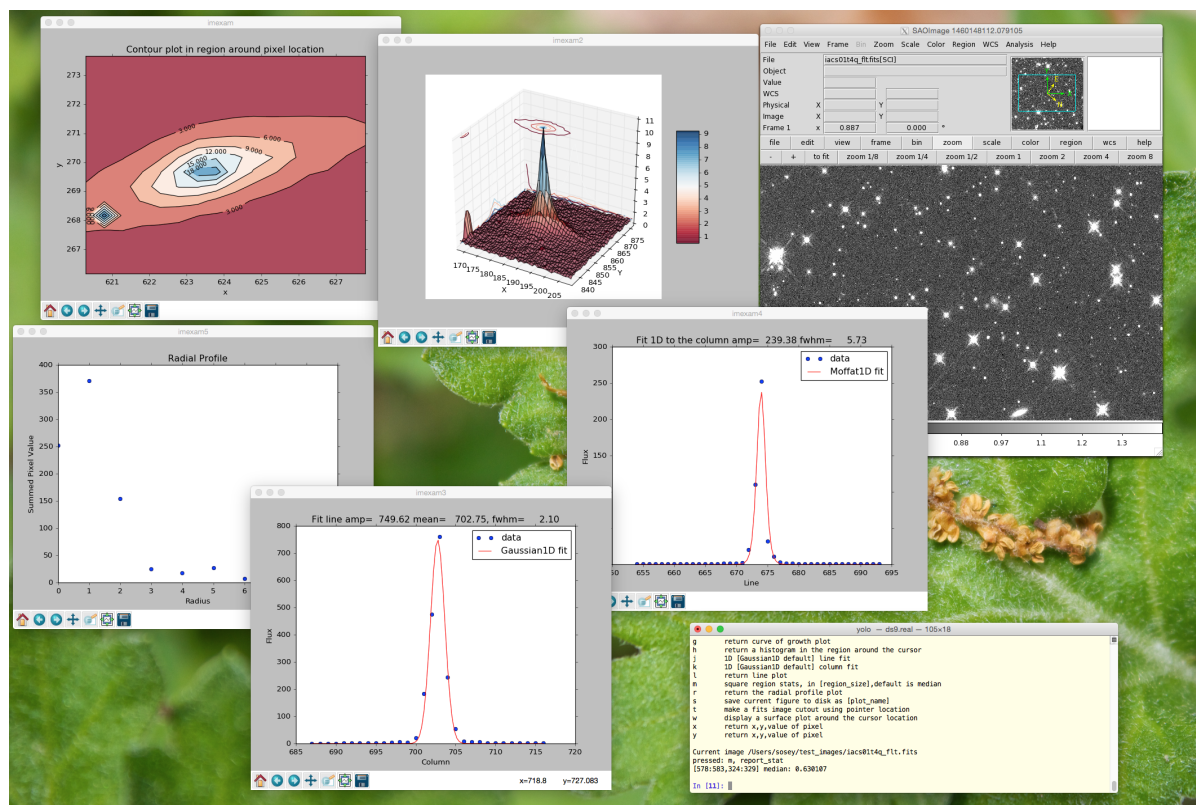
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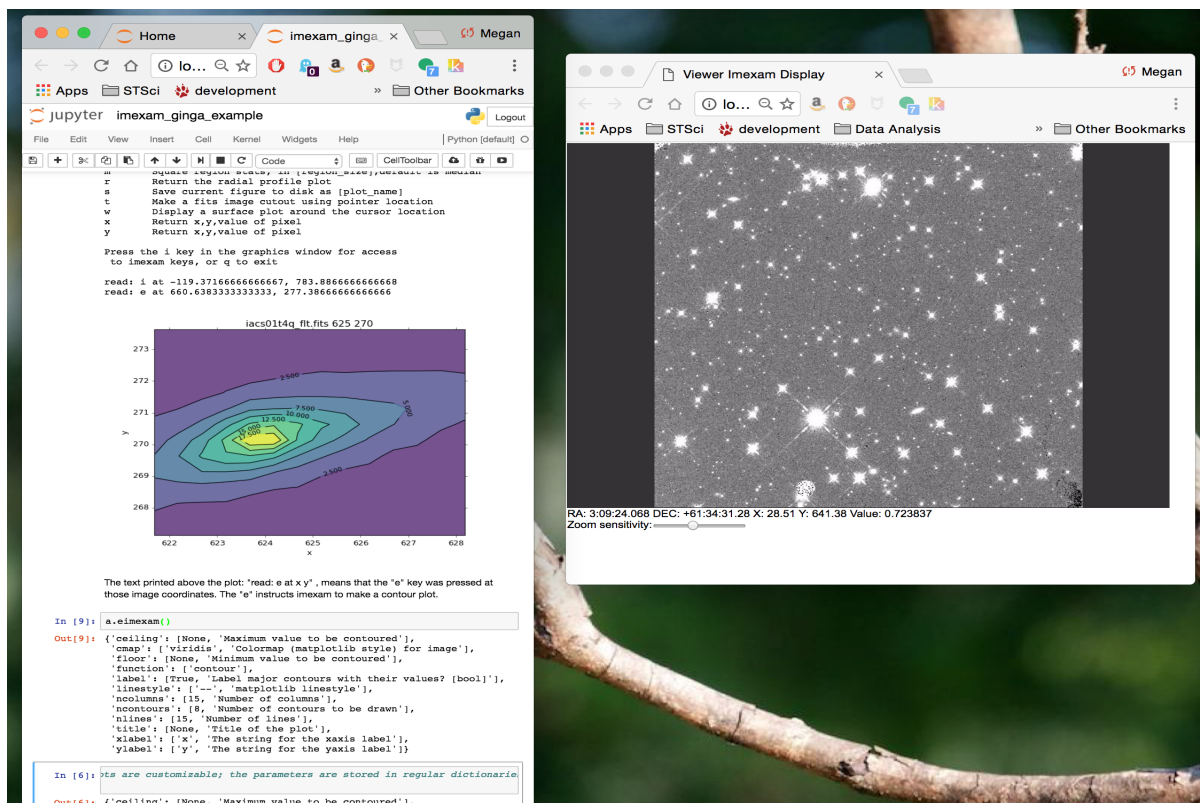
The above image is an example desktop interfacing with DS9.

`imexam` is an affiliated package of `AstroPy`. It was designed to be a lightweight library that enables users to explore data using common methods which are constant across viewers. The power of this python tool is that it is essentially a library of plotting and analysis routines that can be directed towards any viewer. It attempts to standardize the analysis interface so that no matter what viewer is in use the calls and results are the same. It can also be used without connecting to any viewer since the calls take only data and location information. This means that given a data array and a list of x,y positions you can create plots and return information without having to interact with the viewers, just by calling the functions directly either from a command line shell or from a private script.

`imexam` can be used:

- from a command line interface
- through a Jupyter notebook or through a Jupyter console
- with multiple viewers, such as DS9 or Ginga (submit a github issue or PR to add others)
- without a viewer as a simple library to make plots and grab quick photometry information.

`imexam` may be used as a replacement for the IRAF `imexamine` task. You should be able to perform all of the most used functions that `imexamine` provided in IRAF, but you also gain the flexibility of python and the ability to add your own analysis functions. The standalone library has also been used as a replacement for `psfmeasure`.



The above image is an example desktop using the Jupyter notebook and the Ginga HTML5 viewer.

REQUIREMENTS

This package can be used on Windows, Linux, and MacOS operating systems.

Windows users may download the git repository or do a direct pip install from the git repository. However, they will not have default access to DS9 because compiling the cython+xpa code cannot currently be done with default installed software. Instead, Windows users should make sure they install the Ginga viewer for image examination and plotting using its HTML5 viewer. You will have all the same imexam functionality available to you, including the use of Jupyter notebooks and screen plotting.

`imexam` currently provides display support two viewers: DS9 and Ginga. The default, when no parameters are supplied to the connect call, is for `imexam` to start up its own DS9 process and shut it down nicely upon exit. A Ginga widget using an HTML5 backend is also available as a viewer, most usefull when interacting with the package inside a Jupyter notebook. The package is designed so that it may easily accept other display devices in the future. Additionally, an experimental ginga plugin is available which allows use of the basic ginga gui and interaction with the image display and plots in the `imexam` style.

The `imexam` library can be used standalone, without a viewer, to create the plots which are available in the interactive sessions by importing the plotting object and feeding the functions your data with x,y coordinates for the plots. It can also be used within the Jupyter notebook framework with either DS9 or the HTML5 backend for viewing. In either case, the images and plots may be saved inside the notebook in conjunction with the notebook (nbAgg) matplotlib backend. If you choose to interact with separate plotting windows, it's still possible to grab an image of the current image display or plot and save it inside the notebook.

Note: For DS9, it is important to know if you have XPANS installed on your machine and available through your PATH if you plan to use the nameserver functionality. XPANS is the XPA Name Server, it keeps track of all the open socket connections for DS9 and provides a reference for their names. If you DO NOT have XPANS installed, then `imexam` will still work, but you should either start the DS9 window after importing `imexam` through the `imexam.connect()` interface, OR after you start DS9 from the shell.

You can connect to an already open DS9 window by specifying the title or the XPA_METHOD. The XPA_METHOD is the address in the File->Information dialog. If users don't specify a title in the ds9 window when they open one up, ds9 will just call the window "ds9", so you can end up with multiple windows with the same name. This works for DS9 because the XPA_METHOD is always unique. The most straightforward way is for users to open the DS9 windows with explicit titles, and then tell `imexam` to connect to that window:

```
python> !ds9 -title custom_title
python> window=imexam.connect('custom-title')
```

However, if there are windows already open with no unique titles, the best way is to connect using the method. The `list_active_ds9` function can be used to return a dictionary which contains the information for all the windows, but its keys are the unique XPA_METHOD strings.:

```
In [3]: !ds9&
In [4]: imexam.list_active_ds9()
DS9 ds9 gs c0a80106:61894 username
Out[4]: {'c0a80106:61894': ('ds9', 'username', 'DS9', 'gs')}
```

Using this dictionary, you can also you can return the list of windows you can connect to without too much thinking, making it easy to incorporate into your own scripts as well::

```
In [1]: import imexam

In [2]: windows=imexam.list_active_ds9()
DS9 ds9 gs c0a80106:61915 username

In [3]: list(windows)
Out[3]: ['c0a80106:61915']

In [4]: !ds9&

In [5]: windows=imexam.list_active_ds9()
DS9 ds9 gs c0a80106:61915 username
DS9 ds9 gs c0a80106:61923 username

In [6]: list(windows)
Out[6]: ['c0a80106:61915', 'c0a80106:61923']

In [7]: ds9=imexam.connect(list(windows)[0])
```

But you can also use it as below to cycle through connecting to a set of windows::

```
In [8]: windows=imexam.list_active_ds9()
DS9 ds9 gs c0a80106:61915 username
DS9 ds9 gs c0a80106:61923 username

In [9]: ds=imexam.connect(windows.popitem()[0]) #connect to first window, remove as_
↪possible window
In [10]: windows
Out[11]: {'c0a80106:61923': ('ds9', 'username', 'DS9', 'gs')}

In [12]: w2=imexam.connect(windows.popitem()[0])

In [13]: windows
Out[31]: {}
```

In order to use the Ginga widget display you must have Ginga installed. More information about Ginga can be found in its package documentation: <http://ginga.readthedocs.org/en/latest/>. If you are using Python 3 you should also install Pillow which will aid in the image display. The Ginga documentation will tell you of any of it's other dependencies. If you install Ginga you will have access to another display tool for your images and data, the HTML5 widget. You can find the source code on GitHub, but you can also install it with `pip` or `conda`.

You can access this help file on your locally installed copy of the package by using the `imexam.display_help()` call after import. This will display the help in your web browser.

Note: All information returned from this module should be considered an estimate of an actual refined result, more precise analysis of the data should be performed for verification before publication.

HOW TO INSTALL

These are some tips on installing the package, or tracking down problems you might be having during or after installation.

`imexam` can be installed from the source code in the normal python fashion after downloading it from the git repo:

```
python setup.py install
```

`imexam` can also be installed using `pip` or `conda`, and is included in the Astroconda distribution from STScI:

```
# from PyPI
pip install imexam

# if you already have an older version installed
pip install --upgrade imexam

# from the master trunk on the repository, considered developmental code
pip install git+https://github.com/spacetelescope/imexam.git

#install version 0.6.3 from the git repository, this uses the git tag reference
pip install git+https://github.com/spacetelescope/imexam.git@v0.6.3#egg=imexam

# from the STScI conda release package
conda install imexam -c http://ssb.stsci.edu/astroconda
```

If you want to build the documentation locally, clone the git repository and then issue the document build command from the `imexam` directory:

```
# python setup.py build_sphinx
```

If you want to have access to the photometry features of the `imexam()` analysis, download and install `photutils` - another of the astropy associated packages. The full list of astropy packages can be found here: <https://github.com/astropy>. If `photutils` is not installed, `imexam` should issue a nice statement saying that the photometry options are not available upon import, and any time an analysis key is pressed during the `imexam()` function loop which requires `photutils` to render a result.

USAGE

`imexam` displays plots using `matplotlib`, if you find that no windows are popping up after installation it's probably the backend that was loaded. One quick way to get things started is to load `ipython`:

```
>ipython
>import imexam
```

`Matplotlib` magic can also be used inside the Jupyter notebook for interaction with the plots. If one of the standard backends is used the plots should be saved into the cell from which the command was issued. The notebook backend (`nbagg`) will require you to close the plotting window from inside the cell.

`imexam` is a class based library. The user creates an object which is tied to a specific image viewing window, such as a DS9 window. In order to interact with multiple windows the user must create multiple objects. Each object stores all the relevant information about the window and data with which it is associated.

For example, in order to open a new DS9 window and use the object “viewer” to control it, you would issue the command:

```
viewer=imexam.connect()
```

The “viewer” object now has associated methods to view, manipulate and analyze data in the DS9 session. When you start the connection, you also have the option of specifying a currently open DS9 window using the target keyword. This keyword can contain the name, the actual text name that you gave the window, or the address of the window. The address of the window can be found in the File->XPA->Information menu item, is stored as `XPA_METHOD`, and is of the form “82a7e75f:58576” for INET sockets, and a file path for local sockets. The following is an example of connecting to an already active DS9 window which was started outside of `imexam`:

```
viewer=imexam.connect("82a7e75f:58576")

or

viewer=imexam.connect("my_window_title")
```

When `imexam` starts up a DS9 window itself, it will create an inet socket by default. However, `imexam` will first check to see if `XPA_METHOD` was set in your environment and default to that option. If you are experiencing problems, or you don't have an internet connection (the two might be related because the XPA structures INET sockets with an ip address), you can set your environment variable `XPA_METHOD` to `local` or `localhost`. This will cause `imexam` to start a local(unix) socket which will show an `XPA_METHOD` that is a filename on your computer. `imexam` defaults to a local socket connection to allow for users who do not have the XPA installed on their machine or available on their PATH.

The full XPA source code is maintained as a submodule to the `imexam` package. If you don't have the XPA on your path, simply point it to that location, or copy the `xpans` executable to the location of your choice, and make sure you update your PATH. Any time DS9 is started it will start up the `xpa` nameserver automatically. Then all the `xpans` query options will be available through `imexam` (such as `imexam.list_active_ds9()`). `imexam` itself uses Cython wrappers

around the `get` and `set` methods from the XPA for it's communication which is why the fully installed XPA is not necessary.

If you wish to open multiple DS9 windows outside of `imexam`, then it's recommended that you give each a unique name. If you've forgotten which window had which name, you can look in the same XPA info menu and use the `XPA_NAME` specified there. If you haven't given them a unique name, you can list the available windows using `imexam.list_active_ds9()` (as long as `XPANS` is running) and specify their unique address.

`imexam` will attempt to find the current location of the DS9 executable by default, but you may also supply the path to the DS9 executable of your choice using the `path` keyword when you call `connect`. The fully optional calling sequence is:

```
imexam.connect(target="",path=None,viewer="ds9",wait_time=10)
```

Where `target` **is** the name of the ds9 window that **is** already running, `path` **is** the location of the ds9 executable, `viewer` **is** the name of the viewer to use (ds9 **is** the only one which **is** currently activated), **and** `wait_time` **is** the time to wait to establish a connection to the socket before exiting the process.

If it seems like the ds9 window is opening or hanging, there could be few things going on:

- `imexam` will default to an inet socket connection for the XPA. However, it will first check your environment variable `XPA_METHOD` and preferably use that instead. If you don't have an internet connection, check this environment variable, and set it to "local".
- If things seem in order, it's possible that your machine is waiting for X11 to start up, give it time to start, or when you call `imexam` increase the wait time sufficiently; you can do this by specifying "`wait_time=60`" when you open your viewing object with `connect()`. The 60 here is an example of the number of seconds `imexam` should wait before returning a connection error.
- Next, check that the path to the DS9 executable is somewhere on your path and that it has not been aliased to something else. You can check this from any terminal window by trying to start DS9. You can also use the unix "which ds9" command to return the full path to the executable, as well as "`ls -al ds9`" to return the full path and any soft links which might have been established.

In order to return a list of the current DS9 windows that are running, issue the command:

```
imexam.list_active_ds9()
```

Note: More information on DS9 can be found at: <http://ds9.si.edu/site/Home.html>

If you are using the Ginga widget, the interaction with the `imexam` code stays the same, you simply specify that you would like to use Ginga in the call to `connect`:

```
viewer=imexam.connect(viewer='ginga')
```

"ginga" tells `imexam` that you'd like to use the Ginga widget with the HTML5 background.

In order to turn logging to a file on, issue the command: `window.setlog()`. The log will be saved to the default filename `imexam_session.log` in the current directory unless you give it another filename to use. Here's an example of how that might work:

```
import imexam
window=imexam.connect('ds9')
window.setlog() <-- turns on logging with default filename
window.imexam() <-- all output will be logged to the file and displayed on the screen
```

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```

window.setlog(on=False) <-- turns off logging to file
window.setlog(filename='my_other_log.txt') <-- turns on logging and sets the save_
↪filename

```

The log will look something like this, you can see it contains a mention of the command used along with the results

```

gauss_center
xc=812.984250   yc=706.562612

aper_phot
x      y      radius  flux    mag(zpt=25.00)  sky    fwhm
812.98  706.56  5      1288669.29    9.72    11414.53    4.83

show_xy_coords
813.5  706.625

gauss_center
xc=812.984250   yc=706.562612

gauss_center
xc=239.856464   yc=233.444783

aper_phot
x      y      radius  flux    mag(zpt=25.00)  sky    fwhm
239.86  233.44  5      126601.26    12.24    11574.32    -12.67

show_xy_coords
253.0  234.75

gauss_center
xc=239.856464   yc=233.444783

```

More detailed examples can be found in the examples section of this documentation.

COMMON PROBLEMS

You're getting the following error statement when you try to `connect()` to a DS9 window, or display an image:

```
XpaException: Unknown XPA Error : XPAGet returned 0!
```

You can first try using local unix sockets by setting your environment variable `XPA_METHOD` to `local`:

```
setenv XPA_METHOD local      #csh
```

or if you have a bash-like shell:

```
export XPA_METHOD="local"
```

or if you want to do it from inside Python:

```
import os
os.environ['XPA_METHOD'] = "local"
```

That will create local unix file sockets for communication with ds9. If that doesn't solve the problem, see if your path includes the location of xpans, the XPA name server. If you have it installed, but it's not on your path, put it there.

Alternatively, if you're getting an error on calling `connect()` along the lines of:

```
Connection timeout with the ds9
```

you may want to force XPA to use the "inet" mode, which is the default unless your `XPA_METHOD` is set. E.g.,

```
setenv XPA_METHOD inet      #csh
export XPA_METHOD='inet'   #bash
```

(Or similar based on the examples above)

If you are having display issues, some build problems may exist with the dependency packages which deal with back-end graphics, try setting your `matplotlib` backend to "Qt4Agg". You can set this in your `.matplotlib/matplotlibrc` file

```
backend: Qt4Agg
```

The package works with the Qt5Agg and notebook backends, but on occasion I've seen the `matplotlib` window take two cycles to update, especially inside the Jupyter notebook with inline plots, meaning you may have to hit the exam key twice for the plot to appear. This issue still needs to be worked out, if you're running into it try using the Qt4Agg backend or plotting outside the notebook and saving the figures through the `imexam grab` or `save` calls. More information about the backends for `matplotlib` can be found here: <https://matplotlib.org/users/shell.html>

If you get an error about not finding the file "import" when you use the `grab()` function to save a copy of the DS9 window.

```
`FileNotFoundError: [Errno 2] No such file or directory: 'import'`
```

“import” is the unix/linux import command, it saves any visible window on an X server and outputs it as an image file, it’s included with many macos and linux installations, it’s likely not on windows. Users should check their path to see if it’s included. This only affects grab() for DS9 which saves a copy of the DS9 window on the workspace, it does not affect saves for ginga or matplotlib plots.

imexam switched to using `import` to get around a bug in the XPA for the `saveimage` call to the XPA. The DS9 `saveimage` function basically does a screen capture. In the case of MacOSX (and XQuartz) when you are configured to be rootless, the screen capture fails if your DS9 window is not in the upper left corner of the primary screen - the call should work if you are using a laptop that is not connected to a larger display, or a workstation with only one monitor. Since these are harder things to automatically grab from user environments, the workaround was to ‘Print’ to a file, generating a postscript image that can be rendered outside of ds9 (for example /Applications/Preview). However, I was unable to get this to save to file, the functions it insisted on sending the image directly to the printer. This also makes for greater unknowns on user machines. The workarounds for users who hit this may be:

- screen grab a copy of the window yourself (grabbing saves any overlays as well)
- move the DS9 window to the appropriate screen and issue the `saveimage` command, assuming “a” is your control object, that would look like: `a.window.xpa.set(“saveimage ds9.jpeg”)`

If you are experiencing an issue not related to those described above you can open a new issue on the [imexam GitHub issue tracker](#). You can view older closed issues there as well.

SIMPLE WALKTHROUGH

5.1 Simple Walkthrough

This is intended as a basic example of using the imexam package as a quicklook for image examination. If you are new to python or to the python version of imexam, start here to get your feet wet.

First you need to import the package

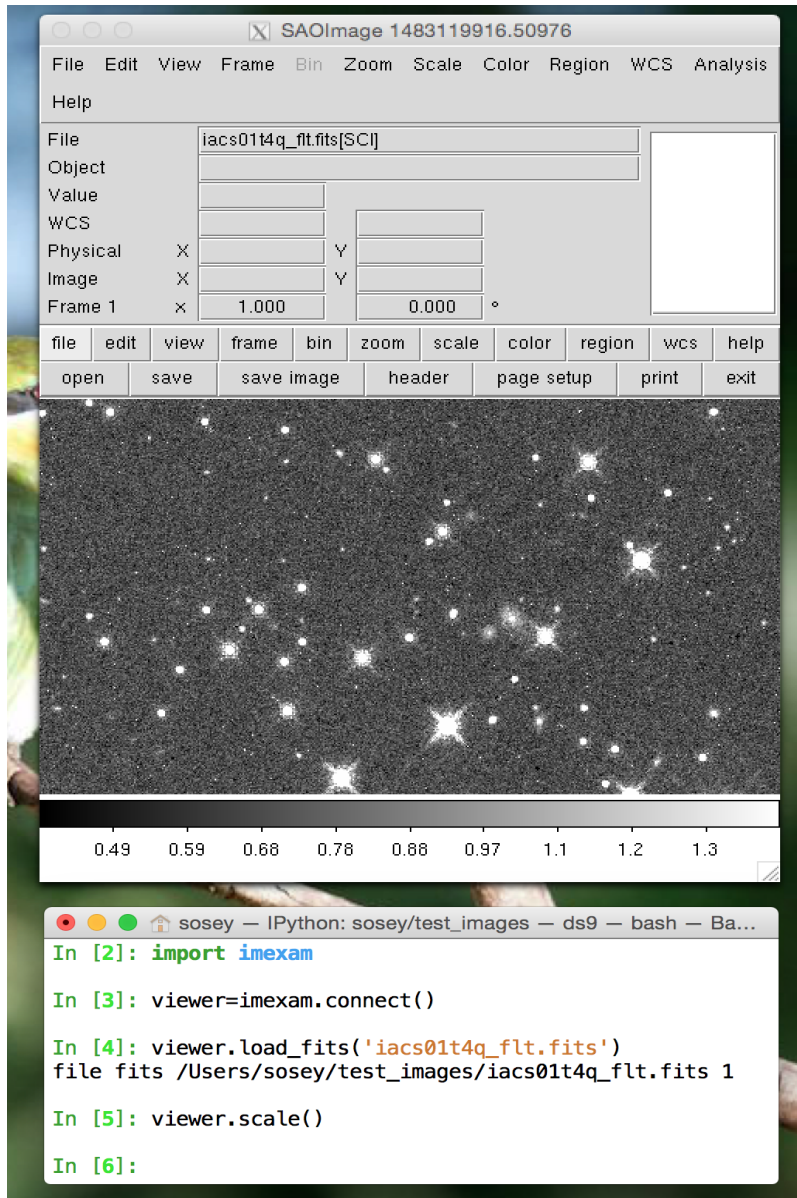
```
import imexam
```

5.1.1 Usage with D9 (the current default viewer)

Start up a DS9 window (DS9 is the default viewer):

- a new DS9 window will be opened
- open a fits image
- scale the image using zscale():

```
viewer=imexam.connect() # startup a new DS9 window
viewer.load_fits('iacs01t4q_flt.fits') # load a fits image into it
viewer.scale() # run default zscaling on the image
```



If you already have a DS9 gui running, you can ask for a list of available windows:

```
# This will display if you've used the default command above and have no other DS9_
↪ windows open
In [1]: imexam.list_active_ds9()
DS9 imexam1522943947.288667 gs a825364:62436 sosey
Out[2]: {'a825364:62436': ('imexam1522943947.288667', 'sosey', 'DS9', 'gs')}
```

imexam puts its own unique name on the window

```
# open a window in another process from the shell
# you should see it use the default name, 'ds9'
In [3]: !ds9&
In [4]: imexam.list_active_ds9()
Out[7]:
{'a825364:62436': ('imexam1522943947.288667', 'sosey', 'DS9', 'gs'),
 'a825364:62459': ('ds9', 'sosey', 'DS9', 'gs')}
```

You can attach to a current DS9 window by specifying its unique name, this is the first name listed in the dictionary item values tuple:

```
viewer1 = imexam.connect('ds9')
```

If you haven't given your windows unique names using the `-title <name>` option from the commandline, then you must use the ip:port address. This address is also the key that is returned in the dictionary of active DS9 windows. In order to attached to the window we stared in the shell, use : a825364 : 62459

```
viewer1 = imexam.connect('a825364:62459')
```

Load a fits image into the new DS9 window:

```
viewer1.load_fits('n8q624e8q_cal.fits')
```

You may have noticed that the information from `list_active_ds9()` is returned in a python dictionary structure, this is to enable quick cycling or picking of available DS9 windows by asking for the keys in the dictionary. This following is just for instruction purposes, the code below asks for the list of windows and then successively displays the same image to each one:

```
ds9_windows = imexam.list_active_ds9()
for window in ds9_windows:
    temp=imexam.connect(window)
    temp.load_fits('n8q624e8q_cal.fits')
```

It's also possible to load a FITS image object that you already have opened in your python session, if no extension is given, then the first IMAGE extension that is found will be loaded as a numpy array:

```
from astropy.io import fits
image = fits.open('n8q624e8q_cal.fits')
viewer1.load_fits(image)
```

Using `get_viewer_info()` returns information about what is contained inside the DS9 window. There could be many uses for the returned dictionary, here I'm just listing the information to show you how the display of the FITS file versus the FITS object changes the information that imexam stores:

```
In [23]: viewer1.get_viewer_info()
Out[23]:
{'1': {'extname': 'SCI',
      'extver': 1,
      'filename': '/Users/sosey/test_images/n8q624e8q_cal.fits',
      'iscube': False,
      'mef': True,
      'naxis': 0,
      'numaxis': 2,
      'user_array': None}}
```

*# Above, you can see there is only 1 frame, named 1, that
contains a multi-extension fits file*

```
In [24]: from astropy.io import fits
In [25]: image = fits.open('n8q624e8q_cal.fits')
In [26]: viewer1.load_fits(image)
In [27]: viewer1.get_viewer_info()
Out[27]:
{'1': {'extname': None,
      'extver': None,
      'filename': None,
      'iscube': False,
```

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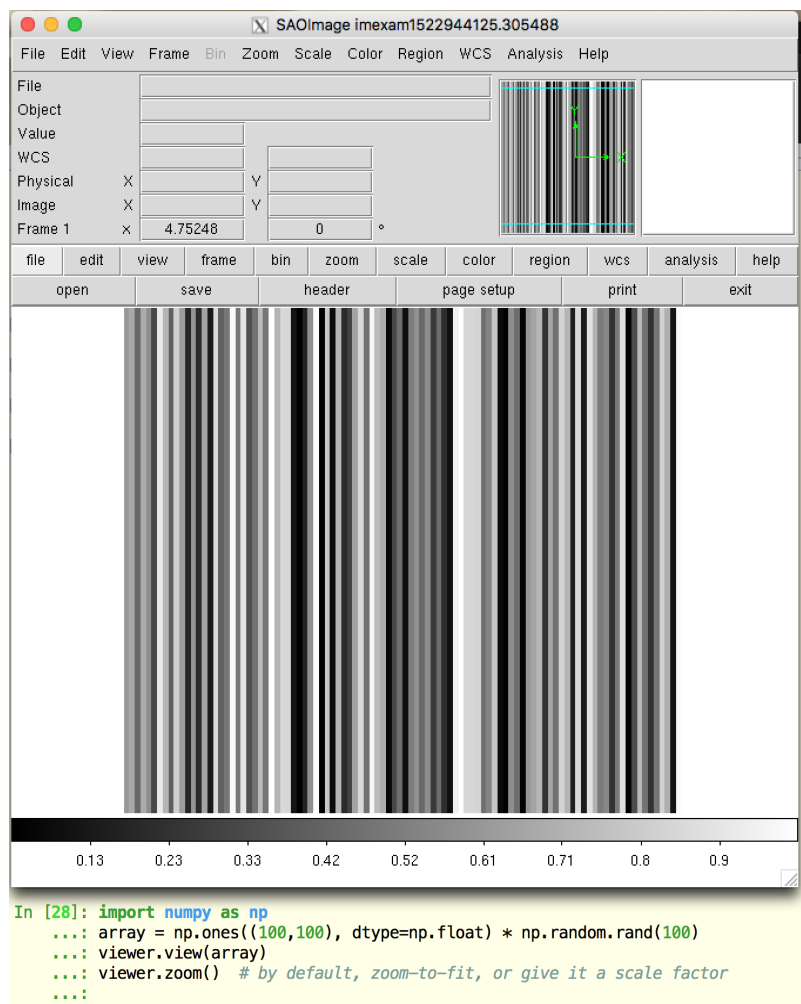
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```
'mef': False,
'naxis': 0,
'numaxis': 2,
'user_array': array([[ 0.          ,  0.          ,  0.73420113, ...,  2.29928851,
  1.13779497,  0.40814143],
 [ 0.          ,  0.76415622,  0.          , ...,  2.02307796,
  1.07565212,  0.44265628],
 [ 0.          ,  0.76297635,  0.65969932, ...,  0.61184824,
  0.48248726,  0.41064522],
 ...,
 [ 0.5144701 ,  0.38698068,  0.31468284, ...,  1.57044649,
  0.42518842,  0.50868863],
 [ 0.44805121,  0.34715804,  0.33939072, ...,  0.67747742,
  0.46475834,  0.51104462],
 [ 0.53063494,  0.54570055,  0.53724855, ...,  0.4361479 ,
  0.58057427,  0.45152891]], dtype=float32))

# Above you can see that there is only 1 frame, but it contains
# a numpy array and no filename reference.
```

You can also load a numpy array directly, we'll create an example array and display it to our viewer:

```
import numpy as np
array = np.ones((100,100), dtype=np.float) * np.random.rand(100)
viewer.view(array)
viewer.zoom() # by default, zoom-to-fit, or give it a scale factor
```

Now lets use `imexam()` to create a couple plots:

```
viewer.load_fits('n8q624e8q_cal.fits')
viewer.imexam()
```

The available key mappings should be printed to your terminal:

```
In [7]: viewer.imexam()

Press 'q' to quit

2 Make the next plot in a new window
a Aperture sum, with radius region_size
b Return the 2D gauss fit center of the object
c Return column plot
d Return the Center of Mass fit center of the object
e Return a contour plot in a region around the cursor
g Return curve of growth plot
h Return a histogram in the region around the cursor
j 1D [Gaussian1D default] line fit
k 1D [Gaussian1D default] column fit
l Return line plot
m Square region stats, in [region_size], default is median
```

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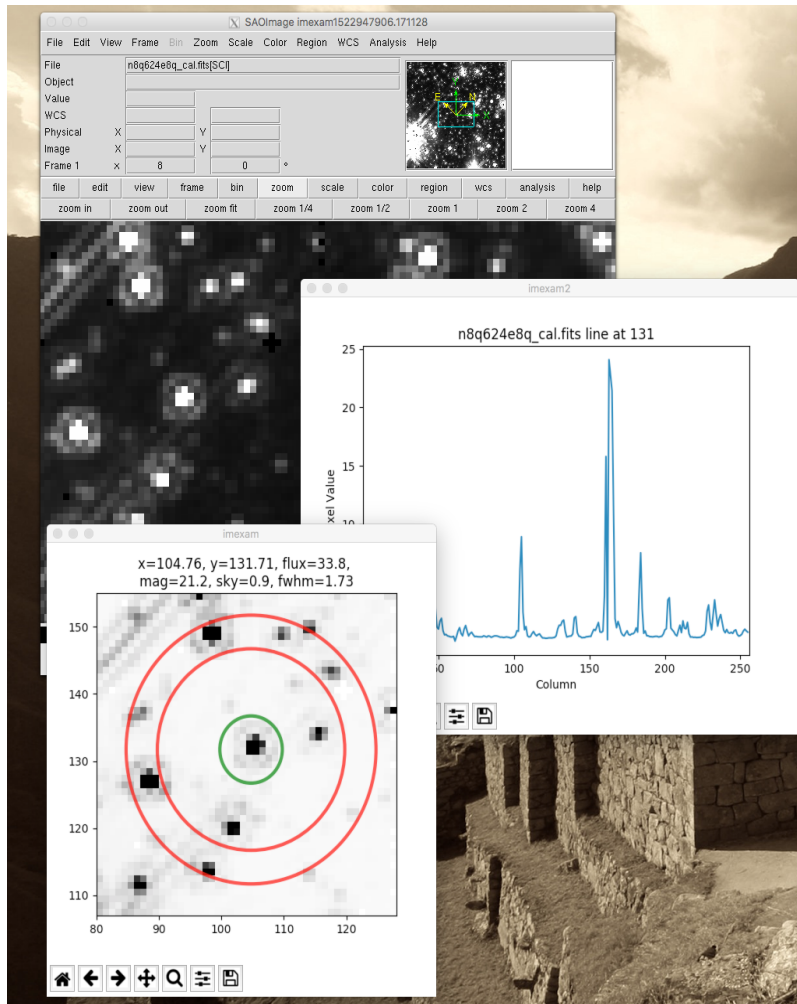
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```

r Return the radial profile plot
s Save current figure to disk as [plot_name]
t Make a fits image cutout using pointer location
w Display a surface plot around the cursor location
x Return x,y,value of pixel
y Return x,y,value of pixel

```

Look at the window below, I've started the imexam loop and then pressed the 'a' key to create an aperture photometry plot (which also printed information about the photometry to the terminal), then I pressed the '2' key in order to keep the current plot open and direct the next plot to a new window, where I've asked for a line plot of the same star, using the 'l' key.



You should see the printed information in your terminal:

```

Current image /Users/sosey/test_images/n8q624e8q_cal.fits
xc=104.757598   yc=131.706727
x               y               radius      flux      mag(zpt=25.00)  sky/pix
→ fwhm(pix)
104.76         131.71           5          33.84      21.18          0.87
→ 1.73
Plots now directed towards imexam2
Line at 104.75 131.625

```

Users may change the default settings for each of the imexamine recognized keys by editing the associated dictionary. You can edit it directly, by accessing each of the values by their keyname and then reset mydict to values you prefer. You can also create a new dictionary of functions which map to your own analysis functions.

However, you can access the same dictionary and customize the plotting parameters using `set_plot_pars`. In the following example, I'm setting three of the parameters for the contour map, whose imexam key is "e":

```
#customize the plotting parameters (or any function in the imexam loop)
viewer.set_plot_pars('e','title','This is my favorite galaxy')
viewer.set_plot_pars('e','ncontours',4)
viewer.set_plot_pars('e','cmap','YlOrRd') #see http://matplotlib.org/users/colormaps.
↪html
```

where the full dictionary of available values can be found using the `eimexam()` function described above.:

```
In [1]: viewer.eimexam()
Out[2]:
{'ceiling': [None, 'Maximum value to be contoured'],
 'cmap': ['RdBu', 'Colormap (matplotlib style) for image'],
 'floor': [None, 'Minimum value to be contoured'],
 'function': ['contour'],
 'label': [True, 'Label major contours with their values? [bool]'],
 'linestyle': ['--', 'matplotlib linestyle'],
 'ncolumns': [15, 'Number of columns'],
 'ncontours': [8, 'Number of contours to be drawn'],
 'nlines': [15, 'Number of lines'],
 'title': [None, 'Title of the plot'],
 'xlabel': ['x', 'The string for the xaxis label'],
 'ylabel': ['y', 'The string for the yaxis label']}
```

Users may also add their own imexam keys and associated functions by registering them with the `register(user_func=dict())` method. The new binding will be added to the dictionary of imexamine functions as long as the key is unique. The new functions do not have to have default dictionaries association with them, but users are free to create them.

5.1.2 Usage with Ginga viewer

Start up a ginga window using the HTML5 backend and display an image. Make sure that you have installed the most recent version of ginga, imexam may return an error that the viewer cannot be found otherwise.:

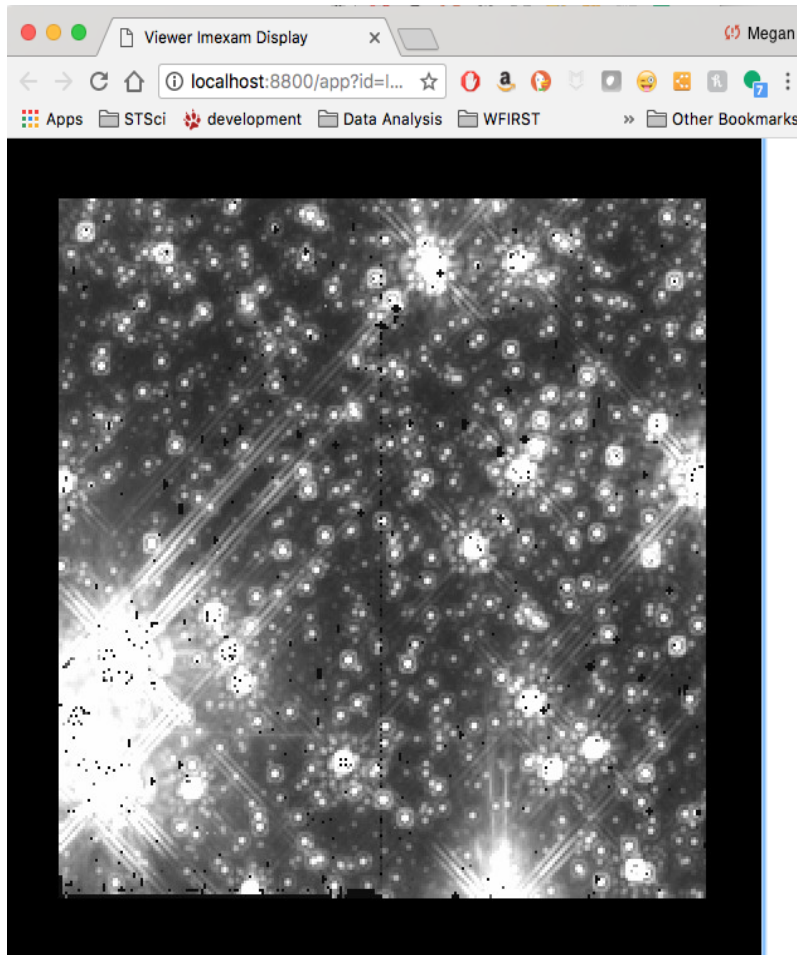
```
# since we've already used the viewer object
# to point to a DS9 window in the example
# above, we'll first cleanly close that down
viewer.close()

