IRAF LAB REPORT 2

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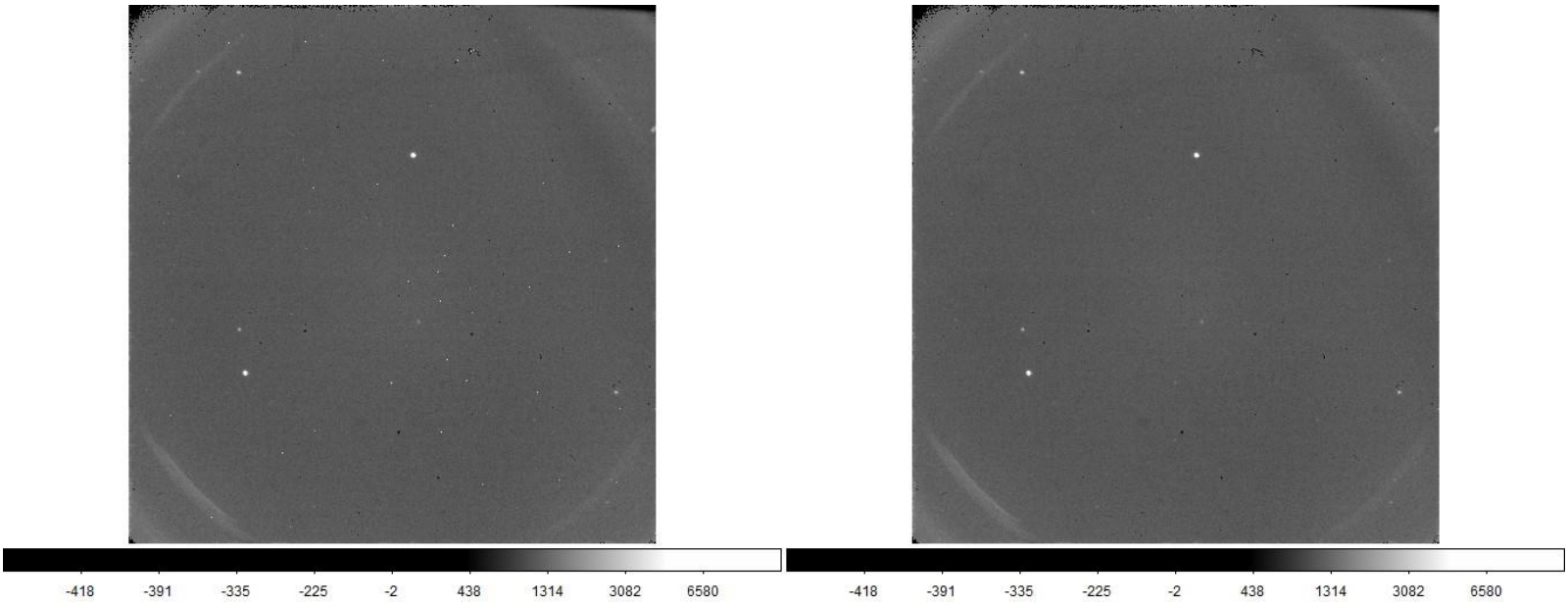
1. Cosmic Ray Correction

Cosmic rays or astro-particles are high-energy particles or clusters of particles (primarily represented by protons or atomic nuclei) that move through space at nearly the speed of light. They are not widespread like a PSF but will affect certain pixels during exposure time. If not removed cosmic rays compromise with the photometry and often give rise to spurious detections. Hence to remove them we can take the nearby value and put that in those pixels affected by cosmic rays or else just remove them and put some negative number which is actually done by IRAF.

The picture below is an example of before and after removal of cosmic rays from the fits image.



a) **Raw Set3_3 image** **b) Cosmic ray removed Set3_3 image**

Fig 1.1: Before and after removal of cosmic rays from the fits image

2. Image Statistics

```
im> imstatistics
List of input images (@filelist):
#               IMAGE      NPIX      MEAN    STDDEV       MIN       MAX
 fs24_50s_J_set1_1.fits   1048576     1160.     117.2     -226.    14325.
 fs24_50s_J_set1_2.fits   1048576     1161.     100.9     -99.7    12936.
 fs24_50s_J_set1_3.fits   1048576     1167.     98.08     -139.    11761.
 fs24_50s_J_set2_1.fits   1048576     1166.     205.6    -170.1    13567.
 fs24_50s_J_set2_2.fits   1048576     1166.     206.2    -170.1    13567.
 fs24_50s_J_set2_3.fits   1048576     1131.      196.    -817.4    13217.
 fs24_50s_J_set3_1.fits   1048576     1161.      159.    -139.1    11333.
 fs24_50s_J_set3_2.fits   1048576     1158.     160.9    -130.6    12675.
 fs24_50s_J_set3_3.fits   1048576     1170.     163.2    -79.52    12322.
 fs24_50s_J_set4_1.fits   1048576     1154.     123.4    -76.42    12585.
 fs24_50s_J_set4_2.fits   1048576     1137.     122.5    -114.9    12447.
 fs24_50s_J_set4_3.fits   1048576     1128.     121.5    -117.3    12828.
 fs24_50s_J_set5_1.fits   1048576     1097.     177.2     -73.3    12257.
 fs24_50s_J_set5_2.fits   1048576     1088.     174.7     -141.    11457.
 fs24_50s_J_set5_3.fits   1048576     1085.     177.6    -110.4    11546.
im> imstatistics
List of input images (@filelist): combined_image.fits
#               IMAGE      NPIX      MEAN    STDDEV       MIN       MAX
  combined_image.fits   1048576     1142.     90.78     307.8    11278.
im> imstatistics
List of input images (combined_image.fits): combined_image_median.fits
#               IMAGE      NPIX      MEAN    STDDEV       MIN       MAX
 combined_image_median.fits   1048576     1147.     76.95     20.36    11938.
```

Fig 2.1: Image statistics of cosmic rays removed files and the final average and median co-added image

3. Image Shifting

For star fs24 its RA, DEC and magnitude is taken from SIMBAD. They are as follows: -

ICRS Coordinate (J200):-
14 40 06.9977539536 +00 01 45.108751116 (Optical) [0.0179 0.0160 90] A 2020yCat.1350....0G

Magnitude: -
J 10.889 [0.023] C 2003yCat.2246....0C
H 10.811 [0.027] C 2003yCat.2246....0C
K 10.769 [0.026] C 2003yCat.2246....0C

There are so many sets of images (5 sets) to do dithering. As we know the atmosphere condition changes rapidly and it affects the image, especially in the IR band. Therefore, in order to solve this issue, we take multiple short-exposure images with a frequency faster than that of atmospheric changes. Then by shifting and coadding them, we can get a good SNR image. That is precisely what we will do in this lab.

Shifting is done with respect to the set1_1 image. Noted down the position of one star in various image and delta x and delta y is calculated using Python (import txt file, subtract, export). That file is provided for the shift. Before and after shifted images are shown below:

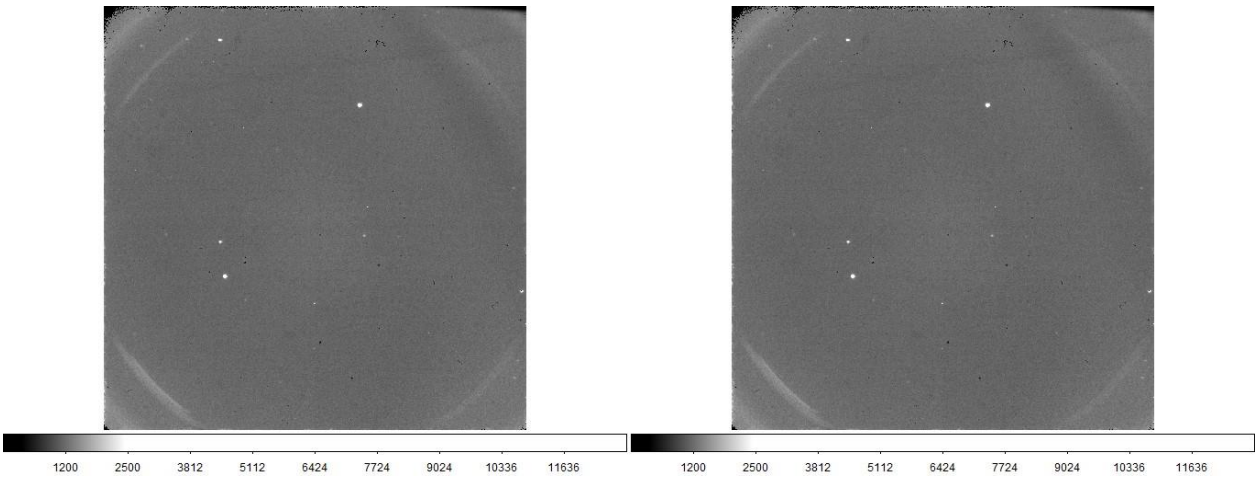


Fig 3.1. Set1_1

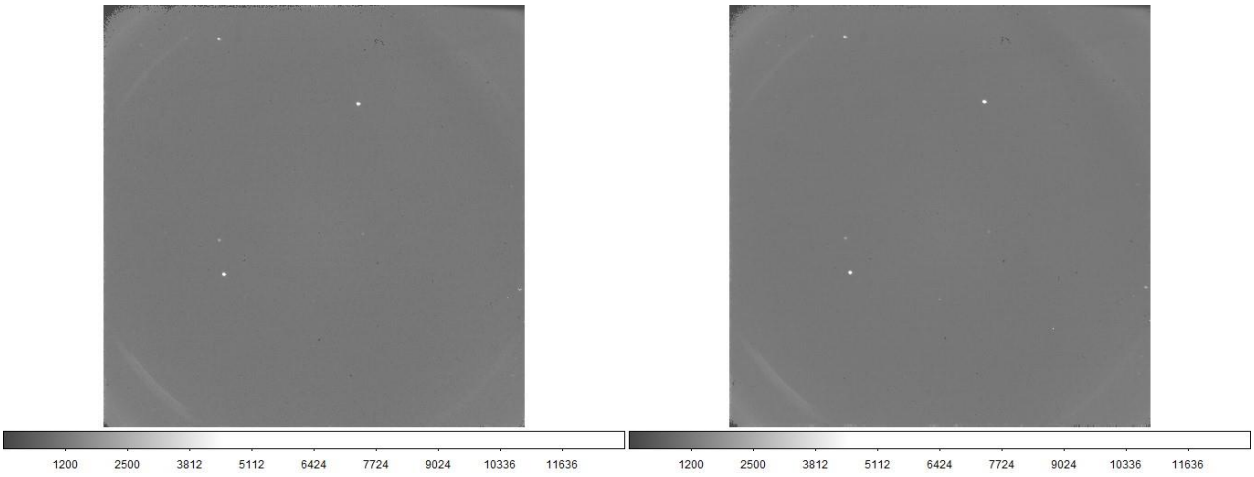


Fig 3.2. Set1_2

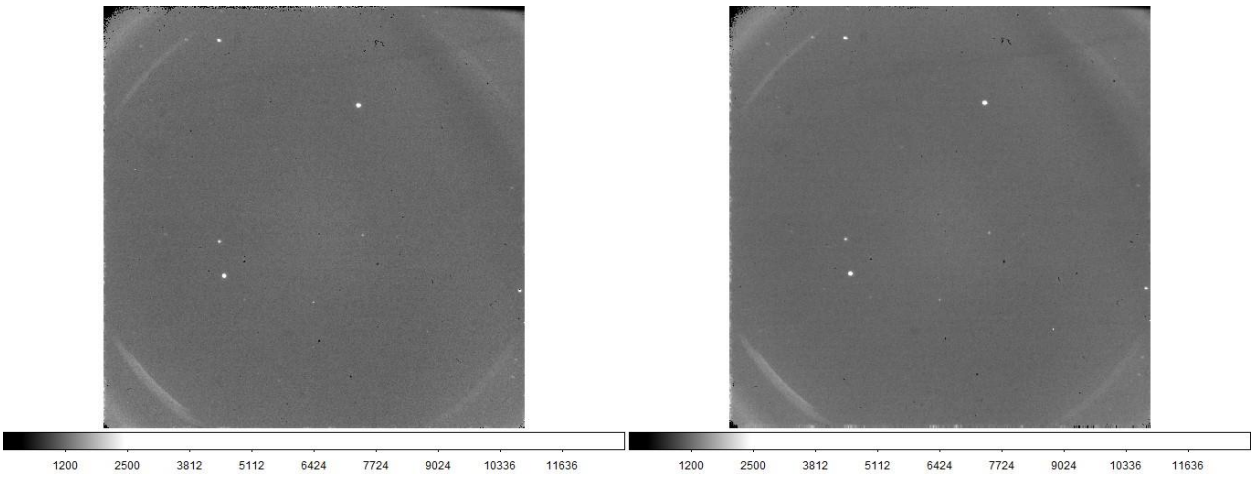


Fig 3.3. Set1_3

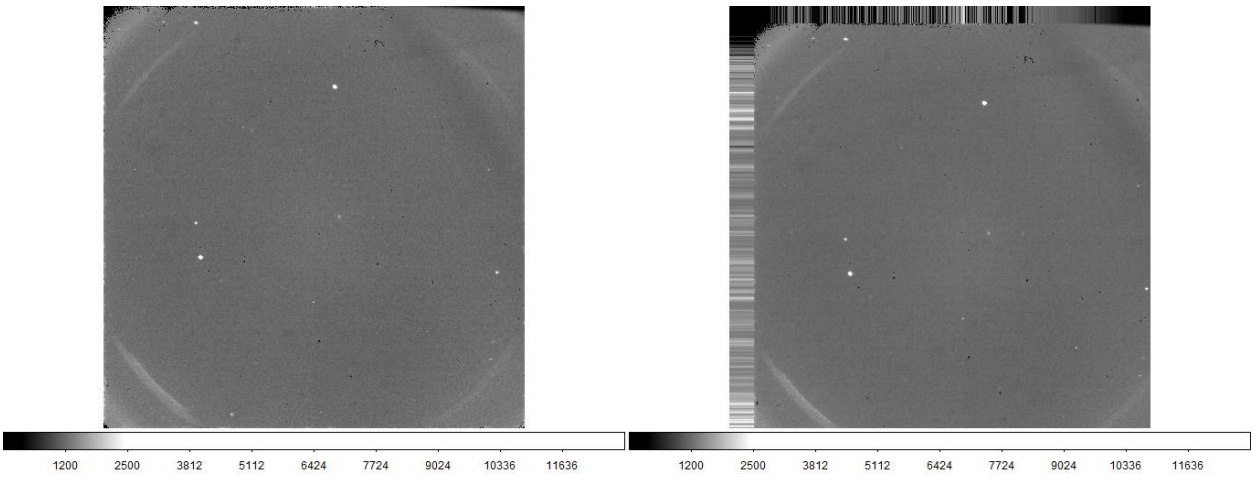


Fig 3.4. Set2_1

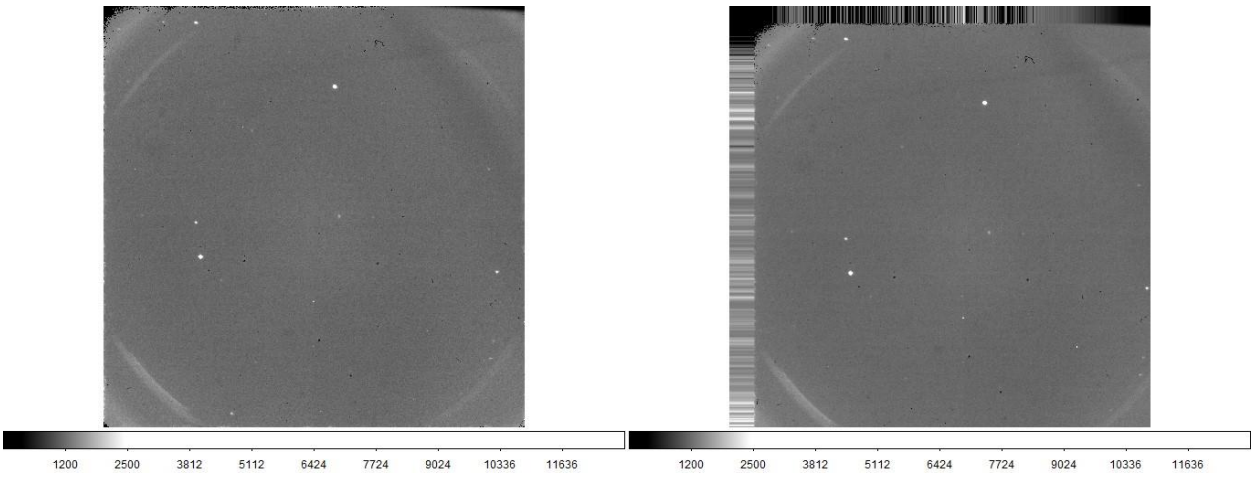


Fig 3.5. Set2_2

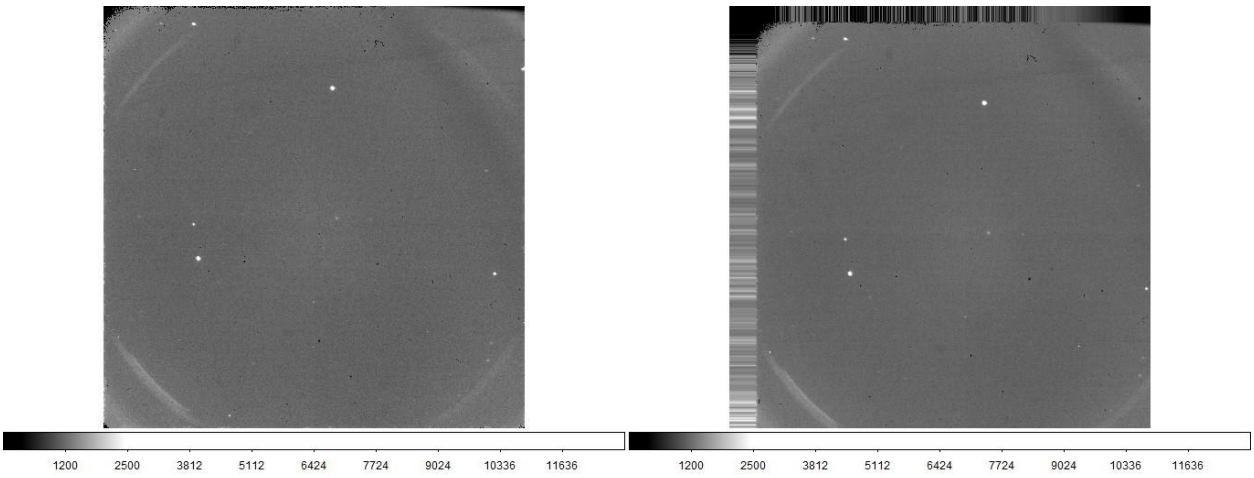


Fig 3.6. Set2_3

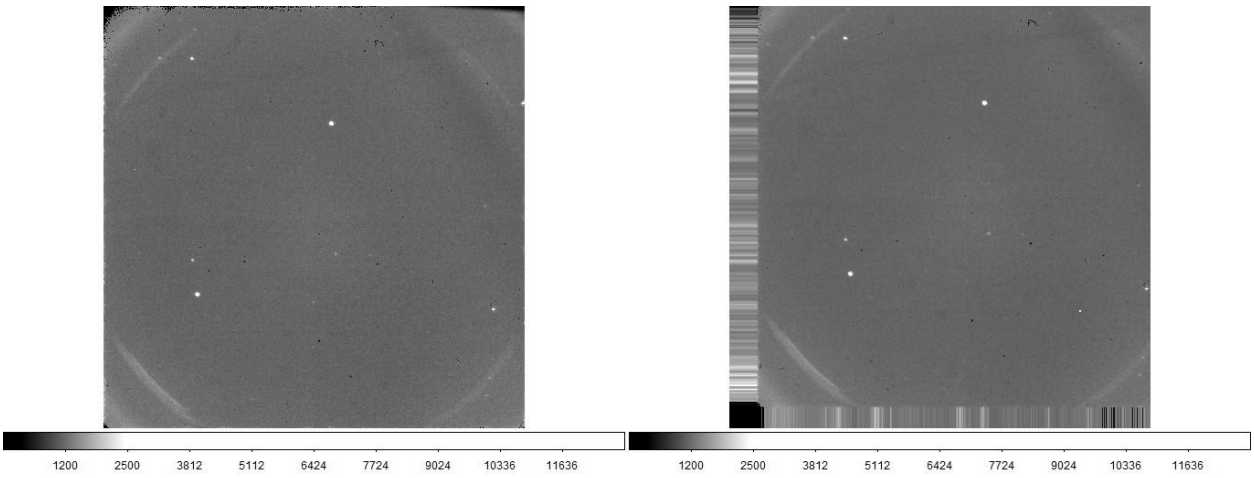


Fig 3.7. Set3_1

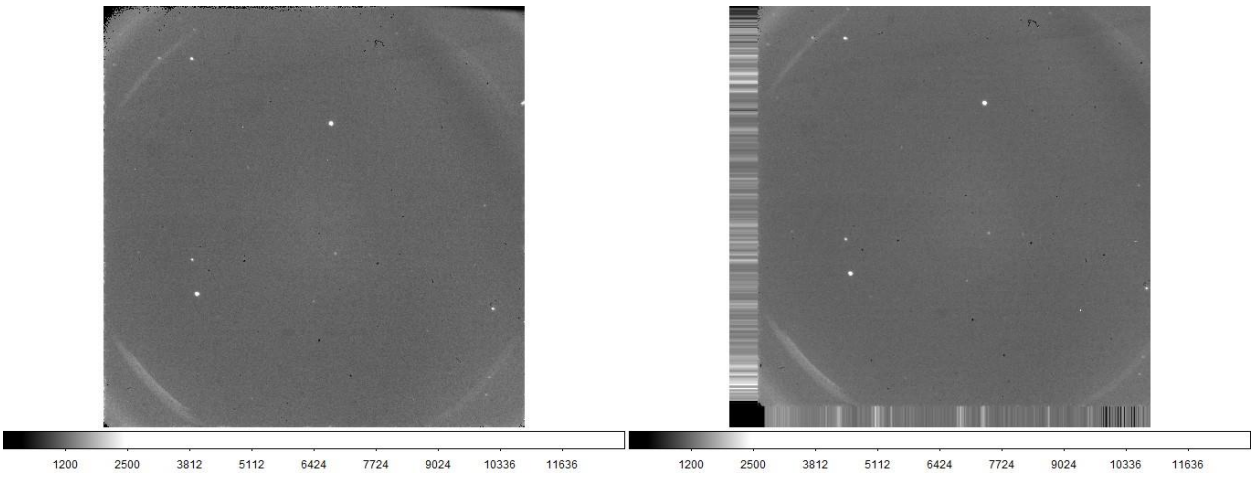


Fig 3.8. Set3_2

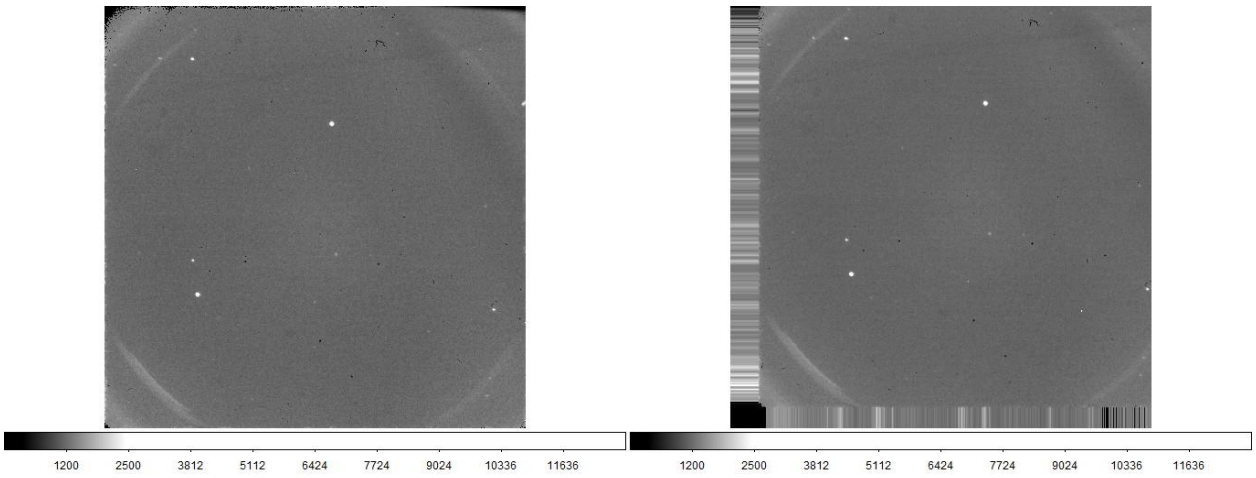


Fig 3.9. Set3_3

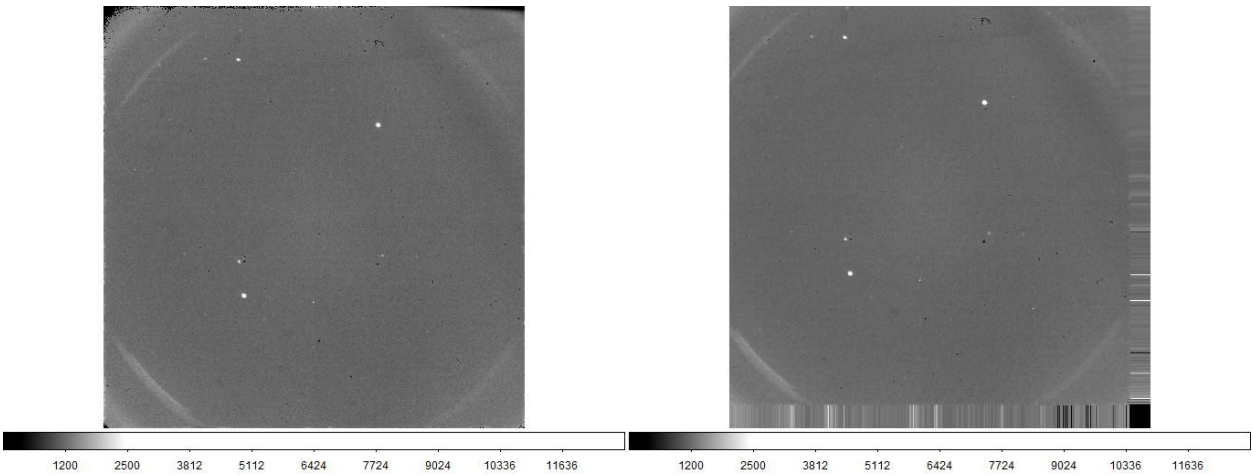


