ASTRONOMY LAB: Session I (IRAF)

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Installation

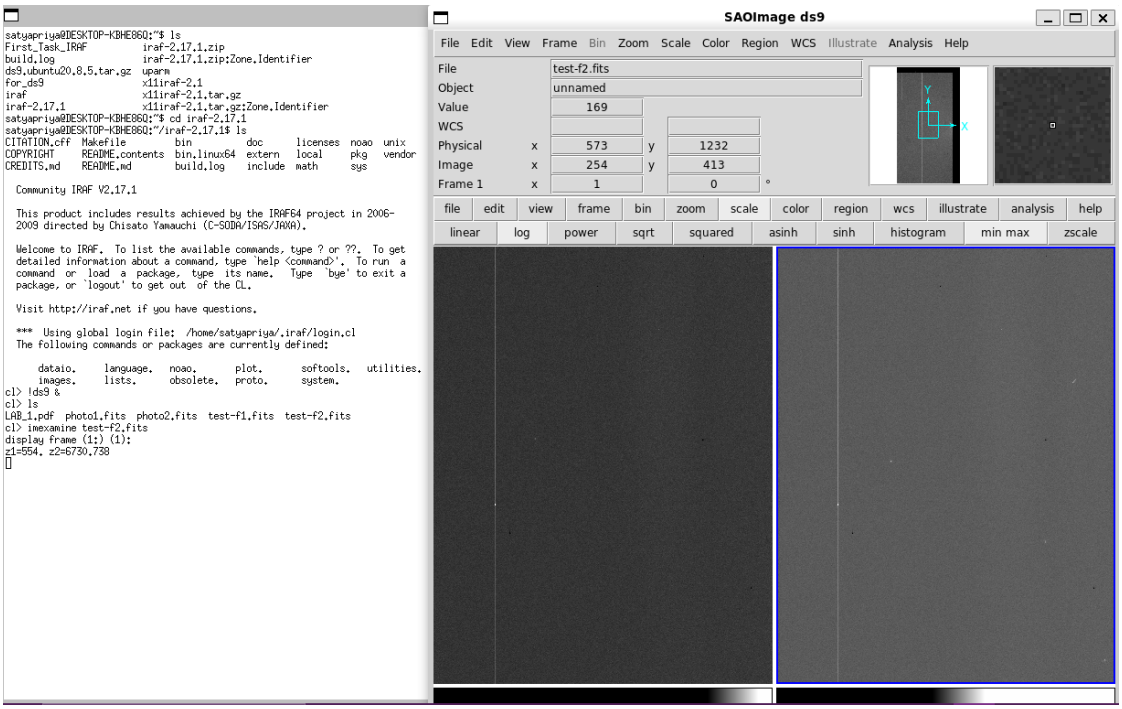
Since I am using windows so in order to use IRAF I installed windows subsystem for linux (wsl) from where we can install and use all linux softwares and features. In that I have successfully installed xgterm,ds9 and IRAF. Xgterm is not that user friendly so I am also looking for ways into it for my own convenience.

I have to open wsl terminal from there then xgterm terminal. After that I went to the file location where the login.cl file is there and then open IRAF by writing the command cl. Also by writing the linux command inside it !ds9 & so that ds9 will open and the terminal remain usable this whole process is done. Now it is ready to use for any sort of image analysis.

Exploring Images in DS9

The most interesting thing that I think is there are the alphabets that we can push to see nearby pixel values, various kind of plots, statistics etc. So even though it was only asked for few of them, I have added other things too.

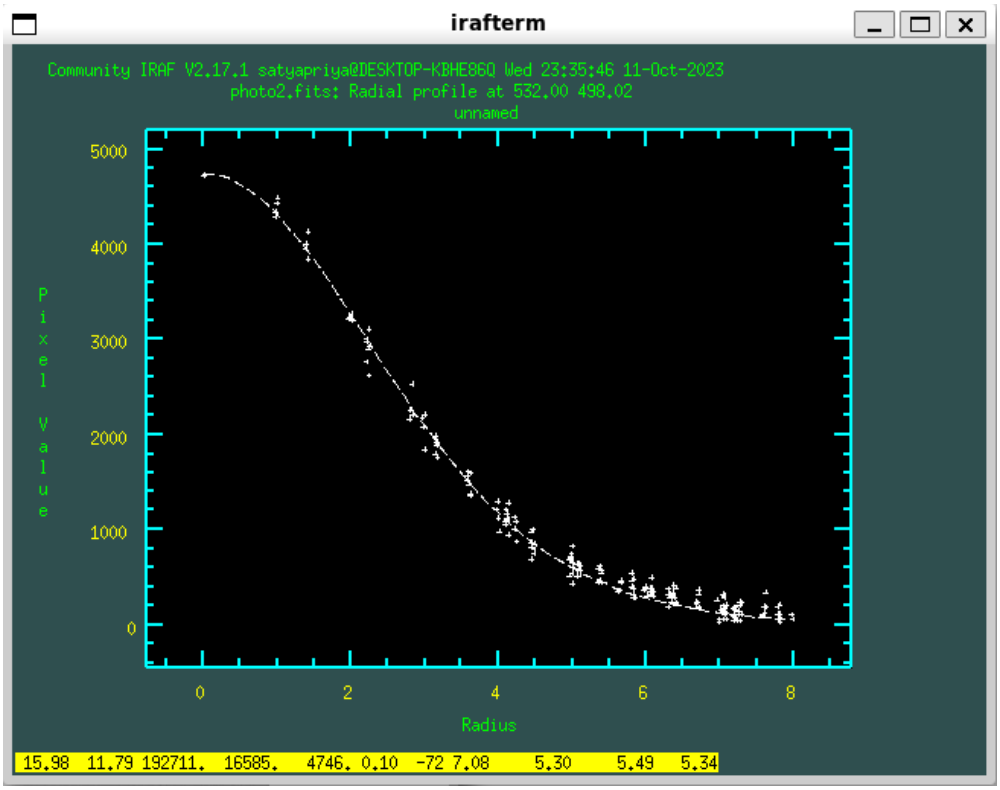
Using epar display we can change the settings/parameters of the images we want to open. I changed scale to log and while opening from ds9 also (the same image as asked in the question) I converted the scale to log for proper conversion.


satyapriya@DESKTOP-KBHE86Q:~$ ls
First_Task_IRAF iraf-2.17.1.zip
build.log iraf-2.17.1.zip:Zone.Identifier
ds9.ubuntu20.8.5.tar.gz uparm
for_ds9 x11iraf-2.1
iraf x11iraf-2.1.tar.gz
iraf-2.17.1 x11iraf-2.1.tar.gz:Zone.Identifier
satyapriya@DESKTOP-KBHE86Q:~$ cd iraf-2.17.1
satyapriya@DESKTOP-KBHE86Q:~/iraf-2.17.1$ ls
CITATION.cff Makefile bin doc licenses noao unix
COPYRIGHT README.contents bin.linux64 extern local pkg vendor
CREDITS.md README.md build.log include math sys
Community IRAF V2.17.1
This product includes results achieved by the IRAF64 project in 2006-2009 directed by Chisato Yamauchi (C-SODA/ISAS/JAXA).
Welcome to IRAF. To list the available commands, type ? or ??. To get detailed information about a command, type `help <command>'. To run a command or load a package, type its name. Type `bye' to exit a package, or `logout' to get out of the CL.
Visit http://iraf.net if you have questions.
*** Using global login file: /home/satyapriya/.iraf/login.cl
The following commands or packages are currently defined:
dataio. language. noao. plot. softtools. utilities.
images. lists. obsolete. proto. system.
cl> !ds9 &
cl> ls
LAB_1.pdf photo1.fits photo2.fits test-f1.fits test-f2.fits
cl> imexamine test-f2.fits
display frame (1;) (1):
z1=554. z2=6730.738
SAOImage ds9
File Edit View Frame Bin Zoom Scale Color Region WCS Illustrate Analysis Help
File test-f2.fits
Object unnamed
Value 169
WCS
Physical x 573 y 1232
Image x 254 y 413
Frame 1 x 1 y 0
file edit view frame bin zoom scale color region wcs illustrate analysis help
linear log power sqrt squared asinh sinh histogram min max zscale

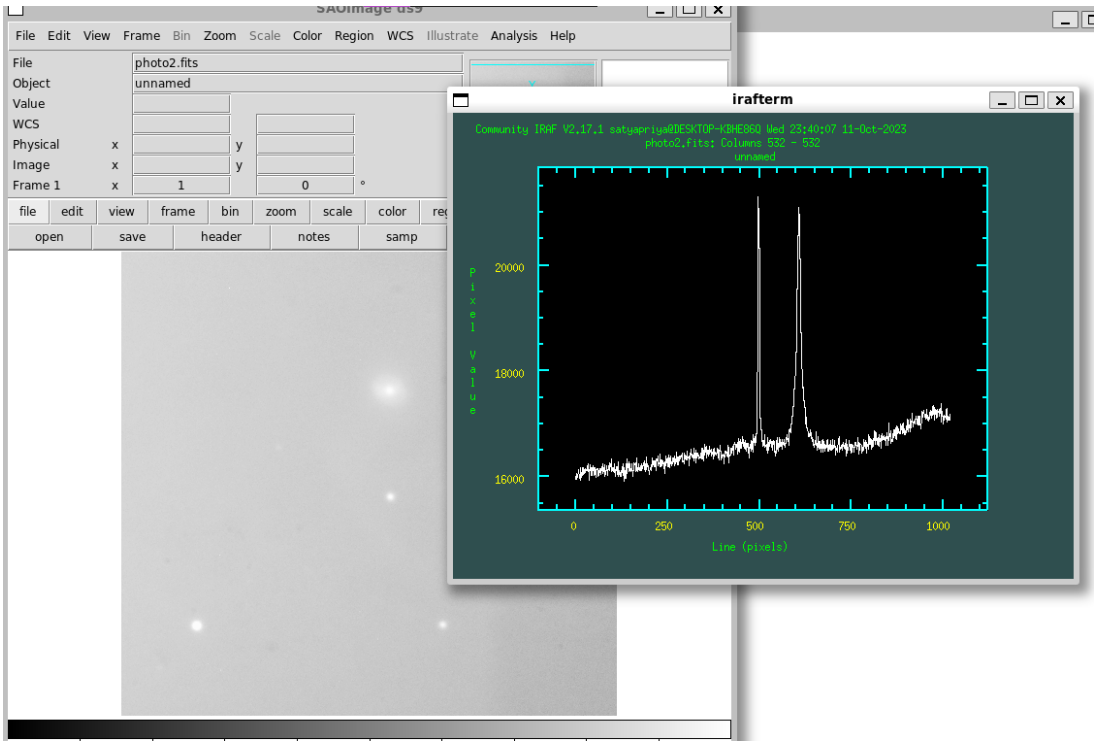
This shows the help one. Really HELPful since we don't have to remember anything. But anyway it is quite intuitive too.

Below for a star(I have marked in one figure which one) I have added all the corresponding figures and values as asked (and beyond).

