MICHAEL CALLER

# MY PIXINSIGHT GUIDE

WWW.ASTROCALLER.CO.UK

Astro Caller
ASTROPHOTOGRAPHY

My PixInsight Guide is a personal guide I wrote for Calibration, Integration and Processing of deep sky objects through PixInsight 1.8, however this personal guide evolved into a guide that I can share with all fellow astrophotographers. All methods used in this guide are my own personal preference that I have spent the past 18 months experimenting with and may vary dependant on data collected.

Within this guide I share my PixInsight steps but in simple terms without the technical jargon that can put many astrophotographers off using Pixinsight or for those that do not understand the complexity of PixInsight modules. Lets face it! They can be very overwhelming.

Please be aware that this guide does not explain the in-depth details of these processes. There are books such as Warren A Keller Inside PixInsight and Chris Woodhouse The Astrophotography Manual that are great for learning the technical side of astrophotography and more advance processing. Therefore the reader of this guide should have experience and knowledge of each process and the basic use of PixInsight.

My recommendation is to experiment with each module to meet your needs!

Michael Caller
England
www.astrocaller.co.uk

# *INDEX*

# CHAPTER 1 - CALIBRATION FRAMES

## CREATING CALIBRATION FRAMES

*Im not a personal fan of batch stacking or the use of Deep Sky Stacker (DSS) I always find that the batch stacking algorithms don't always give you the best results.*

*Therefore I prefer to use PixInsight image calibration and image integration to create master calibration frames. Then calibrated with my light frames!*

*This is very time consuming but the results are worth the time you invest. I would recommend you create a calibration library.*

*Bias & Darks frames can be kept between 4-6 months when using a cooled camera, if you do not have a cooled camera you should change your master dark when ambient conditions change by +-5 degrees celsius. Flat frames must be replaced if you remove your camera from your optical assembly. If like me you don't , then replace flat frames every 1 - 2 months or if you notice dust bunnies when calibrating your flats with your light frames.*

## Integration of Bias Frames

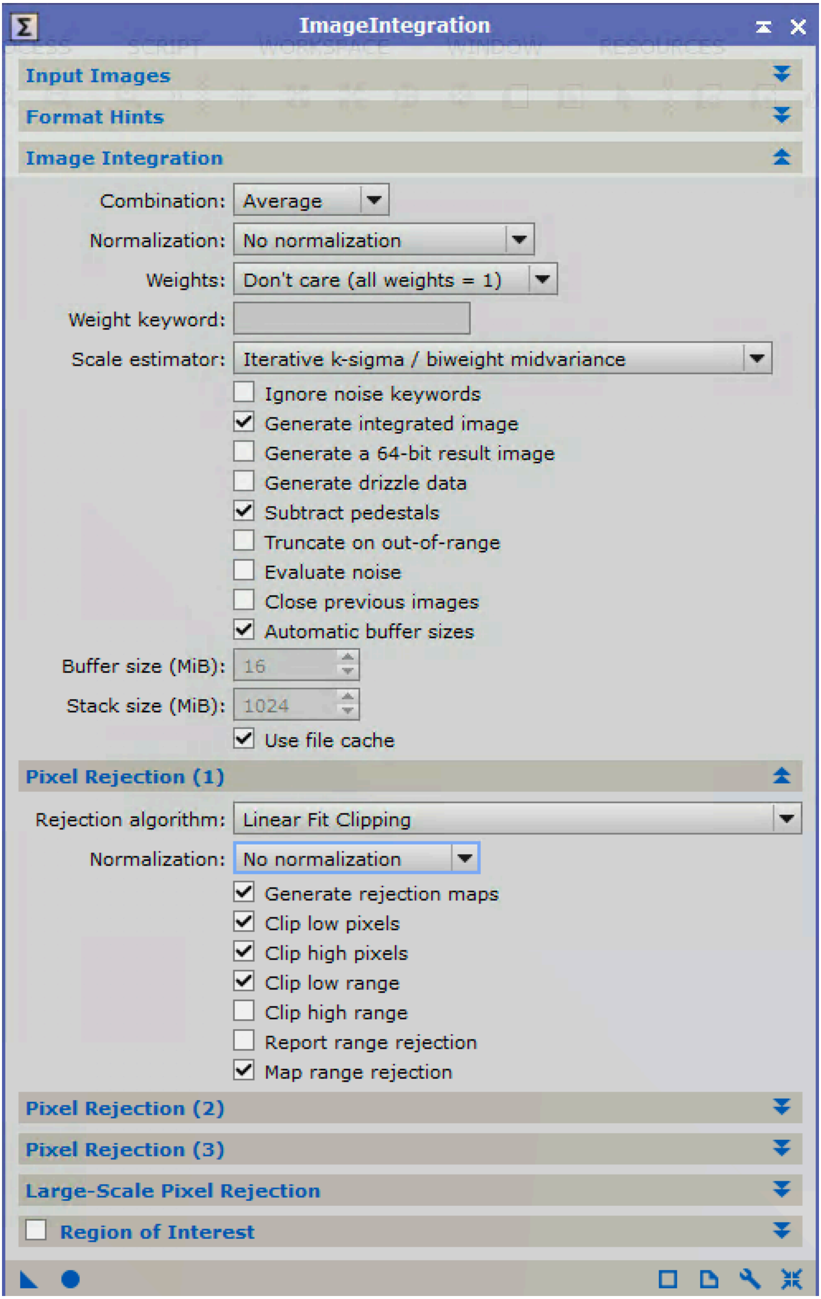
Obtain approx 50 - 500 Bias frames at the fastest frame your camera can achieve. Yes, 500, thats a lot of frames, but more is better! My ASI1600MM fastest capture is 0.000032 sec.

Please be aware you're processing computer will require a lot of RAM if integrating images over 250 frames. 8Gb memory can safely integrate 250 frames. I have 64GB of RAM so doing 500 images is no match for my computer!

1. Open ImageIntegration. (Fig 1.1)
2. Add files. (load individual Bias frames) (Fig 1.2)
3. Combination method use Average.
4. Normalization use No Normalization.
5. Weights use Don’t Care (all weights = 1).
6. Uncheck Evaluate Noise.
7. Pixel Rejection 1.
   - Less than 7 frames - Percentile Clipping.
   - 7 - 15 frames - Averaged Sigma Clipping.
   - 15 - 25 frames - Winsorized Sigma Clipping.
   - 25 or more frames - Linear Fit Clipping.
8. Normalization use No Normalization.
9. Apply Global.

Save MasterBias in XISF format. (32-bit IEEE 754 floating point, this can be discarded after a superbias has been created.

Note: You will need a powerful processor too when integrating 500 frames I'm using an Intel i9 9900K overclocked to 5Ghz



ImageIntegration
Input Images
Format Hints
Image Integration
Combination: Average
Normalization: No normalization
Weights: Don't care (all weights = 1)
Weight keyword:
Scale estimator: Iterative k-sigma / biweight midvariance
Ignore noise keywords
Generate integrated image
Generate a 64-bit result image
Generate drizzle data
Subtract pedestals
Truncate on out-of-range
Evaluate noise
Close previous images
Automatic buffer sizes
Buffer size (MiB): 16
Stack size (MiB): 1024
Use file cache
Pixel Rejection (1)
Rejection algorithm: Linear Fit Clipping
Normalization: No normalization
Generate rejection maps
Clip low pixels
Clip high pixels
Clip low range
Clip high range
Report range rejection
Map range rejection
Pixel Rejection (2)
Pixel Rejection (3)
Large-Scale Pixel Rejection
Region of Interest


*Fig 1.1*

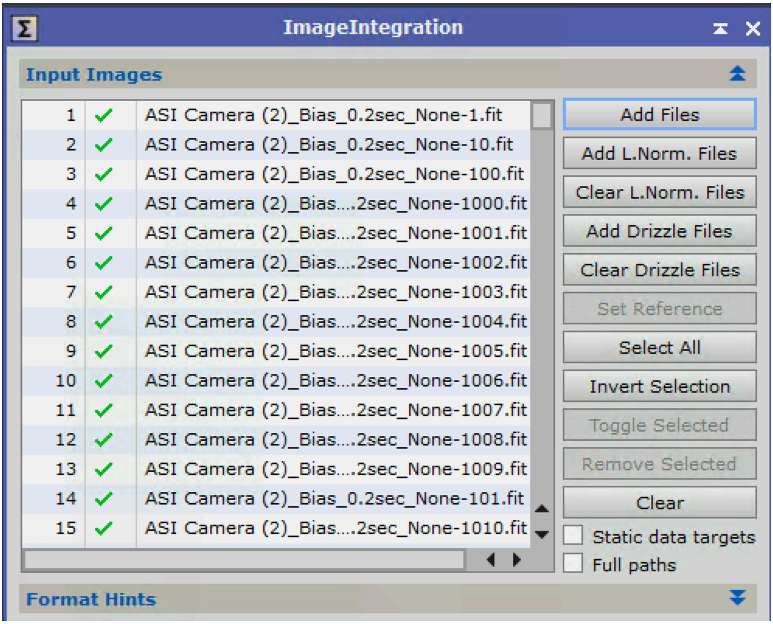

ImageIntegration
Input Images
1 ASI Camera (2)_Bias_0.2sec_None-1.fit
2 ASI Camera (2)_Bias_0.2sec_None-10.fit
3 ASI Camera (2)_Bias_0.2sec_None-100.fit
4 ASI Camera (2)_Bias....2sec_None-1000.fit
5 ASI Camera (2)_Bias....2sec_None-1001.fit
6 ASI Camera (2)_Bias....2sec_None-1002.fit
7 ASI Camera (2)_Bias....2sec_None-1003.fit
8 ASI Camera (2)_Bias....2sec_None-1004.fit
9 ASI Camera (2)_Bias....2sec_None-1005.fit
10 ASI Camera (2)_Bias....2sec_None-1006.fit
11 ASI Camera (2)_Bias....2sec_None-1007.fit
12 ASI Camera (2)_Bias....2sec_None-1008.fit
13 ASI Camera (2)_Bias....2sec_None-1009.fit
14 ASI Camera (2)_Bias_0.2sec_None-101.fit
15 ASI Camera (2)_Bias....2sec_None-1010.fit
Add Files
Add L.Norm. Files
Clear L.Norm. Files
Add Drizzle Files
Clear Drizzle Files
Set Reference
Select All
Invert Selection
Toggle Selected
Remove Selected
Clear
Static data targets
Full paths
Format Hints

*Fig 1.2*

## Super Bias

Now you have successfully created a master bias this can be convert into a master superbias which is very easy.

1. Open Superbias. (Fig 1.3)
2. Change Multiscale to 6. (use 5 if using 50 frames or more).
3. Apply to master bias image. (This will produce a new image)
4. Save master superbias in XISF format. (32-bit IEEE 754 floating point)

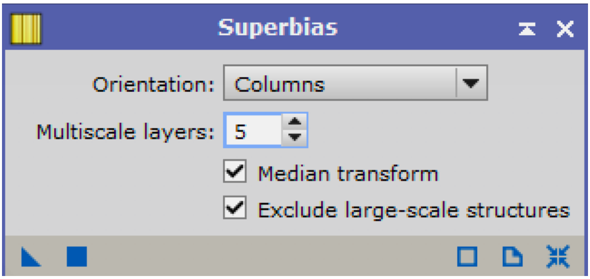
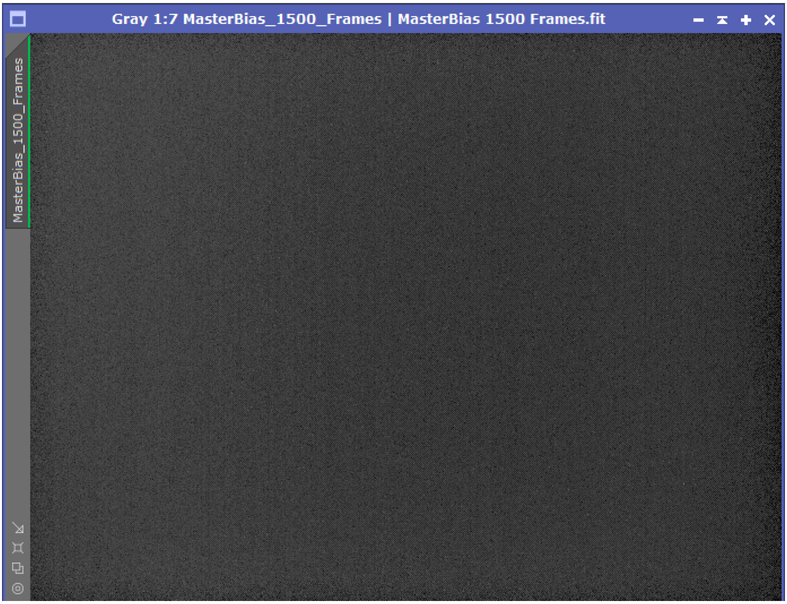
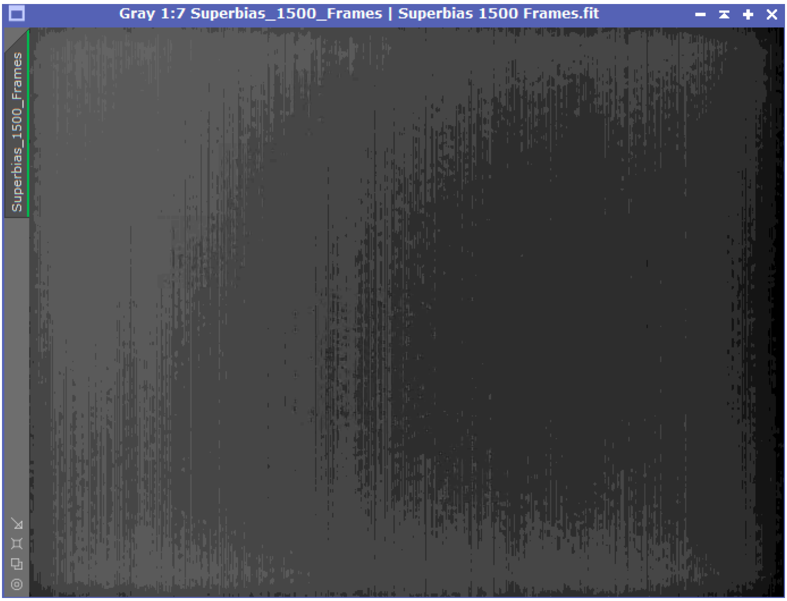



*Fig 1.3*




*Master Bias*




*Master SuperBias*

## Integration of Dark Frames

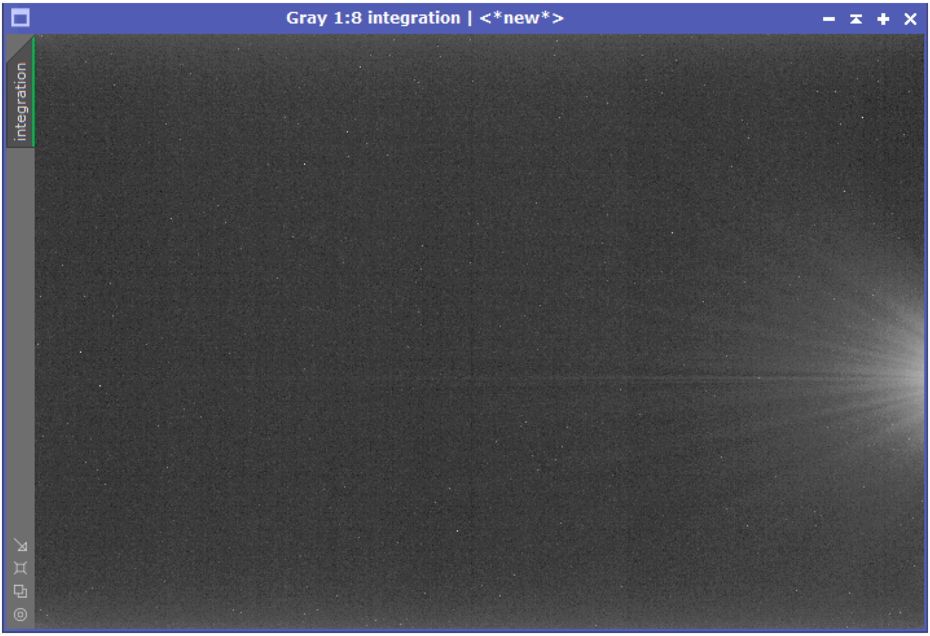
Obtain approx 2 - 10 hours of darks at the same temperature and exposure length as your light frames.

When using a cooled camera obtaining 10 hours of darks is easy! Just switch the camera on whether is mounted to your scope of not, as long as you have the sensor cap on and cooled to the correct temperature you can obtain darks even inside during the day or overnight.

Top Tip: leave your uncooled camera outside over night with lens cap on during cloudy nights either before or after you have taken your lights, this way you can obtain 10 hours of dark frames at approximate required temperature.

1. Open ImageIntegration.
2. Add files (load individual dark frames).
3. Combination method use Average.
4. Normalization use No Normalization.
5. Weights use Don’t Care (all weights = 1).
6. Uncheck Evaluate Noise.
7. Pixel Rejection.
    - Less than 7 frames - Percentile Clipping.
    - 7 - 15 frames - Averaged Sigma Clipping.
    - 15 - 25 frames - Winsorized Sigma Clipping.
    - 25 or more frames - Linear Fit Clipping.
8. Normalization use No Normalization.
9. Apply Global.

Save master dark in XISF format. (32-bit IEEE 754 floating point)




*MasterDark*

In this master dark image you will notice we have amp-glow pattern to the right!

## What is amp-glow

Amp glow is a generalised term! It originally referred to “amplifier glow," however these days it generally refers to any kind of “glow” in the image that is caused by the camera itself. Glows are areas of the image that become brighter than neighbouring areas due to circuitry within the camera or sensor.

Amp glow is perfectly normal so no need to panic this pattern will be processed out during the calibration and integration process.

## Calibrate Flat Frames.

Obtain approx 50 - 500 flat frames at same temperature as light frames.  Not imperative but I like everything to be at same temperature. Remember if you're using a mono camera you require a master flat per filter.

1. Open ImageCalibration. (Fig 1.4)
2. Add files. (load individual flat frames)
3. Choose output folder.
4. Uncheck Evaluate noise.
5. Enable Master Bias and load master superbias.
6. Enable Master Dark, load master dark and check calibrate. (Keep opitmize checked)
7. Apply Global.

Notes:-

- If you're using a OSC camera DO NOT debayer your flat frames.
- If you're using a filter wheel each filter requires a master flat frame.
- I use the flats calibration wizard in sequence generator pro , you want to aim for 30 - 50% of the total full well depth (ADU) for example my ASI1600 has a total full well depth of 65,535 therefore my flat’s target is set to 21,500 ADU.

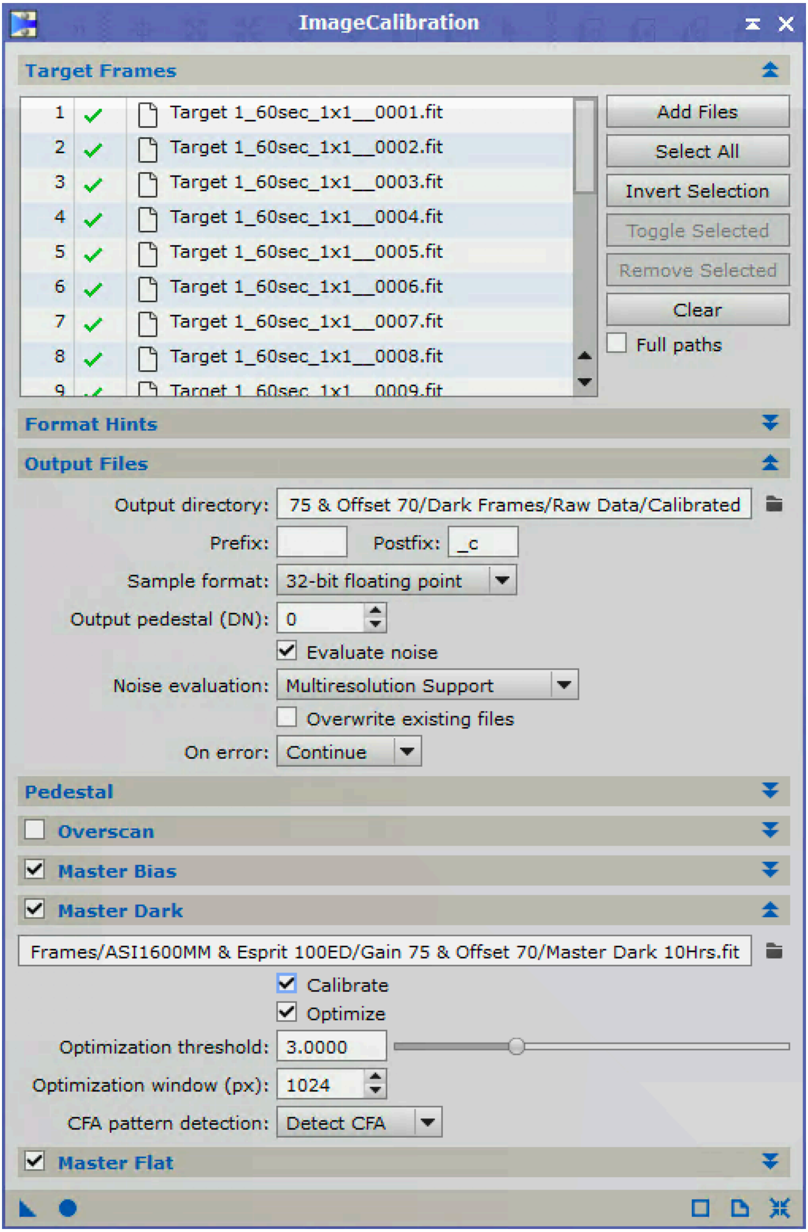

ImageCalibration
Target Frames
Target 1_60sec_1x1__0001.fit
Target 1_60sec_1x1__0002.fit
Target 1_60sec_1x1__0003.fit
Target 1_60sec_1x1__0004.fit
Target 1_60sec_1x1__0005.fit
Target 1_60sec_1x1__0006.fit
Target 1_60sec_1x1__0007.fit
Target 1_60sec_1x1__0008.fit
Add Files
Select All
Invert Selection
Toggle Selected
Remove Selected
Clear
Full paths
Format Hints
Output Files
Output directory: 75 & Offset 70/Dark Frames/Raw Data/Calibrated
Prefix:
Postfix: _c
Sample format: 32-bit floating point
Output pedestal (DN): 0
Evaluate noise
Noise evaluation: Multiresolution Support
Overwrite existing files
On error: Continue
Pedestal
Overscan
Master Bias
Master Dark
Frames/ASI1600MM & Esprit 100ED/Gain 75 & Offset 70/Master Dark 10Hrs.fit
Calibrate
Optimize
Optimization threshold: 3.0000
Optimization window (px): 1024
CFA pattern detection: Detect CFA
Master Flat

*Fig 1.4*

## Integration of Flat Frames

1. Open ImageIntegration.
2. Add files. (load individual calibrated flat frames)
3. Combination method use Average.
4. Normalization use Multiplicative.
5. Weights use Don't Care (all weights = 1).
6. Uncheck Evaluate Noise.
7. Pixel Rejection.
    - Less than 7 frames - Percentile Clipping.
    - 7 - 15 frames - Averaged Sigma Clipping.
    - 15 - 25 frames - Winsorized Sigma Clipping.
    - 25 or more frames - Linear Fit Clipping.
8. Deselect Generate Rejection maps.
9. Normalization use Equalize Fluxes.
10. Apply Global.

Save master flat in XISF format. (32-bit IEEE 754 floating point)

Note:-

- If using a filter wheel each filter requires a master flat frame.
- These settings above are only suitable for flat box or a stable light source I.e. iPad or laptop screen.


*Master Flat OIII*

# CHAPTER 2 - SELECTING LIGHT FRAMES

## IDENTIFYING THE BEST LIGHT FRAMES FOR INTEGRATION

It is good practice to carefully inspect your light frames visually and via weighing. You're looking to only integrate the best images for the best results, many astrophotographers will say even images with aircraft or satellite trails are still good enough for integration. Which is true as you can process them out! However I only prefer to use my best data for best results.

## Saving Light Frames

Prior to undertaking any calibration or integration of your light frames. Create the following folders in you're processing folder. (Fig 2.1)

A. Lights_Cal - This is where calibrated light frames are saved.
B. Lights_Cal_CC - This is where calibrated & cosmetically corrected light frames are saved.
C. Lights_Cal_CC_SS - This is where calibrated, cosmetically corrected and weighed light frames are saved.
D. Lights_Cal_CC_SS_Reg - This is where calibrated, cosmetically corrected, weighed & registered light frames are saved.

Notes:-

- If you are processing data collected from a OSC camera add the folder Light_Cal_CC_SS_DB in between C & D above and change D to Lights_Cal_CC_SS_DB_Reg . This folder is for saved debayered images.
- You can discard all folders other than Lights_Cal_CC_SS_Reg once you have completed you're processing to save on disk space.
- Save your files as XISF format. (32-bit IEEE 754 floating point)

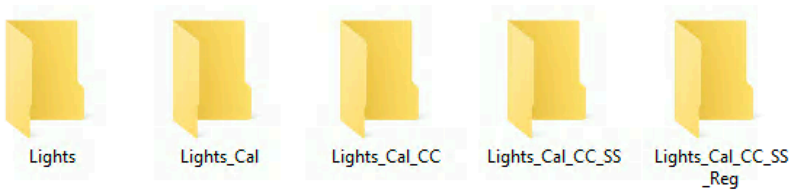



*Fig 2.1*

## Blink (Visual Inspection)

1. Open blink. (Fig 2.2)
2. Add light frames.
3. Set delay in seconds to next image. (Suggest 2 - 5 seconds)
4. Hit play button.

Durning the blink process it will display each image for the time set, make reference to any images of poor quality i.e. clouds and aircraft/satellite trails.

Top tip: don't use auto STF function, use HT function i.e. the top box on the left hand side next to the display image on blink.

Iv noticed that STF increases and decreases background brightness and this can be confused for poor image quality.

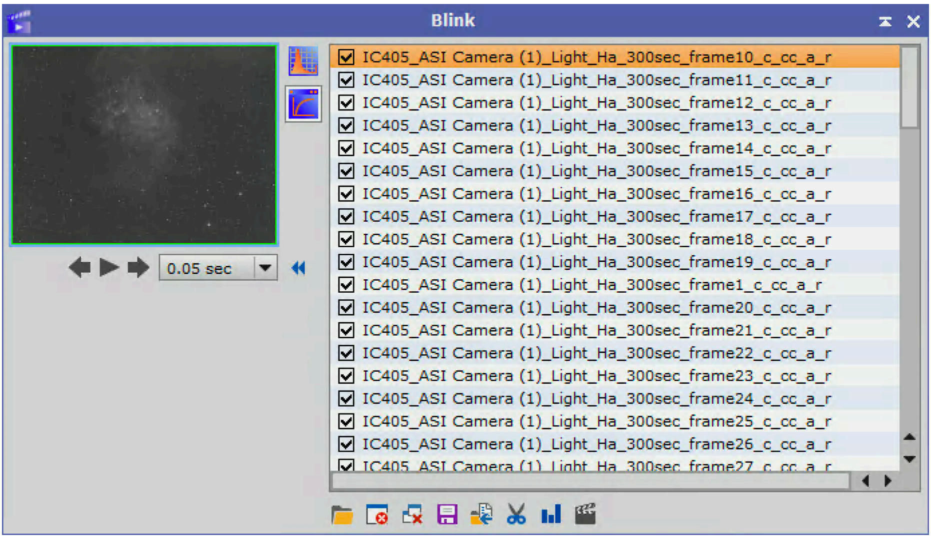



*Fig 2.2*

## Subframe Selector (Weighing)

You should carry out subframe selector post cosmetic correction. (Chapter 3)

1. Open SubframeSelector. (Fig 2.3)
2. Add files. (load individual cosmetically corrected frames)
3. Set subframe scale, calculate using (206 x pixel size in $\mu$m ÷ focal length) or find this in the FITSHeader in image processes.
4. Set Camera Gain (again find this in the FITSHeader)
5. Set Camera Resolution.
6. Add *FWHM < 6 && Eccentricity <= 0.7* to approver & *SNRWeight* to weighting. (this will reject images above these values. See notes below)
7. Push Measure (or apply global) and wait for results.

You are looking for the image with the highest *Weight* this will be the image you set as reference during registration and integration of light frames. (Chapter 3)

Images with a FWHM of 6 and Eccentricity of 7 or lower is perfect and means those stars are pinpoint!

If most of your images are being rejected this means your data is poor and you will need to make the most of it! Just because your data has been rejected, doesn't mean you can't use it.

Top Tips:-

- If an image is rejected for example FWHM is 6.13! This is extremely close to the recommended threshold. Therefore increase FWHM to say 6.2 this will then approve these rejected images.
- Set measurement table to weight and descending. Note the image at the top , this is the image with the highest weight and should be used as a reference image throughout the integration process.
- Choose to keep rejected images by double left clicking rejected images. (green tick will appear)

8. Now replace the script in weighting with the following.

(15*(1-(FWHM-FWHMMin)/(FWHMMax-FWHMMin)) + 15*(1-(Eccentricity-EccentricityMin)/(EccentricityMax-EccentricityMin)) + 20*(SNRWeight-SNRWeightMin)/(SNRWeightMax-SNRWeightMin)) +50

9. Change routine to output subframe.
10. Set output folder to Lights_Cal_CC_SS.
11. Apply global.

Note:-

- Im currently using Cameron Ledger version of Subframe Selector which is a lot quicker and more user friendly. You can download Cameron Ledger version from downloads at www.astrocaller.co.uk.

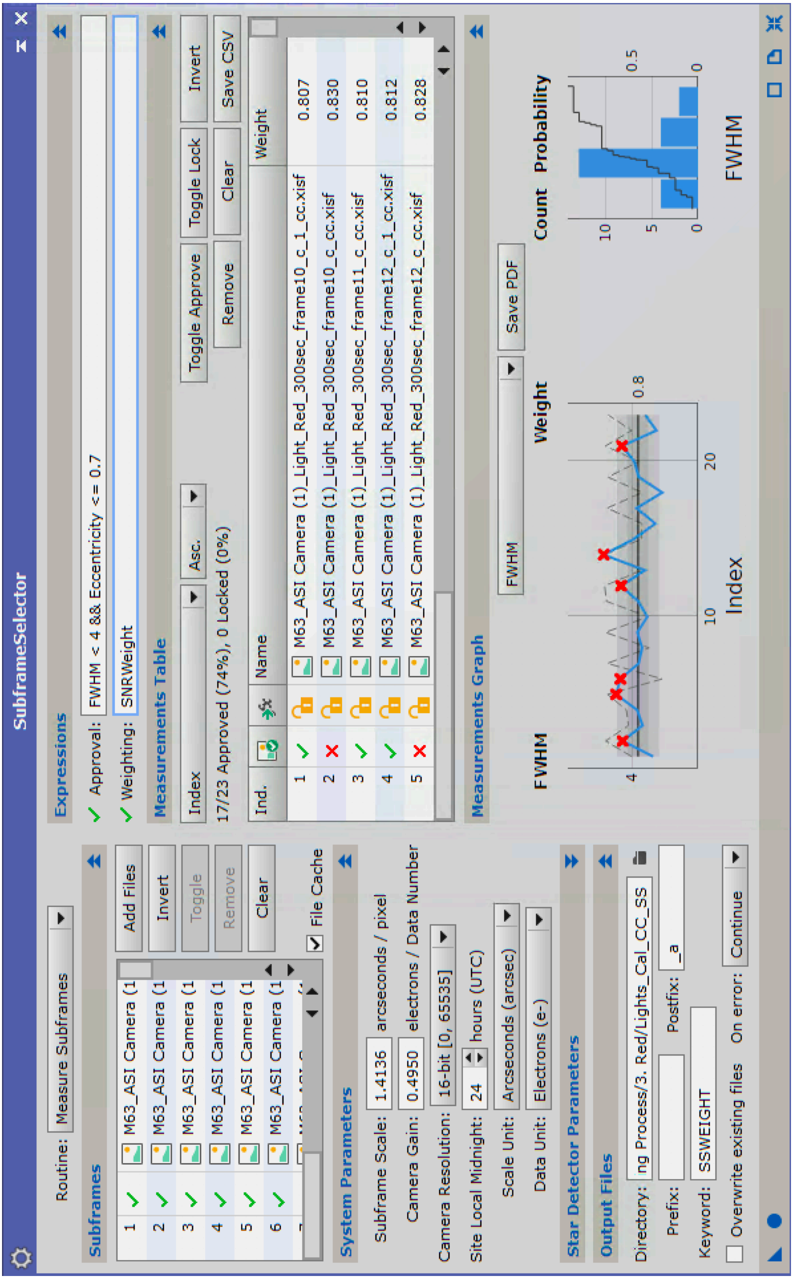

SubframeSelector
Routine: Measure Subframes
Subframes
Add Files
Invert
Toggle
Remove
Clear
File Cache
System Parameters
Subframe Scale: 1.4136 arcseconds / pixel
Camera Gain: 0.4950 electrons / Data Number
Camera Resolution: 16-bit [0, 65535]
Site Local Midnight: 24 hours (UTC)
Scale Unit: Arcseconds (arcsec)
Data Unit: Electrons (e-)
Star Detector Parameters
Output Files
Directory: ng Process/3. Red/Lights_Cal_CC_SS
Prefix:
Postfix: _a
Keyword: SSWEIGHT
Overwrite existing files
On error: Continue
Expressions
Approval: FWHM < 4 && Eccentricity <= 0.7
Weighting: SNRWeight
Measurements Table
Index
Asc.
Toggle Approve
Toggle Lock
Invert
Remove
Clear
Save CSV
17/23 Approved (74%), 0 Locked (0%)
Ind.
Name
Weight
M63_ASI Camera (1)_Light_Red_300sec_frame10_c_1_cc.xisf
0.807
M63_ASI Camera (1)_Light_Red_300sec_frame10_c_cc.xisf
0.830
M63_ASI Camera (1)_Light_Red_300sec_frame11_c_cc.xisf
0.810
M63_ASI Camera (1)_Light_Red_300sec_frame12_c_1_cc.xisf
0.812
M63_ASI Camera (1)_Light_Red_300sec_frame12_c_cc.xisf
0.828
Measurements Graph
FWHM
Save PDF
Weight
Index
Count
Probability

*Fig 2.3*

# CHAPTER 3 - CREATING A MASTER LIGHT FRAME

A master light frame in simple terms is a stacked image i.e. your light frames that have been calibrated with your calibration frames and integrated.

It is very important that light frames are calibrated with master superbias, dark and flat frames to obtain those perfect images with balanced backgrounds, reduced noise and most common issue vignetting.

## Calibration of light frames

1. Open ImageCalibration.
2. Add files. (load individual blinked approved light frames)
3. Choose output folder Lights_Cal.
4. Enable Master Bias and load the master superbias.
5. Enable Master Dark and load master dark. (check calibrate & ensure opitmize is checked. See notes)
6. Enable Master flat and load the master flat.
7. Apply Global.

Notes:
- IMPORTANT: If using CMOS or DSLR camera uncheck optimise under master dark.

## Cosmetic Correction

1. Open CosmeticCorrection. (Fig 3.1)
2. Add files. (load individual light frames from Lights_Cal)
3. Choose output folder Lights_Cal_CC.
4. Enable auto detect.
5. Check hot and Cold pixels.
6. All defaults are good.
7. Apply Global.
8. Inspect image if you still have bad pixels adjust pixel slider and reapply.

Notes:-
- Enable CFA if you're using a OSC or DSLR RAW camera.

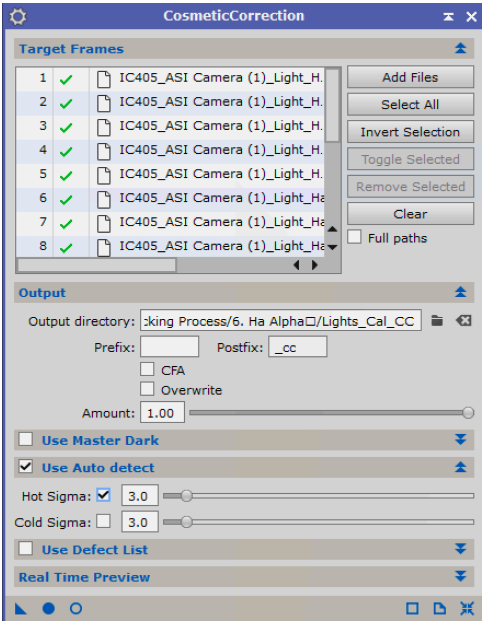

CosmeticCorrection
Target Frames
1 IC405_ASI Camera (1)_Light_H.
2 IC405_ASI Camera (1)_Light_H.
3 IC405_ASI Camera (1)_Light_H.
4 IC405_ASI Camera (1)_Light_H.
5 IC405_ASI Camera (1)_Light_H.
6 IC405_ASI Camera (1)_Light_Ha
7 IC405_ASI Camera (1)_Light_Ha
8 IC405_ASI Camera (1)_Light_Ha
Add Files
Select All
Invert Selection
Toggle Selected
Remove Selected
Clear
Full paths
Output
Output directory: :king Process/6. Ha Alpha/Lights_Cal_CC
Prefix:
Postfix: _cc
CFA
Overwrite
Amount: 1.00
Use Master Dark
Use Auto detect
Hot Sigma: 3.0
Cold Sigma: 3.0
Use Defect List
Real Time Preview

*Fig 3.1*

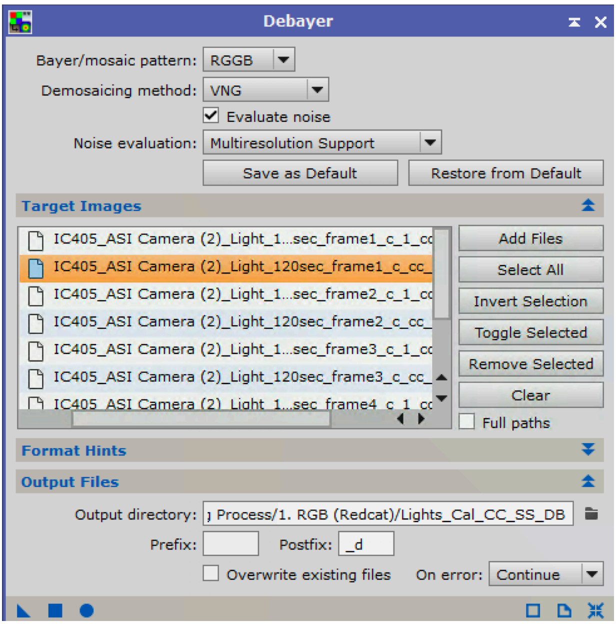

Debayer
Bayer/mosaic pattern: RGGB
Demosaicing method: VNG
Evaluate noise
Noise evaluation: Multiresolution Support
Save as Default
Restore from Default
Target Images
IC405_ASI Camera (2)_Light_1...sec_frame1_c_1_cc
IC405_ASI Camera (2)_Light_120sec_frame1_c_cc_
IC405_ASI Camera (2)_Light_1...sec_frame2_c_1_cc
IC405_ASI Camera (2)_Light_120sec_frame2_c_cc_
IC405_ASI Camera (2)_Light_1...sec_frame3_c_1_cc
IC405_ASI Camera (2)_Light_120sec_frame3_c_cc_
IC405_ASI Camera (2)_Light_1...sec_frame4_c_1_cc
Add Files
Select All
Invert Selection
Toggle Selected
Remove Selected
Clear
Full paths
Format Hints
Output Files
Output directory: Process/1. RGB (Redcat)/Lights_Cal_CC_SS_DB
Prefix:
Postfix: _d
Overwrite existing files
On error: Continue

*Fig 3.2*

## Debayer

Only applies to light frames obtained from OSC camera or RAW DSLR.

1. Open Debayer. (Fig 3.2)
2. Set bayer pattern to RGGB.
3. Add files. (load individual frames from Lights_Cal_CC_SS).
4. Choose output folder Lights_Cal_CC_SS_DB.
5. All other defaults are good.
6. Apply Global.

## Star Alignment

1. Open StarAlignment. (Fig 3.3)
2. Set reference image. (image with highest *Weight* refer to chapter 2)
3. Ensure Generate Drizzle Data is enabled.
4. Add files. (load individual light frames from Lights_Cal_CC_SS or Lights_Cal_CC_SS_DB)
5. Choose output folder Lights_Cal_CC_SS_Reg or Lights_Cal_CC_SS_DB_Reg.
6. Apply global.

Notes:-

- If using multiple filters it is good practice to register all lights frames to the same reference image which should always be a Red, luminance or Hydrogen Alpha image i.e. the image with the most detail.
- Binned images to be registered with un-binned images use full resolution luminance image as reference.
- Your drizzle data will be saved in the same output folder as registered files.

- If registering images from two different optical and camera combinations adjust Registration model to Thin Plate Splines and check Distortion Correction.
- If star alignment fails try increasing star detection and experiment with parameters.

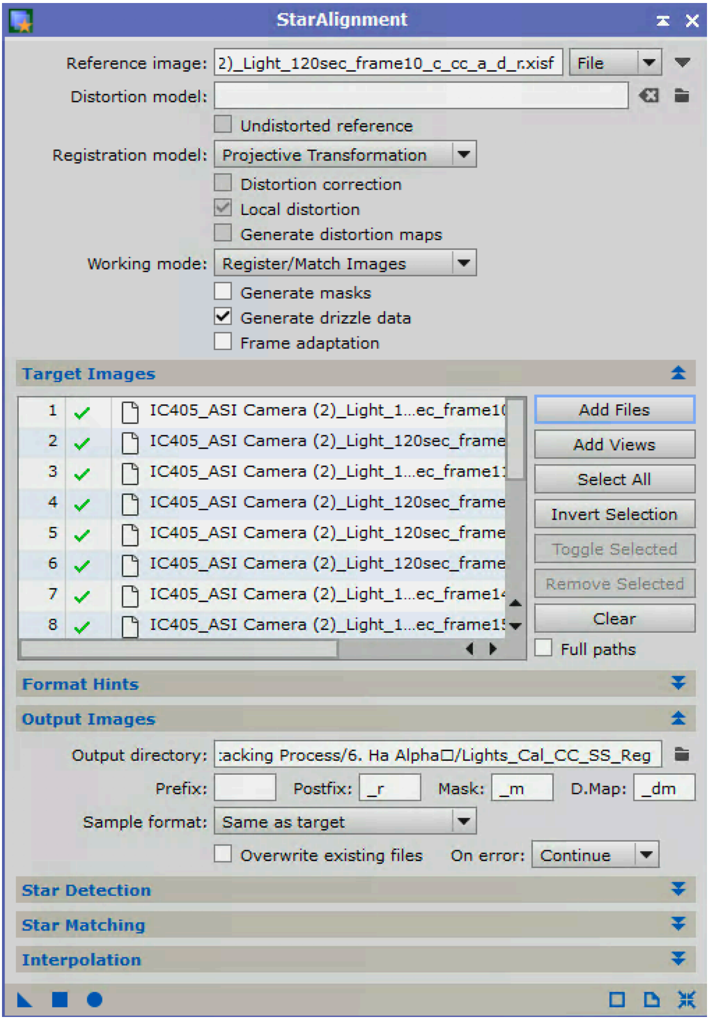



*Fig 3.3*

## Local Normalization

1. Open LocalNormalization. (Fig 3.4)
2. Set reference image. (image with highest *Weight* refer to chapter 2)
3. Adjust scale to 258, 512 or 1024. (Subject to data)
4. Ensure generate normalization data is checked.
5. Add files (load individual light frames from Lights_Cal_CC_SS_Reg).
6. Choose output folder (Lights_Cal_CC_SS_Reg
7. Apply Global.

## Image Integration

1. Open ImageIntegration.
2. Add files. (load individual light frames from Lights_Cal_CC_SS_Reg)
3. Add Norm.L Files, a (n) will appear next to each light frame. (load individual normalization frames from Lights_Cal_CC_SS_Reg)
4. Add Drizzle Files, a (d) will appear next to each light frame. (load individual drizzle frames from Lights_Cal_CC_SS_Reg)
5. Select image reference. (image with highest *Weight* refer to chapter 2)
6. Combination method use Average.
7. Normalization use Local Normalization
8. Weights use Noise Evaluation. (If you used subframe selector use FITS Keyword and type SSWEIGHT in weight keyword.
9. Ensure generate drizzle data is checked. (this will update drizzle data created by star alignment)
10. Ensure Evaluate Noise is checked.

*Continued*

11.Pixel Rejection.
- Less than 7 frames - Percentile Clipping.
- 7 - 15 frames - Averaged Sigma Clipping.
- 15 - 25 frames - Winsorized Sigma Clipping.
- 25 or more frames - Linear Fit Clipping.

10. Normalization use Local Normalization
12. Apply Global

I know this sounds weird but discard the integrated image! Yes, permanently delete it! Don't worry all that was wanted is the updated drizzle data for the next process. Smart thing to do is delete once a successfully completed drizzle integration has been achieved.

## Drizzle Integration

1. Open DrizzleIntegration. (Fig 3.5)
2. Add files. (load individual drizzle frames from Lights_Cal_CC_SS_Reg)
3. Add Norm.L Files, a (n) appear next to each light frame. (load individual normalization frames from normalization folder within Lights_Cal_CC_SS_Reg).
4. Apply Global.

Save Drizzle image as XISF file. (32-bit IEEE 754 floating point)

Notes:-
- If integrating data from a OSC or DSLR check enable CFA drizzle.

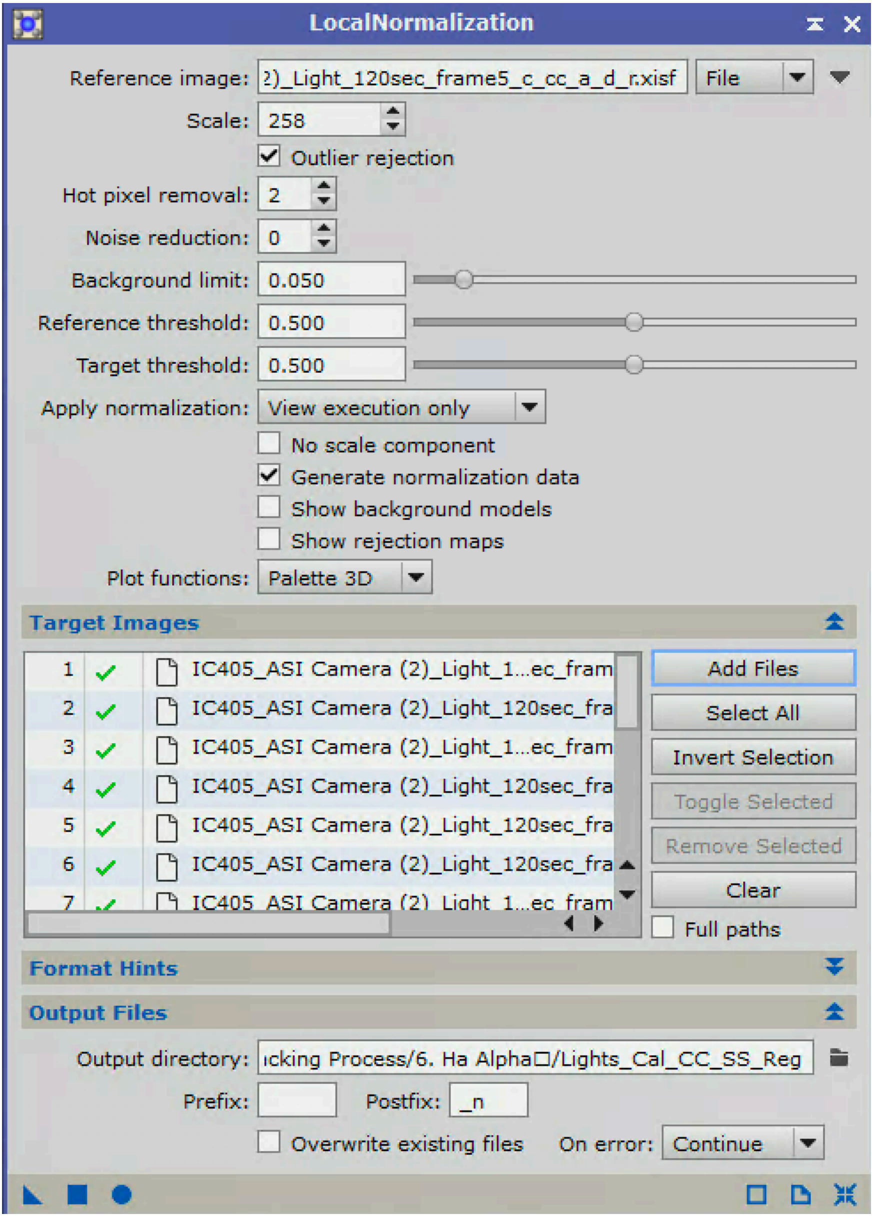

LocalNormalization
Reference image:
2)_Light_120sec_frame5_c_cc_a_d_r.xisf
File
Scale:
258
Outlier rejection
Hot pixel removal:
2
Noise reduction:
0
Background limit:
0.050
Reference threshold:
0.500
Target threshold:
0.500
Apply normalization:
View execution only
No scale component
Generate normalization data
Show background models
Show rejection maps
Plot functions:
Palette 3D
Target Images
1 IC405_ASI Camera (2)_Light_1...ec_fram
2 IC405_ASI Camera (2)_Light_120sec_fra
3 IC405_ASI Camera (2)_Light_1...ec_fram
4 IC405_ASI Camera (2)_Light_120sec_fra
5 IC405_ASI Camera (2)_Light_120sec_fra
6 IC405_ASI Camera (2)_Light_120sec_fra
Add Files
Select All
Invert Selection
Toggle Selected
Remove Selected
Clear
Full paths
Format Hints
Output Files
Output directory:
ıcking Process/6. Ha Alpha/Lights_Cal_CC_SS_Reg
Prefix:
Postfix:
_n
Overwrite existing files
On error:
Continue

*Fig 3.4*

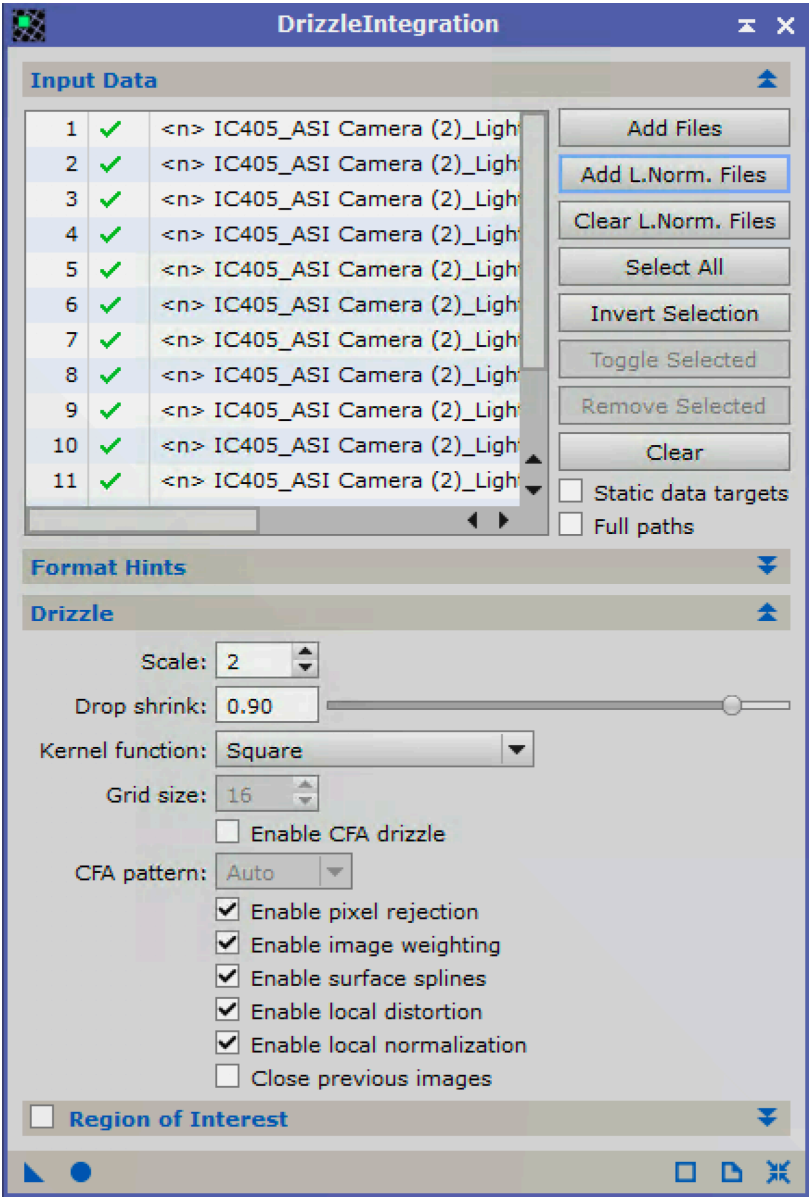

DrizzleIntegration
Input Data
<n> IC405_ASI Camera (2)_Ligh
Add Files
Add L.Norm. Files
Clear L.Norm. Files
Select All
Invert Selection
Toggle Selected
Remove Selected
Clear
Static data targets
Full paths
Format Hints
Drizzle
Scale: 2
Drop shrink: 0.90
Kernel function: Square
Grid size: 16
Enable CFA drizzle
CFA pattern: Auto
Enable pixel rejection
Enable image weighting
Enable surface splines
Enable local distortion
Enable local normalization
Close previous images
Region of Interest

*Fig 3.5*

# CHAPTER 4 - POST PROCESSING

## PREPARING LINEAR IMAGES

Now you have successfully calibrated, cosmically corrected, registered , normalised and drizzle integrated light frames the next step is to prepare linear images prior to de-linearisation for final processing.

