Table of Contents

PixInsight Processing Workflow

Cropping

This needs to be done to get rid of any overlapping edges produced during the stacking phase.

Dynamic Crop

- Use the STF nuclear button to stretch the stacked image.
- Crop the perimeter of the image using Dynamic Crop to remove residual stacking/overlap noise.

- Close the Dynamic Crop tool.
- Remove the STF stretch using the icon on the main toolbar.

Background Extraction

This needs to be done to get rid of the red hue to the background of the image.

There are two options to consider for background extraction.
Option 1.
Automatic Background Extraction (ABE).
Option 2.
Dynamic Background Extraction (DBE).

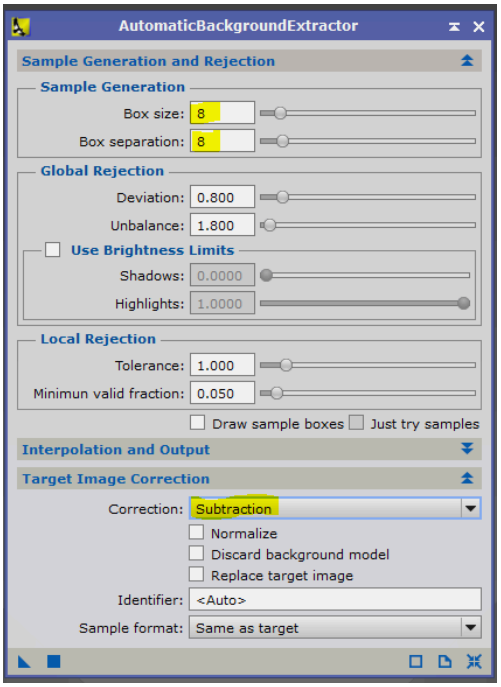
Occasionally, you could run DBE and then ABE, but sometimes this might be too much.

Automatic Background Extraction (Option 1)

Set the following values.

- Sample Generation
  - Box size, increase to 8.
  - Box Separation, increase to 8.
- Target Image Correction

- Correction – Subtraction



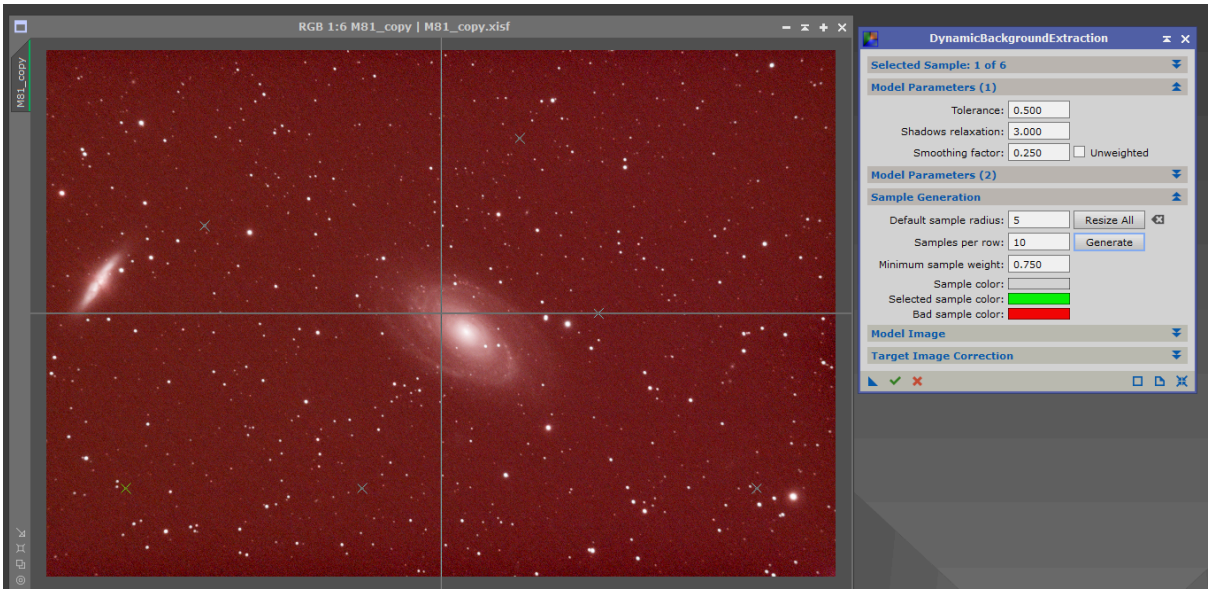
- Click the square 'Apply' button.
- Two additional frames will open. One background frame, which when nuclear stretched will be predominantly red. This frame can be discarded. The second frame will be a cleaner version of the image with the red background extracted. This is the frame we need to keep, and will be used to continue processing.
- Minimise the original frame in case we need to return to it in the future.
- Delete the STF nuclear stretch from the new frame.
- Close the **AutomaticBackgroundExtractor** tool.

Dynamic Background Extraction (Option 2)

- Open and reset the **DynamicBackgroundExtraction** tool.

Sample Generation

- STF nuclear stretch the image.
    - Click ‘Generate’.
    - If required, change ‘Default Sample Radius’ to 20 to make them easier to see.
    - If required, change ‘Sample Colour’ by double clicking on the colour bar.



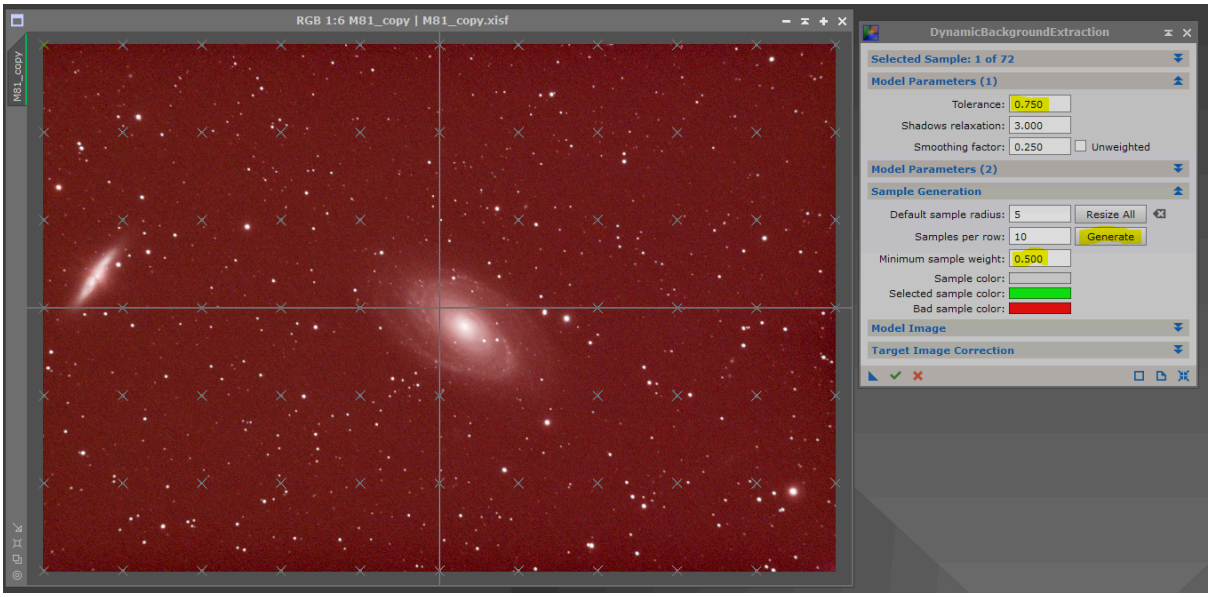
- All samples should be on background only, not on the target object.
- To increase the number of generated samples…

Model Parameters (1)

- Increase **Tolerance** to **0.750**
- Click **Generate**.

Sample Generation

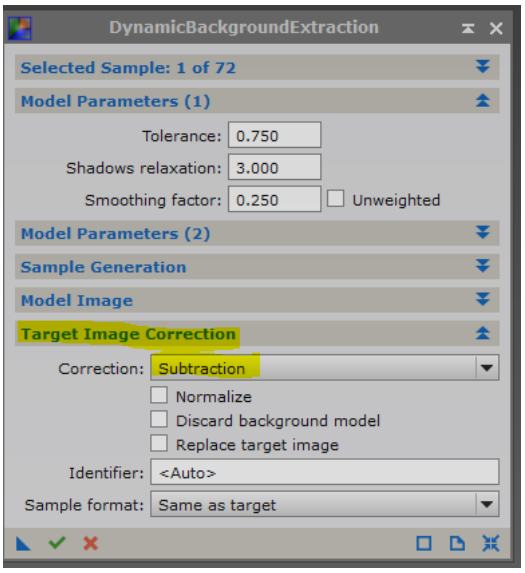
- Decrease **Minimum sample weight** to **0.500**
- Click **Generate**.



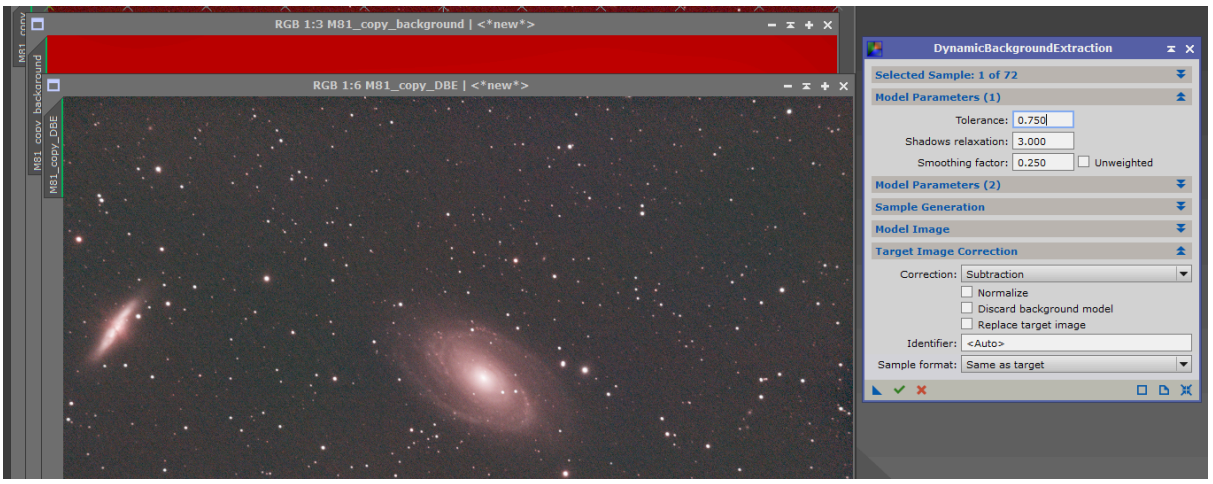
- Remove any bad samples. (Samples that have appeared on the galaxy, stars or nebulae part of the target. They need to be kept on the background only.)

Target Image Correction

- Change **Correction** to **Subtraction.**



- Click the tick to apply.
- Two additional frames will open. One background frame, which when nuclear stretched will be predominantly red. This frame can be discarded. The second frame will be a cleaner version of the image with the red background extracted. This is the frame we need to keep, and will be used to continue processing.
- Close the **DynamicBackgroundExtraction** tool.



Calibration (Pre Linear Stretch)

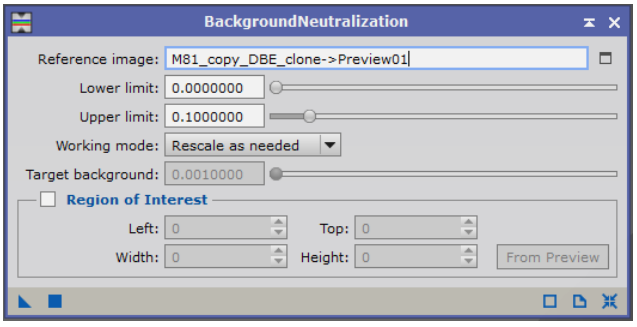
There are now 2 options available for the following calibration steps.
Option 1. **Background Neutralisation**, **Colour Calibration** and **Histogram Transformation.**
Option 2. **Photometric Colour Calibration.**

Option 1.

- To start this part of the process, the image will need to be stretched using the STF nuclear icon.

Background Neutralisation

- Open the **BackgroundNeutralisation** tool.
- Find part of the image with few/no stars and create a preview. View the preview.
- In the tool, change the **Reference Image** to show **Preview01**



- Remove the STF stretch from the preview.
- Apply the setting (F5).
- Very little will happen.
- Keep Preview 1 open.
- Minimise the tool.

Colour Calibration

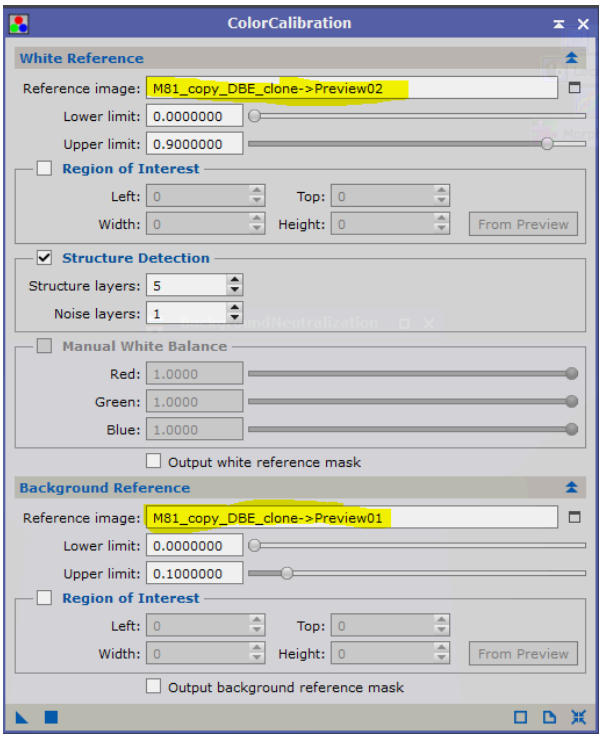
- Open the **ColorCalibration** tool and reset it.
- Create a new preview around the brightest part of the galaxy/nebula, potentially even the whole target.

White Reference

- Change **Reference image** to show **Preview02**

Background Reference

- Change **Reference image** to show **Preview01**

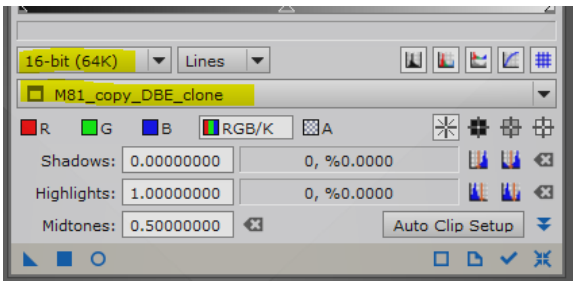


Remove the STF stretch from the previews and the main image.