# now connect to a ginga window
viewer=imexam.connect(viewer='ginga')
viewer.load_fits('n8q624e8q_cal.fits')
```

Note: All commands after your chosen viewer is opened are the same. Each viewer may also have its own set of commands which you can additionally use.

Scale the image to the default scaling, which is a zscale algorithm, but the viewers other scaling options are also available:

```
viewer.scale()  
viewer.scale('asinh') # <-- uses asinh
```



RA: 17:59:04.781 DEC: -29:02:14.34 X: 273.43 Y: 160.88 Value: None

Note: When using the Ginga interface, the `imexam` plotting and analysis functions are used by pressing the ‘i’ key to enter `imexam` mode. Inside this mode the key mappings are as listed by `imexam`, outside of this mode (pressing ‘q’) the Ginga key mappings are in effect.

When you are using the HTML5 Ginga viewer, the `close()` method will stop the HTTP server, but you must close the window manually.

In [34]: `viewer.close()` Stopped http server

USER DOCUMENTATION

6.1 The imexam() method

This is the main method which allows live interaction with the image display when you are viewing your image or data array. If you execute `imexam()` while using the Ginga widget, it will display the available options, however they are always available for use via keystroke and are event-driven (using the same keys described below). In order to turn the key-press capture on and off while you have your mouse in the Ginga widget press the “i” key. Either the “i” or “q” key can be used to quit out of the examination mode.

imexam (): access realtime imexamine functions through the keyboard and mouse

Current recognized keys available during imexam are:

```
2 Make the next plot in a new window
a Aperture sum, with radius region_size
b Return the 2D gauss fit center of the object
c Return column plot
d Return the Center of Mass fit center of the object
e Return a contour plot in a region around the cursor
g Return curve of growth plot
h Return a histogram in the region around the cursor
j 1D [Gaussian1D default] line fit
k 1D [Gaussian1D default] column fit
l Return line plot
m Square region stats, in [region_size], default is median
r Return the radial profile plot
s Save current figure to disk as [plot_name]
t Make a fits image cutout using pointer location
w Display a surface plot around the cursor location
x Return x,y,value of pixel
y Return x,y,value of pixel

aimexam(): return a dict of current parameters for aperture photometry

cimexam(): return dict of current parameters for column plots

dimexam(): return the center of mass around the current position

eimexam(): return dict of current parameters for contour plots

himexam(): return dict current parameters for histogram plots

jimexam(): return dict current parameters for 1D line plots
```

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```

kimexam(): return dict of current parameters for 1D column plots

limexam(): return dict of current parameters for line plots

gimexam(): return dict of current parameters for curve of growth plots

rimexam(): return the dict of current parameters for radial profile plots

wimexam(): return dict of current parameters for surface plots

mimexam(): return dict of current parameters for area statistics

timexam(): return a dict of the current parameters for image cutouts

```

Note: Some of the plots accept a marker type, any valid Matplotlib marker may be specified. See this page for the full list: http://matplotlib.org/api/markers_api.html#module-matplotlib.markers

The `imexam` key dictionary is stored inside the user object as `<object_name>.exam.imexam_option_funcs{}`. Each key in the dictionary is the keyboard key to recognize from the user, it's associated value is a tuple which contains the name of the function to call and a description of what that function does. "q" is always assumed to be the returned key when the user wishes to quit interaction with the window. Users may change the default settings for each of the imexamine recognized keys by editing the associated dictionary. You can edit it directly, by accessing each of the values by their keyname and then reset `mydict` to values you prefer. You can also create a new dictionary of function which maps to your own

However, you can access the same dictionary and customize the plotting parameters using `set_plot_pars`. In the following example, I'm setting three of the parameters for the contour map, whose `imexam` key is "e":

```

#customize the plotting parameters (or any function in the imexam loop)
viewer.set_plot_pars('e','title','This is my favorite galaxy')
viewer.set_plot_pars('e','ncontours',4)
viewer.set_plot_pars('e','cmap','YlOrRd') #see http://matplotlib.org/users/colormaps.html
↪html

```

where the full dictionary of available values can be found using the `eimexam()` function described above.:

```

In [1]: viewer.eimexam()
Out[2]:
{'ceiling': [None, 'Maximum value to be contoured'],
 'cmap': ['RdBu', 'Colormap (matplotlib style) for image'],
 'floor': [None, 'Minimum value to be contoured'],
 'function': ['contour'],
 'label': [True, 'Label major contours with their values? [bool]'],
 'linestyle': ['--', 'matplotlib linestyle'],
 'ncolumns': [15, 'Number of columns'],
 'ncontours': [8, 'Number of contours to be drawn'],
 'nlines': [15, 'Number of lines'],
 'title': [None, 'Title of the plot'],
 'xlabel': ['x', 'The string for the xaxis label'],
 'ylabel': ['y', 'The string for the yaxis label']}

```

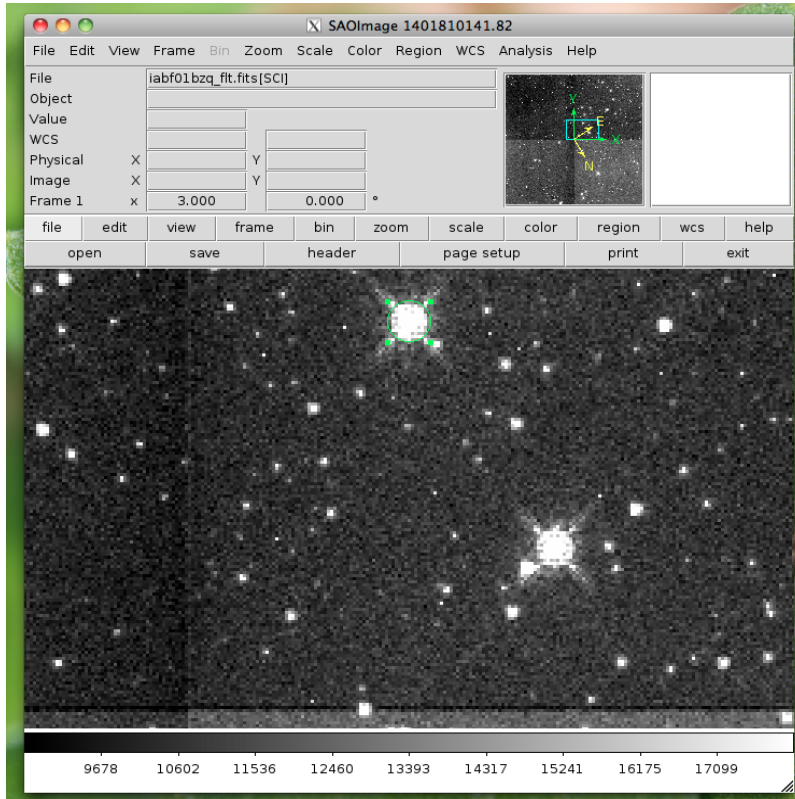
Users may also add their own `imexam` keys and associated functions by registering them with the `register(user_func=dict())` method. The new binding will be added to the dictionary of imexamine functions as long as the key is unique. The new functions do not have to have default dictionaries association with them, but users are free

to create them.

For all the examples below I will use a session similar to the following example:

```
#This will default to DS9 for the viewer

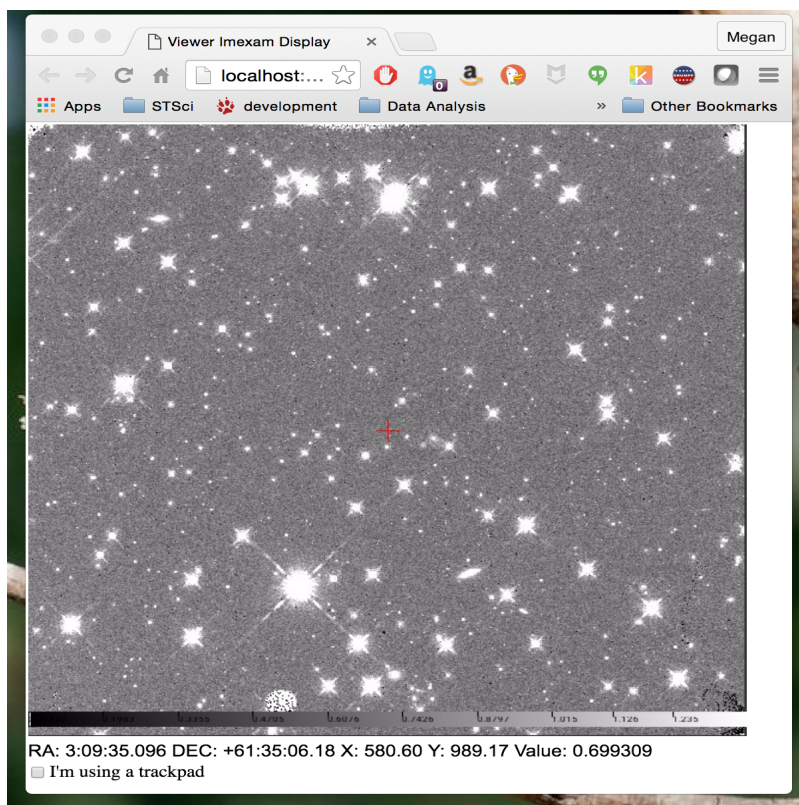
import imexam
viewer=imexam.connect()
viewer.load_fits('iabf01bzqflt.fits')
viewer.scale()
viewer.panto_image(576,633)
viewer.zoom(3)
```



This will use Ginga (instead of the default DS9) for the viewer:

```
#Use Ginga for the image viewer, make sure it is installed

import imexam
viewer=imexam.connect(viewer='ginga')
viewer.load_fits('iabf01bzqflt.fits')
viewer.scale()
viewer.panto_image(576,633)
viewer.zoom(3)
```

6.1.1 Circular Aperture Photometry

Aperture photometry is performed when you press the “a” key. It is implemented using the `photutils` python package, an affiliated package of `astropy` that is still in development.

Currently, the calculation which is performed is similar to the “,” or “a” IRAF `imexamine` keys. It is circular aperture photometry, centered on the mouse location at the time the key is pressed, with a background annulus subtraction for the sky. The radius of the aperture is set with the `region_size` keyword (default to 5 pixels). The annulus size is also set to the width, and taken a distance of `skyrad` pixels from the center. The pixels used to calculate the enclosed flux are those whose centers fall inside the radius distance, in the same way that IRAF `imexamine` computes the flux.

If `center` is set to `True`, and `center_com` is set to `False`, then a 2D Gaussian profile will be used to refine the center of the object. If `center_com` is set to `True`, then a center of mass will instead be calculated, using the `delta` box size around the object.

These are the default parameters for aperture photometry. They live in a dictionary in the `exam` object:

The direct access:

```
viewer.exam.aper_phot_pars= {'function': ["aperphot", ],
                             'center': [True, "Center the object (choose center_type)"],
                             'center_com': [False, "gaussian2d, True=center of mass"],
                             'width': [5, "Width of sky annulus in pixels"],
                             'subsky': [True, "Subtract a sky background?"],
                             'skyrad': [15, "Distance to start sky annulus is pixels"],
                             'radius': [5, "Radius of aperture for star flux"],
                             'zmag': [25., "zeropoint for the magnitude calculation"],
                             'title': [None, 'Title of the plot'],
                             'scale': ['zscale', 'How to scale the image'],
```

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```

        'color_min': [None, 'Minimum color value'],
        'color_max': [None, 'Maximum color value'],
        'cmap': ['Greys', 'Matplotlib colormap to use'],
        'delta': [10, "bounding box for centering measurement"],
    }

```

Using the convenience function:

```
In [1]: viewer.aimexam()
```

```
Out[2]:
```

```

{'center': [True, "Center the object (choose center_type)"],
 'center_com': [False, "gaussian2d, True=center of mass"],
 'function': ['aper_phot'],
 'radius': [5, 'Radius of aperture for star flux'],
 'skyrad': [15, 'Distance to start sky annulus is pixels'],
 'subsky': [True, 'Subtract a sky background?'],
 'width': [5, 'Width of sky annulus in pixels'],
 'zmag': [25.0, 'zeropoint for the magnitude calculation'],
 'genplot': [True, 'Plot the apertures'],
 'title': [None, 'Title of the plot'],
 'scale': ['zscale', 'How to scale the image'],
 'color_min': [None, 'Minimum color value'],
 'color_max': [None, 'Maximum color value'],
 'cmap': ['Greys', 'Matplotlib colormap to use'],
 'delta': [10, "bounding box for centering measurement"]}

```

In order to change the width of the photometry aperture around the object you would do this::

```
viewer.set_plot_pars('a', "radius", 10)
```

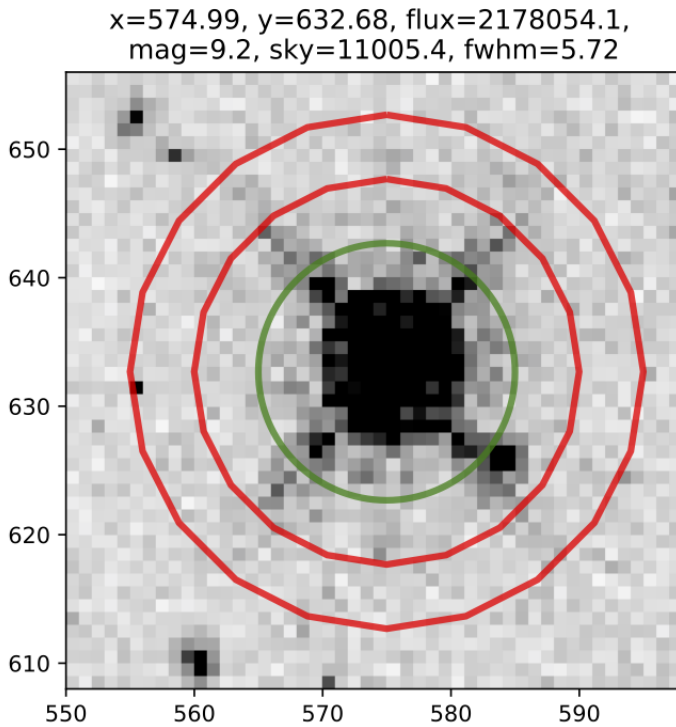
This is what the return looks like when you do photometry, where I've asked for photometry from the star above:

```
viewer.imexam()

xc=574.988523   yc=632.680333
x              y              radius      flux      mag(zpt=25.00)  sky/pix
↪ fwhm(pix)
574.99         632.68         10          2178054.09    9.15          11005.40
↪ 5.72
```

xc = xcenter, yc=ycenter; these were found using a Gaussian2D fit centered on the pixel location of the mouse. You can turn the fit off by setting the “center” parameter to “False”.

This is the resulting plot:



Using the Center of Mass:

```
com_center_pars = {"function": ["com_center",],
                  "delta": [10, "bounding box size"],
                  "oversample": [1., "oversample pixels by"],
                  }
```

6.1.2 Available 1D profiles

These include Gaussian1D, Moffat1D, MexicanHat1D, AiryDisk2D, and Polynomial1D.

If you press the “j” or “k” keys, a 1D profile is fit to the data in either the line or column of the current pointer location. An option to use a Polynomial1D fit is also available, although not something of use for looking at stellar profiles. A plot of both the data and the fit + parameters is displayed. If the centering option is True, then the center of the flux is computed by fitting a 2d Gaussian to the data.

```
line_fit_pars={"function":["line_fit",],
              "func":["gaussian", "function for fitting [see available]"],
              "title":["Fit 1D line plot", "Title of the plot"],
              "xlabel":["Line", "The string for the xaxis label"],
              "ylabel":["Flux", "The string for the yaxis label"],
              "background": [False, "Solve for background? [bool]"],
              "width": [10.0, "Background width in pixels"],
              "xorder": [0, "Background terms to fit, 0=median"],
              "rplot": [20., "Plotting radius in pixels"],
              "pointmode": [True, "plot points instead of lines? [bool]"],
              "logx": [False, "log scale x-axis?"],
              "logy": [False, "log scale y-axis?"]}
```

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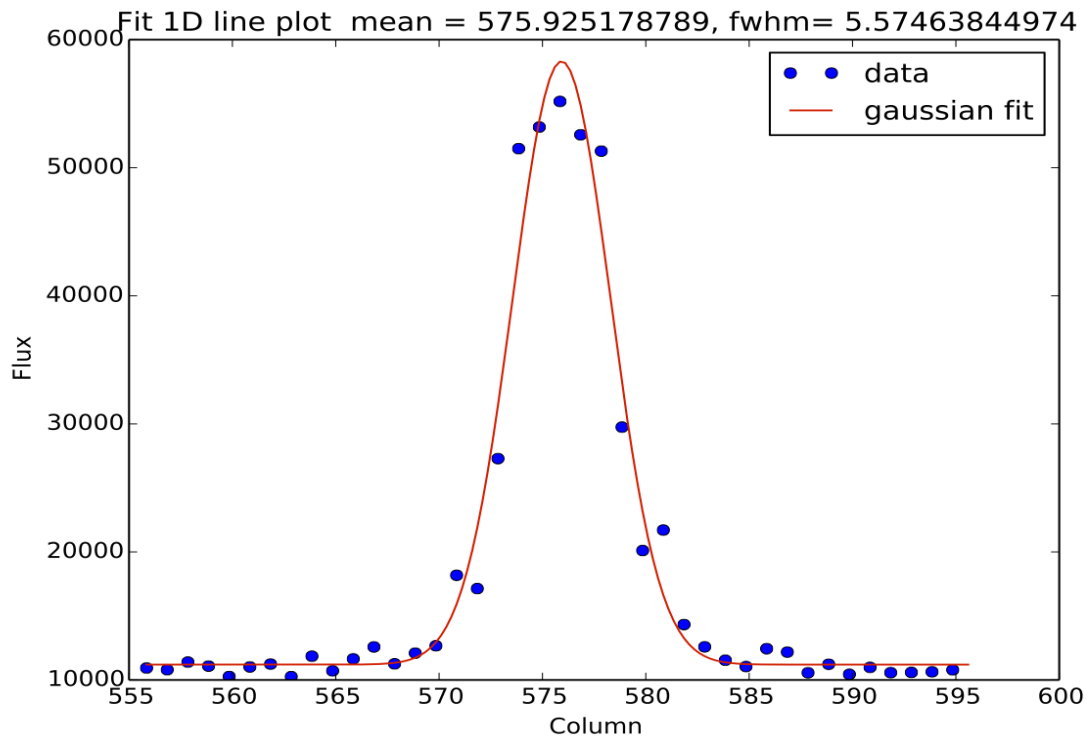
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```
"center": [True, "Recenter around the local max"],
}
```

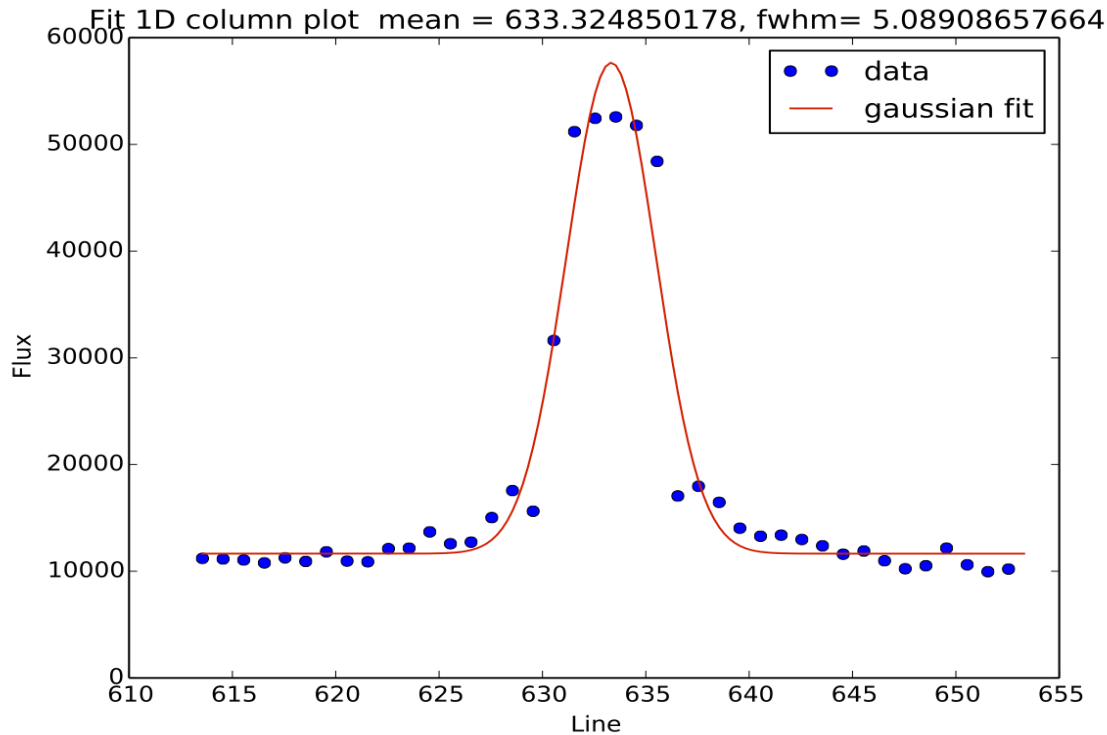
The column fit parameters are similar:

```
column_fit_pars={"function": ["column_fit", ],
                 "func": ["Gaussian1D", "function for fitting [see available]"],
                 "title": ["Fit 1D column plot", "Title of the plot"],
                 "xlabel": ["Column", "The string for the xaxis label"],
                 "ylabel": ["Flux", "The string for the yaxis label"],
                 "background": [False, "Solve for background? [bool]"],
                 "width": [10.0, "Background width in pixels"],
                 "xorder": [0, "Background terms to fit, 0=median"],
                 "rplot": [20., "Plotting radius in pixels"],
                 "pointmode": [True, "plot points instead of lines? [bool]"],
                 "logx": [False, "log scale x-axis?"],
                 "logy": [False, "log scale y-axis?"],
                 "center": [True, "Recenter around the local max"],
}
```

This is the resulting line fit:



and the corresponding column fit:



6.1.3 Square region statistics

If you press the “m” key, the pixel values around the pointer location are calculated inside a box which has a side equal to the `region_size`, defaulted to 5 pixels, and using the statistical function chosen.

The user can map the function to any reasonable numpy function, it’s set to `numpy.median` by default:

```
report_stat_pars= {"function":["report_stat",],
                  "stat":["median", "numpy stat name or describe for scipy.stats"],
                  "region_size":[5, "region size in pixels to use"],
                  }
```

```
[573:578, 629:634] median: 50632.000000
```

You can change the statistic reported by changing the “stat” parameter:

```
viewer.set_plot_pars('m', "stat", "max")
```

```
[572:577, 629:634] amax: 55271.000000
```

You can make a quick comparison of the max reported above with the line fit graph in the 1D gaussian profile example.

You can also choose to use the `scipy.stats.describe` function if you have `scipy` installed by changing the stat to “describe”; this will report the combined stats for the region::

```
pressed: m, report_stat
[551:556, 653:658] describe:
nobs: 25
```

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```

minamx: (0.51326549, 0.85604763)
mean 0.6851165890693665
variance: 0.00780616095289588
skew: 0.05719175934791565
kurtosis: -0.47930471400886976

```

6.1.4 Pixel Coordinates and Value

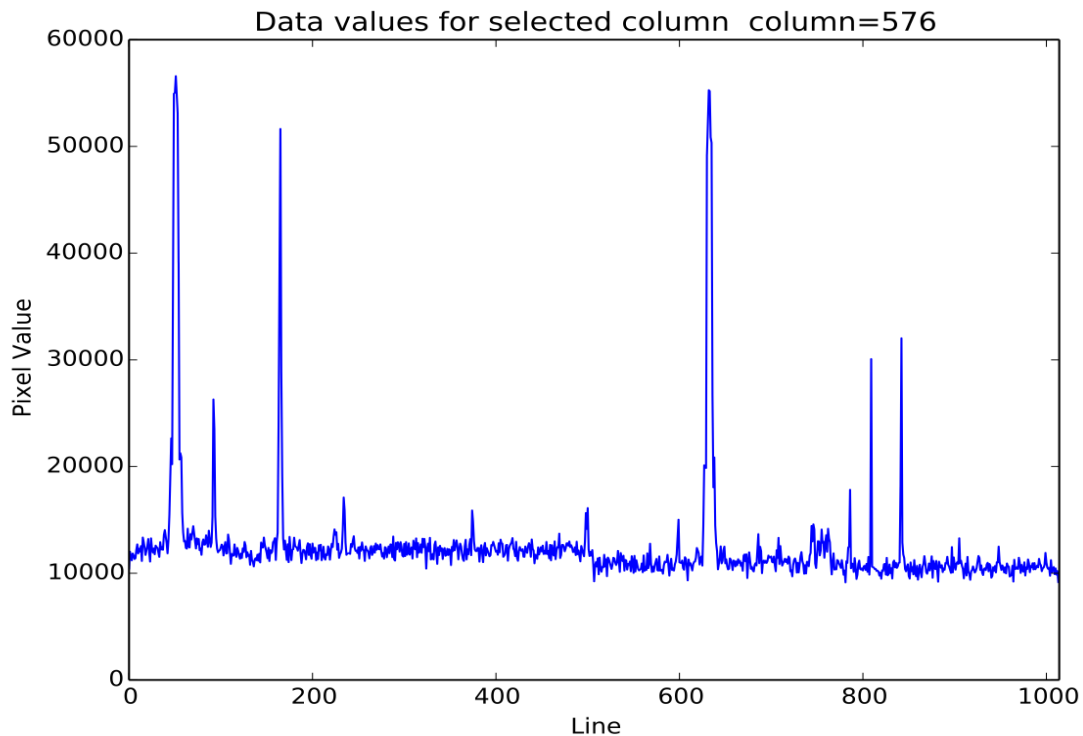
Hitting the ‘x’ or ‘y’ will return the x,y coordinate and pixel value under the mouse pointer.:

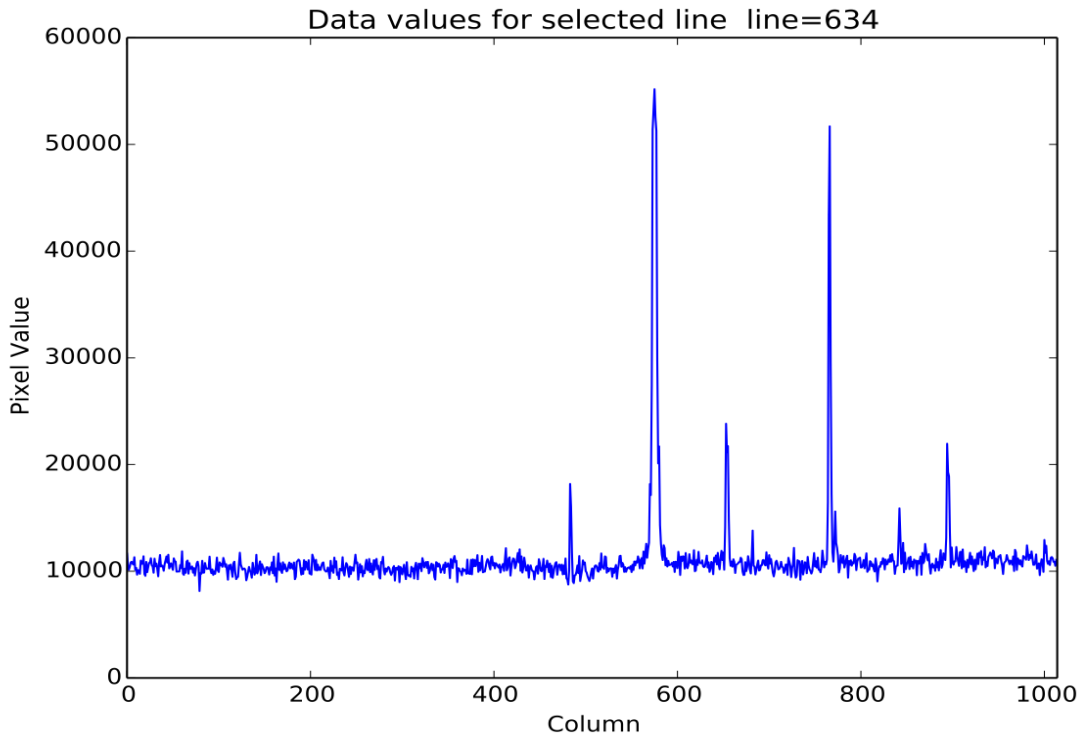
```
576.0 633.66667 55271.0
```

When not inside the `imexam()` loop, you can also set the location of the pointer using the wcs or pixel location you wish to view.

6.1.5 Line or Column plots

Pressing the “l” or “c” keys will display a plot of the points through either the line or column closest to the cursor location.





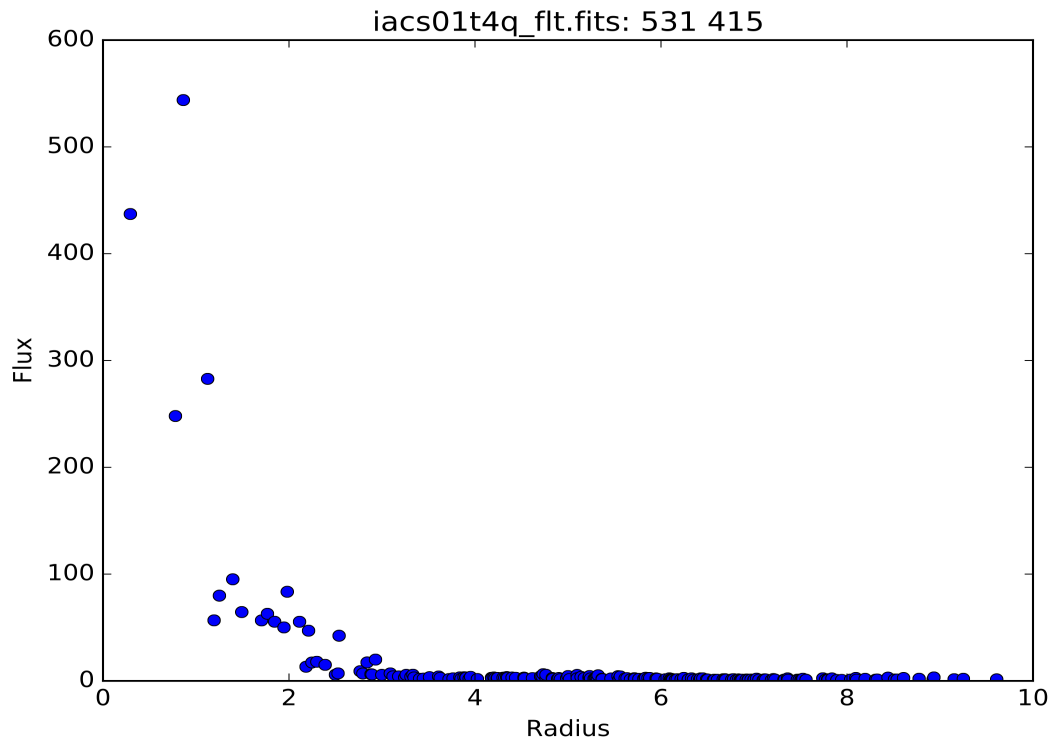
6.1.6 Radial Profile Plot

Pressing the “r” key displays a radial profile plot for the flux around the current pointer location. If centering is on, the center is computed close to the star using a Gaussian2D fit. The default plot uses every pixel

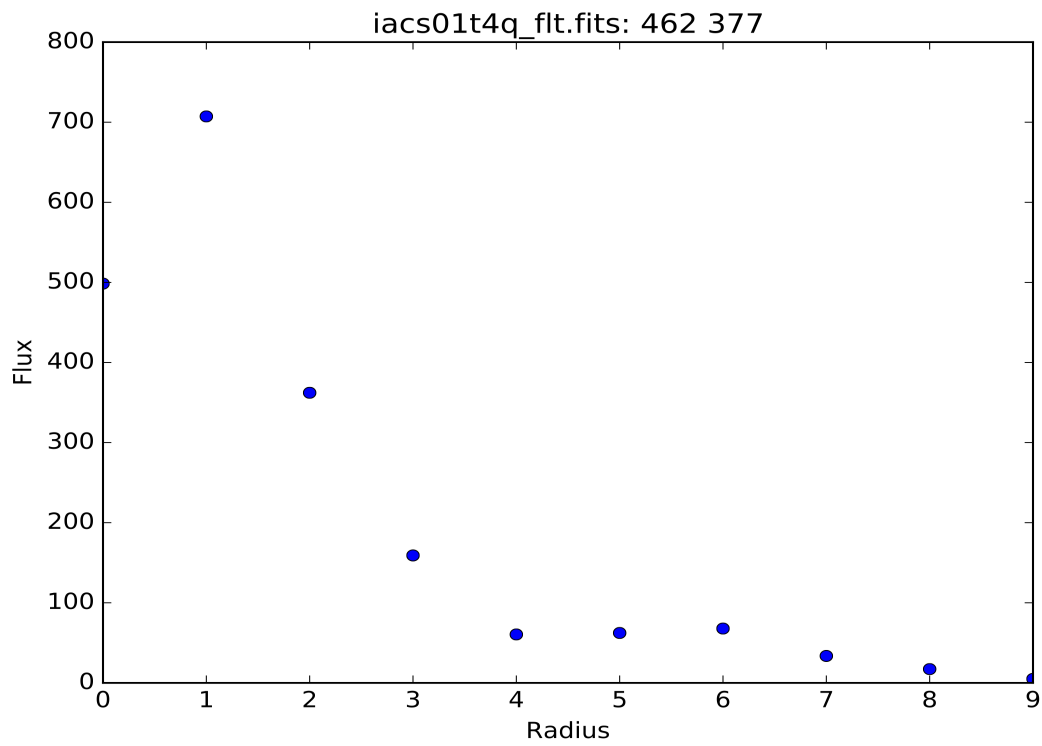
The available parameters are

```
radial_profile_pars = {"function": ["radial_profile_plot", ],
    "title": ["Radial Profile", "Title of the plot"],
    "xlabel": ["Radius", "The string for the xaxis label"],
    "ylabel": ["Summed Pixel Value", "The string for the yaxis label"],
    'pixels': [True, 'Plot all pixels at each radius? (False bins the data)'],
    "fitplot": [False, "Overplot profile fit?"],
    "fittype": ["Gaussian1D", "Profile type to fit (gaussian)"],
    "center": [True, "Solve for center using 2d Gaussian? [bool]"],
    "background": [True, "Subtract background? [bool]"],
    "skyrad": [10., "Background inner radius in pixels, from center of object
↪"],
    "width": [5., "Background annulus width in pixels"],
    "magzero": [25., "magnitude zero point"],
    "rplot": [8., "Plotting radius in pixels"],
    "pointmode": [True, "plot points instead of lines? [bool]"],
    "marker": ["o", "The marker character to use, matplotlib style"],
    "minflux": [0., "only measure flux above this value"],
    "getdata": [True, "return the plotted data values"]
}
```

Radial profile plot for all pixels around the location:



Radial profile plot for all pixels, binned to integer radii:

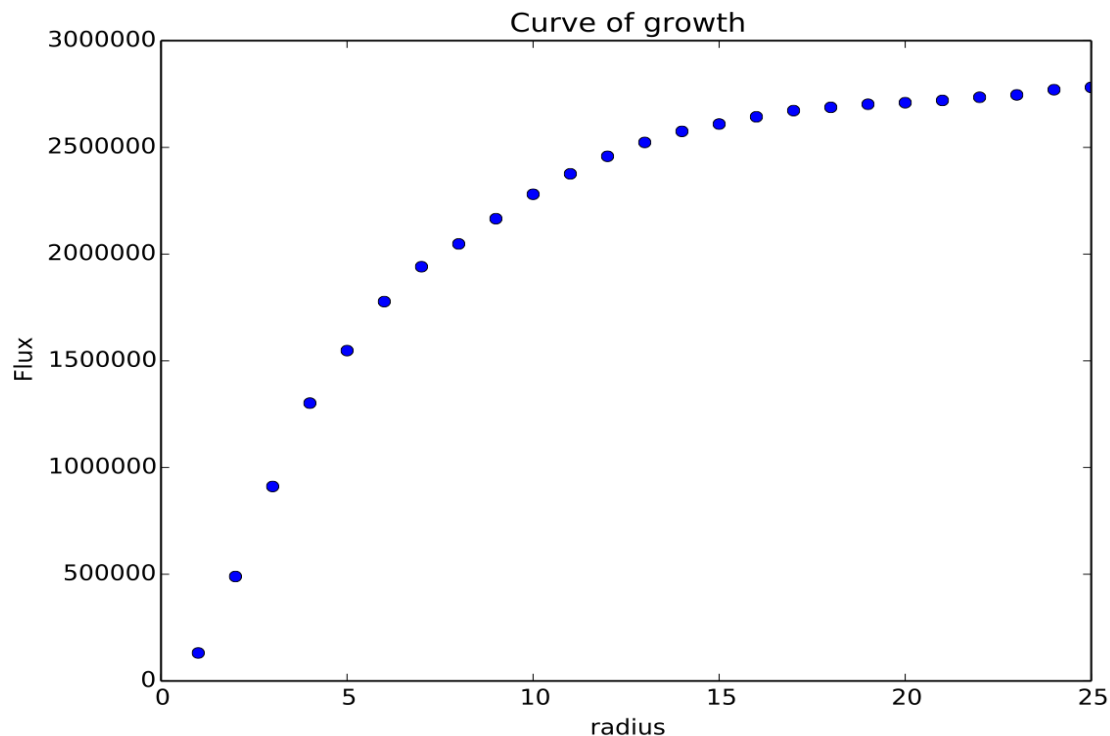


6.1.7 Curve of Growth plot

Pressing the “r” key displays a curve of growth for the flux around the current pointer location in successively larger radii. If centering is on, the center is computed close to the star using a 2d gaussian fit.

The available parameters are

```
curve_of_growth_pars={ "function":["curve_of_growth_plot",],
    "title":["Curve of Growth","Title of the plot"],
    "xlabel":["radius","The string for the xaxis label"],
    "ylabel":["Flux","The string for the yaxis label"],
    "center":[True,"Solve for center using 2d Gaussian? [bool]"],
    "background":[True,"Fit and subtract background? [bool]"],
    "buffer":[25.,"Background inner radius in pixels,from center of ↵
↵star"],
    "width":[5.,"Background annulus width in pixels"],
    "magzero":[25.,"magnitude zero point"],
    "rplot":[8.,"Plotting radius in pixels"],
    "pointmode":[True,"plot points instead of lines? [bool]"],
    "marker":["o","The marker character to use, matplotlib style"],
    "logx":[False,"log scale x-axis?"],
    "logy":[False,"log scale y-axis?"],
    "minflux":[0.,"only measure flux above this value"],
}
```



Returned to the screen is the data information from the plot, the (x,y) location of the center, followed by the radius and corresponding flux which was measured:

```
viewer.set_plot_pars('g',"rplot",25)  #set the default radius larger
```

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```

xc=577.242311      yc=634.578361

at (x,y)=577,634
radii:[ 1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25]
flux:[131192.03694247041, 489485.48536408512, 911376.50226695999, 1301726.7189847208,
↪1547865.8684735354, 1777547.7859571185, 1940955.1267221647, 2047700.7156964755,
↪2165971.1952809561, 2280391.5901085823, 2376090.3555588746, 2458370.0006153183,
↪2523384.2243051622, 2575208.3657517368, 2609309.6524876151, 2643279.3635597304,
↪2672443.1546003688, 2687659.5178374872, 2702128.5513395425, 2709501.1520242952,
↪2720134.8632924128, 2734777.3482598308, 2746056.5231984705, 2770352.0070485324,
↪2781242.3299104609]

```

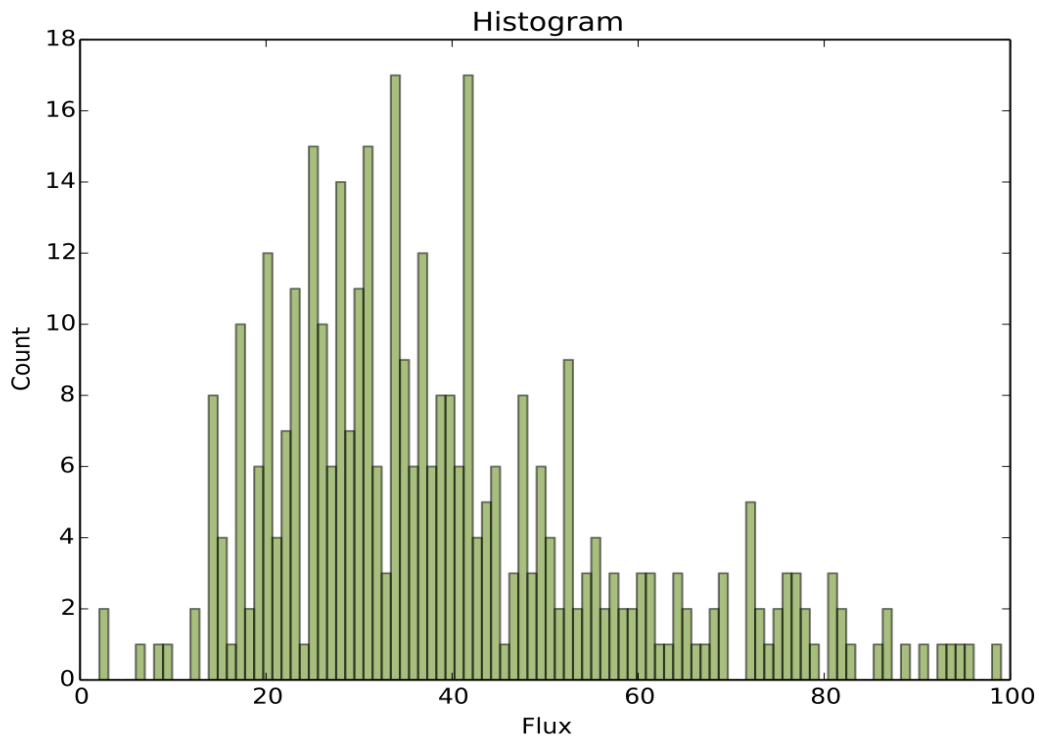
6.1.8 Histogram Plots

Pressing the “h” key will display a histogram of pixel values around the pixel location under the mouse pointer.

```

histogram_pars={"function":["histogram",],
                "title":["Histogram","Title of the plot"],
                "xlabel":["Flux (bin)","The string for the xaxis label"],
                "ylabel":["Count","The string for the yaxis label"],
                "ncolumns":[21,"Number of columns"],
                "nlines":[21,"Number of lines"],
                "nbins":[100,"Number of bins"],
                "z1":["None","Minimum histogram intensity"],
                "z2":[100,"Maximum histogram intensity"],
                "pointmode":["True","plot points instead of lines? [bool]"],
                "marker":["o","The marker character to use, matplotlib style"],
                "logx":["False","log scale x-axis?"],
                "logy":["False","log scale y-axis?"],
                }

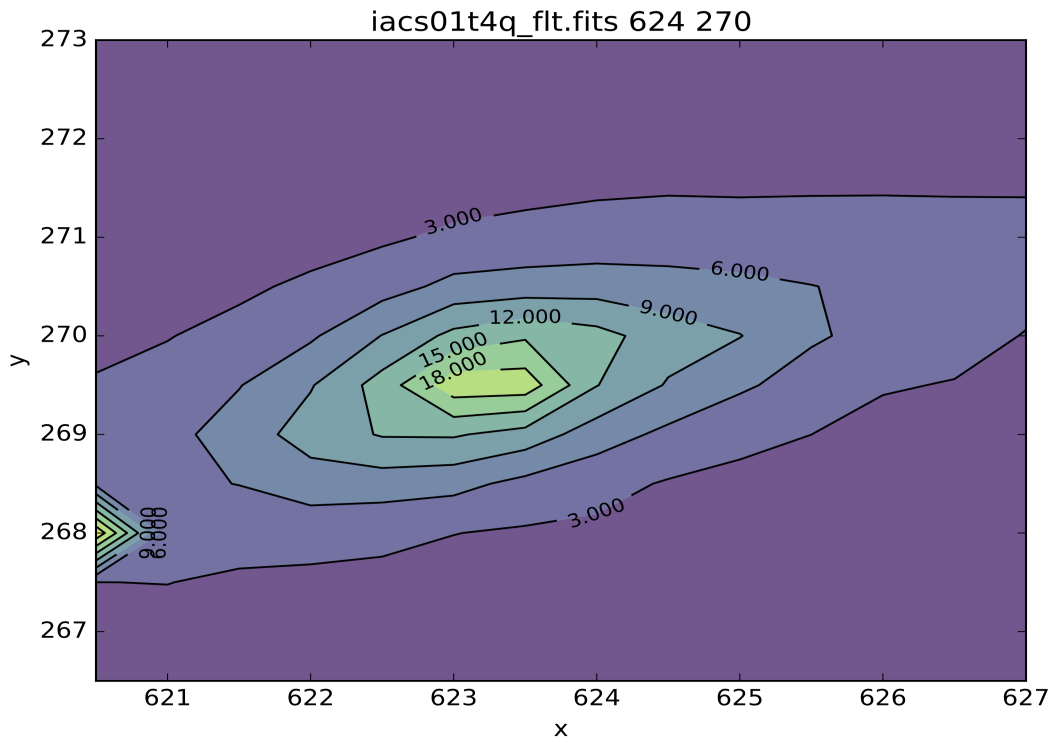
```



6.1.9 Contour Plots

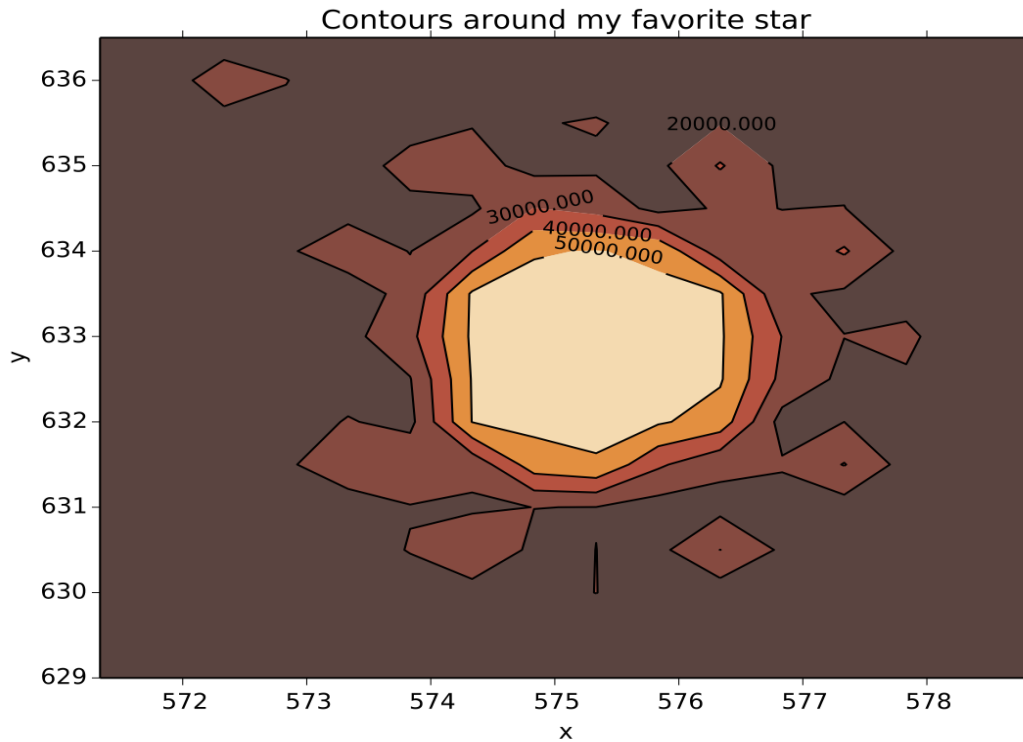
Pressing the “e” key will display a contour plot around the clicked pixel location.

```
contour_pars={"function":["contour",],
              "title":["Contour plot in region around pixel location","Title of ↵
↵the plot"],
              "xlabel":["x","The string for the xaxis label"],
              "ylabel":["y","The string for the yaxis label"],
              "ncolumns":[15,"Number of columns"],
              "nlines":[15,"Number of lines"],
              "floor":["None","Minimum value to be contoured"],
              "ceiling":["None","Maximum value to be contoured"],
              "ncontours":[8,"Number of contours to be drawn"],
              "linestyle":["--","matplotlib linestyle"],
              "label":["True","Label major contours with their values? [bool]"],
              "cmap":["viridis","Colormap (matplotlib style) for image"],
              }
```



Here's what it looks like if we change some of the default parameters:

```
viewer.set_plot_pars('e', "cmap", "gist_heat")
viewer.set_plot_pars('e', "title", "Contours around my favorite star")
viewer.set_plot_pars('e', "ncontours", 4)
viewer.set_plot_pars('e', "floor", 0)
```

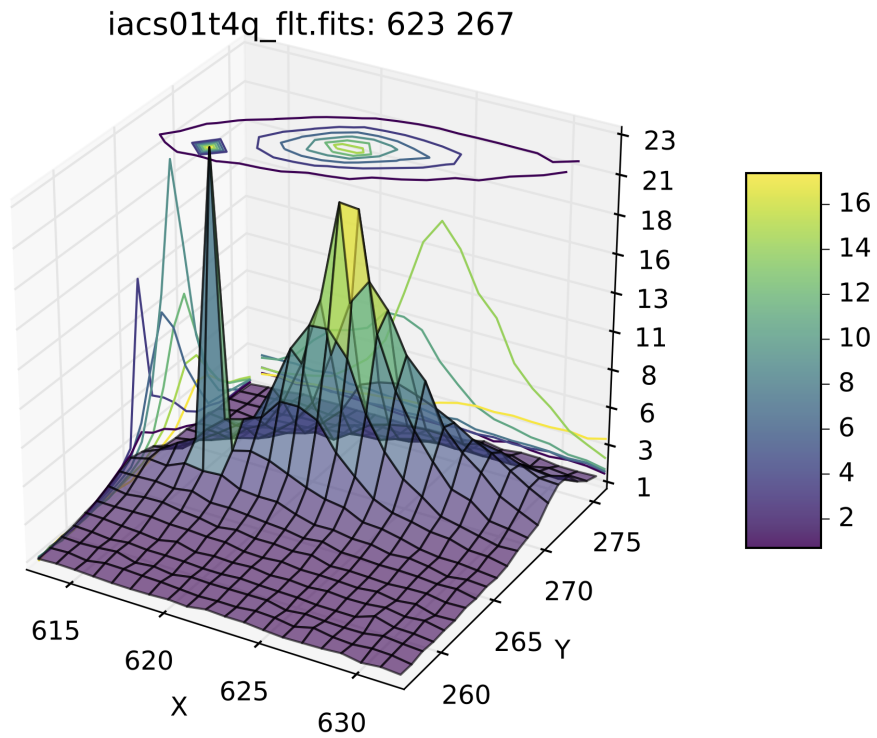


Note: You can use any of the matplotlib standard cmaps, see the following link for more information: http://matplotlib.org/api/pyplot_summary.html?highlight=colormaps#matplotlib.pyplot.colormaps

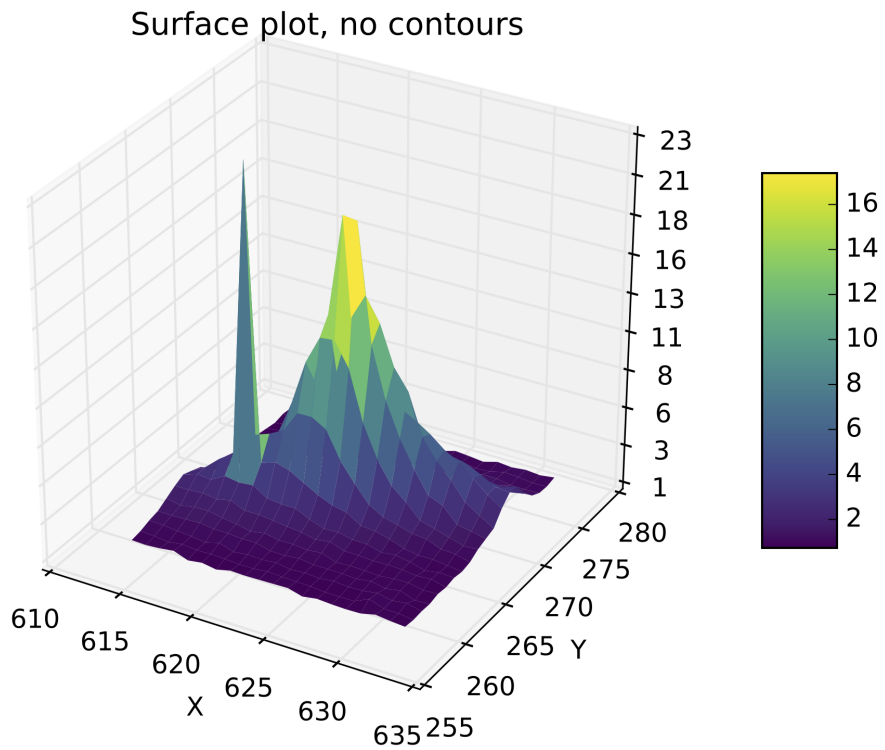
6.1.10 Surface Plots

Pressing the “s” key will display a 3D surface plot of pixel values around the mouse pointer location with the default parameters:

```
surface_pars = {"function": ["surface", ],
                "title": [None, "Title of the plot"],
                "xlabel": ["X", "The string for the xaxis label"],
                "ylabel": ["Y", "The string for the yaxis label"],
                "zlabel": [None, "Label for zaxis"],
                "ncolumns": [10, "Number of columns"],
                "nlines": [10, "Number of lines"],
                "azim": [None, "azimuthal viewing angle in degrees"],
                "floor": [None, "Minimum value to be contoured"],
                "ceiling": [None, "Maximum value to be contoured"],
                "stride": [1, "step size, higher vals will have less contour"],
                "cmap": ["viridis", "colormap (matplotlib) for display"],
                "fancy": [True, "This aint your grandpas iraf"],
                }
```



Or, with the contours turned off (by setting fancy to False) and changing the title:



6.1.11 Cutout a Simple FITS Image

Press 'q' to quit

```

2      make the next plot in a new window
a      aperture sum, with radius region_size
b      return the gauss fit center of the object
c      return column plot
e      return a contour plot in a region around the cursor
h      return a histogram in the region around the cursor
j      1D [gaussian|moffat] line fit
k      1D [gaussian|moffat] column fit
l      return line plot
m      square region stats, in [region_size], default is median
r      return curve of growth plot
s      save current figure to disk as [plot_name]
t      Cut out an image stamp from under the mouse and save it
w      display a surface plot around the cursor location
x      return x,y,value of pixel
y      return x,y,value of pixel

```

pressed: t,576.0,634.0

Cutout at (575.0,633.0) save to ./cutout_575.0_633.07fdinJ.fits

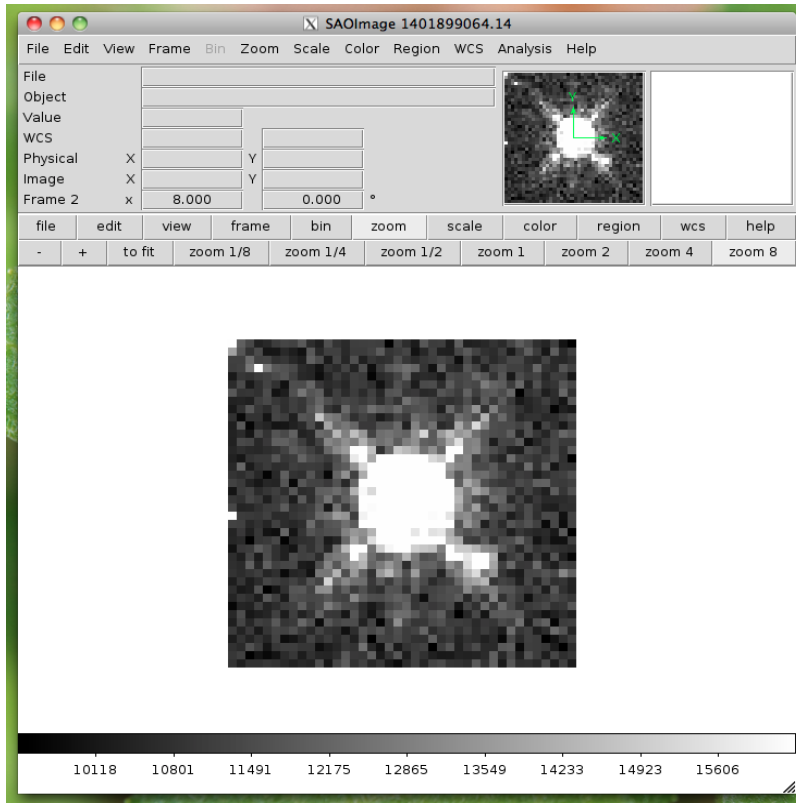
Okay, I went to the star I like and pressed “t”. Let’s verify that we got what we wanted, it should be a cutout centered on the star that we’ve used in all the examples here:

```

image=fits.open('cutout_575.0_633.07fdinJ.fits')
viewer.frame(2)
viewer.view(image)

```

And the resulting frame view?



Sweet. Because this is a often used function I've made it a part of the standard selection set. If you wish to use the astropy 2D cutout method, you can create your own function which will also pass in the WCS object for the data so that the cutout retains it's WCS information.

6.1.12 User Specified functions

Users may code their own functions and bind them to keys by registering them with the `imexam` dictionary through the `register` method that lives in the `exam` object. As long as a unique key is provided, the new binding will be added to the dictionary of `imexam` functions. The new functions do not have to have default dictionaries associated with them. The binding is only good for the current object, new instantiations of `imexam.connect()` will not have the new function unless the user specifically registers them.

Here's all the code for a function which saves the cursor location to a file called 'test.list' when the user presses the 'p' key:

```
def save_to_file(self, x, y, data):
    """Save the cursor location only to a file"""
    if data is None:
        data = self._data
    with open('test.list', 'a') as ofile:
        ofile.write("{0}\t{1}\n".format(x, y))
    print("Saved star to ", 'test.list')
```

Now, import that into your python session, file, or here I'll just copy paste the definition to the session. This is an important step because the function reference is what you are going to send to the registration method. The registration method wants you to supply a dictionary which contains the key you want to assign that function to during the `imexam()` loop, and a tuple with the function name and description:


```
my_dict = {'p': (save_to_file, 'Save cursor location to file')}

viewer.exam.register(my_dict)
User function: save_to_file added to imexam options with key p
```

Okay, so let's try out our new function! We should be able to see it in the list of available options.

```
In [18]: a.imexam()

Press 'q' to quit

2      Make the next plot in a new window
a      Aperture sum, with radius region_size
b      Return the 2D gauss fit center of the object
c      Return column plot
e      Return a contour plot in a region around the cursor
g      Return curve of growth plot
h      Return a histogram in the region around the cursor
j      1D [Gaussian1D default] line fit
k      1D [Gaussian1D default] column fit
l      Return line plot
m      Square region stats, in [region_size], default is median
p      Save cursor location to file
r      Return the radial profile plot
s      Save current figure to disk as [plot_name]
t      Make a fits image cutout using pointer location
w      Display a surface plot around the cursor location
x      Return x,y,value of pixel
y      Return x,y,value of pixel

Current image /Users/sosey/test_images/iacs01t4q_flt.fits
pressed: p, save_to_file
Saved star to test.list

In [19]: !more test.list
463.0    376.75
```

6.1.13 Plot Multiple Windows

During a single `viewer.imexam()` session, you can choose to send your plots to multiple windows. Each window may only be used once, but if you would like to plot multiple things to compare, either the same plots for multiple objects or multiple types of plots for a single object, you can press the “2” key. This will save the current plotting window on your desktop and send the next plot to a new window. The plotting windows will be closed when you exit the imexam loop, so be sure to use the “s” key to save a quick copy of any plots you’d like to save for reference. Here’s what that might look like:

```
#run aperture photometry("a"):

xc=576.522433      yc=634.578085
x      y      radius      flux      mag(zpt=25.00) sky
↪      fwhm
576.52      634.58      5      1560462.68      9.52      10996.52
↪      5.58

#make a column plot ("c")
```

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```

#direct to a new window and make a contour plot ("e")
Plots now directed towards imexam2

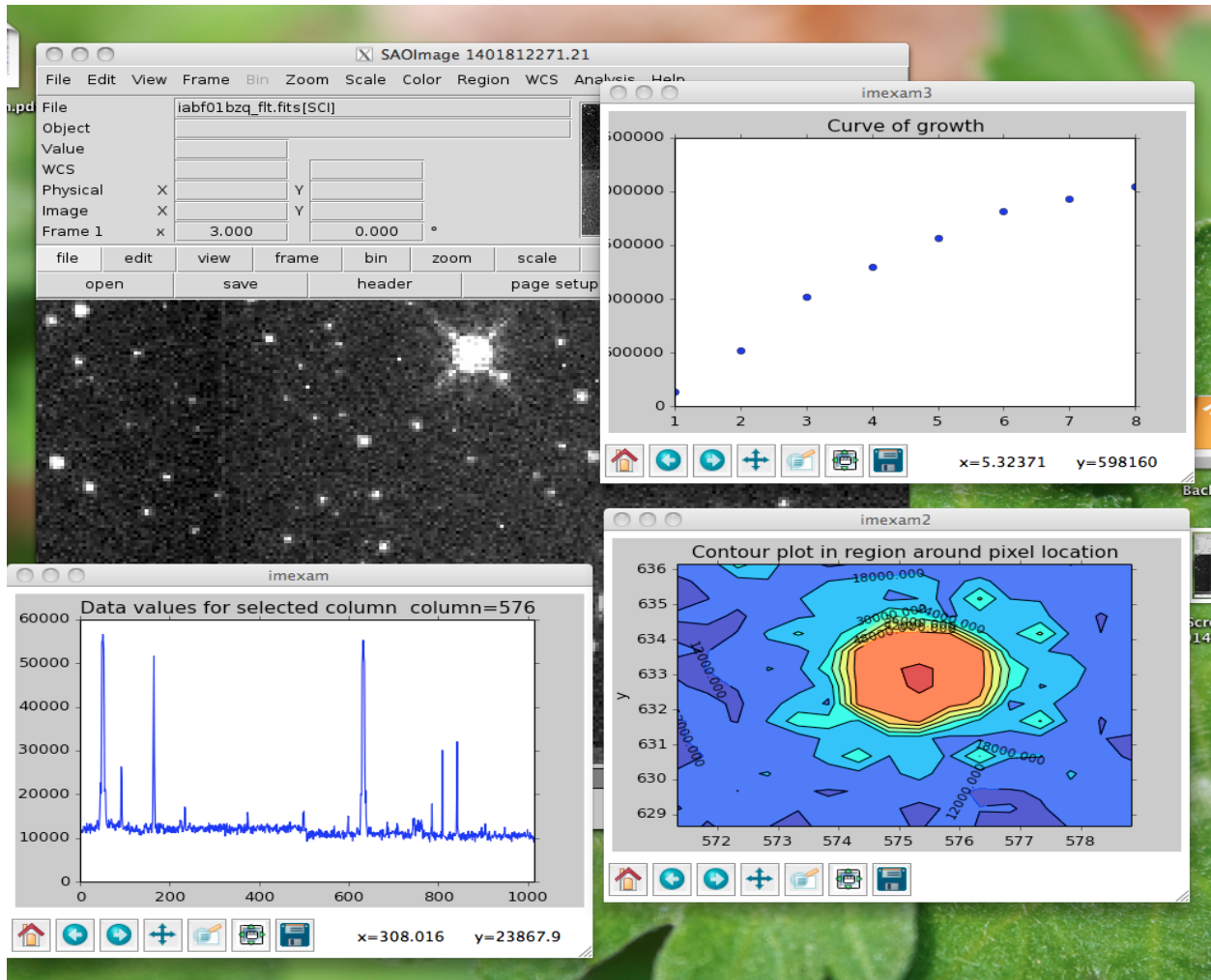
#direct to a new window and make a curve of growth ("r")
Plots now directed towards imexam3

#the resulting curve of growth information on the screen
xc=576.855763      yc=634.911425

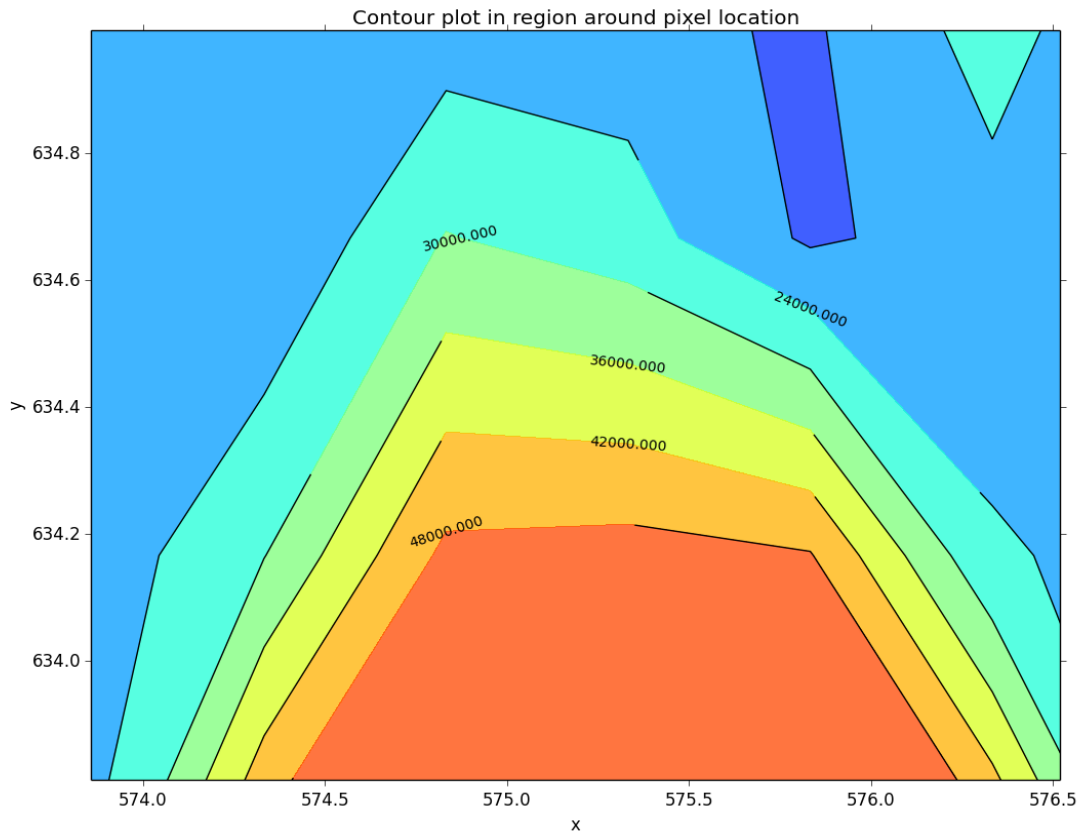
at (x,y)=576,634
radii:[1 2 3 4 5 6 7 8]
flux:[134294.19631173008, 521208.13904411002, 1017231.0442446949, 1297592.7076232315,
↪1568629.6771239617, 1813434.3810552177, 1935335.7549474821, 2049080.846300941]

```

This is what the workspace could look like with DS9 as the viewer:



As an aside, you can use the GUI tools on the bottom of the plot windows to move around the displayed data, such as zooming in and out, as shown below for the contour plot, which was also saved using the GUI save button:



6.2 imexam User Methods

These are methods particular to the `imexam` package which are meant to aid users in their image analysis. They are called from the main object you created with `imexam.connect()`.

At the top library level, the follow commands are available::

```
imexam.connect(): connect to a viewer and return a control object
imexam.display_help(): Takes you to the help documents for your installed version of imexam
imexam.defpars: contains the default plotting function dictionaries
imexam.imexamine: this class contains the plotting functions and can be instantiated by itself
imexam.set_logging(): set the logging parameters for your session.
```

Each object has access to it's own logging which can be edited using `viewer.setlog()` The following will also be available for those not on a Windows system, where the XPA and DS9 are installed::

```
imexam.display_xpa_help(): Takes you to the XPA help page for DS9
imexam.list_active_ds9(): returns a dictionary of available DS9 sessions for connection
```

You can always get the commands available to your local viewer by asking the control object for them directly. If you called your control object "viewer" then the following example will return the list::

```
viewer.show_window_commands() # will return a list of available commands
```

Not all viewers have all commands implemented, commands which are available but not yet fully implemented should return an error to that affect.

alignwcs(on=True): Align the images in the viewer using the WCS in their headers

```
viewer.alignwcs()
```

blink(blink=True, interval=None): For viewers with multiple frames, blink the images

clear_contour(): Clear contours from the screen

close(): close the image viewing window and end the connection.

```
viewer.close()
```

cmap(color=None, load=None, invert=False, save=False, filename='colormap.ds9'): Set the colormap for the window

colorbar(on=True): Turn the colorbar in the window on or off

contour(on=True, construct=True): Show contours in the window

crosshair(x=None, y=None, coordsys="physical", skyframe="wcs", skyformat="fk5", match=False, lock=False):
Control the position of the crosshair in the current frame

cursor(x=None, y=None): Move the cursor in the window to the specified pixel location

disp_header(): Display the image header

frame(n=None): Convenience function to change or report the frame

get_data(): Return a numpy array of the data displayed in the current frame

get_filename(): Return the filename for the data in the current window

```
In [1]: viewer.get_filename()
Out[2]: '/Users/sosey/ssb/imexam/iabf01bzq_flt.fits'
```

get_frame_info(): Return more explicit information about the data displayed in the current frame. A dictionary of the information is returned.

```
In [1]: viewer.get_frame_info()

{'extname': 'SCI',
 'extver': 1,
 'filename': '/Users/sosey/ssb/imexam/iabf01bzq_flt.fits',
 'iscube': False,
 'mef': True,
 'naxis': 0,
 'numaxis': 2,
 'user_array': None}
```

get_header(): Return the header of the dataset in the current frame

get_image(): Return the full image object for the data in the current frame

get_slice_info(): Return the slice tuple for the image currently displayed

get_viewer_info(): Return a dictionary which contains information about all frames which have data loaded. This could be useful to users who are scripting an analysis for polling what items are available, how many frames or displayed, what type of data is hanging around, etc ...

```
In [1]: viewer.get_viewer_info()

{'1': {'extname': 'SCI',
      'extver': 1,
      'filename': '/Users/sosey/ssb/imexam/iabf01bzqflt.fits',
      'iscube': False,
      'mef': True,
      'naxis': 0,
      'numaxis': 2,
      'user_array': None}}
```

grab(): Take a snapshot of the image view

grid(on=True, param=False): Turn a grid on and off in the window

hideme(): Reduce the precedence of the window

iscube(): Boolean return if the image is multidimensional cube

load_fits(fname="", extver=1, extname=None): Load a fits image into the current frame. fname can be a filename or a fits HDU

load_mef_as_cube(filename=None): Load a Mult-Extension-Fits image into one frame as an image cube

load_mef_as_multi(filename=None): Load a Mult-Extension-Fits image into multiple frames

load_region(filename): Load regions from a file which uses standard formatting

load_rgb(red, green, blue, scale=False, lockwcs=False): Load three images into an RGB colored frame

make_region(infile,doLabels=False): Make an input reg file which contains rows with “x,y,comment” into a region file that the DS9 viewer recognizes.

infile: str input filename

labels: bool add labels to the regions

header: int number of header lines in text file to skip

textoff: int offset in pixels for labels

rtype: str region type, one of the acceptable DS9 regions

size: int size of the region type

Here's what the input file 'test' looks like:

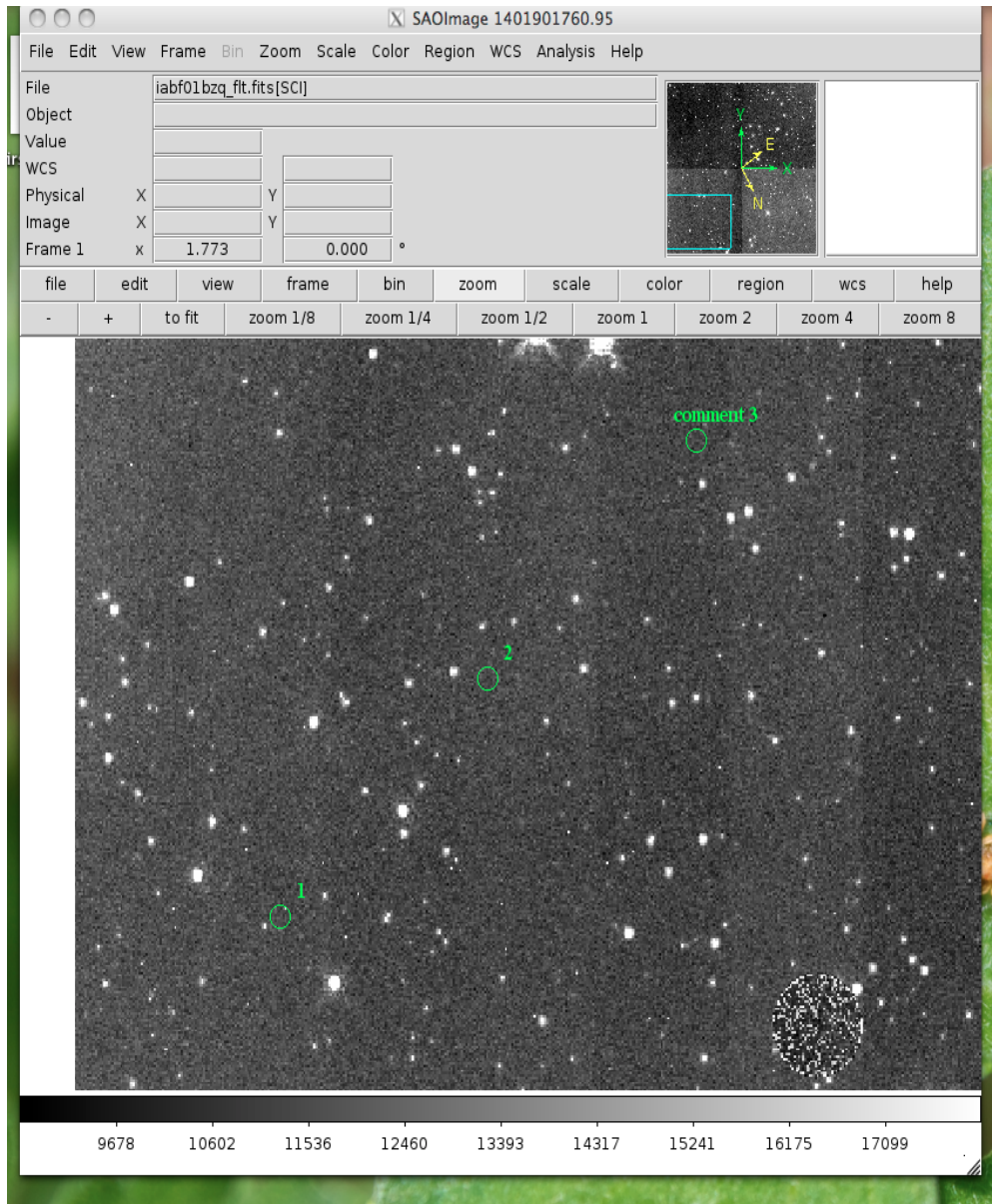
```
100,100, 1
200,200, 2
300,300, comment 3
```

```
viewer.make_region('test',labels=True)
```

And the output region file:

```
image; circle(100,100,5)
image;text(110.0,110.0{ 1 })# font="time 12 bold"
image; circle(200,200,5)
image;text(210.0,210.0{ 2 })# font="time 12 bold"
image; circle(300,300,5)
image;text(310.0,310.0{ comment 3 })# font="time 12 bold"
```

Now let's load the region file into our image:



mark_region_from_array(input_points, rtype="circle", ptype="image", textoff=10, size=5): mark regions on the display given a list of tuples, a single tuple, or a string, where each object has x,y,comment specified

input_points: an iterable contains: (x,y,comment) tuples

ptype: string the reference system for the point locations, imagelphysicalfk5

rtype: string the matplotlib style marker type to display

size: int the size of the region marker

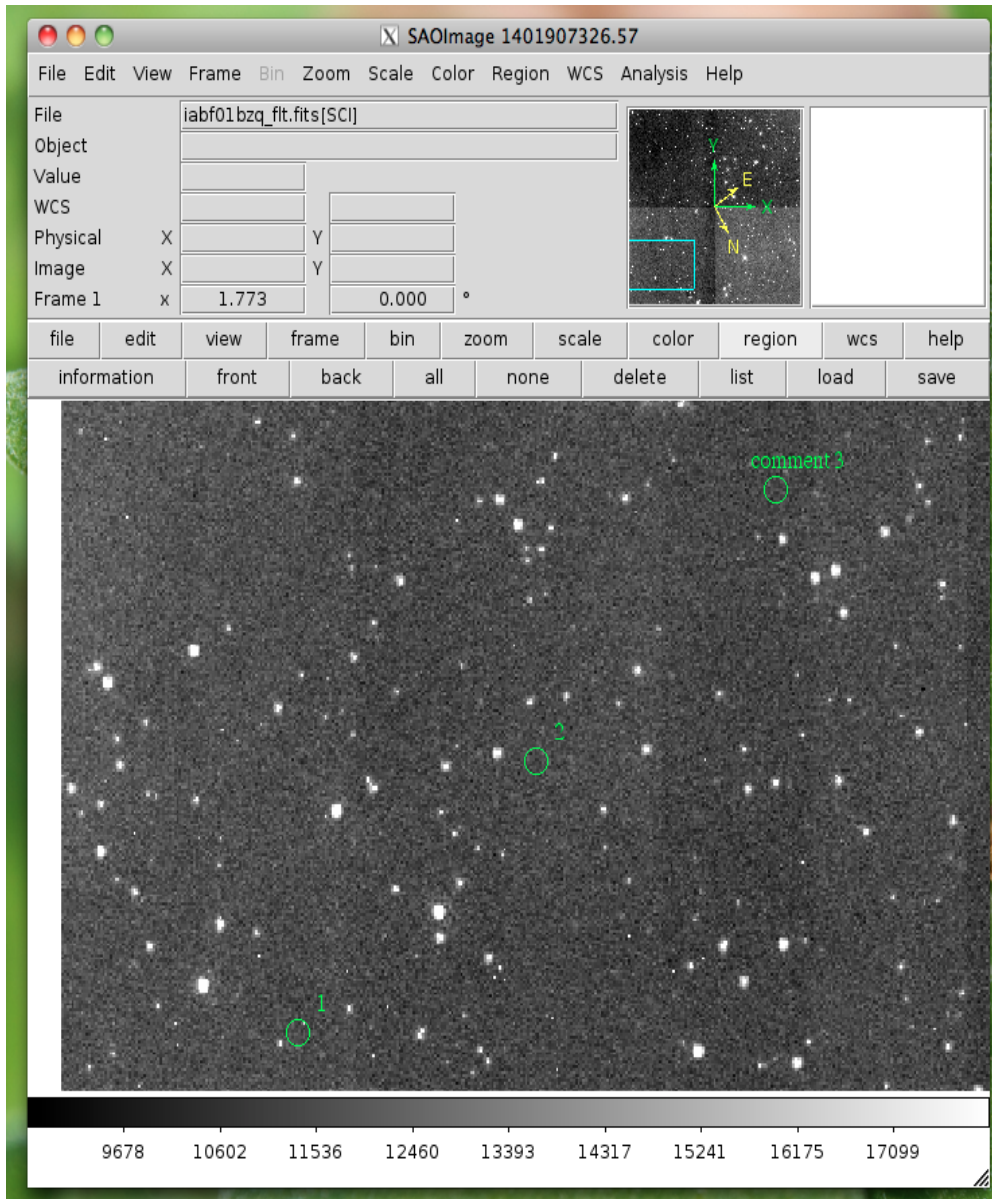
textoff: string the offset for the comment text, if comment is empty it will not show

```
locations=list()
locations.append( (100,100,1) )
locations.append( (200,200,2) )
```

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```
locations.append( (300,300,'comment 3') )
viewer.mark_region_from_array(locations)
```



```
match(coordsys="wcs", frame=True, crop=False, fslice=False,
       scale=False, bin=False, colorbar=False, smooth=False, crosshair=False):
```

Match all other frames to the current frame

nancolor(color='red'): Set the not-a-number color

panto_image(x, y): Convenience function to change to x,y physical image coordinates

panto_wcs(x, y, system='fk5'): Pan to the wcs location in the image

readcursor(): Returns image coordinate position and key pressed as a tuple of the form float(x), float(y), str(key).

```
In [1]: viewer.readcursor()
Out[2]: (56.0, 28.333333, 'a')

or with a click of the first mouse button

In [1]: viewer.readcursor()
Out[2]: (67.333333, 80.0, '<1>')
```

reopen(): Reopen a closed viewing window, mostly used for ginga windows right now

rotate(value=None, to=False): Rotate the current frame (in degrees)

save_regions(filename=None): Save the regions currently displayed in the window to a regions file

save_rgb(filename=None): Save an rgbimage frame as an MEF fits file

scale(scale='zscale'): Scale the pixel values in the window, zscale is the default

set_region(region_string): Use this to send the DS9 viewer a formatted region string it's expecting

For example, in DS9:

```
viewer.set_region("text 110.0 110.0 '1' #font=times")
```

See the DS9 XPA documentation [for](#) more examples.

show_xpa_commands(): Print the available XPA commands (DS9 only)

showme(): Raise the precedence of the viewing window

showpix(): Display a pixel value table

snapsave(filename=None, format=None, resolution=100): Create a snapshot of the current window in the specified format

valid_data_in_viewer(): Return bool if valid file or array is loaded into the viewer

view(img, header=None, frame=None, asFits=False): Load an image array into the image viewing frame, if no frame is specified, the current frame is used. If no frame exists, then a new one is created. A basic header is created and sent to DS9. You can look at this header with `disp_header()` but `get_header()` will return an error because it looks for a filename, and no file was loaded, just the array.

```
image_array=fits.getdata('image.fits')
viewer.view(image_array)

or

image_array=numpy.ones([100,100])*numpy.random.rand(100)
viewer.view(image_array)
```

zoom(par=None): Zoom using the specified command in par

zoomtofit(): Zoom the image to fit the window

setlog(self, filename=None, on=True, level=logging.DEBUG): Turn on and off `imexam` logging to the a file. You can set the filename to something specific or let the package record to the default logfile. Once you give the object a logfile name, it will continue to use that file until you change it.

```
In [5]: viewer.setlog()
Saving ``imexam`` commands to imexam_log.txt
```


This is what's displayed in the terminal when you use `imexam()`:

```
In [8]: viewer.imexam()
```

Press 'q' to quit

```
2      make the next plot in a new window
a      aperture sum, with radius region_size
b      return the gauss fit center of the object
c      return column plot
e      return a contour plot in a region around the cursor
h      return a histogram in the region around the cursor
j      1D [gaussian|moffat] line fit
k      1D [gaussian|moffat] column fit
l      return line plot
m      square region stats, in [region_size], default is median
r      return curve of growth plot
s      save current figure to disk as [plot_name]
w      display a surface plot around the cursor location
x      return x,y,value of pixel
y      return x,y,value of pixel
```

Current image /Users/sosey/ssb/imexam/iabf01bzq_flt.fits

pressed: x

586.0 698.0 56186.0

pressed: a

xc=586.604008 yc=698.523846

x	y	radius	flux	mag(zpt=25.00)	sky	fwhm
586.60	698.52	5	1577310.08	9.51	11166.86	6.03

pressed: b

xc=586.604008 yc=698.523846

```
In [9]: █
```

and this is what shows up in the logfile:

```
In [9]: more imexam_log.txt

_run_imexam
Current image /Users/sosey/ssb/imexam/iabf01bzq_flt.fits

show_xy_coords
623.0 560.0 51241.0

aper_phot
x          y          radius    flux      mag(zpt=25.00) sky      fwhm
1.00       1.00       5         11897.56  14.81      3057.51  0.00

_run_imexam
Current image /Users/sosey/ssb/imexam/iabf01bzq_flt.fits

show_xy_coords
586.0 698.0 56186.0

gauss_center
xc=586.604008  yc=698.523846

aper_phot
x          y          radius    flux      mag(zpt=25.00) sky      fwhm
586.60     698.52     5         1577310.08  9.51      11166.86  6.03

gauss_center
xc=586.604008  yc=698.523846

In [10]:
```

You can see there are some leftovers from a previous logging session to the same file. You can toggle logging during a session too:

```
viewer.setlog(on=False)

#and to turn off even messages to the screen:

viewer.setlog(on=False, level=logging.CRITICAL)
```

unlearn(): Reset all the imexam default function parameters

plotname(): change or show the default save plotname for imexamine

```
In [1]: viewer.plotname()
imexam_plot.pdf

In [2]: viewer.plotname('myplot.jpg')
In [3]: viewer.plotname()
myplot.jpg
```

The extension of the filename controls the plot type.

display_help(): Display the help documentation into a webpage from the locally installed version. This is done from the main package:

```
In [1]: import imexam

In [2]: imexam.display_help()
```

6.3 Convenience functions for DS9's (XPA) commands

Note: The full list of XPA access points can be found at: <http://ds9.si.edu/doc/ref/xpa.html> and XPA itself is maintained here <https://github.com/ericmandel/xpa>

If there is no convenience function for an access point that you would like to use, you can still call it using the `imexam` hooks into the xpa GET and SET functions. They are aliased to your object (for example “window”) as `window.window.xpa.get()` or `window.window.xpa.set()`

alignwcs (on=True): align loaded images by wcs,

blink (blink=None,interval=None): blink frames

clear_contour (): clear contours from the screen

cmap (color=None,load=None,invert=False,save=False,filename='colormap.ds9'): set the color map of the current frame The available maps are “heat”, “grey”, “cool”, “aips0”, “a”, “b”, “bb”, “he”, “i8”

color: string color must be set to one of the available DS9 color map names

load: string, optional set to the filename which is a valid colormap lookup table valid contrast values are from 0 to 10, and valid bias values are from 0 to 1

invert: bool, optional invert the colormap

save: bool, optional save the current colormap as a file

filename: string, optional the name of the file to save the colormap to

colorbar (on=True): turn the colorbar at the bottom of the screen on and off

contour (on=True, construct=True): on: Set to true to turn on contours

construct: optional Will open the contour dialog box which has more options

contour_load (filename): load contours into the window from the specified filename

crosshair (x=None,y=None,coordsys="physical",skyframe="wcs",skyformat="fk5",match=False,lock=False): control the current position of the crosshair in the current frame, crosshair mode is turned on

x: string or int The value of x is converted to a string for the call to XPA, use a value here appropriate for the skyformat you choose

y: string or int The value of y is converted to a string for the call to XPA, use a value here appropriate for the skyformat you choose

coordsys: string, optional The coordinate system your x and y are defined in

skyframe: string, optional If skyframe has “wcs” in it then skyformat is also sent to the XPA

skyformat: string, optional Used with skyframe, specifies the format of the coordinate which were given in x and y

match: bool, optional If set to True, then the wcs is matched for the frames

lock: bool, optional If set to True, then the frame is locked in wcs

cursor (x=None,y=None): move the cursor in the current frame to the specified image pixel, it will also move selected regions

disp_header (): display the current header using the ds9 header display window

frame (n=None): convenience function to switch frames or load a new frame (if that number does not already exist)

n: int, string, optional The frame number to open or change to. If the number specified doesn't exist, a new frame will be opened. If nothing is specified, then the current frame number will be returned. The value of n is converted to a string before passing to the XPA

frame(1) sets the current frame to 1 frame("last") set the current frame to the last frame frame() returns the number of the current frame frame("new") opens a new frame frame(3) opens frame 3 if it doesn't exist already, otherwise goes to frame 3

get_header (): return the header of the current extension as a string, or None if there's a problem

grid (on=True, param=False): turn the grid on and off if param is True, then a dialog is opened for the grid parameters

hideme (): lower the ds9 window on your display

load_fits (fname=None, extname=1, extver='SCI'): load a fits image to the current frame. You provide just the name, or either of the extname or extver, or you can specify the extension with the filename string. For example:

load_fits('something.fits',extver='SCI') will load the SCI,1 extension

load_fits('something.fits[SCI,1]') will load the SCI,1 extension

load_fits('something.fits') will load the main data extension; the only data information in the case of simple fits, or the first extension in the case of a multiextension file

load_region (filename): load the specified DS9 formatted region filename

load_rgb (red, green, blue,scale=False, lockwcs=False): load 3 images into an RGBimage frame, the parameters are:

```
red: string, The name of the fits file which will be loaded into the red channel
green: string, The name of the fits file which will be loaded into the green_
      ↪channel
blue: string, The name of the fits file which will be loaded into the blue channel
scale: bool, If True, then each image will be scale with zscale() after loading
lockwcs: bool, If True, then the image positions will be locked to each other_
      ↪using the WCS information in their headers
```

load_mef_as_cube (filename=None): Load a Mult-Extension-Fits image into one frame as an image cube in the image viewer

load_mef_as_multi (filename=None): Load a Mult-Extension-Fits image into multiple frames in the image viewer

match (coordsys="physical",frame=False,crop=False,fslice=False,scale=False,bin=False,colorbar=False,smooth=False,crosshair=False): match all other frames to the current frame using the specified option. You can only choose one of the options at a time, so set frame=False and something else in addition to your choice if you don't want the default option.

coordsys: string, optional The coordinate system to use

frame: bool, optional Match all other frames to the current frame, using the set coordsys

crop: bool, optional Set the current image display area, using the set coordsys

fslice: bool, optional Match current slice in all frames

scale: bool, optional Match to the current scale for all frames

bin: bool, optional Match to the current binning for all frames

colorbar: bool, optional Match to the current colorbar for all frames

smooth: bool, optional Match to the current smoothing for all frames

crosshair: bool, optional Match the crosshair in all frames, using the current coordsys

nancolor (color="red"): set the not-a-number color, default is red

panto_image (x, y) convenience function to change to x,y images coordinates using ra,dec

panto_wcs (x, y,system='fk5'): pan to the wcs coordinates in the image using the specified system

x: string The x location to move to, specified using the given system

y: string The y location to move to

system: string The reference system that x and y were specified in, they should be understood by DS9

rotate (value, to=False):

value: float [degrees] Rotate the current frame {value} degrees If value is 0, then the current rotation is printed

to: bool Rotate the current frame to the specified value instead

save_header (filename=None): save the header of the current image to a file

save_rgb (filename=None): save an rgbimage frame as an MEF fits file

save_regions (filename=None): Save the regions in the current window to a DS9 style regions file

filename: string The name of the file to which the regions displayed in the current window are saved If no filename is provided then it will try and save the regions to the name of the file in the current display with _regions.txt appended

If a file of that name already exists on disk it will no attempt to overwrite it

scale (scale='zscale'): Scale the image on display. The default zscale is the most widely used option:

```
Syntax

scales available: [linear|log|pow|sqrt|squared|asinh|sinh|histequ]

[log exp <value>]
[datasec yes|no]
[limits <minvalue> <maxvalue>]
[mode minmax|<value>|zscale|zmax]
[scope local|global]
[match]
[lock [yes|no]]
[open|close]
```

set_region (region_string): display a region using the specifications in region_string example: set_region("physical; ruler 200 300 200 400")

showme (): raise the ds9 display window

showpix (): display the pixel value table

snapsave (filename,format=None,resolution=100): create a snap shot of the current window and save in specified format. If no format is specified the filename extension is used

filename: str, optional filename of output image, the extension in the filename can also be used to specify the format. If no filename is specified, then the filename will be constructed from the name of the currently displayed image with `_snap.jpg` appended.

format: str, optional available formats are fits, eps, gif, tiff, jpeg, png. If no format is specified the filename extension is used.

resolution: int, optional 1 to 100, for jpeg images

zoom (par="to fit"):

par: string it can be a number (ranging 0.1 to 8), and successive calls continue zooming in the same direction. It can be two numbers '4 2', which specify zoom on different axes. It can be a specific value 'to 8' or 'to fit', 'to fit' is the default. It can be 'open' to open the dialog box, it can be 'close' to close the dialog box (only valid if the box is already open).

zoomtofit (): zoom to the best fit for the display window

6.4 Basic Usage

Note: More examples in the form of Jupyter notebooks can be downloaded from the git repository and are contained in the "example_notebooks" directory.

6.4.1 Basic Usage

First you need to import the package

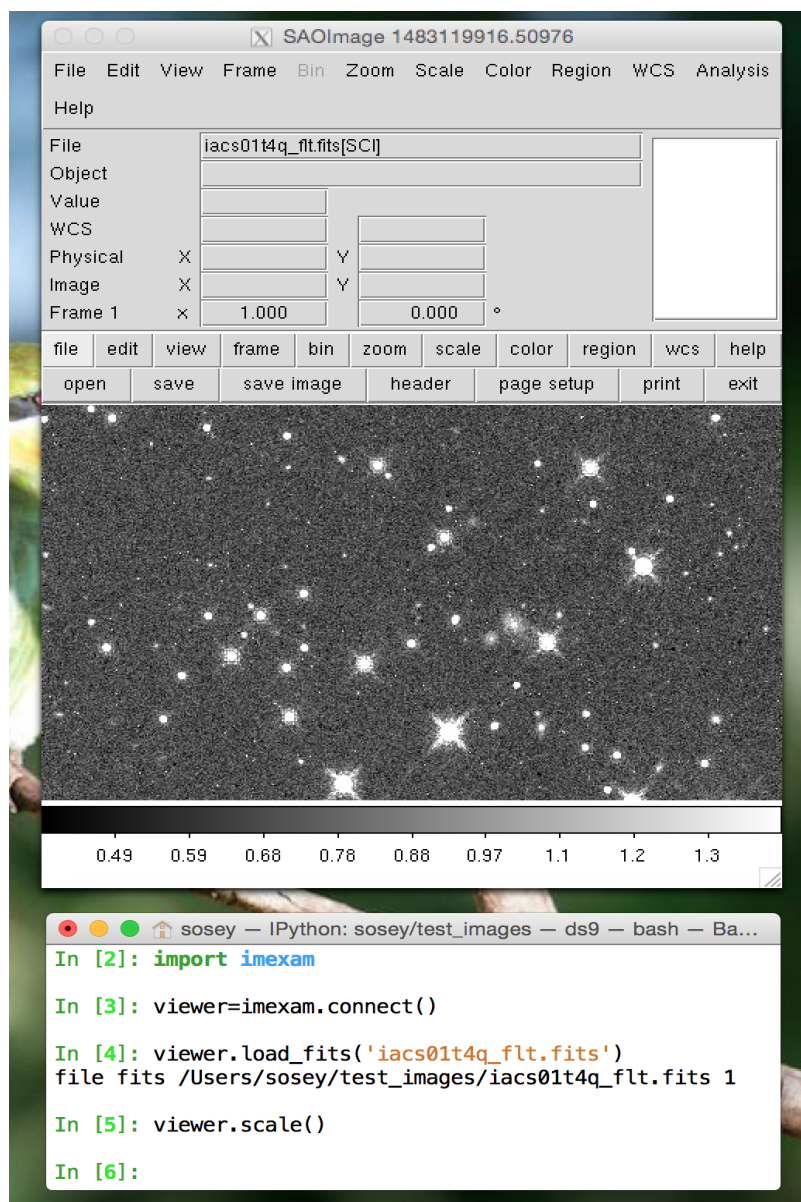
```
import imexam
```

6.4.2 Usage with D9 (the current default viewer)

If you are on a windows system, and DS9 is not available, move on to the Ginga specification.

Start up a DS9 window (by default), a new DS9 window will be opened, open a fits image, and scale it:

```
viewer=imexam.connect()
viewer.load_fits('iacs01t4q_flt.fits')
viewer.scale()
```



If you already have a window running, you can ask for a list of windows; windows that you start from the `imexam` package will not show up, this is to keep control over their processes and prevent double assignments.

```
# This will display if you've used the default command above and have no other DS9_
↪ windows open
In [1]: imexam.list_active_ds9()
No active sessions registered
Out[2]: {}

# open a window in another process
In [3]: !ds9&
In [4]: imexam.list_active_ds9()
DS9 ds9 gs /tmp/xpa/DS9_ds9.60457 sosey
Out[5]: {'/tmp/xpa/DS9_ds9.60457': ('ds9', 'sosey', 'DS9', 'gs')}imexam.list_active_
↪ ds9()
DS9 ds9 gs 82a7e75f:57222 sosey
```


You can attach to a current DS9 window by specifying its unique name

```
viewer1=imexam.connect('ds9')
```

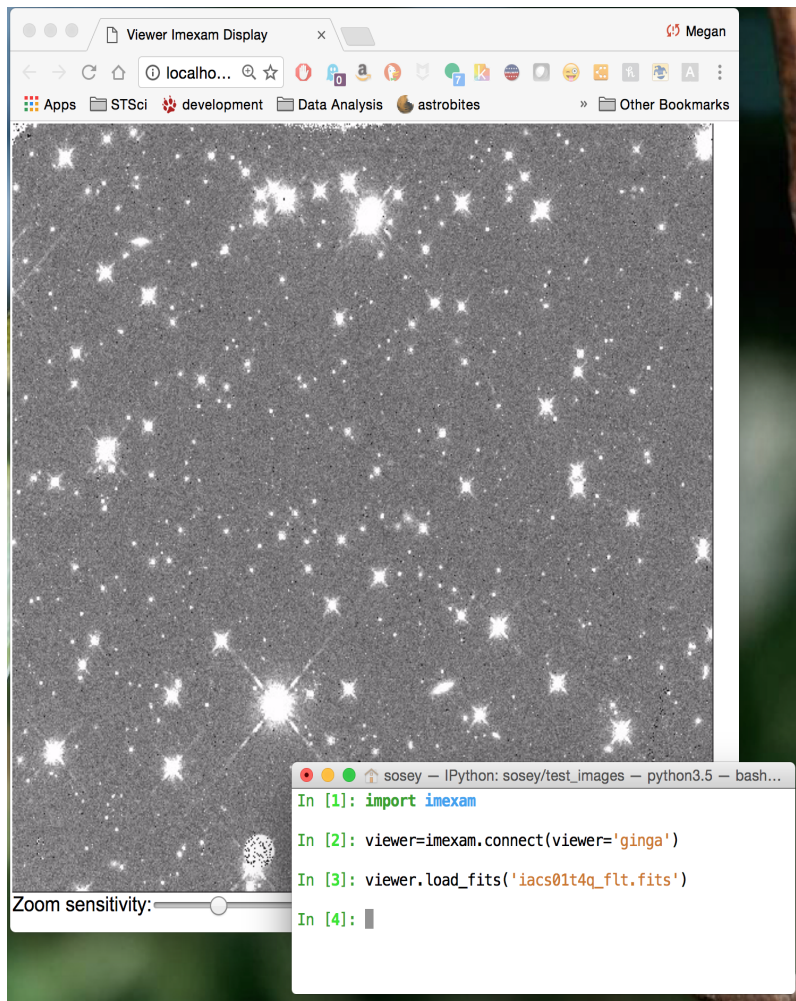
If you haven't given your windows unique names using the `-title <name>` option from the commandline, then you must use the ip:port address:

```
viewer=imexam.connect('82a7e75f:57222')
```

6.4.3 Usage with Ginga viewer

Start up a ginga window using the HTML5 backend and display the same image as above. Make sure that you have installed the most recent version of ginga, imexam will return an error that the viewer cannot be found otherwise.:

```
viewer=imexam.connect(viewer='ginga')
viewer.load_fits()
```



Note: All commands after your chosen viewer is opened are the same. Each viewer also has it's own set of commands which you can additionally use. You may use any viewer for the examples which follow.

Load a fits image into the window:

```
viewer.load_fits('test.fits')
```

Scale the image to the default scaling, which is a zscale algorithm, but the viewers other scaling options are also available:

```
viewer.scale()
viewer.scale('asinh') <-- uses asinh
```

Change to heat map colorscheme:

```
viewer.cmap(color='heat')
```

Make some marks on the image and save the regions using a DS9 style regions file:

```
viewer.save_regions('test.reg')
```

Delete all the regions you made, then load from file:

```
viewer.load_regions('test.reg')
```

Plot stuff at the cursor location, in a while loop. Type a key when the mouse is over your desired location and continue plotting with the available options:

```
viewer.imexam()
```

Quit out and delete windows and references, for the ginga HTML5 window, this will not close the browser window with the image display, you'll need to exit that manually. However, if you've accidentally closed that window you can reopen and reconnect to the server:

```
viewer.close()
viewer.reopen()
```

6.5 Aperture Photometry

6.5.1 Aperture Photometry

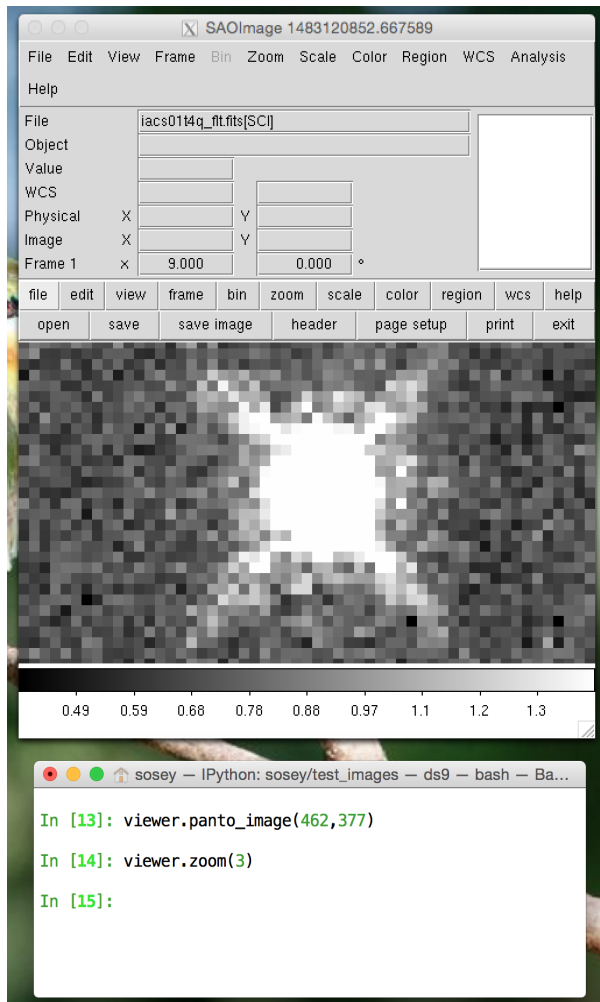
- Perform manual aperture photometry on supplied image
- Make curve of growth and radial profile plots
- Save the profile data and plot to files.

Method 1

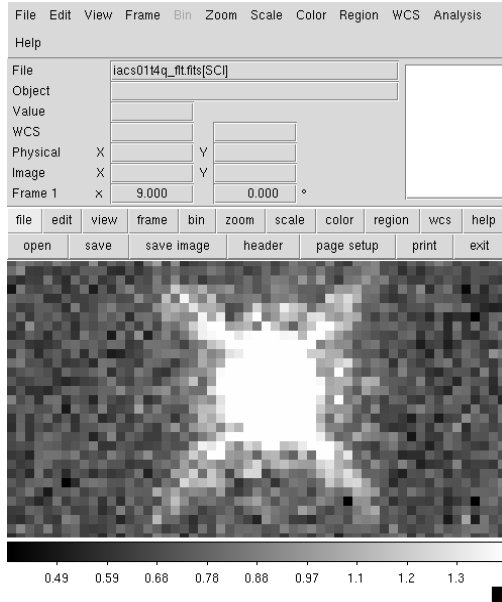
Assuming we've already connected to the window where the data is displayed:

- This method first uses the “a” key to check out the aperture photometry with the default settings
- Display a radial profile “r” plot around the start we choose
- Look at the curve of growth “g” plot
- Make a new profile plot, print the plotted points to the screen, and save a copy of the plotting window for reference

Here a picture of the area I'm looking at on my desktop:



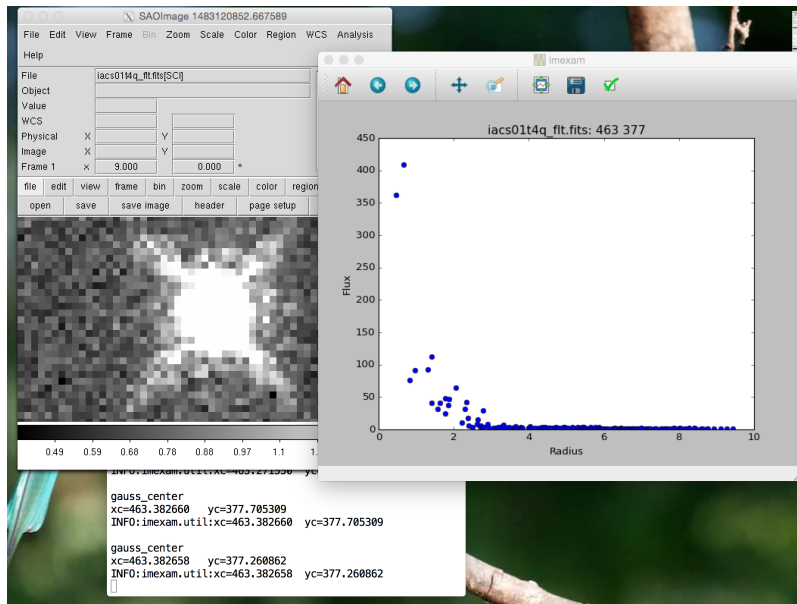
If you wanted to save a screenshot of the viewer display you can use `viewer.grab()`, in DS9 this will save a snap of the whole DS9 window for reference:



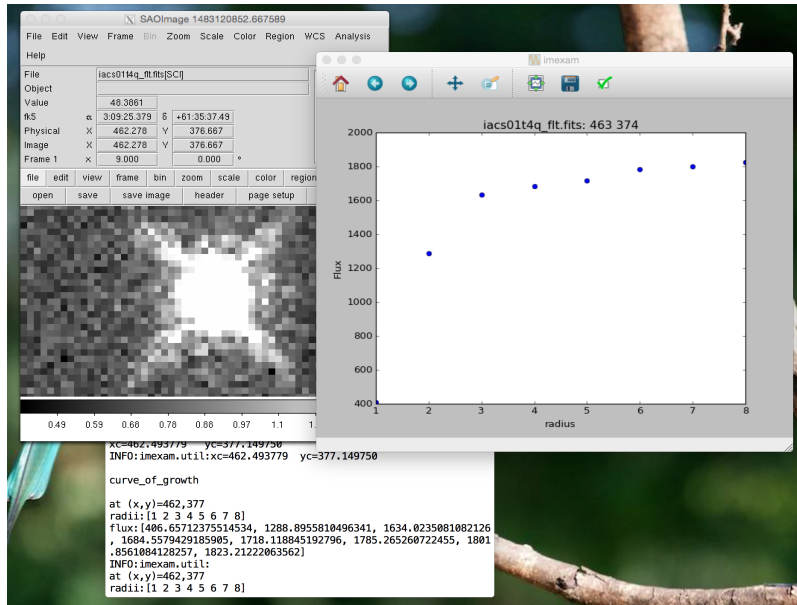
Now let's start up the `imexam()` loop and look at a plot of star:

```
viewer.imexam() #start an imexam session
```

Use the “r” and “g” keys to look at the radial profile and growth curves:



Note that part of the screen information that's returned includes the flux and radii information:



Let's take this information and set the radii for our quick aperture photometry:

```
In [1]: viewer.aimexam()
Out[2]:
{'function': ['aper_phot'],
 'center': [True, 'Center the object (choose center_type)'],
 'center_com': [False, 'gaussian2d, True=center of mass'],
 'width': [5, 'Width of sky annulus in pixels'],
 'subsky': [True, 'Subtract a sky background?'],
 'skyrad': [15, 'Distance to start sky annulus is pixels'],
 'radius': [5, 'Radius of aperture for star flux'],
 'zmag': [25.0, 'zeropoint for the magnitude calculation'],
 'title': [None, 'Title of the plot'],
 'scale': ['zscale', 'How to scale the image'],
 'color_min': [None, 'Minimum color value'],
 'color_max': [None, 'Maximum color value'],
 'cmap': ['Greys', 'Matplotlib colormap to use'],
 'delta': [10, 'bounding box for centering measurement']}
```

```
In [3]: viewer.set_plot_pars('a','radius',4)
set aper_phot_pars: radius to 4
```

```
In [4]: viewer.set_plot_pars('a','skyrad',8)
set aper_phot_pars: skyrad to 8
```

```
In [23]: viewer.imexam()
```

Press 'q' to quit

- 2 Make the next plot in a new window
- a Aperture sum, with radius region_size
- b Return the 2D gauss fit center of the object
- c Return column plot
- e Return a contour plot in a region around the cursor
- g Return curve of growth plot
- h Return a histogram in the region around the cursor
- j 1D [Gaussian1D default] line fit

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```

k  1D [Gaussian1D default] column fit
l  Return line plot
m  Square region stats, in [region_size], default is median
r  Return the radial profile plot
s  Save current figure to disk as [plot_name]
t  Make a fits image cutout using pointer location
w  Display a surface plot around the cursor location
x  Return x,y,value of pixel
y  Return x,y,value of pixel
Current image /Users/sosey/test_images/iacs01t4q_flt.fits

```

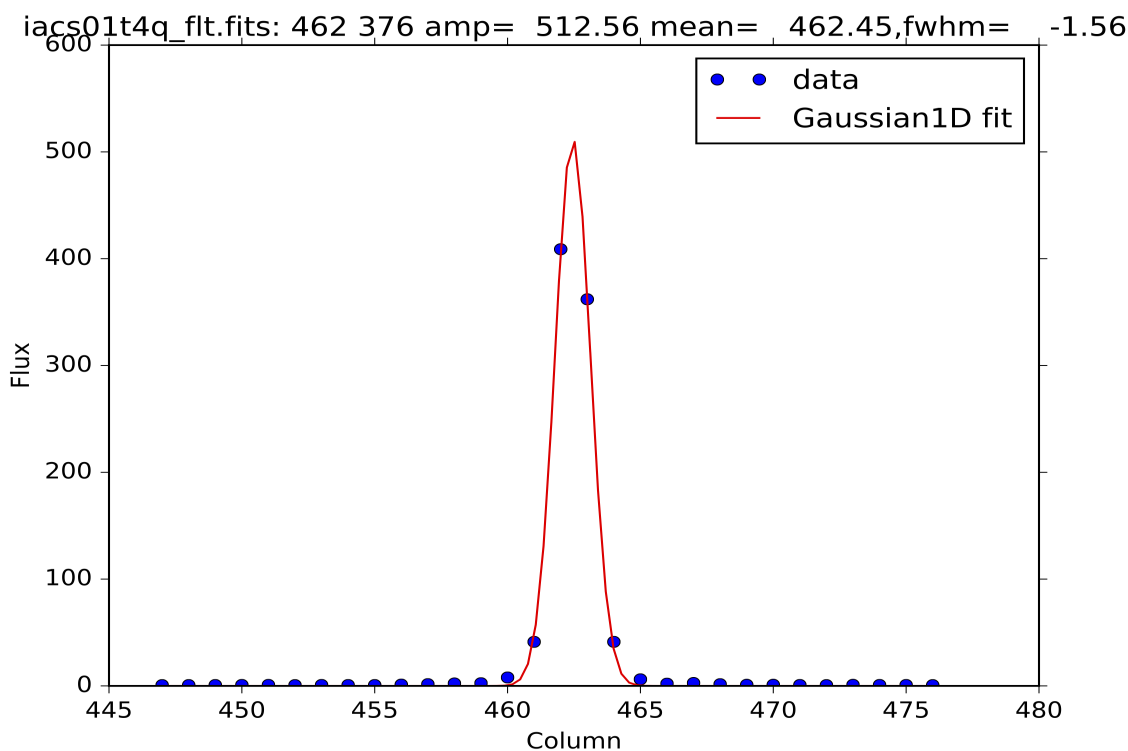
```
gauss_center
```

```
xc=462.827108      yc=377.705312
```

```
aper_phot
```

x	y	radius	flux	mag(zpt=25.00)	sky	fwhm
462.83	377.71	4	1686.24	16.93	0.92	1.71

Just for some more information on the star, below is the gaussian fit “j” to the columns of the same star.



Method 2

Assuming we've already connected to the DS9 window where the data is displayed:

- First we turn on logging so that everything gets saved to a file
- We then use the “a” key to check out the aperture photometry with the default settings
- Use the “g” to look at the curve of growth
- Adjust the aperture photometry with our own settings
- We can then use the log file, to create a plot

```
In [1]: viewer.setlog('mystar.log')
Saving imexam commands to mystar.log
In [2]: viewer.unlearn()

In [3]: viewer.imexam()

Press 'q' to quit

2 Make the next plot in a new window
a Aperture sum, with radius region_size
b Return the 2D gauss fit center of the object
c Return column plot
d Return the Center of Mass fit center of the object
e Return a contour plot in a region around the cursor
g Return curve of growth plot
h Return a histogram in the region around the cursor
j 1D [Gaussian1D default] line fit
k 1D [Gaussian1D default] column fit
l Return line plot
m Square region stats, in [region_size], default is median
r Return the radial profile plot
s Save current figure to disk as [plot_name]
t Make a fits image cutout using pointer location
w Display a surface plot around the cursor location
x Return x,y,value of pixel
y Return x,y,value of pixel
Current image /Users/sosey/test_images/iacs01t4q_flt.fits

xc=462.938220      yc=377.260860
x      y      radius      flux      mag(zpt=25.00)      sky      fwhm
462.94      377.26      5      1739.97      16.90      0.72      1.44

at (x,y)=462,377
radii:[1 2 3 4 5 6 7 8]
flux:[406.65712375514534, 1288.8955810496341, 1634.0235081082126,
1684.5579429185905, 1718.118845192796, 1785.265260722455,
1801.8561084128257, 1823.21222063562]
```

Lets get some more aperture photometry at larger radii by resetting some of the “a” key values::

```
In [4]: viewer.set_plot_pars("a","radius",4)
set aper_phot_pars: radius to 4

In [5]: viewer.set_plot_pars("a","skyrad",8)
set aper_phot_pars: skyrad to 8
```

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```
In [5]: viewer.imexam()  #use the "a" key
```

```
xc=463.049330      yc=377.038640
x      y      radius      flux      mag(zpt=25.00)  sky      fwhm
463.05      377.04      4      1679.23      16.94      0.93      1.71
```

This is what mystar.log contains, you can parse the log, or copy the data and use as you like to make interesting plots later or just have for reference.:

```
gauss_center
xc=462.938220      yc=377.260860

aper_phot
x      y      radius      flux      mag(zpt=25.00)  sky      fwhm
462.94      377.26      5      1739.97      16.90      0.72      1.44

gauss_center
xc=462.827110      yc=377.371969

gauss_center
xc=462.827109      yc=377.260860

gauss_center
xc=462.827109      yc=377.260860

curve_of_growth

at (x,y)=462,377
radii:[1 2 3 4 5 6 7 8]
flux:[406.65712375514534, 1288.8955810496341, 1634.0235081082126,
1684.5579429185905, 1718.118845192796, 1785.265260722455,
1801.8561084128257, 1823.21222063562]

gauss_center
xc=463.049330      yc=377.038640

aper_phot
x      y      radius      flux      mag(zpt=25.00)  sky      fwhm
463.05      377.04      4      1679.23      16.94      0.93      1.71
```

6.6 Interaction with Daophot and Astropy

6.6.1 Advanced Usage - Interact with Daophot and Astropy

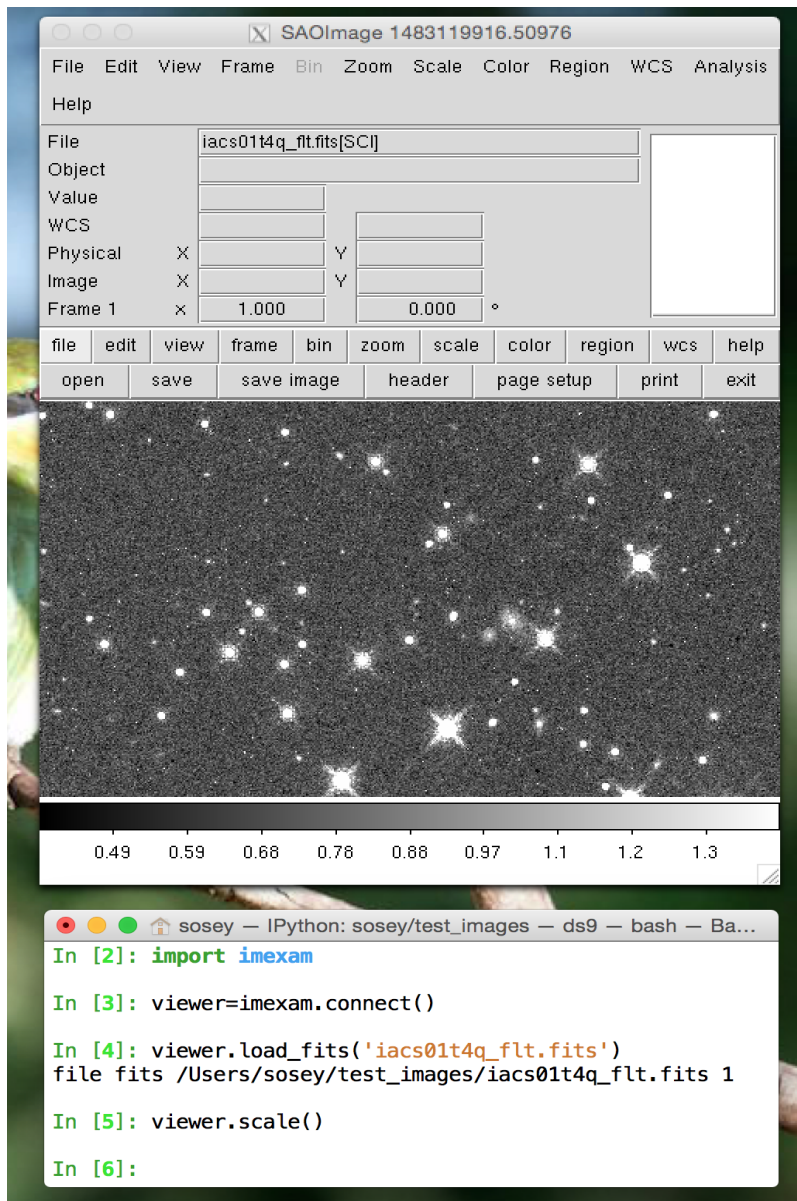
While the original intent for the imexam module was to replicate the realtime interaction of the old IRAF imexamine interface with data, there are other possibilities for data analysis which this module can support. One such example, performing more advanced interaction which can be scripted, is outlined below, using familiar IRAF tasks.