Top Tip: If you have acquired images using a OSC camera my recommendation would be to extract Red, Green and Blue channels using ChannelExtraction and follow post processing steps on each channel then recombine in chapter 7.

## Screen Transfer Function

Screen Transfer Function also known as STF. This function automatically stretches your data while remaining linear.

Therefore it allows you to see images while you perform repair and preparatory functions prior to de-linearisation via histogram transformation.

1. Open STF. (Fig 4.1)
2. Reset STF from any prior functions applied by left clicking the four arrows in the bottom right corner.
3. Apply STF auto stretch.

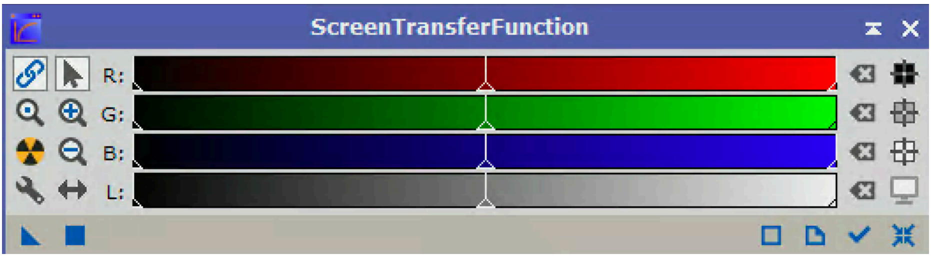



*Fig 4.1*

TOP TIP: After channel combination has been completed images will show unbalanced channels after STF i.e. images appear green, this can gradient can temporally removed for viewing by unlinking channels.

## Dynamic Crop

When working on multiple images such has filtered images apply the same dynamic crop to each image.

1. Open dynamic crop. (Fig 4.2)
2. Set crop area to the image that requires the most trimming.
3. Minimise the image to workspace.
4. Apply the DynamicCrop process to all remaining images by dragging the triangle onto the target image.
5. Now maximise the first image with set crop area and apply dynamic crop by left clicking the green tick.

Notes:-

- You may have to repeat a dynamic crop after you have star aligned grey scale images prior to channel combination.

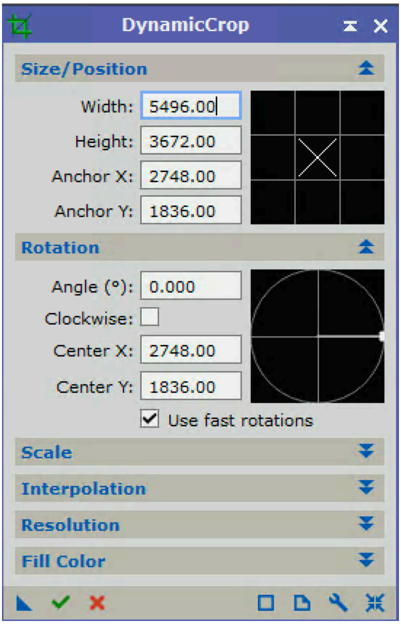



*Fig 4.2*

## Star align greyscale images

If images were obtained with a OSC or DSLR camera skip this step. If combining narrowband data continued with steps below.

A mono camera with multiple filters or image from different optical assembly must be aligned with one another.

During the integration of light frames (Chapter 3) if the same reference image for all filters was used do not need to undertake these steps.

1. Open Star Alignment.
2. Set reference image (image with highest level of detail i.e. Red, luminance or Ha) Load file.
3. Uncheck Generate Drizzle Data.
4. Add files. (Load master light images to be registered to reference image)
5. Choose output folder. (Select a folder where master lights are collectively saved for further processing for examples stacked images)
6. Apply Global.

Notes:-

- If registering images from two different optical and camera combination adjust registration model to Thin Plate Splines and Check Distortion Correction.
- If star alignment fails try increasing star detection and experiment with parameters.

## Linear Fit

Linear Fit is a great tool to balance the background to each master light image with one another.

1. Open LinearFit (Fig 4.3)
2. Set reference image. (image with the darkest background, use HistogramTransformation to confirm the image that is furthest right on the histogram)
3. Apply LinearFit to each master light frame.

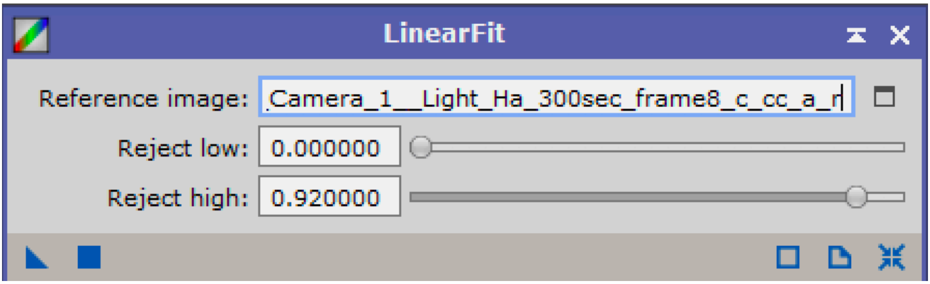



*Fig 4.3*

## Background Modelization

PixInsight offers two different modules DBE (dynamic background extraction) & ABE (automatic background extraction).

My personal preference is to us DBE therefore I will cover these steps below.

1. Open DBE. (Fig 4.4)
2. Select Sample Generation.
3. Set sample radius to 5.
4. Set sample row to 15.
5. Select Resize All & Generate.
6. Select Target Image Correction.
7. Set correction to Subtraction. (Fig 4.5)
8. Check discard background model.
9. Check replace target image.
10. Apply DBE to image.

Carefully inspect samples. Review each sample and ensure there are no stars in the sample area and the samples are not located in heavy nebulosity or centre of galaxy. The sample area on DBE will show stars as black pixels. (Fig 4.4)

(Fig 4.6) Shows a typical image with approved samples. If image samples are red that means they are poor samples and simply move the sample and become green avoiding nebulosity, galaxies or stars.

Save DBE process by dragging triangle to workspace, this can be applied to each filtered image. Left click the green tick to apply DBE to image.

If discard background was left unchecked inspect background model by applying an STF. Analyse gradient that has been subtracted.

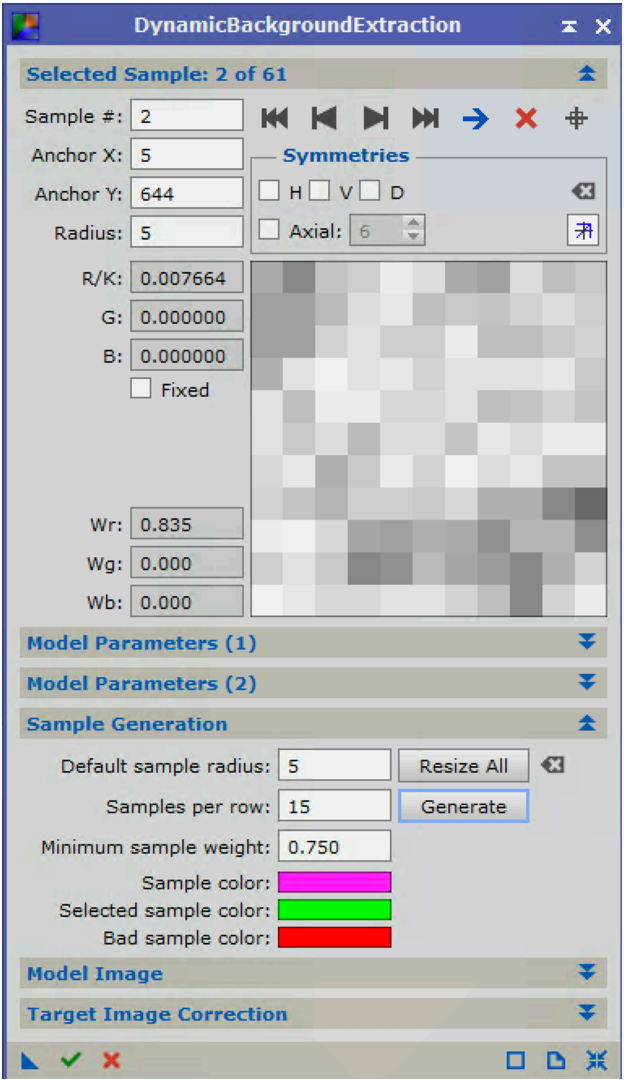



*Fig 4.4*

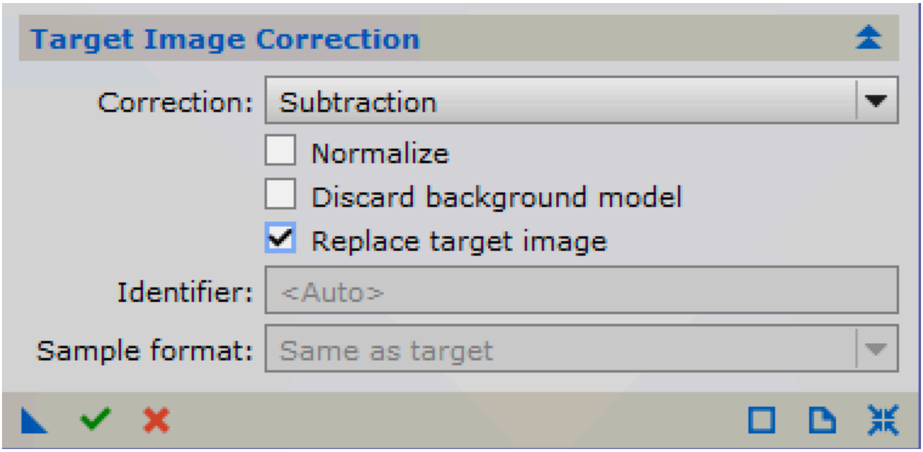

Target Image Correction
Correction:
Subtraction
Normalize
Discard background model
Replace target image
Identifier:
<Auto>
Sample format:
Same as target

*Fig 4.5*

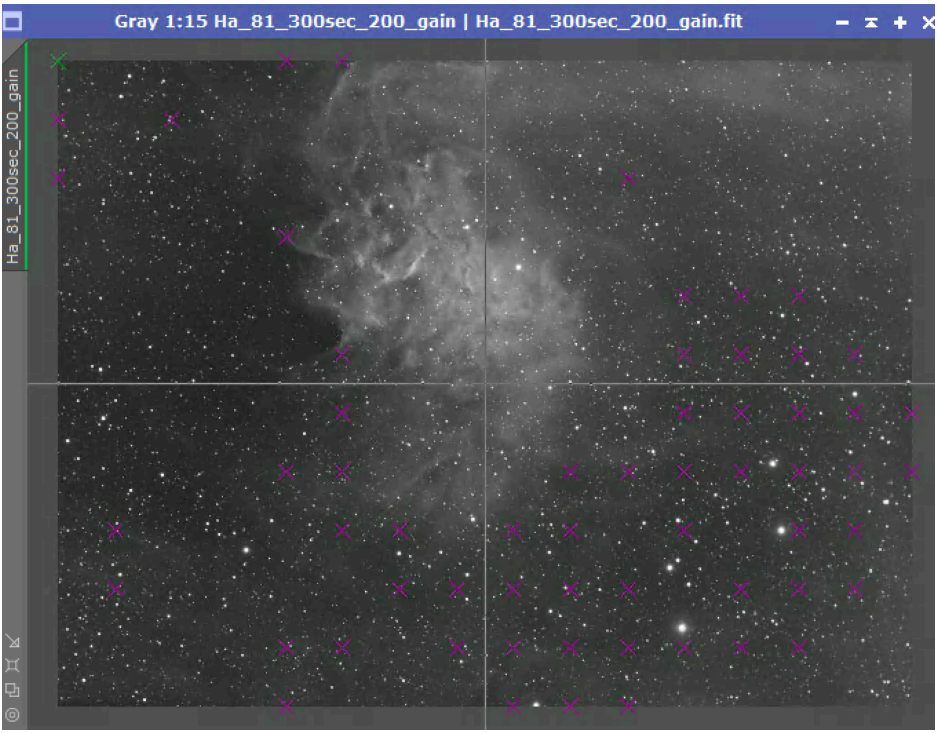

Gray 1:15 Ha_81_300sec_200_gain | Ha_81_300sec_200_gain.fit
Ha_81_300sec_200_gain

*Fig 4.6*

## Linear Noise Reduction

Linear noise reduction is optional, as noise reduction will later be performed when data is nonlinear, however many astrophotographers like myself apply noise reduction when image is linear. This can be done using MultiscaleLinearTransform.

Inspect Wavelet Layers to see what noise is present and how much noise reduction to apply. This can be achieved using ExtractWaveletLayers.

1. Open ExtractWaveletLayers Script. (Fig 4.7)
2. Select target image.
3. Increase number of layers to 5.
4. Select ok.

Five new images will be created, layers 00 (1), 01 (02), 02 (03), 03 (04), 04 (05) inspect layers carefully and analyse what layers have strong noise present, this will help when setting strength parameters during MultiscalelinearTransform.

5. Create small preview to image.
6. Apply a nonlinear luminance mask and invert.
7. Open MultiscalelinearTransform. (Fig 4.8)
8. Set algorithm to multi linear transform.
9. Increase layers to 5.
10. Select layer 1 and check noise reduction.
11. Set threshold, experiment with layer 1 (normally between 2.5 - 5) Apply to preview.
12. Repeat for each selected layer, reduce threshold by 0.5 per layer however experiment with each layer.

Top Tip:-

- When each layer is enabled apply MLT to the preview image, do NOT enable all layers at once and apply, start with layer 1 and enable one layer at a time.
- The **amount** default 1 should be ok. However if strong noise is present within image try reducing the amount to 0.5 and increasing the iterations to 2. Repeat this to each layer.
- Save MultiscaleLinearTransform to workspace, apply to each filtered image.

Notes:-

- ExtractWaveletLayers & MultiscalelinearTransform should only be applied to greyscale images, therefore if using OSC camera extract channels and re-combine later in chapter 7.
- Combine your R, G & B images to extract luminance to create luminance mask, this RGB image can be discarded once masked created.
- If imaging in mono apply linear noise reduction to each filtered image.

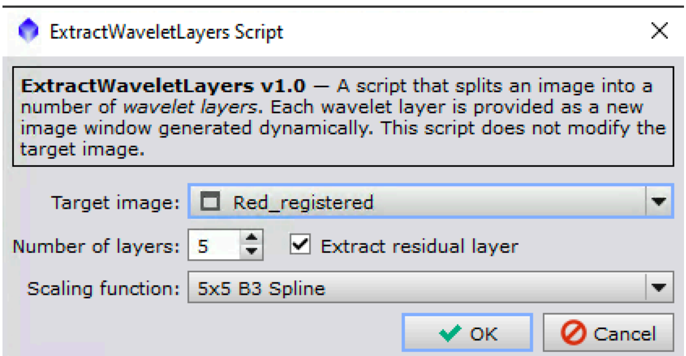



*Fig 4.7*

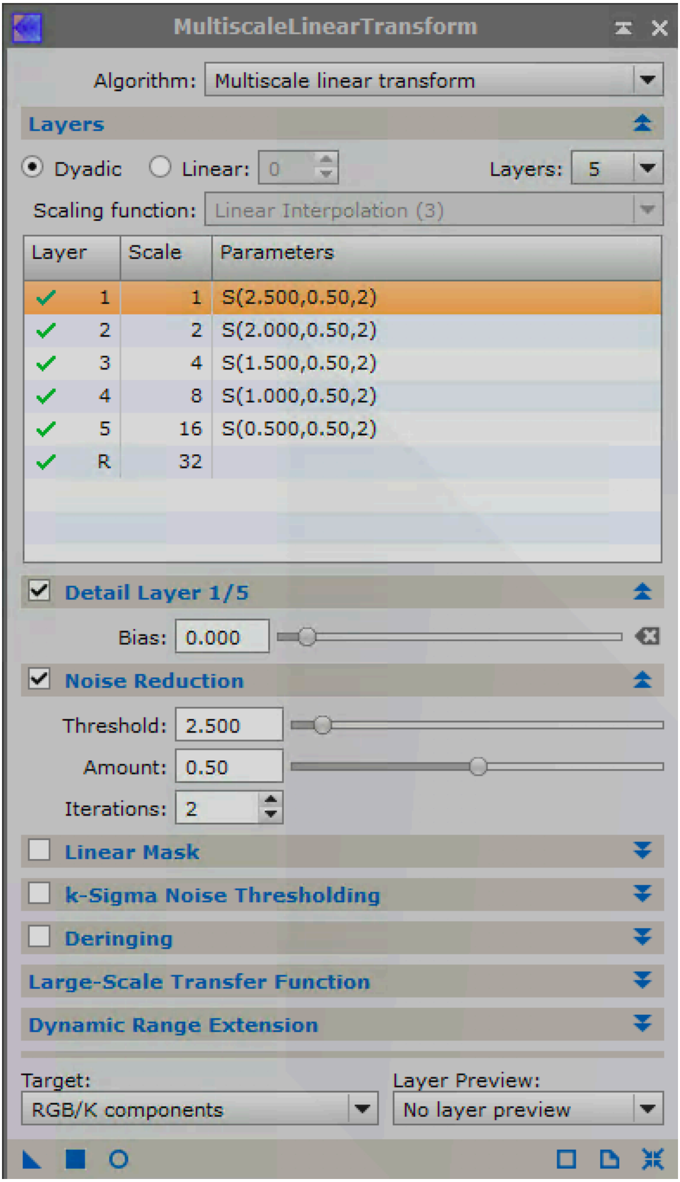
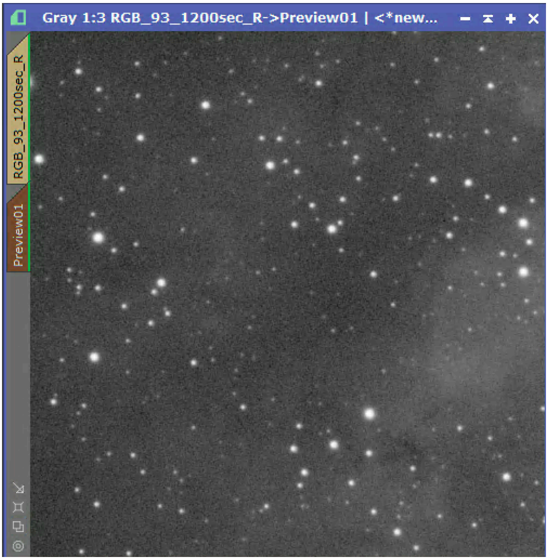
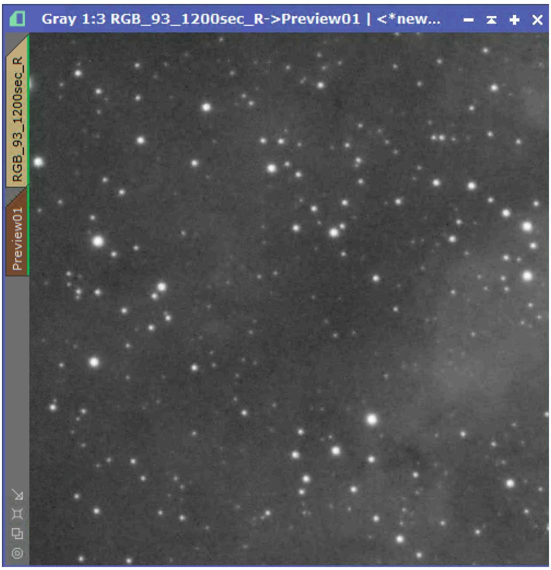

MultiscaleLinearTransform
Algorithm: Multiscale linear transform
Layers
Dyadic
Linear: 0
Layers: 5
Scaling function: Linear Interpolation (3)
Layer
Scale
Parameters
1 1 S(2.500,0.50,2)
2 2 S(2.000,0.50,2)
3 4 S(1.500,0.50,2)
4 8 S(1.000,0.50,2)
5 16 S(0.500,0.50,2)
R 32
Detail Layer 1/5
Bias: 0.000
Noise Reduction
Threshold: 2.500
Amount: 0.50
Iterations: 2
Linear Mask
k-Sigma Noise Thresholding
Deringing
Large-Scale Transfer Function
Dynamic Range Extension
Target:
RGB/K components
Layer Preview:
No layer preview

*Fig 4.8*




*Before MultiscalelinearTransform*




*After MultiscalelinearTransform*

# CHAPTER 5 - IMAGE MASKS

Creating image masks are very important for processing and should be used for processes such as Deconvolution, Curves Transformation, Star Replacement, Noise Reduction, Contrast, Image Sharping and Saturation.

Masks protect areas of the image such as nebulosity , stars , background, etc while undertaking adjustment or enhancements. Masks make a huge difference to brining out those amazing details while protecting star colours, backgrounds, etc.

## Creating a Range Mask

If luminance has been captured with a mono camera the steps are very simple, clone luminance image and perform HistogramTransformation. Luminance can be extracted from RGB & narrowband data using the channel extraction, temporarily combined all channels and post DBE/ABE, BackgroundNeutralisation and ColourCalibration.

1. Rename image Range_Mask
2. Apply a STF.
3. Open HistogramTransformation (HT), drag the STF to HT.
4. Remove STF auto stretch from the image.
5. Apply HT to Range_Mask.

Images obtained by a OSC camera have component luminance data! This can be extracted via ChannelExtraction.

<u>ChannelExtraction</u>

6. Create clone RGB image.
7. Open RGB Working Space. (Fig 5.1)
8. Under luminance coefficients (D50) set red, green and blue sliders to far right.
9. Apply RGBWS to cloned image.
10. Open ChannelExtraction.
11. Set colour space to CIE L*a*b*
12. Check luminance box. (leave as auto)
13. Deselect *a* & *b*
14. Apply ChannelExtraction.

A range mask has successfully been created! Minimise mask to workspace this will be required later and can be applied images during processing!

TOP TIP: A range mask can be converted into a range selection mask.

Notes:-

- Masks can be inverted by heading to the menu, left click mask select invert.

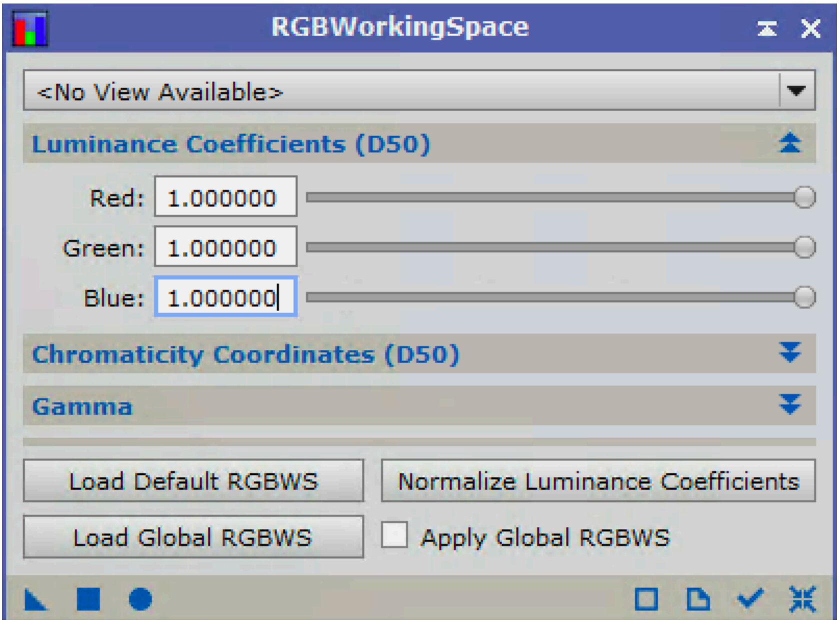



*Fig 5.1*

## Creating Range Selection

Range selection is used to create black and white range mask which are more preferred when making enhancements to areas such as nebulosity without impacting the background or stars.

1. Create a range mask.
2. Open RangeSelection. (Fig 5.2)
3. Open live preview.
4. Drag the lower limit slider right as required.
5. Drag the upper limit slide left as required.
6. Adjust fuzziness & smoothness as required.

Notes:-

- Fuzziness feathers the mask and smoothness softens the edges.
- Mask can be inverted by heading to the menu mask and invert.

