Hidden Light Photography: Basic PixInsight Order of Operations

Introduction

- Brief overview of PixInsight workflow order of operations for OSC image processing.
- Required Programs: Seti Astro Scripts, RC Astro (BlurXterminator, NoiseXterminator StarXterminator)

Step 1: Image Statistics

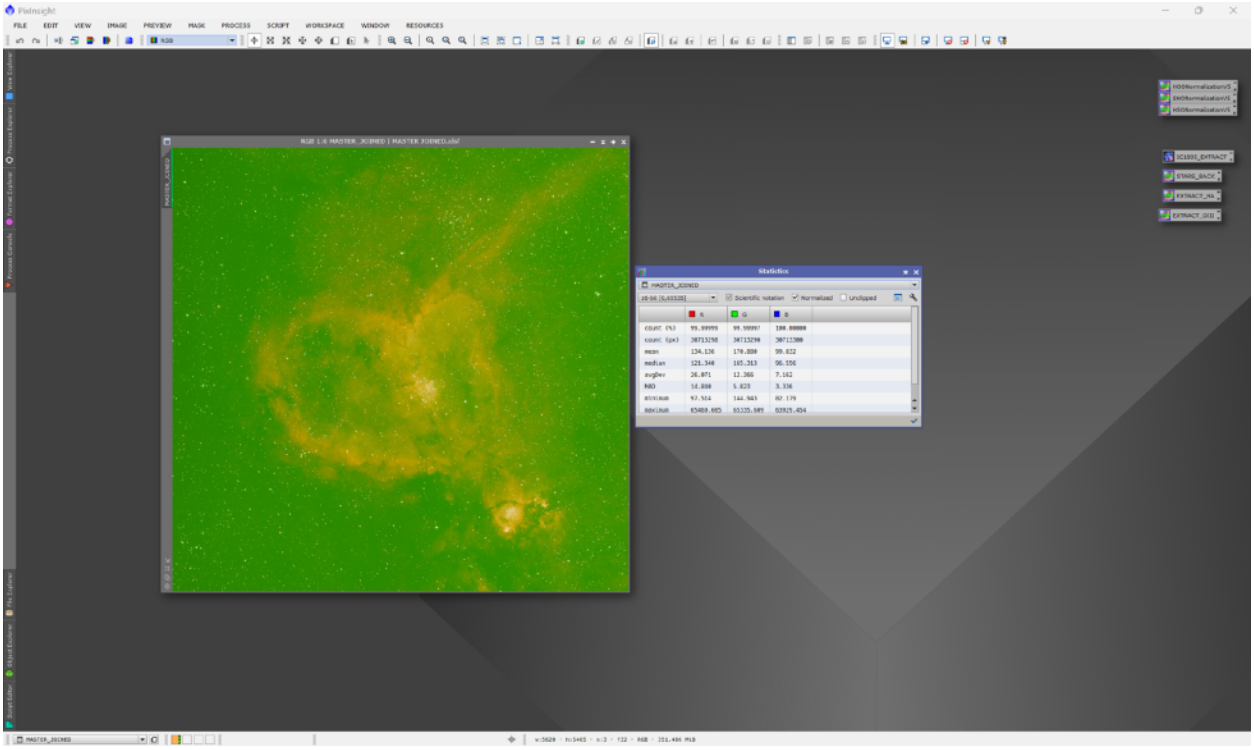


Figure 1

- **Check Mean Value:** Use the Image Statistics tool to analyze the mean value of your image as seen in figure 1. This helps in understanding the overall brightness of each channel. Ensure 16 bit is selected in the top left of the Statics window for easier value reading and you choose your image from the dropdown. Notate the mean value of each channel.
- Statistics is located in Process > All Processes > Statistics

Step 2: Separate Color Channels

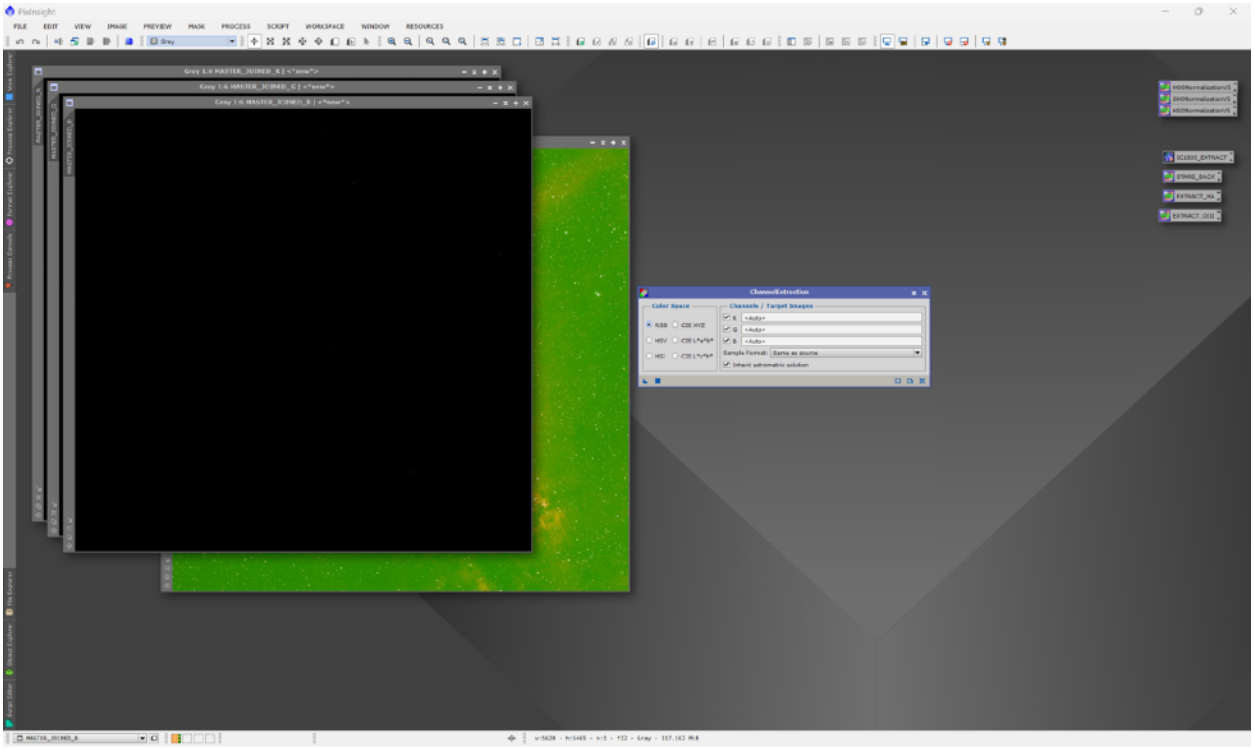


Figure 2

- **Channel Separation:** Split the image into its individual RGB color channels for initial color balancing as seen in figure 2. This prepares the image for Linear fit in Step 3.
- First way to separate color channels is to click the icon in the tool bar located in the first section after the forward and back buttons and is the 4th icon in this section. The icon is located under the menu bar word image
- The second way to separate color channels is located in Process > All Processes > Channel Extraction. Ensure RGB is selected and leave the color channels' drop down as auto as shown in Figure 2. Click and drag the triangle onto your image.

Step 3: Linear Fit and Channel Balancing

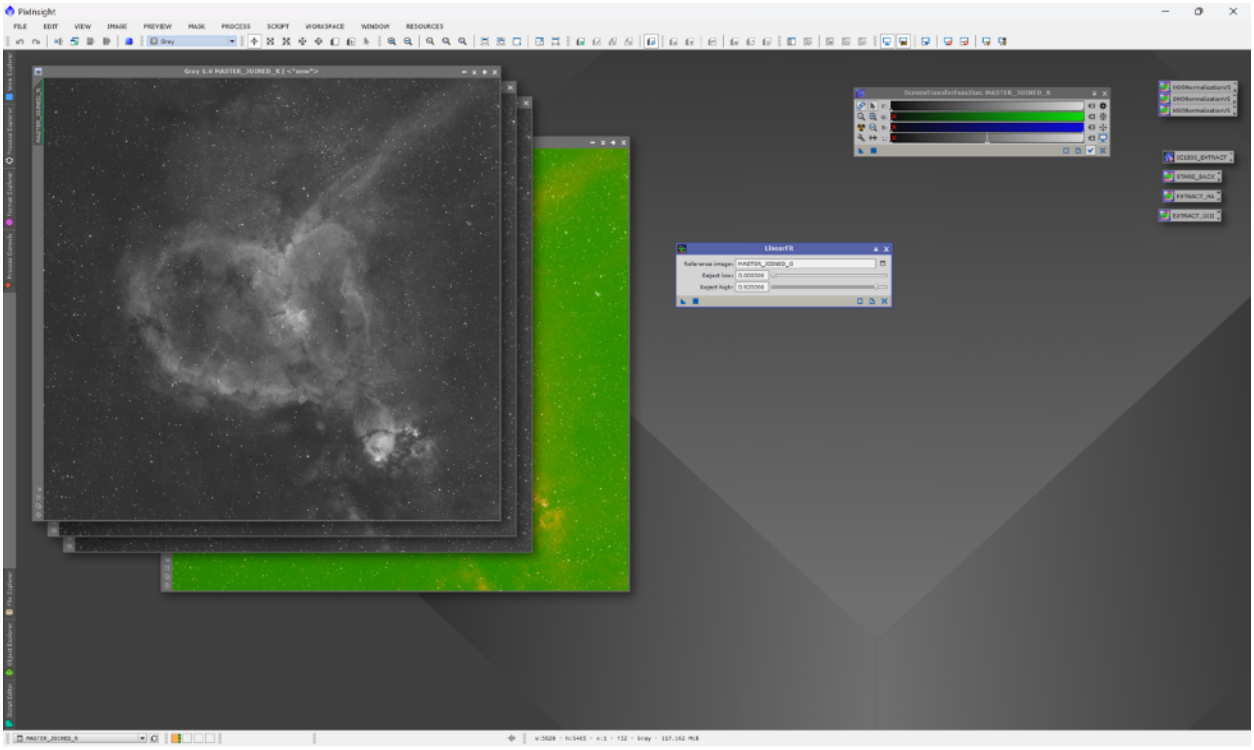


Figure 3

- **Linear Fit:** Perform a linear fit on the channels which balances the color of channels with each other as shown in figure 3. Apply the most prominent or least prominent channel, as determined by the mean value of each channel from Statistics, to the other two channels to achieve balanced colors. If you are using the most prominent channel, click the reference image drop down and select the channel that had the highest mean value. If using the least prominent channel then select the channel that had the lowest mean value in statistics. Click and drag the triangle to the other two channels one at a time. You may need to reapply a stretch to the image using Screen Transfer Function if the image displays strangely after applying Linear Fit.
- Linear Fit is located in Process > All Processes > Linear Fit
- Screen Transfer Function is located in Process > All Processes > Screen Transfer Function

Step 4: Channel Combination

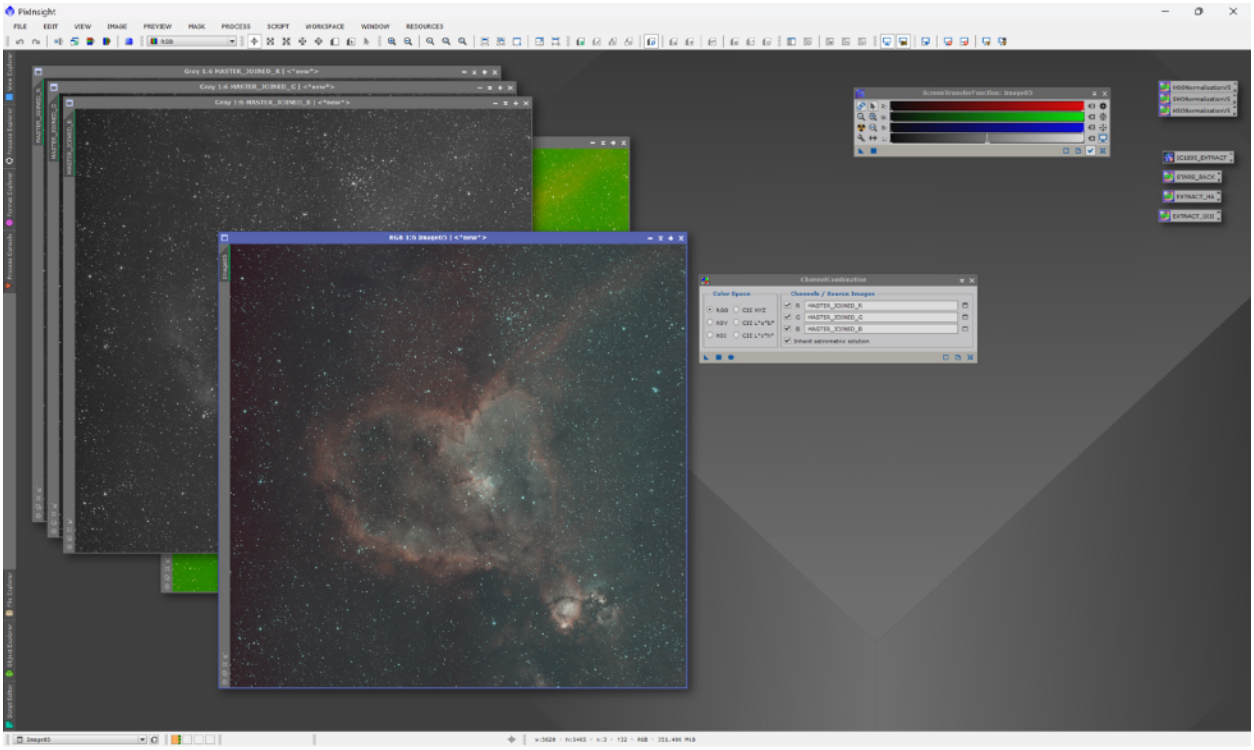


Figure 4

- **Recombine Channels:** Use the Channel Combination tool to recombine the balanced RGB channels into a single image as shown in figure 4. The image will now display with the balanced colors, thus getting rid of the initial color tint displayed. The image will now reveal its potential. Ensure RGB is selected and use the drop downs to assign each channel category the appropriate channel. IE Assign the red category the red channel, green category the green channel and the blue category the blue channel. Click the circle to apply and obtain your new image.
- Channel Combination is located in Process > All Processes > Channel Combination

