



Gradient Removal Plug-in Documentation

The Gradient Removal Plug-in works with both CCDSoft and MaxIm DL. You need version 3.07 or later of MaxIm, or version 5.0.72 or later of CCDSoft, to use this plug-in.

I created the Gradient Removal Plug-in because I was frustrated with most of the automatic (or semi-automatic) gradient removal tools. I designed the plug-in to allow you to remove gradients with a high degree of precision. The more carefully you process your images, the more useful you will find this plug-in to be. Unlike tools that try to figure out the gradient and remove it, this plug-in allows you to measure a gradient, determine its direction, and then remove it cleanly. The plug-in works equally well with both radial (hot-spot) gradients and linear gradients.

Setting up

Installation is easy:

- Go to http://www.newastro.com/newastro/downloads/rem_grad/default.htm
- Click the **Download** trial version link to download the installation program
- Run the installation program
- **For MaxIm DL only:** add the program to the Plug-Ins menu (see below).

The program will run without any limitations for 30 days. If you like the program, and want to continue using it, go to the same link as above the click the “Add to cart” button to buy it. The cost is \$39.95. There is no CD or other article to ship, so there are no shipping charges. Once you buy it, you can use it with MaxIm DL, CCDSoft, or both at no extra charge.

Using the Gradient Removal Plug-in

During installation, the Gradient Removal Plug-in is copied into the following folders:

Program	Installation folder
CCDSOFT	C:\Program Files\Software Bisque\CCDSOFT Version 5\Image Processing Plug Ins\
MaxIm DL	C:\Program Files\Diffraction Limited\MaxIm DL 3\

Note: If you have any trouble with installation, you can manually copy the file `remove_gradient.dll` into the appropriate folder.

Once the Gradient Removal Plug-in is copied into the proper directory, CCDSoft will add the plug-in to the Image menu automatically. For MaxIm DL, you will need to do the following to make the plug-in available:

- Use the Plug-in | Add/Remove Plug-ins menu item to open the Add/Remove Plug-in dialog.
- Click the browse button at the top of the dialog.
- Navigate to the installation folder (see table above), and locate the file remove_gradient.dll
- Click on remove_gradient.dll, and if necessary click on the Open button to complete the selection.
- Click the Close button.

To verify that the plug-in is now available, click the Plug-in menu and verify that there is an entry titled "NewAstro Remove Gradient". If this entry does not exist, repeat the above steps making sure to complete each step before moving to the next.

To use the plug-in in CCDSoft:

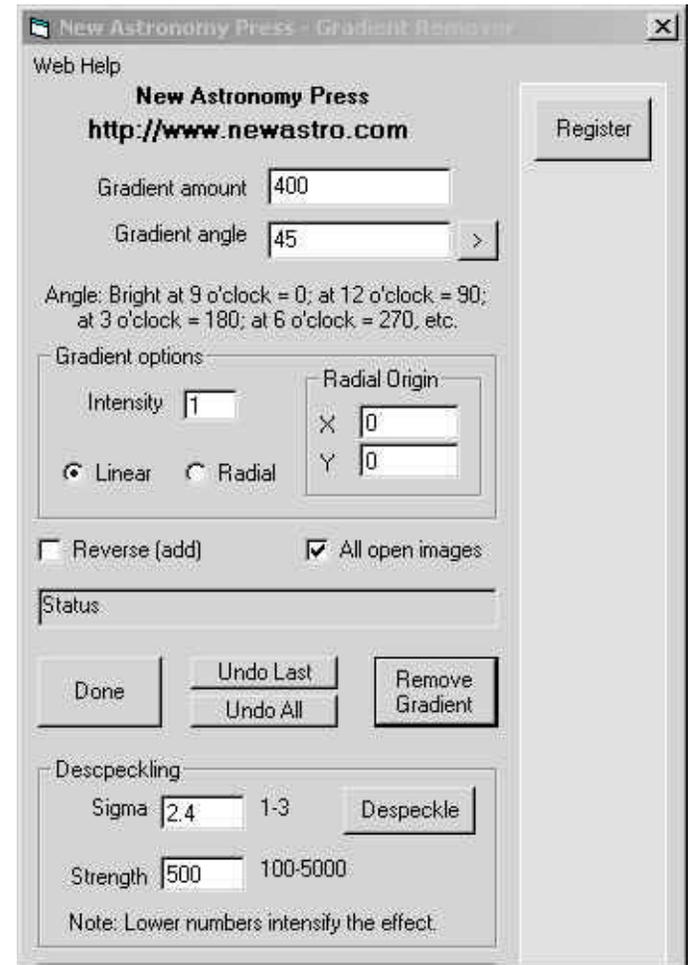
- Open the image you want to work on.
- Use the Image | Plug-ins | NewAstro Remove Gradient menu item to open the plug-in.
- Use the plug-in by following the directions in the rest of the documentation.

To use the plug-in in MaxIm DL:

- Open the image you want to work on.
- