

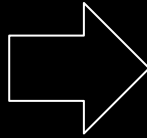


LU^Astro **Siril Processing**



What Is 'Processing'?

Raw data from camera sensors must be interpreted to form an image. By default, astronomy data is in monochrome, and has to be “debayered” to form a colour image.



Typical phone cameras can process images automatically, but sometimes with poor or detrimental results.

Processing software

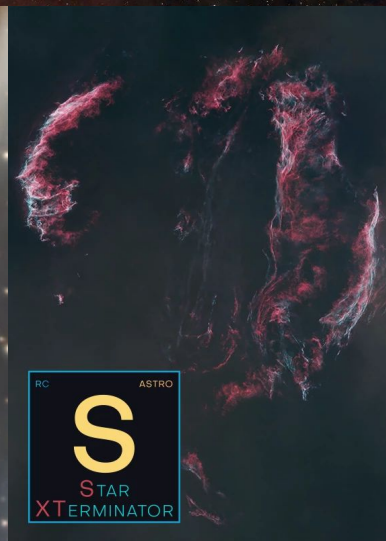
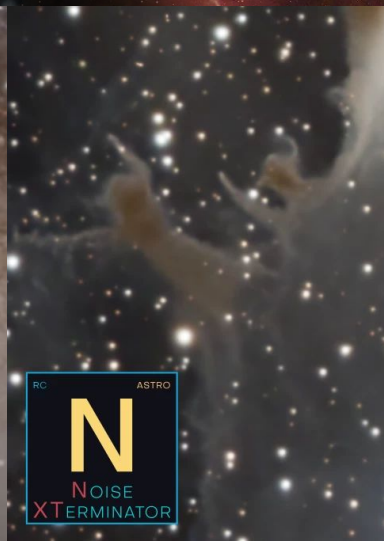
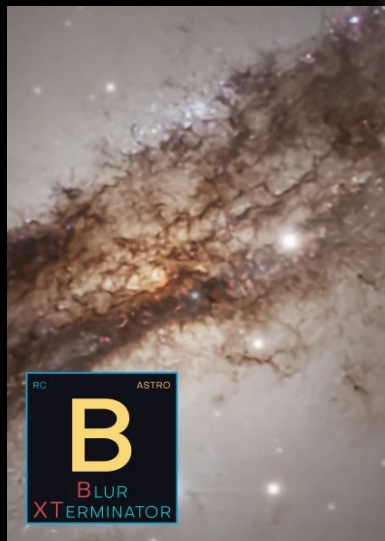


PixInsight



The PixInsight software license costs €300. (£251.77 January 2025)

BlurXT, NoiseXT, StarXT cost \$99.95, \$59.95 and \$59.95. (£81.92, £49.13)

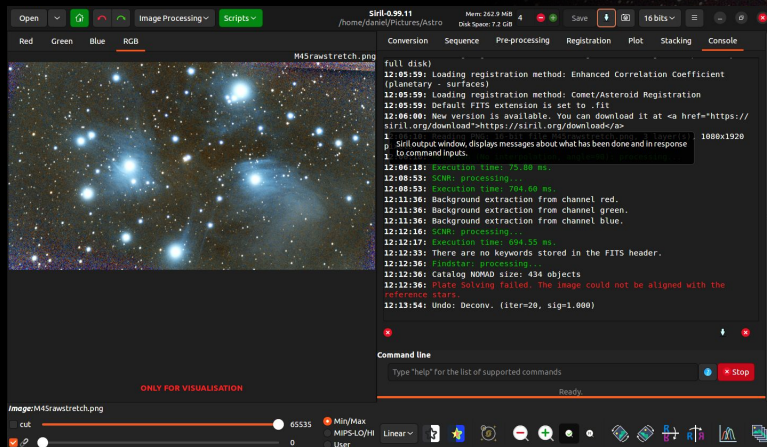


£431.95!

Siril

Siril is free and open source, as are StarNet and GraXpert.

StarNet is a good substitute for StarXT. GraXpert can be used for denoising.



C. Richard et al., Journal of Open Source Software, 2024, 9(102), 7242. DOI: <https://doi.org/10.21105/joss.07242>

Examples

John Ray

These were both taken with the RedCat 51 scope, and processed purely in an older version of Siril, with a couple of tweaks in PhotoShop. These were some of my first attempts at processing.



NGC 1499 California Nebula

M31 Andromeda Galaxy

Examples

John Ray

These are more recent reprocessed results. I stretched both images much more strongly with Asinh transforms this time (this helps darken the background relative to nebulosity), used GraXpert software to further denoise the images, and StarNet software to reduce stars (which makes nebulosity more clear).



Examples

Finlay Daniel-M^cKeigue

Seestar S50, Siril, Pixlr E

Jupiter



NGC 1976 Orion Nebula



C49 Rosette Nebula



NGC 1952 Crab Nebula



Examples

The same data can be processed very differently.

John's image is sharper, and perhaps more true to what a human eye might see.

Finlay's image has been stretched to show the fainter dust, revealing details that otherwise would not be seen.



John Ray



Finlay Daniel-McKeigue

Processing & Setup



Downloading the data

After ensuring that you have Siril downloaded on your device, you can now download the data.

Astronomical data is usually stored in “.fit” files, which are usually quite large (one observing night can yield up to 10GB in files), and so will take time to download.

The data can be downloaded by visiting the link below:

www.luastro.space/documents/Siril-data/

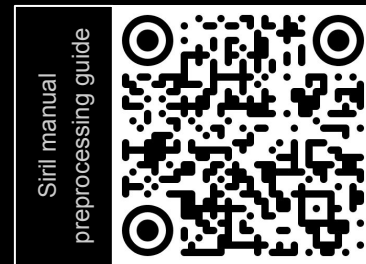
Or by scanning the QR code on the right:



Preprocessing

Before the data can be processed into an image, all of the subframes should be combined - 'stacked' - into one file. Your subframes will be one of four types.

- Lights - exposures of your target
- Calibration Frames
 - Biases - very short exposures with the lens cap left on
 - Darks - exposures with the lens cap left on
 - Flats - exposures of an even bright surface



BIAS

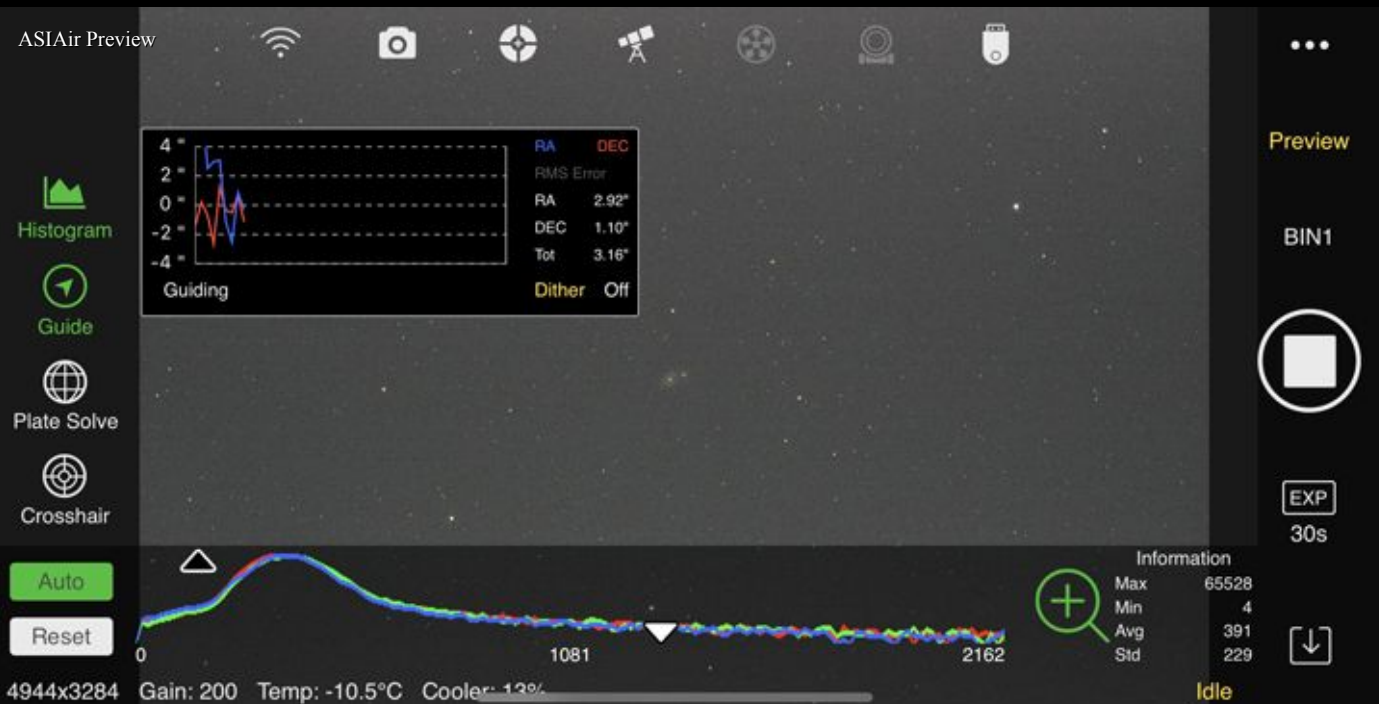
DARK

FLAT

LIGHTS

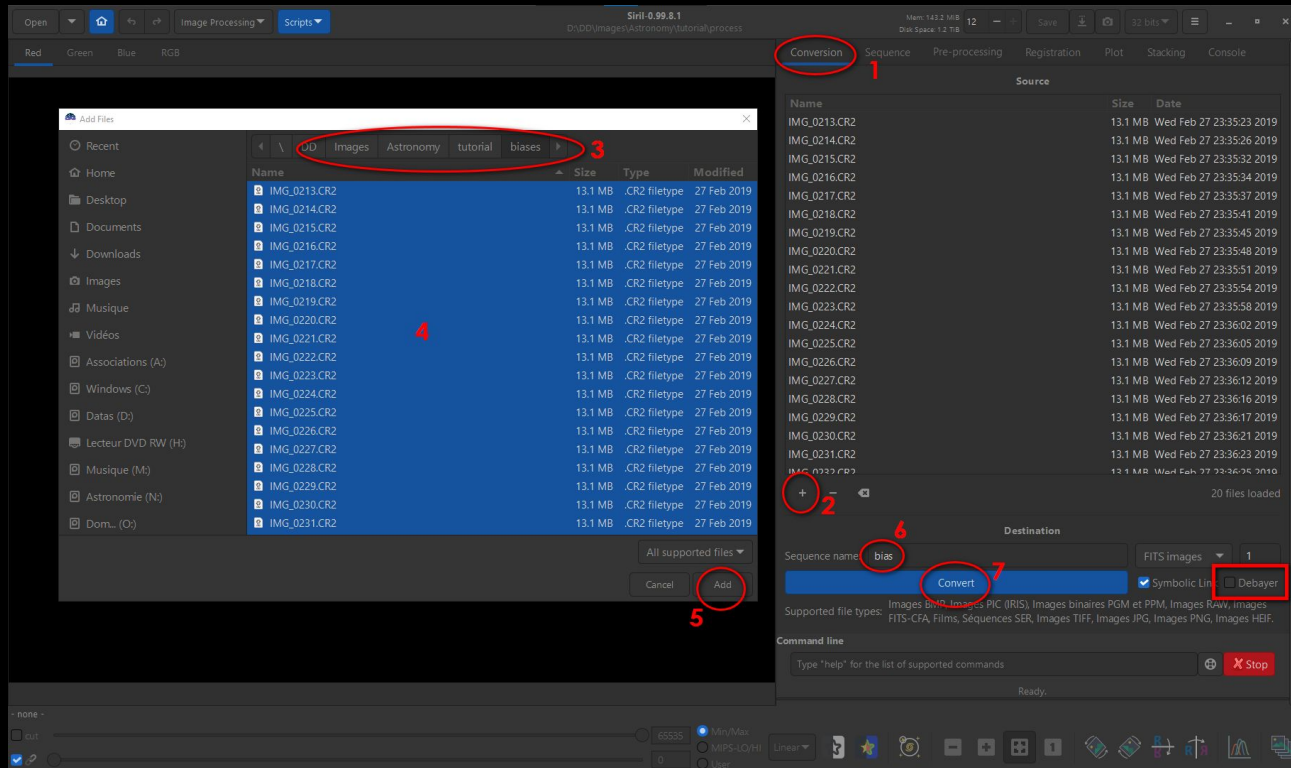
Stretching

M45 Pleiades



Setting a directory, and converting files to sequences

Home button



Pre-Processing Biases

Stacking inputs for Bias
frames



Conversion **Sequence** Pre-processing Registration Plot **Stacking** Console

Sequence stacking

Methods: Average stacking with rejection

Normalisation: No normalisation ☐ Recompute ☐ Output Normalisation

Rejection:

Winsorized Sigma Clipping

Sigma low: 3.000

Sigma high: 3.000

Stacking 11 images of the 11 of the sequence

all

Save in: bias_stacked.fit ☒ Overwrite

Start stacking

Pre-Processing Flats

First, the biases are subtracted from each flat, then the flats themselves are stacked.

Conversion Sequence **Pre-processing** Registration Plot Stacking Console

Dark, offset (bias) and flat files can only be a single FITS file.

☒ Use offset

☐ Use dark ☐ Optimization

☐ Use flat ☒ Equalize CFA

☒ Auto evaluate normalisation value

☐ Fix X-Trans AF artifact

Cosmetic correction (using master-dark)

☒ Enable Cosmetic Correction

☒ Cold Sigma: ☒ Hot Sigma: ☒ CFA

Cold: 0 px Hot: 0 px

Output sequence

Output prefix:

☐ Debayer before saving

Conversion **Sequence** Pre-processing Registration Plot **Stacking** Console

1

Sequence stacking

2

Methods: Average stacking with rejection ▼

Normalisation: Multiplicative ▼ ☐ Recompute ☐ Output Normalisation

Rejection: Winsorized Sigma Clipping ▼ 3

Sigma low: 3.000

Sigma high: 3.000

Stacking 11 images of the 11 of the sequence

all ▼

Save in: ☒ Overwrite

4

Start stacking

Pre-Processing Darks

Stacking inputs for Dark
frames



Conversion **Sequence** Pre-processing Registration Plot **Stacking** Console

Sequence stacking

Methods: Average stacking with rejection

Normalisation: No normalisation ☐ Recompute ☐ Output Normalisation

Rejection: Winsorized Sigma Clipping

Sigma low: 3.000

Sigma high: 3.000

Stacking 20 images of the 20 of the sequence

all

Save in: dark_stacked.fit ☒ Overwrite

Start stacking

Pre-Processing Lights (the fun ones)

Pre-processing inputs for
Light frames



Conversion **Sequence** **Pre-processing** Registration Plot Stacking Console

1 2

Dark, offset (bias) and flat files can only be a single FITS file.

☐ Use offset

☒ Use dark D:\DD\Images\Astronomy\tutorial\process\dark_

☒ Use flat D:\DD\Images\Astronomy\tutorial\process\pp_fli

☒ Auto evaluate normalisation value 5000

☐ Fix X-Trans AF artifact

Cosmetic correction (using master-dark)

☒ Enable Cosmectic Correction

☒ Cold Sigma: 1.000 - + ☒ Hot Sigma: 1.600 - + ☒ CFA

Estimate Cold: 113 px Hot: 123 px

Output sequence

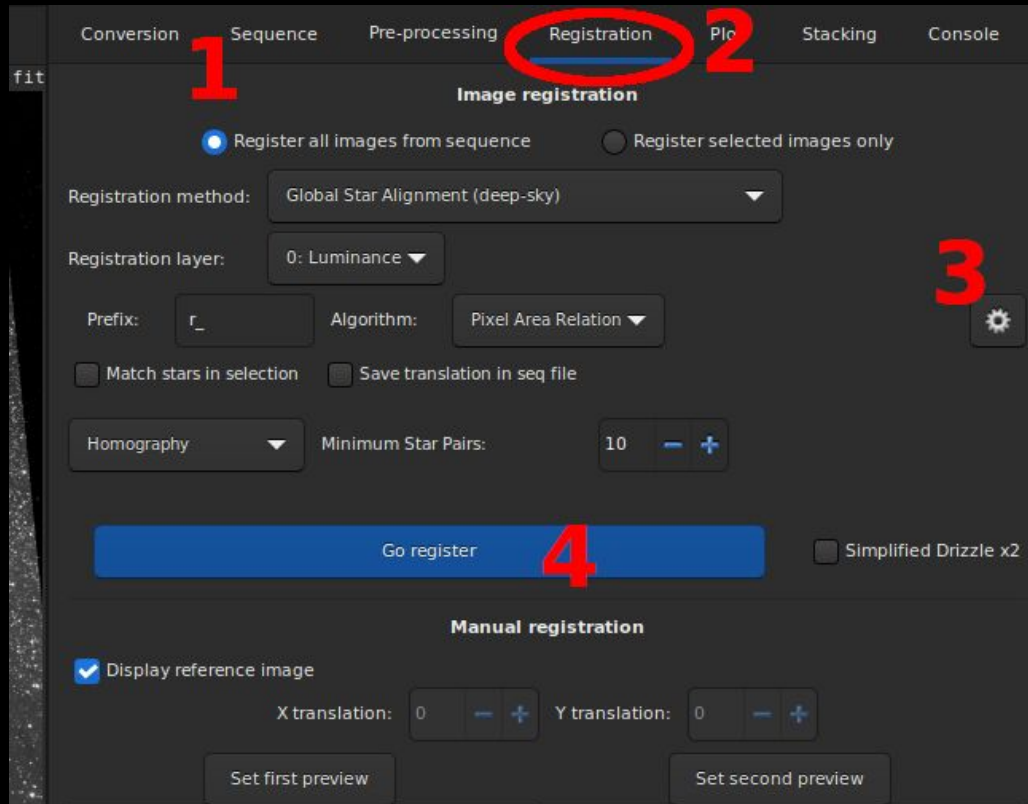
Output prefix: pp_ FITS images

Start pre-processing ☒ Debayer before saving

3 4 5 6

Registration / star alignment

Inputs for registering
Light frames



Analysing images / removing outliers

Occasionally due to light pollution, errors with scope alignment, vibrations near the telescope, etc. some final frames may be less accurate than others.

