Shifting - scale and combine completed in separate notebook

All work completed by Panchami and Monica

In [2]:

```
import numpy as np
import astropy
import ccdproc
from ccdproc import CCDData, Combiner
from astropy import units as u
from astropy.visualization import SqrtStretch
import matplotlib.pyplot as plt
from matplotlib.colors import LogNorm
from photutils import centroid_com, centroid_1dg, centroid_2dg
from photutils import CircularAperture
from photutils import aperture_photometry
from photutils import Background2D
from photutils import MedianBackground
from scipy.ndimage import shift
import gc
gc.enable()
```

Starting with the processed V images

In [4]:

```
# Read in the processed images and filter out the V bands
images = ccdproc.ImageFileCollection(".",glob_include='proc_NGC_2808_V_*')
scim = [CCDData.read(fn, unit = "adu") for fn in images.files_filtered(PICTTYPE = 1)
```

```
INFO:astropy:using the unit adu passed to the FITS reader instead of t
he unit adu in the FITS file.
WARNING: FITSFixedWarning: 'obsfix' made the change 'Set OBSGEO-X to -
4130881.901 from OBSGEO-[LBH].
Set OBSGEO-Y to  2896022.315 from OBSGEO-[LBH].
Set OBSGEO-Z to -3889419.901 from OBSGEO-[LBH]'. [astropy.wcs.wcs]
WARNING:astropy:FITSFixedWarning: 'obsfix' made the change 'Set OBSGEO
-X to -4130881.901 from OBSGEO-[LBH].
Set OBSGEO-Y to  2896022.315 from OBSGEO-[LBH].
Set OBSGEO-Z to -3889419.901 from OBSGEO-[LBH]'.
INFO:astropy:using the unit adu passed to the FITS reader instead of t
he unit adu in the FITS file.
INFO:astropy:using the unit adu passed to the FITS reader instead of t
he unit adu in the FITS file.

INFO: using the unit adu passed to the FITS reader instead of the unit
adu in the FITS file. [astropy.nddata.ccddata]
INFO: using the unit adu passed to the FITS reader instead of the unit
adu in the FITS file. [astropy.nddata.ccddata]
INFO: using the unit adu passed to the FITS reader instead of the unit
```

In [5]:

```
newname=[]
for fn in images.files_filtered(PICTTYPE=1):
    newname.extend(["s"+fn])
print(newname)
```

```
['sproc_NGC_2808_V_00002829.fits', 'sproc_NGC_2808_V_00002830.fits',
'sproc_NGC_2808_V_00002831.fits', 'sproc_NGC_2808_V_00002848.fits', 's
proc_NGC_2808_V_00002849.fits', 'sproc_NGC_2808_V_00002850.fits', 'spr
oc_NGC_2808_V_00002851.fits', 'sproc_NGC_2808_V_00002852.fits', 'sproc
_NGC_2808_V_00002853.fits', 'sproc_NGC_2808_V_00002854.fits', 'sproc_N
GC_2808_V_00002855.fits', 'sproc_NGC_2808_V_00002856.fits', 'sproc_NGC
_2808_V_00002857.fits', 'sproc_NGC_2808_V_00002868.fits', 'sproc_NGC_2
808_V_00002869.fits', 'sproc_NGC_2808_V_00002870.fits', 'sproc_NGC_280
8_V_00002871.fits', 'sproc_NGC_2808_V_00002872.fits', 'sproc_NGC_2808_
V_00002873.fits', 'sproc_NGC_2808_V_00002875.fits', 'sproc_NGC_2808_V_
00002876.fits', 'sproc_NGC_2808_V_00002877.fits', 'sproc_NGC_2808_V_00
002899.fits', 'sproc_NGC_2808_V_00002901.fits', 'sproc_NGC_2808_V_0000
2902.fits', 'sproc_NGC_2808_V_00002903.fits', 'sproc_NGC_2808_V_000029
04.fits', 'sproc_NGC_2808_V_00002905.fits', 'sproc_NGC_2808_V_0000290
6.fits', 'sproc_NGC_2808_V_00002907.fits']
```

In [6]:

```
# Using the first processed V band image, a star has been located at coordinates x=1


temp=scim[0].copy() #defines temporary file
temp=temp-np.ma.median(temp)

# Determine the centroid - (1083, 461)
x1, y1 = centroid_com(temp[1000:1100,400:500])
print(x1+1083, y1+461)
```

```
1120.7532788214335 513.342308164585
```

In [7]:

```
xoffset = 401   # x edge of the box
yoffset = 1023  # y edge of the box
xbox = 60       # comment
ybox = 60       # comment
shiftx=[]        # defines array
shifty=[]        # define array

for idx, thisimage in enumerate(scim):
    temp = scim[idx].copy()
    temp =  temp-np.ma.median(temp)
    x1, y1 = centroid_com( temp[yoffset : yoffset + ybox, xoffset : xoffset + xbox])
    print(x1 +xoffset, y1 + yoffset )
    shiftx.append(x1 + xoffset)
    shifty.append(y1 + yoffset )

print(shiftx)   # What is this?
print(shifty)   # What is this?

print(shiftx[0]-shiftx) # calculate the shift in x
print(shifty[0]-shifty) # calculate the shift in y
```

```
442.7960120395205 1066.136720785921
442.16814411040866 1066.0356416729308
441.71361242123055 1067.526656752369
442.36206339641313 1065.706065065345
442.93307675536477 1066.5233498834355
443.58184430777186 1066.4031611949777
442.47321266582094 1066.7059154569215
442.93039440596283 1066.9695185015808
442.5248802213606 1066.8837784979244
443.066336731942 1066.6397958423777
443.2784015550081 1066.3448731344527
443.7429920684534 1065.9169958675222
443.73115515611653 1066.4008067909372
443.89447937412035 1065.994099602866
443.88163256544493 1065.988826132378
443.5496807378928 1066.677556576289
443.2918702587794 1066.7218738218244
443.65540437327553 1066.973097264775
443.02837536243584 1066.8330640664265
444.50153415001296 1066.597251050656
443.0204527067165 1066.4705210792258
443.73460176974714 1066.6188812149553
442.1708076815321 1067.720649688266
443.04082914983053 1069.1721025032189
443.84506195712095 1067.3376294768423
441.9638274565777 1068.390641274415
441.6924152005056 1068.604785049092
442.1128164555398 1065.548733533069
442.7488241779673 1067.7056035448682
443.91671589247716 1068.6540710331415
[442.7960120395205, 442.16814411040866, 441.71361242123055, 442.362063
39641313, 442.93307675536477, 443.58184430777186, 442.47321266582094,
442.93039440596283, 442.5248802213606, 443.066336731942, 443.278401555
0081, 443.7429920684534, 443.73115515611653, 443.89447937412035, 443.8
8163256544493, 443.5496807378928, 443.2918702587794, 443.6554043732755
```

```
3, 443.02837536243584, 444.50153415001296, 443.0204527067165, 443.7346
0176974714, 442.1708076815321, 443.04082914983053, 443.84506195712095,
441.9638274565777, 441.6924152005056, 442.1128164555398, 442.748824177
9673, 443.91671589247716]
[1066.136720785921, 1066.0356416729308, 1067.526656752369, 1065.706065
065345, 1066.5233498834355, 1066.4031611949777, 1066.7059154569215, 10
66.9695185015808, 1066.8837784979244, 1066.6397958423777, 1066.3448731
344527, 1065.9169958675222, 1066.4008067909372, 1065.994099602866, 106
5.988826132378, 1066.677556576289, 1066.7218738218244, 1066.9730972647
75, 1066.8330640664265, 1066.597251050656, 1066.4705210792258, 1066.61
88812149553, 1067.720649688266, 1069.1721025032189, 1067.337629476842
3, 1068.390641274415, 1068.604785049092, 1065.548733533069, 1067.70560
35448682, 1068.6540710331415]
[ 0.          0.62786793  1.08239962  0.43394864 -0.13706472 -0.785832
27
  0.32279937 -0.13438237  0.27113182 -0.27032469 -0.48238952 -0.946980
03
 -0.93514312 -1.09846733 -1.08562053 -0.7536687  -0.49585822 -0.859392
33
 -0.23236332 -1.70552211 -0.22444067 -0.93858973  0.62520436 -0.244817
11
 -1.04904992  0.83218458  1.10359684  0.68319558  0.04718786 -1.120703
85]
[ 0.          0.10107911 -1.38993597  0.43065572 -0.3866291  -0.266440
41
 -0.56919467 -0.83279772 -0.74705771 -0.50307506 -0.20815235  0.219724
92
 -0.26408601  0.14262118  0.14789465 -0.54083579 -0.58515304 -0.836376
48
 -0.69634328 -0.46053026 -0.33380029 -0.48216043 -1.5839289  -3.035381
72
 -1.20090869 -2.25392049 -2.46806426  0.58798725 -1.56888276 -2.517350
25]
```

In [8]:

```
#implementing shifts for all of the images
shifts=[]
for idx, thisimage in enumerate(scim):
    shiftsval=[-99,-99]
    shiftsval[0]=shiftx[0]-shiftx[idx]
    shiftsval[1]=shifty[0]-shifty[idx]
    shifts.append(shiftsval)

print(shifts)
np.rint(shifts)
```

```
[[0.0, 0.0], [0.6278679291118578, 0.10107911299019179], [1.08239961828
99691, -1.3899359664480926], [0.4339486431073851, 0.4306557205759418],
[-0.13706471584424662, -0.3866290975145148], [-0.7858322682513403, -0.
2664404090567132], [0.32279937369958134, -0.5691946710005595], [-0.134
38236644230983, -0.8327977156598081], [0.2711318181599154, -0.74705771
2003425], [-0.27032469242146817, -0.503075056456737], [-0.482389515487
5686, -0.20815234853171205], [-0.9469800289328987, 0.219724918398696
9], [-0.9351431165960093, -0.2640860050162246], [-1.0984673345998317,
0.14262118305487093], [-1.085620525924412, 0.14789465354283493], [-0.7
536686983722802, -0.5408357903679644], [-0.49585821925887785, -0.58515
30359034314], [-0.8593923337550109, -0.836376478854163], [-0.232363322
9153188, -0.6963432805055163], [-1.7055221104924385, -0.46053026473509
817], [-0.22444066719600642, -0.3338002933048756], [-0.938589730226624
4, -0.48216042903436573], [0.625204357988423, -1.583928902344951], [-
0.2448171103100094, -3.0353817172979234], [-1.0490499176004278, -1.200
9086909213238], [0.8321845829428298, -2.253920488494032], [1.103596839
0149264, -2.4680642631710725], [0.6831955839807051, 0.587987252851917
2], [0.04718786155319776, -1.5688827589472112], [-1.1207038529566375,
-2.51735024722052]]
```

Out[8]:

```
array([[ 0.,  0.],
       [ 1.,  0.],
       [ 1., -1.],
       [ 0.,  0.],
       [-0., -0.],
       [-1., -0.],
       [ 0., -1.],
       [-0., -1.],
       [ 0., -1.],
       [-0., -1.],
       [-0., -0.],
       [-1.,  0.],
       [-1., -0.],
       [-1.,  0.],
       [-1.,  0.],
       [-1., -1.],
       [-0., -1.],
       [-1., -1.],
       [-0., -1.],
       [-2., -0.],
       [-0., -0.],
       [-1., -0.],
       [ 1., -2.],
       [-0., -3.],
```

```
[-1., -1.],
[ 1., -2.],
[ 1., -2.],
[ 1.,  1.],
[ 0., -2.],
[ 1.,  3.]])
```

In [10]:

```
xoffset = 1058   # x edge of the box
yoffset = 436

xbox=50
ybox=50

# creating loop
for idx, thisimage in enumerate(scim):
    yxshifts=(shifts[idx][1], shifts[idx][0]) # Note the y-x convention being used h
    temp = shift(scim[idx], yxshifts, order=0, mode='constant', cval=-1000)
    temp=temp-np.ma.median(temp)

    # implementing the shifts
    x1, y1 = centroid_com(temp[yoffset:yoffset+ybox,xoffset:xoffset+xbox])
    print(x1+xoffset, y1+yoffset, shifts[idx][0], shifts[idx][1])
```

```
1078.3757936900668 468.97357719279137 0.0 0.0
1074.8773416165757 472.58584960273953 0.6278679291118578 0.10107911299
019179
1076.0538842051078 474.2739373482446 1.0823996182899691 -1.38993596644
80926
1074.0217710310806 474.614934530293 0.4339486431073851 0.4306557205759
418
1077.8395967937206 471.3384564622101 -0.13706471584424662 -0.386629097
5145148
1071.4090053913883 479.7529533369606 -0.7858322682513403 -0.2664404090
567132
1074.589161790444 470.5007325814054 0.32279937369958134 -0.56919467100
05595
1078.518405770734 468.65078816909397 -0.13438236644230983 -0.832797715
6598081
1076.9179278353627 470.5380607900156 0.2711318181599154 -0.74705771200
3425
1075.044409435185 467.1001881629667 -0.27032469242146817 -0.5030750564
56737
1076.226921249155 472.2519701022842 -0.4823895154875686 -0.20815234853
171205
1068.5847497128018 473.02959249362556 -0.9469800289328987 0.2197249183
986969
1072.320851583708 478.5868800492915 -0.9351431165960093 -0.26408600501
62246
1075.5365985020926 470.7830665976041 -1.0984673345998317 0.14262118305
487093
1073.9131875027417 474.57968822038407 -1.085620525924412 0.14789465354
283493
1076.5692739126066 467.0405932572065 -0.7536686983722802 -0.5408357903
679644
1074.7147429210036 470.6674191572452 -0.49585821925887785 -0.585153035
9034314
1074.4221322548133 469.1442028047218 -0.8593923337550109 -0.8363764788
54163
1073.622215873776 470.38740488063945 -0.2323633229153188 -0.6963432805
055163
1076.7897594722783 473.3820939304429 -1.7055221104924385 -0.4605302647
3509817
1074.2114816759606 477.3293131132282 -0.22444066719600642 -0.333800293
3048756
```

```
1072.8113110367508 471.22388249675805 -0.9385897302266244 -0.482160429
03436573
1080.1609901869779 473.5439878460405 0.625204357988423 -1.583928902344
951
1073.778411767197 474.0097138128028 -0.2448171103100094 -3.03538171729
79234
1075.7352885696791 466.8186326127991 -1.0490499176004278 -1.2009086909
213238
1075.3899487327678 472.58579375870795 0.8321845829428298 -2.2539204884
94032
1079.0111398804163 474.5942476851726 1.1035968390149264 -2.46806426317
10725
1075.4254330074293 472.7389770775004 0.6831955839807051 0.587987252851
9172
1079.396098677433 471.3049189401498 0.04718786155319776 -1.56888275894
72112
1072.5465425720788 470.43355832618124 -1.1207038529566375 -2.517350247
22052
```

In [11]:

```
for idx, thisimage in enumerate(scim):
    yxshifts=(shifts[idx][1], shifts[idx][0])
    temp = CCDData(shift(scim[idx], yxshifts, order=0, mode='constant', cval=-1000)-
    temp.write(newname[idx])
```

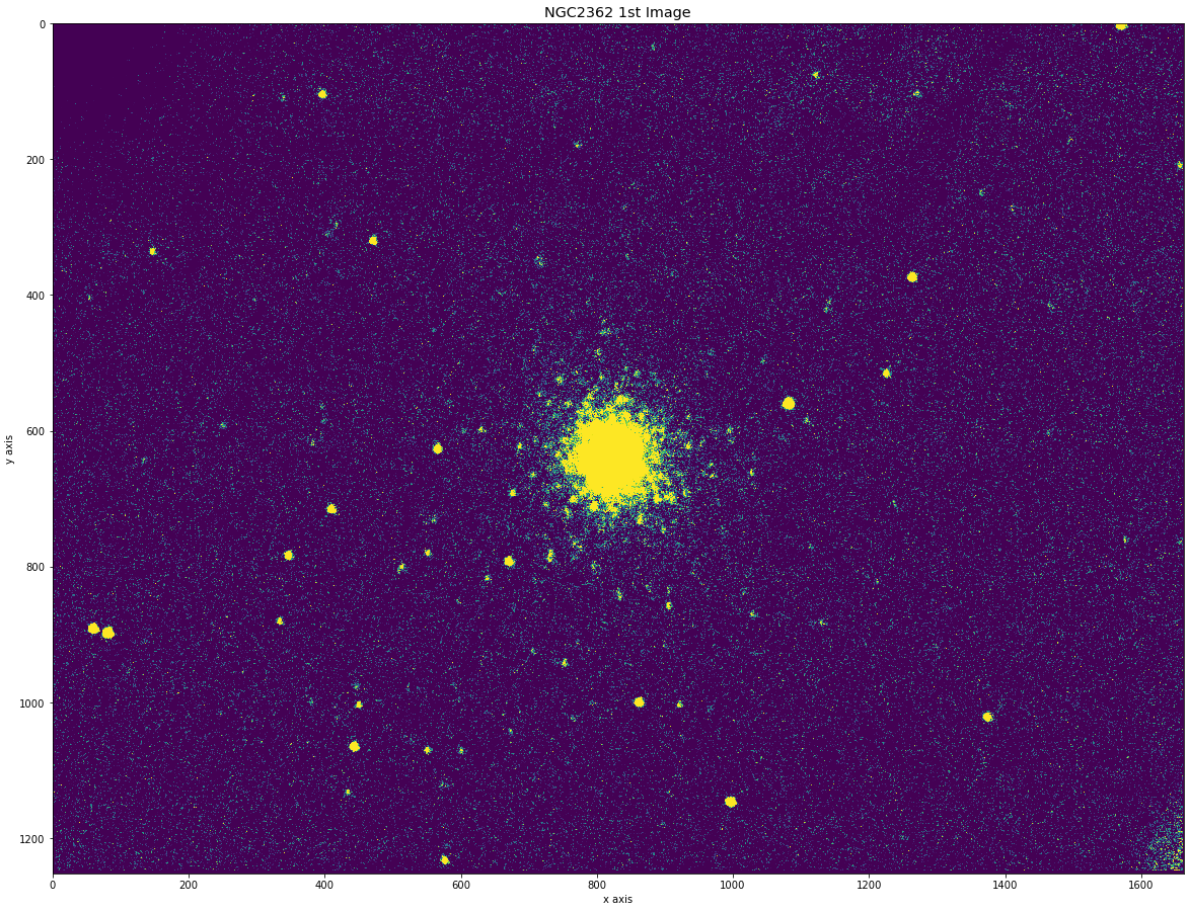
In [13]:

```
#Printing an image
image_1 = CCDData.read('sproc_NGC_2808_V_00002901.fits', unit="adu")

fig, ax = plt.subplots(figsize = (20,30))
plt.rcParams.update({'font.size': 12 })
plt.xlabel('x axis')
plt.ylabel('y axis')
plt.title('NGC2362 1st Image')
plt.imshow(image_1, cmap=None, norm=None, aspect=None, interpolation=None, alpha=Nor
```

```
INFO:astropy:using the unit adu passed to the FITS reader instead of t
he unit adu in the FITS file.

INFO: using the unit adu passed to the FITS reader instead of the unit
adu in the FITS file. [astropy.nddata.ccddata]
```

Out[13]:

```
<matplotlib.image.AxesImage at 0x7ff6156d4850>
```



I images

In [32]:

```
# Read in the processed images and filter out the I bands
images = ccdproc.ImageFileCollection(".",glob_include='proc_NGC_2808_I_*')
scim = [CCDData.read(fn, unit = "adu") for fn in images.files_filtered(PICTTYPE = 1)
```

```
INFO:astropy:using the unit adu passed to the FITS reader instead of t
he unit adu in the FITS file.
INFO:astropy:using the unit adu passed to the FITS reader instead of t
he unit adu in the FITS file.
INFO:astropy:using the unit adu passed to the FITS reader instead of t
he unit adu in the FITS file.
INFO:astropy:using the unit adu passed to the FITS reader instead of t
he unit adu in the FITS file.
INFO:astropy:using the unit adu passed to the FITS reader instead of t
he unit adu in the FITS file.
INFO:astropy:using the unit adu passed to the FITS reader instead of t
he unit adu in the FITS file.
INFO:astropy:using the unit adu passed to the FITS reader instead of t
he unit adu in the FITS file.

INFO: using the unit adu passed to the FITS reader instead of the unit
adu in the FITS file. [astropy.nddata.ccddata]
INFO: using the unit adu passed to the FITS reader instead of the unit
adu in the FITS file. [astropy.nddata.ccddata]
INFO: using the unit adu passed to the FITS reader instead of the unit
```