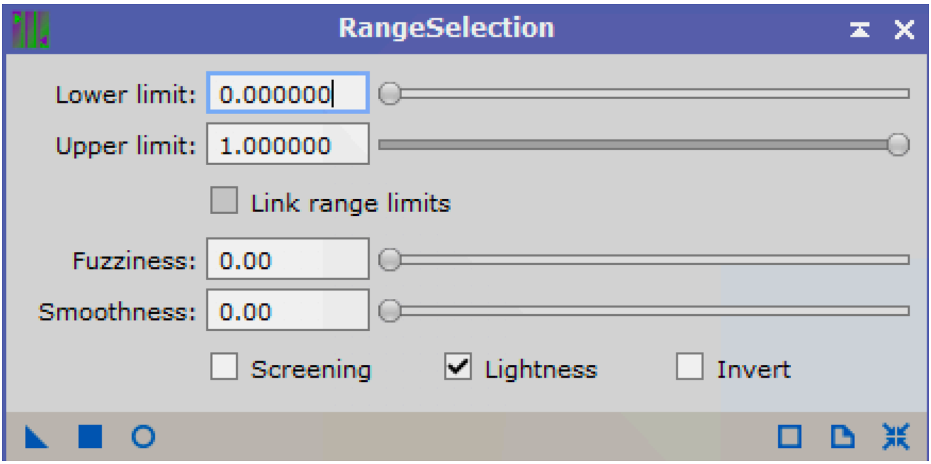



*Fig 5.2*

## Creating a Star Mask

Star masks are used to protect stars from extreme adjustments to deep sky objects,  these adjustments can blow stars out and destroy the working image. Star mask can also be used for enhancing star colour and even replacement stars with RGB stars on SHO palette or Bicolour images.

1. Open StarMask. (Fig 5.3)
2. Adjust Scale.
3. Adjust large scale.
4. Adjust small scale.
5. Adjust compensation.
6. Adjust smoothness.
7. Apply to image.

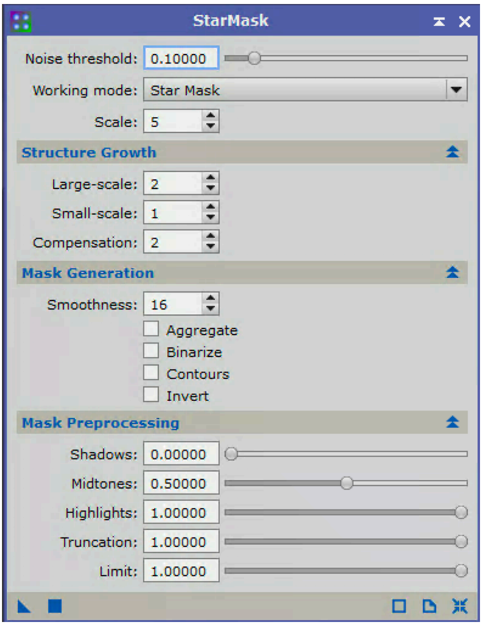



*Fig 5.3*

# Creating Colour Mask

ColorMask is a great tool for enhancement of nebulosity or adjusting colours in SHO, HOO & Bicolour palettes. Every image is different when using ColorMask so experiment with the colours to obtain the best results.

1. Open ColorMask. (Fig 5.4)
2. Set Blur to 3.
3. Select colour. (Red, Green, Blue, Yellow, Cyan & Magenta)
4. Apply to image.

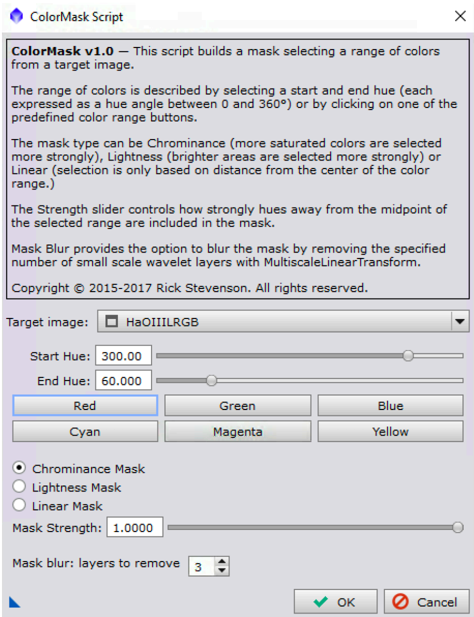
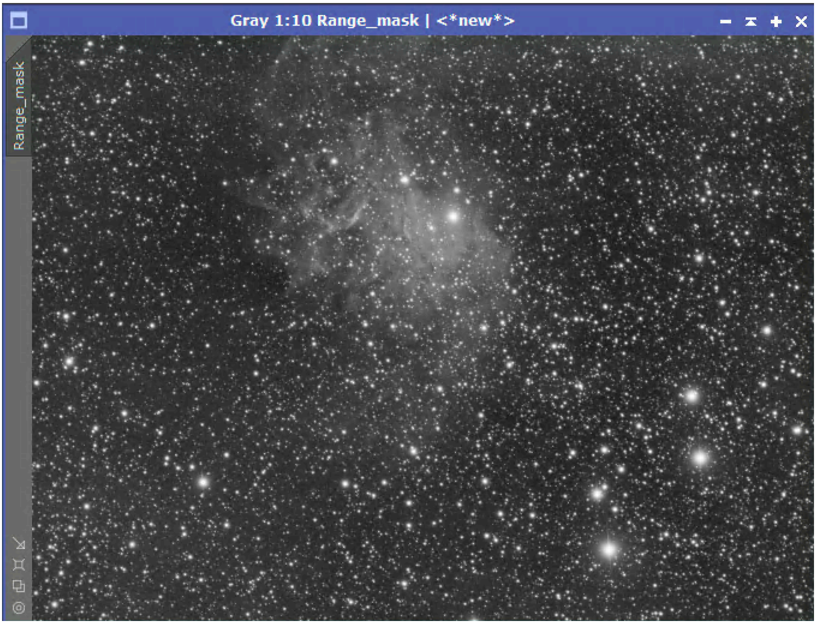
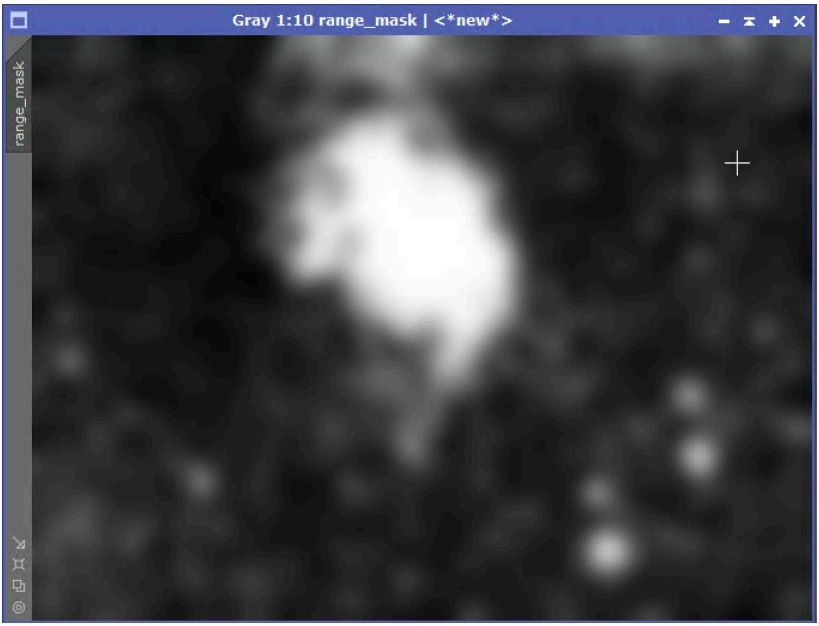


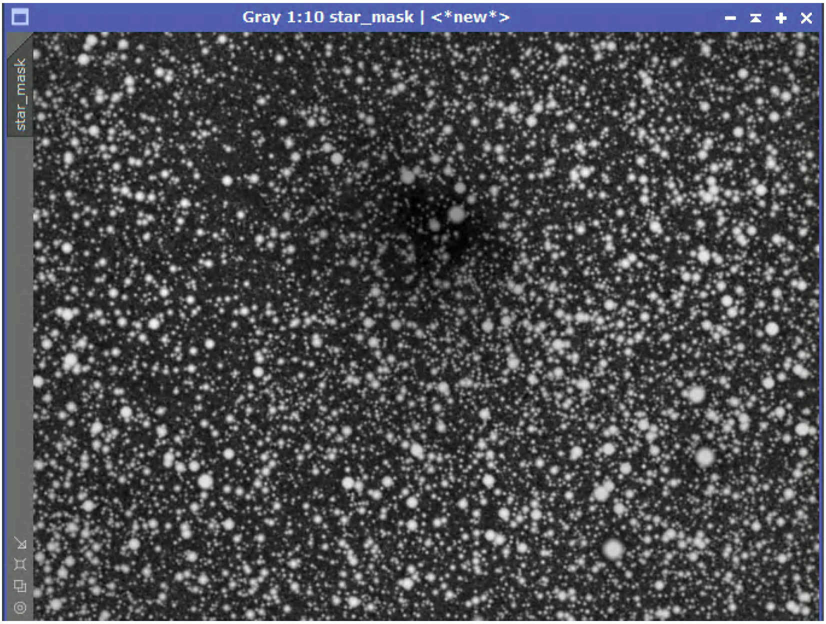

*Fig 5.4*




*Range Mask*




*Range Selection Mask*




*Star Mask*


*Color Mask*

# CHAPTER 6 - DECONVOLUTION

## CORRECTING PSF (POINT SPREAD FUNCTION)

Deconvolution is a method that treats the stars as an estimate of the true specimen intensity and using an expression for the point spread function that performs the mathematical inverse of the stars to obtain an improved estimate of the star intensity.

## Deconvolution

Deconvolution should only be applied to a linear luminance image.

Create an average Point Spread Function (PSF) of the image stars. See steps below.

1. Apply STF to linear luminance image.
2. Open Dynamic PSF. (Fig 6.1)
3. Generate star points (collect approx 30 - 40 stars) do NOT sample saturated stars, best way to identify saturated stars is to remove the STF auto stretch , as only saturated stars will appear. Avoid image edges and nebulosity. (Stars with amplitude between 0.3 - 0.5 are recommended)
4. Select all the star points on Dynamic PSF. (CLT + A or Command A)
5. Left click the camera icon to generate average star PSF.

Save PSF to workspace this will be needed in deconvolution. (Fig 6.2)

6. Apply a range mask to luminance image.
7. Reduce K value to luminance image in STF, this reduces background image brightness.
8. Create star mask (via StarMask) use a nonlinear luminance copy as nonlinear images provide more star details.
9. Rename star mask **Star_Mask_ Deconvolution**
10. Open Deconvolution. (Fig 6.3)
11. Select external PSF and load PSF image saved to workspace.

*Continued*

12. Create small preview on luminance image. (mainly stars)
13. Apply deconvolution to preview.
14. Check de-ringing. (If rings are present to stars)
15. Add star mask to local support in de-ringing.
16. Re-apply deconvolution to preview.
17. Adjust Global Bright/Dark until de-ringing has disappeared.

Ok ready to start experimenting with Deconvolution to your preview area.

18. Start iteration at 30, don't go above 50.
19. Adjust global dark settings. Recommended 0.01 - 0.09
20. Adjust your global bright. Recommended between 0.0018 - 0.0025. (Not always required)
21. Apply Deconvolution to your main image.
22. Save luminance image to workspace for LRGB combination in chapter 7.

Notes:-

- **T**oggle your changes during testing by CTL+SHIFT+Z.
- Star mask should be created from a stretched copy of your image, as nonlinear star mask contains more star details.

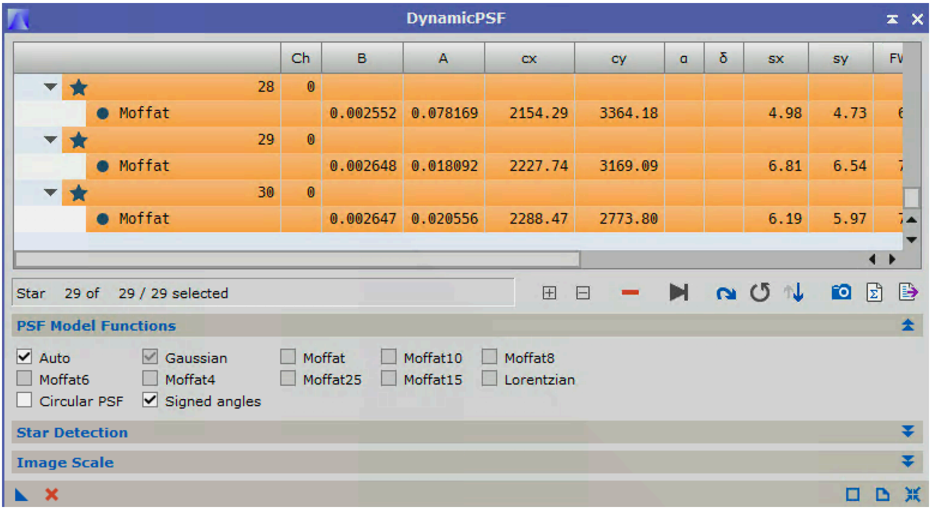

DynamicPSF
Ch
B
A
cx
cy
sx
sy
28
0
Moffat
0.002552
0.078169
2154.29
3364.18
4.98
4.73
29
0
Moffat
0.002648
0.018092
2227.74
3169.09
6.81
6.54
30
0
Moffat
0.002647
0.020556
2288.47
2773.80
6.19
5.97
Star 29 of 29 / 29 selected
PSF Model Functions
Auto
Gaussian
Moffat
Moffat10
Moffat8
Moffat6
Moffat4
Moffat25
Moffat15
Lorentzian
Circular PSF
Signed angles
Star Detection
Image Scale

*Fig 6.1*

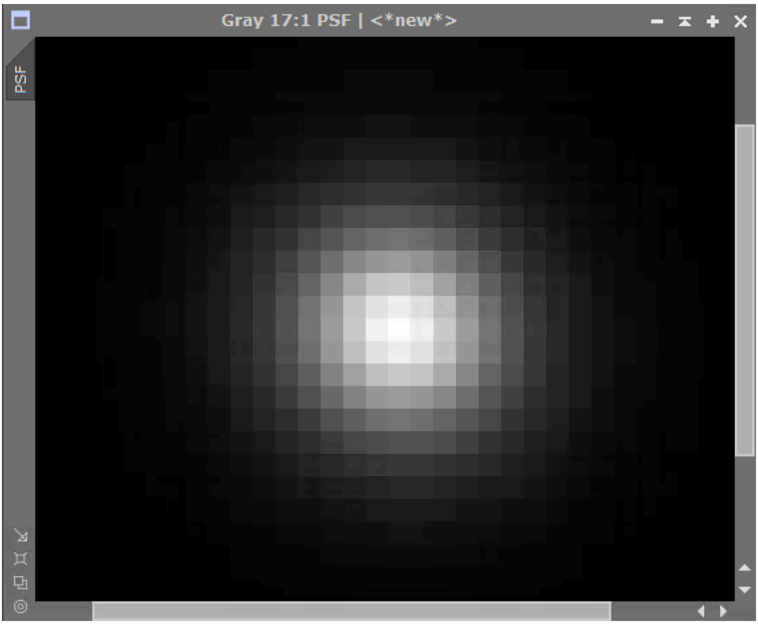

Gray 17:1 PSF | <*new*>
PSF

*Fig 6.2*

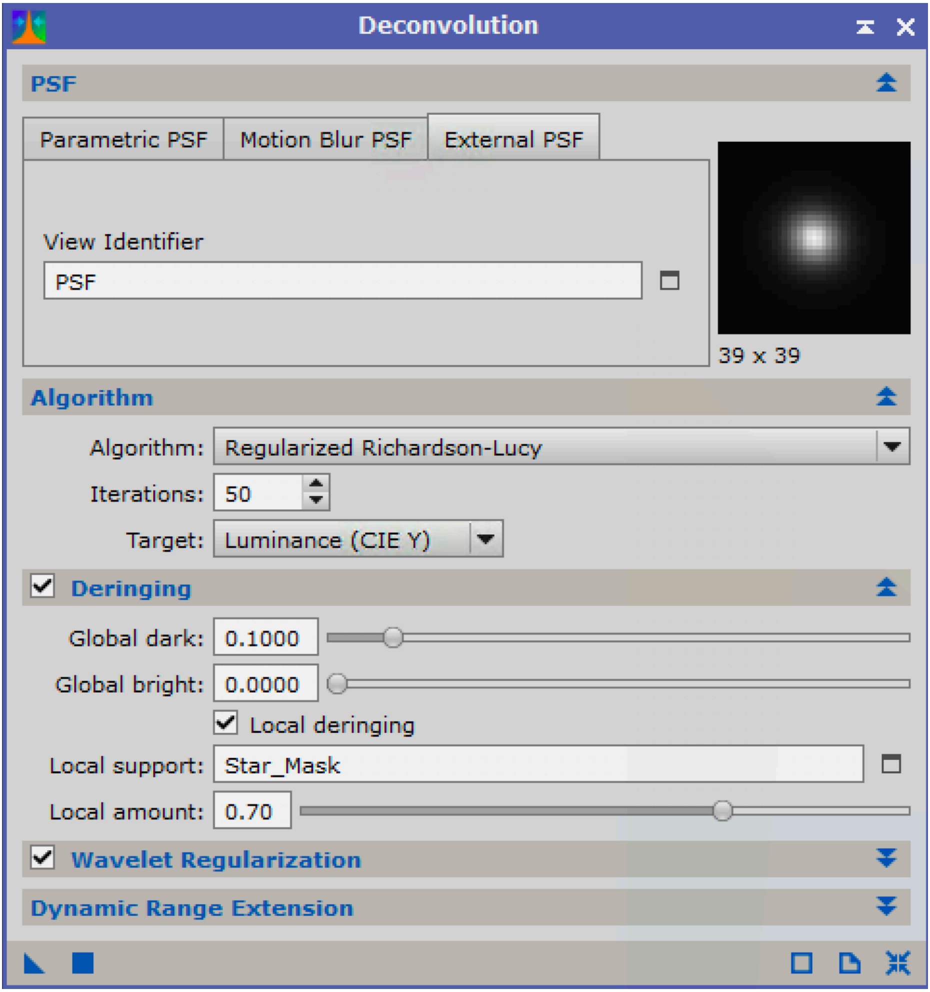

Deconvolution
PSF
Parametric PSF
Motion Blur PSF
External PSF
View Identifier
PSF
39 x 39
Algorithm
Algorithm:
Regularized Richardson-Lucy
Iterations:
50
Target:
Luminance (CIE Y)
Deringing
Global dark:
0.1000
Global bright:
0.0000
Local deringing
Local support:
Star_Mask
Local amount:
0.70
Wavelet Regularization
Dynamic Range Extension

*Fig 6.3*

# CHAPTER 7 - LINEAR COLOUR PROCESSING

## COMBINING DATA TO CREATE A COLOUR IMAGE

In this chapter we will now combine all images together to create an RGB image for colour processing and background modelization prior to delinearization.

## Channel Combination

1. Open channel combination. (Fig 7.1)
2. Add filtered images into required channels.
3. Apply Global.
4. Rename image (examples SHO, RGB, HOO)

Luminance and narrowband images can also be combined with RGB data! This will be explained in chapter 6.

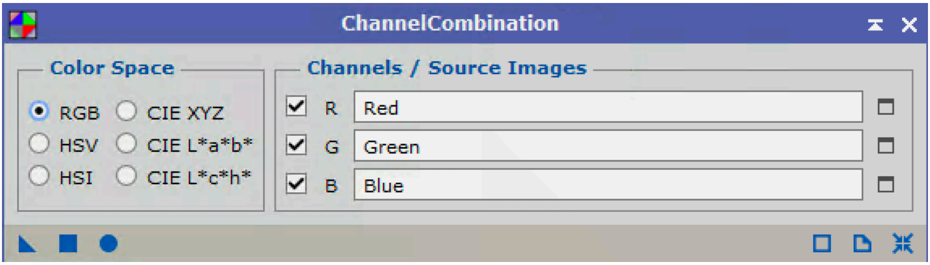



*Fig 7.1*

| Description | Red Channel | Green Channel | Blue Channel |
|---|---|---|---|
| RGB | Red | Green | Blue |
| Hubble Palette | S-II | Ha | O-III |
| HOO Palette | Ha | O-III | O-III |

**For Bicolour blending via PixelMath refer to method 2 SHO processing in chapter 8.**

## SNR (Signal Noise Ratio)

If the image is green especially when combining SHO, no drama SNR removes this. This is because Ha located in the green channel in the SHO palette is dominant.

1. Open SNR (Fig 7.2)
2. All defaults should be good.
3. Apply SNR to image.

## Background Neutralization

1. Open BackgroundNeutralization. (Fig 7.3).
2. Create preview or preview aggregator image. (Previews must be in neutral area of the sky with no stars)
3. Set reference image as preview or aggregator image.
4. Apply to image.
5. Apply STF to image.

Note:-

- Keep preview active this will be required for colour calibration.

## Dynamic Background Extraction

As before in (Chapter 4) apply a DBE or ABE to the coloured image.

1. Apply DBE or ABE to image
2. Apply STF to image.

## Colour Calibration

1. Open ColourCalibration. (Fig 7.4).
2. Leave white reference as <target image> if imaging galaxy set a preview on its nucleus and set as white reference.
3. Ensure structure detection is checked. (disable if white reference used.
4. Set dark reference as preview or aggregator image used in Background Neutralization.
5. Apply to image.
6. Apply STF to image.

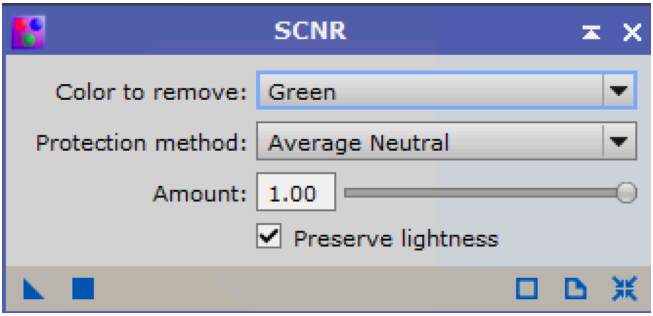



*Fig 7.2*

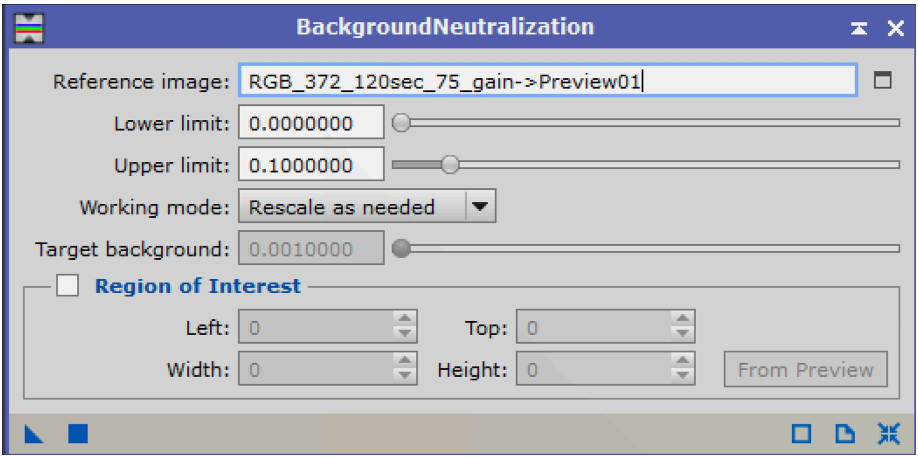



*Fig 7.3*

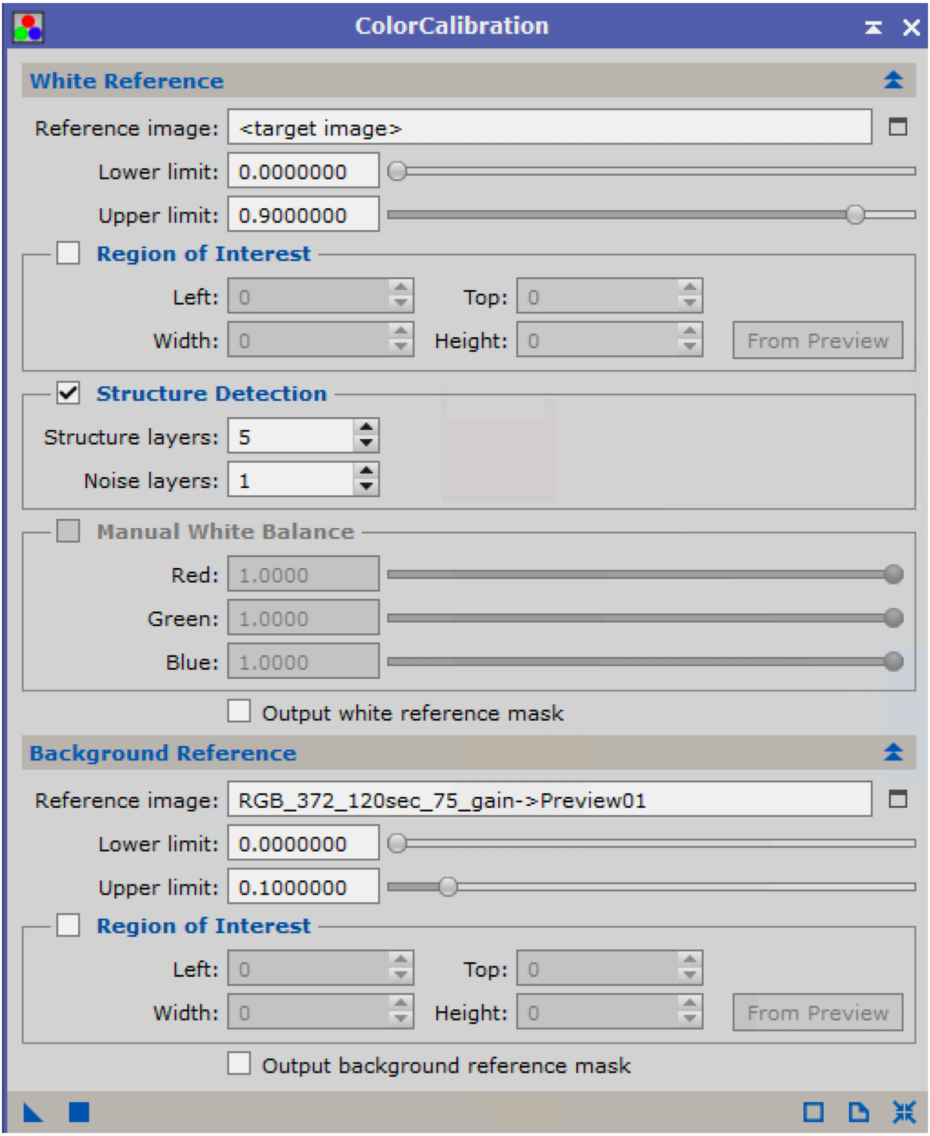

ColorCalibration
White Reference
Reference image:
<target image>
Lower limit:
0.0000000
Upper limit:
0.9000000
Region of Interest
Left:
Top:
Width:
Height:
From Preview
Structure Detection
Structure layers:
5
Noise layers:
1
Manual White Balance
Red:
Green:
Blue:
1.0000
Output white reference mask
Background Reference
Reference image:
RGB_372_120sec_75_gain->Preview01
Lower limit:
0.0000000
Upper limit:
0.1000000
Region of Interest
Left:
Top:
Width:
Height:
From Preview
Output background reference mask

*Fig 7.4*

# CHAPTER 8 - IMAGE PROCESSING

## MAKING YOUR IMAGE NONLINEAR (DELINEARIZATION)

Ok your data is now ready for de-linearisation. In this chapter I have split these steps up depending on what combination you are going to process, whether its LRGB or SHO, they all have different techniques.