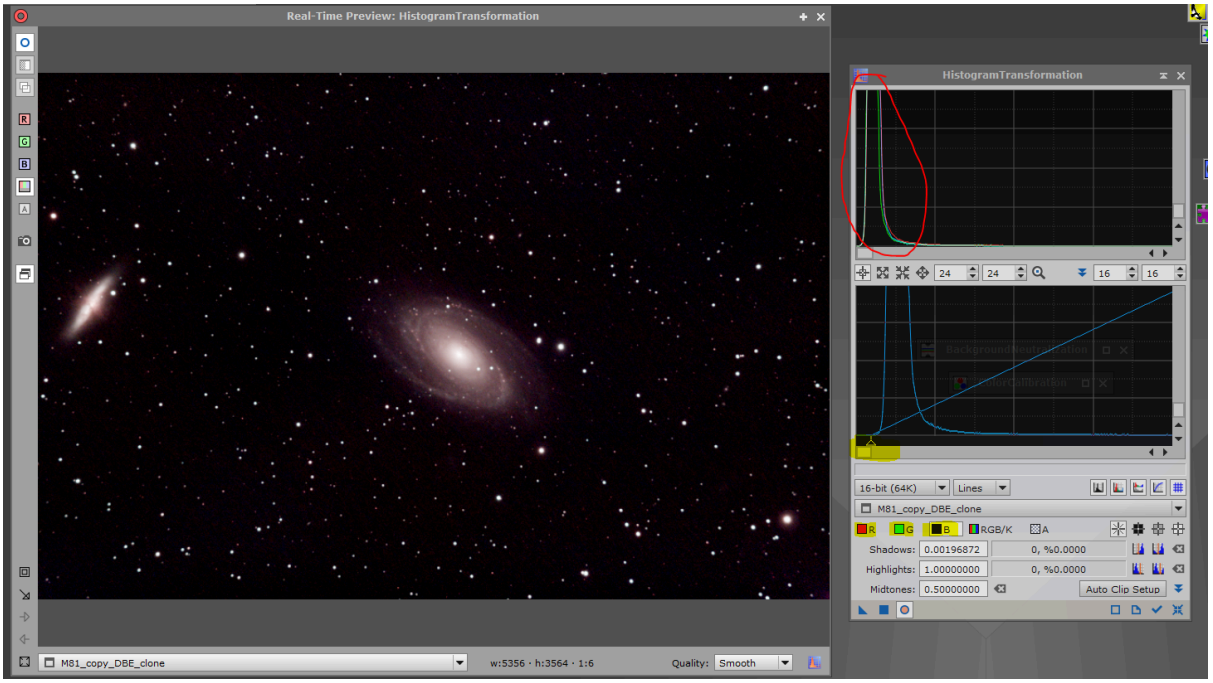
- Drag triangle to the main image to apply.
- STF stretch the resulting image.
- Minimise the **ColorCalibration** tool.
- Close **Preview01** and **Preview02**.

Histogram Transformation

- Open the **HistogramTransformation** tool and reset it.
- Select Image View.
- Change the image quality to **16-bit (64k)** from the drop down.



- Zoom in on the histogram top and bottom. If the Red, Blue and Green lines are overlapping, the colours a well aligned, and no adjustments need to be made. If they are not overlapping, the colours will need to be manually aligned.
- If required, open a real time review, select R, G or B and drag the colour to the left or right and make sure the top histogram lines up.



- Keep an eye on the real time preview. The image should look reasonable. Possibly turning a bit greyscale.
- Close the real time preview.
- Drag the triangle from the tool to the main image to apply the settings. The main image should appear the same as the real time preview.
- The resulting image will be used to proceed with the remaining calibration steps.

Close the **HistogramTransformation**, **BackgroundNeutralisation** and **ColorCalibration** tools.

Option 2.

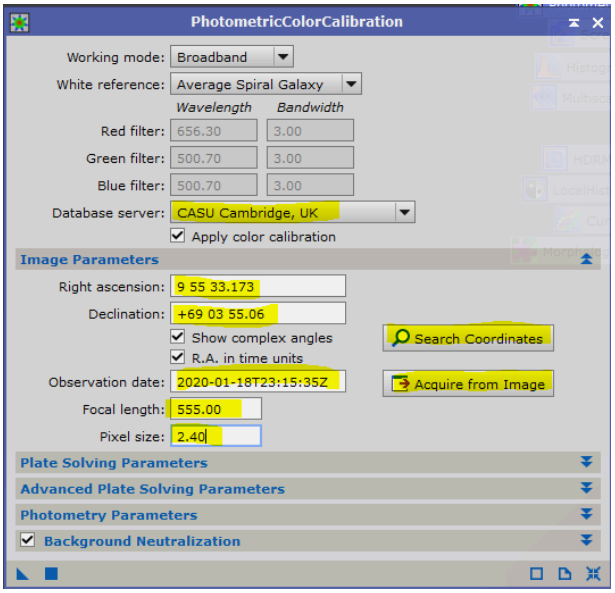
Photometric Colour Calibration

The goal of PCC is to apply an absolute white balance to the image. Among other important things, this means that the white reference does not need to be present in the picture. This is possible because we know the colours of the white reference in the photometric filter system used by a given star catalogue.

- The target image should be open, and have no STF nuclear stretch applied to it at this stage.
- Open and reset the **PhotometricColourCalibration** tool.
- Select a **Database server**. Typically **CASU Cambridge, UK** as this is our closest one.

Image Parameters

- Click on **Search Coordinates.**
- Enter the target name and click **Search** to get the coordinates of the imaged target.
- Click **Get** to populate the tool.
- For **Observation date** click **Acquire from Image**. The date and time will change to the approximate date/time that the data was acquired.
- Enter the **Focal length** (555mm for the 80 ED-R)
- Enter the **Pixel size** (2.40 microns for the 183c)
- Leave all other things default.



- Drag the triangle to the image to apply.
- Apply an STF nuclear stretch to the image to see the result.
- Close the charts window.
- Close the tool.

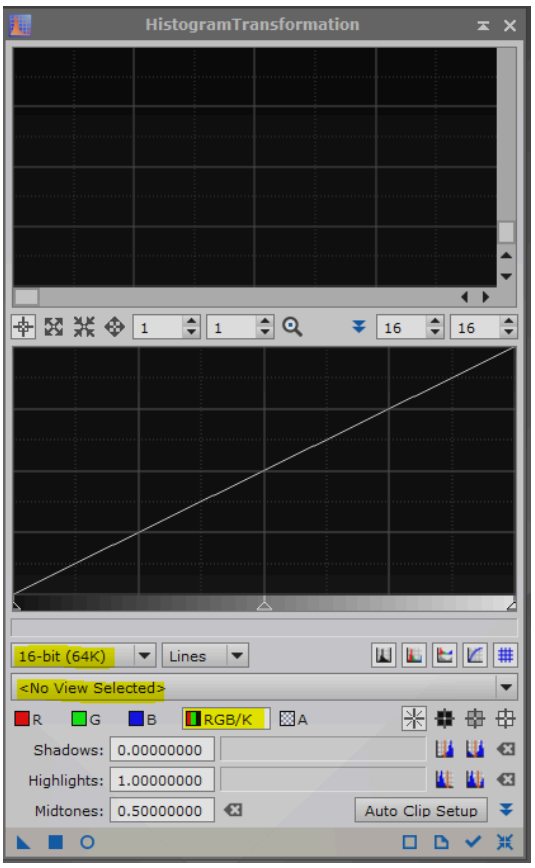
Denoising

Getting rid of background noise brought by camera sensor settings is a big part of image processing. There are several tools and many combinations of using these different tools to reduce noise. These denoising steps are carried out during the **Linear** stage of processing (BEFORE the image has been stretched permanently and you still need to use the nuclear button to see what the finished image might look like). However, tools such as **ACDNR** can be used both during the **Linear** and **None-Linear** stages.

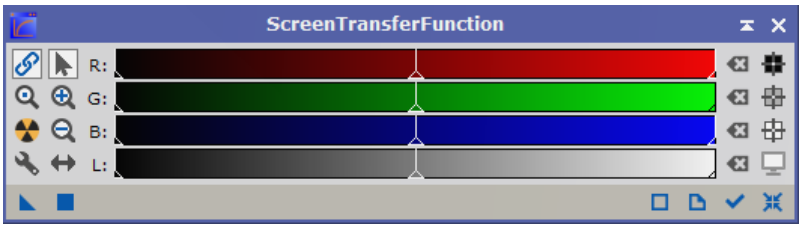
To start this process, the image needs to be in a Linear state, so remove the STF nuclear stretch if it has been applied.