Step 5: Dynamic Crop

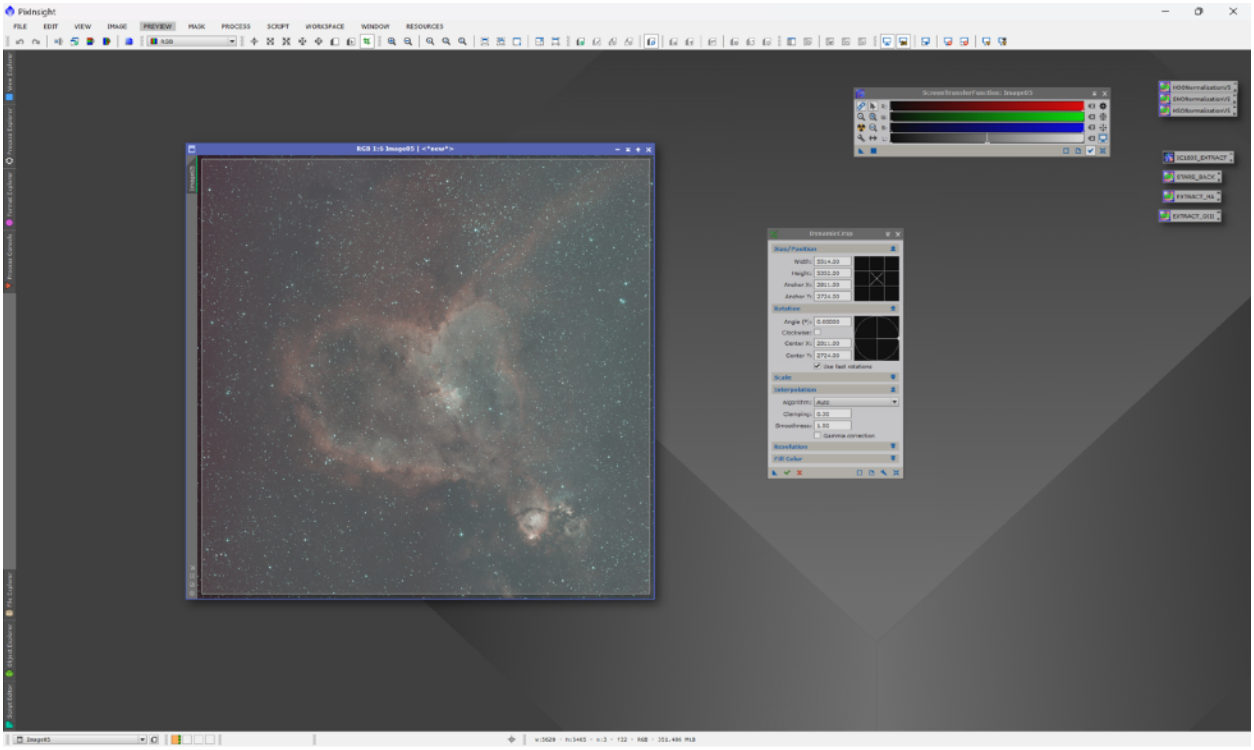


Figure 5

- **Crop Image:** Use the Dynamic Crop tool to crop your image to your liking as shown in figure 5. Keep in mind the more you crop your image, the more pixels you are removing which reduces how much you can enlarge it if you wish to print your work. The main point of cropping is to remove stacking artifacts. Zoom in on your image and examine the edges of your image for imperfections or “roughness”. These need to be removed in order for background extraction to work correctly. Ensure your cropping removes any and all stacking artifacts. After opening Dynamic Crop, hover your mouse over the image, left click and hold your mouse and drag to your desired destination to draw your cropping box. The cropping box can be adjusted as needed by hovering your mouse on the edge of the cropping box until you see an arrow appear. At that point, left click and hold and the cropping box can be dragged to a new location within the image. Click the green check mark to apply the crop once the cropping box is set to your liking. There will be a warning that pops up stating the astrometric solution will be lost. Click ok as this will be corrected in a later step.
- Dynamic Crop is located in Process > All Processes > Dynamic Crop

Step 6: Initial Star Correction

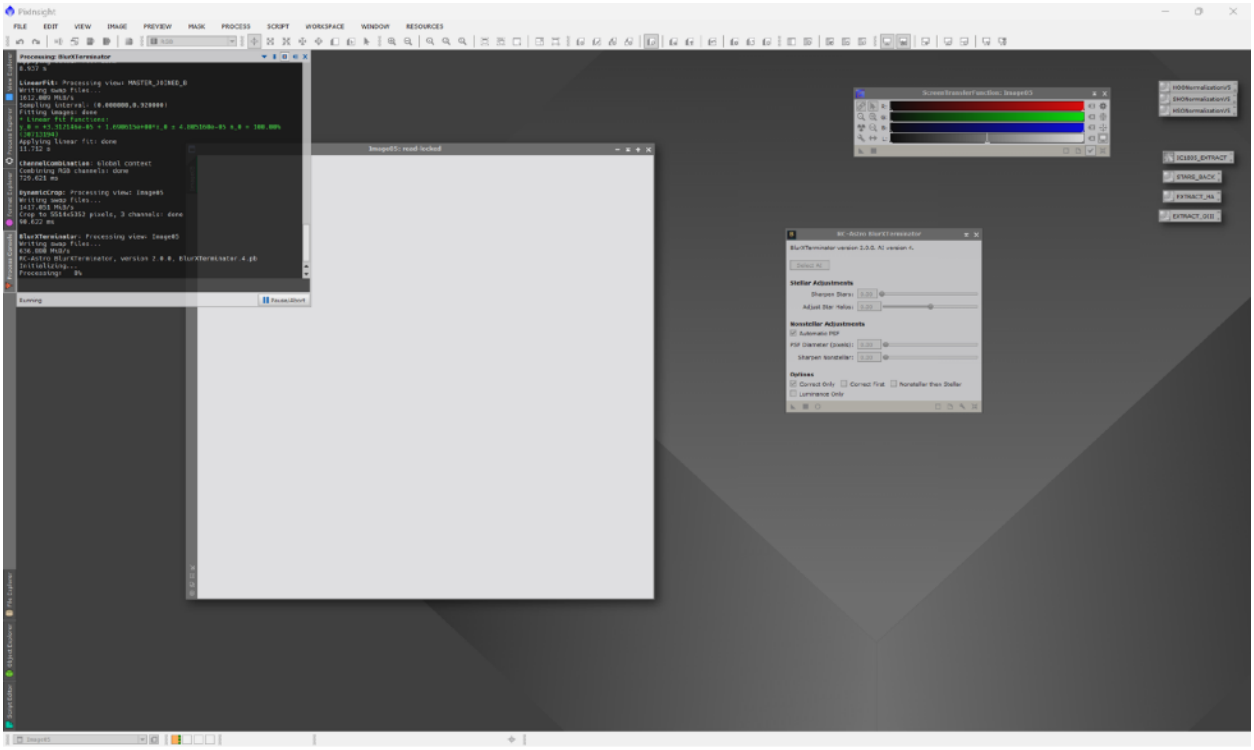


Figure 6

- **BlurXterminator (Correct Only):** Apply this process to perform an initial correction of the stars in the image as shown in figure 6. Located in the bottom left of the BlurXterminator Process window is a check box “Correct Only” which needs to be checked. Checking this will allow BlurXterminator to do an initial correction of the stars which is necessary in order for background extraction to function correctly and efficiently. One “Correct Only” is checked, click and drag the triangle onto the image.
- BlurXterminator is located in Process > All Processes > BlurXterminator

Step 7: Background Extraction

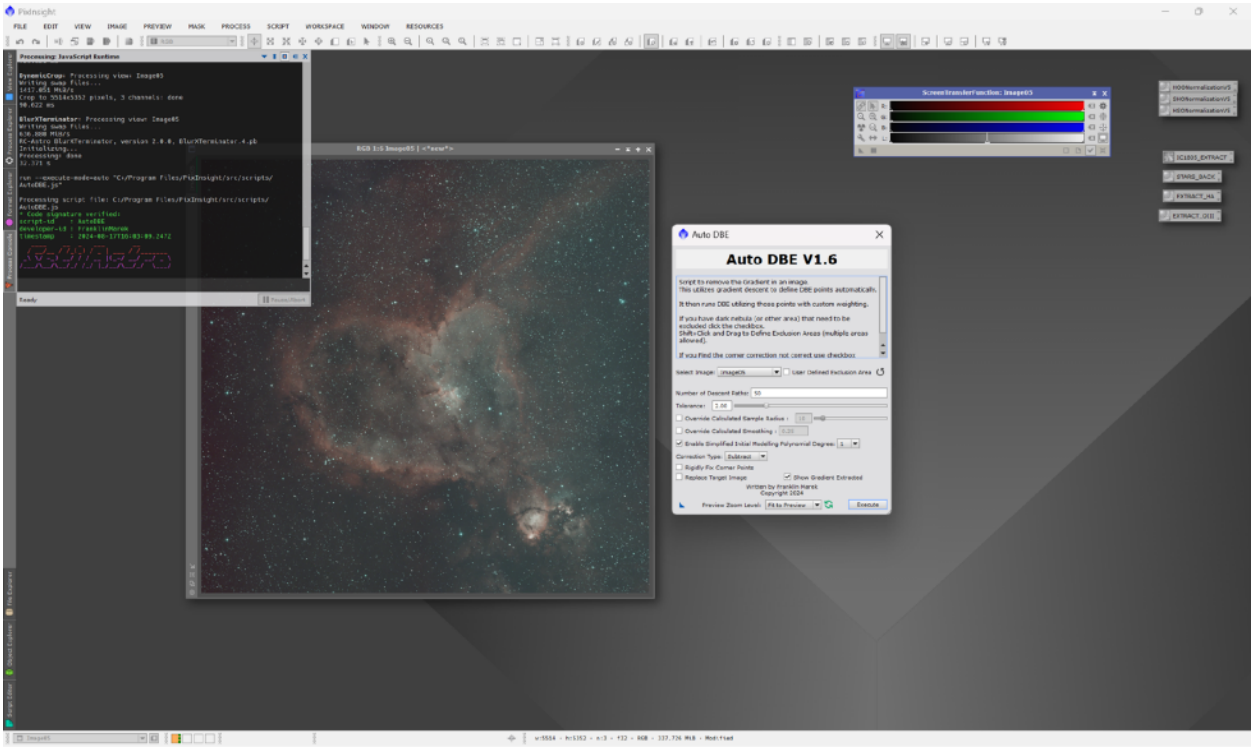


Figure 7

- **Seti Astro Automatic DBE:** Extract the background of the image as shown in figure 7. This removes any remaining gradients that still exist after preprocessing and is essential for a clean final image. The default settings do a very good job and generally do not need to be adjusted.
- Vignetting (halo) choose a polynomial degree of 2 and click execute
- Linear gradient (brighter on one side or corner) choose a polynomial degree of 1 and click execute
- Stretch and inspect the background model to ensure accuracy
- If you have unexpected results, double check the edges of your image for anomalies or remaining stacking artifacts and corrected as needed. If none exist, go to the menu bar at the top and select View > Explorer Windows > History Explorer and then choose your image from the drop down, then double click on DBE. Move any point(s) that were near bright stars, drag the DBE triangle onto the workspace and close out of DBE. Double click on the new DBE process icon, click and drag the triangle onto your image to rerun the process. Ensure you do NOT rerun it on the image labeled (ImageName)_DBE
- Seti Astro Automatic DBE is located in Script > Seti Astro > Automatic DBE

Step 8: Background Preview

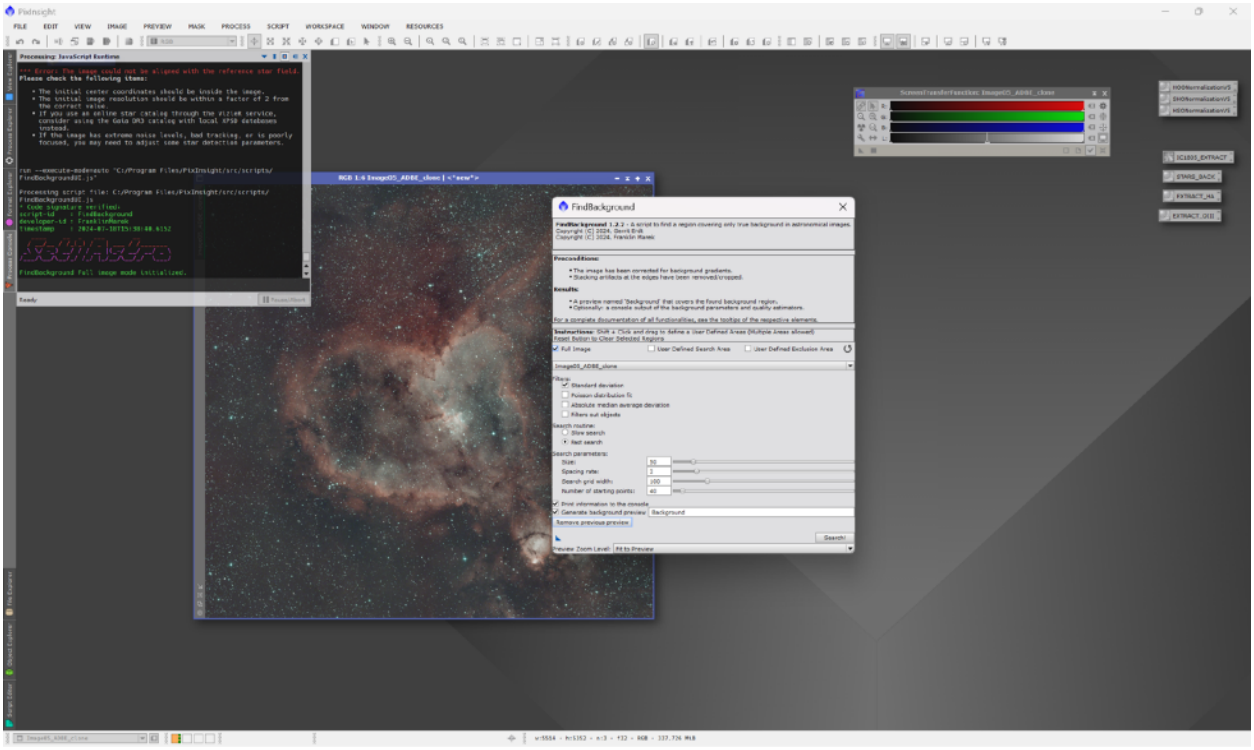


Figure 8

- **Seti Astro Find Background:** Get a preview of the background for reference as shown in figure 8. Seti Astro's Find Background automatically examines your image and chooses the ideal background based on the image data and is allows for idea results in Background Neutralization and SPCC. Open Find Background and click Search. We will select this background int the next step and will need to do this one more time in our workflow.
- Seti Astro Find Background is located in Script > Seti Astro > Find Background

Step 9: Background Neutralization

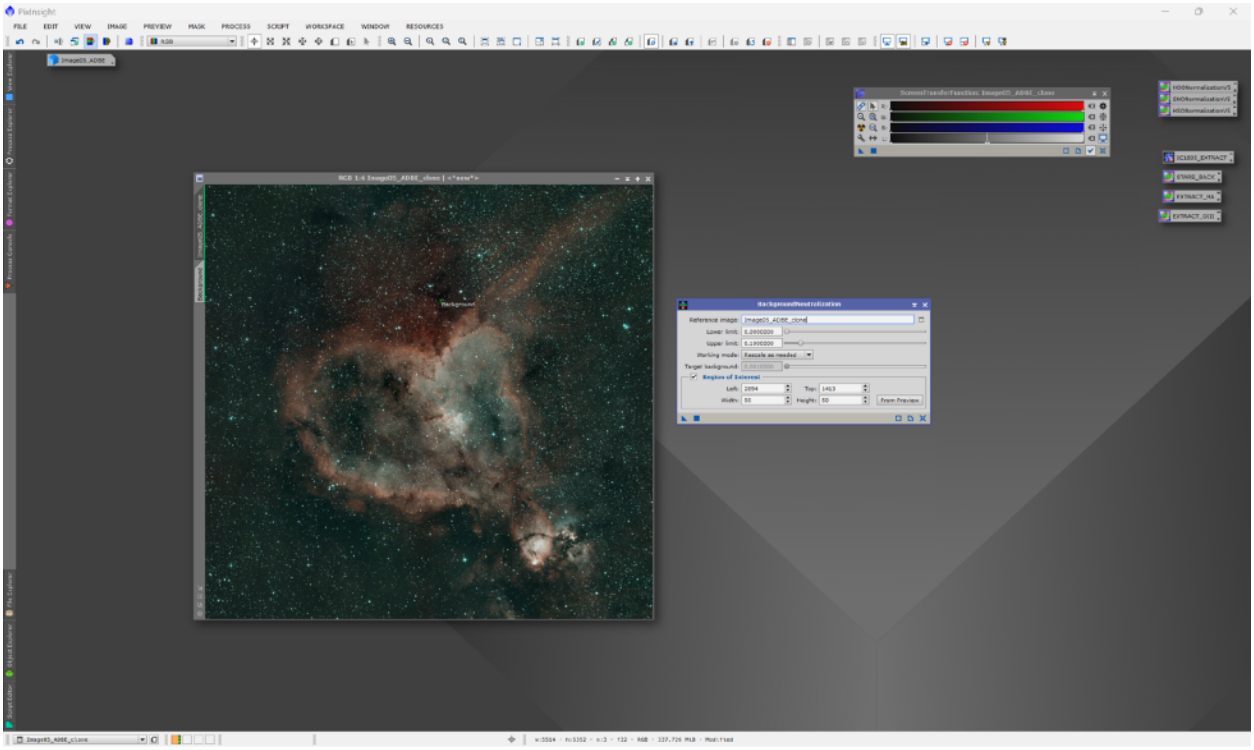


Figure 9

- **Background Neutralization:** Neutralize the background as a final image correction step to get a clean background for final processing as shown in figure 9. There are two steps to operating this process listed below
- **Primary Image Reference:** Use the primary image as a reference for background neutralization. Click the Reference Image dropdown and choose your primary image
- **Region of Interest:** Check the box next to “Region of Interest” and then click the box labeled “From Preview” and select the preview (background we got from Step 8.
- Click the triangle and drag it onto the image.
- Background Neutralization is located in Process > All Processes > Background Neutralization

Step 10: Plate Solve the Image

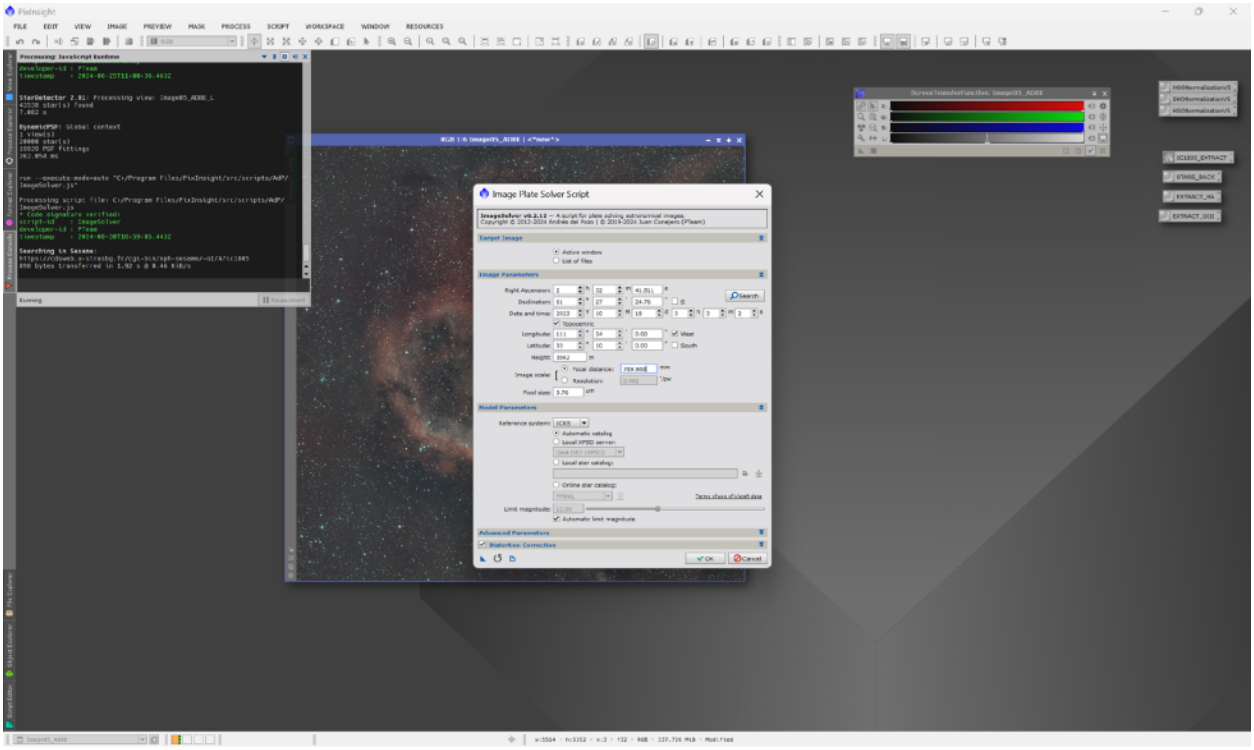


Figure 10

- **Image Solver:** Now we need to reassign the astrometric solution we lost in Step 5 when we cropped the image as shown in figure 10. This examines the stars and plate solves your image, writing this information back into your image's data and allowing PixInsight to know exactly where in the sky your image was taken. This is essential for SPCC as SPCC uses this information to calibrate your image's colors based on the Gaia Observatory database of spectral information. Ensure Target Image is set to Active Window and everything in Image Parameters is accurate. Once confirmed, click search and enter the target ID (IE IC1805) and click enter. Choose the most accurate target information and click OK. Then click OK on the bottom right of the Image Solver window.