Fig 3.10. Set4_1

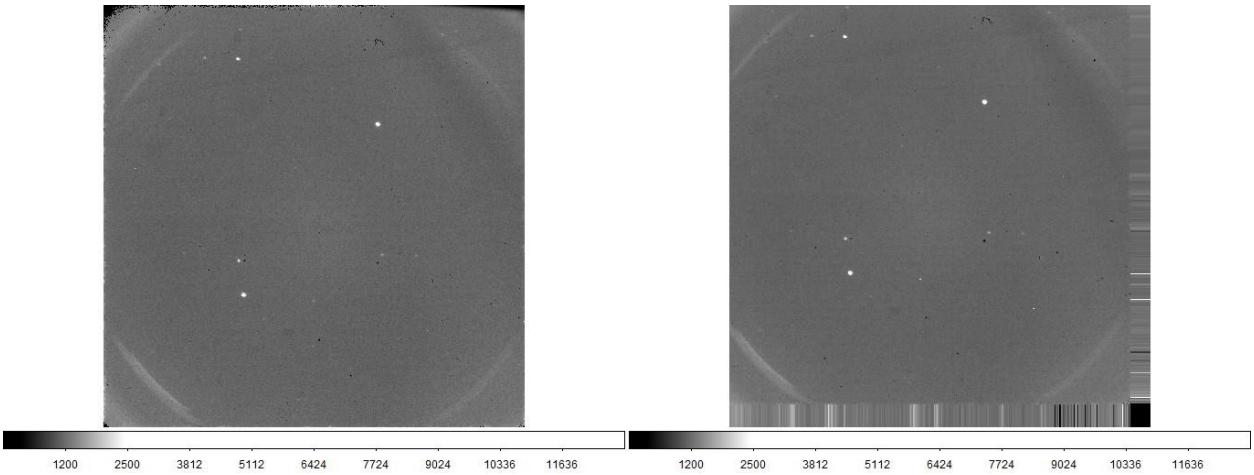


Fig 3.11. Set4_2

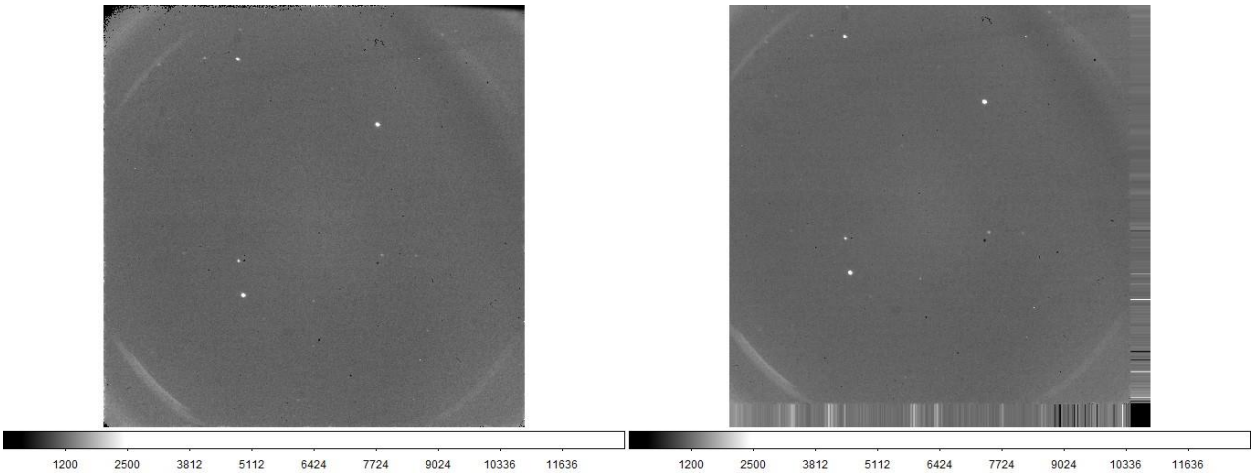


Fig 3.12. Set4_3

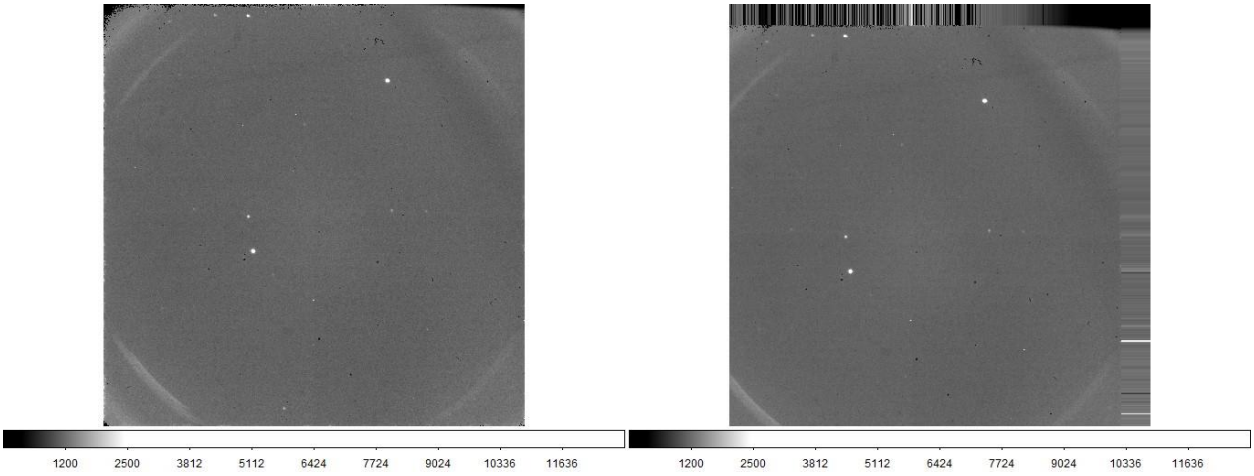


Fig 3.13. Set5_1

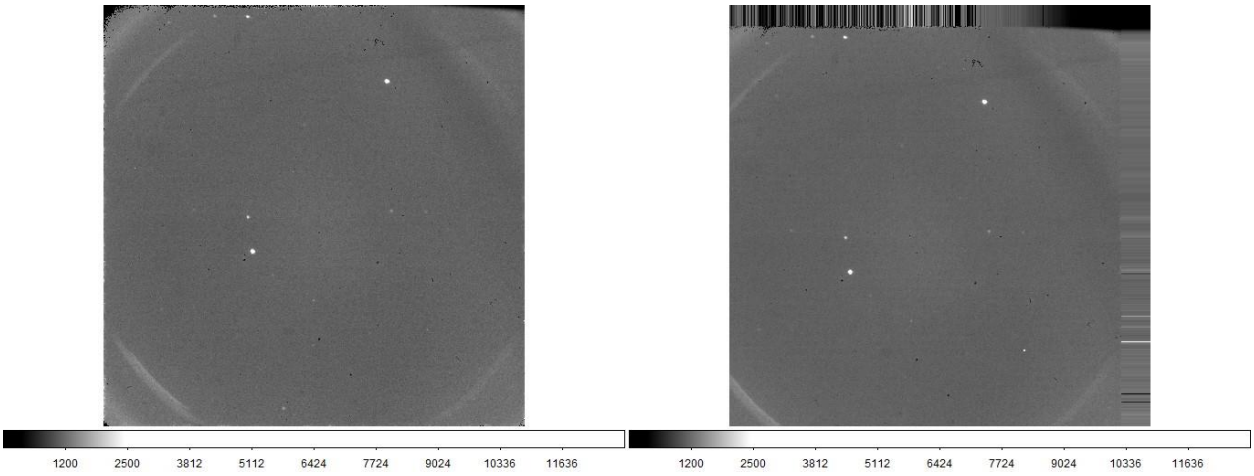


Fig 3.14. Set5_2

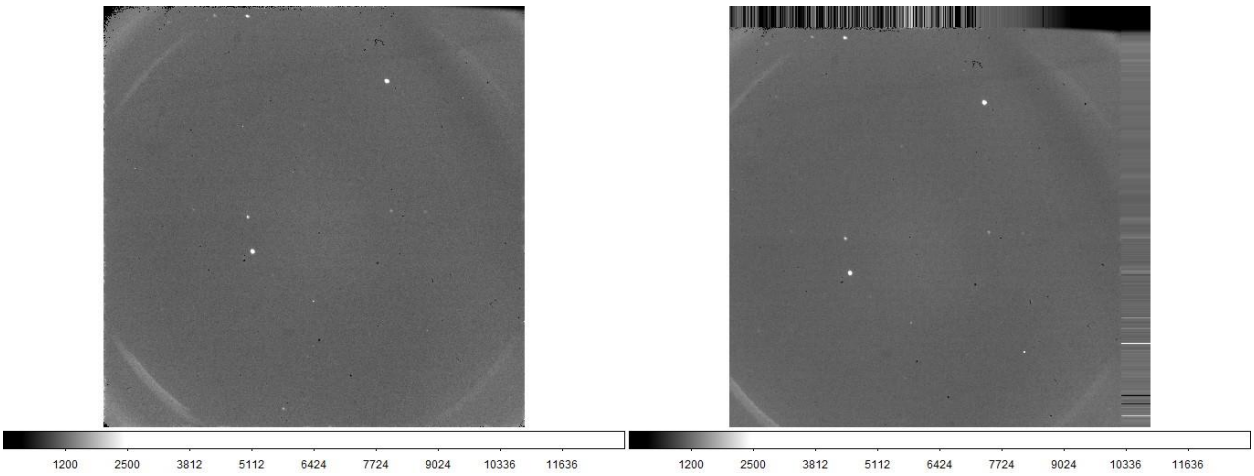
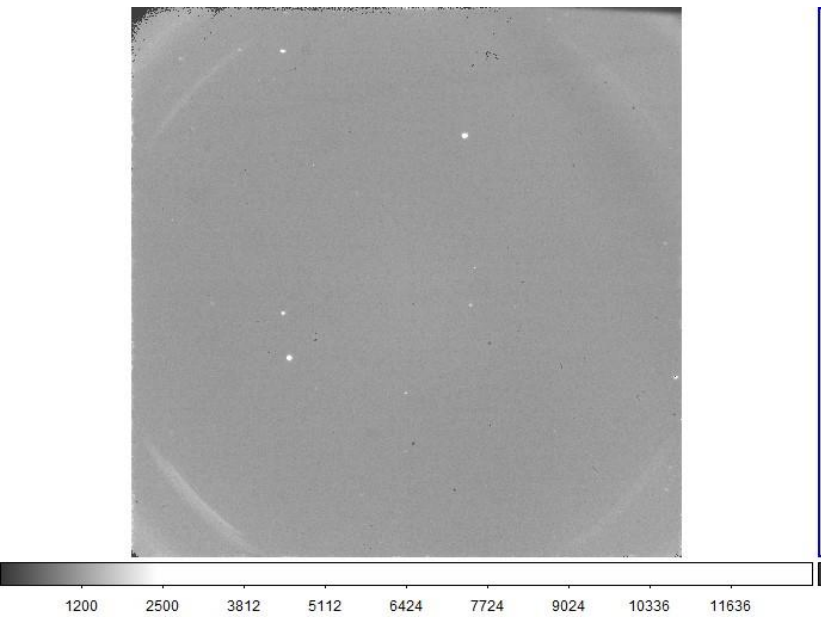


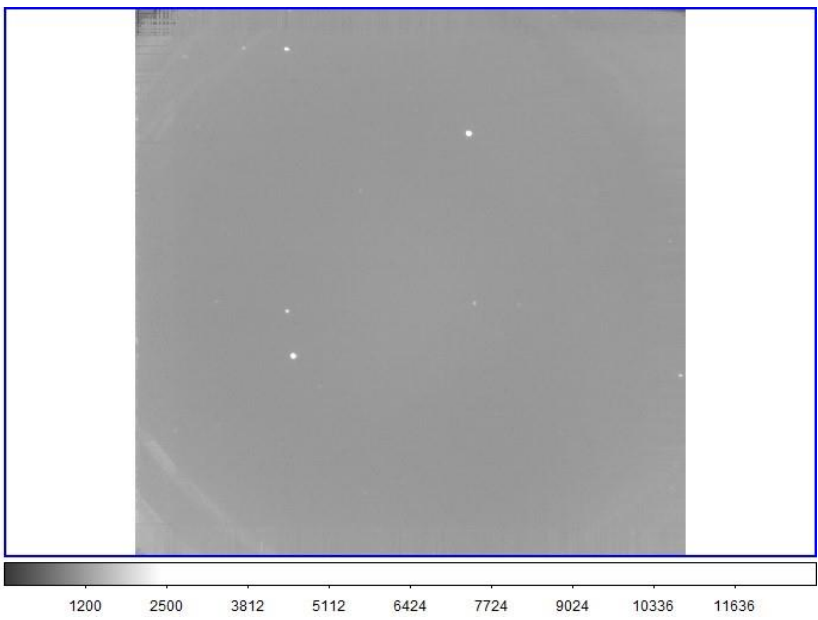
Fig 3.15. Set5_3

Co-adding

After shifting all the images they are co-added using imcombine in order to increase the SNR. The final adding is done using average and via median. They are shown below.

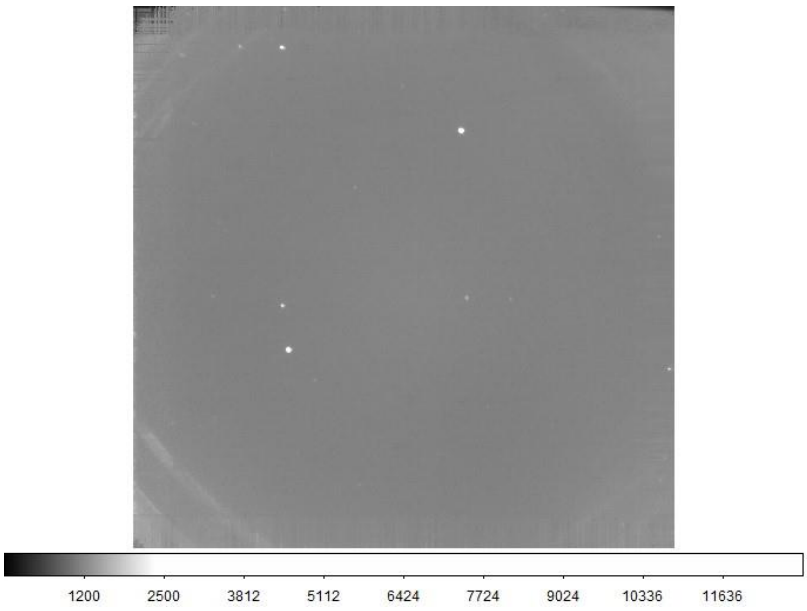


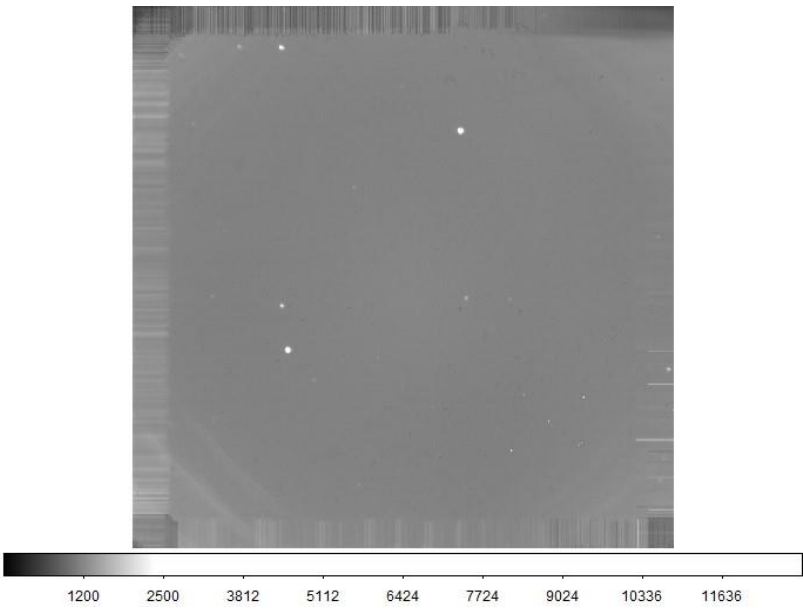
a) Set1_1



b) Median image

Fig 4.1. a) Represent the Set1_1 image b) Median image. From these we can see that the effect of bad pixel has reduced, and the overall noise level has reduced. Hence leading to better SNR.





a) Median Image **b) Average Image**

Fig 4.2.: a) Represent median image b) Average image. We can observe that SNR has improved in both , but the key difference is the effect of shifting is very less prominent in median image compared to the average image.