Histogram Transformation and Screen Transfer Function

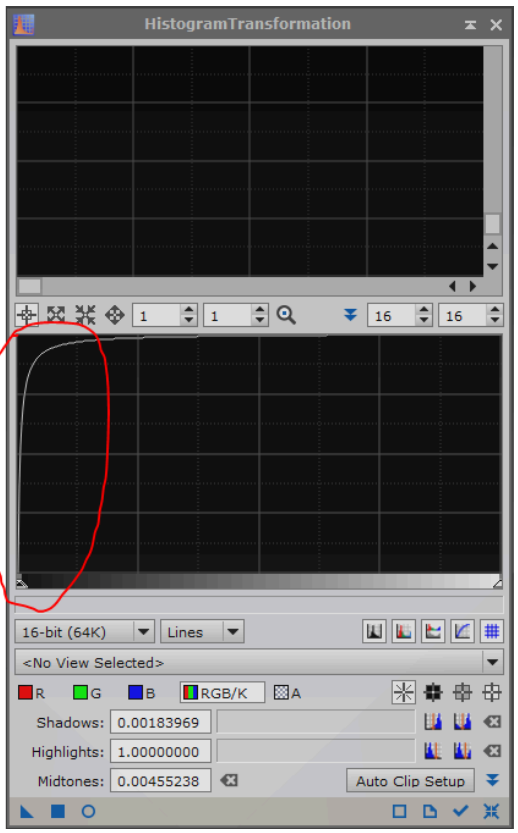
- Open and reset the **HistogramTransformation** tool. There should be **<no view selected>** and **RGB/K** selected. The histogram should be blank and displaying **16-bit (64k)** quality.



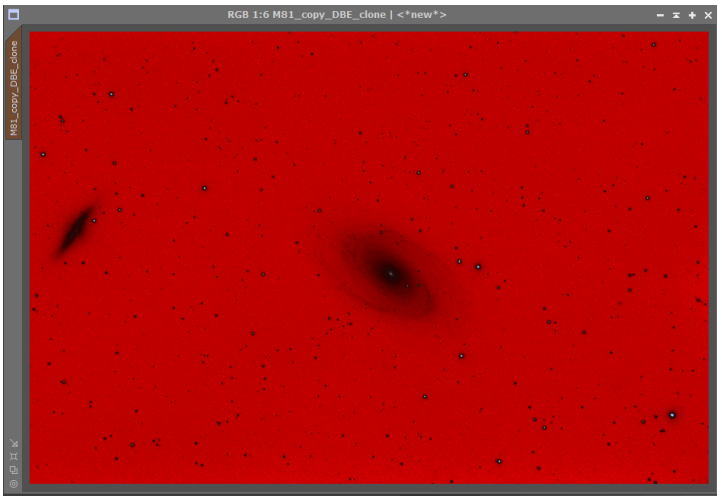
- Open the **ScreenTransferFunction** tool and reset it.



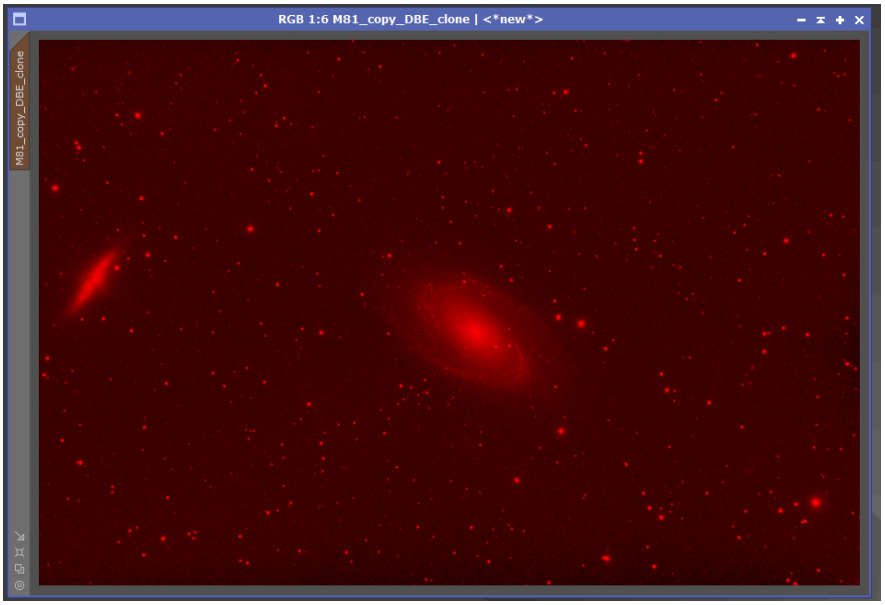
- Create a mask image by clicking the – **Extract Lightness (CIE *L)** icon on the main toolbar.
    - This creates a black and white image.
- Apply a STF nuclear stretch to the mask **using the ScreenTransferFunction** tool to the black and white mask image.
- Drag the triangle from the STF tool to the bottom bar of the Histogram Transformation tool. The bottom histogram in the Histogram Transformation tool will change.



- Drag the triangle from the Histogram Transformation tool to the grey image/mask. The mask image will turn white as in effect, the mask image has been stretched twice at this point. Once by the STF nuclear stretch (which is still in place) and one by the histogram changes just applied.
- Reset the STF tool. This will bring the grey mask image back to a state where only a single stretch is applied.
- Close the Histogram Transformation tool.
- Drag the mask image tab to the linear image to create the mask. The image will turn red.



- At this time, everything covered in red is protected. To deal with noise, we need to protect the target, not the background. Invert the mask to protect the target, so the next part of the work will only affect the background.



- Now, the background has changed, and the target is red, showing the target is now protected, and the background is more exposed to the changes being made.
- Hide the mask.
- Apply an STF nuclear stretch to the image to expose the target.
- Create a preview around part of the target and part of the background.
- View the preview.

Multiscale Linear Transformation

- Open the **MultiscaleLinearTransformation** tool and reset it.
- Open a real time preview of the preview created in the previous step.
- The following settings are starting points. Use these first, although they are open to experimentation if required.

Dynamic Range Extension

- Change **Target** to **Luminance (CIE Y)**

Layers and Noise Reduction

- In each case, select the layer number to work on in the **Layers** section, and tick the **Noise Reduction** section to apply the values.
  - Layers: 4
  - Noise Reduction

	Threshold	Amount	Iterations
1	3.000	0.30	3
2	2.000	0.30	1
3	1.000	0.30	1

  - Close the real time preview.
- Apply the settings to the main image and reset the tool.

Dynamic Range Extension

- Open a real time preview of the preview again.

- Change **Target** to **Chrominance (restore CIE Y)** this works on any blotchiness present in the colours of the target.

Layers and Noise Reduction

- In each case, select the layer number to work on in the **Layers** section, and tick the **Noise Reduction** section to apply the values.
- Open a real time preview of preview01
    - Layers: 7
    - Noise Reduction

	Threshold	Amount	Iterations
1	3.000	1.00	1
2	3.000	1.00	1
3	3.000	0.90	1
4	3.000	0.80	1

    - Close the real time preview.
- Apply global and reset the tool.
- Close the **MultiLinearTransformation** tool.
- Remove the image preview.
- Remove the mask.
- Delete the grayscale mask image.
- Close the **ScreenTransferFunction** tool.
- Remove any STF nuclear stretch that might still be applied to the image.

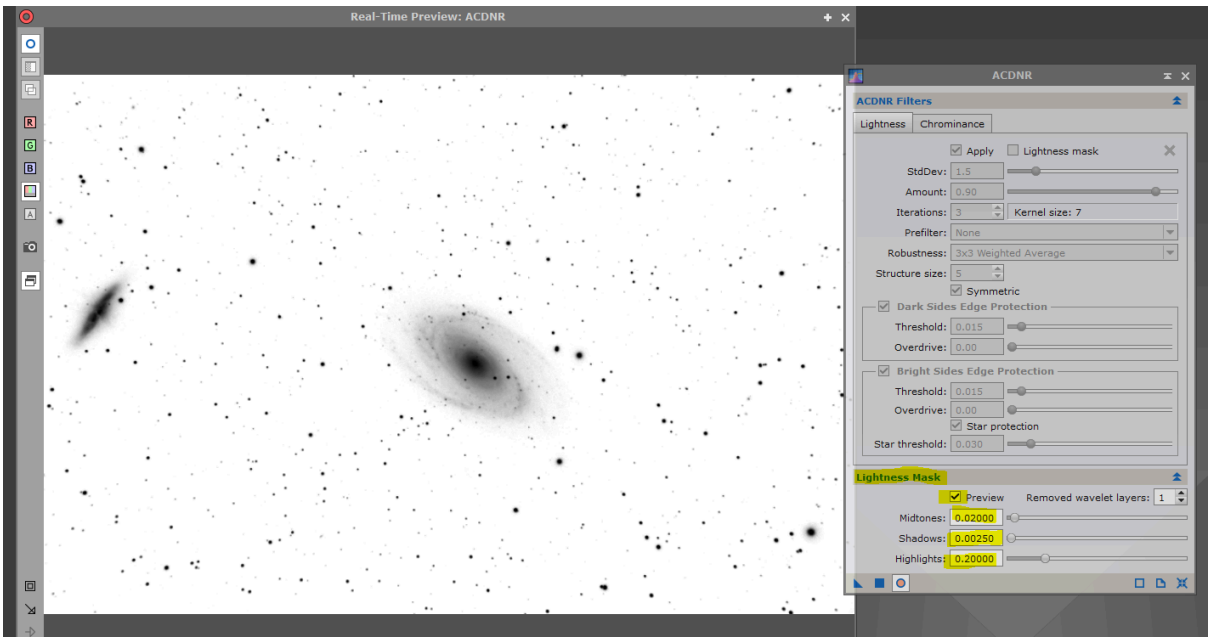
Sometimes, the previous noise reduction steps can be a little too subtle, and more aggressive processing is required.

ACDNR

- Open the **ACDNR** tool and reset it.
- Using the tool, create a real time preview of the image.

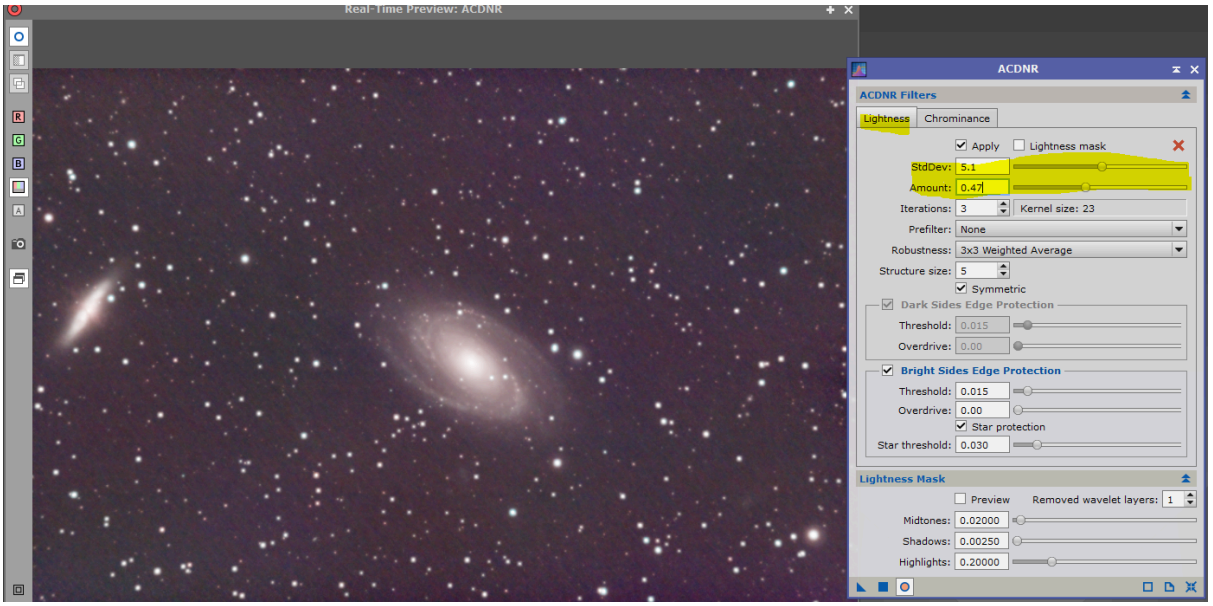
Lightness Mask

- Tick **Preview**. Black areas are protected by the mask. Change protection by playing with the sliders in the Luminance mask area. Use a very heavy mask for background noise.
- Once happy with the mask, untick the **Preview** box and close the real time preview.



ACDNR Filters

- Select the **Lightness** tab.
- Open another real time preview of the main image.
- Use **StdDev.** values of 5 or 6 for large scale noise reduction. Use the **Amount** slider to also make changes. **Iterations** can be changed if the star size starts getting too big. Other values can be left as default.



- Select the **Chrominance** tab (posh word for colour). These values might need changing. They deal with blotchiness and noise in colours. Possibly more useful in nebulae. The same 3 values can be amended as required.
- Use undo/redo to compare.
- Once happy, close the real time preview.
- Apply (F5) the changes to the main image.
- Close the **ACDNR** tool.

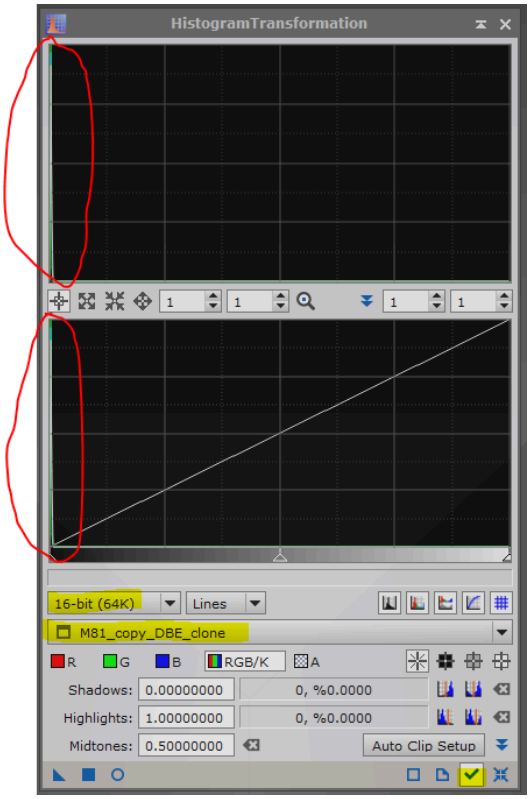
- Remove the STF nuclear stretch.

Linear to None-Linear Transformation

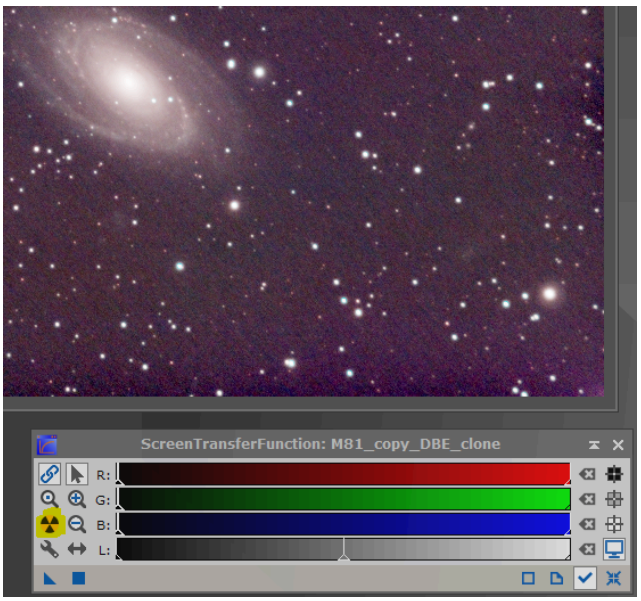
The following section deal with switching from Linear (none-stretched) to None-Linear (stretched).