In [33]:

```
# creating new names for the shifted images
newname=[]
for fn in images.files_filtered(PICTTYPE=1):
    newname.extend(["s"+fn])
print(newname)
```

```
['sproc_NGC_2808_I_00002835.fits', 'sproc_NGC_2808_I_00002836.fits',
'sproc_NGC_2808_I_00002838.fits', 'sproc_NGC_2808_I_00002840.fits', 's
proc_NGC_2808_I_00002841.fits', 'sproc_NGC_2808_I_00002843.fits', 'spr
oc_NGC_2808_I_00002844.fits', 'sproc_NGC_2808_I_00002845.fits', 'sproc
_NGC_2808_I_00002846.fits', 'sproc_NGC_2808_I_00002878.fits', 'sproc_N
GC_2808_I_00002879.fits', 'sproc_NGC_2808_I_00002880.fits', 'sproc_NGC
_2808_I_00002881.fits', 'sproc_NGC_2808_I_00002882.fits', 'sproc_NGC_2
808_I_00002883.fits', 'sproc_NGC_2808_I_00002884.fits', 'sproc_NGC_280
8_I_00002885.fits', 'sproc_NGC_2808_I_00002887.fits', 'sproc_NGC_2808_
I_00002908.fits', 'sproc_NGC_2808_I_00002909.fits', 'sproc_NGC_2808_I_
00002910.fits', 'sproc_NGC_2808_I_00002911.fits', 'sproc_NGC_2808_I_00
002912.fits', 'sproc_NGC_2808_I_00002913.fits']
```

In [41]:

```
# Using the first processed I band image, a star has been located at coordinates x=1

temp=scim[0].copy() #defines temporary file
temp=temp-np.ma.median(temp)

# Determine the centroid - (1083, 461)
x1, y1 = centroid_com(temp[1000:1100,500:600])
print(x1+1083, y1+461)
```

```
1120.444768775305 494.1001414329662
```

In [42]:

```
xoffset = 400   # x edge of the box
yoffset = 1080  # y edge of the box
xbox = 60       # comment
ybox = 60       # comment
shiftx=[]        # defines array
shifty=[]        # define array

for idx, thisimage in enumerate(scim):
    temp = scim[idx].copy()
    temp =  temp-np.ma.median(temp)
    x1, y1 = centroid_com( temp[yoffset : yoffset + ybox, xoffset : xoffset + xbox])
    print(x1 +xoffset, y1 + yoffset )
    shiftx.append(x1 + xoffset)
    shifty.append(y1 + yoffset )

print(shiftx)   # What is this?
print(shifty)   # What is this?

print(shiftx[0]-shiftx) # calculate the shift in x
print(shifty[0]-shifty) # calculate the shift in y
```

```
486.3778297357918 1107.8905589124172
486.5671766126813 1107.4670635750022
486.909629124311 1107.9632531381778
487.3945943372409 1108.2263247288547
487.00974978375064 1107.640041864734
486.1752331189301 1108.3861543309456
485.1957453384492 1108.1978679086665
485.5401225813506 1107.058654480869
485.8545220932398 1107.9239151560857
485.492391303034 1108.6582958988872
486.25017340369004 1107.8056444122415
485.92461364660517 1107.7290900379915
486.9043070409585 1108.4605893228286
485.7102925730183 1107.5339468968052
486.35080555104537 1107.4629845950794
485.56957633324845 1107.9856483737633
485.7775936586664 1107.2675942557225
486.60457256316965 1107.6430903832252
486.05095822018944 1108.2329997396228
485.62121904328086 1107.3024734010603
486.01352815691774 1109.330958519505
486.85610780087165 1107.9337878994506
485.9988379764168 1107.8621158493313
485.5838043193984 1106.9360118943641
[486.3778297357918, 486.5671766126813, 486.909629124311, 487.394594337
2409, 487.00974978375064, 486.1752331189301, 485.1957453384492, 485.54
01225813506, 485.8545220932398, 485.492391303034, 486.25017340369004,
485.92461364660517, 486.9043070409585, 485.7102925730183, 486.35080555
104537, 485.56957633324845, 485.7775936586664, 486.60457256316965, 48
6.05095822018944, 485.62121904328086, 486.01352815691774, 486.85610780
087165, 485.9988379764168, 485.5838043193984]
[1107.8905589124172, 1107.4670635750022, 1107.9632531381778, 1108.2263
247288547, 1107.640041864734, 1108.3861543309456, 1108.1978679086665,
1107.058654480869, 1107.9239151560857, 1108.6582958988872, 1107.805644
4122415, 1107.7290900379915, 1108.4605893228286, 1107.5339468968052, 1
107.4629845950794, 1107.9856483737633, 1107.2675942557225, 1107.643090
```

```
3832252, 1108.2329997396228, 1107.3024734010603, 1109.330958519505, 11
07.9337878994506, 1107.8621158493313, 1106.9360118943641]
[ 0.         -0.18934688 -0.53179939 -1.0167646  -0.63192005  0.202596
62
  1.1820844   0.83770715  0.52330764  0.88543843  0.12765633  0.453216
09
 -0.52647731  0.66753716  0.02702418  0.8082534   0.60023608 -0.226742
83
  0.32687152  0.75661069  0.36430158 -0.47827807  0.37899176  0.794025
42]
[ 0.          0.42349534 -0.07269423 -0.33576582  0.25051705 -0.495595
42
 -0.307309    0.83190443 -0.03335624 -0.76773699  0.0849145   0.161468
87
 -0.57003041  0.35661202  0.42757432 -0.09508946  0.62296466  0.247468
53
 -0.34244083  0.58808551 -1.44039961 -0.04322899  0.02844306  0.954547
02]
```

