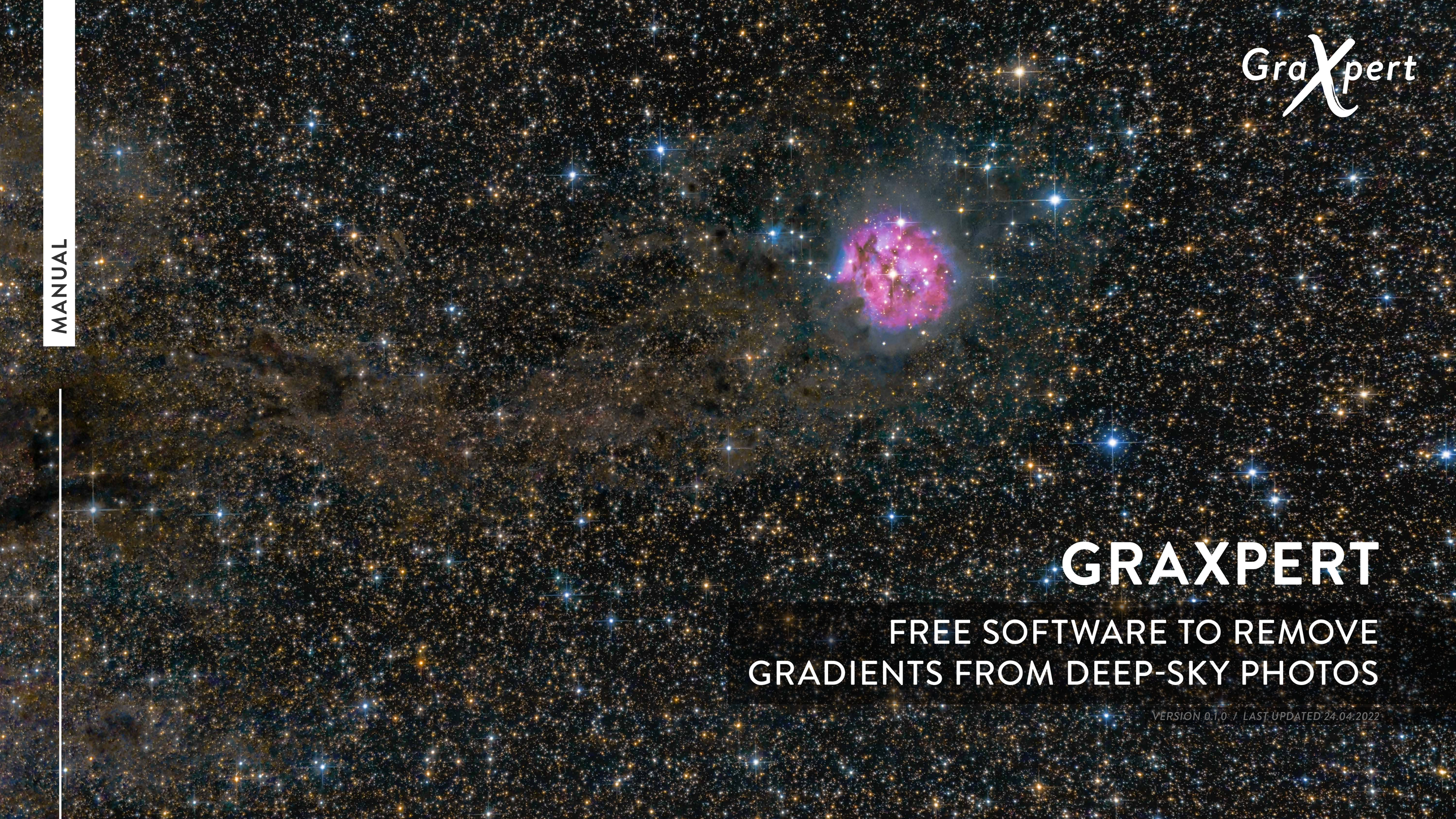


MANUAL

GraXpert

GRAXPERT

FREE SOFTWARE TO REMOVE GRADIENTS FROM DEEP-SKY PHOTOS

VERSION 0.1.0 / LAST UPDATED 24.04.2022

CONTENTS

WHAT ARE GRADIENTS AND WHY SHOULD THEY BE REMOVED FROM ASTRO PHOTOS?

As the name suggests, gradients are gradual changes in brightness that are not part of the astro photo but are caused by external interference. Causes can be e.g. light pollution or incorrect or missing flat correction, but also natural brightness gradients of the night sky and peculiarities of the optics used (shading in the form of a vignette).

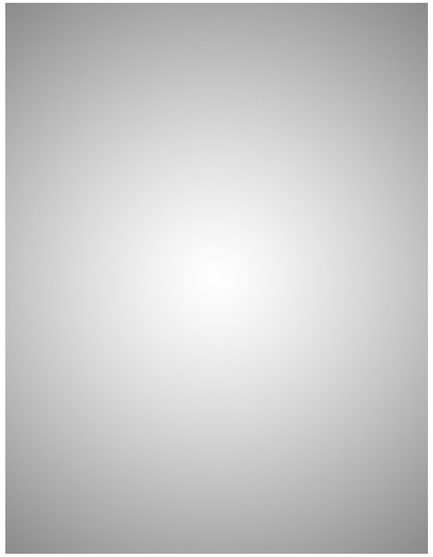
Simple gradient – a linear decrease in brightness.

In order to edit deep-sky photos, it makes sense to remove such gradients from the images. Not only does it look better, but it also simplifies further processing of the image. Color casts can also be removed in this way and it generally makes sense to free the astro photo from the amount of the sky background. In short: A gradient removal is very useful, if not mandatory.

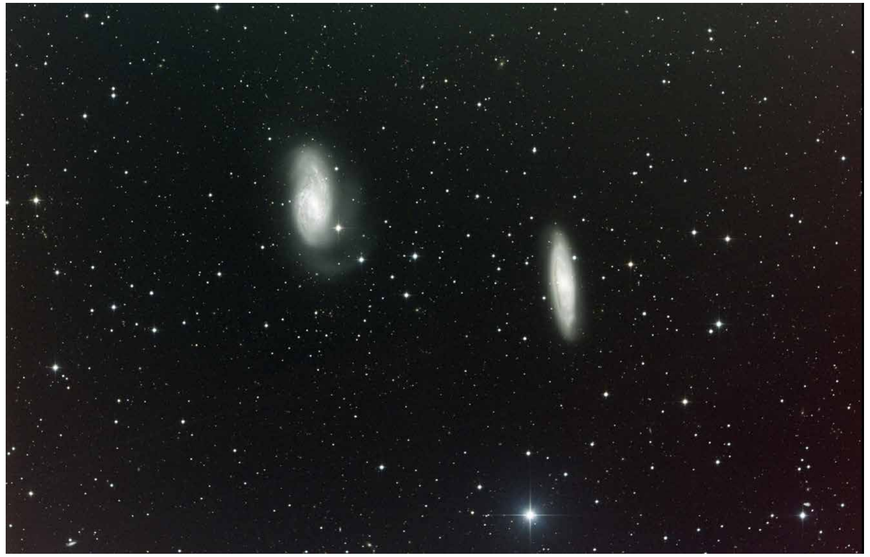
Various paid astro software offers very good tools for gradient removal such as PixInsight (DBE,ABE) or AstroPixelProcessor. You can also purchase paid plug-ins for the software Adobe Photoshop or Affinity Photo to solve the problem.

GraXpert is a freely available open source software that was programmed exclusively for this purpose. It works stand alone, not as a plug-in for any other software.

EXAMPLES OF GRADIENTS



Simple gradients, so-called first-order gradients, are easy to remove in astro photos. However, gradients in astro photos are often much more complex (higher order) and require special algorithms for calculation.



An astro photo as it corresponds more to reality. One recognizes partly chaotic and multicolored gradients of higher order. GraXpert was developed to remove such more complex gradients.

EASIER PHOTO EDITING WITHOUT GRADIENTS

Gradients are best removed very early in the image processing workflow. Ideally it is done on images in linear state, i.e. directly after the stacking (in some external software) is finished and artefacts at the edges of the image have been removed by cropping.