IMPORTANT: PLAN AHEAD IN THE CHAPTER AS YOU MAY NOT WANT TO DELINERIZE YOUR DATA AT THE START!

## De-linearisation (Histogram Stretch)

Before de-linearisation is undertaken, copy RGB data, this maybe require for further processes later on.

There are two methods when it comes to completing histogram stretch. Manual stretch or STF stretch, on most occasions produces the best results.

STF Histogram Stretch:-
1. Open STF.
2. Apply STF to image.
3. Open Histogram Transformation. (Fig 8.1)
4. Drag the STF to the HT.
5. Reset STF.
6. Apply HT to image.

For manual stretching open real time preview on HT and adjust accordantly until you are satisfied and apply HT to image.

## Non-Linear Processing

Now the image is non linear and in RGB format continue with following steps.

1. Curves Tranformation.
2. Noise Reduction.
3. Contrast & Sharpness.
4. Colour Saturation.

However if data is not just a basic RGB image it may require further pre-processing.

Therefore the remainder of this chapter will cover the following combinations.

1. LRGB (Luminance + RGB)
2. HaLRGB (Ha + LRGB)
3. HOO-RGB (Ha+Oiii+Oiii+RGB)
4. HOO (Ha + Oiii + Oiii)
5. SHO (Hubble Palette Sii + Ha + Oiii)
6. Bicolour (Ha + Oiii)


*Fig 8.1*

## LRGB Combination

Adding luminance to non-linear RGB image will required a HT stretch to the linear luminance image, if performing a STF stretch I recommend that the background is darken by adjustments in HT, this prevents stars or DSO from being saturated, this also darkens the background slightly.

Images obtained from a OSC camera will require extraction of luminance. This must be done prior to delinearization of your RGB image.

I mentioned at the start of this chapter when performing a HT stretch to copy RGB linear image! If this was carried out, extract luminance with ease.

1. Open RGB Working Space.
2. Under luminance coefficients (D50) set red, green and blue sliders to far right.
3. Apply RGBWS to linear RGB image.
4. Open Channel extraction.
5. Select CIE L*a*b*.
6. Apply to linear RGB image.
7. Luminance image must be post processed and deconvolution. If luminance was extracted these post processing steps would have been applied during RGB post processing.
8. Perform HT stretch to your extracted or captured luminance.
9. Save image to workspace as Non_Linear_Luminance.

Luminance image is ready for LRGB combination.

10. Darken luminance slightly via HT. (Personal Preference)
11. Open LRGB Combination. (Fig 8.2)

*Continued*

12. Uncheck R,G & B.
13. Load your non-linear luminance image to L.
14. Check chrominance noise reduction.
15. Apply LRGB Combination to RGB image.
16. Rename RGB image LRGB.

Luminance has successfully been combined with RGB data, continue with non-linear processing.

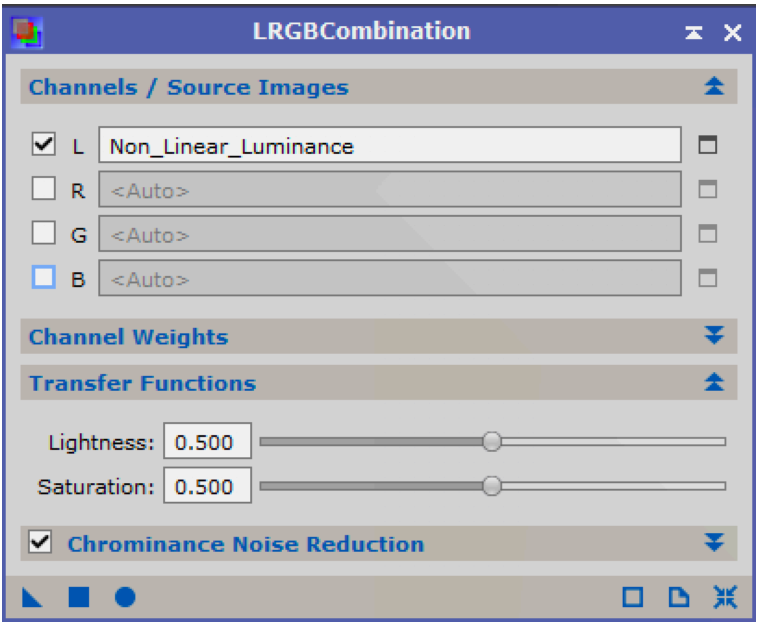



*Fig 8.2*

## HaRGB & HOO-RGB Combination

I use different methods for combining Ha & OIII to RGB data Method 1 my preferred method is extracting the red or blue channel from the RGB image and combing narrowband image using PixelMath. Method 2 which is very simple! The NBRGB Combination script, however I believe this methods does not give you the best results.

Method 1 *(data should be linear and post linear processing complete, however non-linear data can be used)*

1. Open channel extraction.
2. Deselect the G and B channels leaving the R channel selected.
3. Apply channel extraction to RGB image.
4. Rename image (Red) and save to workspace.
5. Open your Ha image.
6. Rename image (Ha)

Ok now lets move onto the difficult part , my advise is take your time PixelMath is very sensitive especially case sensitive and only takes one spelling mistake or incorrect case and it you get errors. When adding images to your formula do this using the expression editor by double clicking the image on the right.

7. Open PixelMath. (Fig 8.3)
8. Deselect use a single RGB/K expression.
9. Open Expression Editor.
10. In the RGB/K channel enter the following formula.

*((Ha*Red_bandwidth)-(Red*Ha_bandwidth))/(Red_bandwidth-Ha_bandwidth)*

*Continued*

11.In the symbol channel add the following.

*Red_bandwidth=40, Ha_bandwidth=7*

12.Select ok.
13.Drop destination menu.
14.Check generate output.
15.Check create new image.
16.Select colour space as Greyscale.
17.Apply PixelMath to Red image. (Extracted Red)
18.Rename new image. (comp)

Next step is to apply Red and Ha combined image to the RGB image.

19. Reset PixelMath.
20.Deselect use a single R/K expression.
21.Select Expression Editor.
22.In the RGB/K channel enter the following formula.

*$T+((comp-med(comp))*boostfactor)*

23. In the Green and Blue channel enter the following.

*$T*

24. In the symbol channel enter the following formula.

*boostfactor=1.0*

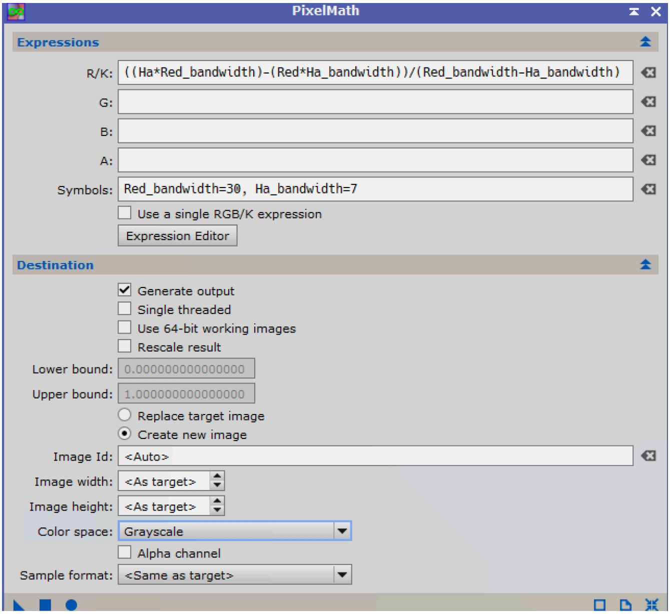



*Fig 8.3*

*Continued*

25. Select ok.
26. Drop destination menu.
27. Check generate output.
28. Check create new image.
29. Select colour space as RGB color.
30. Apply PixelMath to RGB image.
31. Experiment with the boost factor , it's currently set to 1.0 , if the channel is too exposed decrease the boost factor , if the boost is not enough increase the boost factor.
32. Rename your new image HaRGB.

Apply the same steps for adding OIII data to the HaRGB image by extracting the green and blue channels and following the same steps but using the G & B channel in PixelMath, add $T too the channels you want to remain the same.

Notes:-

- The Ha bandwidth values of 7 used in the symbol formula is the filter bandwidth, the value 40 on the red can be experimented with, the lower the value the more aggressive the combination.
- PixelMath must have image open in workspace to function.
- Extract luminance for adjustments and recombine via LRGB combination

<u>Method 2</u> *(data should be non-linear, however linear data can be used)*

1. Open RGB & Ha Images.
2. Open NBRGB Combination script. (Fig 8.4)
3. Uncheck autoSTF.
4. Check non-linear. (leave unchecked if using linear data)
5. Set RGB source. (RGB Image)
6. Set Narrowband red channel with your Ha image.
7. Adjust red channel bandwidth, (nm) to your filter specification. Example my ASI  NB filters are 7nm.
8. Adjust red channel scale. (recommend between 0.75 - 1.00)
9. Select NBRGB button. This will create a preview. Once happy select ok , a new image will be created.

Notes:-

- If Oiii data has been obtained try adding this via NBRGB to create HORGB image, follow the same steps as adding Ha, however add Oiii data to the green and blue channel. Recommended scale for green and blue channel is 0.30 - 0.50.

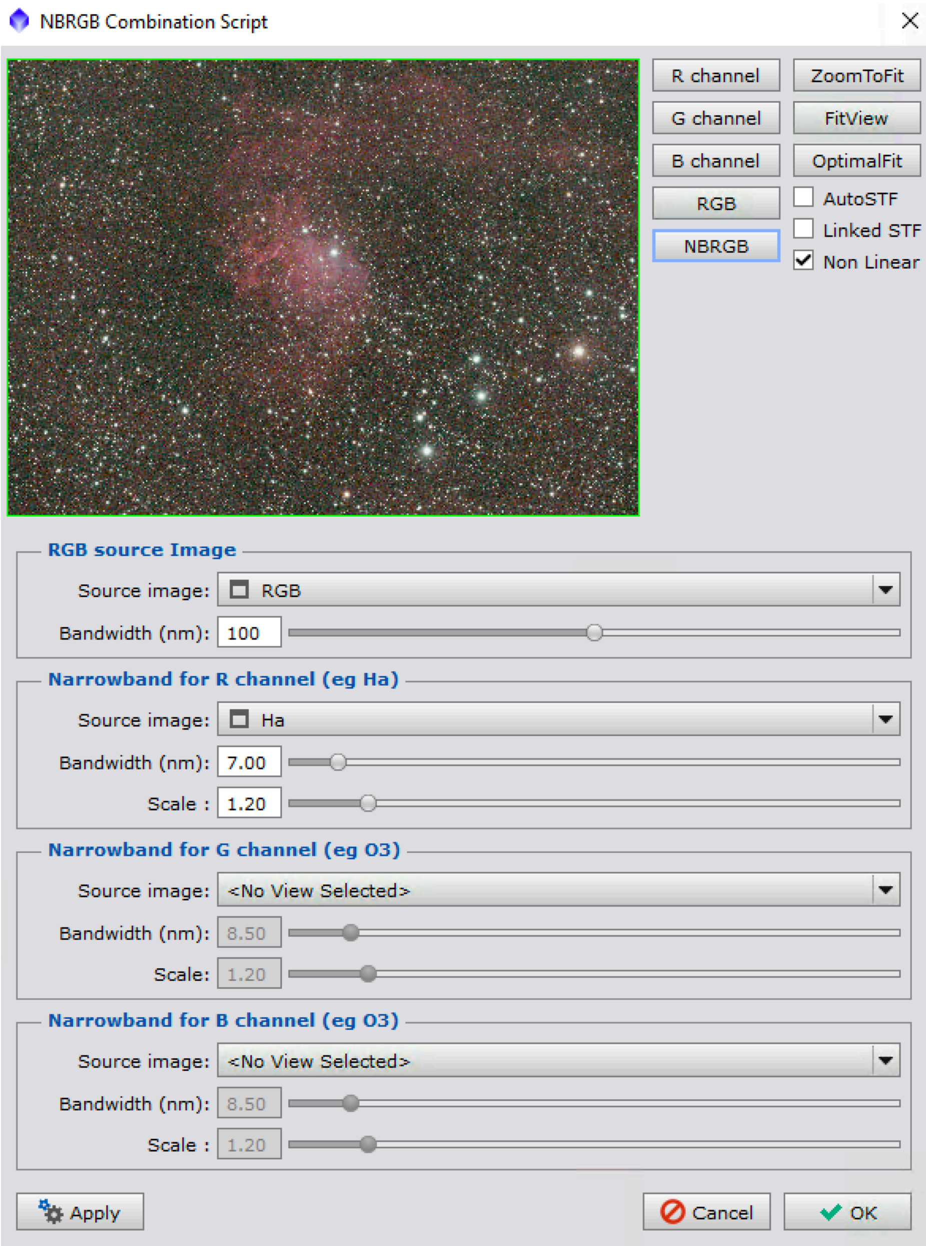

NBRGB Combination Script
R channel
ZoomToFit
G channel
FitView
B channel
OptimalFit
RGB
AutoSTF
Linked STF
NBRGB
Non Linear
RGB source Image
Source image:
RGB
Bandwidth (nm):
100
Narrowband for R channel (eg Ha)
Source image:
Ha
Bandwidth (nm):
7.00
Scale :
1.20
Narrowband for G channel (eg O3)
Source image:
<No View Selected>
Bandwidth (nm):
8.50
Scale:
1.20
Narrowband for B channel (eg O3)
Source image:
<No View Selected>
Bandwidth (nm):
8.50
Scale :
1.20
Apply
Cancel
OK

*Fig 8.4*

## HOO Palette

This palette is very simple and does not require any further pre-processing, combine Ha to Red, OIII to Green and OIII to Blue in channel combination, therefore continue with non-linear processing.

## SHO Hubble Palette

The Hubble Palette requires the most amount of pre-processing to get those beautiful gold and blue details, these steps are simple however experiment with curves transformation to get the colours you require.

1. Open SHO image.
2. Extract luminance and rename SHO_Luminance , perform HT stretch and save to workspace.
3. Perform HT stretch to data if linear.
4. Perform SNR. (Green)
5. Open color mask script.
6. Select target image.
7. Set mask blur to 3. (must be done prior to selecting colour)
8. Select Green.
9. Apply. (Ok)
10. Save mask as Green_Mask.
11. Repeat this for Magenta & Cyan.

Now lets reduce those Magenta stars and make them blue

12. Apply Magenta mask to SHO image.
13. Uncheck show mask. (Allows you to see adjustments)
14. Perform Curves Transformation.

*Continued*

15. Adjust green channel. (Normally decrease)
16. Magenta stars should now be more blue.
17. Adjust RGB. (S Curve)
18. Remove mask.

Adjust using the green mask and get those gold & yellow details.

19. Apply green mask.
20. Uncheck show mask. (Allows you to see adjustments)
21. Perform Curves Transformation.
22. Adjust red channel.
23. Adjust green channel.
24. Adjust RGB.
25. Remove mask.

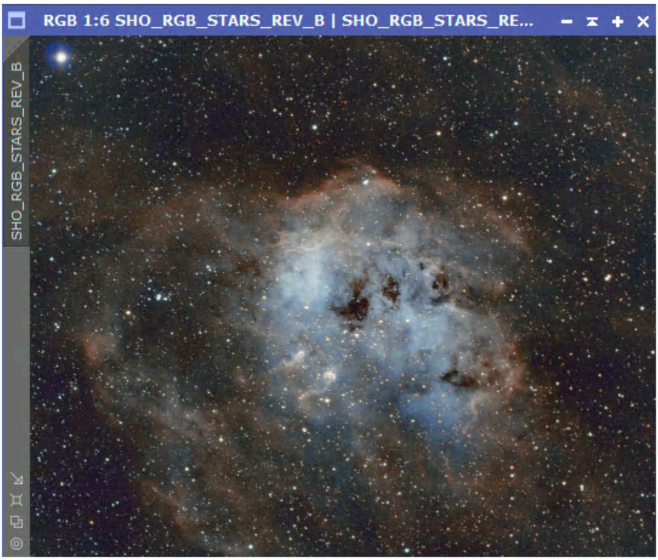
Now apply the cyan mask and bring those blue details through.

26. Apply cyan mask.
27. Uncheck show mask. (Allows you to see adjustments)
28. Perform Curves Transformation.
29. Adjust red channel.
30. Adjust green channel.
31. Adjust blue channel.
32. Adjust RGB.
33. Remove mask.

Re-apply the green mask and increase the red slightly after making adjustments using the cyan mask. Every target is different therefore you will need to experiment with these masks applied. Apply the luminance extraction to clean up the noise created our masked curves adjustments.

34. Open LRGB Combination.
35. Uncheck Red, Green & Blue.
36. Load luminance extraction.
37. Check chrominance noise reduction
38. Apply LRGB to SHO image.
39. Apply the luminance image as a mask to our SHO image.
40. Perform Curves Transformation. (RGB)
41. Perform DarkStructureEnhancement Script. (use defaults)
42. Adjust histogram and make fine adjustments to dark and light end of the scale.

Now you are ready to continue with non-linear processing.




*SHO Palette*

## Bicolour Palette

Using PixelMath to combine Ha, OIII, SII and a synthetic Green using both Ha & OIII. This allows you to try different bicolour blending methods giving you a wide range of colours. See table below.

| Channel Combinations | R/K | Green | Blue |
|---|---|---|---|
| Synthetic Green | *Ha* | *(Ha*0.01)+ (OIII*~0.01)* | *OIII* |
| Synthetic Green | *Ha* | *(Ha*0.5)+ (OIII*~0.5)* | *OIII* |
| Synthetic Green | *Ha* | *(Ha*1.0)+ (OIII*~1.0)* | *OIII* |
| Blended Channels | *Ha* | *(0.4*Ha)_(0.6*OI II)* | *OIII* |
| Blended Channels | *(0.5*SII) +(0.5*Ha)* | *(0.2*Ha) +(0.8*OIII)* | *OIII* |

1. Open Linear Ha & OIII images.
2. Make sure images are named or renamed. (Ha) & (OIII)
3. Open PixelMath. (Fig 8.5)
4. Uncheck use single RGB/K expression.
5. Check generate output.
6. Check create new image.
7. Set colour space as RGB Color.

*Continued*

8. Open expression editor
9. Select the R/K channel and add the following combination formula.

*Ha*

10. Select the G channel and add the following formula.

*(Ha*0.01)+(OIII*~0.01)*

11. Select the B channel and add the following formula.

*OIII*

12. Apply PixelMath (select square button, note you must have an image open or you will get an Error)

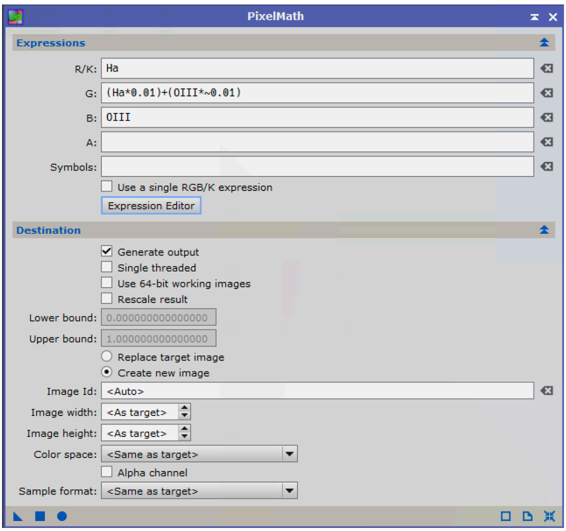



*Fig 8.5*

*Continued*

13. Rename your new image Bicolour.
14. If there is green present in the image after an STF apply a Green SNR.
15. Apply BackgroundNeutralisation.
16. Apply ColorCalibration.
17. De-linearise Image (Non-linear) via STF & HT.
18. Apply a Range Mask to Bicolour image. (or try ColorMasks)
19. Perform Curve Transformation. (Adjust RGB, Saturation, Red & Blue Channels)
20. Remove Mask.
21. Clone Ha Linear Image and rename Ha_Lum.
22. De-linearise your Ha_Lum image.
23. Open Convolution.
24. Adjust StdDev to 5. (may need to experiment , we looking to blur the image)
25. Open LRGB combination.
26. Uncheck R, G & B.
27. Add Ha_Lum to the luminance channel.
28. Check Chrominance noise reduction.
29. Apply to Bicolour image.

Adding luminance should have slightly darkened the background and reduced star size.

30. Apply Ha_lum image as a mask to Bicolour image.
31. Perform Curve Transformation. (Adjust RGB & Saturation)
32. Remove mask.

The image is almost complete , enhance the dark dust details before continuing with the final steps i.e. Noise Reduction , Contrast enhancement and Final Saturation adjustment further in this chapter.

33. Open DarkStructureEnhancement Script. (Fig 8.6)
34. Apply defaults to Bicolour image.

Bicolour processing is now complete, continue with the final processing steps of this chapter! Before and After images below show the working on of DarkStructureEnhancement. Notice the dark dust areas have been slightly enhanced.

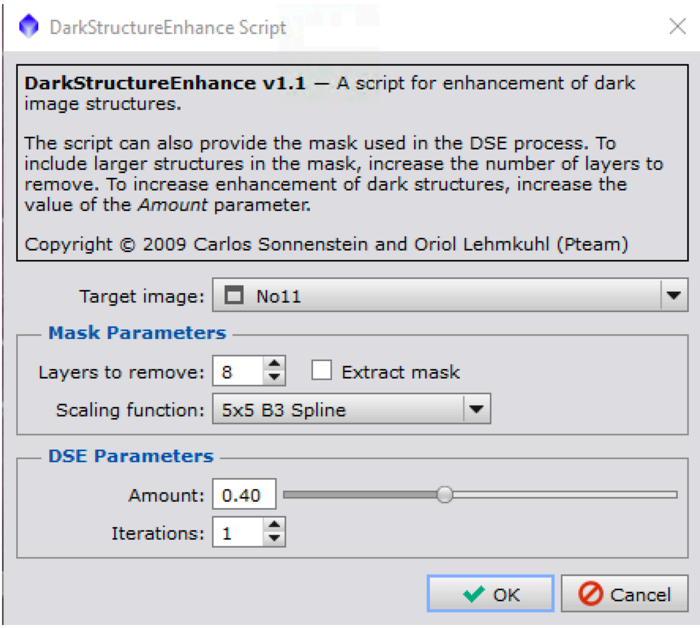
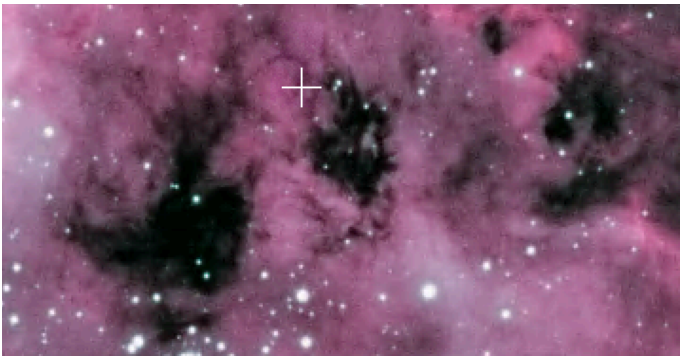
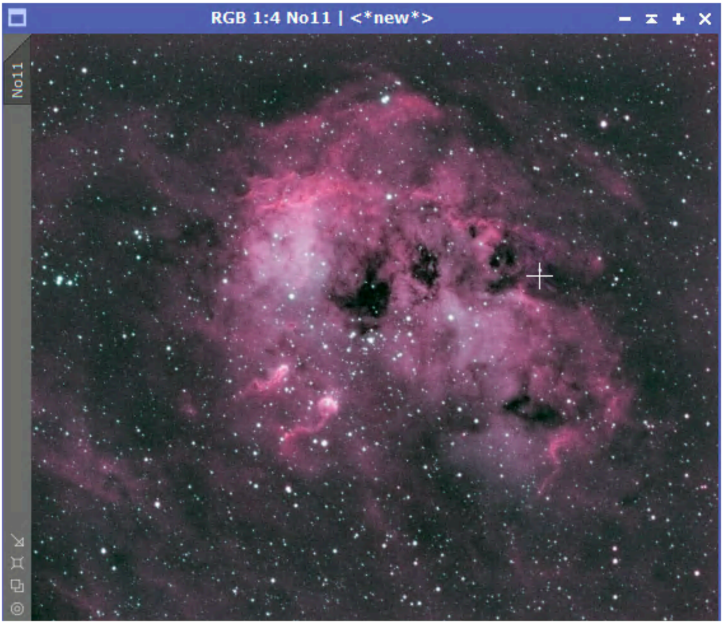



*Fig 8.6*

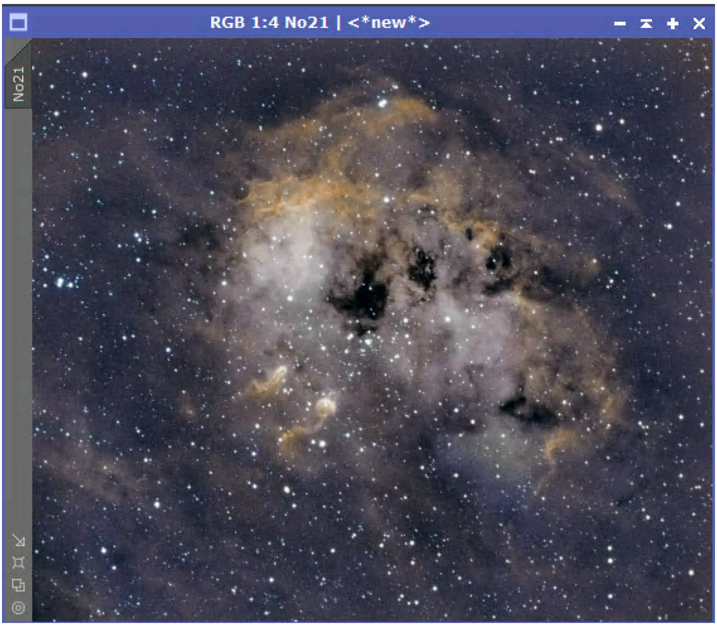
*Before*



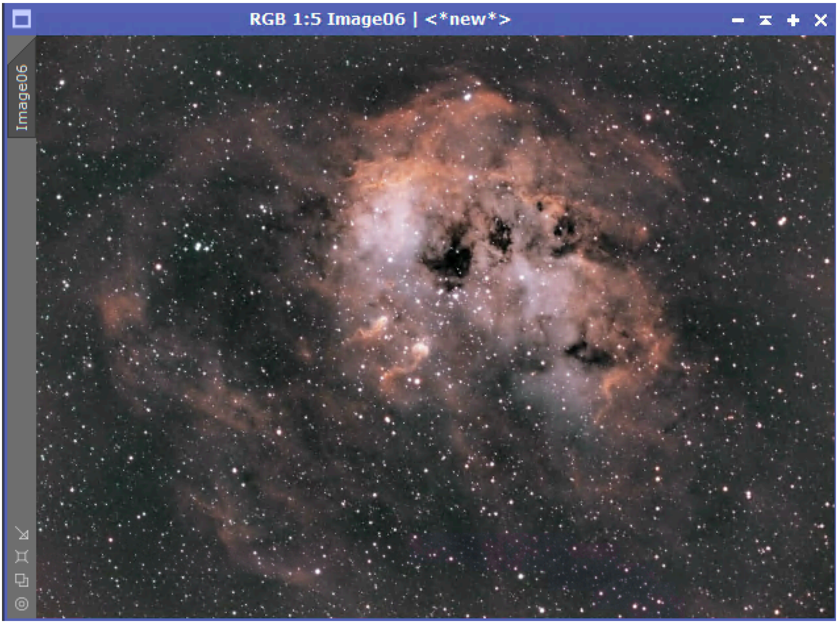
*After*




*(Ha*0.01)+(OIII*~0.01)*




*(Ha*0.5)+(OIII*~0.5)*




*R/K - (0.5*SII)+(0.5*Ha) ,Green - (0.2*Ha)+(0.8*OIII) ,Blue - OIII*

## Replace Stars with RGB

When a Bicolour Palette is created, such as SHO image the natural star colours is lost, which personally I don't like, we all know that stars are not purple.