In [43]:

```
#implementing shifts for all of the images
shifts=[]
for idx, thisimage in enumerate(scim):
    shiftsval=[-99,-99]
    shiftsval[0]=shiftx[0]-shiftx[idx]
    shiftsval[1]=shifty[0]-shifty[idx]
    shifts.append(shiftsval)

print(shifts)
np.rint(shifts)
```

```
[[0.0, 0.0], [-0.1893468768894877, 0.42349533741503365], [-0.531799388
5191754, -0.07269422576064244], [-1.016764601449097, -0.33576581643751
524], [-0.631920047958829, 0.25051704768316085], [0.2025966168616833,
-0.49559541852840994], [1.182084397342578, -0.3073089962492759], [0.83
77071544412047, 0.8319044315480824], [0.5233076425520267, -0.033356243
66854972], [0.8854384327577804, -0.7677369864700267], [0.1276563321017
6475, 0.08491450017572788], [0.4532160891866397, 0.16146887442573643],
[-0.5264773051666793, -0.5700304104113911], [0.667537162773499, 0.3566
120156119723], [0.02702418474643764, 0.42757431733775775], [0.80825340
25433574, -0.09508946134610596], [0.6002360771254303, 0.62296465669464
85], [-0.2267428273778478, 0.24746852919201956], [0.32687151560236316,
-0.34244082720556435], [0.7566106925109466, 0.5880855113568941], [0.36
430157887406267, -1.4403996070877838], [-0.4782780650798486, -0.043228
987033444355], [0.37899175937502605, 0.028443063085887843], [0.7940254
163934242, 0.9545470180530629]]
```

Out[43]:

```
array([[ 0.,  0.],
       [-0.,  0.],
       [-1., -0.],
       [-1., -0.],
       [-1.,  0.],
       [ 0., -0.],
       [ 1., -0.],
       [ 1.,  1.],
       [ 1., -0.],
       [ 1., -1.],
       [ 0.,  0.],
       [ 0.,  0.],
       [-1., -1.],
       [ 1.,  0.],
       [ 0.,  0.],
       [ 1., -0.],
       [ 1.,  1.],
       [-0.,  0.],
       [ 0., -0.],
       [ 1.,  1.],
       [ 0., -1.],
       [-0., -0.],
       [ 0.,  0.],
       [ 1.,  1.]])
```

In [44]:

```
xoffset = 490   # x edge of the box
yoffset = 1197

xbox=50
ybox=50

# creating loop
for idx, thisimage in enumerate(scim):
    yxshifts=(shifts[idx][1], shifts[idx][0]) # Note the y-x convention being used h
    temp = shift(scim[idx], yxshifts, order=0, mode='constant', cval=-1000)
    temp=temp-np.ma.median(temp)

    # implementing the shifts
    x1, y1 = centroid_com(temp[yoffset:yoffset+ybox,xoffset:xoffset+xbox])
    print(x1+xoffset, y1+yoffset, shifts[idx][0], shifts[idx][1])
```

```
519.5971817964601 1241.0606220662337 0.0 0.0
519.1772857094808 1244.0720915669463 -0.1893468768894877 0.42349533741
503365
516.7545588737963 1241.2452493416104 -0.5317993885191754 -0.0726942257
6064244
517.2716231148185 1239.9472896166092 -1.016764601449097 -0.33576581643
751524
517.327316739003 1237.4879316484414 -0.631920047958829 0.2505170476831
6085
519.3538264489957 1242.8479181218731 0.2025966168616833 -0.49559541852
840994
517.1252310748125 1246.0696551780995 1.182084397342578 -0.307308996249
2759
520.3549251621899 1244.258468474404 0.8377071544412047 0.8319044315480
824
520.3741657273235 1246.4640015371099 0.5233076425520267 -0.03335624366
854972
516.5463559655848 1247.9448279505 0.8854384327577804 -0.76773698647002
67
519.0602634712474 1240.2536899537056 0.12765633210176475 0.08491450017
572788
518.9200923239346 1240.524062777355 0.4532160891866397 0.1614688744257
3643
514.7412986394193 1239.4098623616455 -0.5264773051666793 -0.5700304104
113911
519.041212796261 1246.7194109331408 0.667537162773499 0.35661201561197
23
519.6937323204876 1242.1950897339966 0.02702418474643764 0.42757431733
775775
516.9830906182651 1242.2080292359167 0.8082534025433574 -0.09508946134
610596
521.5725168394548 1251.0706182911292 0.6002360771254303 0.622964656694
6485
519.848418287674 1245.1303244363553 -0.2267428273778478 0.247468529192
01956
520.9785603881181 1246.0411789568986 0.32687151560236316 -0.3424408272
0556435
518.7870893305966 1253.6615803434731 0.7566106925109466 0.588085511356
8941
515.4958655190127 1238.1130993105508 0.36430157887406267 -1.4403996070
```

```
877838
519.1059683037201 1241.8403416639408 -0.4782780650798486 -0.0432289870
33444355
519.8176862480523 1244.3921213067879 0.37899175937502605 0.02844306308
5887843
522.6317607037864 1250.11401662679 0.7940254163934242 0.95454701805306
29
```

In [45]:

```
for idx, thisimage in enumerate(scim):
    yxshifts=(shifts[idx][1], shifts[idx][0])
    temp = CCDData(shift(scim[idx], yxshifts, order=0, mode='constant', cval=-1000)-
    temp.write(newname[idx])
```