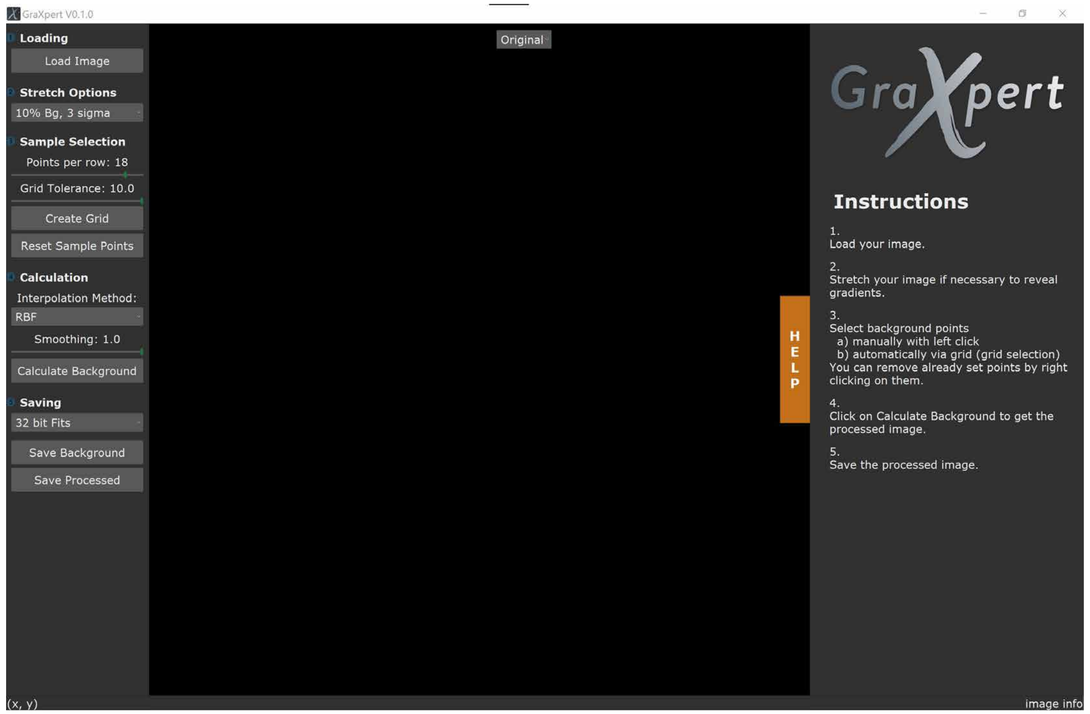
GraXpert also allows you to edit images whose brightness has already been changed, e.g. by a tone curve or a histogram transformation (so-called stretching). Those images are then called non-linear images.

DOWNLOAD AND INSTALLATION

The software can easily be downloaded from the GitHub platform using the following link:
https://github.com/Steffenhir/GraXpert/releases

GraXpert runs on Windows, Linux and MacOS. All you have to do is download the relevant file (GraXpert-win64.exe for Windows, GraXpert-linux for Linux and GraXpert-macos-x86_64.dmg). GraXpert can be executed after the download without installation.

After double-clicking, the software's user interface opens, with a large preview window in the middle and control panels on the left that can be executed one by another. On the right side there is a small help menu containing a quick start guide. Pixel coordinates and intensity values are displayed in the footer. The language is set automatically according to the language settings of your operating system.



POINT 1: LOADING

GraXpert works with linear, i.e. non-stretched images, as well as with non-linear, i.e. already stretched images. A bit depth of 16 bit as well as 32 bit is supported, as well as the file formats fits, tiff, jpeg and png. Monochrome images as well as color images are supported. Load the corresponding images into the software using the Load image button.

After loading the image file, it may be very dark as it is a linear image.

POINT 2: STRETCH OPTIONS

After the image has been loaded, you now have the option for linear images to make them brighter in order to examine the gradients in the view. To do this, select one of the options under the Stretch Options button. Set this function to „no stretch“ for images that have already been stretched. For linear images, it is advisable to choose the highest percentage level. Even if your images appear unnatural as a result, the weakest gradients are immediately recognizable then.

After applying the highest level of stretch, the image looks unnatural. After gradient removal, you can gradually reduce the change in brightness to obtain a more realistic image and thus assess the success of the gradient removal.

POINT 3: SAMPLE POINT SELECTION

To allow GraXpert to calculate a model of the gradient, you have to set so-called sample points in the image. To do this, click on the picture in places where you only expect sky background. The sample point is set with a click and appears as a small red box. With a right click you can remove such a sample point. You can move it with the left mouse button pressed (caution, the mouse must be exactly over the sample point, otherwise the whole image will be moved). With the mouse wheel you can easily zoom in and out of the image to set samples more precisely. Avoid placing samples on stars or deep sky objects. This can affect the gradient model and lead to an unintentional subtraction of the object signal.

Alternatively, you can let GraXpert set the sample points automatically using the Create grid button. The points per row slider can be used to specify how many of such sample points should be set automatically per row. The grid tolerance slider can be used to determine a threshold value for the brightness above which no sample point is set in the image. This is to prevent samples from accidentally being placed on the object.

However, this method has its pitfalls:
The software cannot distinguish whether there is a gradient, a star, a galaxy, or a nebula. So you will quickly find that if the tolerance is set too low, GraXpert sets too few samples. And if it is set too high, sample points end up on stars and objects. Try to find a sweet spot and, if necessary, correct samples by moving or deleting them. If you are sure that no sample was set in an area which definitely belongs to the sky background, set a sample point with a mouse click, then set a sample point with a mouse click. The grid selection tool is intended to make your work easier, but it cannot completely work on its own.

With a click on the Reset Points button, you can undo all sample points and start over.

You can easily place sample points in the image with a mouse click. Put samples only where you suspect sky background (even if this is covered by the gradient).

Example for tolerance being too high.

Example for tolerance being too low. Try to find the sweet spot.

POINT 4: METHOD OF INTERPOLATION

Here you can select one of the three methods that can be used in GraXpert to calculate a gradient model under the Interpolation Method button: RBF, Splines and Kriging. Which method is better suited for your images depends on the type of gradient and cannot be said in general. If in doubt, you have to try the different methods here.

However, we can provide you with a few clues:

Splines: The fastest and easiest method. Good for simple gradients of the first order (see above).

RBF: The default setting. It delivers very good results in most cases and is still reasonably fast.

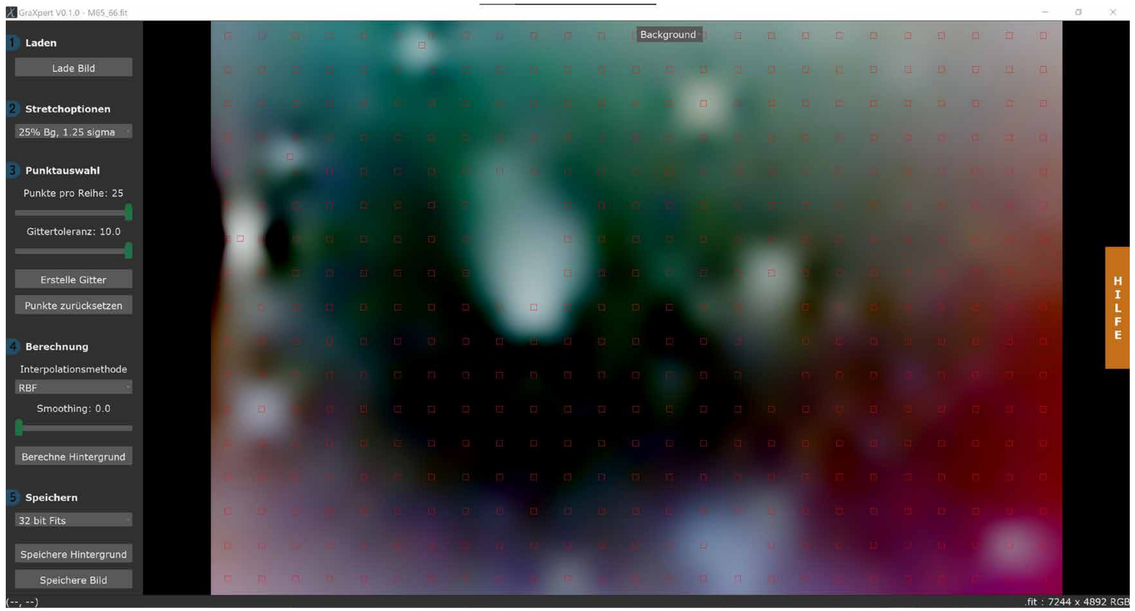
Kriging: Should provide the most accurate results, but is very computationally intensive.

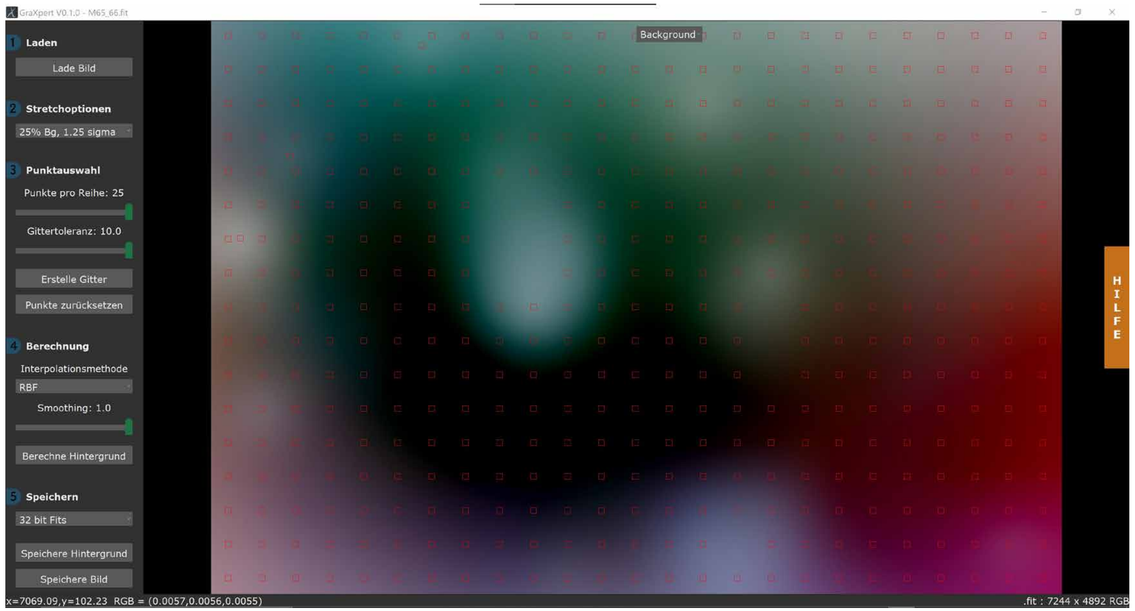
Remember that the computation time increases with the number of sample points. Especially with the kriging method and a large number of samples (more than 100), the computing time can take a few minutes, depending on the computer.

Smoothing

With this value you can determine how soft or hard the transition between the sample points is calculated. A high smoothing factor makes sense for large and uniform gradients, and a correspondingly lower value for small, local gradations. Tip: Start with the basic setting (50%) and gradually tweak for optimal results.

You can execute the calculation in GraXpert with the Calculate background button.





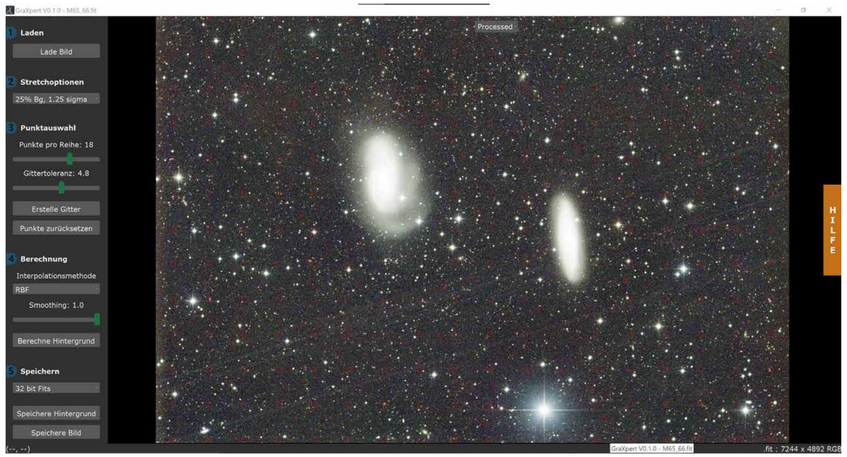
Here you can see the effect of the smoothing factor.

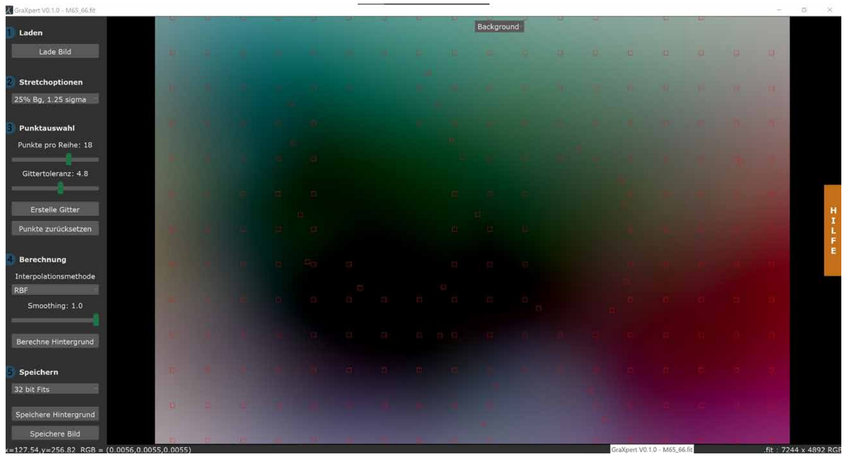
EVALUATION

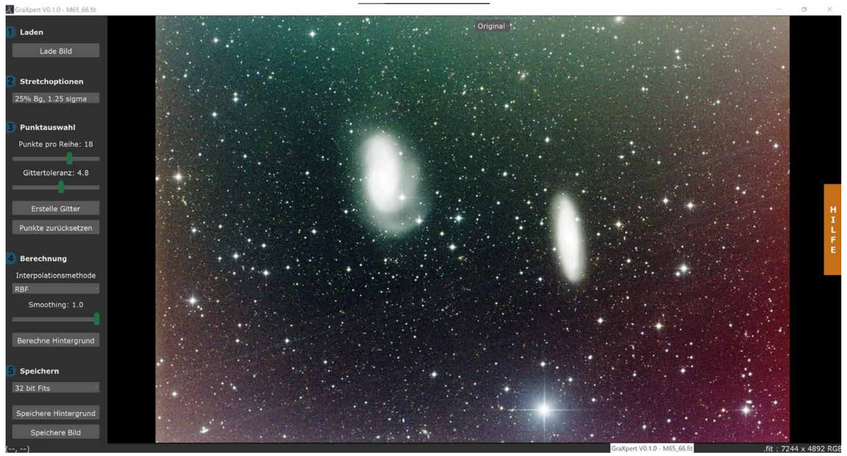
You see the corrected image directly in the image window as soon as the calculation is complete. With the button above the image window, you can now switch views between the original image, the background calculated by GraXpert, and the corrected image. This makes it easy to assess whether the correction was carried out well or whether, for example, there are still gradients in the image. If this is the case, you can now e.g. set further samples where there still is a gradient left and trigger the process again (the calculation then starts over from scratch).

It can also happen that a sample is too close to or over an object and too much has been subtracted from the image. This is often recognized by dark edges around the deep sky object. Then try to move the affected samples away from the object and start the calculation again.

Always check your results by switching between the different views.







After the calculation, you can quickly switch back and forth between the original image and the corrected image, as well as the background model. With a little practice, you can see immediately whether the background correction was successful.

POINT 5: SAVING

Under this point you will find three fields. In the first field you can select the image format in which you would like to save your result. You can choose between tiff and fits format. The standard for astronomical image processing is 32 bit fits. If fits format is selected, initial fits header of the original picture is copied to the new picture. If you want to edit the image further in a graphics application such as Adobe Photoshop, select the tiff format. You can choose between 16 bit and 32 bit data depth for both file formats.

Note that the image will not be saved at the brightness level it is displayed in the software. The stretch options are only for visualization and do not replace a histogram transformation.
In addition to the image, you can also save the gradient model that GraXpert has calculated. In this way, you can also carry out the actual subtraction of this model in other software (useful, for example, if you do not want to interrupt the history of an image processing process).

SOURCES

Here are some sources for the interpolation methods used in GraXpert.

Splines
https://en.wikipedia.org/wiki/Smoothing_spline

Kriging
https://en.wikipedia.org/wiki/Kriging

RBF
https://en.wikipedia.org/wiki/Radial_basis_function_interpolation
https://en.wikipedia.org/wiki/Thin_plate_spline

The Python libraries on which the calculations of the GraXpert software are based.

Splines
https://docs.scipy.org/doc/scipy/reference/generated/scipy.interpolate.bisplrep.html

RBF mit thin-plate-spline Kernel
https://docs.scipy.org/doc/scipy/reference/generated/scipy.interpolate.Rbf.html

Kriging
https://geostat-framework.readthedocs.io/projects/pykrige/en/stable/generated/pykrige.ok.OrdinaryKriging.html

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