So with my telescope rig I have a William Optics Redact 51 combined with a ZWO ASI183MC equipped with IDAS D2 light suppression filter just to obtain RGB data.

A non linear fully processed RGB image tis required.

I like to replace stars prior to moving onto noise reduction and saturation, if stars are not being replaced skip this step.

1. Open current workspace image.
2. Open starmask and generate a star mask. Mask needs to include both small & large stars including halos.
3. Apply starmask to primary image.
4. Open curves transformation and active real-time preview.
5. Reduce saturation to narrowband stars.
6. Keep mask active on your primary image.

Extract RGB stars from our fully processed RGB star image.

7. Open channel extraction.
8. Check CIE L*a*b*.
9. Uncheck Luminance.
10. Check (a)
11. Check (b)
12. Apply extraction to RGB image.

Two new images will be created, a & b, add these to our primary image via channel combination.

13. Open channel combination.
14. Check CIE L*a*b*.
15. Uncheck Luminance.
16. Load (a) image.
17. Load (b) image.
18. With the mask still active on the primary image apply combination to this image.

Notes:-

- You will need to adjust the scale on star mask to ensure you have all stars included, increase scale to capture those large stars or halos.

## Noise Reduction

Firstly not all images require aggressive noise reduction! Providing images are obtained with a low SNR camera and good optical scope noise reduction may not be required at all and if so , only small red lion required.

43. Create a small to medium size preview to image, with mixture of stars and DSO.
44. Open TVGDenoise. (Fig 8.7)
45. If image is RGB or greyscale, check RGB/K, if Bicolour image (SHO) check CIE L*a*b* mode.
46. Adjust strength. (higher the value the more aggressive the smoothness.

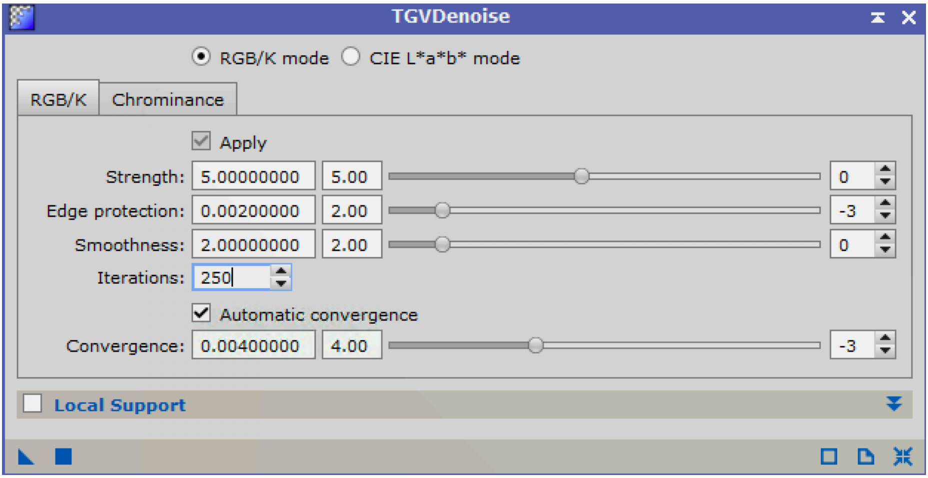



*Fig 8.7*

*Continued*

47. Adjust edge protection (smaller values are more protective of the edges and will preserve finer details.
48. Adjust smoothness if required, generally the defaults work well.
49. Adjust Iterations to 250 for experimenting on preview. (However after experimenting increase to 500 - 1000 when applying to full image)
50. Once satisfied , apply to main image.

Notes:-
- These steps are not suitable for linear data.
- Try adding a mask if local noise reductions required.

## Constrast & Sharpness

This is my favourite part of processing! This is where you can really make your image a beautiful master peace.

### Constrast

This is very hard to explain when writing it down, a lot easier on a video tutorial but lets give it a go! For this stage you will need to understand curves transformation and the 3 different parts to the diagonal line.

- Shadows - Bottom left of the diagonal darkens the shadows by pulling it down.
- Midtones - middle of the diagonal boost the midtones by pulling it up.
- Highlights - Top right of the diagonal is used to anchor to keep the right side of the diagonal nears its current level.

The first steps to improving contrast is to adjust luminance in curves transformation.

1. Open curves transformation.
2. Select L. (Luminance)
3. Adjust as required.

Now we can move onto Local Histogram Equalization which is a great tool for enhancing your image.

1. Open LocalHistogramEqualization. (Fig 8.8)
2. Adjust histogram resolution to your camera specification.
3. Enable real-time preview.
4. Lower amount to 0.50 (50%) to start with and adjust accordingly. (stay between 25 - 75%)
5. Adjust Kernel Radius. (lower values produce stronger effect) recommend setting 25 - 150.
6. Adjust Contrast Limit. (recommend between 1.5 - 3.0).

Notes:-
- This process is very fiddly you need to experiment a lot with this to find that sweet spot.
- IMPORTANT To protect image i.e. background or weak areas from being sharpened apply a Range Selection Mask see chapter 4.

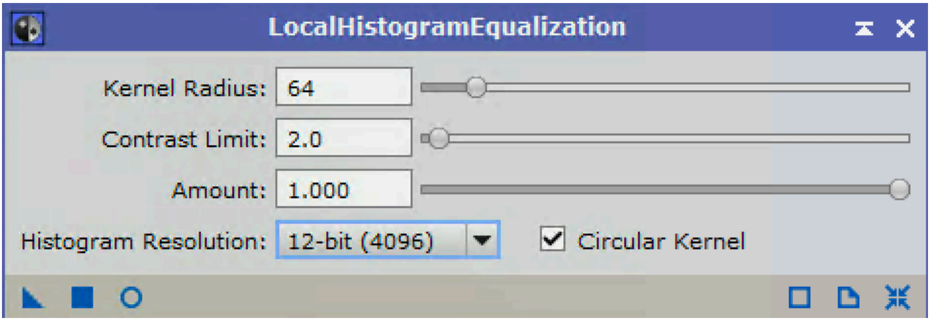



*Fig 8.8*

## Sharpness

Don't be alarm that we are using MultiScaleLinearTransformation this is a great tool for sharpening your images in nonlinear form.

### Method 1

1. Apply a mask to image. (protected areas)
2. Open MultiScaleLinearTransformation. (Fig 8.9)
3. Select Algorithm to Starlet Transform.
4. Set layers to 4.
5. Select each layer and make sure noise reduction & linear mask are both disabled.
6. Enable De-ringing.
7. Set Dark to 0.0100 to start with and adjust accordingly.
8. Set target to CIE L*.
9. Leave layer 1 at default value.
10. Adjust layer 2 to 4 bias in the range of 0.012 - 0.075 (evaluate the results by increasing the Bias to each layer one by one using the real-time preview.
11. Once satisfied apply to image.

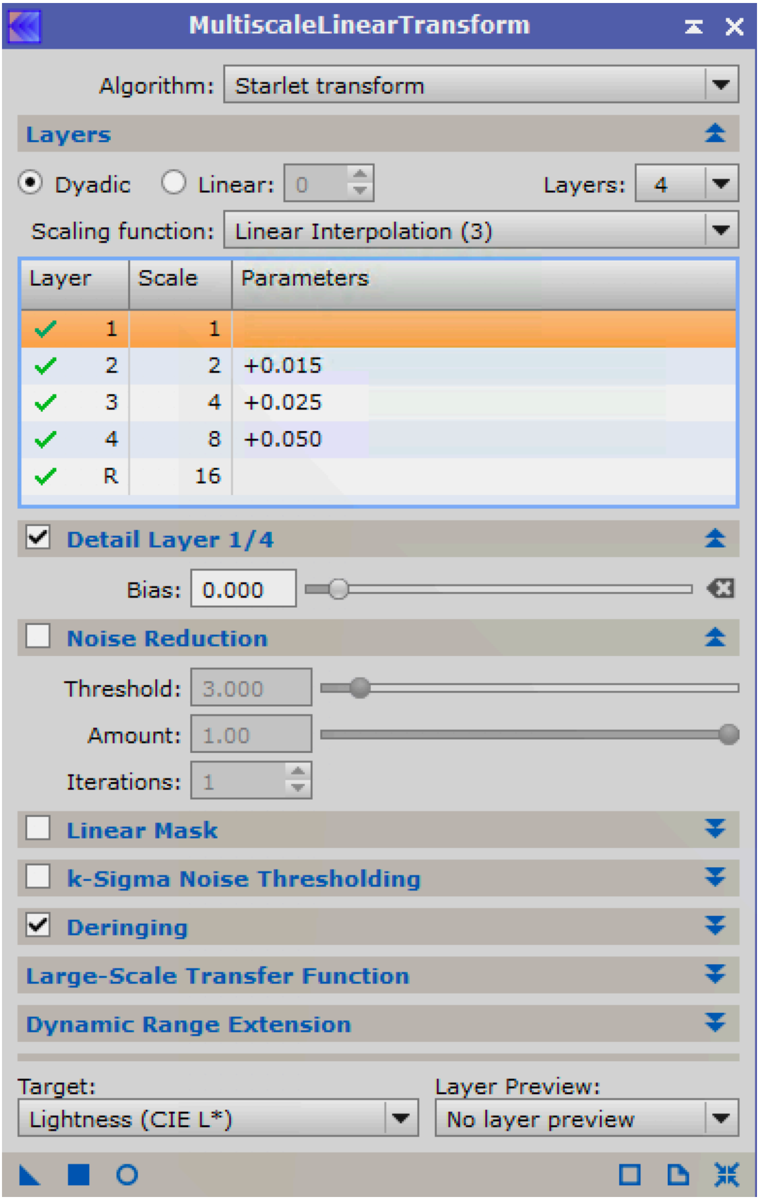

MultiscaleLinearTransform
Algorithm:
Starlet transform
Layers
Dyadic
Linear:
0
Layers:
4
Scaling function:
Linear Interpolation (3)
Layer
Scale
Parameters
1
1
2
2
+0.015
3
4
+0.025
4
8
+0.050
R
16
Detail Layer 1/4
Bias:
0.000
Noise Reduction
Threshold:
3.000
Amount:
1.00
Iterations:
1
Linear Mask
k-Sigma Noise Thresholding
Deringing
Large-Scale Transfer Function
Dynamic Range Extension
Target:
Lightness (CIE L*)
Layer Preview:
No layer preview

*Fig 8.9*

Method 2

1. Apply a mask to image. (protected areas)
2. Open UnsharpMask. (Fig 8.10
3. Open real-time preview.
4. Adjust StdDev to suit. (Between 1.5 - 5.0)
5. Adjust amount to suit. (Between 0.20 - 0.75)
6. Enable Deringing. (Dark setting between 0.01 - 0.05)
7. Adjust dynamic range extension to suit.
8. Once satisfied apply to image.

Notes:-

- Both of these methods require a lot of experimentation.
- IMPORTANT To protect image i.e. background or weak areas from being sharpened apply a Range Selection Mask see chapter 4.

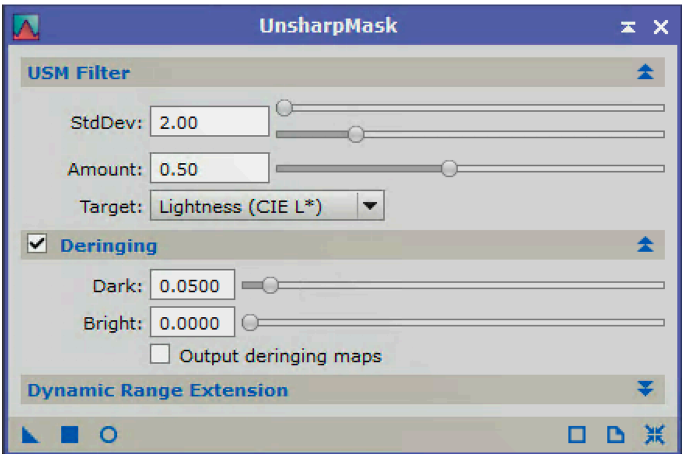



*Fig 8.10*

## Colour Saturation

There are two methods I use for colour saturation, which is all dependant on the data. Method 2 is probably the better of the two and allows you to adjust the saturation levels to direct colours.

Method 1:-

1. Apply a mask to image. (protected areas)
2. Open CurvesTransformation.
3. Open real-time preview.
4. Select (S) saturation and adjust to suit your needs.
5. Select (C) colour and adjust to suit your needs.
6. Select (RGB) and adjust to suit your needs.
7. Remove mask.

Method 2:-

1. Open ColorSaturation.
2. Open real-time preview.
3. Apply points to the horizontal line to lock in colours leaving gaps between the colours to be adjusted and pull the line up or down (Fig 8.10) this example would increase the blue saturation levels on a SHO image.
4. Once satisfied apply to image.
5. Remove mask.

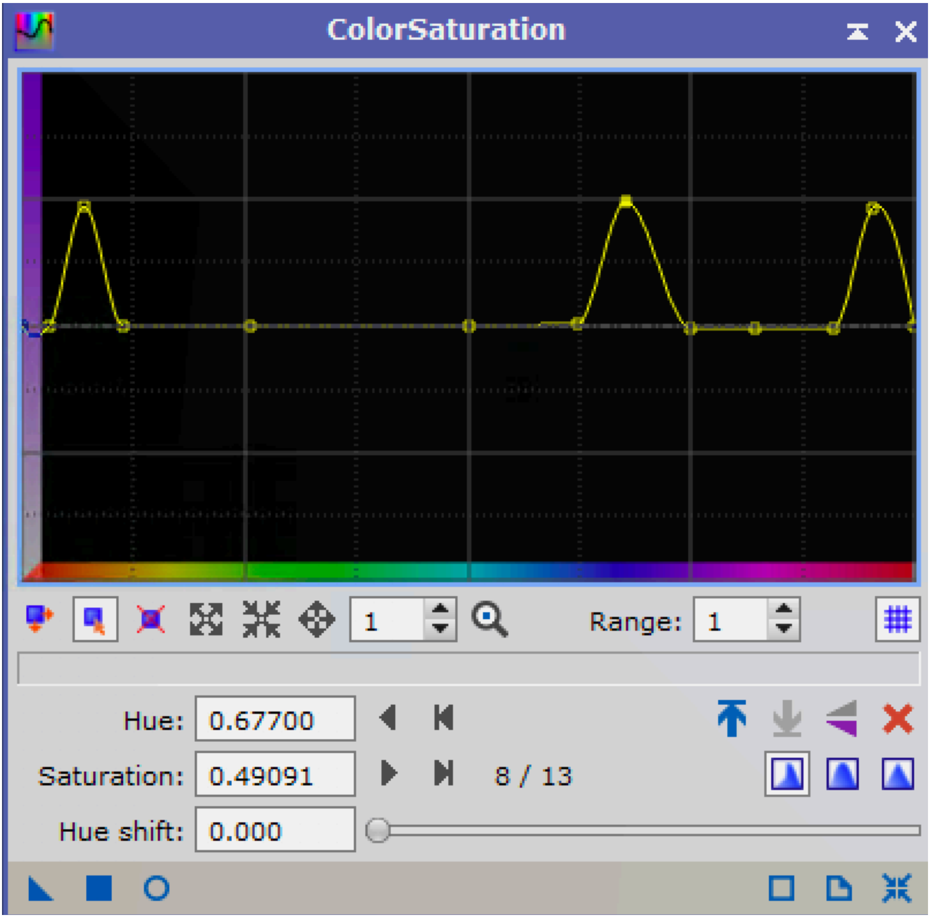

ColorSaturation
1
Range:
1
Hue:
0.67700
Saturation:
0.49091
8 / 13
Hue shift:
0.000

*Fig 8.10*

# CHAPTER 9 - END OF PROCESSING

This is the end of processing! Your image is complete and you can now step back and proudly say I did that! After all the images I have ever captured and processed that moment at the end never changes.

Thank you for following my steps I hope you have learnt that Pixinsight can be very simple when its put into simple steps and you invest the time to experiment with your data.

## Saving your Image

Firstly the best idea is to always save the primary image without any logo's or annotations , etc  as a XISF file, this way future adjustments can be made.

Following this a JPEG maybe required for uploading online or sending to the print shop, maybe further processing in Photoshop CC  is required, therefore save as a TIFF file or maybe image is required in other editing software or online portal that require a FITS file.

**Saving as XISF file**

1. Select FILE and Save As.
2. Select XISF file and name image. (left click save)
3. Select 32bit IEEE 754 floating point. (left click ok)

**Saving as FITS file**

1. Select FILE and Save As.
2. Select FITS file and name image. (left click save)
3. Select 32bit IEEE 754 floating point. (left click ok)

**Saving as TIFF file**

1. Select FILE and Save As.
2. Select TIFF file and name image. (left click save)
3. Select 16-bit unsigned integer. (left click ok)

**Saving as JPEG for web uploads**

Many online uploads are limited by the maximum megabytes or pixels of an image that can uploaded, if image exceeds this limit you will be unable to complete this upload and this can be very frustrating.

Therefore convert image from 32-bits to 8-bits using SampleFormatConversion then downsample image via Resample until the correct size image is achieved. (megabytes).

1. Open SampleFormatConversion. (Fig 11.1)
2. Select 8-bit unsigned integer. (0,255)
3. Apply to image.
4. Open Resample. (Fig 11.2)
5. Select primary image.
6. Ensure preserve aspect ratio is checked.
7. Adjust the width of the image from a choice of pixels, percentage, cm or inches the height will automatically be adjusted to suit the aspect ratio.

Benefit Preserve Aspect Ratio will show the image size details i.e. bit, current size and previous size , use this information too achieve the maximum limited image file size.

Apply resample to the primary image and Save As JPEG, Notice that when saving the image the error messages are no longer appearing when saving a 32-bit XISF to an 8-bit JPEG.

Top Tip: most JPEG files are between 800 - 1920 pixels in width

**Saving as JPEG for printing**

Most high quality printing services or direct prints (home printing) require a TIFF file or high quality JPEG file to provide the best results.

This step is the opposite to saving a JPEG for web uploads i.e. we down-sampled the image  now we going to up-sample the image to match the print size . Again convert from 32-bit to 8-bit using SampleFormatConversion.

1. Open SampleFormatConversion (Fig 11.1)
2. Select 8-bit unsigned integer (0,255)
3. Apply to image.
4. Open Resample. (Fig 11.2)
5. Select primary image.
6. Set resolution to 240x240 (must be done prior to adjusting image size)
7. Uncheck preserve aspect ratio this time , this will allow to force the height of the image.
8. Adjust the width and height of the image in cm or inches to match the print size for example 30” x 20”
9. Apply resample and save image as JPEG.

## Adding your logo & signature

If like me you have produced your own logo and signature in Photoshop CC you can open your saved image in Photoshop (TIFF, PNG, JPEG) and add your logo.

# CHAPTER 10 - TIPS & TRICKS

In this chapter I share some good really good tips and tricks that may help and ease you're processing steps. Here you will find some useful processes that can really make a difference to your final image.

## Image Processing Icons

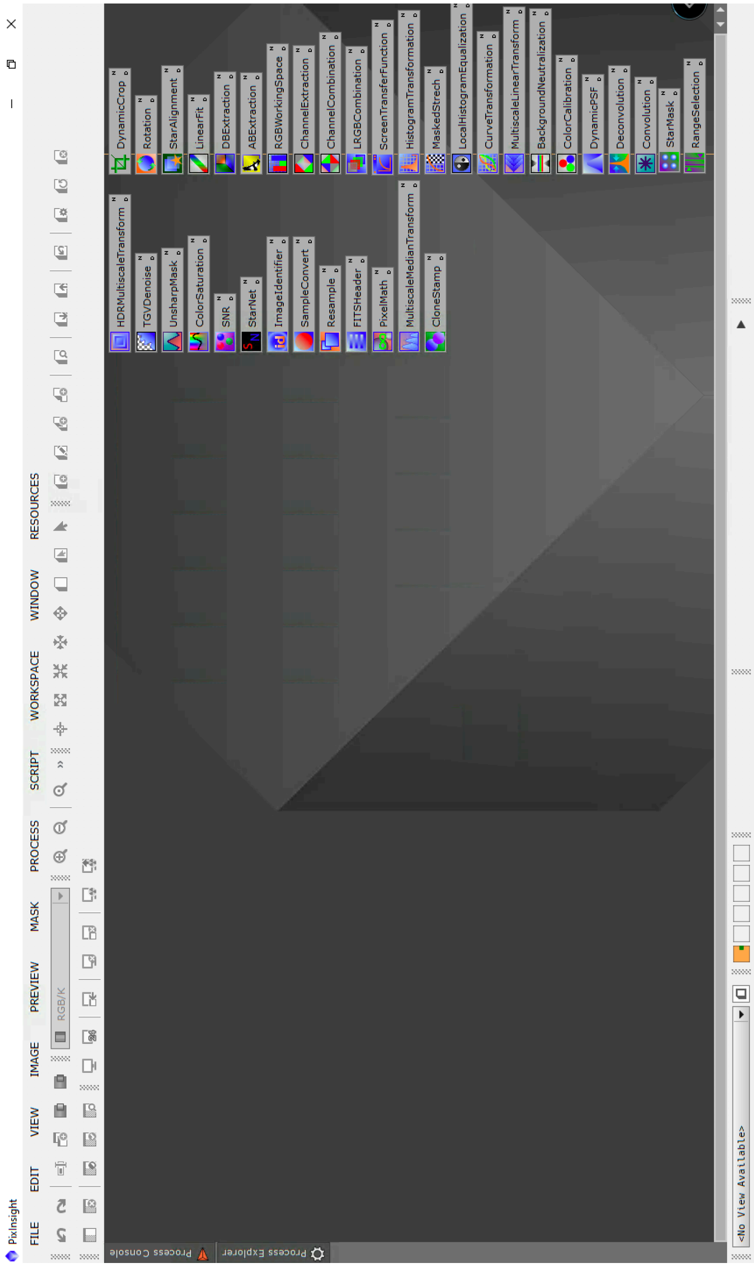
Save processes icons to the workspace and load them in every time a new project is started.

Saving commonly used icons saves a lot of time and frustration constantly looking for them!

1. Open desired processing tool.
2. On the bottom left of each process drag the blue triangle to workspace, ensure the processes have been reset and hold not adjustments or data.
3. This will generate a process icon on your main workspace, on the top right find a N, select this icon.
4. Rename icon, example ChannelCombination.
5. Select Ok

Once all the icons required are created, select them all on the workspace and arrange them by right clicking, select arrange icons.