R band shifts

In [46]:

```
# Read in the processed images and filter out the R bands
images = ccdproc.ImageFileCollection(".",glob_include='proc_NGC_2808_R_*')
scim = [CCDData.read(fn, unit = "adu") for fn in images.files_filtered(PICTTYPE = 1)
```

```
INFO:astropy:using the unit adu passed to the FITS reader instead of t
he unit adu in the FITS file.
INFO:astropy:using the unit adu passed to the FITS reader instead of t
he unit adu in the FITS file.
INFO:astropy:using the unit adu passed to the FITS reader instead of t
he unit adu in the FITS file.

INFO: using the unit adu passed to the FITS reader instead of the unit
adu in the FITS file. [astropy.nddata.ccddata]
INFO: using the unit adu passed to the FITS reader instead of the unit
adu in the FITS file. [astropy.nddata.ccddata]
INFO: using the unit adu passed to the FITS reader instead of the unit
adu in the FITS file. [astropy.nddata.ccddata]

INFO:astropy:using the unit adu passed to the FITS reader instead of t
he unit adu in the FITS file.
INFO:astropy:using the unit adu passed to the FITS reader instead of t
he unit adu in the FITS file.
INFO:astropy:using the unit adu passed to the FITS reader instead of t
he unit adu in the FITS file.
```

In [47]:

```
# creating new names for the shifted images
newname=[]
for fn in images.files_filtered(PICTTYPE=1):
    newname.extend(["s"+fn])
print(newname)
```

```
['sproc_NGC_2808_R_00002832.fits', 'sproc_NGC_2808_R_00002833.fits',
'sproc_NGC_2808_R_00002834.fits', 'sproc_NGC_2808_R_00002858.fits', 's
proc_NGC_2808_R_00002859.fits', 'sproc_NGC_2808_R_00002860.fits', 'spr
oc_NGC_2808_R_00002861.fits', 'sproc_NGC_2808_R_00002863.fits', 'sproc
_NGC_2808_R_00002864.fits', 'sproc_NGC_2808_R_00002865.fits', 'sproc_N
GC_2808_R_00002867.fits', 'sproc_NGC_2808_R_00002888.fits', 'sproc_NGC
_2808_R_00002889.fits', 'sproc_NGC_2808_R_00002890.fits', 'sproc_NGC_2
808_R_00002891.fits', 'sproc_NGC_2808_R_00002892.fits', 'sproc_NGC_280
8_R_00002893.fits', 'sproc_NGC_2808_R_00002894.fits', 'sproc_NGC_2808_
R_00002895.fits', 'sproc_NGC_2808_R_00002896.fits', 'sproc_NGC_2808_R_
00002897.fits']
```

In [58]:

```
# Using the first processed V band image, a star has been located at coordinates x=1

temp=scim[0].copy() #defines temporary file
temp=temp-np.ma.median(temp)

# Determine the centroid - (1083, 461)
x1, y1 = centroid_com(temp[1000:1100,400:500])
print(x1+1083, y1+452)
```

```
1125.3050684153159 505.64614423284416
```

In [59]:

```
xoffset = 402   # x edge of the box
yoffset = 1023  # y edge of the box
xbox = 60       # comment
ybox = 60       # comment
shiftx=[]        # defines array
shifty=[]        # define array

for idx, thisimage in enumerate(scim):
    temp = scim[idx].copy()
    temp =  temp-np.ma.median(temp)
    x1, y1 = centroid_com( temp[yoffset : yoffset + ybox, xoffset : xoffset + xbox])
    print(x1 +xoffset, y1 + yoffset )
    shiftx.append(x1 + xoffset)
    shifty.append(y1 + yoffset )

print(shiftx)   # What is this?
print(shifty)   # What is this?

print(shiftx[0]-shiftx) # calculate the shift in x
print(shifty[0]-shifty) # calculate the shift in y
```

```
445.384995807251 1066.6833207026787
444.9106354969915 1065.9193359323058
444.93114117180636 1067.3338463372788
444.7098290821605 1066.3425026896803
445.5775716725196 1066.3354585472946
446.70439939985636 1066.27554656811
445.1132301387067 1066.7405751708238
445.9976804972119 1066.3999623254972
445.8111096167675 1066.3995262327392
446.75523749866795 1066.8964166373971
446.0209427796538 1066.1687946120223
446.6987958724004 1066.5235230249314
444.5191991703913 1068.2213397595276
445.16941241103405 1066.4815969090773
446.29693692755785 1068.7792882136193
445.5669338668419 1067.6271062001424
445.28142573450566 1066.9218846272834
446.04974398831047 1066.4436247332537
445.7118512645397 1066.45642512804
446.0248269244598 1067.3167649865838
445.80550384918365 1067.1987002194853
[445.384995807251, 444.9106354969915, 444.93114117180636, 444.70982908
21605, 445.5775716725196, 446.70439939985636, 445.1132301387067, 445.9
976804972119, 445.8111096167675, 446.75523749866795, 446.020942779653
8, 446.6987958724004, 444.5191991703913, 445.16941241103405, 446.29693
692755785, 445.5669338668419, 445.28142573450566, 446.04974398831047,
445.7118512645397, 446.0248269244598, 445.80550384918365]
[1066.6833207026787, 1065.9193359323058, 1067.3338463372788, 1066.3425
026896803, 1066.3354585472946, 1066.27554656811, 1066.7405751708238, 1
066.3999623254972, 1066.3995262327392, 1066.8964166373971, 1066.168794
6120223, 1066.5235230249314, 1068.2213397595276, 1066.4815969090773, 1
068.7792882136193, 1067.6271062001424, 1066.9218846272834, 1066.443624
7332537, 1066.45642512804, 1067.3167649865838, 1067.1987002194853]
[ 0.          0.47436031  0.45385464  0.67516673 -0.19257587 -1.319403
59
  0.27176567 -0.61268469 -0.42611381 -1.37024169 -0.63594697 -1.313800
```

```
07
  0.86579664  0.2155834  -0.91194112 -0.18193806  0.10357007 -0.664748
18
 -0.32685546 -0.63983112 -0.42050804]
[ 0.          0.76398477 -0.65052563  0.34081801  0.34786216  0.407774
13
 -0.05725447  0.28335838  0.28379447 -0.21309593  0.51452609  0.159797
68
 -1.53801906  0.20172379 -2.09596751 -0.9437855  -0.23856392  0.239695
97
  0.22689557 -0.63344428 -0.51537952]
```