This step is where we can remove these frames, before finally stacking the images.



Stacking the Images

Inputs for stacking the
Light frames



The screenshot shows the 'Stacking' tab of a software interface. The tabs at the top are Conversion, Sequence, Pre-processing, Registration, Plot, Stacking, and Console. The 'Stacking' tab is selected and circled in red, with a red '2' next to it. Below the tabs, the 'Sequence stacking' section is visible. A red '1' points to the 'Sequence' tab. The 'Methods' dropdown is set to 'Average stacking with rejection'. The 'Normalisation' dropdown is set to 'Additive with scaling', with checkboxes for 'Recompute' and 'Output Normalisation'. The 'Rejection' dropdown is set to 'Winsorized Sigma Clipping', with a red '3' next to it. The 'Sigma low' and 'Sigma high' fields are both set to 3.000. The 'Stacking 16 images of the 19 of the sequence' section has a dropdown set to 'selected' and a '+' button, with a red '5' next to it. The 'Save in:' field is set to 'r_bkg_pp_light_stacked.fit', with a checked 'Overwrite' checkbox. A large blue 'Start stacking' button is at the bottom, with a red '4' next to it.

Conversion Sequence Pre-processing Registration Plot **Stacking** Console

Sequence stacking

Methods: Average stacking with rejection

Normalisation: Additive with scaling ☐ Recompute ☐ Output Normalisation

Rejection: Winsorized Sigma Clipping

Sigma low: 3.000 - +

Sigma high: 3.000 - +

Stacking 16 images of the 19 of the sequence

selected +

Save in: r_bkg_pp_light_stacked.fit ☒ Overwrite

Start stacking

Post-Processing

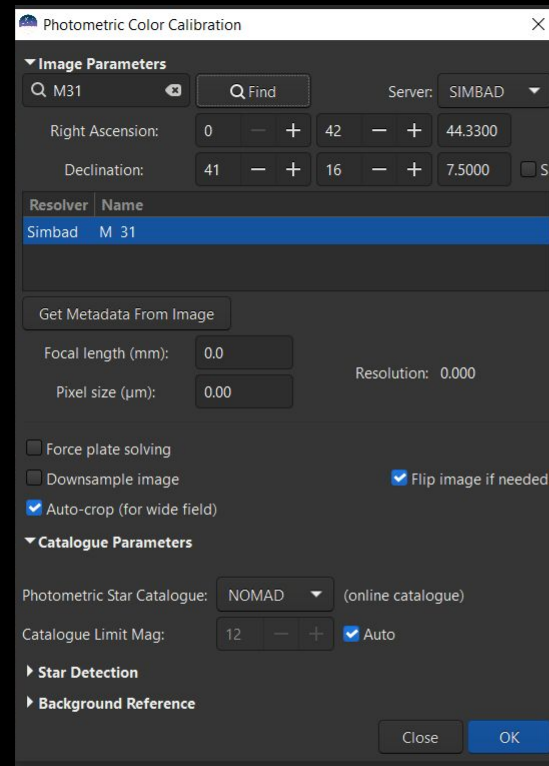
A variety of software can be used for post-processing your data. As we've used Siril so far, we will go on to show its uses for post-processing your lights to create a stacked image.

This is where other software, like PixInsight, can help produce a better final result.

Photometric Colour Calibration

Before applying transforms, it is usually best to apply photometric colour calibration first. This compares your final image to previous images taken of the object and calibrates (matches) the colours. This can only be done before applying transforms.

To do this, click on Image Processing → Colour Calibration → Photometric Colour Calibration. Enter the object of the image (e.g M31, NGC1234, etc.) Click on “Get Metadata from Image”, turn the options of “Auto-crop” and “Flip image if needed” on, and then click OK.