Note: You can see a similar photometry example which uses `photutils` and it's implementation of DAOPhot aperture photometry instead of IRAF in the [imexam_ds9_photometry example jupyter notebook](#).

If you have a list of source identifications, perhaps prepared by SExtractor, DAOFind, Starfind or a similar program,

you can use `imexam` to display the science image and overlay apertures for all their locations. From there you can do some visual examination and cleaning up of the list with a combination of region manipulation and useful `imexam` methods.

Here's our example image to work with, which is a subsection of a larger image:



I'll use the IRAF DAOFind to find objects in my field:

```
from pyraf import iraf
from iraf import noao,digiphot,daophot
from astropy.io import fits

image='iabf01bzq_flt.fits'

fits.info('iabf01bzq_flt.fits')

    Filename: iabf01bzq_flt.fits
```

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No.	Name	Type	Cards	Dimensions	Format
0	PRIMARY	PrimaryHDU	210	()	int16
1	SCI	ImageHDU	81	(1014, 1014)	float32
2	ERR	ImageHDU	43	(1014, 1014)	float32
3	DQ	ImageHDU	35	(1014, 1014)	int16
4	SAMP	ImageHDU	30	()	int16
5	TIME	ImageHDU	30	()	float32

```

#set up some finding parameters, you can make this more explicit
iraf.daophot.findpars.threshold=3.0 #3sigma detections only
iraf.daophot.findpars.nsigma=1.5 #width of convolution kernel in sigma
iraf.daophot.findpars.ratio=1.0 #ratio of gaussian axes
iraf.daophot.findpars.theta=0.
iraf.daophot.findpars.sharplo=0.2 #lower bound on feature
iraf.daophot.findpars.sharphi=1.0 #upper bound on feature
iraf.daophot.findpars.roundlo=-1.0 #lower bound on roundness
iraf.daophot.findpars.roundhi=1.0 #upper bound on roundness
iraf.daophot.findpars.mkdetections="no"

In [84]: iraf.lpar(iraf.daophot.datapars)
          (scale = 1.0)           Image scale in units per pixel
          (fwhmpsf = 2.5)        FWHM of the PSF in scale units
          (emission = yes)        Features are positive?
          (sigma = 1.0)           Standard deviation of background in counts
          (datamin = 0.0)         Minimum good data value
          (datamax = INDEF)       Maximum good data value
          (noise = "poisson")     Noise model
          (ccdread = "")          CCD readout noise image header keyword
          (gain = "ccdgain")      CCD gain image header keyword
          (readnoise = 2.0)       CCD readout noise in electrons
          (epadu = 1.0)           Gain in electrons per count
          (exposure = "exptime")  Exposure time image header keyword
          (airmass = "")          Airmass image header keyword
          (filter = "")           Filter image header keyword
          (obstime = "")          Time of observation image header keyword
          (itime = 1.0)           Exposure time
          (xairmass = INDEF)       Airmass
          (ifilter = "INDEF")     Filter
          (otime = "INDEF")       Time of observation
          (mode = "ql")

iraf.daophot.datapars.datamin=0.
iraf.daophot.datapars.gain="ccdgain"
iraf.daophot.datapars.exposure="exptime"
iraf.daophot.datapars.sigma=105.

#assume the science extension and find some stars
sci="[SCI,1]"
output_locations='iabf01bzq_stars.dat'
iraf.daofind(image=image+sci,output=output_locations,interactive="no",verify="no",
↳ verbose="no")

#This is just the top of the file that daofind produced:

```

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```

In [24]: more iabf01bzq_stars.dat
#K IRAF      = NOAO/IRAFV2.16      version    %-23s
#K USER     = sosey               name       %-23s
#K HOST      = intimachay.stsci.edu  computer   %-23s
#K DATE      = 2014-03-28          yyyy-mm-dd %-23s
#K TIME      = 15:34:56            hh:mm:ss   %-23s
#K PACKAGE   = apphot              name       %-23s
#K TASK      = daofind              name       %-23s
#
#K SCALE     = 1.                  units      %-23.7g
#K FWHMPSF   = 2.5                 scaleunit  %-23.7g
#K EMISSION   = yes                switch     %-23b
#K DATAMIN    = 0.                 counts     %-23.7g
#K DATAMAX    = INDEF              counts     %-23.7g
#K EXPOSURE   = exptime            keyword    %-23s
#K AIRMASS    = ""                 keyword    %-23s
#K FILTER     = ""                 keyword    %-23s
#K OBSTIME    = ""                 keyword    %-23s
#
#K NOISE      = poisson            model      %-23s
#K SIGMA      = 105.               counts     %-23.7g
#K GAIN       = ccdgain            keyword    %-23s
#K EPADU      = 2.5                e-/adu     %-23.7g
#K CCDREAD    = ""                 keyword    %-23s
#K READNOISE  = 0.                 e-         %-23.7g
#
#K IMAGE      = iabf01bzqflt.fits[SCI, imagename %-23s
#K FWHMPSF    = 2.5                scaleunit  %-23.7g
#K THRESHOLD   = 3.                 sigma      %-23.7g
#K NSIGMA     = 2.                  sigma      %-23.7g
#K RATIO      = 1.                  number     %-23.7g
#K THETA      = 0.                  degrees    %-23.7g
#
#K SHARPLO    = 0.2                number     %-23.7g
#K SHARPHI    = 1.                 number     %-23.7g
#K ROUNDLO    = -1.                number     %-23.7g
#K ROUNDHI    = 1.                 number     %-23.7g
#
#N XCENTER    YCENTER    MAG      SHARPNESS  SROUND    GROUND    ID      \
#U pixels     pixels     #        #          #          #        #        \
#F %-13.3f    %-10.3f    %-9.3f  %-12.3f   %-12.3f   %-12.3f  %-6d     \
#
    194.694    2.357      -3.335    0.919     0.141     -0.004     1
    232.659    2.889      -1.208    0.768     0.572     -0.289     2
    237.782    2.925      -1.182    0.669     0.789     -0.971     3
    265.715    2.797      -1.395    0.976     -0.450     -0.669     4
    419.792    2.902      -3.045    0.925     -0.990     0.213     5
    424.566    3.081      -1.202    0.923     0.513     -0.555     6
    534.758    2.856      -1.341    0.659     -0.676     -0.302     7
    580.964    2.485      -1.326    0.821     -0.489     -0.752     8
    587.521    3.568      -1.282    0.911     -0.537     -0.119     9
    725.016    3.999      -1.103    0.714     -0.653     -0.490    10
    736.495    2.808      -1.345    0.710     -0.996     -0.730    11
    746.529    3.200      -0.868    0.303     -0.376     -0.682    12
    757.672    3.172      -1.527    0.420     0.271      0.211    13
    768.768    2.830      -1.321    0.741     -0.842     -0.252    14
    799.199    2.696      -2.096    0.926     0.476     -0.511    15

```

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807.575	2.445	-4.136	0.745	0.171	-0.131	16
836.661	2.790	-1.482	0.709	0.205	0.636	17
879.390	3.069	-1.018	0.549	-0.479	-0.495	18
912.820	2.806	-1.414	0.576	0.504	0.109	19
938.794	3.448	-1.731	0.997	-0.239	0.100	20
17.713	2.731	-1.896	0.286	-0.947	-0.359	21
48.757	2.755	-1.172	0.586	0.646	-0.543	22
105.894	3.030	-1.700	0.321	-0.233	-0.006	23

Now we want to read in the file that Daofind produced and save the x,y and ID information. I'm going to read the results using astropy.io.ascii

```
reader=ascii.Daophot()
photfile=reader.read(output_locations)

#some quick information on what we have now
photfile.colnames

['XCENTER', 'YCENTER', 'MAG', 'SHARPNESS', 'SROUND', 'GROUND', 'ID']

photfile.print()
```

```
In [103]: photfile.pprint()
```

XCENTER	YCENTER	MAG	SHARPNESS	SROUND	GROUND	ID
194.694	2.357	-3.335	0.919	0.141	-0.004	1
232.659	2.889	-1.208	0.768	0.572	-0.289	2
237.782	2.925	-1.182	0.669	0.789	-0.971	3
265.715	2.797	-1.395	0.976	-0.450	-0.669	4
419.792	2.902	-3.045	0.925	-0.990	0.213	5
424.566	3.081	-1.202	0.923	0.513	-0.555	6
534.758	2.856	-1.341	0.659	-0.676	-0.302	7
580.964	2.485	-1.326	0.821	-0.489	-0.752	8
587.521	3.568	-1.282	0.911	-0.537	-0.119	9
725.016	3.999	-1.103	0.714	-0.653	-0.490	10
736.495	2.808	-1.345	0.710	-0.996	-0.730	11
746.529	3.200	-0.868	0.303	-0.376	-0.682	12
757.672	3.172	-1.527	0.420	0.271	0.211	13
768.768	2.830	-1.321	0.741	-0.842	-0.252	14
799.199	2.696	-2.096	0.926	0.476	-0.511	15
807.575	2.445	-4.136	0.745	0.171	-0.131	16

You can even pop this up in your web browser if that's a good format for you: `photfile.show_in_browser()`. imexam has several functions to help display regions on the DS9 window. Since we have this data loaded into memory, the one we will use here is `mark_region_from_array()`.

Let's make an array that the method will accept, namely a list of tuples which contain the (x,y,comment) that we want marked to the display. It will also accept any iterator containing a tuple of (x,y,comment).

```
#lets make a list of our locations as a tuple of x,y,comment
#we'll cut the list to a smaller area and only include those points whose mag is < -4.
locations=list()
for point in range(0,len(photfile['XCENTER']),1):
    if photfile['MAG'][point] < -4:
        locations.append((photfile['XCENTER'][point],photfile['YCENTER'][point],
        ↪photfile['ID'][point]))
```

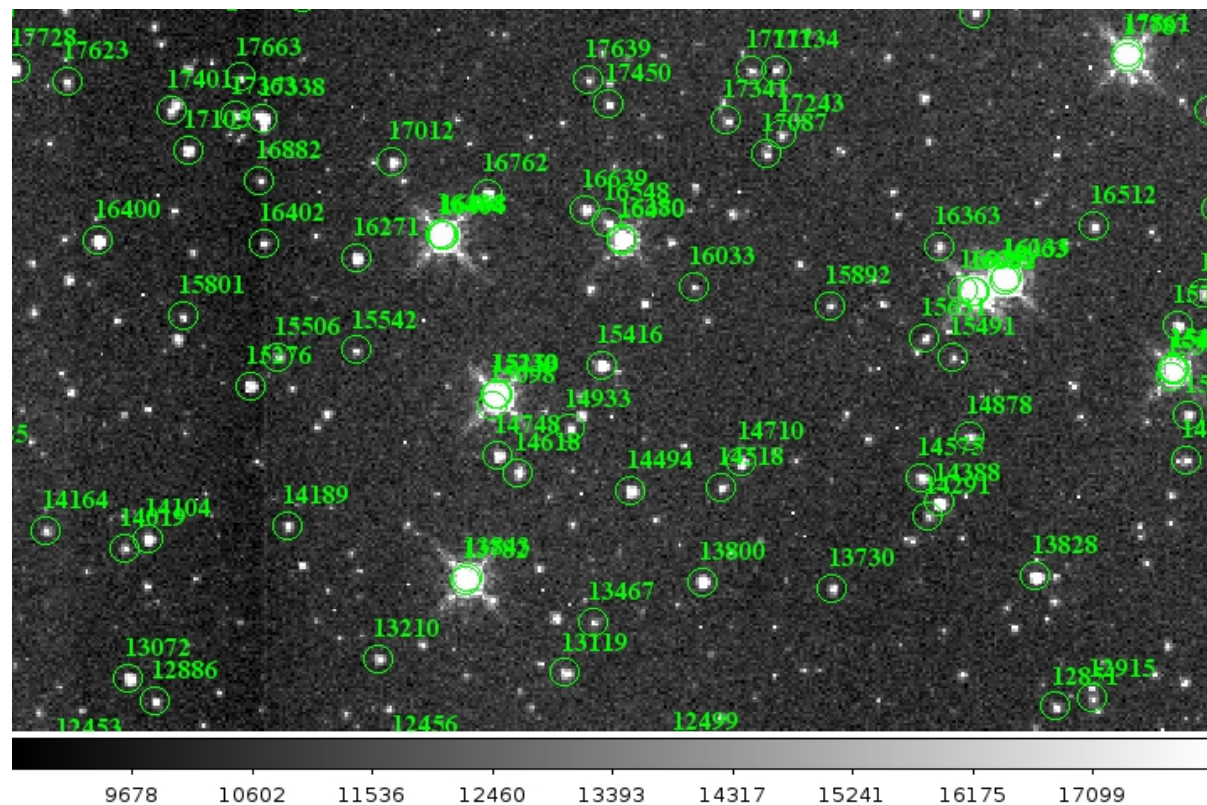
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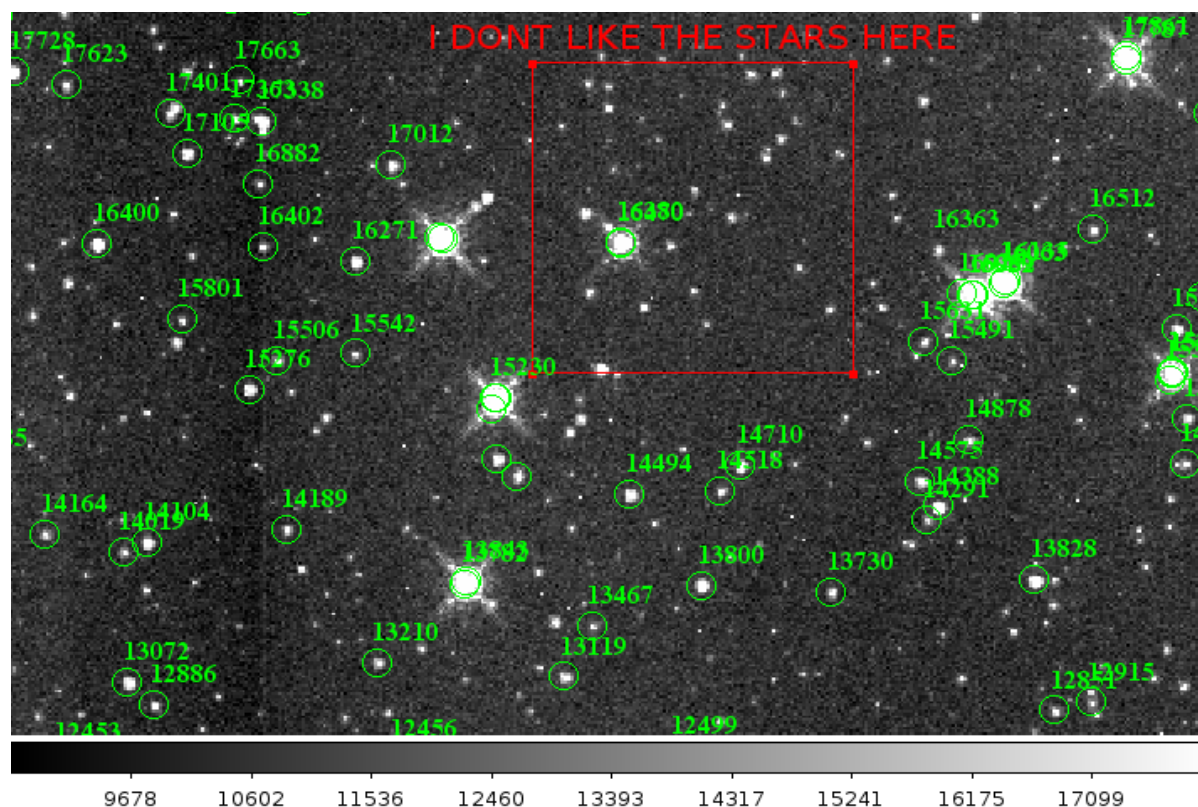
```
#so the first item looks like:
In [91]: locations[0]
Out[91]: (807.57500000000005, 2.4449999999999998, 16)
```

Let's open up a DS9 window (if you haven't already) and display your image. This will let us display our source locations and play with them

```
viewer=imexam.connect()
viewer.load_fits('iabf01bzq_flt.fits')
viewer.scale() #scale to DS9 zscale by default
viewer.mark_region_from_array(locations)
```



Now we can get rid of some of the stars by hand and save a new file of locations we like. I did this arbitrarily because I decided I didn't like stars in this part of space. Click on the regions you don't want and delete them from the screen. You can even add more regions of your own choosing.



You can save these new regions to a DS9 style region file, either through DS9 or imexam

```
viewer.save_regions('badstars.reg')
```

Note: A future version of the imexam package will make use of the region interpreter currently being developed with astropy for smoother creation and use of parsable regions files

Here is what the saved region file looks like, you can choose to import this file into any future DS9 display of the same image using the `viewer.load_regions()` method. You might also want to parse the file to save just the location and comment information in a separate text file.

```
In [7]: !head badstars.reg
# Region file format: DS9 version 4.1
# Filename: /Users/sosey/ssb/sosey/testme/iabf01bzbq_flt.fits[SCI]
global color=green dashlist=8 3 width=1 font="helvetica 10 normal roman" select=1
highlite=1 dash=0 fixed=0 edit=1 move=1 delete=1 include=1 source=1
fk5
circle(0:22:38.709,-72:02:50.58,0.677464")
# text(0:22:39.097,-72:02:50.86) font="time 12 bold" text={ 16 }
circle(0:22:36.340,-72:02:58.27,0.677464")
# text(0:22:36.729,-72:02:58.55) font="time 12 bold" text={ 140 }
circle(0:22:29.068,-72:03:20.78,0.677464")
# text(0:22:29.457,-72:03:21.06) font="time 12 bold" text={ 225 }

. . .

# text(0:22:56.855,-72:04:23.16) font="time 12 bold" text={ 21985 }
circle(0:22:42.791,-72:05:04.04,0.677464")
```

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```
# text(0:22:43.180,-72:05:04.32) font="time 12 bold" text={ 22002 }
box(0:22:45.694,-72:04:19.19,14.593",13.1774",149.933) # color=red font="helvetica 16_
↪normal roman" text={I DONT LIKE THE STARS HERE}
```

6.6.2 Advanced Usage II - Cycle through objects from a list

This example will step through a list of object locations and center that object in the DS9 window with a narrow zoom so that you can examine it further (think about PSF profile creation options here..)

If you haven't already, start DS9 and load your image into the viewer. I'll assume that you started DS9 outside of imexam and will need to connect to the window first.

```
import imexam
imexam.list_active_ds9()

    DS9 1396283378.28 gs 82a7e75f:53892 sosey

viewer=imexam.connect('82a7e75f:53892')

#A little unsure this is the correct window? Let's check by asking what image is_
↪loaded. The image I'm working with is iabf01bzq_flt.fits

viewer.get_filename()

    '/Users/sosey/ssb/sosey/testme/iabf01bzq_flt.fits' <-- notice it returned the_
↪full pathname to the file

viewer.zoomtofit() <-- let's zoom out to see the whole image, incase just a small_
↪section was loaded
```

Read in your list of object locations, I'll use the same DAOphot targets from the previous example

```
from astropy.io import ascii
reader=ascii.Daophot()
output_locations='iabf01bzq_stars.dat'
photfile=reader.read(output_locations)

#make some cuts on the list

locations=list()
for point in range(0,len(photfile['XCENTER']),1):
    if photfile['MAG'][point] < -4:
        locations.append((photfile['XCENTER'][point],photfile['YCENTER'][point],
↪photfile['ID'][point])) <-- appending tuple to the list
```

Take your list of locations and cycle through each one, displaying a zoomed in section on the DS9 window and starting imexam for each coordinate. I'm just going to go through 10 or so random stars. You can set this up however you like, including using a keystroke as your stopping condition in conjunction with `viewer.readcursor()`

I'll also mark the object we're interested in on the display for reference

```
viewer.zoom(8)
for object in locations[100:110]:
    viewer.panto_image(object[0],object[1])
    viewer.mark_region_from_array(object)
    viewer.imexam()
```


6.7 Loading an Image Cube

6.7.1 Load and examine an image CUBE

Note: image cubes are currently only supported for the DS9 viewer.

Image cubes can be multi-extension fits files which have multidimensional (> 2) images in any of their extensions. When they are loaded into DS9, a cube dialog frame is opened along with a box which allows the user to control which slices are displayed. Here's what the structure of such a file might look like:

```
astropy.io.fits.info('test_cube.fits')

Filename: test_cube.fits
No.      Name      Type      Cards  Dimensions  Format
0  PRIMARY  PrimaryHDU  215    ()
1  SCI      ImageHDU    13     (1032, 1024, 35, 5)  int16
2  REFOUT   ImageHDU    13     (258, 1024, 35, 5)  int16
```

You can use all the regular imexam methods with this image, including `imexam()` and the current slice which you have selected will be used for analysis. You can also ask imexam which slice is display, or the full image information of what is in the current frame for your own use (ds9 is just the name I chose, you can call the control object connected to your display window anything)

```
viewer=imexam.connect()
viewer.load_fits('test_cube.fits')
viewer.window.get_filename()

Out[24]: '/Users/sosey/ssb/imexam/test_cube.fits'

viewer.window.get_frame_info()
Out[25]: '/Users/sosey/ssb/imexam/test_cube.fits[SCI,1](0, 0)'
```

Now I'm going to use the Cube dialog to change the slice I'm looking at to (4,14) -> as displayed in the dialog. DS9 displayed 1-indexed numbers, and the fits utility behind imexam uses 0-indexed numbers, so expect the return to be off by a value of 1.

Let's ask for the information again:

```
In [26]: viewer.window.get_filename()
Out[26]: '/Users/sosey/ssb/imexam/test_cube.fits'

In [27]: viewer.window.get_frame_info()
Out[27]: '/Users/sosey/ssb/imexam/test_cube.fits[SCI,1](3, 13)'
```

You can ask for just the information about which slice is displayed and it will return the tuple(extension n, ..., extension n-1). The extensions are ordered in row-major form in `astropy.io.fits`:

```
In [28]: viewer.window.get_slice_info()
Out[28]: (3, 13)
```

The returned tuple contains just which 2d slice is displayed. In our cube image, which is 4D (1032, 1024, 35, 5) == (NAXIS1, NAXIS2, NAXIS3, NAXIS4) in DS9, however in `astropy.io.fits` this is (5,35,1024,1032) == (NAXIS4, NAXIS3, NAXIS2, NAXIS1)

By default, the first extension will be loaded from the cube fits file if none is specified. If you would rather see another extension, you can load it the same as with simpler fits files:

```
viewer.load_fits('test_cube.fits',extname='REFOUT')
```

6.8 Usage Without A Viewer

6.8.1 Use the imexamine library standalone to create plots without viewing

It's possible to use the imexamine library of plotting functions without loading an image into the viewer. All of the functions take 3 inputs: the x, y, and data array. In order to access the function, first create an imexamine object:

```
from imexam.imexamine import Imexamine
import numpy as np

data=np.random.rand((100,100)) #create a random array thats 100x100 pixels
plots=Imexamine()
```

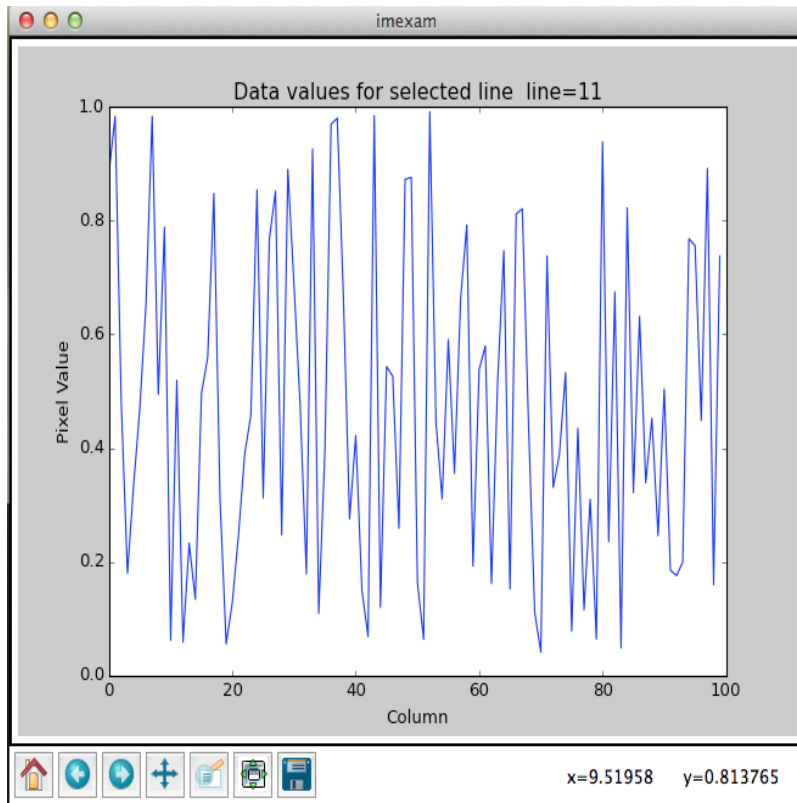
These are the functions you now have access to:

plots.aper_phot	plots.contour_plot	plots.histogram_plot
→ plots.plot_line	plots.set_colplot_pars	plots.set_
→ surface_pars		
plots.aperphot_def_pars	plots.curve_of_growth_def_pars	plots.imexam_option_
→ funcs plots.plot_name	plots.set_column_fit_pars	plots.
→ show_xy_coords		
plots.aperphot_pars	plots.curve_of_growth_pars	plots.line_fit
→ plots.print_options	plots.set_contour_pars	plots.set_
→ plot_name		
plots.colplot_def_pars	plots.curve_of_growth_plot	plots.line_fit_def_
→ pars plots.register	plots.set_data	plots.
→ sleep_time		
plots.colplot_pars	plots.do_option	plots.line_fit_pars
→ plots.report_stat	plots.set_histogram_pars	plots.
→ surface_def_pars		
plots.column_fit	plots.gauss_center	plots.lineplot_def_
→ pars plots.report_stat_def_pars	plots.set_line_fit_pars	plots.
→ surface_pars		
plots.column_fit_def_pars	plots.get_options	plots.lineplot_pars
→ plots.report_stat_pars	plots.set_lineplot_pars	plots.
→ surface_plot		
plots.column_fit_pars	plots.get_plot_name	plots.new_plot_window
→ plots.reset_defpars	plots.set_option_funcs	plots.
→ unlearn_all		
plots.contour_def_pars	plots.histogram_def_pars	plots.option_descrip
→ plots.save_figure		
plots.contour_pars	plots.histogram_pars	plots.plot_column
→ plots.set_aperphot_pars	plots.set_radial_pars	

To create a plot, just specify the method:

```
plots.plot_line(10,10,data)
```

produces the following plot:



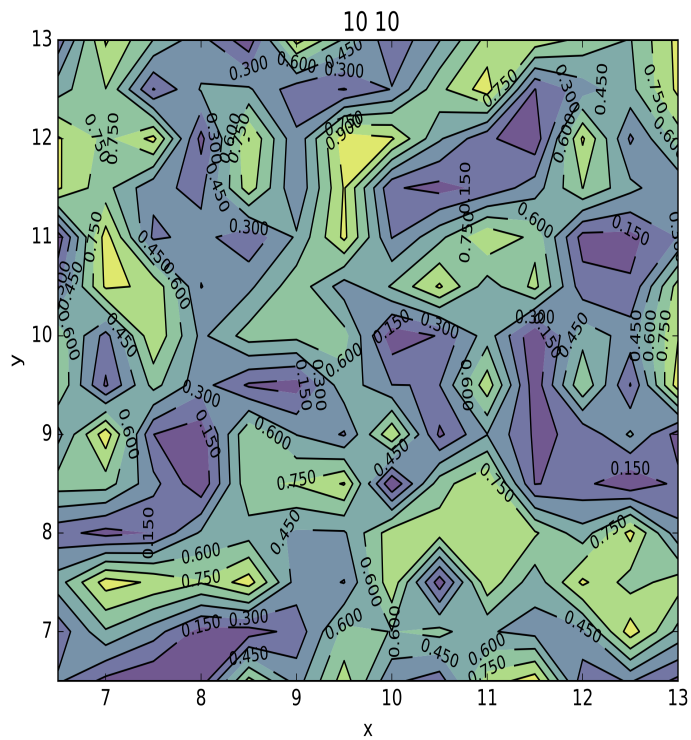
You can then save the current plot using the save method:

```
plots.contour(10,10,data)
plots.save() # with an optional filename using filename="something.extname"

In [1]: plots.plot_name
Out[2]: 'imexam.pdf'

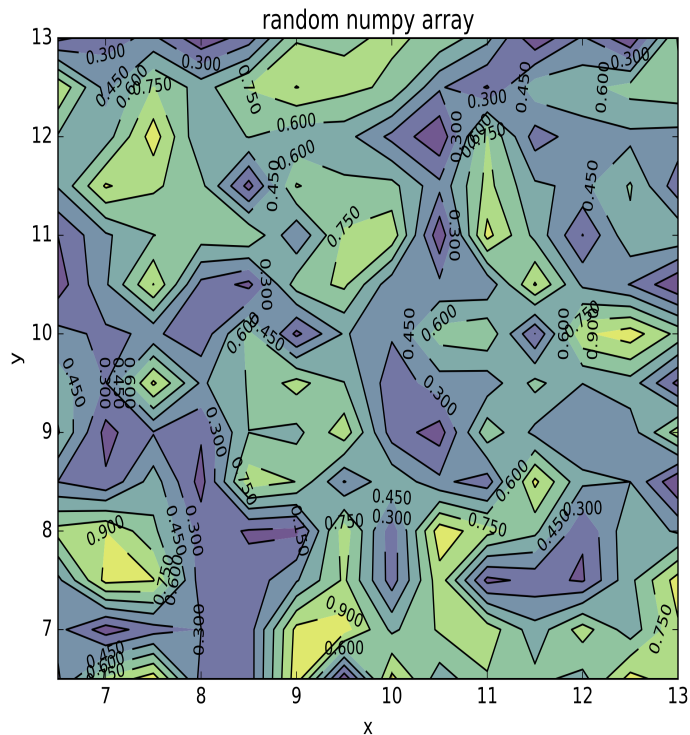
plots.close() # close the plot window
```

Where the extname specifies the format of the file, ex: jpg or pdf. A pdf file will be the default output, using the current self.plot_name.



Note that no name is attached to the above contour plot because we plotted a data array. When you are using the plotting class without a viewer, you can attach any title you like by editing the plotting parameters using the dictionary directly::

```
plots.contour_pars['title'][0] = "random numpy array"
```



6.8.2 Return information to variables without plotting

Some of the `imexamine()` methods are capable of returning their results as data objects. First, let's import some useful things to use in the examples:

```
from astropy.io import fits
from imexam.imexamine import Imexamine

# get my example data from a fits image
data=fits.getdata()
```

Return the fitting result for a line (the same can be done for `column_fit`):

```
In [1]: plots.line_fit(462, 377, data, genplot=False)
using model: <class 'astropy.modeling.functional_models.Gaussian1D'>
Name: Gaussian1D
Inputs: ('x',)
Outputs: ('y',)
Fittable parameters: ('amplitude', 'mean', 'stddev')
xc=462.438219      yc=377.038640
Out[1]: <Gaussian1D(amplitude=512.5638896303021, mean=462.45102207881393, stddev=-0.
→ 6638566150545719)>
```

I could have specified an output object here instead and saved the model object:

```
In [1]: results = plots.line_fit(462, 377, data, genplot=False)
using model: <class 'astropy.modeling.functional_models.Gaussian1D'>
Name: Gaussian1D
```

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```

Inputs: ('x',)
Outputs: ('y',)
Fittable parameters: ('amplitude', 'mean', 'stddev')
xc=462.438219      yc=377.038640

In [2]: results
Out[2]: <Gaussian1D(amplitude=512.5638896303021, mean=462.45102207881393, stddev=-0.
↳6638566150545719)>

In [3]: type(results)
Out[3]:
<class 'astropy.modeling.functional_models.Gaussian1D'>
Name: Gaussian1D
Inputs: ('x',)
Outputs: ('y',)
Fittable parameters: ('amplitude', 'mean', 'stddev')

```

Return the radial profile data points:

```

In [1]: results = plots.radial_profile(462, 377, data, genplot=False)
xc=462.438220      yc=377.038640

# here, results is a tuple of the radius and the flux arrays
In [2]: type(results)
Out[2]: tuple

In [3]: results
Out[3]:
(array([ 0.43991986,  0.56310764,  1.05652729,  1.11346785,  1.12730166,
        1.18083435,  1.4387386 ,  1.56225828,  1.72993907,  1.77404857,
        1.83394967,  1.8756147 ,  2.00971898,  2.0402282 ,  2.08520709,
        2.11462747,  2.43216151,  2.43852579,  2.49490037,  2.50720797,
        2.56207175,  2.56811411,  2.62090222,  2.65022406,  2.73622589,
        2.76432473,  2.99360832,  3.0141751 ,  3.07007625,  3.09013412,
        3.12919301,  3.17820187,  3.22639932,  3.27395339,  3.29213154,
        3.34795643,  3.36181609,  3.41650254,  3.43843675,  3.56198995,
        3.57009352,  3.59167466,  3.68924014,  3.71012829,  3.83595742,
        3.89592694,  3.91565741,  3.95831886,  3.97442453,  3.98552521,
        3.9971748 ,  4.00099637,  4.0623451 ,  4.06610542,  4.0775248 ,
        4.10394097,  4.21436241,  4.25811375,  4.28708374,  4.33010037,
        4.43838783,  4.53773166,  4.541146 ,  4.55813187,  4.56194401,
        4.58853854,  4.63205502,  4.65159003,  4.66197958,  4.67852677,
        4.68183843,  4.71753044,  4.71757631,  4.78260702,  4.85229095,
        4.88403989,  4.96555878,  4.98067583,  4.99306443,  4.99658806,
        5.05766026,  5.06986075,  5.16561429,  5.20137031,  5.2398823 ,
        5.24535309,  5.27513495,  5.30395753,  5.32716192,  5.33548947,
        5.37876614,  5.3848761 ,  5.43835691,  5.43870338,  5.48116519,
        5.52253984,  5.52811091,  5.53651564,  5.56191459,  5.58370969,
        5.59757142,  5.64425498,  5.65248702,  5.65793014,  5.78110428,
        5.80777797,  5.89748546,  5.92363512,  5.94896363,  5.97744528,
        5.98777194,  6.00070036,  6.03626122,  6.04170629,  6.05451954,
        6.06471496,  6.09265553,  6.09993812,  6.10748513,  6.13239687,
        6.16254603,  6.17042707,  6.19224411,  6.20754751,  6.22957178,
        6.23733343,  6.30103604,  6.33772298,  6.43833558,  6.44070886,
        6.48849245,  6.50959949,  6.51230262,  6.52146032,  6.5595647 ,
        6.56189413,  6.63183044,  6.64347305,  6.65679268,  6.71458743,
        6.72804634,  6.73034962,  6.73980232,  6.75327507,  6.77383526,

```

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```

6.79689127, 6.82830694, 6.84864187, 6.87117266, 6.87342797,
6.8817999 , 6.94435706, 6.9488506 , 6.97513961, 6.98399121,
7.01080949, 7.08663012, 7.10837617, 7.11926989, 7.13440215,
7.19907049, 7.23120275, 7.3613401 , 7.37600509, 7.41364442,
7.41776616, 7.43206628, 7.45308634, 7.49419535, 7.50475127,
7.50650756, 7.55930201, 7.56802554, 7.60008443, 7.66481157,
7.70503555, 7.76414132, 7.81964293, 8.06920371, 8.12646314,
8.12808509, 8.15298819, 8.17548548, 8.20966328, 8.22630274,
8.25580581, 8.27314042, 8.32288269, 8.77430839, 8.8269951 ,
8.83372905, 8.86536955, 8.91032754, 8.91751826, 9.48215209,
9.56647781]],
array([ 408.87057495, 41.23228073, 91.90717316, 48.38606262,
112.11755371, 64.6014328 , 361.9876709 , 7.88528776,
76.15605927, 92.4905777 , 5.74170589, 8.54299355,
37.25744629, 17.17868423, 41.94879532, 29.16669464,
25.11438942, 41.24355316, 31.41527748, 2.35880852,
2.51266503, 3.61639667, 31.96870041, 47.24103928,
1.86882472, 2.25345397, 3.43679786, 2.95230484,
7.01711893, 4.25243187, 10.45163536, 15.06377506,
2.06799817, 1.55962014, 3.2355001 , 3.58886528,
4.77823544, 2.61030412, 6.15013599, 2.26734257,
3.79847336, 5.18475103, 2.02961087, 1.86825836,
2.26850033, 1.98072493, 2.40412855, 2.35658216,
2.2638216 , 1.48555958, 2.15530491, 1.40320516,
2.42260337, 3.59516048, 1.49309242, 2.70001984,
1.35936797, 2.50372696, 1.99834633, 2.1075139 ,
2.10088921, 3.91031456, 1.40116227, 1.58724546,
1.64244962, 4.27553177, 2.86458731, 2.07594514,
1.24715221, 1.55571783, 3.28257489, 1.08224833,
1.99108934, 1.28673184, 2.22391272, 2.01411462,
1.27933741, 2.57424259, 2.27977562, 1.34119225,
2.46366167, 2.04145074, 2.27879167, 3.32902098,
2.0256803 , 3.04667783, 3.214293 , 2.71672273,
1.18290937, 3.39013147, 2.61141396, 1.24552131,
2.7109127 , 1.20734 , 1.065956 , 2.0110569 ,
2.63785267, 2.08804011, 1.23607028, 1.53105474,
2.9585526 , 0.92856985, 1.70498252, 0.98702717,
3.00484014, 2.96310997, 1.10799265, 1.02301562,
2.59040713, 1.55507016, 1.1307373 , 1.46614468,
3.7729485 , 0.8989926 , 1.81300449, 1.49930847,
0.97070342, 3.58096623, 1.45315814, 1.37846851,
1.22037327, 2.02710581, 3.06499743, 1.60018504,
3.15293145, 1.34511912, 1.04039967, 0.94602752,
1.5991565 , 1.11648059, 0.90265507, 1.25119698,
1.32048595, 1.331002 , 1.26167858, 0.81102282,
0.99124312, 0.76625013, 1.42264056, 1.41574192,
1.67775941, 1.15894651, 1.19685972, 0.99676919,
1.16761708, 1.20492256, 1.09948123, 1.0989542 ,
0.92135239, 0.89912277, 1.15777898, 1.07870626,
1.32945871, 1.06859183, 0.77524334, 1.4281857 ,
1.05790067, 1.08861005, 1.03711545, 1.00277674,
1.11795783, 1.04079187, 1.77855933, 0.875655 ,
1.70616186, 0.95955884, 1.2846061 , 0.9819802 ,
1.09096873, 1.12618971, 2.52278042, 1.14947557,
2.55132389, 1.16845107, 1.0366509 , 1.03310716,
0.76811701, 0.98454052, 1.38449657, 1.41319823,
1.30402267, 1.26531458, 0.88282102, 1.33250594,

```

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```

0.86149669,    1.13119161,    0.89653128,    1.47101414,
2.82045436,    2.37812138,    0.82307637,    1.3075676 ,
1.45813155,    1.30278611,    1.60565269,    1.01857305], dtype=float32))

```

Return the curve of growth points:

```

In [1]: results = plots.curve_of_growth(462, 377, data, genplot=False)
xc=462.438220      yc=377.038640

at (x,y)=462,377
radii:[1 2 3 4 5 6 7 8]
flux:[406.65712375514534, 1288.8955810496341, 1634.0235081082126, 1684.5579429185905,
↪1718.118845192796, 1785.265260722455, 1801.8561084128257, 1823.21222063562]

In [2]: type(results)
Out[2]: tuple

In [3]: results
Out[3]:
(array([1, 2, 3, 4, 5, 6, 7, 8]),
 [406.65712375514534,
 1288.8955810496341,
 1634.0235081082126,
 1684.5579429185905,
 1718.118845192796,
 1785.265260722455,
 1801.8561084128257,
 1823.21222063562])

# the tuple can be separated into it's parts
radius, flux = results

```

Return the histogram information as a tuple of values and bin edges:

```

In [1]: counts, bins = plots.histogram(462, 377, data, genplot=False)

In [2]: counts
Out[2]:
array([[372,    7,    1,    1,    1,    0,    1,    3,    1,    2,    1,    2,    0,
        0,    0,    1,    0,    0,    1,    0,    0,    0,    2,    0,    0,    0,
        0,    1,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
        0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
        0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
        0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    1,    0,    0,
        0,    0,    0,    0,    0,    0,    0,    0,    0,    0])

In [3]: bins
Out [3]:
array([ 0.58091092,  4.66380756,  8.7467042 , 12.82960084,
 16.91249748,  20.99539412,  25.07829076,  29.1611874 ,
 33.24408404,  37.32698068,  41.40987732,  45.49277396,
 49.5756706 ,  53.65856725,  57.74146389,  61.82436053,
 65.90725717,  69.99015381,  74.07305045,  78.15594709,
 82.23884373,  86.32174037,  90.40463701,  94.48753365,
 98.57043029, 102.65332693, 106.73622357, 110.81912021,
114.90201685, 118.98491349, 123.06781013, 127.15070677,

```

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```

131.23360341, 135.31650005, 139.39939669, 143.48229333,
147.56518997, 151.64808661, 155.73098325, 159.81387989,
163.89677653, 167.97967317, 172.06256981, 176.14546645,
180.22836309, 184.31125973, 188.39415637, 192.47705302,
196.55994966, 200.6428463 , 204.72574294, 208.80863958,
212.89153622, 216.97443286, 221.0573295 , 225.14022614,
229.22312278, 233.30601942, 237.38891606, 241.4718127 ,
245.55470934, 249.63760598, 253.72050262, 257.80339926,
261.8862959 , 265.96919254, 270.05208918, 274.13498582,
278.21788246, 282.3007791 , 286.38367574, 290.46657238,
294.54946902, 298.63236566, 302.7152623 , 306.79815894,
310.88105558, 314.96395222, 319.04684886, 323.1297455 ,
327.21264215, 331.29553879, 335.37843543, 339.46133207,
343.54422871, 347.62712535, 351.71002199, 355.79291863,
359.87581527, 363.95871191, 368.04160855, 372.12450519,
376.20740183, 380.29029847, 384.37319511, 388.45609175,
392.53898839, 396.62188503, 400.70478167, 404.78767831,
408.87057495])

```

6.9 Software Dependencies

- Astropy (for some analysis functions)
- photutils (for photometry)
- matplotlib (for plotting)
- DS9 (image display - optional) * XPA: <https://github.com/ericmandel/xpa>
- Ginga (image display - optional)

astropy >= 3.0

python >= 3.5

numpy >= 1.12.0

photutils This must be installed to enable the photometry options for imexam() but it is not required

Ginga This must be installed in order to use the Ginga displays instead of DS9. Windows users who install from source should also install Ginga if they wish to use an image viewer since the DS9 and XPA compiles will be disabled. It's possible to compile and install the XPA and DS9 from source, but not with typical default software.

Using ginga has the advantage that the imexam() loop is now event driven.

You can issue the viewer.imexam() command to print out the available examination command keys. The user can then press the “i” key while the mouse is in the graphics window, all subsequent key-presses will be grabbed without blocking your terminal command line. If you wish to turn of the imexam keys you can press either the “i” key a second time or the “q” key. A notification message will appear on screen that imexam mode has either started or stopped.

If you are using the Ginga HTML5 widget under python3 in the Jupyter notebook you should also install Pillow to get the correct image viewing.

6.10 IRAF imexamine capabilities

These are the capabilities of the IRAF version of the imexam task, called with **imexamine [input [frame]]**, which lives in `images.tv.imexamine`. The following are imexamines input options:

- **input** is an optional list of images to be examined. If specified, images are examined in turn, displaying them automatically. If no images are specified the images currently loaded into the image display are examined.
- **output** contains the rootname for output images created with the “t” key. If no name is specified then the name of the input image is used. A three digit number is appended to the rootname, such as “.001”, starting with 1 until no image is found with that name. Successive output images are numbered sequentially
- **ncoutput** and **nloutput** are the size of the output image created when the “t” key is pressed, where the output image is centered on the cursor location
- **frame** specifies which frame should be used
- **logfile** is the filename which records output of the commands producing text, if no filename is given no logfile will be produced
- **defkey** is the default key for cursor x-y input list. This key is applied to input cursor lists which do not have a cursor key specified. It is used to repetitively apply a cursor command to a list of positions typically obtained from another task
- **allframes**, if true then images from an input list are loaded by cycling through the available frames, otherwise the last frame loaded is reused
- **nframes** is then number of display frames to use when automatically loading images. It should not exceed the number of frames provided by the display device. If the number of frames is set to 0 then the task will query the display device to determine how many frames are currently allocated. New frames may be allocated during program execution by displaying images with the ‘d’ key.
- **nstat**, **nlstat** correlate with the statistics command which computes values from a box centered on the specified cursor position with the number of columns and lines given by these parameters.

The following is a list of available cursor and colon commands while imexamine is active in the display, many but not all are available in this python imexam package:

-- IMEXAMINE COMMANDS --					
CURSOR KEY COMMAND SUMMARY					
? Help	h Histogram	p Previous frame	x Coordinates		
a Aperture Sum	i Image cursor	q Quit	y Set origin		
b Box coords	j Line gauss fit	r Radial plot	z Print grid		
c Column plot	k Col gauss fit	s Surface plot	, Quick phot		
d Load display	l Line plot	t Output image	. Quick prof fit		
e Contour plot	m Statistics	u Vector plot			
f Redraw	n Next frame	v Vector plot			
g Graphics cursor	o Overplot	w Toggle logfile			
COLON COMMAND SUMMARY					
allframes	ceiling	iterations	naverage	pointmode	width
angh	center	label	nbins	radius	x
angv	constant	logfile	ncolumns	round	xformat
autoredraw	dashpat	logx	ncontours	rplot	xlabel
autoscale	defkey	logy	ncoutput	select	xorder

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background	eparam	magzero	ncstat	szmarker	y
banner	fill	majrx	nhi	ticklabel	yformat
beta	fitplot	majry	nlines	title	ylabel
boundary	fittype	marker	nloutput	top_closed	yorder
box	floor	minrx	nlstat	unlearn	z1,z2
buffer	interval	minry	output	wcs	zero

OUTPUT OF 'a' AND 'r' KEYS

The 'a' key and logfile output has column labels and each object has one line of measurements in the logfile and two lines on the terminal. The 'r' key shows only the second line on the status line and the information from the first line is in the graph title. The first line contains the x and y center coordinates and optional world coordinates. The second line contains the aperture magnitude and flux, the estimated background sky, the profile fit peak, the ellipticity and position angle from the moment analysis, and four estimates of the profile width. The four estimates are from the moment analysis, the full-width enclosing half the flux, the profile fit, and a direct estimate of the full width at half-maximum.

CURSOR KEY COMMANDS

```

?      Print help
a      Aperture radial photometry measurement (see above for output)
b      Box coordinates for two cursor positions - c1 c2 l1 l2
c      Column plot
d      Load the image display
e      Contour plot
f      Redraw the last graph
g      Graphics cursor
h      Histogram plot
i      Image cursor
j      Fit 1D gaussian to image lines
k      Fit 1D gaussian to image columns
l      Line plot
m      Statistics
      image[section] npixels mean median stddev min max
n      Next frame or image
o      Overplot
p      Previous frame or image
q      Quit
r      Radial profile plot (see above for output)
s      Surface plot
t      Output image centered on cursor (parameters output, ncoutput, nloutput)
u      Centered vector plot from two cursor positions
v      Vector plot between two cursor positions
w      Toggle write to logfile
x      Print coordinates
      col line pixval [xorigin yorigin dx dy r theta]
y      Set origin for relative positions
z      Print grid of pixel values - 10 x 10 grid
,      Quick profile photometry measurement (Gaussian or Moffat)
.      Quick radial profile plot and fit (Gaussian or Moffat)

```

COLON COMMANDS

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Explicit image coordinates may be entered using the colon command syntax:

```
:column line key
```

where column and line are the image coordinates and the key is one of the cursor keys. A special syntax for line or column plots is also available as :c# or :l# where # is a column or line and no space is allowed.

Other colon commands set or show parameters governing the plots and other features of the task. Each graph type has it's own set of parameters. When a parameter applies to more than one graph the current graph is assumed. If the current graph is not applicable then a warning is given. The "eparam" and "unlearn" commands may be used to change many parameters and without an argument the current graph parameters are modified while with the graph key as an argument the appropriate parameter set is modified. In the list below the graph key(s) to which a parameter applies are shown.

allframes		Cycle through all display frames to display images
angh	s	Horizontal angle for surface plot
angv	s	Vertical angle for surface plot
autoredraw	cehlrsuv.	Automatically redraw graph after colon command?
autoscale	h	Adjust number of histogram bins to avoid aliasing
axes	s	Draw axes in surface plot?
background	jkr.	Subtract background for radial plot and photometry?
banner	cehjklsuv.	Include standard banner on plots?
beta	ar	Moffat beta parameter (INDEF to fit or value to fix)
boundary	uv	Boundary extension type for vector plots
box	cehjklsuv.	Draw box around graph?
buffer	r.	Buffer distance for background subtraction
ceiling	es	Data ceiling for contour and surface plots
center	jkr.	Find center for radial plot and photometry?
constant	uv	Constant value for boundary extension in vector plots
dashpat	e	Dash pattern for contour plot
eparam	cehjklsuv.	Edit parameters
fill	e	Fill viewport vs enforce unity aspect ratio?
fitplot	r	Overplot profile fit on data?
fittype	ar	Profile fitting type (gaussian moffat)
floor	es	Data floor for contour and surface plots
interval	e	Contour interval (0 for default)
iterations	ar	Iterations on fitting radius
label	e	Draw axis labels for contour plot?
logfile		Log file name
logx	chjklsuv.	Plot x axis logarithmically?
logy	chjklsuv.	Plot y axis logarithmically?
magzero	r.	Magnitude zero for photometry
majrx	cehjklsuv.	Number of major tick marks on x axis
majry	cehjklsuv.	Number of major tick marks on y axis
marker	chjklsuv.	Marker type for graph
minrx	cehjklsuv.	Number of minor tick marks on x axis
minry	cehjklsuv.	Number of minor tick marks on y axis
naverage	cjkluv	Number of columns, lines, vectors to average
nbins	h	Number of histogram bins
ncolumns	ehs	Number of columns in contour, histogram, or surface plot
ncontours	e	Number of contours (0 for default)
ncoutput		Number of columns in output image

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ncstat		Number of columns in statistics box
nhi	e	hi/low marking option for contours
nlines	ehs	Number of lines in contour, histogram, or surface plot
nloutput		Number of lines in output image
nlstat		Number of lines in statistics box
output		Output image root name
pointmode	chjkluv	Plot points instead of lines?
radius	r.	Radius of object aperture for radial plot and photometry
round	cehjkluuv.	Round axes to nice values?
rplot	jkr.	Radius to plot in 1D and radial profile plots
select		Select image or display frame
sigma	jk	Initial sigma for 1D gaussian fits
szmarker	chjkluv.	Size of marks for point mode
ticklabels	cehjkluuv.	Label ticks?
title	cehjklsuv.	Optional title for graph
top_closed	h	Close last bin of histogram
unlearn	cehjklsuv.	Unlearn parameters to default values
wcs		World coordinate system for axis labels and readback
width	jkr.	Width of background region
x [min max]	chjkluv.	Range of x to be plotted (no values for autoscaling)
xformat		Coordinate format for column world coordinates
xlabel	cehjklsuv.	Optional label for x axis
xorder	jkr.	X order of surface for background subtraction
y [min max]	chjkluv.	Range of y to be plotted (no values for autoscaling)
yformat		Coordinate format for line world coordinates
ylabel	cehjklsuv.	Optional label for y axis
yorder	r.	Y order of surface for background subtraction
z1	h	Lower intensity value limit of histogram
z2	h	Upper intensity value limit of histogram
zero	e	Zero level for contour plot

6.11 Comparison with the IRAF version of imexamine

The following is a comparison of the outputs, returned values and user options for this module versus imexamine in IRAF

- All plot types are replicated between the codes, though they may be rendered differently. The images below are representative of the basic plots from each package.
- The same user plot options, as in the rimexam, cimexam etc. type IRAF param files are replicated to their useful extent using python dictionaries for each imexamine key.
- Colormaps and point styles for the matplotlib plots may be changed by the user through the `imexam` key default dictionaries
- In `imexam`, once the plot is displayed on the screen, you can zoom in and out using the controls in the plotting window.
- `imexam` allows users to register their own analysis functions
- `imexam` does not attempt to replicate the colon command interaction, if users wish to change the plot settings they should exit the `imexam()` method, reset the options and call it again.
- all of the `imexam()` functions in `imexam` can be called by themselves if you supply an x,y coordinate

How do the numerical results compare with the IRAF version? This is a little harder to judge with cursor centering. Visual comparison of the resulting plots shows good agreement, as well as some random checks of the photometry

and statistical return methods.

6.11.1 Statistical returns

IRAF “m” key:

```
:: -> imexam
      # SECTION NPIX MEAN MEDIAN STDDEV MIN MAX
      [584:588,697:701] 25 46533. 51314. 10281. 21215. 56186.
```

imexam “m” key (with cursor location flooring):

```
[583:588,695:700] median: 51458.000000
```

imexam only shows one statistic at a time. The same function call may be used to show the results from *any* valid numpy function, it will return an attribute error for invalid functions. For example, if you edit the defaults dictionary for the “m” key:

```
viewer.mimexam()

{'function': ['report_stat'],
 'region_size': [5, 'region size in pixels to use'],
 'stat': ['median',
 'which numpy stat to return [median,min,max...must map to a numpy func]']}

viewer.exam.report_stat_pars["stat"][0] = "max" <---- will report np.max for the_
↪array

[584:589,695:700] amax: 56186.000000

viewer.exam.report_stat_pars["stat"][0] = "mean" <---- will report np.mean for the_
↪array

[583:588,694:699] mean: 45412.878906

viewer.exam.report_stat_pars["stat"][0]="std"

[583:588,694:699] std: 10706.179688
```

6.11.2 Aperture Photometry

IRAF “a” key:

#	COL	LINE	COORDINATES								
#	R	MAG	FLUX	SKY	PEAK	E	PA	BETA	ENCLOSED	MOFFAT	DIRECT
585.81	698.16	585.81	698.16								
17.51	8.86	2.858E6	10840.	45443.	0.03	-64	8.32		5.23	7.10	5.83

imexam “a” key (using the defaults):

xc=586.138728	yc=697.990516						
x	y	radius	flux	mag(zpt=25.00)	sky	fwhm	
586.14	697.99	5	1508664.63	9.55	11160.89	6.03	

The “xc” and “yc” returns are the gaussian fit centers, as well as the FWHM from the fit. If we set the values to be similar to what IRAF.imexamine used, we can see the numbers are closer, the radius for the apertures are floored though before being sent to photutil:

```
viewer.aimexam()

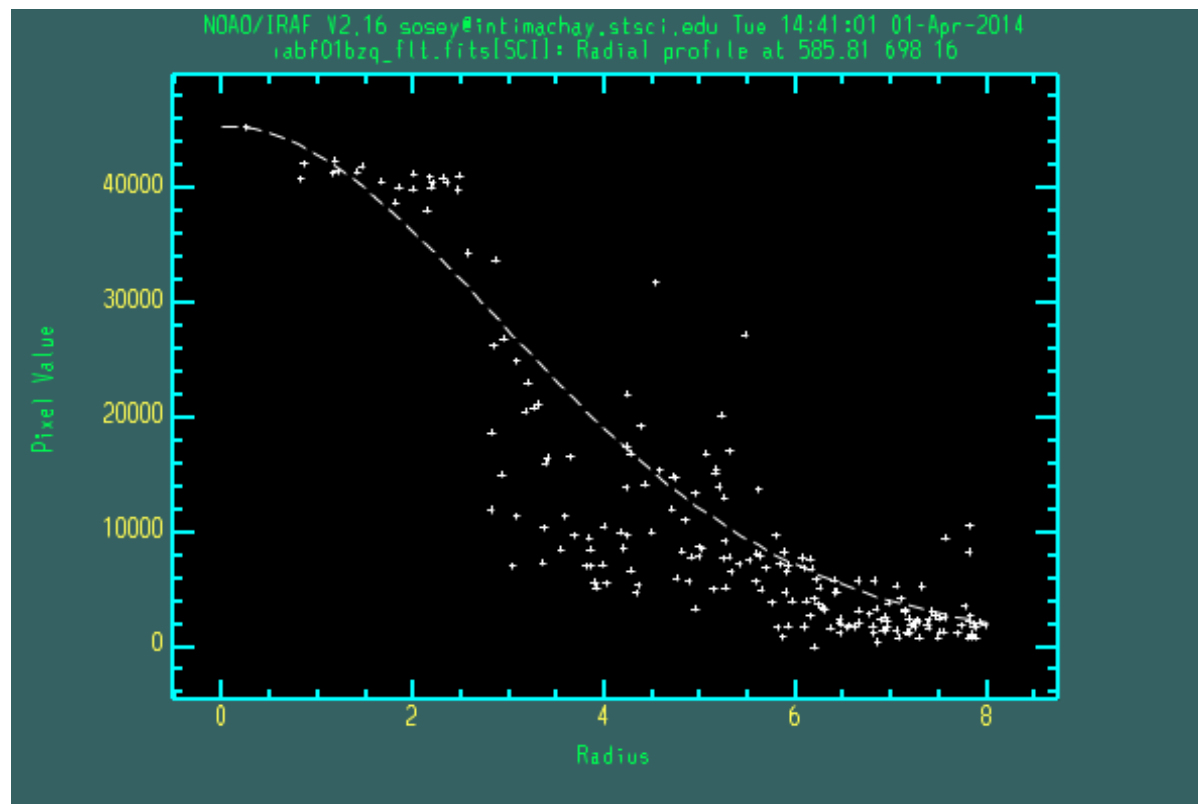
{'center': [True, 'Center the object location using a 2d gaussian fit'],
 'function': ['aperphot'],
 'radius': [5, 'Radius of aperture for star flux'],
 'skyrad': [15, 'Distance to start sky annulus is pixels'],
 'subsky': [True, 'Subtract a sky background?'],
 'width': [5, 'Width of sky annulus in pixels'],
 'zmag': [25.0, 'zeropoint for the magnitude calculation']}
```

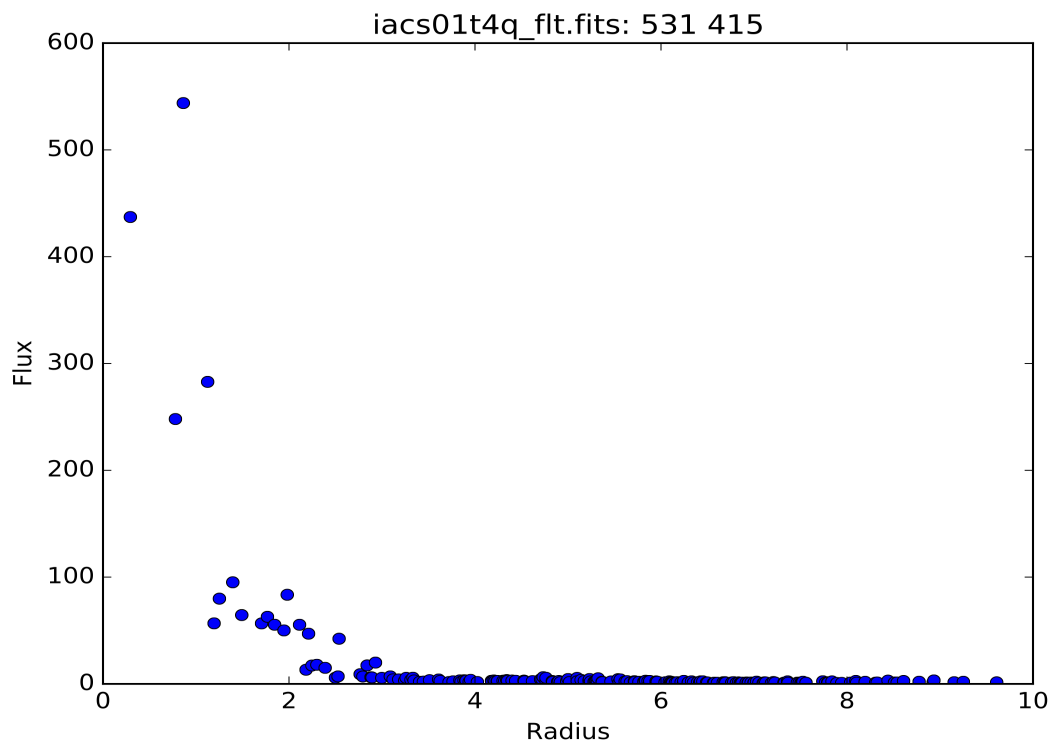
```
viewer.exam.aperphot_pars["radius"][0]=17.5
```

```
xc=586.213790    yc=697.501845
x      y      radius  flux    mag(zpt=25.00)  sky    fwhm
586.21  697.50   17    2565167.11      8.98    11162.83    6.02
```

6.11.3 Radial Profile Plot

The fit profile of the star out to the specified radius. Users can look at the fit profile of the star using the 1D gaussian option. By default, imexam prints the data point values to the screen.





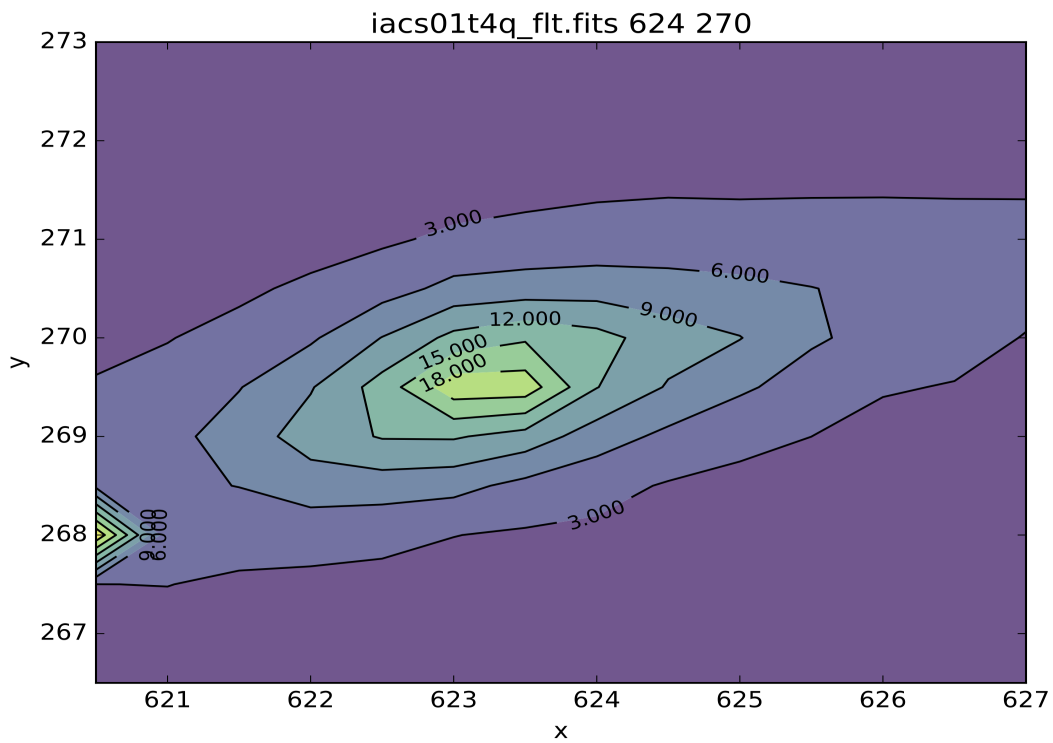
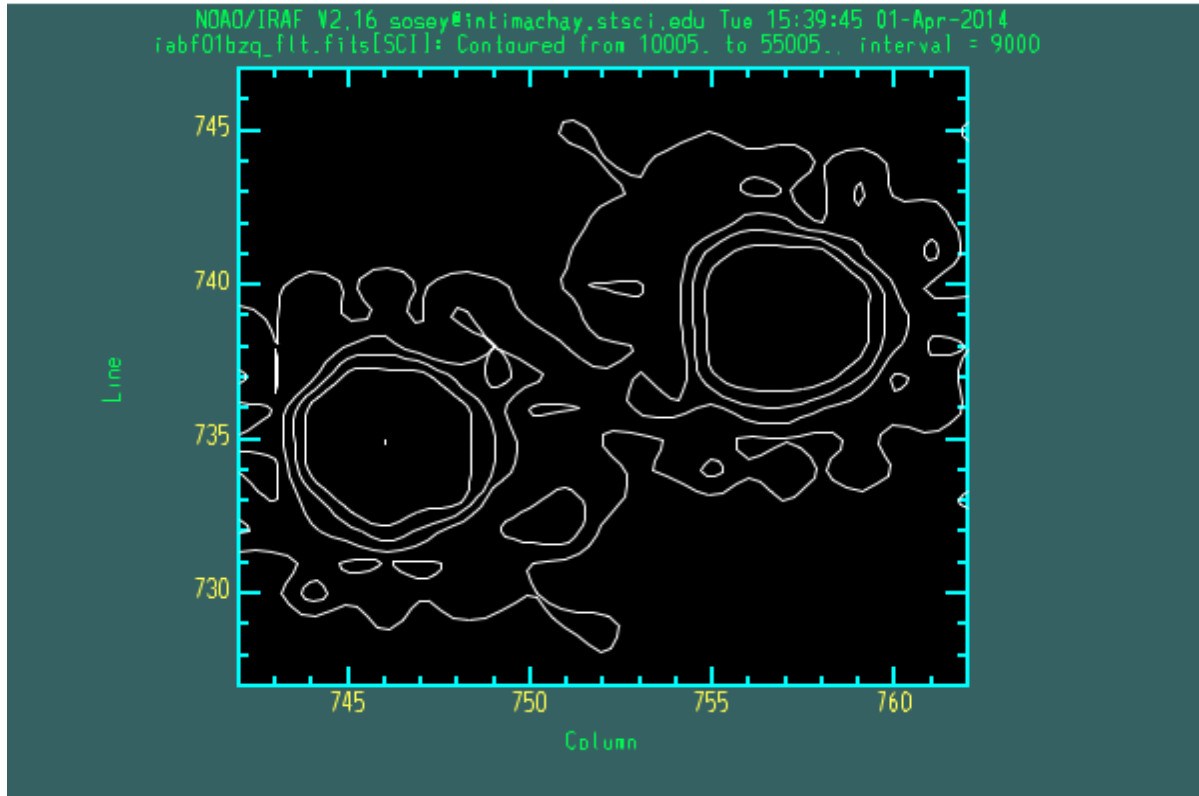
imexam prints the plotted data to the screen

```
pressed: r
xc=655.659205   yc=698.937124
Sky per pixel: 0.7021602984249302 using(rad=10.0->15.0)

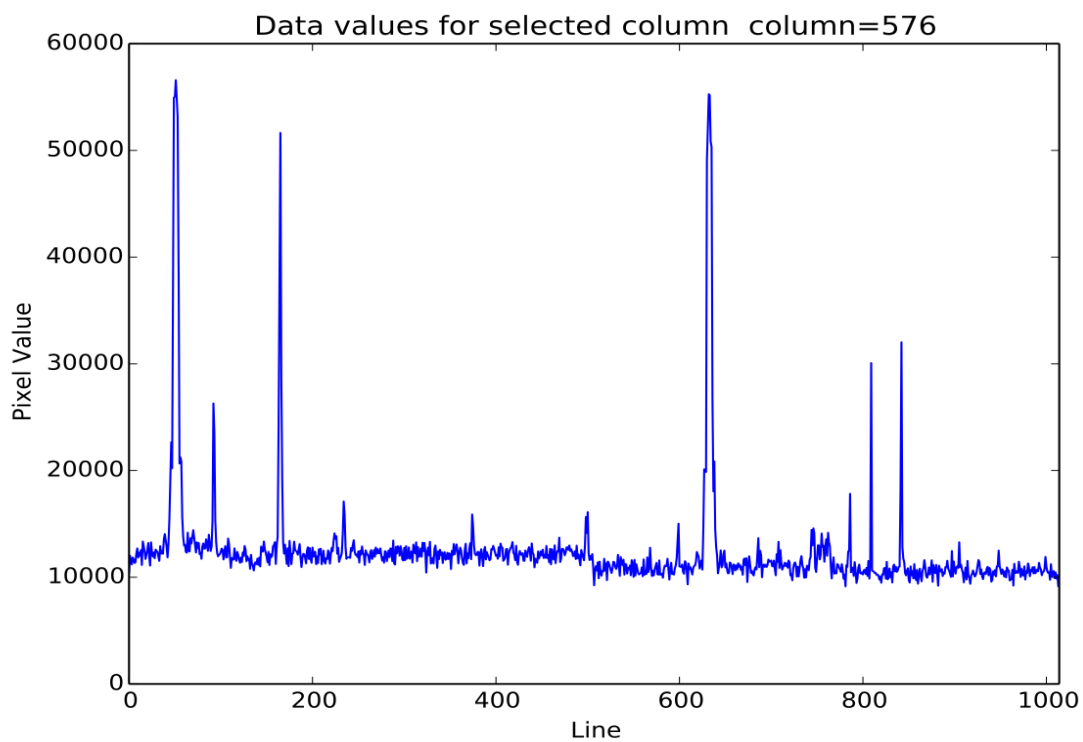
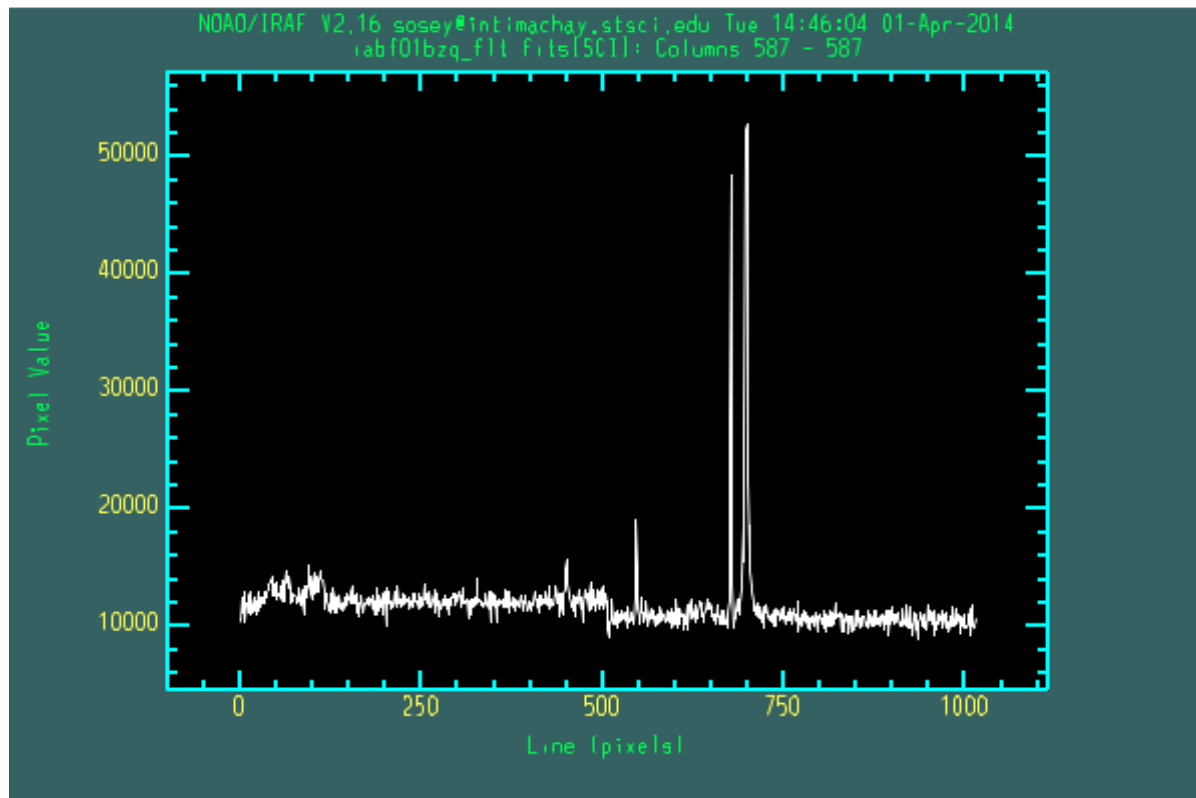
at (x,y)=655,698
radii:[0 1 2 3 4 5 6 7 8 9]
flux:[ 74.23025852 153.66757441 60.17693806 9.7988813 7.10537578
      9.08464076 3.1673068 2.92777784 0.26435121 0.18440688]
```

6.11.4 Contour plot

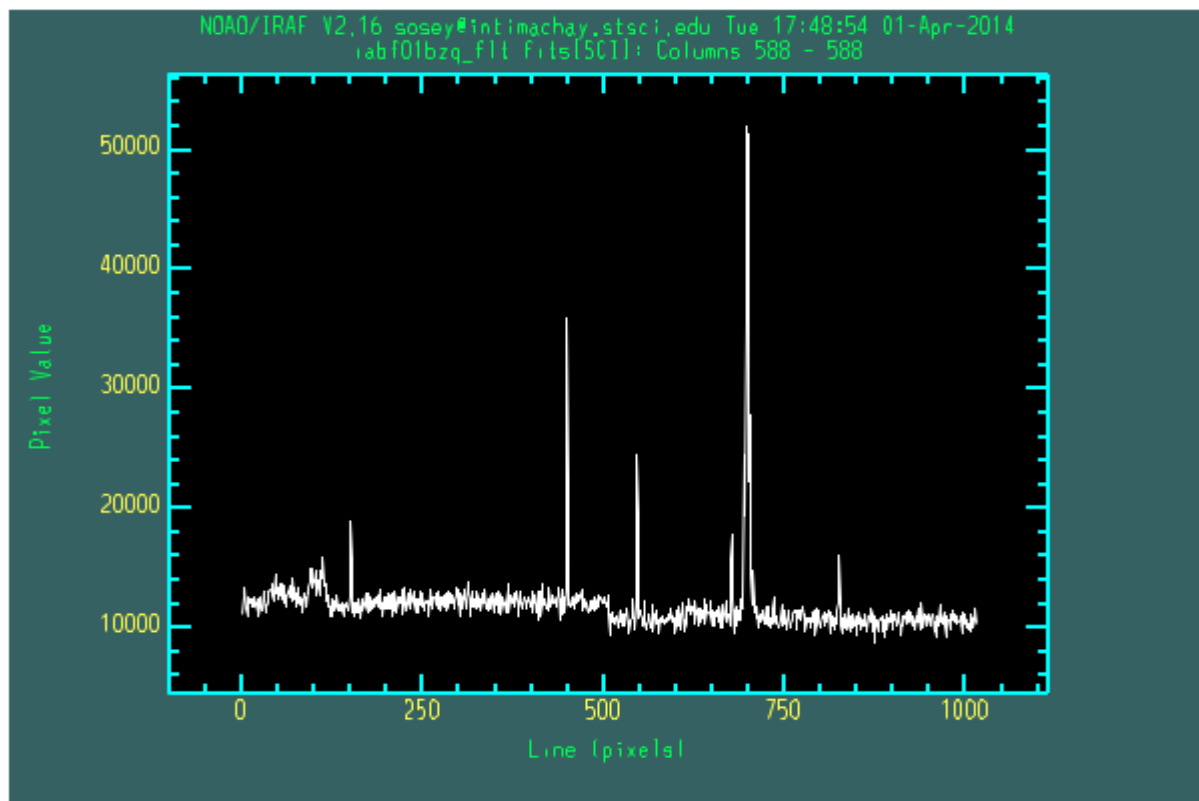
Note the added availability in this package for labeling the contours