In [60]:

```
#implementing shifts for all of the images
shifts=[]
for idx, thisimage in enumerate(scim):
    shiftsval=[-99,-99]
    shiftsval[0]=shiftx[0]-shiftx[idx]
    shiftsval[1]=shifty[0]-shifty[idx]
    shifts.append(shiftsval)

print(shifts)
np.rint(shifts)
```

```
[[0.0, 0.0], [0.4743603102594989, 0.7639847703728719], [0.453854635444
65665, -0.6505256346001715], [0.6751667250904916, 0.3408180129983975
3], [-0.19257586526856585, 0.34786215538406395], [-1.3194035926053402,
0.4077741345686263], [0.27176566854433304, -0.05725446814517454], [-0.
6126846899608722, 0.2833583771814574], [-0.4261138095164938, 0.2837944
6993949387], [-1.3702416914169362, -0.2130959347184671], [-0.635946972
4027917, 0.5145260906563 18], [-1.313800065149394, 0.1597976777472922
5], [0.8657966368597272, -1.5380190568489525], [0.2155833962169 7087,
0.20172379360133164], [-0.9119411203068353, -2.0959675109406817], [-0.
18193805959089104, -0.9437854974637503], [0.1035700727453559, -0.23856
392460470488], [-0.6647481810594513, 0.239695969424929], [-0.326855457
2886728, 0.22689557463854726], [-0.6398311172087574, -0.63344428390519
17], [-0.420508041932635, -0.5153795168066608]]
```

Out[60]:

```
array([[ 0.,  0.],
       [ 0.,  1.],
       [ 0., -1.],
       [ 1.,  0.],
       [-0.,  0.],
       [-1.,  0.],
       [ 0., -0.],
       [-1.,  0.],
       [-0.,  0.],
       [-1., -0.],
       [-1.,  1.],
       [-1.,  0.],
       [ 1., -2.],
       [ 0.,  0.],
       [-1., -2.],
       [-0., -1.],
       [ 0., -0.],
       [-1.,  0.],
       [-0.,  0.],
       [-1., -1.],
       [-0., -1.]])
```

In [61]:

```
xoffset = 1205   # x edge of the box
yoffset = 492

xbox=50
ybox=50

# creating loop
for idx, thisimage in enumerate(scim):
    yxshifts=(shifts[idx][1], shifts[idx][0]) # Note the y-x convention being used h
    temp = shift(scim[idx], yxshifts, order=0, mode='constant', cval=-1000)
    temp=temp-np.ma.median(temp)

    # implementing the shifts
    x1, y1 = centroid_com(temp[yoffset:yoffset+ybox,xoffset:xoffset+xbox])
    print(x1+xoffset, y1+yoffset, shifts[idx][0], shifts[idx][1])
```

```
1227.6095594517762 516.5089787247542 0.0 0.0
1226.5495432865193 516.2686684740019 0.4743603102594989 0.763984770372
8719
1226.8641757979153 515.8286228772862 0.45385463544465665 -0.6505256346
001715
1227.6802989495554 516.0073511976738 0.6751667250904916 0.340818012998
39753
1227.8691398143933 516.3147439680906 -0.19257586526856585 0.3478621553
8406395
1227.975713896101 515.9057112750401 -1.3194035926053402 0.407774134568
6263
1227.467215099535 516.8729032402136 0.27176566854433304 -0.05725446814
517454
1226.7538619195054 515.7739342088489 -0.6126846899608722 0.28335837718
14574
1227.6784156195868 515.9573887582029 -0.4261138095164938 0.28379446993
949387
1227.3471145332626 516.5443692943561 -1.3702416914169362 -0.2130959347
184671
1226.93323304474 516.3424788655888 -0.6359469724027917 0.5145260906563
18
1227.3184085117775 515.0889372822804 -1.313800065149394 0.159797677747
29225
1226.2895100541505 514.2314956369155 0.8657966368597272 -1.53801905684
89525
1227.1912408047451 516.2352531683376 0.21558339621697087 0.20172379360
133164
1225.9040823513358 515.1411679266491 -0.9119411203068353 -2.0959675109
406817
1227.2851550958167 516.0601832240939 -0.18193805959089104 -0.943785497
4637503
1227.0547619707156 516.6138640259296 0.1035700727453559 -0.23856392460
470488
1226.8684073522686 515.5316206253095 -0.6647481810594513 0.23969596942
4929
1227.7789932088322 516.0799714129325 -0.3268554572886728 0.22689557463
854726
1226.3105862674913 514.9701254286258 -0.6398311172087574 -0.6334442839
051917
```

```
1227.3101602884492 514.9990547186443 -0.420508041932635 -0.51537951680
66608
```

In [62]:

```
for idx, thisimage in enumerate(scim):
    yxshifts=(shifts[idx][1], shifts[idx][0])
    temp = CCDData(shift(scim[idx], yxshifts, order=0, mode='constant', cval=-1000)-
    temp.write(newname[idx])
```

In [ ]:

```

```