The screenshot shows the 'Photometric Color Calibration' dialog box. It has a title bar with a close button. The 'Image Parameters' section includes a search bar with 'M31' entered, a 'Find' button, and a 'Server' dropdown set to 'SIMBAD'. Below are input fields for Right Ascension (0, 42, 44.3300) and Declination (41, 16, 7.5000). A table lists 'Simbad' and 'M 31' as the selected resolver and name. The 'Get Metadata From Image' button is present. Focal length (mm) is 0.0 and Pixel size (μm) is 0.00. Resolution is 0.000. Checkboxes for 'Force plate solving', 'Downsample image', and 'Auto-crop (for wide field)' are shown, with 'Auto-crop' checked. 'Flip image if needed' is also checked. The 'Catalogue Parameters' section shows 'Photometric Star Catalogue' set to 'NOMAD' (online catalogue) and 'Catalogue Limit Mag' set to 12 with 'Auto' checked. At the bottom, there are 'Star Detection' and 'Background Reference' sections, and 'Close' and 'OK' buttons.

Photometric Color Calibration

Image Parameters

Q M31 Q Find Server: SIMBAD

Right Ascension: 0 42 44.3300

Declination: 41 16 7.5000

Resolver	Name
Simbad	M 31

Get Metadata From Image

Focal length (mm): 0.0 Resolution: 0.000

Pixel size (μm): 0.00

☐ Force plate solving

☐ Downsample image ☒ Flip image if needed

☒ Auto-crop (for wide field)

Catalogue Parameters

Photometric Star Catalogue: NOMAD (online catalogue)

Catalogue Limit Mag: 12 ☒ Auto

Star Detection

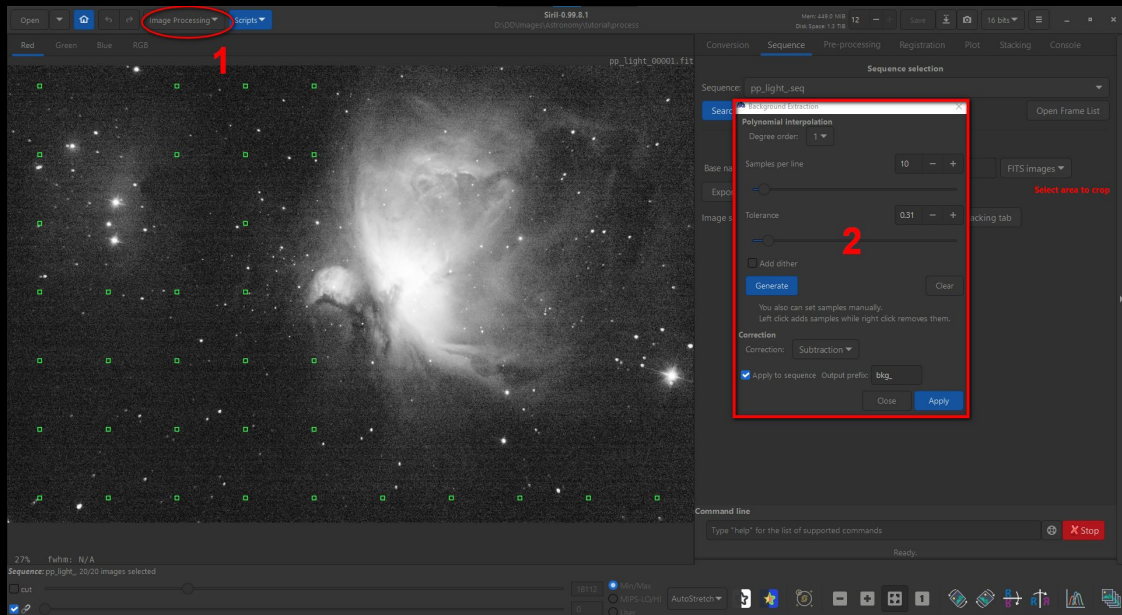
Background Reference

Close OK

Gradients

After stacking, a gradient is often seen over the image (due to external light).

This can be removed with Siril's background extraction.