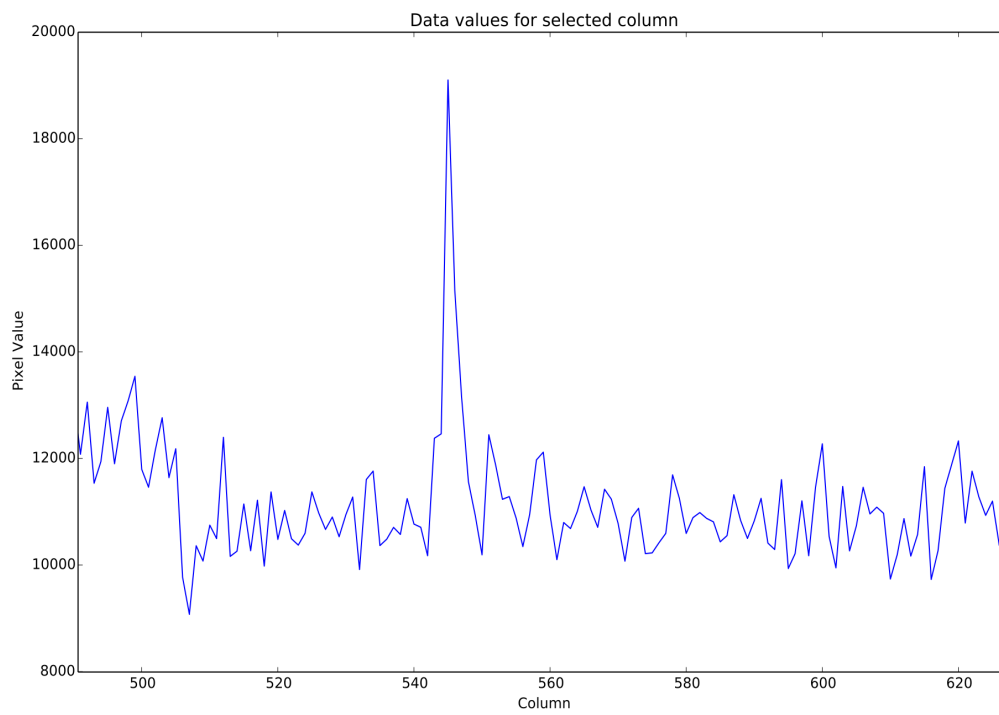
6.11.5 Column and Line plots



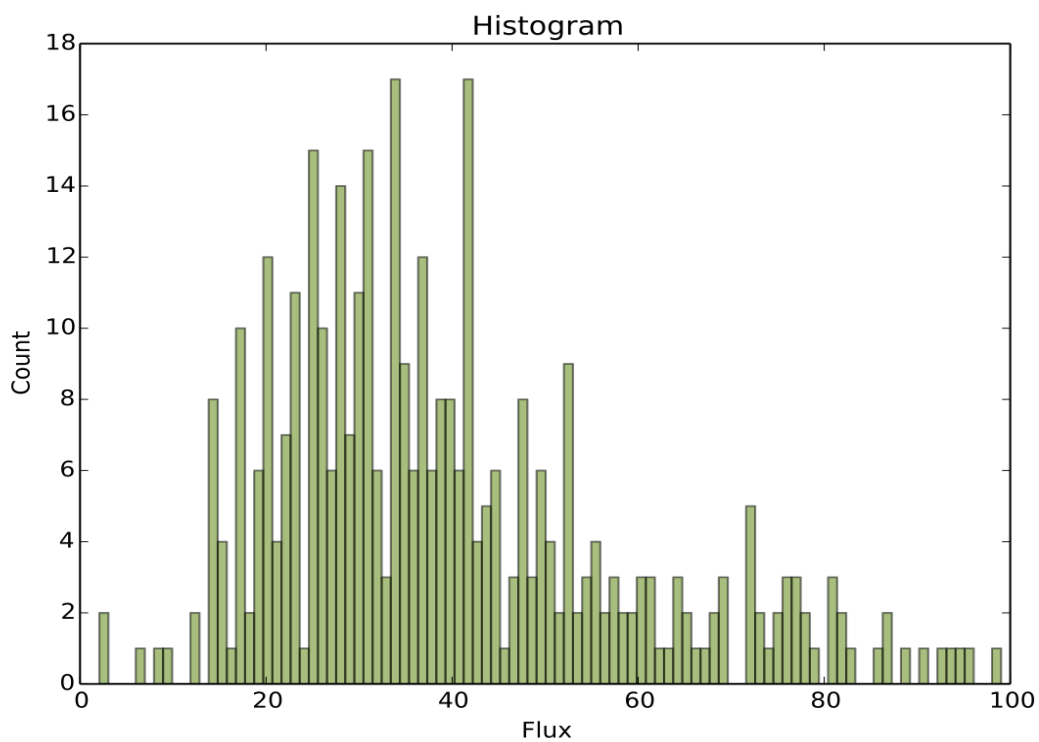
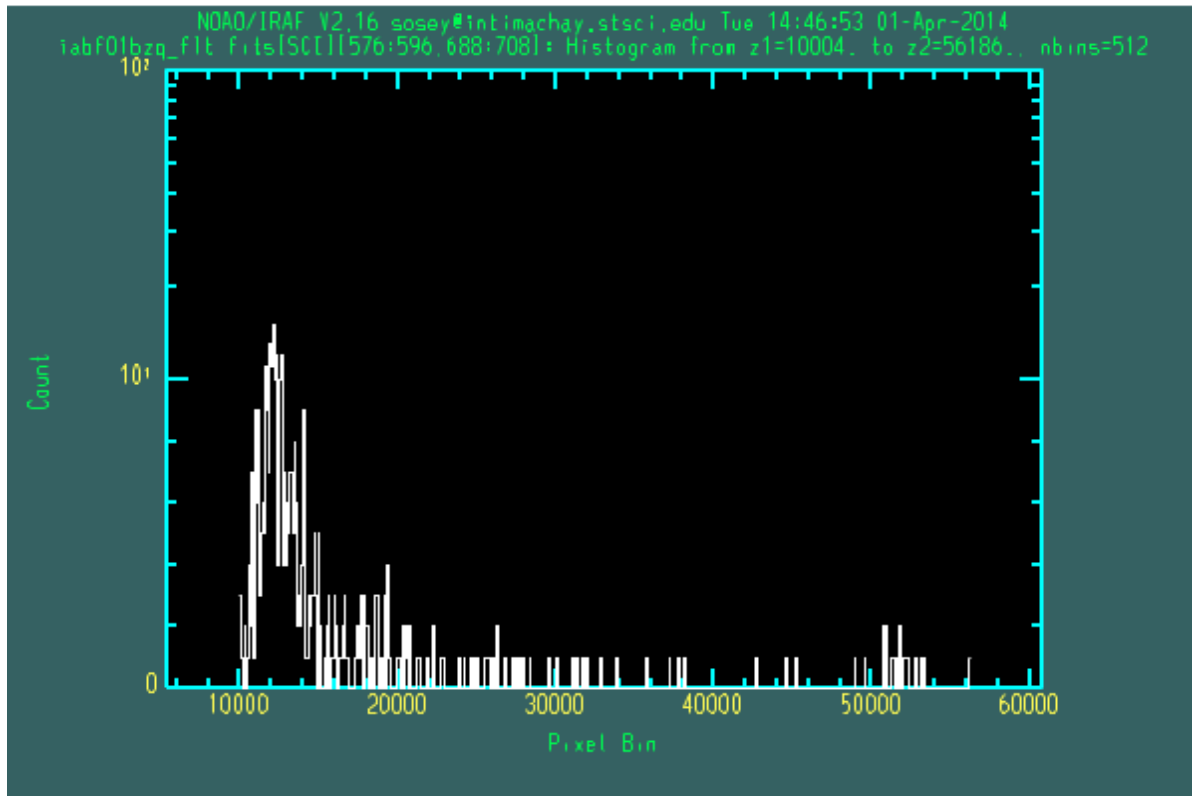
Keep in mind that python is 0-index and IRAF returns 1-index arrays, so the equivalent IRAF plot of 587 is really 588:



An added benefit in the python package is that you can zoom in and out of the plots using the window controls, below is a zoomed in area of the column plot as it appears in the window:



6.11.6 Histogram plots

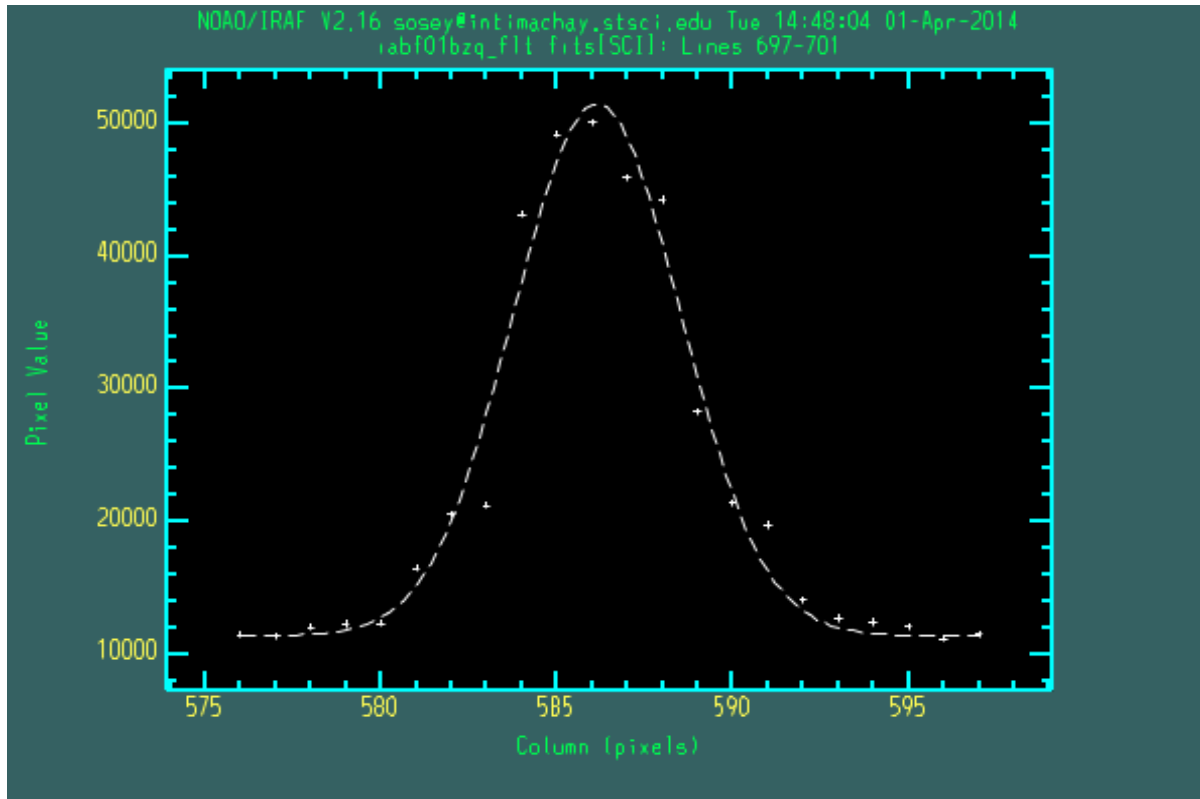


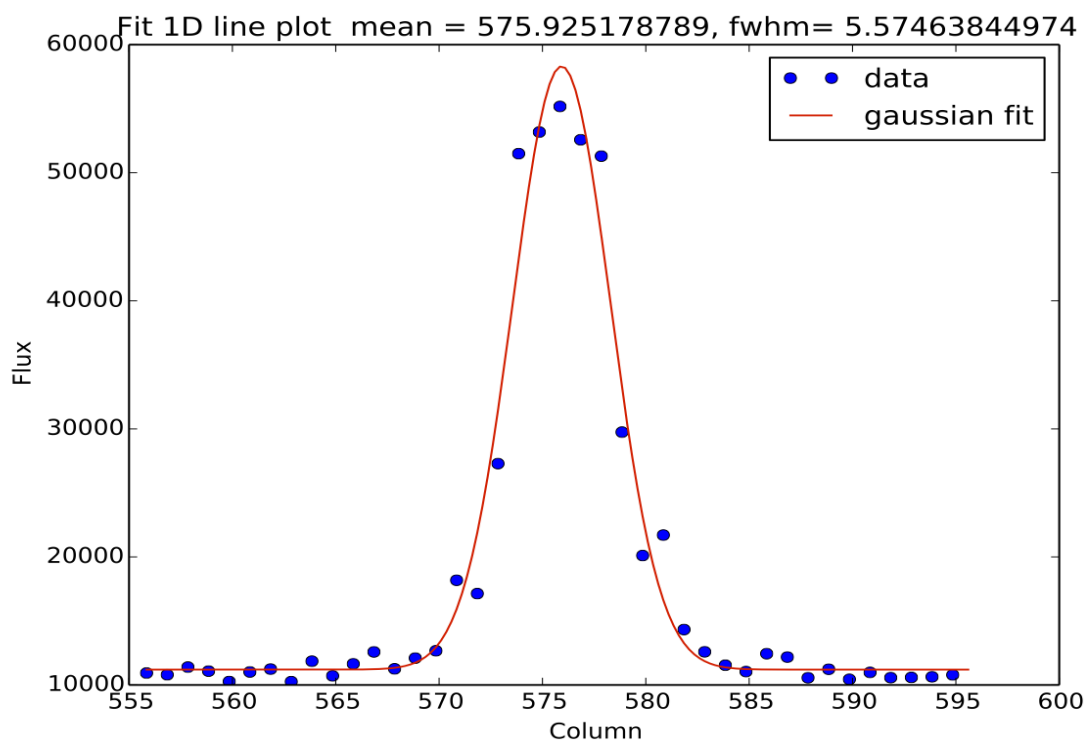
imexam prints bin information to the screen

```
100 bins
```

6.11.7 1D Gaussian plots

These plots are representative for both the column and line versions



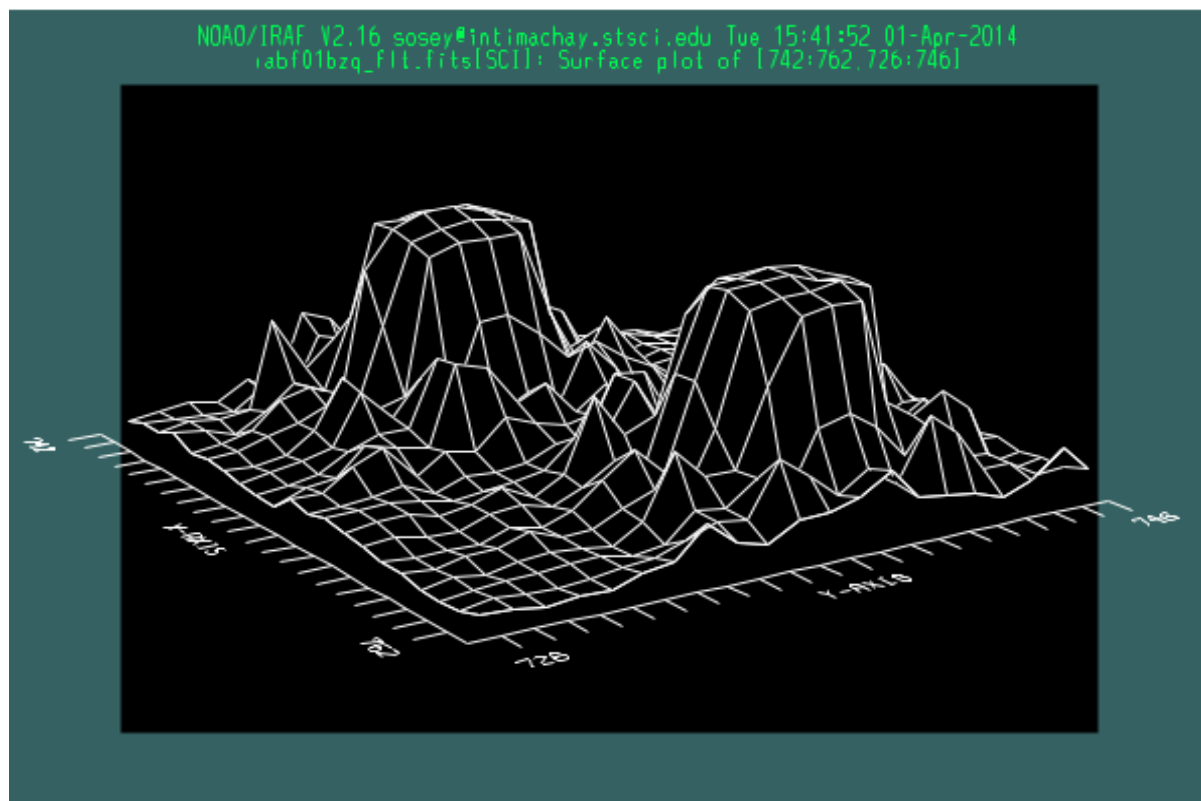


imexam prints the fit information to the screen

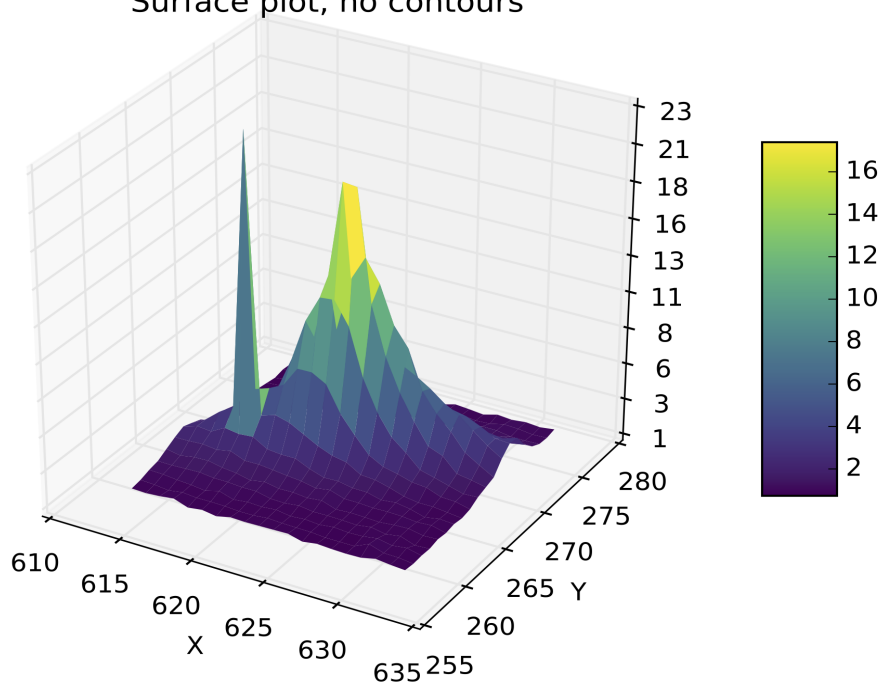
```
xc=585.660034      yc=697.499370
(585,697) mean=585.900, fwhm=5.653
```

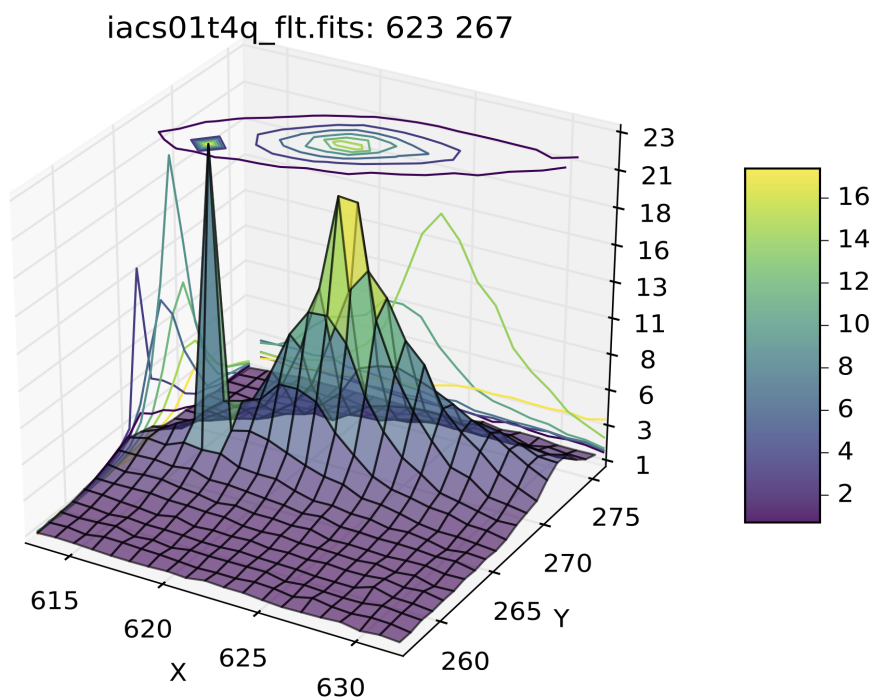
6.11.8 Surface plots

The default viewing angle for this package was set to that the axis are easiest to read, the user may choose a different azimuthal value as well. The most fancy imexam surface plot is displayed, the user can alter it with the available options.



Surface plot, no contours





REPORTING ISSUES

If you have found a bug in `imexam` please report it by creating a new issue on the `imexam` [GitHub issue tracker](#).

Please include an example that demonstrates the issue sufficiently so that the developers can reproduce and fix the problem. You may also be asked to provide information about your operating system and a full Python stack trace. The developers will walk you through obtaining a stack trace if it is necessary.

CONTRIBUTING

Like the [Astropy](#) project, `imexam` is made both by and for its users. We accept contributions at all levels, spanning the gamut from fixing a typo in the documentation to developing a major new feature. We welcome contributors who will abide by the [Python Software Foundation Code of Conduct](#).

`imexam` follows the same workflow and coding guidelines as [Astropy](#). The following pages will help you get started with contributing fixes, code, or documentation (no git or GitHub experience necessary):

- [How to make a code contribution](#)
- [Coding Guidelines](#)
- [Try the development version](#)
- [Developer Documentation](#)

For the complete list of contributors please see the [imexam contributors](#) page on Github.

REFERENCE API

9.1 imexam.connect Module

This is the main controlling class, it allows the user to connect to the viewer and the imexamine classes

9.1.1 Classes

<code>Connect</code> ([target, path, viewer, wait_time, ...])	Connect to a display device to look at and examine images.
---------------------------------------------------------------	------------------------------------------------------------

Connect

class `imexam.connect.Connect` (*target=None, path=None, viewer='ds9', wait_time=10, quit_window=True, port=None*)

Bases: `object`

Connect to a display device to look at and examine images.

The control features below are a basic set that should be available in all display tools.

The class for the display tool should override them and add it's own extra features.

Parameters

- **target** (*string, optional*) – the viewer target name or id (default is to start a new instance of a DS9 window)
- **path** (*string, optional*) – absolute path to the viewers executable
- **viewer** (*string, optional*) – The name of the image viewer you want to use, DS9 is the default
- **wait_time** (*int, optional*) – The time to wait for a connection to be established before quitting

window

controls the viewers functions

Type a pointer to an object

imexam

controls the imexamine functions and options

Type a pointer to an object

Initialize the imexam control object.

Methods Summary

<i>aimexam</i> ([get_name])	Show the current parameters for the 'a' key.
<i>alignwcs</i> (**kwargs)	Align frames with wcs.
<i>blink</i> (**kwargs)	Blink windows if available.
<i>cimexam</i> ([get_name])	Show the current parameters for the 'c' key.
<i>clear_contour</i> ()	Clear contours on window if available.
<i>close</i> ()	Close the window and end connection.
<i>cmap</i> (**kwargs)	Set the color map table to something else.
<i>colorbar</i> (**kwargs)	Turn the colorbar on the screen on and off.
<i>contour</i> (**kwargs)	Show contours on the window.
<i>contour_load</i> (*args)	Load contours from a file.
<i>crosshair</i> (**kwargs)	Control the current position of the crosshair in the current frame.
<i>cursor</i> (**kwargs)	Move the cursor in the current frame to the specified image pixel.
<i>dimexam</i> ([get_name])	Show the current parameters for the 'd' key.
<i>disp_header</i> (**kwargs)	Display the header of the current image to a window.
<i>eimexam</i> ([get_name])	Show the current parameters for the 'e' key, returns dict.
<i>embed</i> (**kwargs)	
<i>frame</i> (*args, **kwargs)	Move to a different frame, or add a new one
<i>get_data</i> ()	Return a numpy array of the data in the current window.
<i>get_filename</i> ()	Return the filename for the data in the current window.
<i>get_frame_info</i> ()	Return explicit information about the data displayed.
<i>get_header</i> (**kwargs)	Return the current fits header as a string.
<i>get_image</i> ()	Return the full image object, not just the numpy array.
<i>get_viewer_info</i> ()	Return a dictionary with information about all frames with data.
<i>gimexam</i> ([get_name])	Show the current parameters for curve of growth plots, returns dict.
<i>grab</i> ()	Display a snapshot of the current image in the browser window.
<i>grid</i> (*args, **kwargs)	Convenience method to turn the grid on and off.
<i>hideme</i> ()	Lower the precedence of the display window.
<i>himexam</i> ([get_name])	Show the current parameters for 'h' key, returns dict.
<i>imexam</i> ()	Run imexamine loop with user interaction.
<i>jimexam</i> ([get_name])	Show the current parameters for 1D fit line plots, returns dict.
<i>kimexam</i> ([get_name])	Show the current parameters for 1D fit column plots, returns dict.
<i>limexam</i> ([get_name])	Show the current parameters for line plots, returns dict.
<i>load_fits</i> (*args, **kwargs)	Convenience function to load fits image to current frame.

Continued on next page

Table 2 – continued from previous page

<code>load_mef_as_cube(*args, **kwargs)</code>	Load a Mult-Extension-Fits image one frame as a cube.
<code>load_mef_as_multi(*args, **kwargs)</code>	Load a Mult-Extension-Fits image into multiple frames.
<code>load_region(*args, **kwargs)</code>	Load regions from a file which uses standard formatting.
<code>load_rgb(*args, **kwargs)</code>	Load three images into a frame, each one for a different color.
<code>make_region(*args, **kwargs)</code>	Make an input reg file with [x,y,comment] to a standard reg file.
<code>mark_region_from_array(*args, **kwargs)</code>	Mark regions on the viewer with a list of tuples as input.
<code>match(**kwargs)</code>	Match all other frames to the current frame.
<code>mimexam([get_name])</code>	Show the current parameters for statistical regions, returns dict.
<code>nancolor(**kwargs)</code>	Set the not-a-number (NaN) color.
<code>panto_image(*args, **kwargs)</code>	Convenience function to change to x,y images coordinates.
<code>panto_wcs(*args, **kwargs)</code>	Pan to wcs coordinates in image.
<code>plotname([filename])</code>	Change or show the default save plotname for imexamine.
<code>readcursor()</code>	Return the image coordinate position and key pressed.
<code>reopen()</code>	Reopen a display window closed by the user but not exited.
<code>rimexam([get_name])</code>	Show the current parameters for curve of growth plots, returns dict.
<code>rotate(*args, **kwargs)</code>	Rotate the current frame (in degrees).
<code>save_header(*args, **kwargs)</code>	Save the header of the current image to a file.
<code>save_regions(*args, **kwargs)</code>	Save the regions on the current window to a file.
<code>save_rgb(*args, **kwargs)</code>	Save an rgb image frame that is displayed as an MEF fits file.
<code>scale(*args, **kwargs)</code>	Scale the image on display.
<code>set_plot_pars([key, item, value])</code>	Set the chosen plot parameter with the provided value.
<code>set_region(*args, **kwargs)</code>	Display a region using the specifications in region_string.
<code>setlog([filename, on, level])</code>	Turn on and off logging to a logfile or the screen.
<code>show_window_commands()</code>	Print the available commands for the selected display window.
<code>showme()</code>	Raise the precedence of the display window.
<code>showpix(*args, **kwargs)</code>	Display the pixel value table, close window when done.
<code>snapsave(*args, **kwargs)</code>	Create a snap shot of the current window.
<code>timexam([get_name])</code>	Show current parameters for image cutouts, returns dict.
<code>unlearn()</code>	Unlearn all the imexam parameters and reset to default.
<code>valid_data_in_viewer()</code>	Return True if a valid file or array is loaded.
<code>view(*args, **kwargs)</code>	Display numpy or nddata image array.

Continued on next page

Table 2 – continued from previous page

<code>wimexam([get_name])</code>	Show the current parameters for surface plots, returns dict.
<code>zoom(*args, **kwargs)</code>	Zoom to parameter which can be any recognized string.
<code>zoomtofit()</code>	Zoom the image to fit the display.

Methods Documentation

aimexam (*get_name=False*)

Show the current parameters for the ‘a’ key.

Either returns the name of the function associated with the keyname Or it returns the dictionary of plotting parameters for that key

alignwcs (***kwargs*)

Align frames with wcs.

blink (***kwargs*)

Blink windows if available.

cimexam (*get_name=False*)

Show the current parameters for the ‘c’ key.

Either returns the name of the function associated with the keyname Or it returns the dictionary of plotting parameters for that key

clear_contour ()

Clear contours on window if available.

close ()

Close the window and end connection.

cmap (***kwargs*)

Set the color map table to something else.

Should verify with a defined list of options

colorbar (***kwargs*)

Turn the colorbar on the screen on and off.

contour (***kwargs*)

Show contours on the window.

contour_load (**args*)

Load contours from a file.

crosshair (***kwargs*)

Control the current position of the crosshair in the current frame.

crosshair mode is turned on by default

cursor (***kwargs*)

Move the cursor in the current frame to the specified image pixel.

it will also move selected regions

dimexam (*get_name=False*)

Show the current parameters for the ‘d’ key.

Either returns the name of the function associated with the keyname Or it returns the dictionary of plotting parameters for that key

disp_header (***kwargs*)

Display the header of the current image to a window.

eimexam (*get_name=False*)

Show the current parameters for the 'e' key, returns dict.

embed (***kwargs*)

frame (**args, **kwargs*)

Move to a different frame, or add a new one

get_data ()

Return a numpy array of the data in the current window.

get_filename ()

Return the filename for the data in the current window.

get_frame_info ()

Return explicit information about the data displayed.

get_header (***kwargs*)

Return the current fits header as a string.

None is returned if there's a problem

get_image ()

Return the full image object, not just the numpy array.

get_viewer_info ()

Return a dictionary with information about all frames with data.

gimexam (*get_name=False*)

Show the current parameters for curve of growth plots, returns dict.

Either returns the name of the function associated with the keyname Or it returns the dictionary of plotting parameters for that key

grab ()

Display a snapshot of the current image in the browser window.

grid (**args, **kwargs*)

Convenience method to turn the grid on and off.

grid can be flushed with many more options

hideme ()

Lower the precedence of the display window.

himexam (*get_name=False*)

Show the current parameters for 'h' key, returns dict.

Either returns the name of the function associated with the keyname Or it returns the dictionary of plotting parameters for that key

imexam ()

Run imexamine loop with user interaction.

At a minimum it requires a copy of the data array

jimexam (*get_name=False*)

Show the current parameters for 1D fit line plots, returns dict.

Either returns the name of the function associated with the keyname Or it returns the dictionary of plotting parameters for that key

kimexam (*get_name=False*)

Show the current parameters for 1D fit column plots, returns dict.

Either returns the name of the function associated with the keyname Or it returns the dictionary of plotting parameters for that key

limexam (*get_name=False*)

Show the current parameters for line plots, returns dict.

Either returns the name of the function associated with the keyname Or it returns the dictionary of plotting parameters for that key

load_fits (**args, **kwargs*)

Convenience function to load fits image to current frame.

load_mef_as_cube (**args, **kwargs*)

Load a Mult-Extension-Fits image one frame as a cube.

load_mef_as_multi (**args, **kwargs*)

Load a Mult-Extension-Fits image into multiple frames.

load_region (**args, **kwargs*)

Load regions from a file which uses standard formatting.

load_rgb (**args, **kwargs*)

Load three images into a frame, each one for a different color.

make_region (**args, **kwargs*)

Make an input reg file with [x,y,comment] to a standard reg file.

the input file should contains lines with x,y,comment

mark_region_from_array (**args, **kwargs*)

Mark regions on the viewer with a list of tuples as input.

match (***kwargs*)

Match all other frames to the current frame.

mimexam (*get_name=False*)

Show the current parameters for statistical regions, returns dict.

Either returns the name of the function associated with the keyname Or it returns the dictionary of plotting parameters for that key

nancolor (***kwargs*)

Set the not-a-number (NaN) color.

panto_image (**args, **kwargs*)

Convenience function to change to x,y images coordinates.

using ra,dec, x, y in image coord

panto_wcs (**args, **kwargs*)

Pan to wcs coordinates in image.

plotname (*filename=None*)

Change or show the default save plotname for imexamine.

readcursor ()

Return the image coordinate postion and key pressed.

in the form of x,y,str with array offset

reopen ()

Reopen a display window closed by the user but not exited.

rimexam (*get_name=False*)

Show the current parameters for curve of growth plots, returns dict.

Either returns the name of the function associated with the keyname Or it returns the dictionary of plotting parameters for that key

rotate (**args, **kwargs*)

Rotate the current frame (in degrees).

save_header (**args, **kwargs*)

Save the header of the current image to a file.

save_regions (**args, **kwargs*)

Save the regions on the current window to a file.

save_rgb (**args, **kwargs*)

Save an rgb image frame that is displayed as an MEF fits file.

scale (**args, **kwargs*)

Scale the image on display.

The default zscale is the most widely used option

set_plot_pars (*key=None, item=None, value=None*)

Set the chosen plot parameter with the provided value.

Parameters

- **key** (*String*) – The value of the option key, should be a single letter or number
- **item** (*string*) – The value of the parameter in the dictionary
- **value** (*float, string, int, bool*) – What the parameters value should be set to

Examples

```
set_plot_par('j','func','MexicanHat1D')
```

where j is the key value during imexam func is the parameter you want to edit MexicanHat1D is the name of the astropy function to use

set_region (**args, **kwargs*)

Display a region using the specifications in region_string.

setlog (*filename=None, on=True, level=20*)

Turn on and off logging to a logfile or the screen.

Parameters

- **filename** (*str, optional*) – Name of the output file to record log information
- **on** (*bool, optional*) – True by default, turn the logging on or off
- **level** (*logging class, optional*) – set the level for logging messages, turn off screen messages by setting to logging.CRITICAL

show_window_commands ()

Print the available commands for the selected display window.

showme ()

Raise the precedence of the display window.

showpix (*args, **kwargs)

Display the pixel value table, close window when done.

snapsave (*args, **kwargs)

Create a snap shot of the current window.

save in the specified format. If no format is specified the filename extension is used

timexam (get_name=False)

Show current parameters for image cutouts, returns dict.

Either returns the name of the function associated with the keyname Or it returns the dictionary of plotting parameters for that key

unlearn ()

Unlearn all the imexam parameters and reset to default.

valid_data_in_viewer ()

Return True if a valid file or array is loaded.

view (*args, **kwargs)

Display numpy or nddata image array.

If an astropy NDData object is passed without a reference to the data one will be added. I haven't tested this yet for multiarray data

wimexam (get_name=False)

Show the current parameters for surface plots, returns dict.

Either returns the name of the function associated with the keyname Or it returns the dictionary of plotting parameters for that key

zoom (*args, **kwargs)

Zoom to parameter which can be any recognized string.

zoomtofit ()

Zoom the image to fit the display.

9.2 imexam.imexamine Module

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This class implements IRAF/imexamine type capabilities for providing powerful diagnostic quick-look tools.

However, the power of this python tool is that it is essentially a library of plotting and analysis routines which can be directed towards any viewer. It can also be used without connecting to any viewer since the calls take only data,x,y information. This means that given a data array and a list of x,y positions you can create plots without having to interact with the viewers.

Users can also register a custom function with the class and have it available for use in either case.

The plots which are made are fully customizable

9.2.1 Classes

<i>Imexamine()</i>	The imexamine class controls plotting and analysis functions.
--------------------	---------------------------------------------------------------

Imexamine

class imexam.imexamine.Imexamine

Bases: `object`

The imexamine class controls plotting and analysis functions.

do imexamine like routines on the current frame.

read the returned cursor key value to decide what to do

region_size is the default radius or side of the square for stat info

Methods Summary

<i>aper_phot</i> (x, y[, data, genplot, fig, error])	Perform aperture photometry.
<i>close</i> ()	For use with the Imexamine object standalone.
<i>column_fit</i> (x, y[, data, form, genplot, fig])	Compute the 1d fit to the column of data.
<i>com_center</i> (x, y[, data, delta, oversampling])	Return the center of mass of the object at x,y
<i>contour</i> (x, y[, data, fig])	plot contours in a region around the specified location.
<i>curve_of_growth</i> (x, y[, data, genplot, fig])	Display a curve of growth plot.
<i>cutout</i> (x, y[, data, size, fig])	Make a fits cutout around the pointer location without wcs.
<i>do_option</i> (x, y, key)	Run the imexam option.
<i>gauss_center</i> (x, y[, data, delta, sigma_factor])	Return the Gaussian 2D fit center of the object at (x,y).
<i>get_options</i> ()	Return the imexam options as a key list.
<i>get_plot_name</i> ()	return the default plot name.
<i>histogram</i> (x, y[, data, genplot, fig])	Calculate a histogram of the data values.
<i>line_fit</i> (x, y[, data, form, genplot, fig, col])	compute the 1D fit to the line of data using the specified form.
<i>new_plot_window</i> (x, y[, data])	make the next plot in a new plot window.
<i>option_descrip</i> (key[, field])	Return the looked up dictionary of options.
<i>plot_column</i> (x, y[, data, fig])	column plot of data at point y.
<i>plot_line</i> (x, y[, data, fig])	line plot of data at point x.
<i>print_options</i> ()	Print the imexam options to screen.
<i>radial_profile</i> (x, y[, data, form, genplot, fig])	Display the radial profile plot (intensity vs radius) for the object.
<i>register</i> (user_funcs)	register a new imexamine function made by the user as an option.
<i>report_stat</i> (x, y[, data])	report the statistic of values in a box with side region_size.
<i>reset_defpars</i> ()	set all pars to their defaults.
<i>save</i> ([filename, fig])	Save to file the figure that's currently displayed.
<i>save_figure</i> ([fig])	Save to file the figure that's currently displayed.

Continued on next page

Table 4 – continued from previous page

<code>set_aper_phot_pars([user_dict])</code>	the user may supply a dictionary of par settings.
<code>set_colplot_pars()</code>	set parameters for column plots.
<code>set_column_fit_pars()</code>	set parameters for 1D line fit plots.
<code>set_com_center_pars()</code>	set paramters for the center of mass function
<code>set_contour_pars()</code>	set parameters for contour plots.
<code>set_curve_pars()</code>	set parameters for curve of growth plots.
<code>set_cutout_pars()</code>	set parameters for cutout images.
<code>set_data([data])</code>	initialize the data that imexamine uses.
<code>set_histogram_pars()</code>	set parameters for histogram plots.
<code>set_line_fit_pars()</code>	set parameters for 1D line fit plots.
<code>set_lineplot_pars()</code>	set parameters for line plots.
<code>set_option_funcs()</code>	Define the dictionary which maps imexam keys to their functions.
<code>set_plot_name([filename])</code>	set the default plot name for the “s” key.
<code>set_radial_pars()</code>	set parameters for radial profile plots.
<code>set_surface_pars()</code>	set parameters for surface plots.
<code>setlog([filename, on, level])</code>	Turn on and off logging to a logfile or the screen.
<code>show_fit_models()</code>	Print the available astropy models for plot fits.
<code>show_xy_coords(x, y[, data])</code>	print the x,y,value to the screen.
<code>surface(x, y[, data, fig])</code>	plot a surface around the specified location.
<code>unlearn_all()</code>	reset the default parameters for all functions.

Methods Documentation

aper_phot (*x, y, data=None, genplot=True, fig=None, error=None*)

Perform aperture photometry.

Uses photutils functions, photutils must be available

Parameters

- **x** (*int*) – The x location of the object
- **y** (*int*) – The y location of the object
- **data** (*numpy array*) – The data array to work on
- **genplot** (*bool*) – plot the apertures to a figure; if false then the tuple of (apertures, annulus_apertures, rawflux_table, sky_per_pix) is returned.
- **fig** (*figure object for redirect*) – Used for interaction with the ginga GUI
- **error** (*float array*) – If error is not None, then it should be given the error array for the corresponding data image. error is assumed to include all sources of error, including the Poisson error of the sources See the docs for photutils for more details. The returned table will include a ‘aperture_sum_err’ column in addition to ‘aperture_sum’. ‘aperture_sum_err’ provides the propagated uncertainty associated with ‘aperture_sum’.

Returns

- *plot or the tuple of apertures, annulus_apertures, rawflux_table, sky_per_pix.*
- *Where apertures and annulus_apertures are photutils objects, or None*

close ()

For use with the Imexamine object standalone.

column_fit (*x*, *y*, *data=None*, *form=None*, *genplot=True*, *fig=None*)

Compute the 1d fit to the column of data.

Parameters

- **x** (*int*) – The x location of the object
- **y** (*int*) – The y location of the object
- **data** (*numpy array*) – The data array to work on
- **form** (*string*) – This is the functional form specified in the column fit parameters
- **genplot** (*int*) – produce the plot or return the fit model
- **fig** (*figure name for redirect*) – Used for interaction with the ginga GUI

Notes

delta is the range of data values to use around the x,y location

The background is currently ignored

if centering is True, then the center is fit with a 2d gaussian, but this is currently not done for Polynomial1D

com_center (*x*, *y*, *data=None*, *delta=None*, *oversampling=1.0*)

Return the center of mass of the object at x,y

Parameters

- **x** (*int*) – The x location of the object
- **y** (*int*) – The y location of the object
- **data** (*numpy array*) – The data array to work on
- **delta** (*int*) – The range of data values (bounding box) to use around the x,y location for calculating the center
- **oversampling** (*int*) – Oversampling factors of pixel indices. If oversampling is a scalar this is treated as both x and y directions having the same oversampling factor; otherwise it is treated as (x_oversamp, y_oversamp)

contour (*x*, *y*, *data=None*, *fig=None*)

plot contours in a region around the specified location.

Parameters

- **x** (*int*) – The x location of the object
- **y** (*int*) – The y location of the object
- **data** (*numpy array*) – The data array to work on
- **fig** (*figure for redirect*) – Used for interaction with the ginga GUI

curve_of_growth (*x*, *y*, *data=None*, *genplot=True*, *fig=None*)

Display a curve of growth plot.