Screen Transfer Function and Histogram Transformation

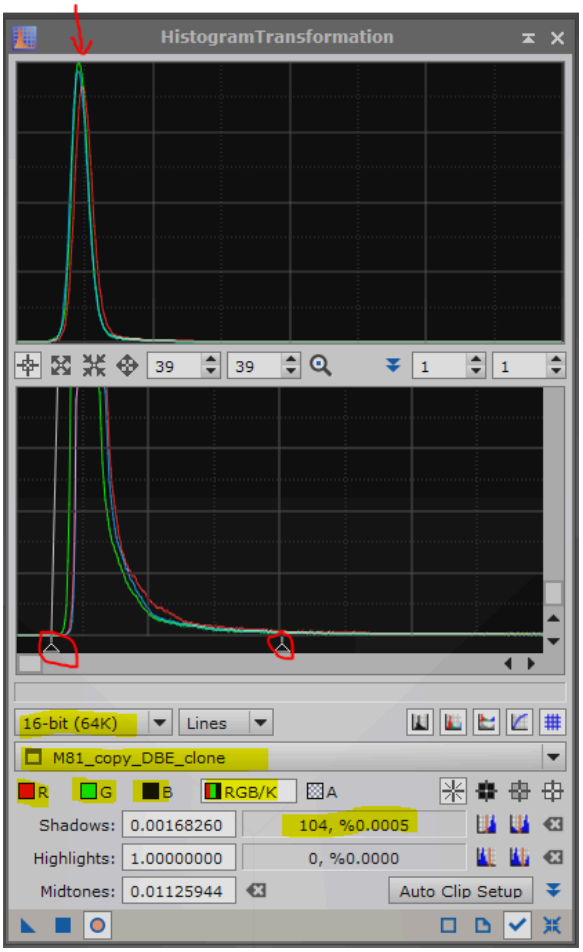
- Open the **ScreenTransferFunction** tool and reset it.
- Open the **HistogramTransformation** tool and reset it.
  - Use **16-bit (64k)** image quality in the drop down option.
  - Change the view to the image name.
  - Click the tick to **Track View**. The histogram will show up hard left in the graph showing that the image has not yet been stretched.



  - On the **ScreenTransferFunction** tool, click the STF nuclear button. The image will change to a stretched version.



- Drag the triangle from the STF tool to the bottom of the **HistogramTransformation** tool.
- Close STF tool.
- Open the Histogram Transformation real time preview. The real time preview image will appear almost white as it has been stretched twice.
- Remove the STF stretch on the main top toolbar.
- Move the left slider left a bit to darken the background slightly if needed. Beware of clipping data. Use mouse scrolling to zoom into the bottom histogram graph if required.
- Move the middle slider (mid tones) to bring the histogram curve 1/8 along the top graph.
- If the histogram line for each of the colours is out of alignment, use the relevant **R**, **G**, or **B** settings to re-align them.

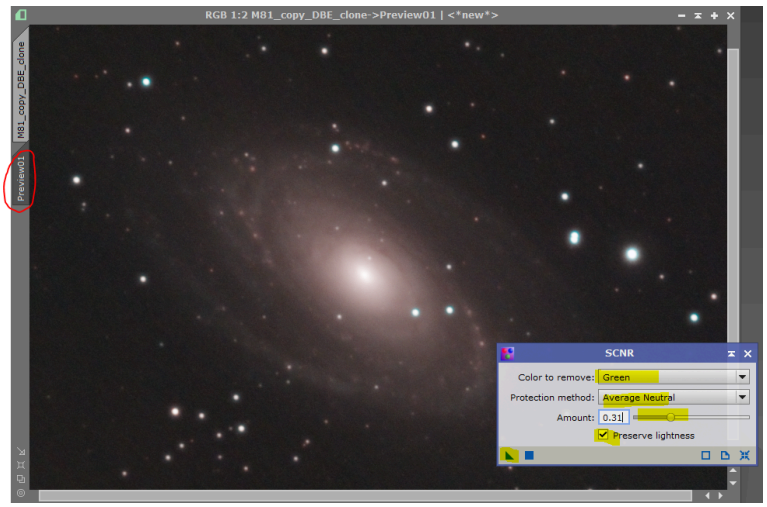


- Once happy with the result, close the real time preview.
- Apply (F5) the settings to the main image. The image will now be stretched according to the Histogram Transformation tool.
- Close the tool.

SCNR

Use the SCNR to remove specific colours if required. Sometimes an image might be too green etc. However, if the image looks good, then this tool can be skipped.

- Open the **SCNR** tool and reset it.
- Create a preview around the area of the image you want to change colour balance settings.
- View the preview.
- On the SCNR tool, choose the pixel colour to work on from the drop down list.
- The **Protection Method** can be left as **Average Neutral**.
- Change the amount slider for each colour. After each change, drag the triangle to the preview image to apply any changes to the preview only. Use the Undo/Redo preview icon to flick between changes.
- Once happy with any changes, click the square **Apply (F5)** icon.



- Close the preview and close the tool.

Calibration (Post Linear Stretch)

This section works on structure and colour of the post linear image. Areas such as galaxy arms, core and sharpness of nebula structure will be worked on.

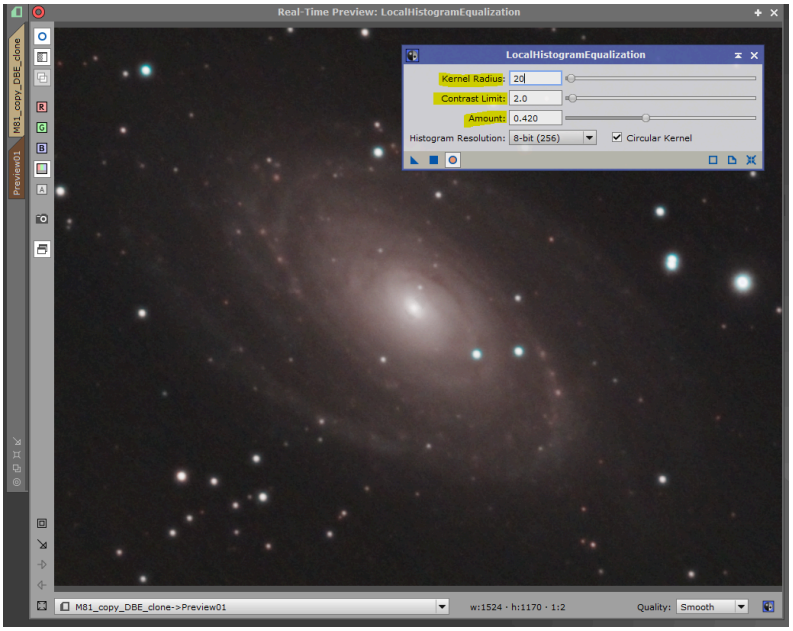
HDR Multiscale Transformation

This tool will help develop areas of the image such as galaxy core and arms. It will also help with structure within nebula.

- Open the **HDRMultiscaleTransformation** tool and reset it.
- We need to create another mask by using the **Extract CIE – L*** icon. This will produce the black and white image.
- Drag the black and white image to the main image to make the mask. Minimise the black and white image. The main image will turn red. Areas in red are protected.
- Hide the mask (Ctrl & K).
- Take a preview of the core area of the galaxy/nebula.
- Leave default values on the tool for the moment.
- Drag the triangle onto the new preview.
    - Use the **Undo/Redo Preview** icon to switch between before/after views.
        - Experiment with different numbers of layers. Increase to brighten, decrease to darken.
- Drag the triangle to the full image when you are happy with what the preview is showing.
- Delete the preview.
- Close the HDR tool, but **keep the mask**.
- Create another preview of the core.

Local Histogram Equalisation

- Open the **LocalHistogramEqualisation** tool and reset it.
- Create a real time preview of the main image preview. The real time preview image may appear slightly poorer than the real time preview itself.
- Change the **Amount** slider for subtle changes to the core/lanes. 0.2000ish seems to work OK, but experiment.
- Change the **Contrast** slider but be careful of introducing noise/graining.
- Change the **Kernel Radius** to improve dust lanes again. Always check stars in case you ring them or black/white dots appear in the centre of the stars.