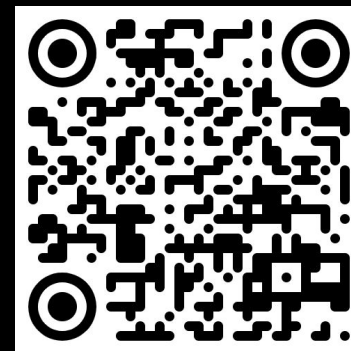
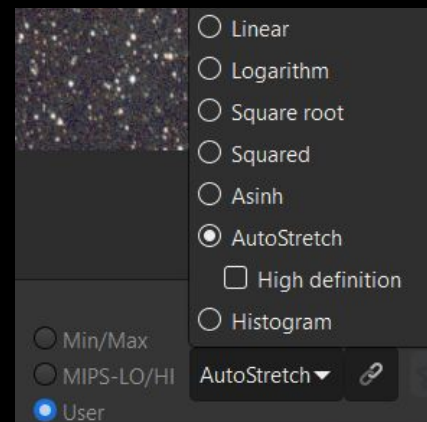
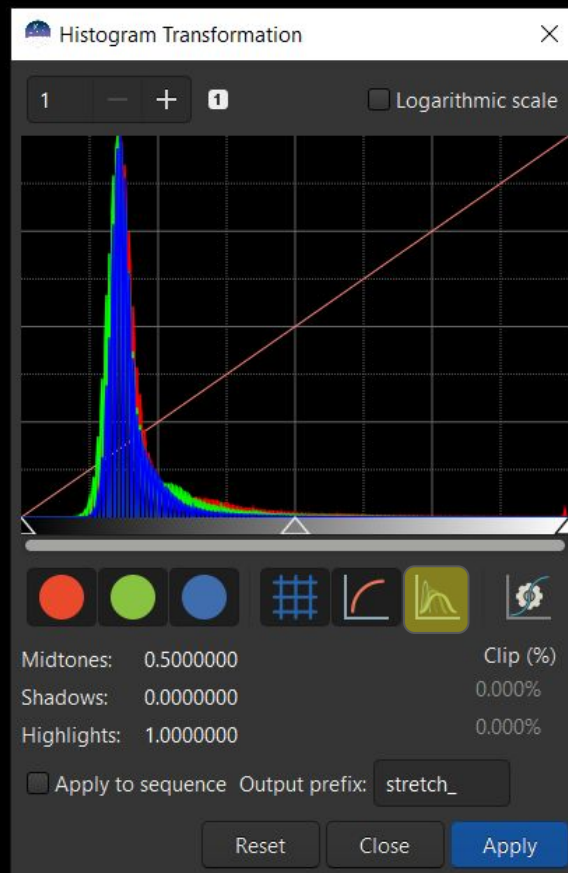


Histogram Transform

The QR Code links to a short explanation of how to histogram transform images on Siril.

The Blackpoint (BP), Midpoint, and Whitepoint (WP) can be moved manually. Alternatively, by clicking the “autostretch” button (highlighted in yellow), they are moved into what Siril determines to be the best place.

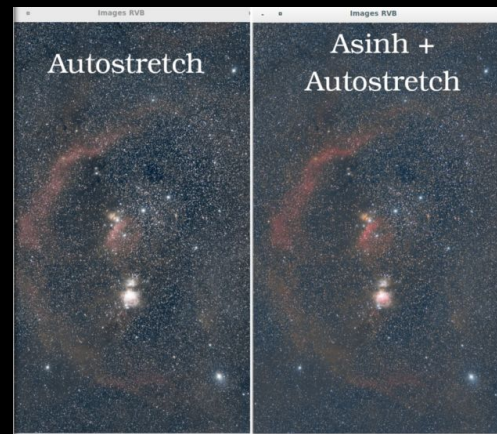
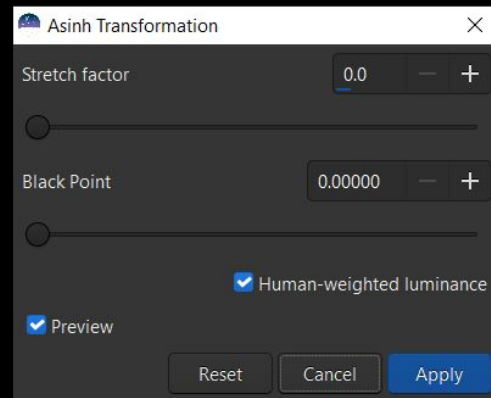
The BP should be before the main peak, the midpoint at the end of the main peak, and the WP at the end of all the data.



OPTIONAL Asinh Transform

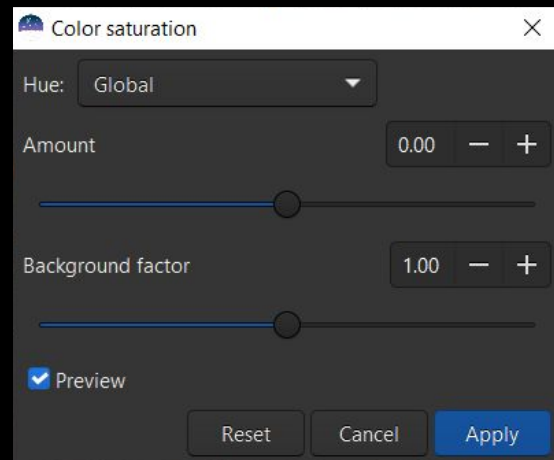
Other ways to transform your data exist, but they tend to have more niche uses. Siril provides an option called “Generalised Hyperbolic Stretch Transformations” that uses all of the available options in one step, but it’s a little too complicated to go into detail here.