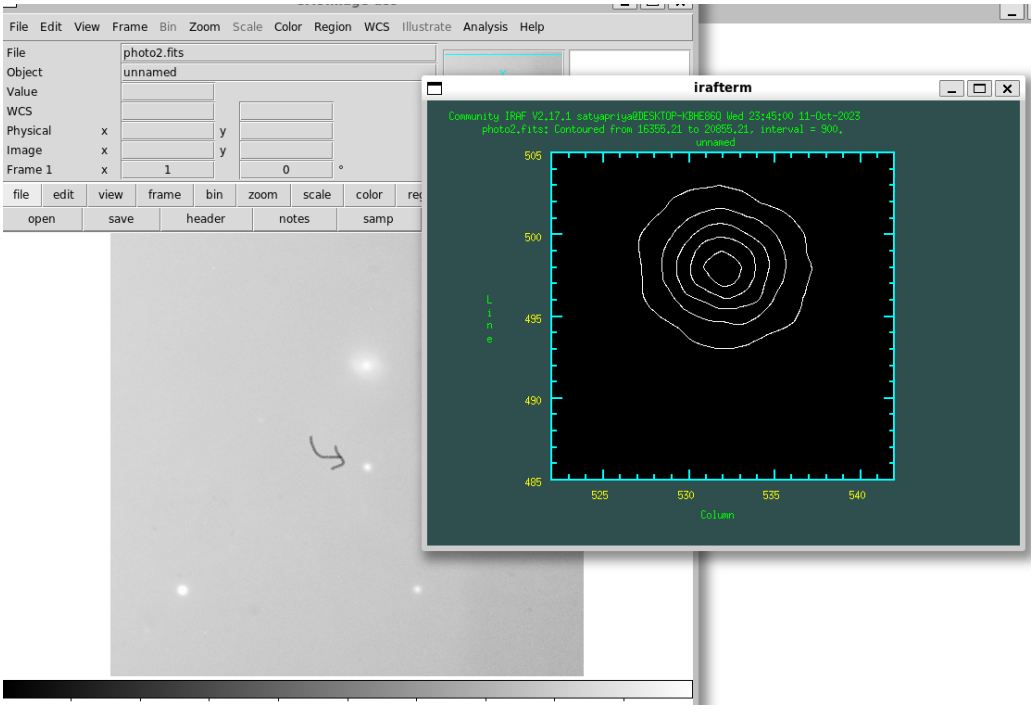
r– gives radial profile of a source



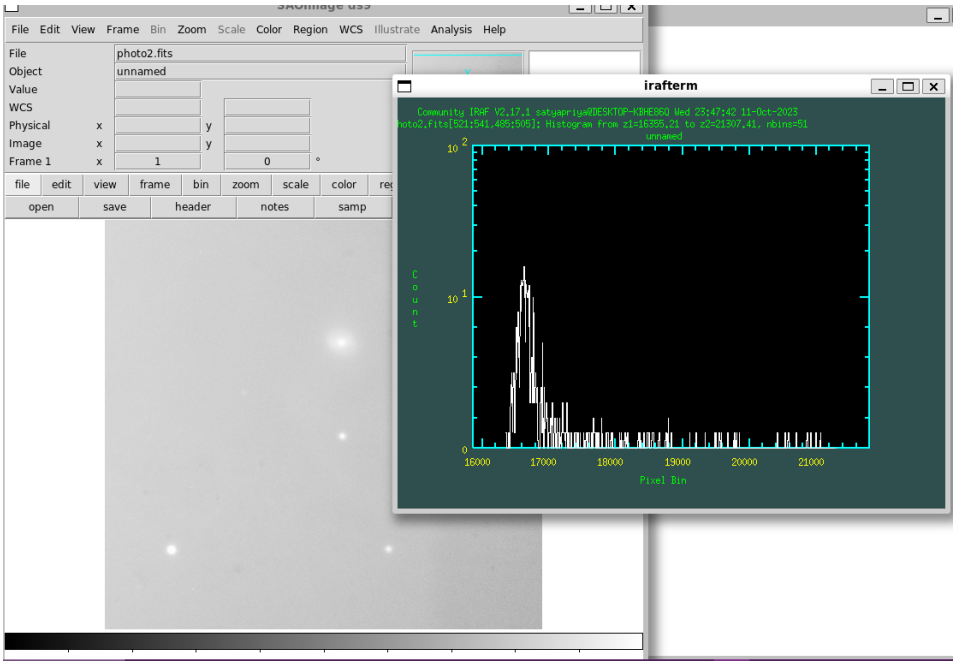
c - Column plot across those two stars



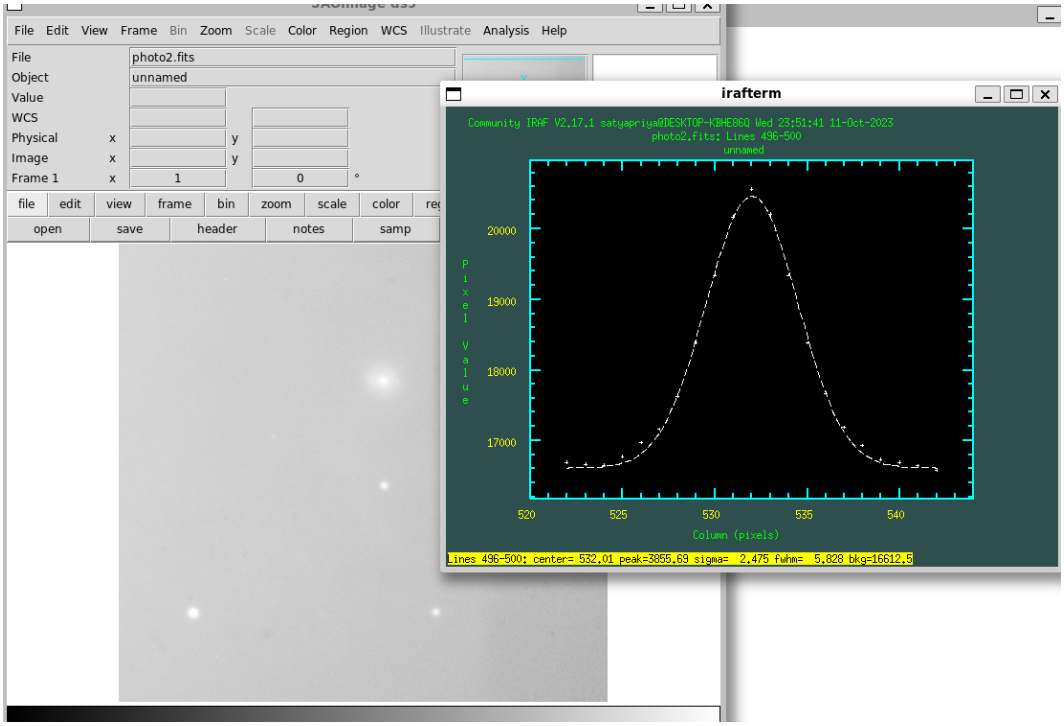
e – contour plot



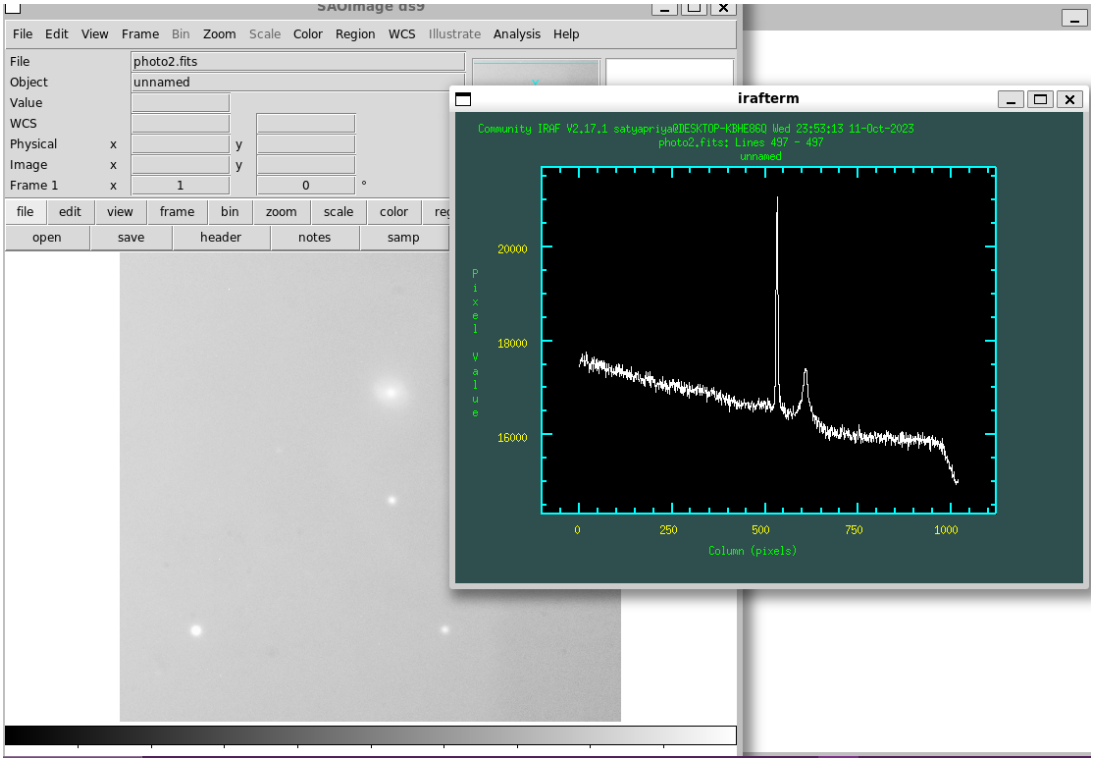
h – histogram plot



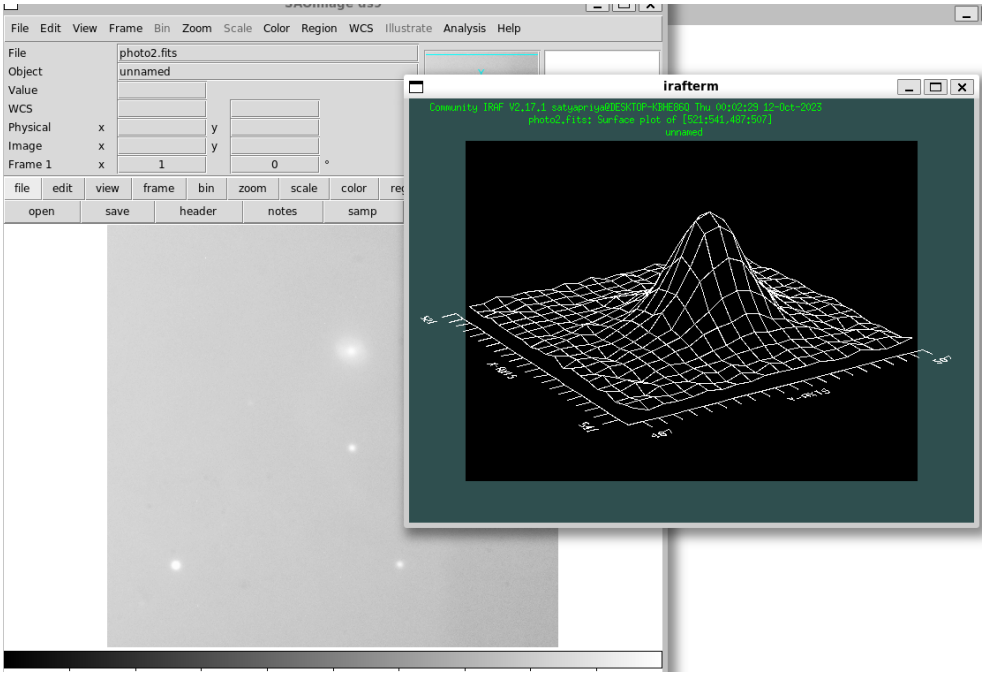
j – line gauss fit



l – line plot



s - surface plot



a (aperture sum) gives:

```
#   COL     LINE   COORDINATES
#     R     MAG    FLUX      SKY     PEAK     E    PA BETA ENCLOSED   MOFFAT DIRECT
 532.00  498.02 532.00 498.02
  15.98  11.79 192711.  16585.   4746. 0.10  -72 7.08     5.30     5.49   5.34
```

m(statistics):

```
#          SECTION     NPIX     MEAN   MEDIAN   STDDEV      MIN      MAX
  [529:533,496:500]       25   19731.   19679.    981.9   17953.   21307.
```

Z(nearby value):

```
      527   528   529   530   531   532   533   534   535   536   537
 502 1.7E4 1.7E4 1.7E4 1.7E4 1.8E4 1.8E4 1.8E4 1.7E4 1.7E4 1.7E4 1.7E4
 501 1.7E4 1.7E4 1.8E4 1.8E4 1.9E4 1.9E4 1.8E4 1.8E4 1.8E4 1.7E4 1.7E4
 500 1.7E4 1.8E4 1.8E4 1.9E4 2.0E4 2.0E4 1.9E4 1.9E4 1.8E4 1.7E4 1.7E4
 499 1.7E4 1.8E4 1.9E4 2.0E4 2.1E4 2.1E4 2.1E4 2.0E4 1.9E4 1.8E4 1.7E4
 498 1.7E4 1.8E4 1.9E4 2.0E4 2.1E4 2.1E4 2.1E4 2.0E4 1.9E4 1.8E4 1.7E4
 497 1.7E4 1.8E4 1.9E4 2.0E4 2.0E4 2.1E4 2.1E4 1.9E4 1.8E4 1.8E4 1.7E4
 496 1.7E4 1.7E4 1.8E4 1.9E4 1.9E4 2.0E4 2.0E4 1.9E4 1.8E4 1.8E4 1.7E4
 495 1.7E4 1.7E4 1.7E4 1.8E4 1.8E4 1.8E4 1.8E4 1.8E4 1.8E4 1.7E4 1.7E4
 494 1.7E4 1.7E4 1.7E4 1.7E4 1.8E4 1.8E4 1.8E4 1.7E4 1.7E4 1.7E4 1.7E4
 493 1.7E4 1.7E4 1.7E4 1.7E4 1.7E4 1.7E4 1.7E4 1.7E4 1.7E4 1.7E4 1.7E4
 492 1.7E4 1.7E4 1.7E4 1.7E4 1.7E4 1.7E4 1.7E4 1.7E4 1.7E4 1.7E4 1.7E4
```

Exercise:

1. **Display 'test-f2.fits' from IRAF environment in buffer #1 and then open the same image in frame #2 using ds9. What is the difference? (You might have to set stdimage. Check your notes).**

   The header is not the same. When loaded
   from imexamine it shows only this in header:

   ```
   SIMPLE  =                    T / Fits Standard
   BITPIX  =                    8 / Bits per pixel
   NAXIS   =                    2 / Number of axes
   NAXIS1  =                 4096 / Axis Length
   NAXIS2  =                 4096 / Axis Length
   END
   ```

   Whereas loading from ds9 it shows full information in header. Also in image opened from display doesn't show the option to change scale, illustrate, icons in view in ds9.

2. **Where was this image taken, with what size of a telescope, and with what instrument and detector?**

   ```
   TELESCOP= 'APO 3.5m         ' / Telescope used for observation
   ORIGIN  = 'Apache Point Obser' / Observatory Location
   LATITUDE=           32.780361 / Observatory Latitute (degrees)
   LONGITUD=          105.820417 / Observatory longitude (degrees)
   INSTRUME= 'Spicam           ' / Instrument used for observation
   DETECTOR= 'Spicam CCD       ' / Detector used for observation
   ```

3. **On what date was the observation made? How long was the exposure?**

   DATE-OBS= '99/03/11 ' / local date of obs (I think it is 11th March 1999)
   EXPTIME = 5.000000 / actual exposure time (No unit given (Problem!!))

4. **We define a 'frame' as entire read-out from the CCD (including any overscan region) and 'image' as that portion of the 'frame' that has the observation. How many pixels are there in the entire image? Is this value consistent with the results obtained in 'imstat'? Explain.**

   ```
   cl> imstat
   List of input images: test-f2.fits
   #               IMAGE      NPIX      MEAN    STDDEV       MIN       MAX
        test-f2.fits   2472500     2438.     1349.      542.     65535.
   ```

   Yes it is consistent for frame because if we look from ds9:

   NAXIS1 = 1150 /

NAXIS2 = 2150 /

But not if see the one opened from display:

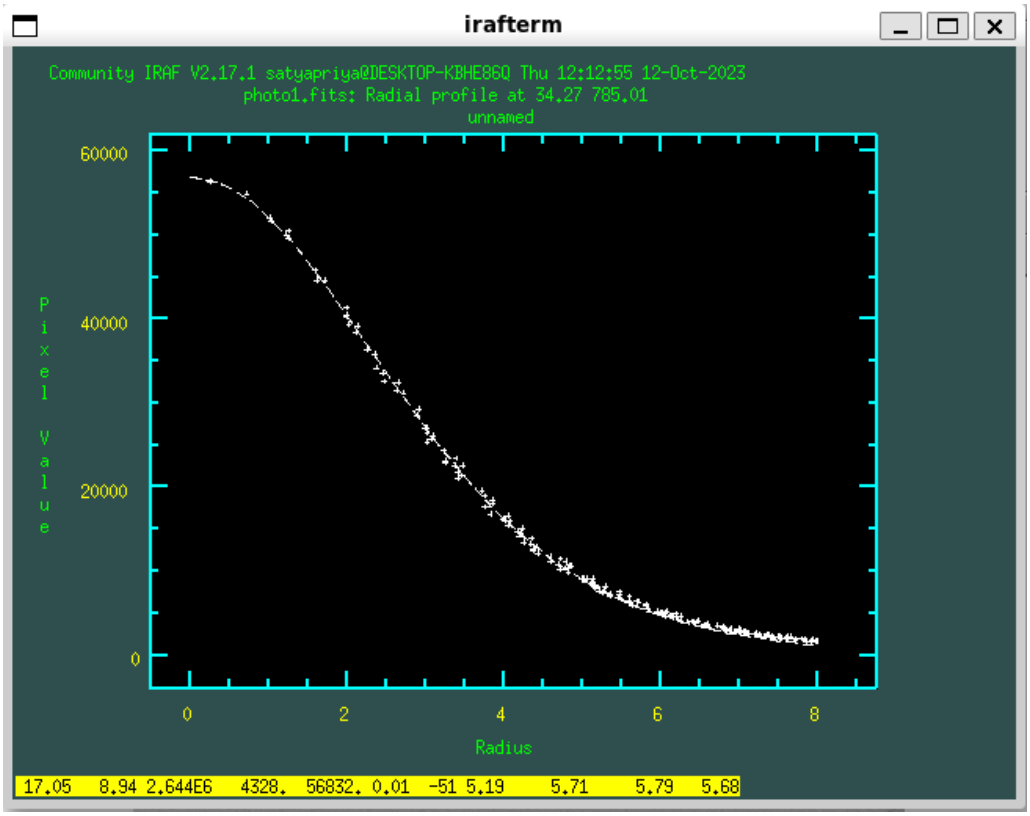
NAXIS1 = 4096 / Axis Length

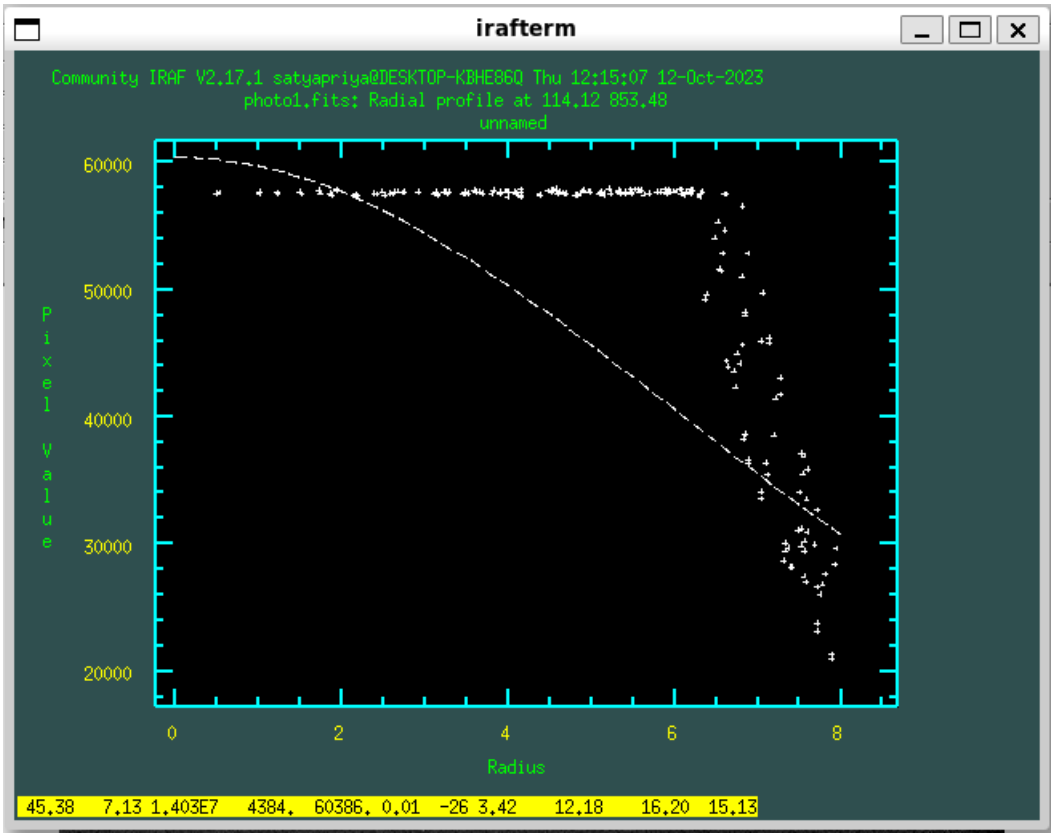
NAXIS2 = 4096 / Axis Length

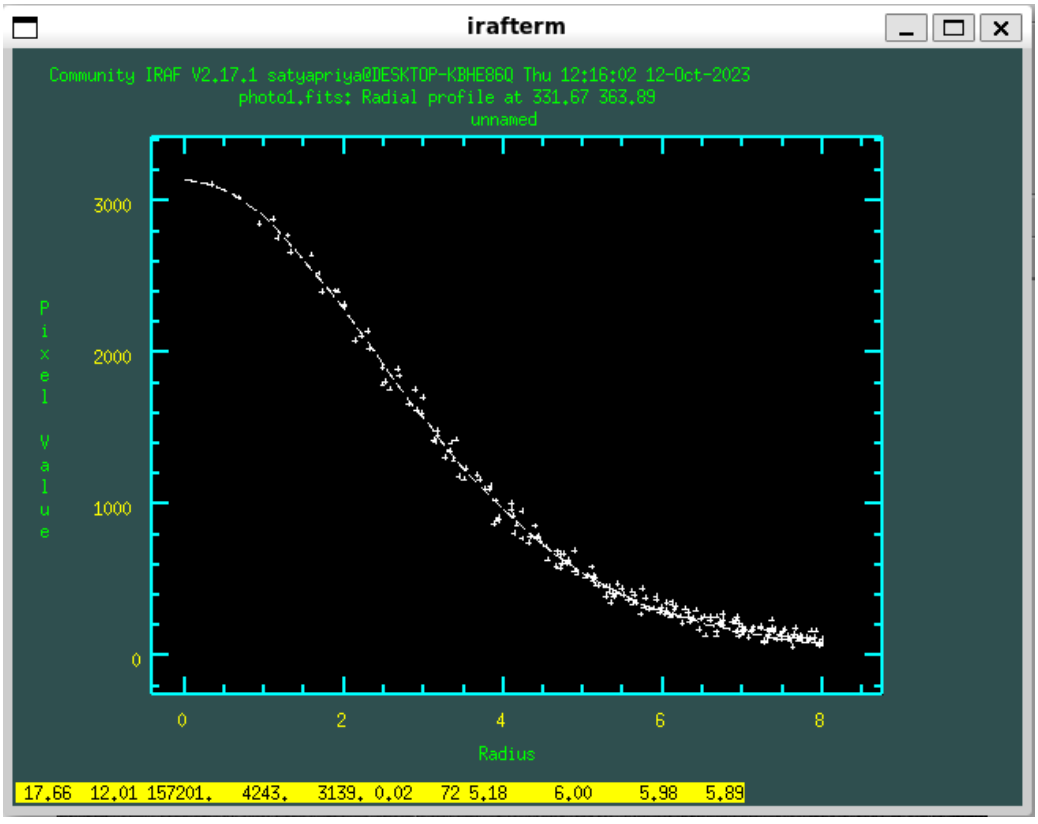
Dimension of actual image was 1024x2045 after inspecting the image in DS9.

5. **Display 'photo1.fits'. Examine the profiles of stars at (34, 785), (114,852) and (331,364). Save the radial profiles in the directory you have created. Comment on the shape. Given that the electronics for this camera used a 16-bit Analog to Digital converter, explain why one particular profile looks weird.**

As we can see that the radial profile for (34, 785 and (331,364) is fine and matching and thus represent the PSF value of the telescope but that is not the case for (114,852) since as we can see it has reached the saturation limit beyond its linear scale. Hence this is not a good source to observe over this integration time.




irafterm
Community IRAF V2.17.1 satyapriya@DESKTOP-KBHE86Q Thu 12:15:07 12-Oct-2023
photo1.fits: Radial profile at 114.12 853.48
unnamed
60000
50000
40000
30000
20000
Pixel Value
0
2
4
6
8
Radius
45.38 7.13 1.403E7 4384. 60386. 0.01 -26 3.42 12.18 16.20 15.13


irafterm
Community IRAF V2.17.1 satyapriya@DESKTOP-KBHE86Q Thu 12:16:02 12-Oct-2023
photo1.fits: Radial profile at 331.67 363.89
unnamed
3000
2000
1000
0
Pixel Value
0
2
4
6
8
Radius
17.66 12.01 157201. 4243. 3139. 0.02 72 5.18 6.00 5.98 5.89