Step 11: Clone Image for SPCC

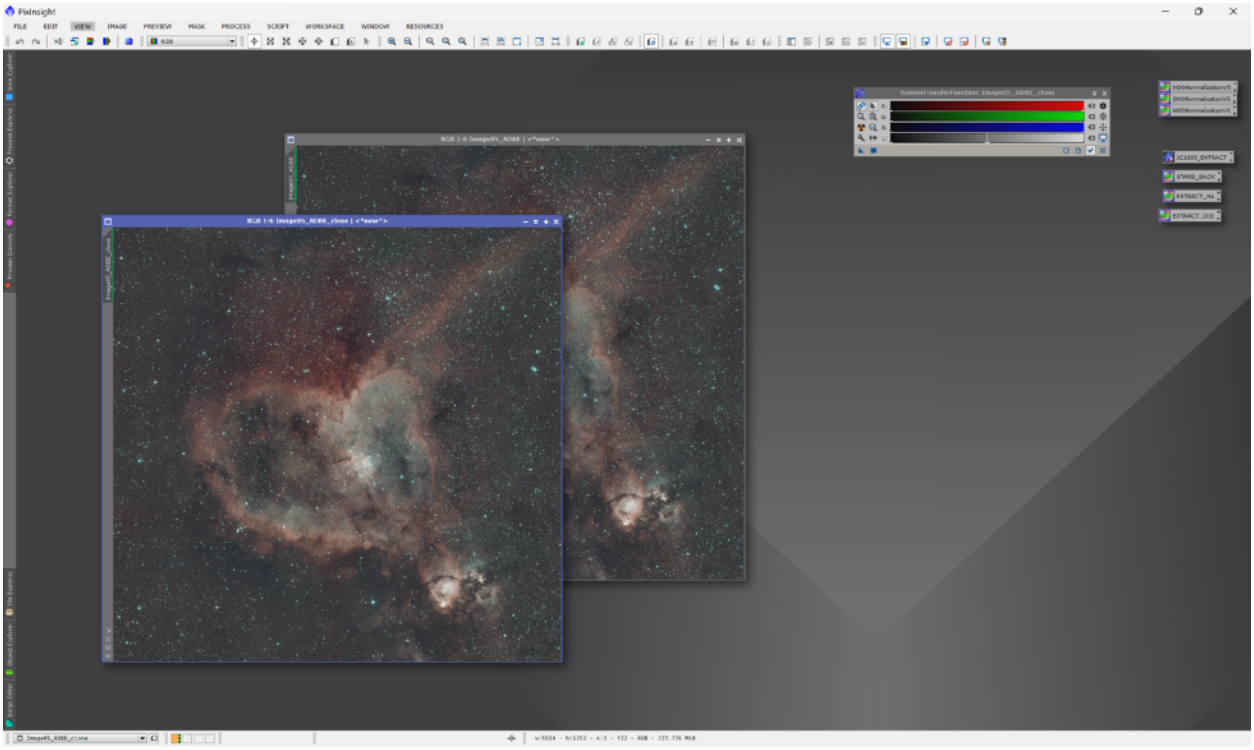
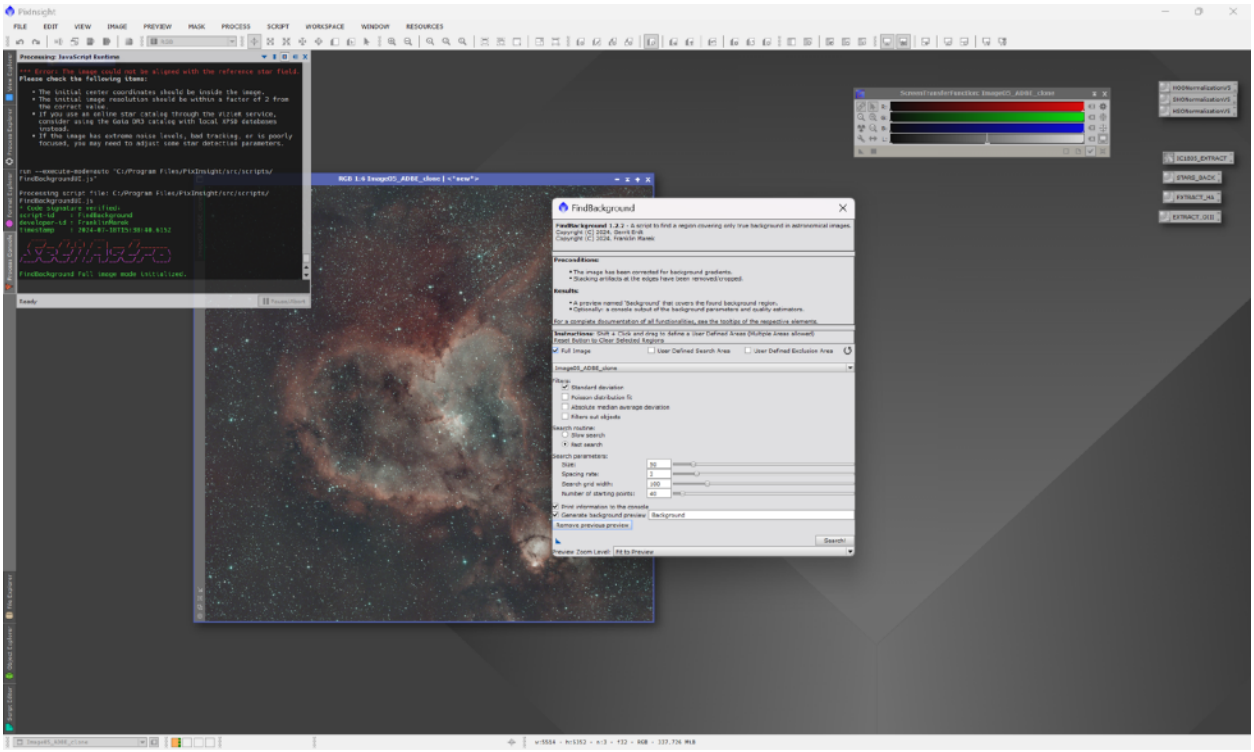


Figure 11

- **Clone for Backup:** Create a clone of the image in case SPCC does not yield the desired colors or results as shown in figure 11. This is also a way to have a false color palette for your image subject and have natural stars within the final image. Click and drag the image tab located on the top of the left wall of your image window and drag it onto the workspace.
- Minimize the clone image and place to the side for use later
- Creating a clone at this stage allows us to clone everything we have done to the image so far.
- Creating Clones is a good way to have a back up between some processes as some processes cannot be undone easily.
- Creating a clone is also useful when you want to process multiple color palettes

Step 12: Background Preview for Neutralized Image



- **Seti Astro Find Background Again:** Extract a background example from the newly background neutralized image. We need a background sample for SPCC, however, the background has changed due to Background Neutralization which means we need to run the script again to get an accurate background example. Repeat the steps from Step 8.
- Seti Astro Find Background is located in Script > Seti Astro > Find Background

Step 13: SPCC (SpectroPhotometric Color Calibration)

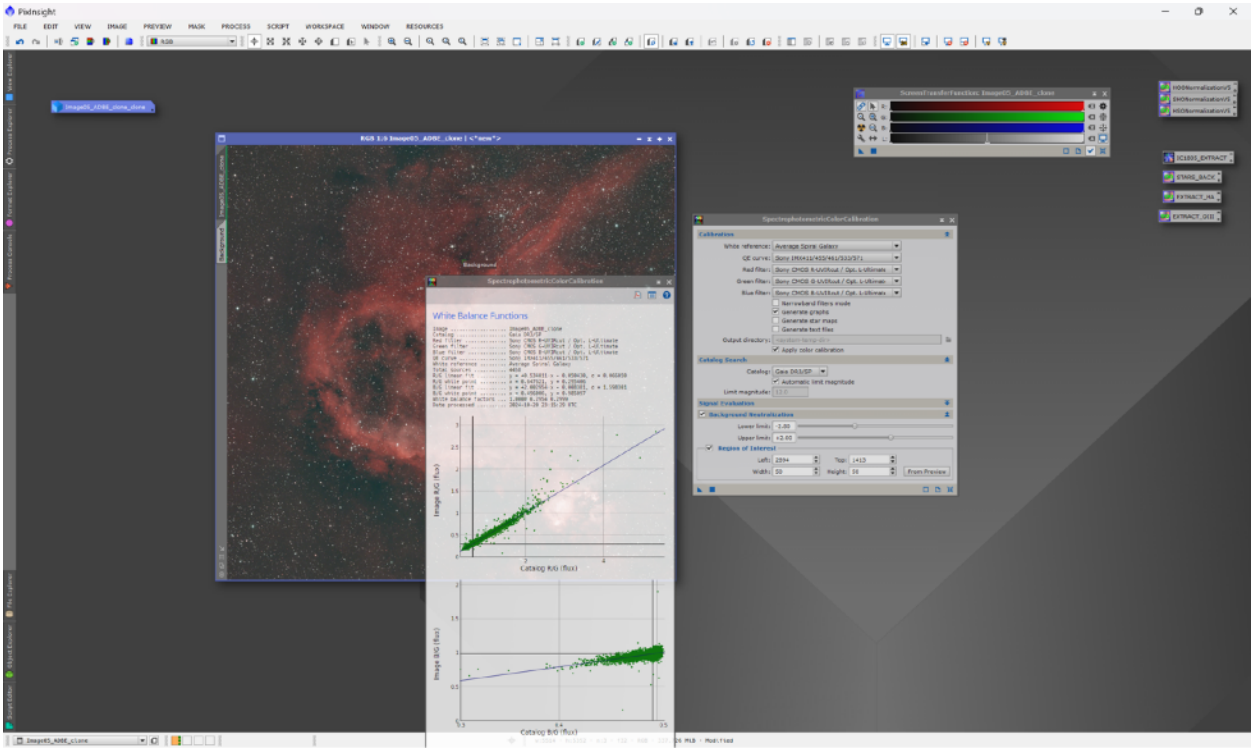


Figure 12

- **SPCC Process:** SPCC (SpectroPhotometric Color Calibration) is a powerful tool that accurately color calibrates your image as shown in figure 12. It uses the astrometric solution to know the exact location in the sky your image was taken and then uses the spectral data gathered by the Gaia Observatory and assigns the exact natural colors based off of the light wavelengths from that location of the universe! Use the QE Cure dropdown to choose your camera sensor. Use the Filter dropdown menus to choose the filter your used for imaging. Click the checkmark next to “Region of Interest” and the click the dropdown to select the preview we created in step 12. Click the triangle and drag it onto your image.
- SPCC is located in Process > All Processes > SpectroPhotometricColorCalibration

Step 14: FWHM Eccentricity

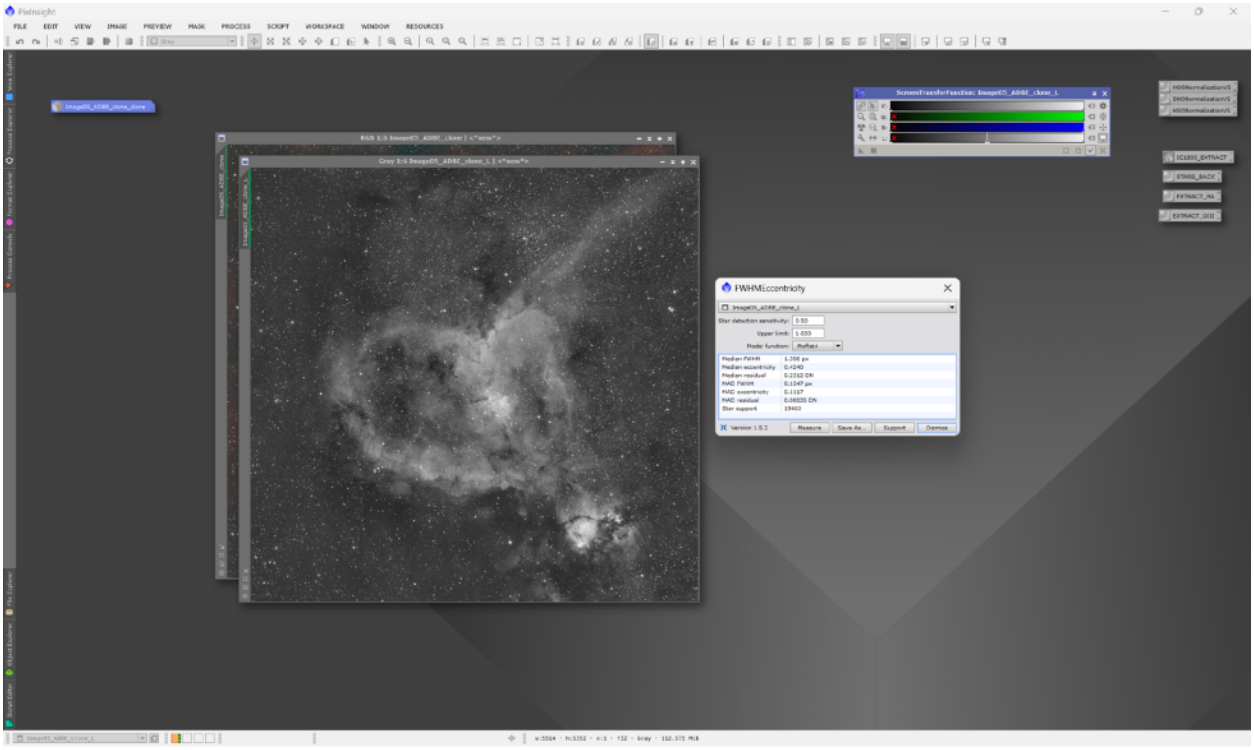


Figure 13

- **FWHM Measurement:** Check the FWHM (Full Width Half Max) values of the image for precise BlurXterminator functionality as shown in figure 13. Extract a Luminance from your image and then go into FWHMEccentricity and click measure. Round the mean FWHM number to the nearest hundredth and notate that number as we will need it in the next step.
- Note that if the hundredth place is a 1 or 2, I will round down and if it is a 3 or higher, I will round up. You can play with this and see what gives you best results
- Note that a Luminance is necessary for the FWHMEccentricity script to function.
- To extract a Luminance from your image click the icon in the toolbar. The icon is located in the toolbar in the first section after the forward and back buttons and is the 3rd icon in this section. The icon is located under the menu bar word “View”
- FWHMEccentricity is located in Script > Image Analysis > FWHMEccentricity