The Asinh transform is one of these. It can help to preserve fainter nebulosity on images with a large change in intensity. It is the first option in Siril’s Image Processing menu and can be used by altering the Stretch factor to capture more detail, and then adjusting the Black Point to make the background dark again. It’s often best when only used lightly, hence why we don’t often bother using it. Most of our images are without it.



Manually change the saturation

Sometimes, due to lower total exposure times or the effects of photometric colour calibration, certain hues in your final image may appear under-saturated. This can be altered using the “Colour Saturation” menu in Siril (other software like Photoshop works well, too).



- Pink-Red / Red-Orange
- Orange-Brown / Yellow
- Yellow-Green / Green-Cyan
- Cyan
- Cyan-Blue / Blue-Magenta
- Magenta / Pink
- Global

Star Deconvolution

The final step of post-processing in Siril is Star Deconvolution. This is simply an algorithm that decreases the blur in stars, by identifying them and reducing their pixel count via a fancy algorithm.

As shown in the gif to the right, it can make a drastic difference in image quality for pictures of star clusters or galaxies.

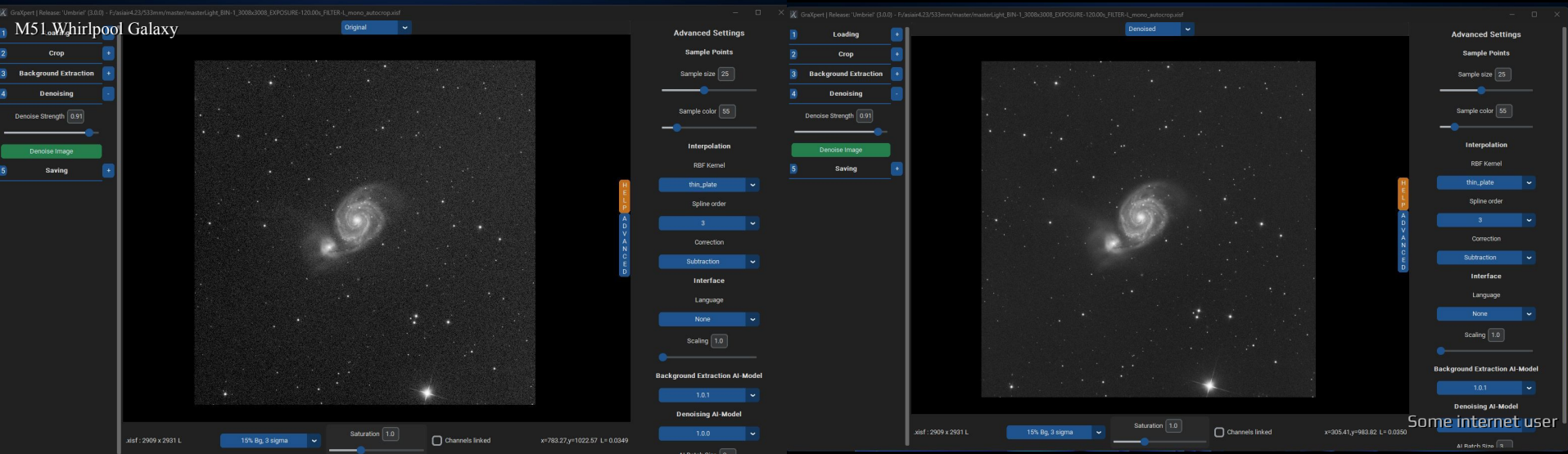


Bonus techniques



GraXpert

GraXpert is primarily for removing gradients, but its noise reduction tools are what we mainly use it for. Siril also has inbuilt denoising, but it is less effective. Only 16-bit .tif files are compatible with GraXpert (any final .fit files can be transferred into this format via Siril).



StarNet

The open source equivalent to StarXT, StarNet is more prone to leaving imperfections in the starless image.



Drizzle

Drizzling is an algorithm developed for the Hubble space telescope which upscales images without neural networks.



In Siril, drizzle can be enabled during registration. Beware that it greatly increases processing time, memory usage and image file size.

The End
Thanks for coming!