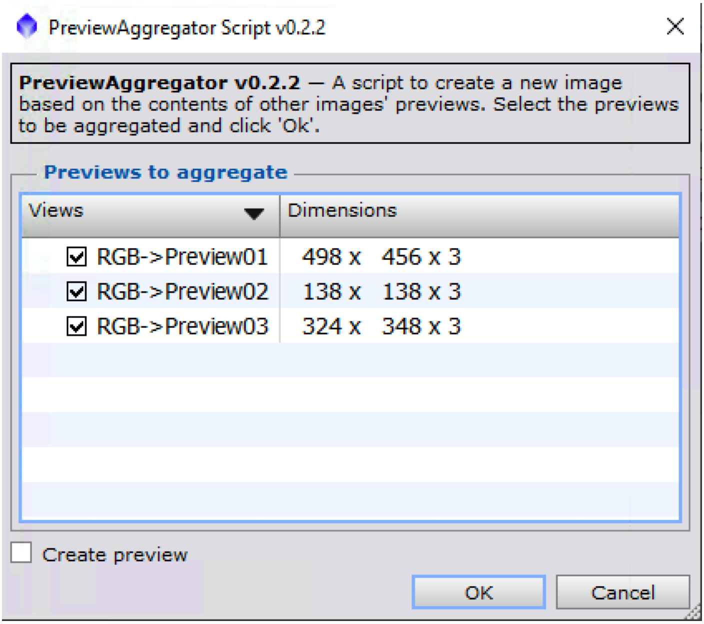
Once happy with location and sequence highlight all icons, right click again and save selected icons.




*My workspace with saved processing icons*

## PreviewAggregator Script

This creates a new image from a preview box created on the primary image. When undertaking task such as deconvolution, noise reduction, etc  I like too apply processes to a preview image created to my needs prior to my main image.




*PreviewAggregator*

## Star alignment with ease

In chapter 3 during star alignment I mention that when integrating multiple filters  only using one reference image!

If you done this then you would have noticed that prior to combining your mono images they were already perfectly aligned and there was no need for further alignment which can cause minor imperfections during post processing.

These imperfections can be seen when you zoom in on a combined RGB image and notice ever so slightly that one or all of the channels is not correctly aligned.

## Mask Stretching

Try replacing Histogram Stretch with Mask Stretching. This process stretches the image using a sample as a target references set via a background preview.

To make this more interesting HistogramTransformation and MaskStretching can be combined using Pixel Math, this will be explained after MS stretching.

1. Create preview (neutral background) to primary liner image.
2. Open MaskStretch. (Fig 10.1)
3. Set reference.
4. Apply MaskStretch to primary image.

You will need to perform a curve transformation prior to continuing with any further processing to brighten the image up. If you wish to combine both a HT and MS stretch please follow steps below.

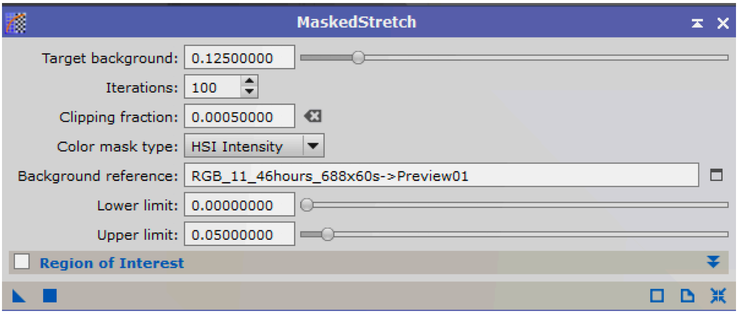



*Fig 10.1*

5. Create copy of MS stretched image and rename RGB_MS.
6. Create another copy of primary image and rename RGB_HT.
7. Apply a HT stretch to RGB_HT image.

To merge the two stretched images via PixelMath.

8. Open PixelMath.
9. Enter the following into RGB/K

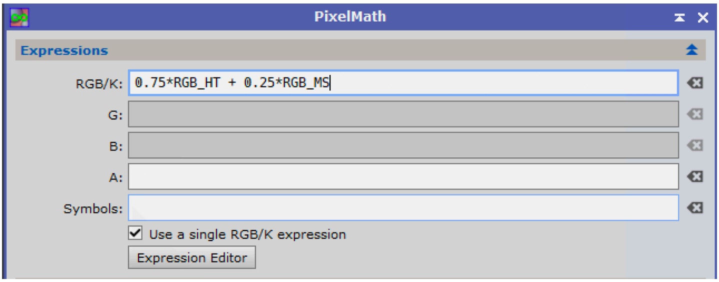
*RGB_HT + RGB_MS*

This formula will equally combine both stretched images , however this may blow the image out so experiment by adjusting the combination ratio. See below alternative.

*0.75*RGB_HT + 0.25*RGB_MS*

The formula will combine 75% HT stretch and 25% Mask stretch I find these values work a lot better with dark background and obtaining faint details on your deep sky object.

10. Drop destination.
11. Create new image.
12. Set colour space as RGB.
13. Apply pixel math. (make sure you have image open on workspace)

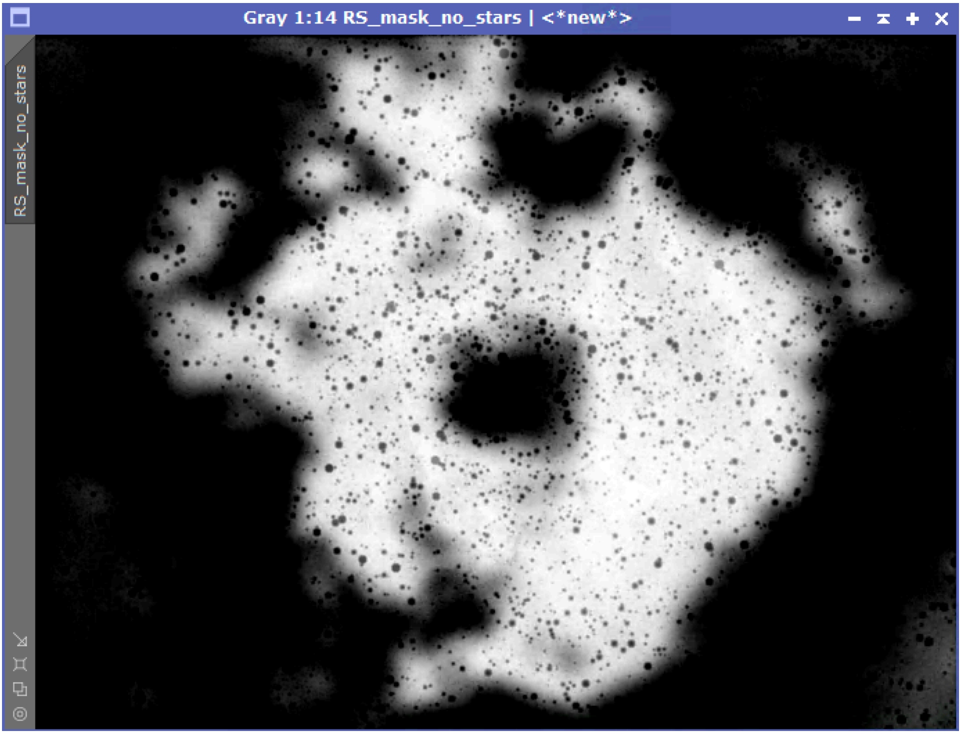



*PixelMath Expression*

## Mask with no stars.

We use mask throughout the entire processing stage and we are aware they play a big part in getting that prefect image.

So when those frustrating moments of stars deep within the nebulosity included within range selection mask for example are hard to remove! Not to worry PixelMath can remove them.




*Range mask with no stars.*

1. Create both a star mask and range selection mask.
2. Rename both mask i.e. star_mask and range_mask.
3. Open PixelMath.
4. Enter the following into RGB/K.

*range_mask - star_mask*

5. Drop destination.
6. Create new image.
7. Set colour space as greyscale.

8. Apply pixel math. (make sure you have image open on workspace)
9. Rename RS_Mask_no_stars.

TOP TIP: Apply this same process to any mask i.e. ColorMask, Convolution, etc. PixelMath can also combine mask just add rather than subtract when entering your expression.

## Mask Inverting

Remember when applying mask you need to understand what you are protecting and whether you need to invert your mask or not!

Best way to check is to open curves transformation with mask applied to your primary image. Open a live preview then boost the curves and see whether the background or DSO blows out.

This will tell you what is protected and whats not.

## Background Enhancement

BackgroundEnhance Script is a great tool for boosting large scale background structures.

1. Open BackgroundEnhance Script.
2. Adjust Small Scale Layers (recommend between 4 - 8)
3. Adjust amount (recommend between 0.05 - 0.5)
4. Select preview.

TOP TIP: You can compare your images using the Show images, select between Original and Enhanced.

## GAME Script

GAME is a great script that allows you to create spacial mask for galaxies such as Luminance Mask, Gradient Mask, Gradient Edoe Mask, Binary Mask, Brightness Mask, Star Mask, these mask can be created to specific areas for repairs and enhancements.

1. Open GAME Script.
2. Select image.
3. Select add and draw the area you want to create a mask. (Fig 10.2)
4. Select what mask you want to export.
5. Select ok.

See examples of M31 Andromeda Galaxy on the following pages.

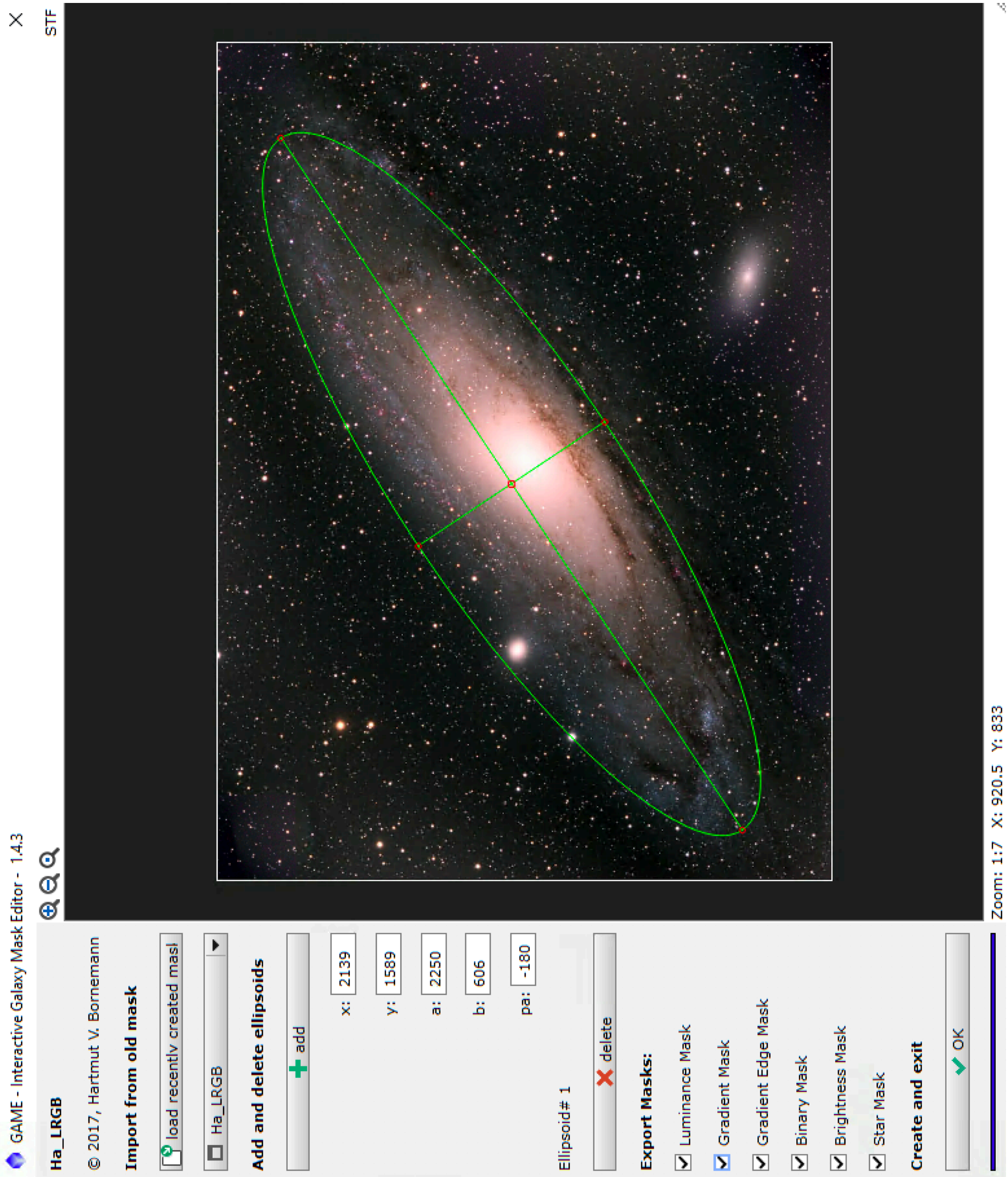
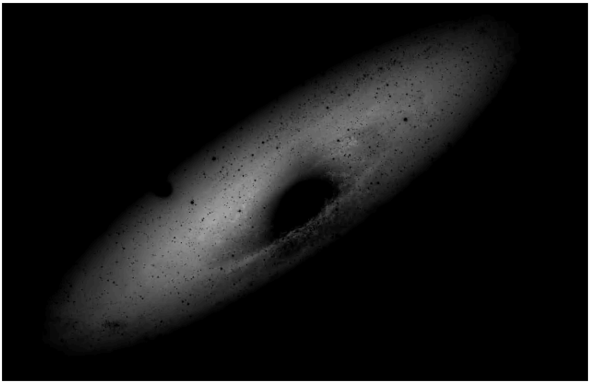
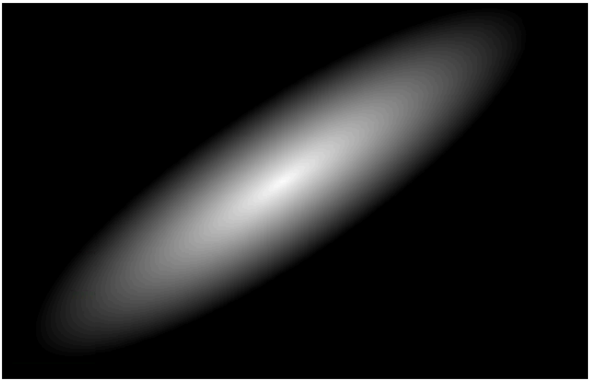

GAME - Interactive Galaxy Mask Editor - 1.4.3
STF
Ha_LRGB
© 2017, Hartmut V. Bornemann
Import from old mask
load recently created masl
Ha_LRGB
Add and delete ellipsoids
add
x: 2139
y: 1589
a: 2250
b: 606
pa: -180
Ellipsoid# 1
delete
Export Masks:
Luminance Mask
Gradient Mask
Gradient Edge Mask
Binary Mask
Brightness Mask
Star Mask
Create and exit
OK
Zoom: 1:7 X: 920.5 Y: 833

*Fig 10.2*

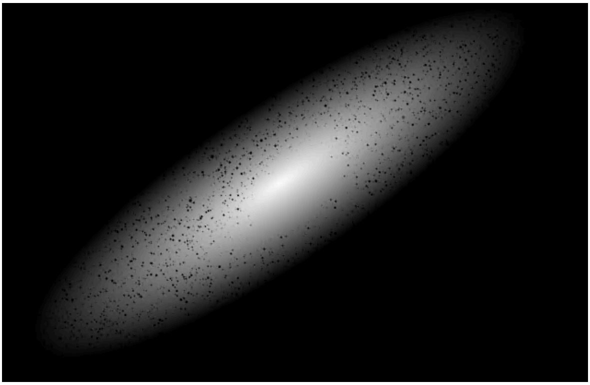


*Luminance Mask*

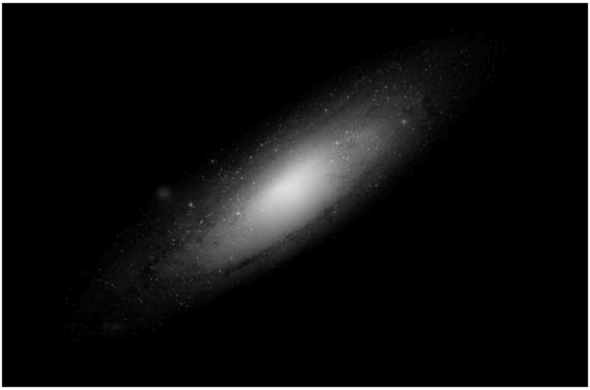


*Gradient Mask*

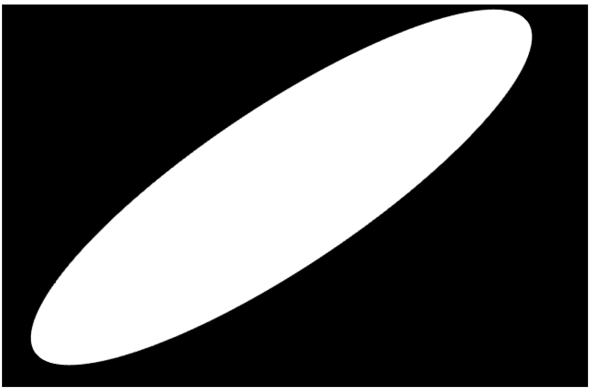
*Gradient Edoe Mask*



*Star Mask*



*Brightness Mask*



*Binary Mask*

## Clone Stamp

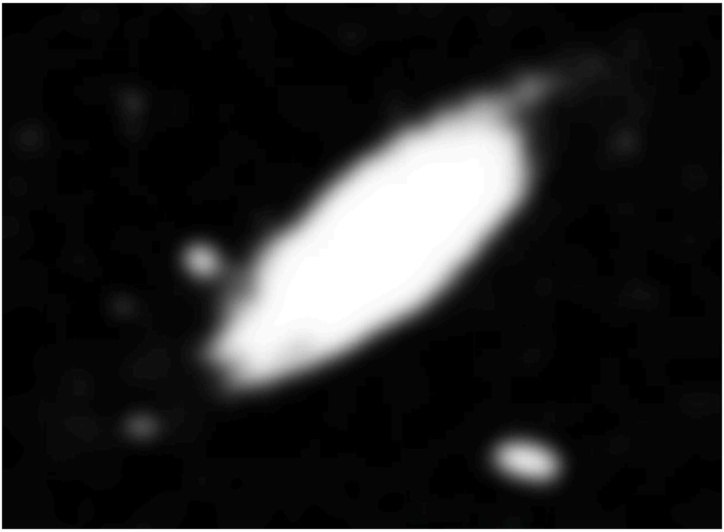
This is a great way to remove items from a mask such as large stars within a range selection mask.

For example a range selection mask may have large stars present these can be remove from your mask. See example on next page.

Experiment with CloneStamp to achieve many different things even repairing haloes , elongated stars etc however the steps below will cover removing dwarf galaxy, large and faint stars from a range selection mask of M31 Andromeda Galaxy.

1. Open CloneStamp.
2. Left click image to activate CloneStamp.
3. Set radius (size of brush)
4. CTRL + Left Click background and release , this will create a sample.
5. Move your brush to the object you wish to replace with the background sample created and left click.
6. Select green tick to confirm CloneStamp.

Notes:-
- Experiment with softness and opacity if required.



*Before Clone Stamp*

*After Clone Stamp*

# CHAPTER 12 - EXTERNAL SCRIPTS FOR PIXINSIGHT

There are several external PixInsight scripts written by many great astrophotographers, however finding them can be difficult, no stress you can find many of these scripts at www.astrocaller.co.uk.

## StarNet

StarNet is a very simple and easy way to remove those stars from an image, leaving only background and nebulosity.

Adjust stride as required and apply. This process can take along time especially if you have a slow machine.

## SubframeSelector Script

Written by Cameron Ledger, this is a simplified and more user friendly SubframeSelector script, refer to chapter 2 for simple steps.

## SHO-AIP, LRVB-AIP, & HaRVB-AIP Scripts

Many people who use PixInsight use SHO-AIP , however recently it became extremely difficult to download off the web, there is no known source for the download therefore many share downloads on forums.

## StarReduction Script

Written by Dave Watson star reduction script is a simple and easy script to reduce and sharpen stars.

### GAME

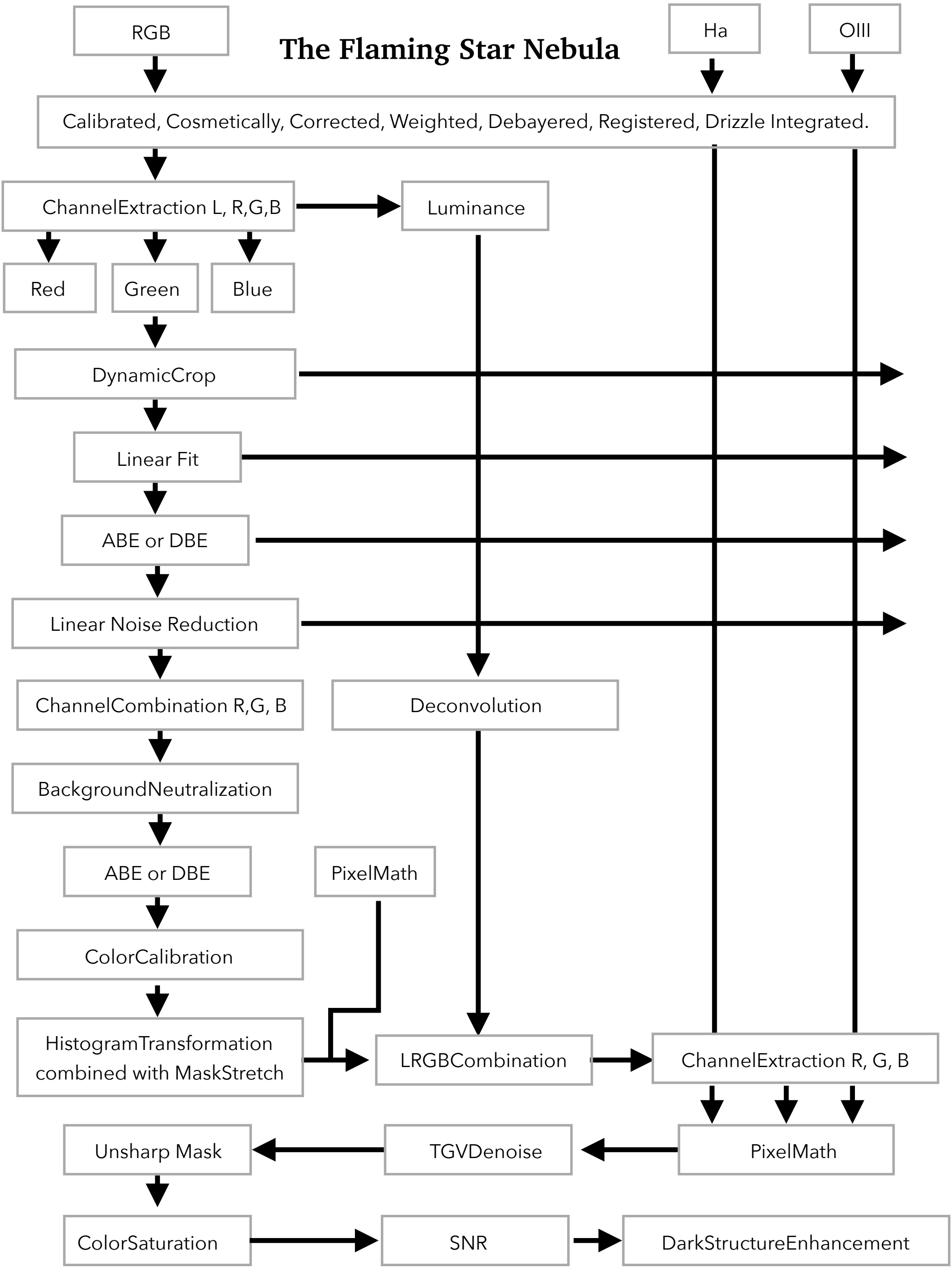
Written by Herbert Walter GAME script is a simple and easy script create special mask for galaxies

**ALL SCRIPTS CAN BE DOWNLOADED FROM WWW.ASTROCALLER.CO.UK**

# CHAPTER 13 - WORKFLOWS

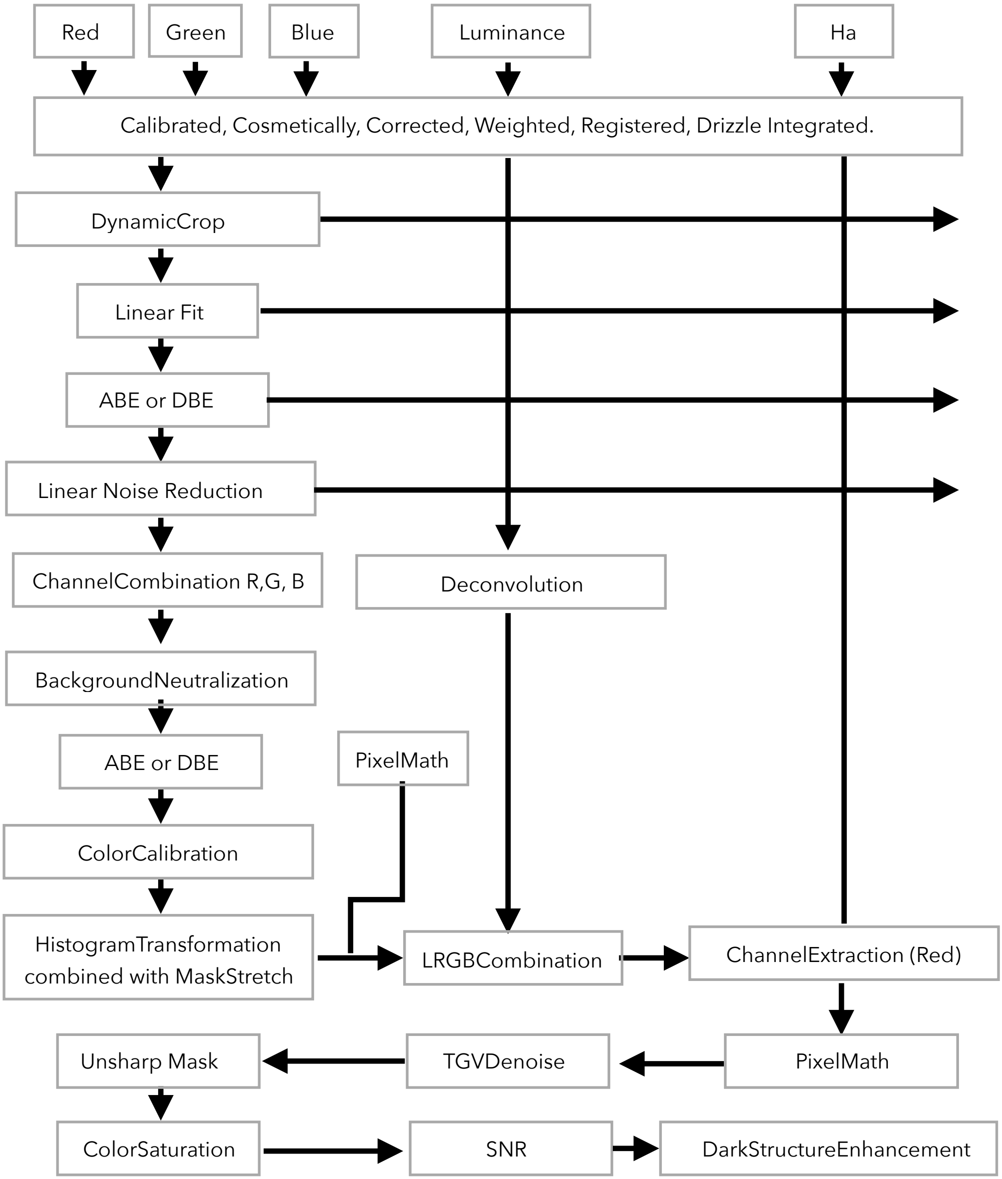
In this Chapter I share my workflows schematically for a number of combinations. I also provide examples of the end result of my own work using the simple steps in My PixInsight Guide.

# The Flaming Star Nebula



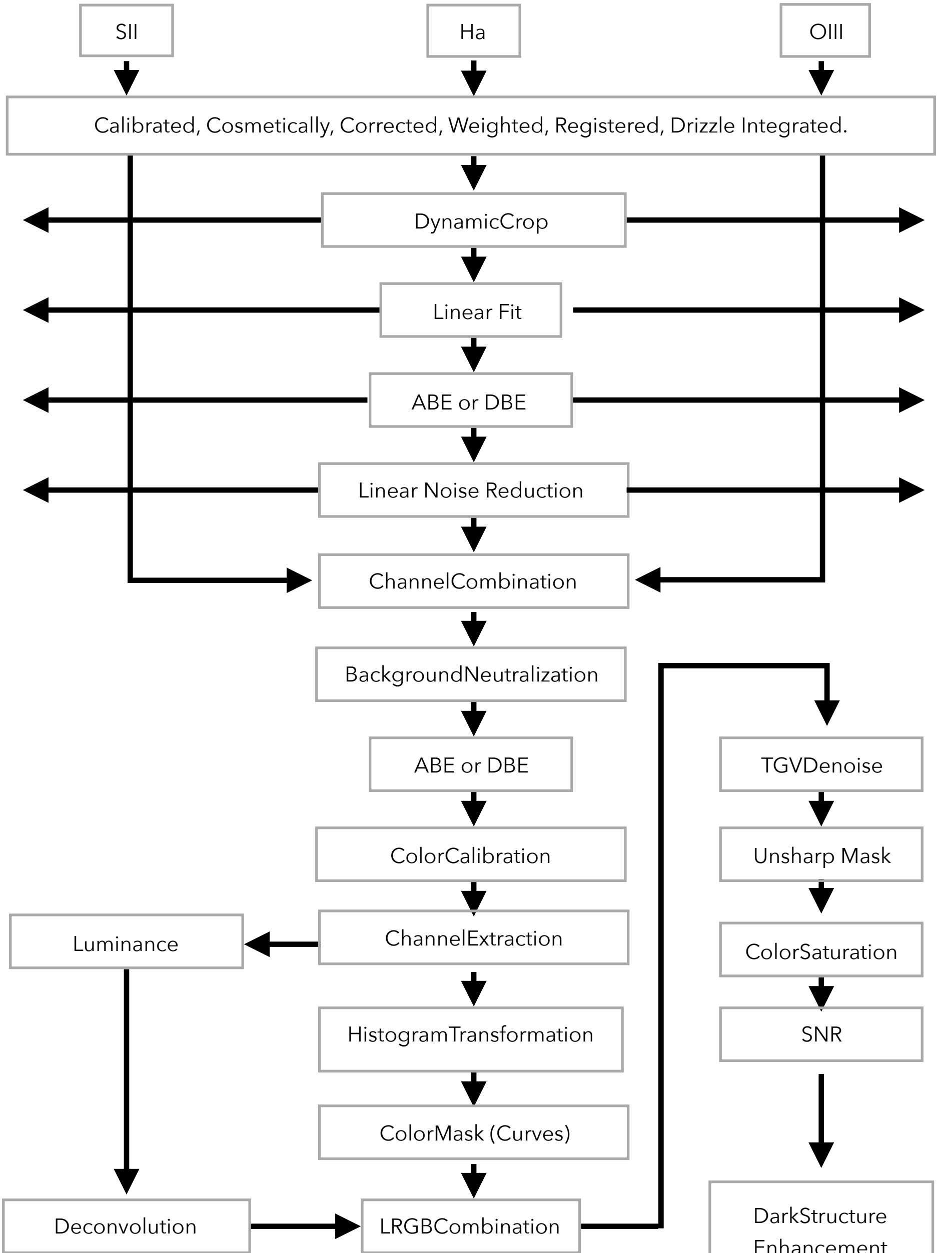
*IC405 Flaming Star Nebula*

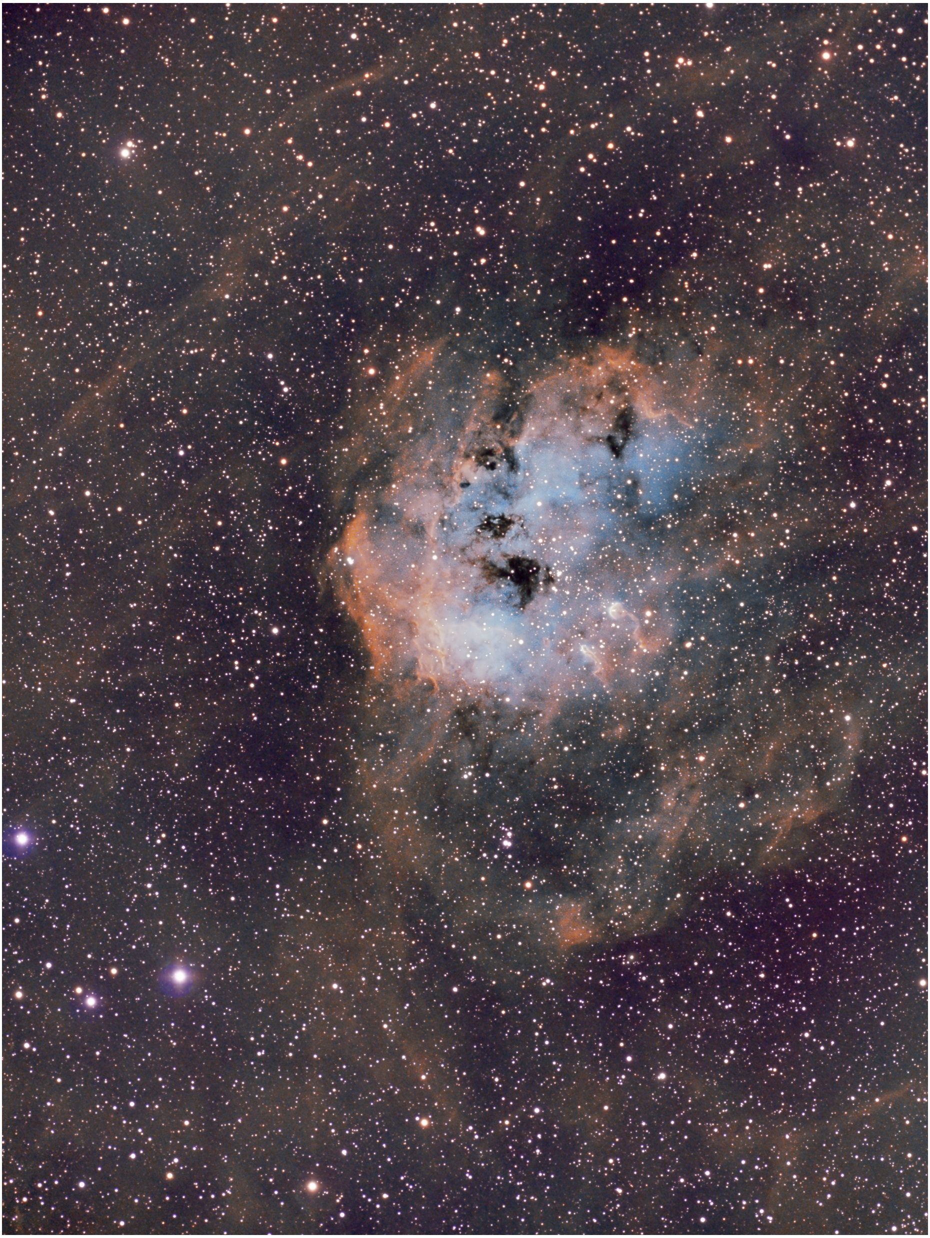
## Andromeda Galaxy M31



*M33 Andromeda Galaxy*

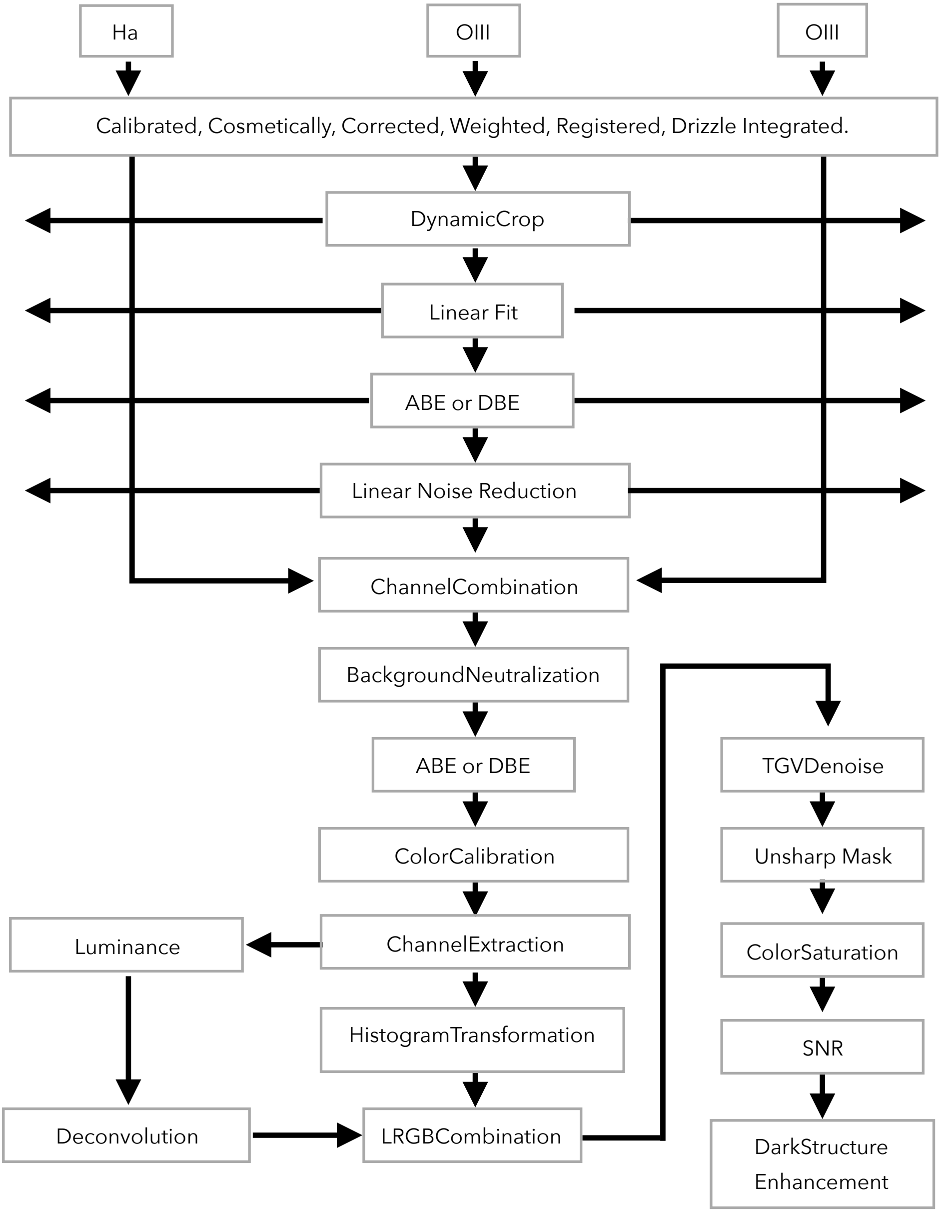
## IC 418 The Tadpoles Nebula

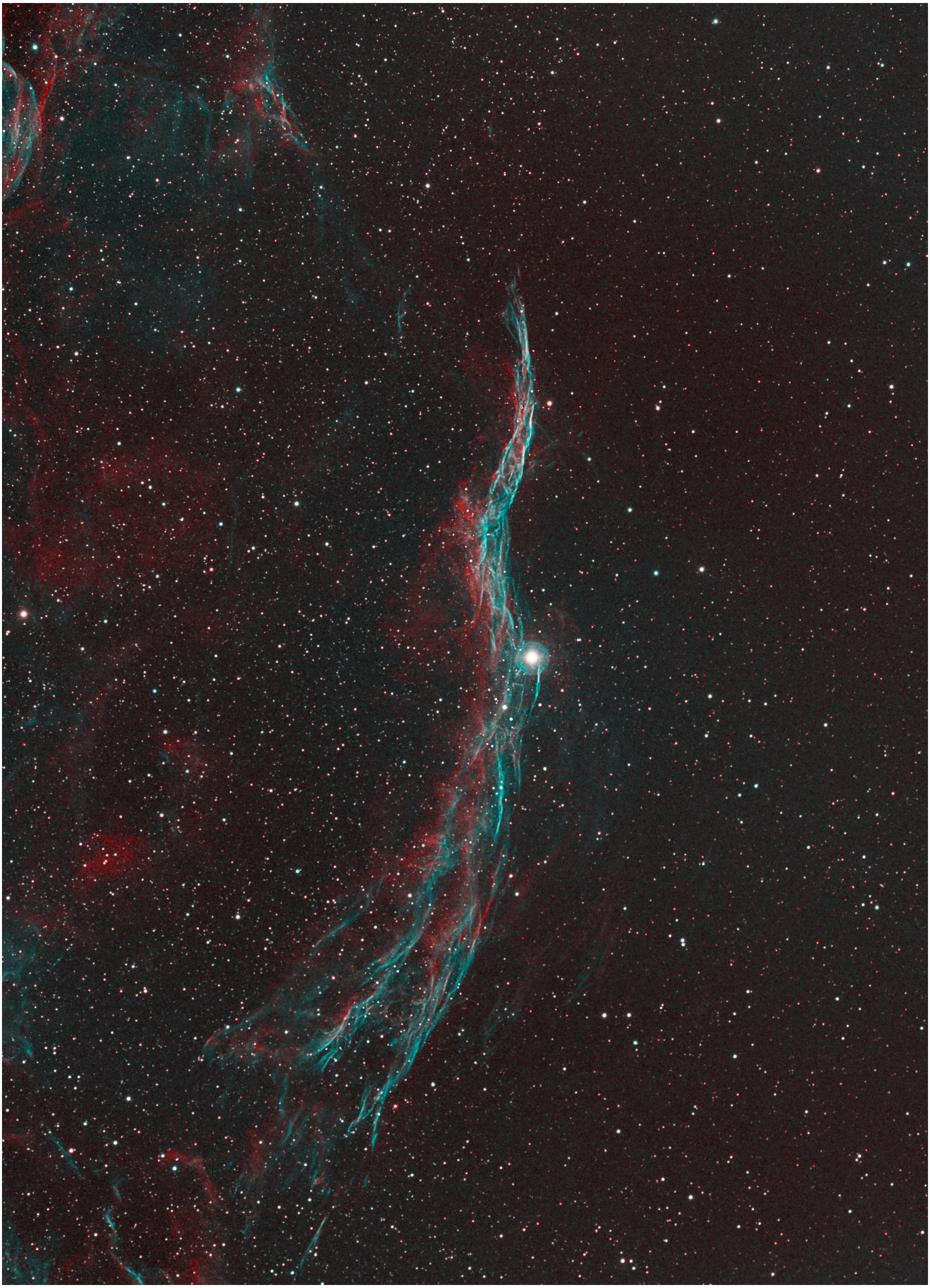




*IC 418 The Tadpoles Nebula*

## NGC6960 The Witches Broom





*NGC 6960 The Witches Broom*

# CHAPTER 14 - ADVANCED PROCESSING

Tone-mapping is a very rewarding advanced processing technique, however there are very little tutorials online. Undertaking a successful work of art using the tone-mapping techniques can be extremely  difficult and frustrating . Therefore chapter 14 made its way into My PixInsight Guide prior to publishing! Enjoy.

## Palette Choice

Tone-mapping can be used on all palette's however most rewarding palette is SHO , therefore I will cover these steps in this chapter.

Prior to undertaking any steps copy images and rename them Ha_TM, OIII_TM & SII_TM.

## Creating Tone Maps

Ensure that the images are linear , registered and gradient free.

First we need to equalise the background using an Offset.

1. Create preview on natural background to Ha_TM.
2. Drag preview to workspace and rename BG
3. Open PixelMath and enter the following into RGB/K

*$T-med(BG)+OFFSET*

4. Enter the following into symbols.

*OFFSET=0.0005*

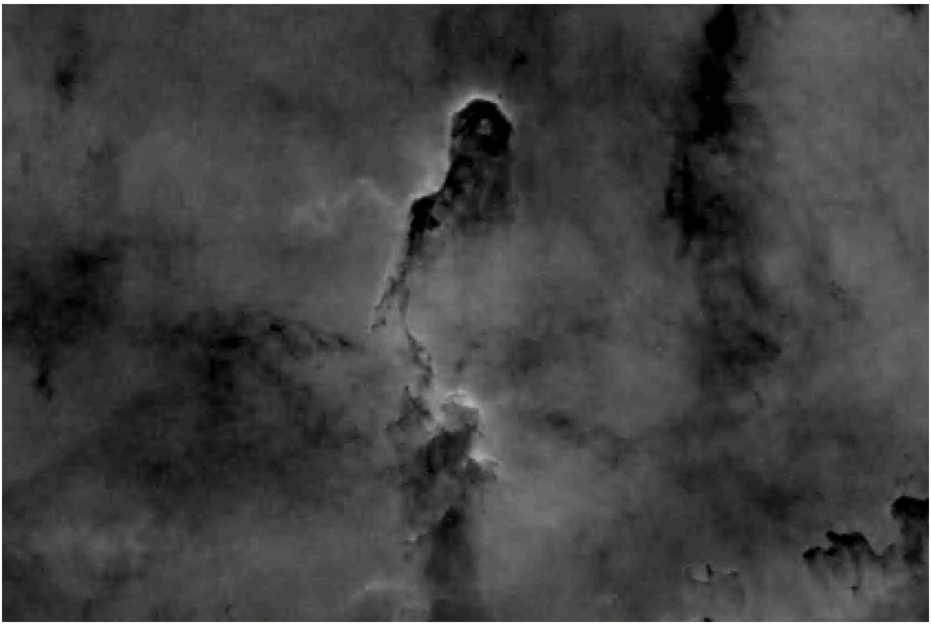
5. Apply to PixelMath to Ha_TM.

Repeat these steps on OIII_TM and SII_TM, use the same background preview. Therefore copy preview from Ha_TM to the target image for example OIII_TM by dragging preview onto target image identifier bar. Don't forget to delete BG image from Ha_TM and create new for each image.

Now we can create a Star Mask.

6. Create Star Mask from your linear Ha_TM and apply to image. (Check Binarize) if DSO captured in star mask use CloneStamp to remove.
7. Perform MultiscaleMedianTransformation (Recommend Layers 6 - 8) disable layers leaving R enabled.
8. Open StarNett and apply to Ha_TM.
9. If stars are still present and faint remove using CloneStamp.
10. Save images to workspace.

Repeat these steps to OIII_TM and SII_TM using the same star mask.



*Ha Tone Map (Linear)*

## Enhanced Luminance

Hα channel does not fully represent luminance because it lacks information about OIII and SII therefore enhance the Hα channel using OIII and SII tone maps.

11. Copy the original Ha image and rename Ha_Lum. Image shall remain linear.
12. Open PixelMath.
13. Open PixelMath and enter the following into RGB/K.

*$T+OIII_TM+SII_TM-2*OFFSET*

14. Enter the following into symbols.

*OFFSET=0.005*

15. Apply PixelMath to Ha_Lum.
16. Undertake Deconvolution.
17. Perform linear noise reduction. (Range mask maybe required)
18. Perform HistogramStretch.
19. Perform TGVDenoise noise reduction. (Range mask maybe required)
20. Final adjustment using curves.

Now at this point I would save my Ha_Lum image as 16-bit TIFF file and sharpen in Photoshop CC then returning to PixIsight with my sharpened Ha_Lum. However you can try using UnsharpMask.

*Enhanced Luminance (Processed)*

## RGB tone map and Final details.

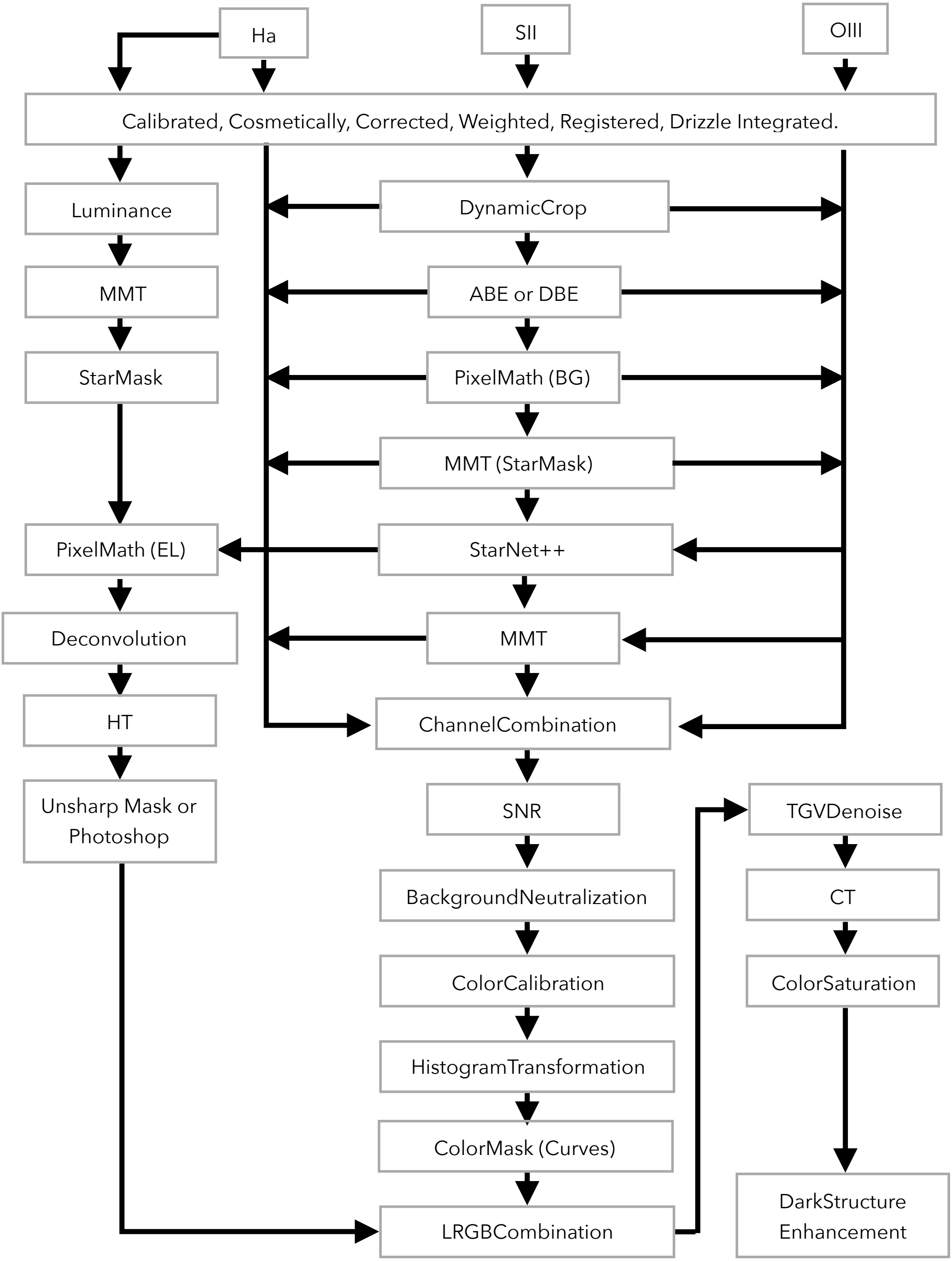
Its now time to combine tone map images using ChannelCombination. Remember the image will have strong green presence as Ha dominate the green channel in SHO, this can be resolved quickly using SNR or curves transformation.

1. Perform ChannelCombination. (SHO)
2. Perform SNR, BackgroundNeutralisation and ColorCalibration.
3. Open ColorMask. (Set blur to 3 prior to choosing colour)

*Combined Tone Map (Processed)*

4. Apply masks and perform CurveTransformation.
5. Perform LRGBCombination.
6. Perform CurvesTransformation.
7. Perform ColorSaturation.

Your image is now complete!


Ha
SII
OIII
Calibrated, Cosmetically, Corrected, Weighted, Registered, Drizzle Integrated.
Luminance
MMT
StarMask
DynamicCrop
ABE or DBE
PixelMath (BG)
MMT (StarMask)
PixelMath (EL)
StarNet++
Deconvolution
MMT
HT
ChannelCombination
Unsharp Mask or Photoshop
SNR
TGVDenoise
BackgroundNeutralization
CT
ColorCalibration
ColorSaturation
HistogramTransformation
ColorMask (Curves)
DarkStructure Enhancement
LRGBCombination


*IC3696 Elephants Trunk (SHO)*