Step 15: Apply BlurXterminator

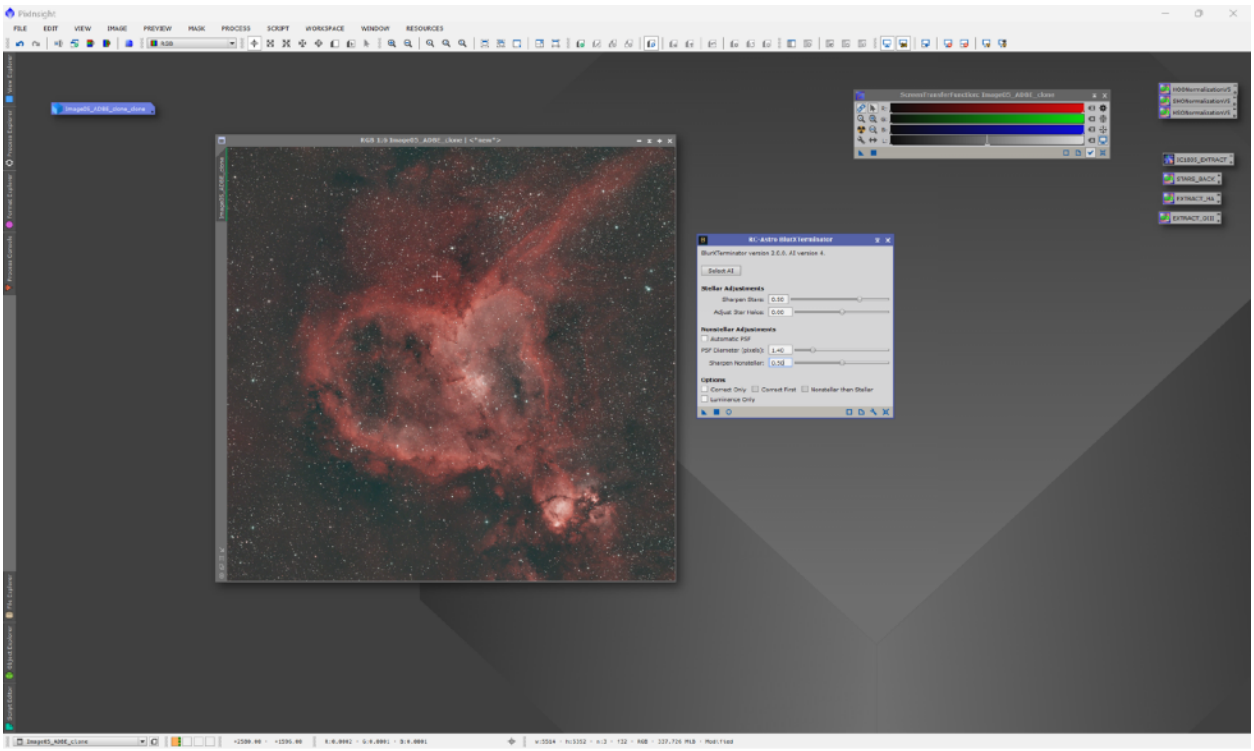


Figure 14

- **Run the Full BlurXterminator:** Now it's time to do a full correction of the stars as shown in figure 14. This does the final correction of the stars to get them ready for final stretching. There are two steps to accomplish this
- **Uncheck Correct Only:** Ensure "Correct Only" located in the lower left of the BlurXterminator process window is unchecked. This allows all options of BlurXterminator to be available.
- **PSF Diameter Input:** Ensure Automatic PSF is unchecked. This allows you to enter a value in PSF Diameter. This is where you will enter the Mean FWHM value you obtained in the FWHM Eccentricity script.
- Click the triangle and drag it onto the image
- BlurXterminator is located in Process > All Processes > BlurXterminator

Step 16: Noise Reduction

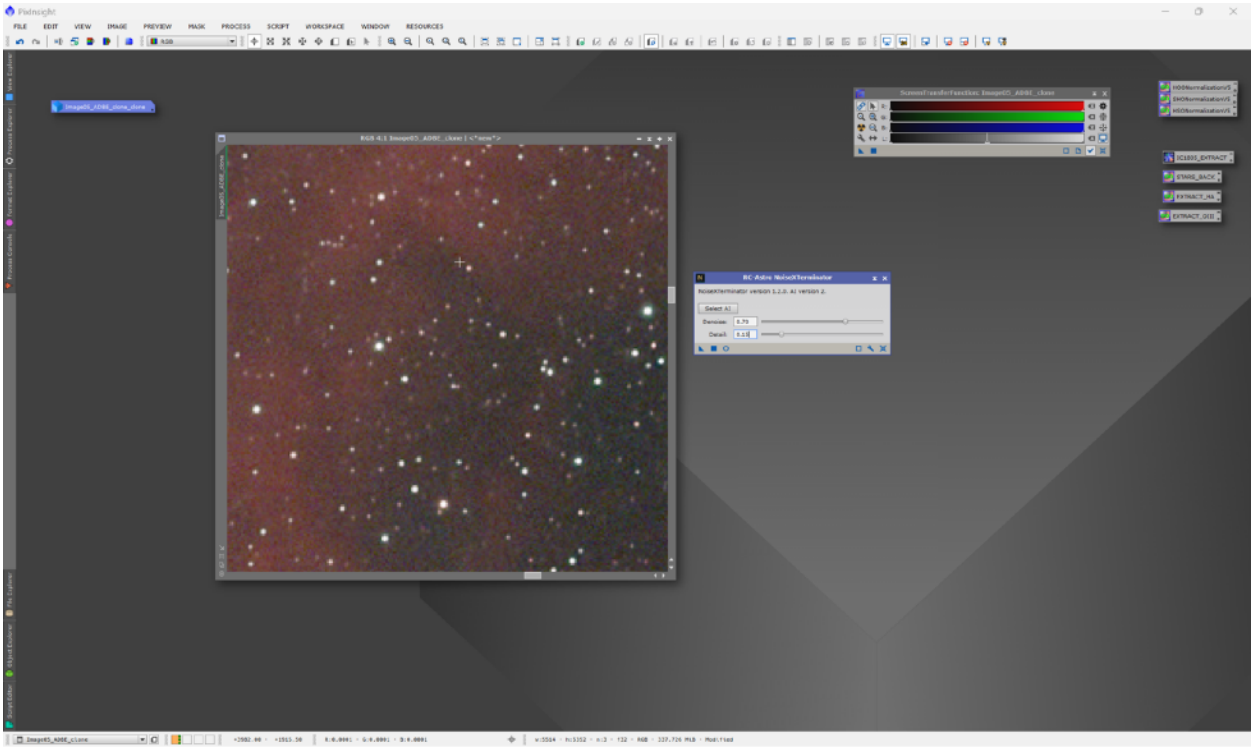


Figure 15

- **NoiseXterminator:** Reduce the noise within the image using NoiseXterminator as shown in figure 15. The goal is to reduce the noise while leaving a small amount. You will need to play with the Denoise setting to achieve desired results. Set your Denoise setting and click the triangle and drag it onto the image.
- Note that you can click back located in the toolbar at the top left of PixInsight if your results are less than desirable and then try again.
- Note generally a Denoise setting of between 0.6 for minor noise and 0.8 for severe noise does a very good job, but results may vary and need to be adjusted.
- NoiseXterminator is located in Process > All Processes > NoiseXterminator

Step 17: Star Removal

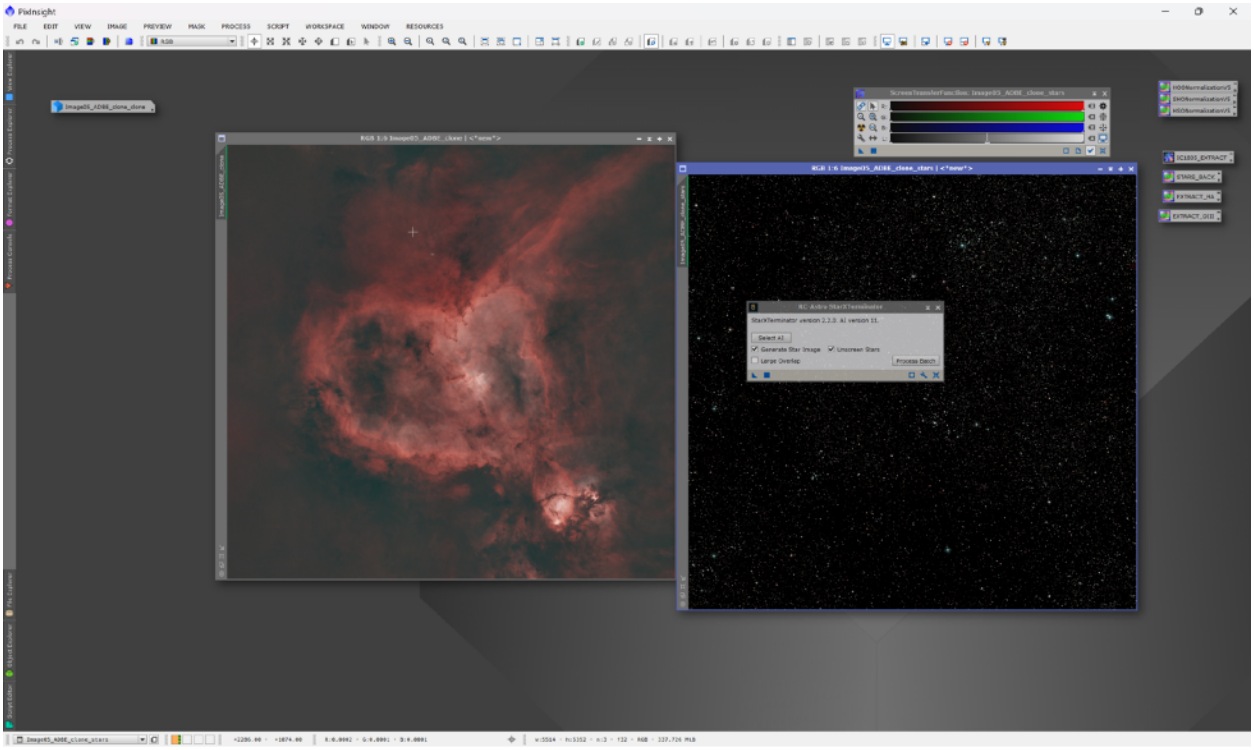


Figure 16

- **StarXterminator:** Use StarXterminator to remove the stars from your image so they can be processed separately from the primary image. The makes processing easier on both ends. Ensure “Generate Star Image” and “Unscreen Stars” is checked. Click the triangle and drag it onto the image.
- StarXterminator is located in Process > All Processes > StarXterminator

Step 18: Repeat on Cloned Image

- **Process Clone:** If you like the image subject’s colors better on the cloned image and want natural looking stars, apply steps 14, 15, 16 and 17 on the cloned image. This get the primary cloned image ready for stretching and ensures the stars are properly removed from the image.

Step 19: Compare the Images

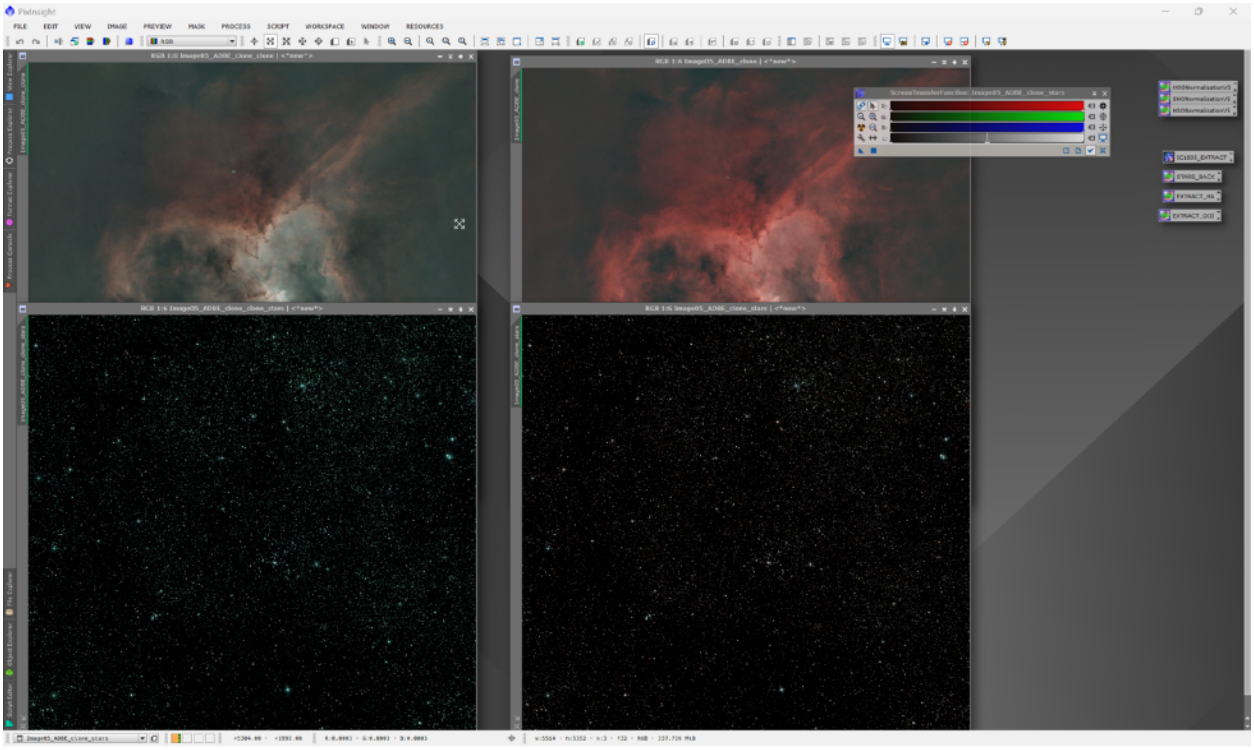


Figure 17

- **Compare the Images:** Figure 17 shows our original color balanced image on the left with its stars image and the SPCC color calibrated image on the right with its star image. For some, the false color palette of IC 1805 as shown on the left might be more appealing than the accurate colors as shown on the right. The stars on the right are natural colors as compared to the more blue hue ones on the left.