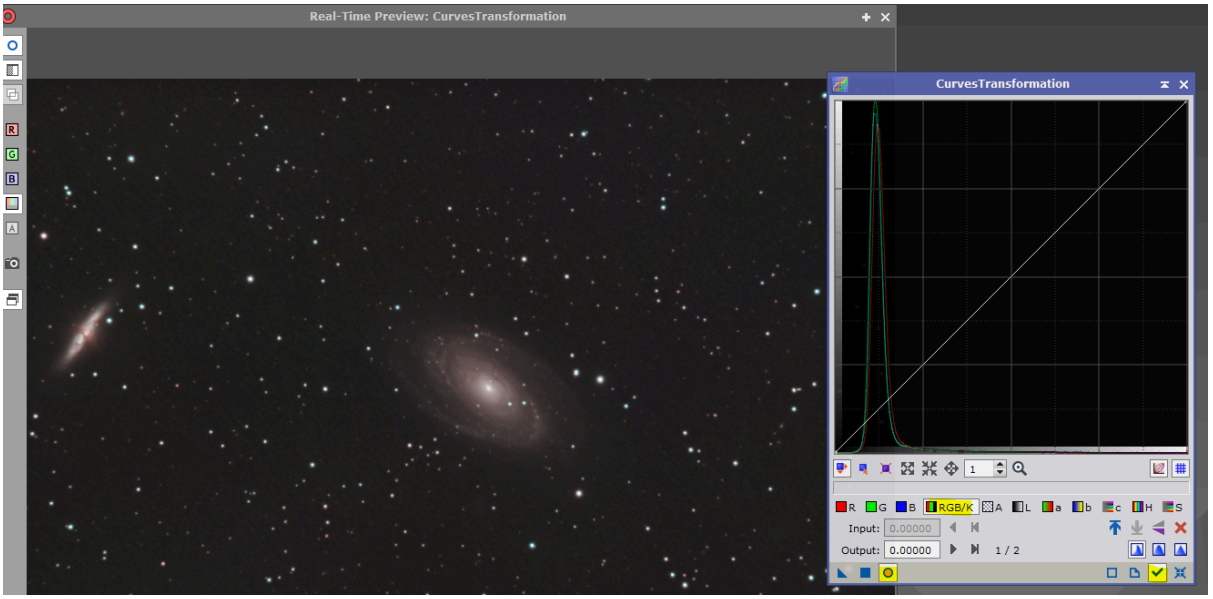


- Close the real time preview.
- Drag the triangle to the main image to apply the settings.
- Delete the preview.
- Close the tool.
- **Keep the mask** in place.

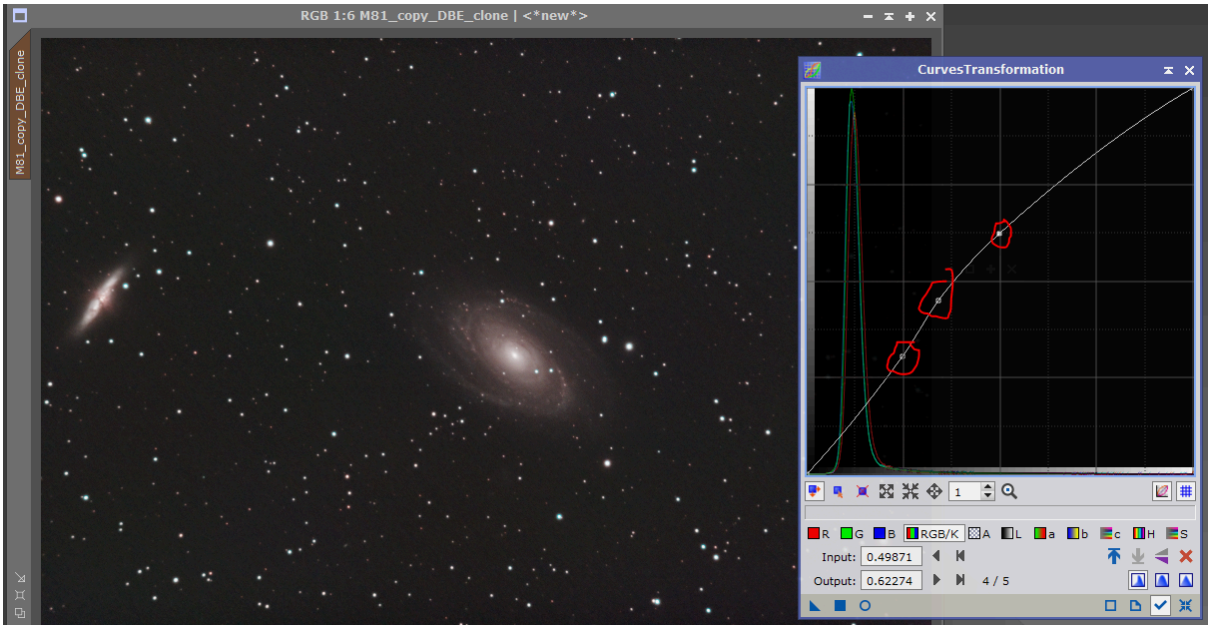
Curves Transformation

This section will help to darken areas of the image which may need further enhancing. Remember that the brighter areas are still protected by the mask, but they can still be enhanced a bit.

- Open the **CurvesTransformation** tool and reset it.
- Select RGB/K
- Select the tick to track changes.
- Open a real time preview.



- On the real time preview, click areas of the image to brighten and watch the histogram. Put a point on the histogram line where the mark appears.
- Start moving the points on the line to increase/decrease brightness. Keep flicking between the before/after image in the real time preview window until happy with the image.



- Close the real time preview.
- Drag the triangle to the main image to apply changes.
- Close the tool.
- Now we can finally remove the mask.

Star Size and Morphological Transformation

This section deals with star sizes in the image. During various steps, the stars in the image may have become too small or too bloated.

Morphological Transformation

- Create a new mask by using the **Extract CIE L*** icon.
- Drag the extracted image over to the main image to create the mask.
- Minimise the black white mask image.
- Make sure the mask is hidden.
- Open the **MorphologicalTransformation** tool.
- Create a preview around part of the target and part of the background, also containing stars. View the preview.

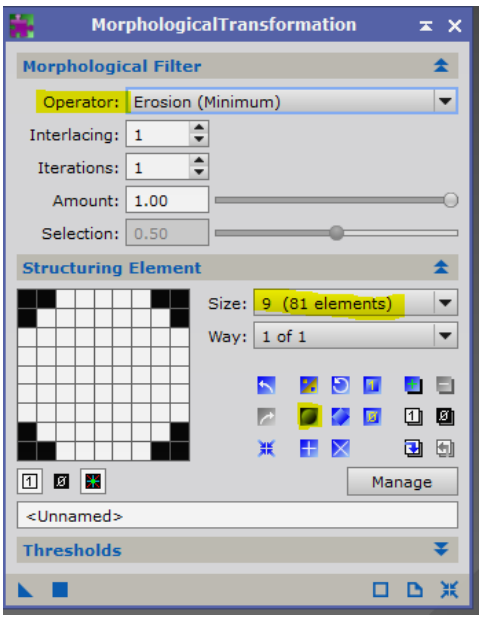
Experiment with these settings.

Morphological Filter

- **Operator** > Erosion (Minimum)

Structuring Element

- **Structuring Element** > Size 9
- **Select circular shaped icon** (2nd icon 2nd row).



- Drag the triangle to the preview window.
- Use the **before/after preview** icon to view the changes. Check for ringing on the stars.
- For example:
    - Consider bringing down the **Amount** slider.
    - Consider slightly changing the **Size** value.
    - Example: Size 7, Amount 0.72
- Drag the triangle to the main image.
- Remove the mask and close the preview.
- Close the tool.

Colourise

Here, we are aiming to introduce, or at least, make some final changes to the colour balance in the image.

- Create a new mask by using the **Extract CIE L*** icon.
- Drag the extracted image over to the main image to create the mask.
- Minimise the black white mask image.
- Make sure the mask is hidden.
- Create a preview of a large part of the main target.

Curves Transformation

- Open the **CurvesTransformation** tool and reset it.
- Open a real time preview of the preview.
- Click the tick to track view the histogram in the curves window.
- Select a darker area of the preview and mark the appropriate place on the line.
- Select a lighter area of the preview and mark the appropriate place on the line.
- Add a marker to the top right of the curve line to protect the core/brightness of the nebula.
- Add a marker to the bottom left of the curve line to protect the background and prevent clipping data.

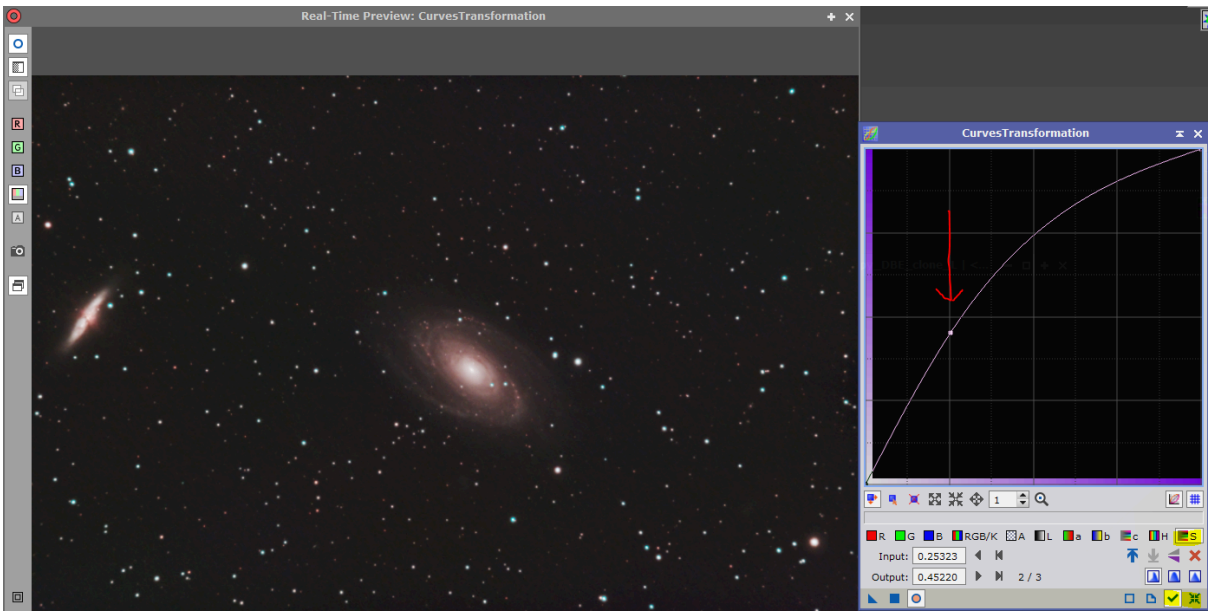
- Change the values of the markers on the curve line until happy.
- Close the real time preview.
- Drag the triangle to the main image to apply the changes.
- Reset the tool.

Colour Saturation

There are two methods to improve colour saturation. Either option, or a combination of both can be used.

Option 1 – Curves Transformation

- Still using the **CurvesTransformation** tool from the previous step…
- Open a new real time preview of the target.
- On the Curves Transformation tool, select **S** (Saturation).
- Move a point on the curve line ¼ along and experiment with saturation until happy with the image.



- Close the real time preview.
- Drag the triangle to the main image to apply the changes.
- **Invert the mask**.
- Delete the old preview01.
- Create a new preview of the background and a little part of the target.
- Close the **CurvesTransformation** tool.

Option 2 – Colour Saturation

This option requires the use of a mask created by extracting the luminance layer, the **HistogramTransformation** tool and **ColorSaturation** tool.

- Create a new mask by using the **Extract CIE L*** icon.
- Open the **HistogramTransformation** tool.
- Change the view field to reflect the name of the luminance image created for the mask.
- Open a real-time preview of the mask image.
- Move the left slider on the histogram slightly to the right. In this instance, it is OK to clip the shadows data to ensure the background is well protected.
- If required, move the middle slider to bring up the mid tones around the edges of the target.
- When happy, close the real time preview.
- Apply the HistogramTransformation settings to the luminance mask image.
- Close the **HistogramTransformation** tool.
- Drag the luminance mask image over the main image to create the mask.
- View the mask to ensure the background is protected (red) but the target is exposed. If not, delete the mask and repeat the process with different histogram settings.
- Hide the mask.
- Create a preview of the main target.
- Open the **ColorSaturation** tool and reset it.
- Open a real time preview of the target preview.
- Click on areas of the image you want to enhance/saturate and note where on the tool the vertical mark appears.
- Along the horizontal line of the tool, add markers along the rest of the colour spectrum.
- Where the vertical line crossed the horizontal line, drag the horizontal line upwards to around ¾ to increase the colour contrast at that point.

- Add additional markers either side of the curve to help arch it slightly, creating a smooth curve as opposed to a sharp spike.
- Repeat the process for any other colours required.
- Once happy, close the real time preview.
- Apply the changes to the main image.
- Remove the mask.
- Delete the main image preview.
- Close the luminance image initially created to make the mask.

Histogram Transformation

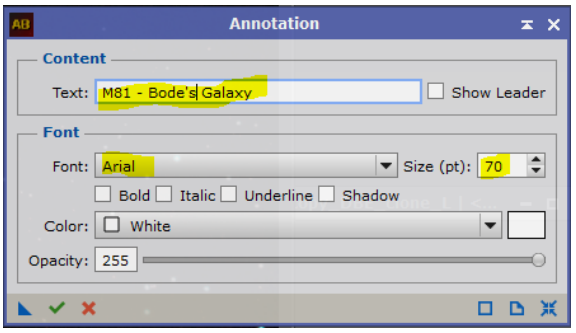
- Open the **HistogramTransformation** tool and reset it.
- Create a real time preview of preview01.
- Click the tick to track view. At this point, you should not need to scroll on the histogram graphs to zoom in, as the image is now none-linear and the stretches have already been performed.
- Bring the left slider of the bottom histogram graph in to the right. Avoid the shadows value getting too high.
- Bring the midpoint slider left or right if needed.
- Ultimately, what we are trying to get is a histogram peak around 1/8 along the graph at the top, but without introducing any noise or graining to the real time preview. Use the undo/redo real time preview icon to help identify changes.
- Close the real time preview when happy with the image.
- Drag the triangle to the main image to apply the changes.
- Close the tool, mask and previews.

Save the final image. This completes the image processing section within PixInsight. Save the final image as a .xisf file, .tif file and .jpg file.
The following steps now look at annotating the final image, final processing in GIMP (if required), and resizing for use on websites, magazines and mobile devices.

Annotation

This is used to watermark/stamp the image for display online.

- Open the **Annotation** tool.
- Enter the catalogue of the target, and it's name if appropriate in the **Text** field.
- The **Font** should be set as **Arial** and the size **70**.



- Use the cross hair cursor on the main image, and click where the text needs to appear. The text can be dragged around until in the correct location. Under the text will be two more rows of text, so make sure enough room is left.

- When happy with the positioning, click the **Green Tick**. The text will then permanently be applied to the image.
- Next, in the Annotation tool, enter the date the image data was captured. Use the cross hair cursor to position the text and click the green tick when happy with its final position.

GIMP Processing Workflow

Sometimes, the image may still benefit from additional curves and histogram work in GIMP. Use the .tiff files to perform the work (to preserve image detail).

Further Noise Reduction

- Open **Filters** > **Enhance** > **Noise Reduction.**
- Try around strength 4, but use the split view to give a good before/after view to help gauge which is best.

Increase Saturation for Colour

- Open **Colours > Saturation.**
- Try around 1.5, but it will differ for each target. Be careful of ringing, or blowing out the target.

Further Sharpening

- Open **Filters > Enhance** > **Sharpen (Unsharpen Mask)**
- Change the **Radius**, **Amount** and **Threshold**.
- Changes to Threshold will probably be quite minimal ~0.041

Re-Visit Noise Reduction

- Return to the first Noise Reduction step to deal with any noise inadvertently re-introduced in the previous steps.

Levels

- Open **Colour** > **Levels**.
- Move the left slider towards the histogram slightly to darken the background, but not too far as to lose detail.

Curves

- Open **Colour** > **Curves**.
- Add some slight tweaks to darken the background and brighten other areas.
- Be careful not to introduce noise.

Saving

- Save/Export the .tif file appended with **_Gimp**
- Save/Export the .tif file appended with **_Gimp** as a .jpeg