Parameters

- **x** (*int*) – The x location of the object
- **y** (*int*) – The y location of the object
- **data** (*numpy array*) – The data array to work on

- **fig** (*figure name for redirect*) – Used for interaction with the ginga GUI

Notes

the object photometry is taken from photutils

cutout (*x, y, data=None, size=None, fig=None*)

Make a fits cutout around the pointer location without wcs.

Parameters

- **x** (*int*) – The x location of the object
- **y** (*int*) – The y location of the object
- **data** (*numpy array*) – The data array to work on
- **size** (*int*) – The radius of the cutout region
- **fig** (*figure for redirect*) – Used for interaction with the ginga GUI

do_option (*x, y, key*)

Run the imexam option.

Parameters

- **x** (*int*) – The x location of the cursor or data point
- **y** (*int*) – The y location of the cursor or data point
- **key** (*string*) – The key which was pressed

gauss_center (*x, y, data=None, delta=10, sigma_factor=0*)

Return the Gaussian 2D fit center of the object at (x,y).

Parameters

- **x** (*int*) – The x location of the object
- **y** (*int*) – The y location of the object
- **data** (*numpy array*) – The data array to work on
- **delta** (*int*) – The range of data values (bounding box) to use around the x,y location for calculating the center
- **sigma_factor** (*float, optional*) – The sigma clipping factor to use on the data fit

get_options ()

Return the imexam options as a key list.

get_plot_name ()

return the default plot name.

histogram (*x, y, data=None, genplot=True, fig=None*)

Calculate a histogram of the data values.

Parameters

- **x** (*int, required*) – The x location of the object
- **y** (*int, required*) – The y location of the object
- **data** (*numpy array, optional*) – The data array to work on
- **genplot** (*boolean, optional*) – If false, returns the hist, bin_edges tuple

- **fig** (*figure name for redirect*) – Used for interaction with the ginga GUI

Notes

This functional originally used the pylab histogram routine for plotting. In order to accomodate returning just the histogram data, this was changed to the numpy histogram, with a subsequent plot if genplot is True.

Does not yet support numpy v1.11 strings for bin estimation.

line_fit (*x, y, data=None, form=None, genplot=True, fig=None, col=False*)
compute the 1D fit to the line of data using the specified form.

Parameters

- **x** (*int*) – The x location of the object
- **y** (*int*) – The y location of the object
- **data** (*numpy array*) – The data array to work on
- **form** (*string*) – This is the functional form specified in the line fit parameters see `show_fit_models()`
- **genplot** (*bool*) – produce the plot or return the fit
- **fig** (*figure for redirect*) – Used for interaction with the ginga GUI
- **col** (*bool (False)*) – Plot column instead of line

Notes

The background is currently ignored

If centering is True in the parameter set, then the center is fit with a 2d gaussian, not performed for Polynomial1D

new_plot_window (*x, y, data=None*)
make the next plot in a new plot window.

Notes

x,y, data, are not used here, but the calls are setup to take them for all imexam options. Is there a better way to do the calls in general? Once the new plotting window is open all plots will be directed towards it. The old window cannot be used again.

option_descrip (*key, field=1*)
Return the looked up dictionary of options.

Parameters

- **key** (*string*) – The key which was pressed, it relates to the function to call
- **field** (*int*) – This tells where in the option dictionary the function name can be found

plot_column (*x, y, data=None, fig=None*)
column plot of data at point y.

Parameters

- **x** (*int*) – The x location of the object

- **y** (*int*) – The y location of the object
- **data** (*numpy array*) – The data array to work on
- **fig** (*figure name for redirect*) – Used for interaction with the ginga GUI

plot_line (*x, y, data=None, fig=None*)

line plot of data at point x.

Parameters

- **x** (*int*) – The x location of the object
- **y** (*int*) – The y location of the object
- **data** (*numpy array*) – The data array to work on
- **fig** (*figure object for redirect*) – Used for interaction with the ginga GUI

print_options ()

Print the imexam options to screen.

radial_profile (*x, y, data=None, form=None, genplot=True, fig=None*)

Display the radial profile plot (intensity vs radius) for the object.

From the parameters Dictionary: If pixel is True, then every pixel at each radius is plotted. If pixel is False, then the sum of all pixels in integer bins is plotted

Background may be subtracted and centering can be done with a 2D Gaussian fit. These options are read from the plot parameters dict.

Parameters

- **x** (*int*) – The x location of the object
- **y** (*int*) – The y location of the object
- **data** (*numpy array*) – The data array to work on
- **form** (*string*) – The string name of the form of the fit to use
- **genplot** (*bool*) – Generate the plot if True, else return the fit data

register (*user_funcs*)

register a new imexamine function made by the user as an option.

Parameters **user_funcs** (*dict*) – Contains a dictionary where each key is the binding for the (function,description) tuple

Notes

The new binding will be added to the dictionary of imexamine functions as long as the key is unique. The new functions do not have to have default dictionaries associated with them.

report_stat (*x, y, data=None*)

report the statistic of values in a box with side region_size.

The statistic can be any numpy function

Parameters

- **x** (*int*) – The x location of the object
- **y** (*int*) – The y location of the object
- **data** (*numpy array*) – The data array to work on

reset_defpars ()

set all pars to their defaults.

save (*filename=None, fig=None*)

Save to file the figure that's currently displayed.

this is used for the standalone plotting

Parameters

- **filename** (*string*) – Name of the file the plot will be saved to. The extension on the filename determines the filetype
- **fig** (*figure name for redirect*) – Used for interaction with the ginga GUI

save_figure (*fig=None*)

Save to file the figure that's currently displayed.

this is used for the imexam loop, because there is a standard api for the loop

Parameters

- **data** (*numpy array*) – The data array to work on
- **fig** (*figure for redirect*) – Used for interaction with the ginga GUI

set_aper_phot_pars (*user_dict=None*)

the user may supply a dictionary of par settings.

set_colplot_pars ()

set parameters for column plots.

set_column_fit_pars ()

set parameters for 1D line fit plots.

set_com_center_pars ()

set paramters for the center of mass function

set_contour_pars ()

set parameters for contour plots.

set_curve_pars ()

set parameters for curve of growth plots.

set_cutout_pars ()

set parameters for cutout images.

set_data (*data=array([], dtype=float64)*)

initialize the data that imexamine uses.

set_histogram_pars ()

set parameters for histogram plots.

set_line_fit_pars ()

set parameters for 1D line fit plots.

set_lineplot_pars ()

set parameters for line plots.

set_option_funcs ()

Define the dictionary which maps imexam keys to their functions.

Notes

The user can modify this dictionary to add or change options, the first item in the tuple is the associated function the second item in the tuple is the description of what the function does when that key is pressed

set_plot_name (*filename=None*)

set the default plot name for the “s” key.

Parameters **filename** (*string*) – The name which is used to save the current plotting window to a file The extension on the name decides which file type is used

set_radial_pars ()

set parameters for radial profile plots.

set_surface_pars ()

set parameters for surface plots.

setlog (*filename=None, on=True, level=20*)

Turn on and off logging to a logfile or the screen.

Parameters

- **filename** (*str, optional*) – Name of the output file to record log information
- **on** (*bool, optional*) – True by default, turn the logging on or off
- **level** (*logging class, optional*) – set the level for logging messages, turn off screen messages by setting to logging.CRITICAL

show_fit_models ()

Print the available astropy models for plot fits.

show_xy_coords (*x, y, data=None*)

print the x,y,value to the screen.

Parameters

- **x** (*int*) – The x location of the object
- **y** (*int*) – The y location of the object
- **data** (*numpy array*) – The data array to work on

surface (*x, y, data=None, fig=None*)

plot a surface around the specified location.

Parameters

- **x** (*int*) – The x location of the object
- **y** (*int*) – The y location of the object
- **data** (*numpy array*) – The data array to work on
- **fig** (*figure for redirect*) – Used for interaction with the ginga GUI

unlearn_all ()

reset the default parameters for all functions.

9.3 imexam.ds9_viewer Module

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This class supports communication with DS9 through the XPA

Some code in this class was adapted from pysao, which can be found at <https://github.com/leejjoon/pysao>. Specifically this package used the existing Cython implementation to the XPA and extended the calls to the other available XPA executables so that more functionality is added. The API information is available here:

<http://hea-www.harvard.edu/RD/xpa/client.html#xpaopen>

Using Cython will allow for broader development of the code and produce faster runtimes for large datasets with repeated calls to the display manager.

XPA is licensed under MIT, help can be found here: <http://hea-www.cfa.harvard.edu/saord/xpa/help.html>

The current XPA can be downloaded from here: <http://hea-www.harvard.edu/saord/xpa/>

9.3.1 Classes

<code>ds9([target, path, wait_time, quit_ds9_on_del])</code>	Control all interactions between the user and the DS9 window.
--------------------------------------------------------------	---------------------------------------------------------------

ds9

class `imexam.ds9_viewer.ds9` (*target=""*, *path=""*, *wait_time=5*, *quit_ds9_on_del=True*)

Bases: `object`

Control all interactions between the user and the DS9 window.

The `ds9()` constructor takes a `ds9` target as its main argument. If none is given, then a new window and process will be started.

DS9's xpa access points are documented in the reference manual, but they can also be returned to the user with a call to `xpaset`.

<http://hea-www.harvard.edu/saord/ds9/ref/xpa.html>

Parameters

- **target** (*string*, *optional*) – the `ds9` target name or id. If `None` or empty string, a new `ds9` instance is created.
- **path** (*string*, *optional*) – path of the `ds9`. Used only if a new `ds9` is requested.
- **wait_time** (*float*, *optional*) – waiting time before error is raised
- **quit_ds9_on_del** (*boolean*, *optional*) – If `True`, try to quit `ds9` when this instance is deleted.

wait_time

The waiting time before error is raised

Type `float`

path

The path to the DS9 executable

Type `string`

_xpa_name

The value in XPA_METHOD, the name of the DS9 window

Type string

_quit_ds9_on_del

Determine whether to quit ds9 when object goes out of scope.

Type boolean

_ds9_unix_name

The full path filename to the unix socket, only if unix sockets are being used with local

Type string

_need_to_purge

whenever there are unix socket directories which need to be purged when the object goes out of scope

Type boolean

_tmpd_name

The full path name to the unix socket file on the local system

Type string

_filename

The name of the image that's currently loaded into DS9

Type string

_ext

Extension of the current image that is loaded. If one extension of an MEF file is loaded this will be 1 regardless of the extension that was specified (because DS9 and the XPA now see it as a single image and header)

Type int

_extname

If available, the EXTNAME of the MEF extension that is loaded, taken from the current data header

Type string

_extver

If available, the EXTVER of the MEF extension that is loaded, taken from the current data header

Type int

_ds9_process

Points to the ds9 process id on the system, returned by Popen, whenever this module starts DS9

Type pointer

_mef_file

The file is a multi-extension fits file

Type boolean

_iscube

The file is a multiextension fits file, and one of the extensions contains at least 1 additional extension (3D or more)

Type boolean

_numaxis

number of image planes, this is NAXIS

Type `int`

`_naxis`

specific image plane displayed, defaulted to 1 image plane, most relevant to cube fits files

Type `tuple`

starter.

Notes

I think this is a quirk in the XPA communication. The xpans, and XPA prefer to have all connections be of the same type. DS9 defaults to creating an INET connection. In some cases, if no IP address can be found for the computer, the startup can hang. In these cases, a local connection is preferred, which uses a unix filename for the socket.

The problem arises that if the user already has DS9 windows running, that were started by default, the name-server is only listening for the default socket type (inet) and not local. There are also cases where the machine running this code does not have xpa installed, so there is no xpans (nameserver) to run and keep track of the open connections. In that case, the user needs to provide this init with the name of the socket in their window (in XPA_METHOD) in order to create the connection.

Methods Summary

<code>alignwcs([on])</code>	align wcs.
<code>blink([blink, interval])</code>	Blink frames.
<code>clear_contour()</code>	clear contours from the screen.
<code>close()</code>	close the window and end connection.
<code>cmap([color, load, invert, save, filename])</code>	Set the color map table, using a defined list of options.
<code>colorbar([on])</code>	turn the colorbar on the bottom of the window on and off.
<code>contour([on, construct])</code>	show contours on the window.
<code>contour_load(filename)</code>	load a contour file into the window.
<code>crosshair([x, y, coordsys, skyframe, ...])</code>	Control the position of the crosshair in the current frame.
<code>cursor([x, y])</code>	move the cursor in the current frame to the specified image pixel.
<code>disp_header()</code>	Display the header of the current image to a DS9 window.
<code>embed()</code>	Embed the viewer in a notebook.
<code>frame([n])</code>	convenience function to change or report frames.
<code>get(param)</code>	XPA get method to ds9 instance which returns received string.
<code>get_data()</code>	return a numpy array of the data displayed in the current frame.
<code>get_filename()</code>	return the filename currently on display.
<code>get_frame_info()</code>	return more explicit information about the data displayed.
<code>get_header([fitsobj])</code>	Return the current fits header.
<code>get_image()</code>	return the full image object instead of just the data array.

Continued on next page

Table 6 – continued from previous page

<code>get_slice_info()</code>	return the slice tuple that is currently displayed.
<code>get_viewer_info()</code>	Return a dictionary of information.
<code>grab()</code>	Make a copy of the image view.
<code>grid([on, param])</code>	convenience to turn the grid on and off.
<code>hideme()</code>	lower the ds9 window.
<code>iscube()</code>	return whether a cube image is displayed in the current frame.
<code>load_fits(fname[, extver, mecube])</code>	convenience function to load fits image to current frame.
<code>load_mef_as_cube([filename])</code>	Load a Multi-Extension-Fits image into one frame as an image cube.
<code>load_mef_as_multi([filename])</code>	Load a Multi-Extension-Fits image into multiple frames.
<code>load_region(filename)</code>	Load regions from a file which uses ds9 standard formatting.
<code>load_rgb(red, green, blue[, scale, lockwcs])</code>	load 3 images into an RGBimage frame.
<code>make_region(infile[, labels, header, ...])</code>	make an input reg file with [x,y,comment] to a DS9 reg file.
<code>mark_region_from_array(input_points[, ...])</code>	mark ds9 regions regions given an input list of tuples.
<code>match([coordsys, frame, crop, fslice, ...])</code>	match all other frames to the current frame.
<code>nancolor([color])</code>	set the not-a-number color, default is red.
<code>panto_image(x, y)</code>	convenience function to change to x,y physical image coordinates.
<code>panto_wcs(x, y[, system])</code>	pan to wcs location coordinates in image.
<code>readcursor()</code>	Returns the image coordinate position and key pressed.
<code>reopen()</code>	Reopen a closed window.
<code>rotate([value, to])</code>	rotate the current frame (in degrees).
<code>run_inet_ds9()</code>	start a new ds9 window using an inet socket connection.
<code>save_regions([filename])</code>	save the regions in the current window to a DS9 style regions file.
<code>save_rgb([filename])</code>	save an rgbimage frame as an MEF fits file.
<code>scale([scale])</code>	The default zscale is the most widely used option.
<code>set(param[, buf])</code>	XPA set method to ds9 instance.
<code>set_region([region_string])</code>	display a region using the specifications in region_string.
<code>show_xpa_commands()</code>	Print the available XPA commands.
<code>showme()</code>	raise the ds9 window.
<code>showpix([close])</code>	display the pixel value table, close window when done.
<code>snapsave([filename, format, resolution])</code>	Create a snap shot of the current window, save in specified format.
<code>valid_data_in_viewer()</code>	return bool if valid file or array is loaded into the viewer.
<code>view(img)</code>	Display numpy image array to current frame.
<code>zoom([par])</code>	Zoom using the specified command.
<code>zoomtofit()</code>	Zoom to fit the image to the viewer.

Methods Documentation

alignwcs (*on=True*)
align wcs.

Parameters *on* (*bool*) – Align the images using the WCS in their headers

blink (*blink=True, interval=None*)
Blink frames.

Parameters

- **blink** (*bool, optional*) – Set to True to start blinking the frames which are open
- **interval** (*int*) – Set interval equal to the length of pause for blinking

Notes

blink_syntax= Syntax: blink [true|false] [interval <value>]

clear_contour ()
clear contours from the screen.

close ()
close the window and end connection.

cmap (*color=None, load=None, invert=False, save=False, filename='colormap.ds9'*)
Set the color map table, using a defined list of options.

Parameters

- **color** (*string*) – color must be set to one of the available DS9 color map names
- **load** (*string, optional*) – set to the filename which is a valid colormap lookup table valid contrast values are from 0 to 10, and valid bias values are from 0 to 1
- **invert** (*bool, optional*) – invert the colormap
- **save** (*bool, optional*) – save the current colormap as a file
- **filename** (*string, optional*) – the name of the file to save the colormap to

colorbar (*on=True*)
turn the colorbar on the bottom of the window on and off.

Parameters *on* (*bool*) – Set to True to turn on the colorbar, False to turn it off

contour (*on=True, construct=True*)
show contours on the window.

Parameters

- **on** (*bool*) – Set to true to turn on contours
- **construct** (*bool, optional*) – Will open the contour dialog box which has more options

contour_load (*filename*)
load a contour file into the window.

Parameters **filename** (*string*) – The name of the file with the contour level defined

crosshair (*x=None, y=None, coordsys='physical', skyframe='wcs', skyformat='fk5', match=False, lock=False*)

Control the position of the crosshair in the current frame.

crosshair mode is turned on automatically

Parameters

- **x** (*string or int*) – The value of x is converted to a string for the call to XPA, use a value here appropriate for the skyformat you choose
- **y** (*string or int*) – The value of y is converted to a string for the call to XPA, use a value here appropriate for the skyformat you choose
- **coordsys** (*string, optional*) – The coordinate system your x and y are defined in
- **skyframe** (*string, optional*) – If skyframe has “wcs” in it then skyformat is also sent to the XPA
- **skyformat** (*string, optional*) – Used with skyframe, specifies the format of the coordinate which were given in x and y
- **match** (*bool, optional*) – If set to True, then the wcs is matched for the frames
- **lock** (*bool, optional*) – If set to True, then the frame is locked in wcs

cursor (*x=None, y=None*)

move the cursor in the current frame to the specified image pixel.

selected regions will also be moved

Parameters

- **x** (*int*) – pixel location x coordinate to move to
- **y** (*int*) – pixel location y coordinate to move to
- **and y are converted to strings for the call (x) –**

disp_header ()

Display the header of the current image to a DS9 window.

embed ()

Embed the viewer in a notebook.

frame (*n=None*)

convenience function to change or report frames.

Parameters n (*int, string, optional*) – The frame number to open or change to. If the number specified doesn’t exist, a new frame will be opened. If nothing is specified, then the current frame number will be returned. The value of n is converted to a string before passing to the XPA

Examples

frame(1) sets the current frame to 1 frame("last") set the current frame to the last frame frame() returns the number of the current frame frame("new") opens a new frame frame(3) opens frame 3 if it doesn't exist already, otherwise goes to frame 3

get (*param*)

XPA get method to ds9 instance which returns received string.

Parameters **param** (*parameter string (eg. "fits" "regions")*)–

Notes

This function is linked with the Cython implementation get(param)

get_data ()

return a numpy array of the data displayed in the current frame.

Notes

This is the data array that the imexam() function from connect() uses for analysis

astropy.io.fits stores data in row-major format. So a 4d image would be [NAXIS4, NAXIS3, NAXIS2, NAXIS1] just the one image is returned in the case of multidimensional data, not the cube

get_filename ()

return the filename currently on display.

This function will check if there is already a filename saved. It's possible that the user can connect to a ds9 window with no file loaded and then ask for the data file name after loading one through the ds9 menu options. This will poll the private filename and then try and set one if it's empty.

get_frame_info ()

return more explicit information about the data displayed.

get_header (*fitsobj=False*)

Return the current fits header.

The return value is the string or None if there's a problem If fits is True then a fits header object is returned instead

get_image ()

return the full image object instead of just the data array.

get_slice_info ()

return the slice tuple that is currently displayed.

get_viewer_info ()

Return a dictionary of information.

The dictionary contains information about all frames which are loaded with data

Notes

Consider adding a loop to verify that all the frames still exist and the user has not deleted any through the gui.

grab()

Make a copy of the image view.

grid(*on=True, param=False*)

convenience to turn the grid on and off.

grid can be flushed with many more options

Parameters

- **on**(*bool, optional*) – Will turn the grid overlay on in the current frame
- **param**(*bool, optional*) – Will open the parameter dialog in DS9

hideme()

lower the ds9 window.

iscube()

return whether a cube image is displayed in the current frame.

load_fits(*fname, extver=None, mecube=False*)

convenience function to load fits image to current frame.

Parameters

- **fname**(*string, FITS object*) – The name of the file to be loaded. You can specify the full extension in the name, such as filename_fit.fits or filename_fit.fits[1] You can also pass it an in-memory FITS object
- **extver**(*int, optional*) – The extension to load (EXTVER in the header)
- **mecube**(*bool, optional*) – If mecube is True, load the fits file as a cube into ds9

Notes

To tell ds9 to open a file whose name or path includes spaces, surround the path with "{...}", e.g.

```
% xpsaset -p ds9 file "{foo bar/my image.fits}"
```

This is assuming that the image loads into the current or next new frame, watch the internal file and ext values because the user can switch frames through DS9 app itself

XPA needs to have the absolute path to the filename so that if the DS9 window was started in another directory it can still find the file to load. The pathname also needs to be stripped of spaces.

load_mef_as_cube(*filename=None*)

Load a Mult-Extension-Fits image into one frame as an image cube.

load_mef_as_multi(*filename=None*)

Load a Mult-Extension-Fits image into multiple frames.

load_region(*filename*)

Load regions from a file which uses ds9 standard formatting.

Parameters filename(*string*) – The file containing the DS9 style region description

load_rgb(*red, green, blue, scale=False, lockwcs=False*)

load 3 images into an RGBimage frame.

Parameters

- **red** (*string*) – The name of the fits file loaded into the red channel
- **green** (*string*) – The name of the fits file loaded into the green channel
- **blue** (*string*) – The name of the fits file loaded into the blue channel
- **scale** (*bool*) – If True, then each image will be scaled with `zscale()` after loading
- **lockwcs** (*bool*) – If True, then the image positions will be locked to each other using the WCS information in their headers

make_region (*infile, labels=False, header=0, textoff=10, size=5*)

make an input reg file with [x,y,comment] to a DS9 reg file.

the input file should contain lines specifying x,y,comment

Parameters

- **infile** (*str*) – input filename
- **labels** (*bool*) – add labels to the regions
- **header** (*int*) – number of header lines in text file to skip
- **textoff** (*int*) – offset in pixels for labels
- **size** (*int*) – size of the region type

Notes

only circular regions are supported currently

mark_region_from_array (*input_points, ptype='image', textoff=10, size=4*)

mark ds9 regions regions given an input list of tuples.

a convenience function, you can also use `set_region`

Parameters

- **input_points** (*iterator, a tuple, or list of tuples*) – or a string: (x,y,comment),
- **ptype** (*string*) – the reference system for the point locations, `image|physical|fk5`
- **size** (*int*) – the size of the region marker
- **textoff** (*string*) – the offset for the comment text, if comment is empty it will not show

Notes

only circular regions are supported currently

match (*coordsys='wcs', frame=True, crop=False, fslice=False, scale=False, bin=False, colorbar=False, smooth=False, crosshair=False*)

match all other frames to the current frame.

Parameters

- **coordsys** (*string, optional*) – The coordinate system to use

- **frame** (*bool*, *optional*) – Match all other frames to the current frame, using the set coordsys
- **crop** (*bool*, *optional*) – Set the current image display area, using the set coordsys
- **fslice** (*bool*, *optional*) – Match current slice in all frames
- **scale** (*bool*, *optional*) – Match to the current scale for all frames
- **bin** (*bool*, *optional*) – Match to the current binning for all frames
- **colorbar** (*bool*, *optional*) – Match to the current colorbar for all frames
- **smooth** (*bool*, *optional*) – Match to the current smoothing for all frames
- **crosshair** (*bool*, *optional*) – Match the crosshair in all frames, using the current coordsys

Notes

You can only choose one of the options at a time, and the logic will select the first True option so set frame=False and something else in addition to your choice if you don't want the default option.

nancolor (*color*='red')

set the not-a-number color, default is red.

Parameters **color** (*string*) – The color to use for NAN pixels

panto_image (*x*, *y*)

convenience function to change to x,y physical image coordinates.

Parameters

- **x** (*float*) – X location in physical coords to pan to
- **y** (*float*) – Y location in physical coords to pan to

panto_wcs (*x*, *y*, *system*='fk5')

pan to wcs location coordinates in image.

Parameters

- **x** (*string*) – The x location to move to, specified using the given system
- **y** (*string*) – The y location to move to
- **system** (*string*) – The reference system that x and y were specified in, they should be understood by DS9

readcursor ()

Returns the image coordinate position and key pressed.

Notes

XPA returns strings of the form: u a 257.5 239

reopen ()

Reopen a closed window.

rotate (*value*=None, *to*=False)

rotate the current frame (in degrees).

the current rotation is printed with no params

Parameters

- **value** (*float [degrees]*) – Rotate the current frame {value} degrees. If value is 0, then the current rotation is printed
- **to** (*bool*) – Rotate the current frame to the specified value

run_inet_ds9 ()

start a new ds9 window using an inet socket connection.

Notes

It is given a unique title so it can be identified later.

save_regions (*filename=None*)

save the regions in the current window to a DS9 style regions file.

Parameters filename (*string*) – The name of the file to which the regions displayed in the current window are saved. If no filename is provided then it will try and save the regions to the name of the file in the current display with `_regions.txt` appended

If a file of that name already exists on disk it will not attempt to overwrite it

save_rgb (*filename=None*)

save an rgbimage frame as an MEF fits file.

Parameters filename (*string*) – The name of the output fits image

scale (*scale='zscale'*)

The default zscale is the most widely used option.

Parameters scale (*string*) – The scale for ds9 to use, these are set strings of [linear|log|pow|sqrt|sqrtd|sinh|sinhl|histeq]

Notes

The xpa doesn't return an error if you set an unknown scale, it just doesn't do anything, this is true for all the xpa calls

set (*param, buf=None*)

XPA set method to ds9 instance.

Notes

This function is linked with the Cython implementation

`set(param, buf=None)` param : parameter string (eg. "fits" "regions") buf : aux data string (sometimes string needed to be ended with CR)

set_region (*region_string=""*)

display a region using the specifications in region_string.

Parameters region_string (*string*) – Should take the form of a region string that DS9 is expecting

Examples

`set_region("physical ruler 200 300 200 400") set_region("line 0 400 3 400 #color=red")`

show_xpa_commands ()

Print the available XPA commands.

showme ()

raise the ds9 window.

showpix (*close=False*)

display the pixel value table, close window when done.

Parameters **close** (*bool, optional*) – If set to True, then the pixel table dialog window is closed

snapsave (*filename=None, format=None, resolution=100*)

Create a snap shot of the current window, save in specified format.

This function bypasses the XPA calling routines to avoid a bug with the X11/XPA interface. Instead it uses the os function which takes a snapshot of the specified window.

Parameters

- **filename** (*str, optional*) – filename of output image, the extension in the filename can also be used to specify the format. If no filename is specified, then the filename will be constructed from the name of the image displayed image with `_snap.png` appended.
- **format** (*str, optional*) – available formats are fits, eps, gif, tiff, jpeg, png If no format is specified the filename extension is used
- **resolution** (*int, optional*) – 1 to 100, for jpeg images

valid_data_in_viewer ()

return bool if valid file or array is loaded into the viewer.

view (*img*)

Display numpy image array to current frame.

Parameters **img** (*numpy array*) – The array containing data, it will be forced to `numpy.array()`

zoom (*par='to fit'*)

Zoom using the specified command.

Parameters **par** (*string*) –

- **it can be a number (ranging 0 to 8 effectively), and successive** calls continue zooming in the same direction
- it can be two numbers '4 2', which specify zoom on different axis
- it can be a specific value 'to 8' or 'to fit'
- it can be 'open' to open the dialog box
- **it can be 'close' to close the dialog box (only valid if the box is already open)**

Examples

```
zoom('0.1')
zoomtofit()
Zoom to fit the image to the viewer.
```

9.4 imexam.ginga_viewer Module

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This class supports communication with a Ginga-based viewer. For default key and mouse shortcuts in a Ginga window, see: <https://ginga.readthedocs.org/en/latest/quickref.html>

9.4.1 Classes

<code>ginga([exam, close_on_del, logger, port, ...])</code>	A ginga-based viewer that displays to an HTML5 widget in a browser.
<code>ginga_general([exam, close_on_del, logger, port])</code>	A base class which controls all interactions between the user and the ginga widget.

ginga

class `imexam.ginga_viewer.ginga` (*exam=None, close_on_del=True, logger=None, port=None, host='localhost', use_opencv=False*)
 Bases: `imexam.ginga_viewer.ginga_general`

A ginga-based viewer that displays to an HTML5 widget in a browser.

This is compatible with the Jupyter notebook and can be run from a server.

This kind of viewer has slower performance than if we choose some widget back ends, but the advantage is that it works so long as the user has a working browser.

All the rendering is done on the server side and the browser only acts as a display front end. Using this you could create an analysis type environment on a server and view it via a browser or from a Jupyter notebook.

initialize a general ginga viewer object.

Parameters

- **exam** (*imexam object*) – This is the imexamine object which contains the examination functions
- **close_on_del** (*bool*) – If True, the window connection shuts down when the object is deleted
- **logger** (*logger object*) – Ginga viewers all need a logger, if none is provided it will create one
- **port** (*int*) – This is used as the communication port for the HTML5 viewer. The user can choose to have multiple windows open at the same time as long as they have different port designations. If no port is specified, this class will choose an open port.

Methods Summary

<code>close()</code>	Close the viewing window.
<code>reopen()</code>	Reopen the viewer window if the user closes it accidentally.

Methods Documentation

close()

Close the viewing window.

reopen()

Reopen the viewer window if the user closes it accidentally.

ginga_general

class `imexam.ginga_viewer.ginga_general` (*exam=None*, *close_on_del=True*, *logger=None*, *port=None*)

Bases: `object`

A base class which controls all interactions between the user and the ginga widget.

The ginga constructor creates a new window using the ginga backend.

Parameters `close_on_del` (*boolean*, *optional*) – If True, try to close the window when this instance is deleted.

view

The object instantiated from a Ginga view class

Type Ginga view object

exam

Type imexamine object

initialize a general ginga viewer object.

Parameters

- **exam** (*imexam object*) – This is the imexamine object which contains the examination functions
- **close_on_del** (*bool*) – If True, the window connection shuts down when the object is deleted
- **logger** (*logger object*) – Ginga viewers all need a logger, if none is provided it will create one
- **port** (*int*) – This is used as the communication port for the HTML5 viewer. The user can choose to have multiple windows open at the same time as long as they have different port designations. If no port is specified, this class will choose an open port.

Methods Summary

<code>blink()</code>	Blink multiple frames.
<code>close()</code>	Close the window.
<code>cmap([color, load, invert, save, filename])</code>	Set the color map table to something else, using a defined list of options.
<code>contour_load()</code>	Load a file with contour information.
<code>crosshair(**kwargs)</code>	Control the current position of the crosshair in the frame.
<code>cursor(**kwargs)</code>	Move the cursor in the current frame to the specified image pixel.
<code>disp_header()</code>	Display the fits header for the current data.
<code>embed([width, height])</code>	Embed the current window into the notebook.
<code>frame()</code>	Convenience function to report frames.
<code>get_data()</code>	Return a numpy array of the data displayed in the current frame
<code>get_filename()</code>	Return the filename currently associated with the data
<code>get_frame_info()</code>	Return more explicit information about the data in current frame.
<code>get_header()</code>	Return current fits header as string, None if there's a problem.
<code>get_image()</code>	Return the AstroImage instance for the data in the viewer
<code>get_slice_info()</code>	Return the slice tuple that is currently displayed.
<code>get_viewer_info()</code>	Return a dictionary of information about all frames with data
<code>grab()</code>	
<code>grid(*args, **kwargs)</code>	Turn the grid display on and off.
<code>hideme()</code>	Lower the display window in precedence.
<code>iscube()</code>	Return whether a cube image is displayed in the current frame.
<code>load_fits([fname, extver])</code>	Load fits image to current frame.
<code>load_mef_as_cube(*args, **kwargs)</code>	Load a Mult-Extension-Fits image one frame as a cube.
<code>load_mef_as_multi(*args, **kwargs)</code>	Load a Mult-Extension-Fits image into multiple frames.
<code>load_region(*args, **kwargs)</code>	Load regions from a file which uses standard formatting.
<code>load_rgb(*args, **kwargs)</code>	Load three images into a frame, each one for a different color.
<code>make_region(*args, **kwargs)</code>	make an input reg file with [x,y,comment] to a standard reg file.
<code>mark_region_from_array(*args, **kwargs)</code>	Mark regions on the viewer with a list of tuples as input.
<code>match(**kwargs)</code>	Match all other frames to the current frame.
<code>nancolor(**kwargs)</code>	Set the not-a-number (Nan) color.
<code>panto_image(x, y)</code>	Change to x,y physical image coordinates.
<code>panto_wcs(x, y[, system])</code>	Pan to wcs location coordinates in image
<code>readcursor()</code>	Returns image coordinate position and key pressed.
<code>rotate([value])</code>	Rotate the current frame (in degrees).

Continued on next page

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<code>save_header(*args, **kwargs)</code>	Save the header of the current image to a file.
<code>save_regions(*args, **kwargs)</code>	Save the displayed regions on the current window to a file.
<code>save_rgb(*args, **kwargs)</code>	Save an rgb image frame that is displayed as an MEF fits file.
<code>scale([scale])</code>	Scale the image intensity, zscale is used as the default.
<code>set_region(*args, **kwargs)</code>	Display a region using the specifications in <code>region_string</code> .
<code>show_window_commands()</code>	Print the available commands for the selected display.
<code>showme()</code>	Raise the precedence of the display window.
<code>showpix(*args, **kwargs)</code>	Display the pixel value table, closing the window when done.
<code>snapsave()</code>	Save a frame display as a PNG file.
<code>start_event_loop()</code>	
<code>transform([flipx, flipy, swapxy])</code>	Transform the frame.
<code>valid_data_in_viewer()</code>	Return bool if a valid file or array is loaded into the viewer
<code>view(img)</code>	Display numpy image array in current frame
<code>zoom(zoomlevel)</code>	Zoom the image using the specified zoomlevel.
<code>zoomtofit()</code>	Zoom the image to fit the display.

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blink()

Blink multiple frames.

close()

Close the window.

cmap (*color=None, load=None, invert=False, save=False, filename='colormap.ds9'*)

Set the color map table to something else, using a defined list of options.

Parameters

- **color** (*string*) – color must be set to one of the available color map names
- **load** (*string, optional*) – set to the filename which is a valid colormap lookup table valid contrast values are from 0 to 10, and valid bias values are from 0 to 1
- **invert** (*bool, optional*) – invert the colormap
- **save** (*bool, optional*) – save the current colormap as a file
- **filename** (*string, optional*) – the name of the file to save the colormap to

contour_load()

Load a file with contour information.

crosshair (***kwargs*)

Control the current position of the crosshair in the frame.

crosshair mode is turned on.

cursor (***kwargs*)

Move the cursor in the current frame to the specified image pixel.

it will also move selected regions

disp_header()

Display the fits header for the current data.

embed(*width=600, height=650*)

Embed the current window into the notebook.

frame()

Convenience function to report frames.

currently only 1 frame is supported per calling object in HTML5 display

get_data()

Return a numpy array of the data displayed in the current frame

Notes

This is the data array that the `imexam()` function from `connect()` uses for analysis

`astropy.io.fits` stores data in row-major format. So a 4d image would be [NAXIS4, NAXIS3, NAXIS2, NAXIS1] just the one image is returned in the case of multidimensional data, not the cube

get_filename()

Return the filename currently associated with the data

get_frame_info()

Return more explicit information about the data in current frame.

get_header()

Return current fits header as string, None if there's a problem.

get_image()

Return the `AstroImage` instance for the data in the viewer

get_slice_info()

Return the slice tuple that is currently displayed.

get_viewer_info()

Return a dictionary of information about all frames with data

grab()

grid(**args, **kwargs*)

Turn the grid display on and off.

grid can be flushed with many more options

hideme()

Lower the display window in precedence.

iscube()

Return whether a cube image is displayed in the current frame.

load_fits(*fname=None, extver=None*)

Load fits image to current frame.

Parameters

- **fname** (*string, FITS HDU*) – The name of the file to be loaded. You can specify the full extension in the name, such as `filename_fit.fits[sci,1]` or `filename_fit.fits[1]`
- **extver** (*int, optional*) – The extension to load (EXTVER in the header)

Notes

Extname isn't used here, ginga wants the absolute extension number, not the version number associated with a name

load_mef_as_cube (*args, **kwargs)

Load a Mult-Extension-Fits image one frame as a cube.

load_mef_as_multi (*args, **kwargs)

Load a Mult-Extension-Fits image into multiple frames.

load_region (*args, **kwargs)

Load regions from a file which uses standard formatting.

load_rgb (*args, **kwargs)

Load three images into a frame, each one for a different color.

make_region (*args, **kwargs)

make an input reg file with [x,y,comment] to a standard reg file.

the input file should contains lines with x,y,comment

mark_region_from_array (*args, **kwargs)

Mark regions on the viewer with a list of tuples as input.

match (**kwargs)

Match all other frames to the current frame.

nancolor (**kwargs)

Set the not-a-number (Nan) color.

panto_image (x, y)

Change to x,y physical image coordinates.

Parameters

- **x** (*float*) – X location in physical coords to pan to
- **y** (*float*) – Y location in physical coords to pan to

panto_wcs (x, y, system='fk5')

Pan to wcs location coordinates in image

Parameters

- **x** (*string*) – The x location to move to, specified using the given system
- **y** (*string*) – The y location to move to
- **system** (*string*) – The reference system that x and y were specified in, they should be understood by DS9

readcursor ()

Returns image coordinate postion and key pressed.

rotate (value=None)

Rotate the current frame (in degrees).

the current rotation is printed with no params

Parameters **value** (*float* [*degrees*]) – Rotate the current frame {value} degrees If value is None, then the current rotation is printed

save_header (*args, **kwargs)

Save the header of the current image to a file.

save_regions (*args, **kwargs)

Save the displayed regions on the current window to a file.

save_rgb (*args, **kwargs)

Save an rgb image frame that is displayed as an MEF fits file.

scale (scale='zscale')

Scale the image intensity, zscale is used as the default.

Parameters **scale** (*string*) – The scale for ds9 to use, these are set strings of [linear|log|pow|sqrt|squared|sinh|sinh|histeq]

set_region (*args, **kwargs)

Display a region using the specifications in region_string.

show_window_commands ()

Print the available commands for the selected display.

showme ()

Raise the precedence of the display window.

showpix (*args, **kwargs)

Display the pixel value table, closing the window when done.

snapsave ()

Save a frame display as a PNG file.

Parameters **filename** (*string*) – The name of the output PNG image

start_event_loop ()

transform (flipx=None, flipy=None, swapxy=None)

Transform the frame.

Parameters

- **flipx** (*boolean*) – if True flip the X axis, if False don't, if None leave current
- **flipy** (*boolean*) – if True flip the Y axis, if False don't, if None leave current
- **swapxy** (*boolean*) – if True swap the X and Y axes, if False don't, if None leave current

valid_data_in_viewer ()

Return bool if a valid file or array is loaded into the viewer

view (img)

Display numpy image array in current frame

Parameters **img** (*numpy array*) – The array containing data, it will be forced to numpy.array()

Examples

```
view(np.random.rand(100,100))
```

zoom (zoomlevel)

Zoom the image using the specified zoomlevel.

Parameters **zoomlevel** (*integer*) –

Examples

`zoom(6) zoom(-3)`

`zoomtofit()`

Zoom the image to fit the display.

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