Step 19: Compare the Images (continued)

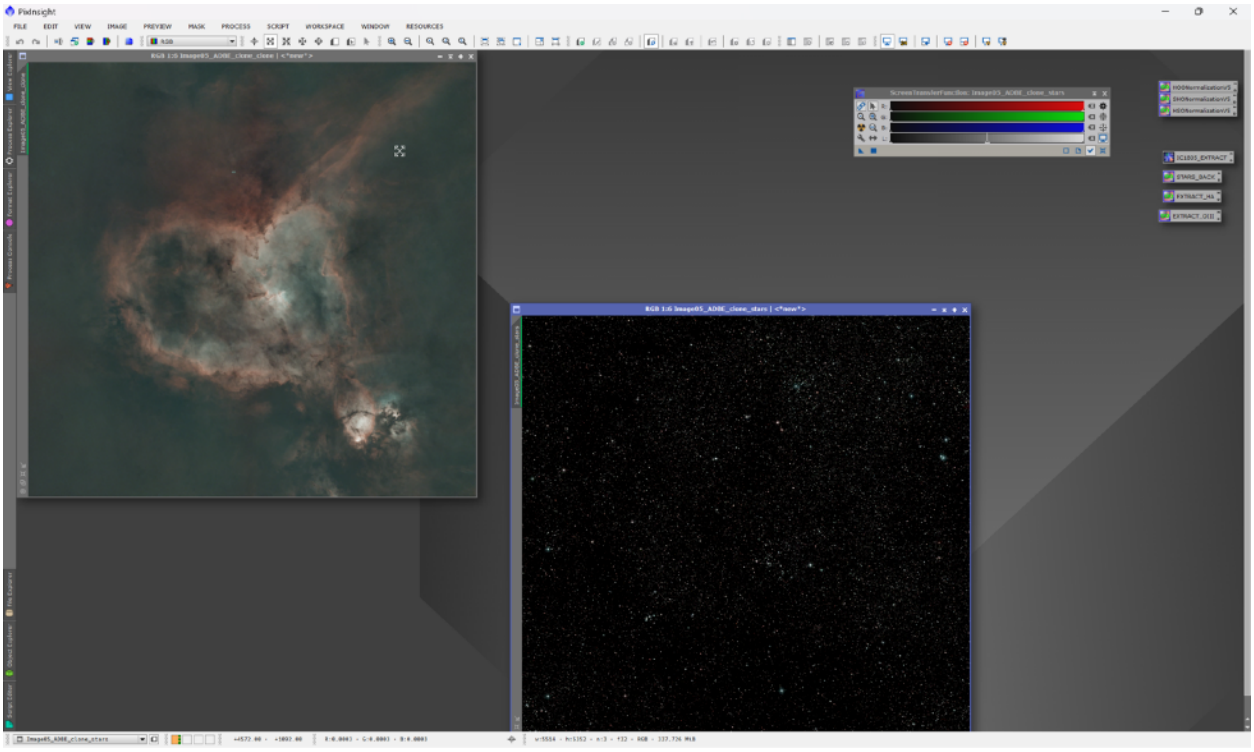


Figure 18

- **Compare the Images (continued):** Figure 18 shows how we chose the false color palette for IC1805 and the natural stars that SPCC produced. The IC 1805 image produced by SPCC and the false color palette stars images were deleted leaving us with a clean workspace to continue processing.
- Note the choice is yours to how you would like to process your image. This is merely an example to cover different options.

Step 20: Stretching the Stars

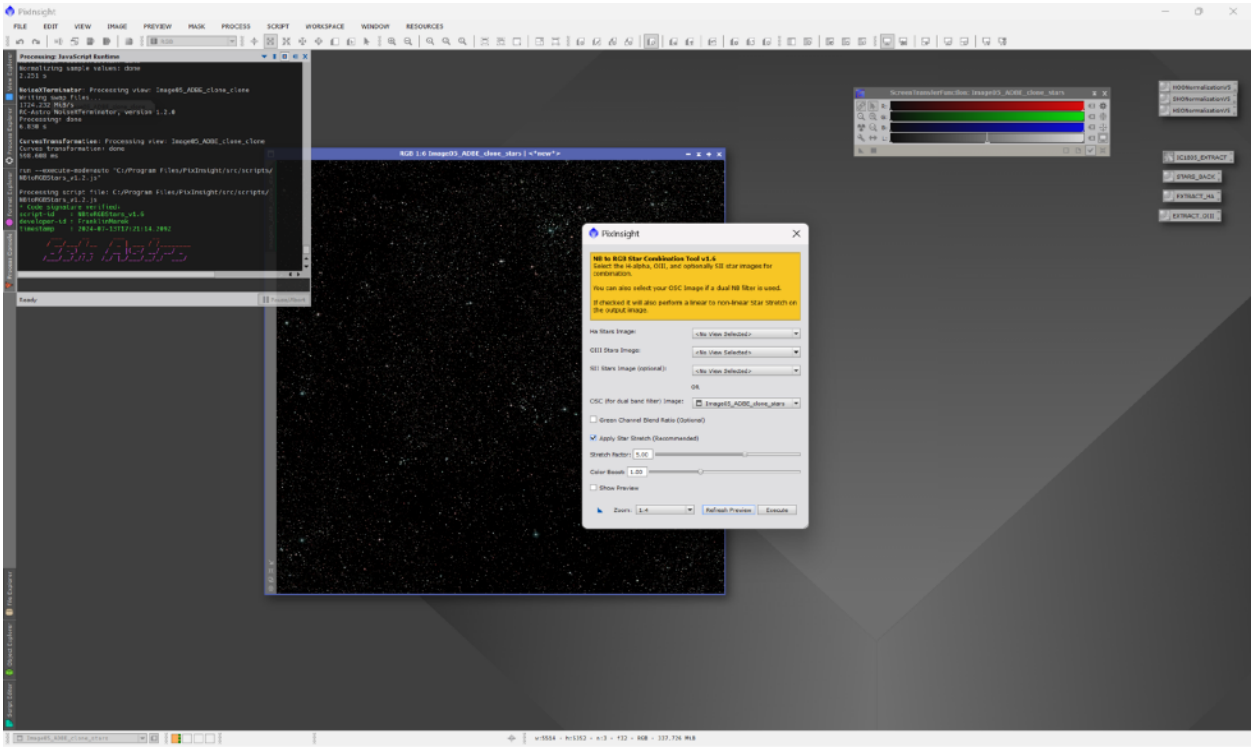


Figure 19

- **Narrowband vs. Broadband:** Depending on the filter used, apply either Seti Astro NB to RGB Stars Combination or the Star Stretch script as shown in figure 19
- If you are using a narrowband type filter such as Optolong L-Ultimate filter and want full natural RGB stars, use Seti Astro NB to RGB Star Combination script. In the "OSC (for dual band filter) image" dropdown, select your star image. Check “Apply Star Stretch” and “Execute”
- Note you are able to check “Show Preview” and adjust the stretching parameters if you wish. The defaults generally do a very good job though.
- If you are using a broadband filter such as Optolong L-Pro, use Seti Astro Star Stretch Script. In the dropdown, select your star image, and click “Execute”.
- Note you are able to check “Show Preview” and adjust the stretching parameters if you wish. The defaults generally do a very good job though.
- Seti Astro NB to RGB Star Combination is located in Script > Seti Astro > NB to RGB Star Combination
- Seti Astro Star Stretch is located in Script > Seti Astro > Star Stretch

Step 21: Stretch Primary Target Image

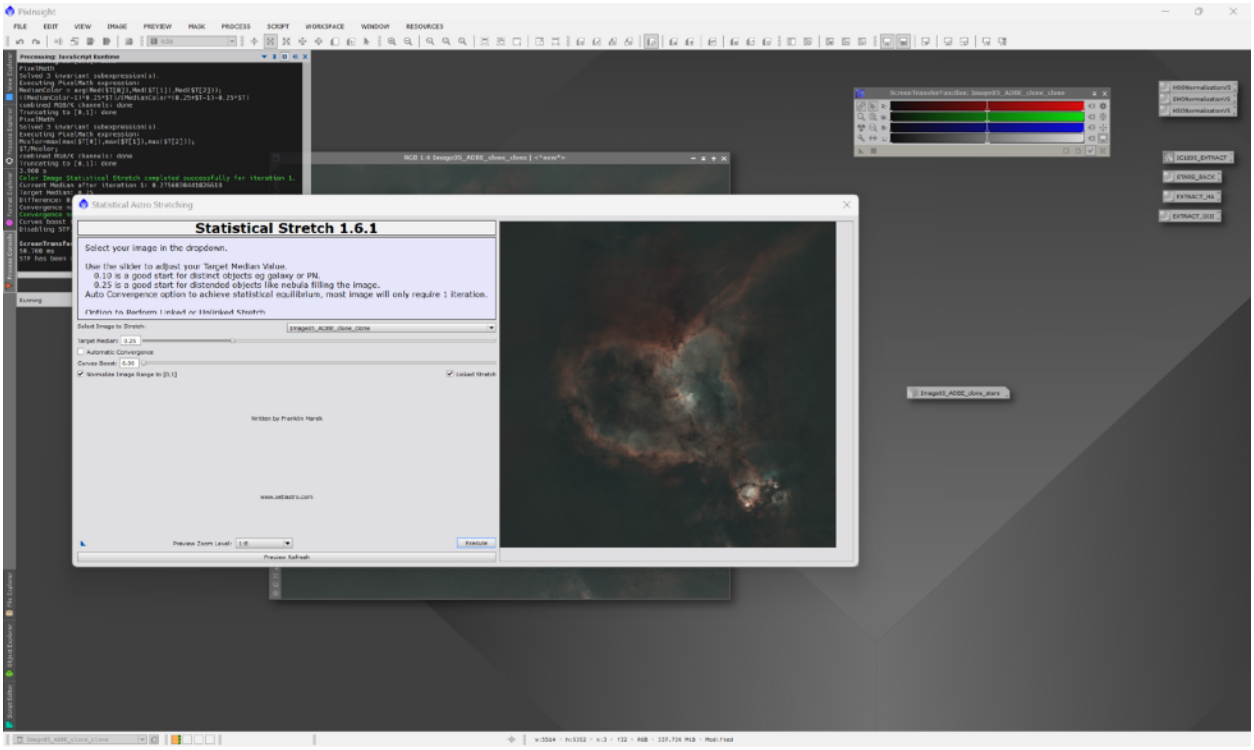


Figure 20

- **Statistical Stretch:** Use Seti Astro Statistical Stretch to perform a permanent stretch on your primary image as shown in figure 20. This script stretches your image based on the image data. Use 0.25 for a nebula that occupies a good portion of the window or 0.10 for a galaxy that takes a small portion of the window and click “Execute”
- Note that you are able to click “Preview Refresh” and adjust the parameters to see what they do. Ensure you click “Preview Refresh” each time you make an adjustment in order to view the changes.
- Note on a nebula image do not worry too much about background brightness as that will be addressed in later steps.

Step 22: Blemish Removal

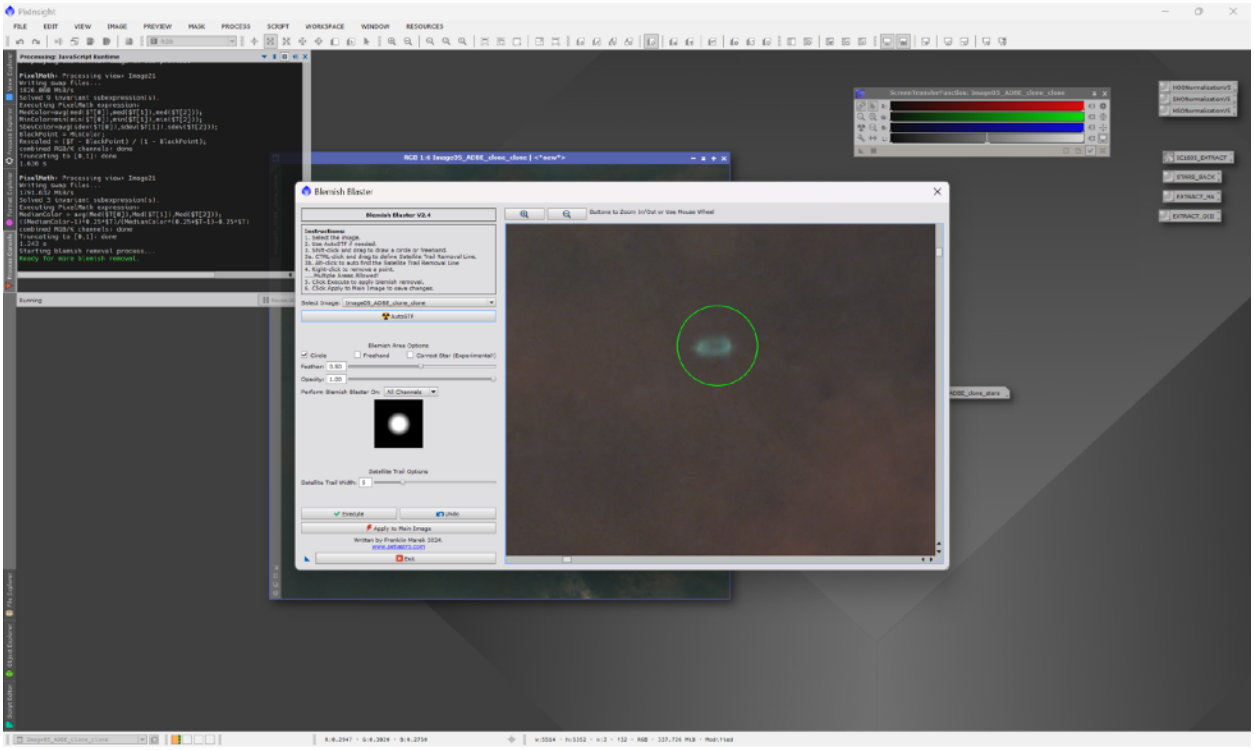


Figure 21

- **Blemish Blaster:** Remove any blemishes from the image using this tool as shown in figure 21. Zoom in or out to locate the blemishes. Once located, line your mouse up with the center of the blemish, hold shift, let click and hold and move the mouse toward the outside of the blemish. You will see a circle forming. Ensure the circle fully encompasses the blemish. Once fully encompassed, let go to the mouse and click execute. Repeat for any remaining blemishes. Click apply to main image when done.
- Note that this process can be done either linear or nonlinear.
- Note, depending on your data, certain blemishes may appear after stretching that did not fully show while in a linear state. With this said, I sometimes prefer to perform Blemish Blaster in a nonlinear state (post stretching).
- Note that if your image is still linear, you will need to click “Auto STF” for the preview to show the image
- Seti Astro Blemish Blaster is located in Script > Seti Astro > Blemish Blaster

Step 23: Adjust Contrast

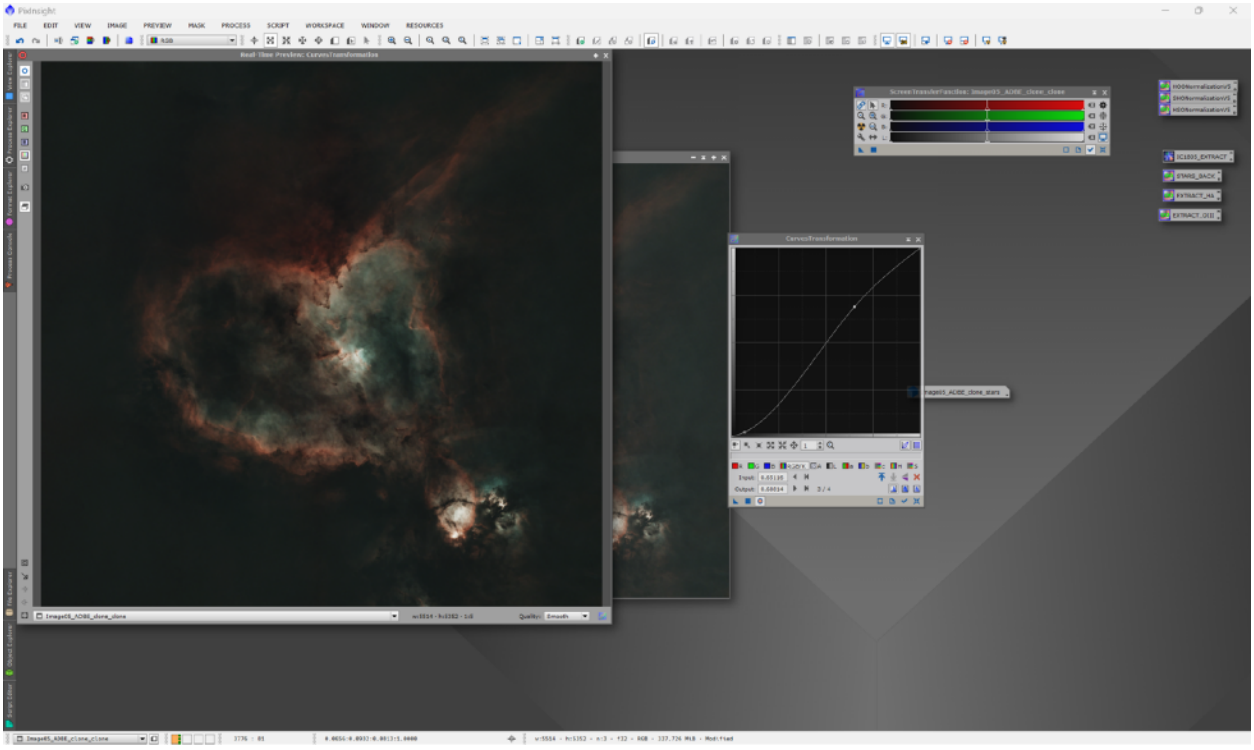
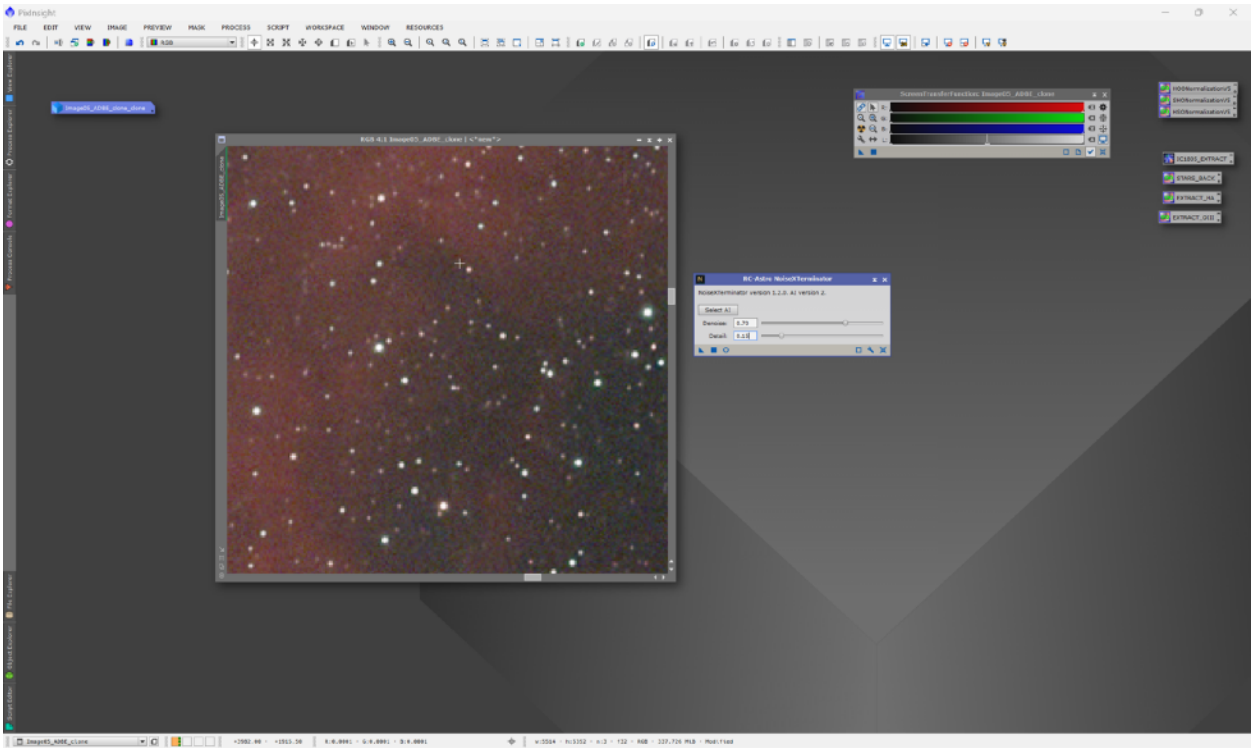


Figure 22

- **Curves Transformation:** Use the RGB/K adjustment within Curves Transformation to adjust contrast to your liking as shown in figure 22. This is the step that will fix a seemingly overly bight background from the Statistical Stretch step. Click the Circle to open a preview and click the reset symbol on the bottom right of the Curves Transformation process window to reset any lingering settings. Drag the bottom left of the curve line down to darken the background or up to brighten and drag the top right of the curve line up to brighten the image subject or down to darken.
- Note if the preview window does not have the process name (IE Curves Transformation) listed on the top of the window, you are not in a live preview). Click the circle in the Curves Transformation process window to toggle live preview on and off. Toggling live preview on and off is also a good way to check before and after to see what your adjustments do to your image.
- When you are happy with an adjustment, click the square to apply. Do little adjustments at a time, accept when you are happy and repeat until done.
- Curves Transformation is located in Process > All Processes > Curves Transformation

Step 24: Noise Check



- **Noise Assessment:** Review the image for any added noise due to stretching and curves adjustment and use NoiseXterminator as needed, being careful not to overdo it. You should only need very subtle application if any at all.
- If you need to take care of any noise, follow step 16
- NoiseXterminator is located in Process > All Processes > NoiseXterminator

Step 25: Multiscale Linear Transform

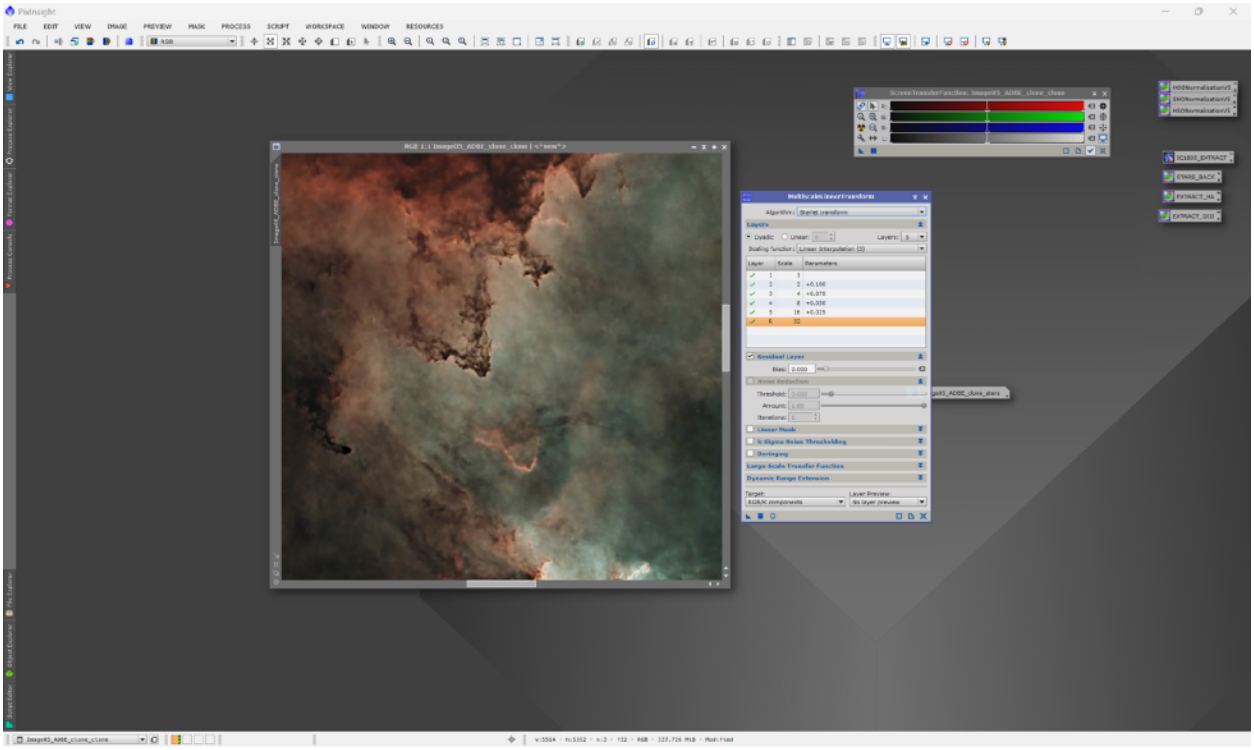
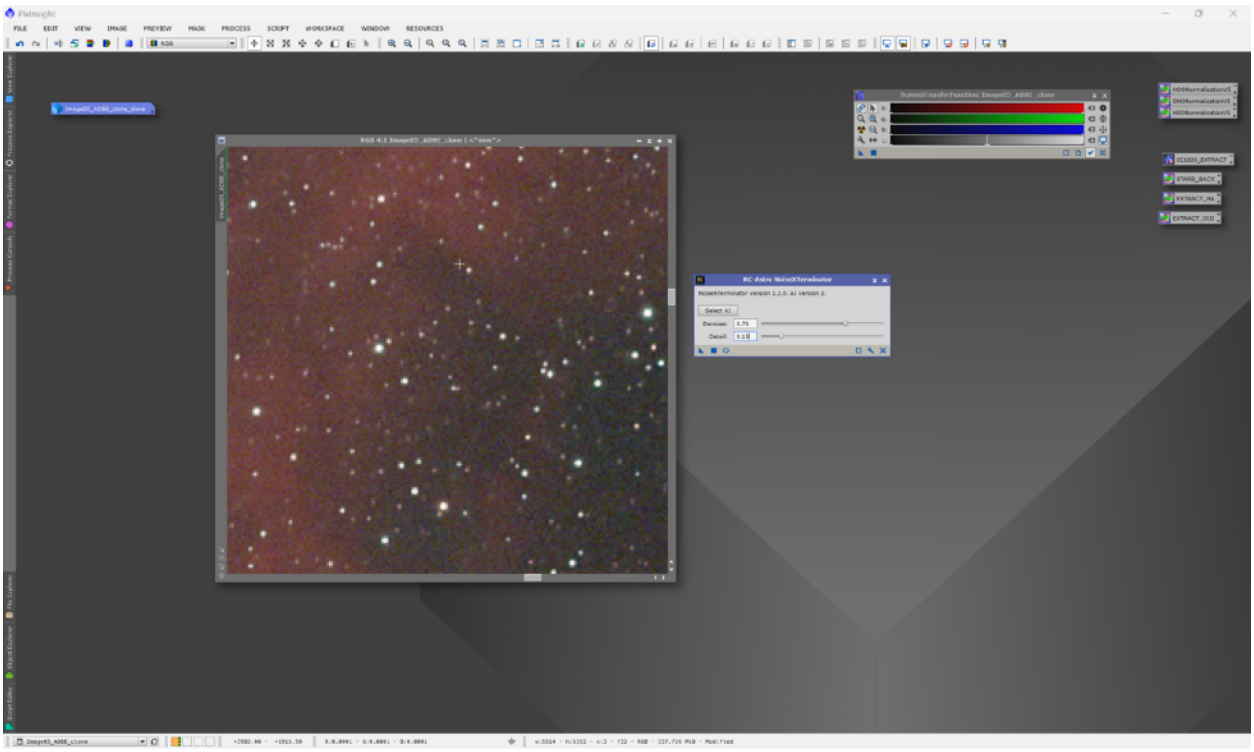


Figure 23

- **MultiScale Linear Transform:** Use this tool to sharpen the image as shown in figure 23. This is a powerful tool that works with the image's wavelets. There are a couple of steps to work with this tool as listed below
- **Add Layer:** Use the dropdown near the top right called "Layers" to add a layer and choose 5. Your image window should now have layers 1-5 and a Residual layer called "R"
- **Set Layer Parameters:** Click on the layer to highlight it and then adjust the bias number for each layer. The bias is located in the section below the layers called "Residual Layer. A good starting point for parameters is as follows: Layer 5 "0.025", layer 4 "0.05", layer 3 "0.075", layer 2 "0.1". Click the triangle and drag it onto the image.
- Note that if you do not like the results you can click the back button located in the tool bar at the top left of PixInsight and then adjust the parameters.
- Note that if the results are unexpected, double check the bias input and ensure layers 3-5 have a 0 in the 10ths position.
- Multiscale Linear Transform is located in Process > All Processes > Multiscale Linear Transform

Step 26: Final Noise Check After Sharpening



- **Final Noise Reduction:** Sharpening adds noise to an image. Reassess for noise post-sharpening and apply NoiseXterminator as needed, being careful not to overdo it. You should only need very subtle application if any at all.
- Depending on the data, you can end up with more severe noise after sharpening in which you will need a higher Denoise value. Just ensure you are leaving a little bit of noise after the NoiseXterminator application.
- Note that if you do not like the result, you can click the back button located in the toolbar in the top left of PixInsight
- If you need to take care of any noise, follow step 16
- NoiseXterminator is located in Process > All Processes > NoiseXterminator

Step 27: Saturation Adjustment

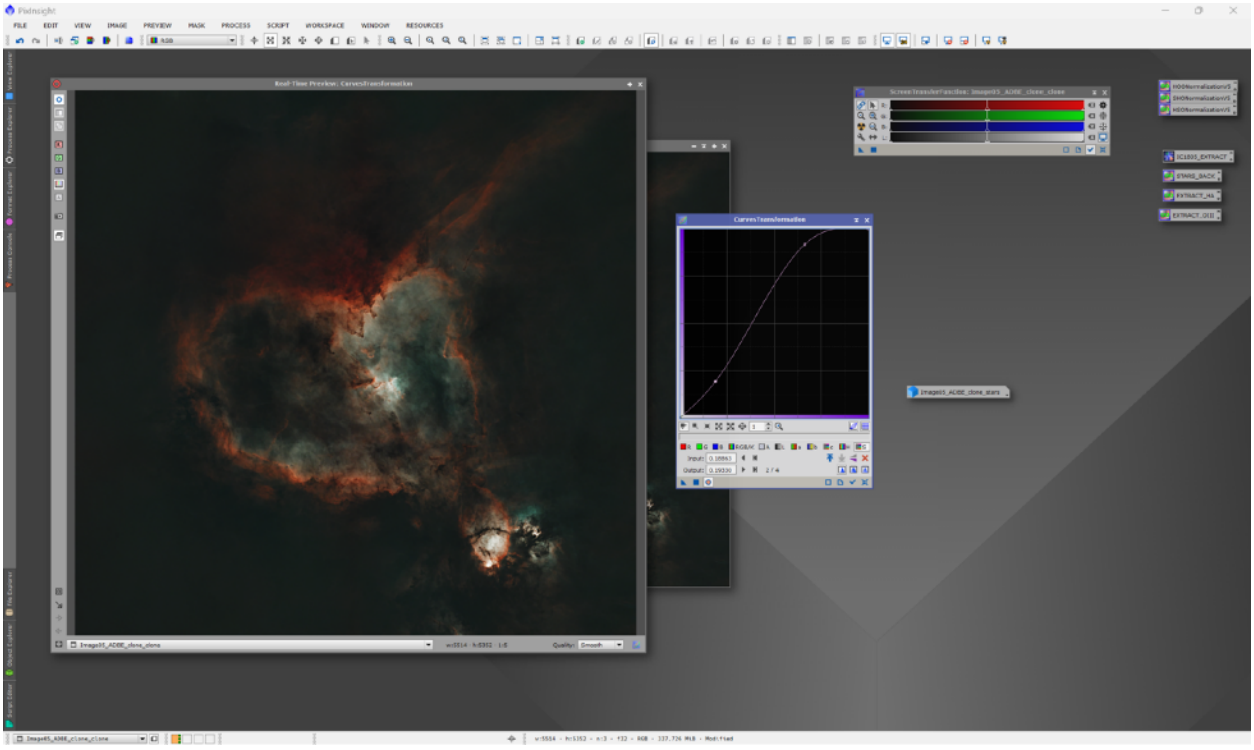


Figure 24

- **Curves Transformation:** Adjust saturation levels to your preference using the Saturation adjustment in Curves Transformation as shown in figure 24. Click the Circle to open a preview and click the reset symbol on the bottom right of the Curves Transformation process window to reset any lingering settings. Making nice “S” curves is common practice with this, however, it depends on your data and taste. This part is completely up to you and how much saturation you want in your image.
- Note if the preview window does not have the process name (IE Curves Transformation) listed on the top of the window, you are not in a live preview). Click the circle in the Curves Transformation process window to toggle live preview on and off. Toggling live preview on and off is also a good way to check before and after to see what your adjustments do to your image.
- When you are happy with an adjustment, click the square to apply. Do little adjustments at a time, accept when you are happy and repeat until done.
- Curves Transformation is located in Process > All Processes > Curves Transformation

Step 28: Add Stars Back into Image

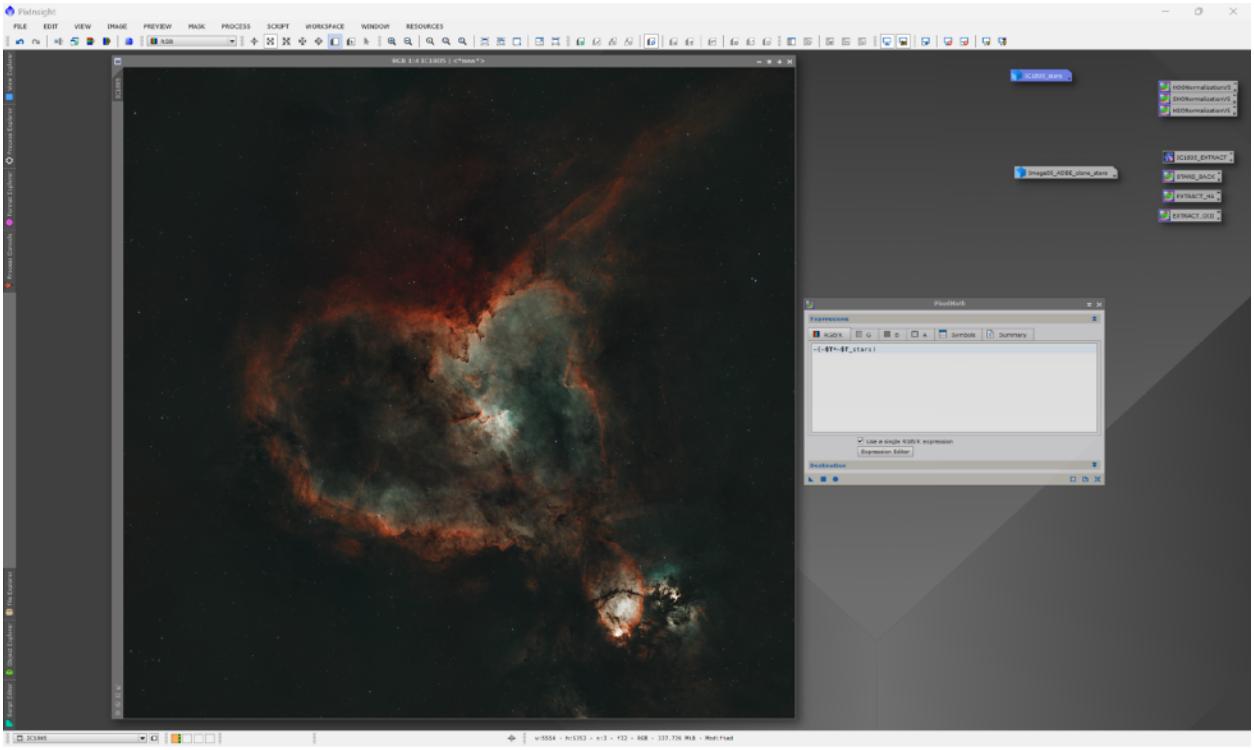


Figure 25

- **Pixelmath Formula:** We will use PixelMath to place our stars back into the image. Open PixelMath and enter following formula to reinsert the unscreened stars back into the image: ~(~$T*~$T_stars). Click the triangle and drag it onto the image.
- Note that the stars image must contain the (primary image's name)_stars. For example it is helpful to name our primary image to something of our choosing and then incorporate that into our stars image name.
    - Primary Image example: IC1805
    - Stars Image example: IC1805_stars
- Note that it might be a good idea to click destination at the bottom of the PixelMath process window and select "Create New Image" prior to dragging the triangle onto the image. This creates a new image instead of overwriting your original image, making it easier to go back in case something unexpected happens.
- PixelMath is located in Process > All Processes > PixelMath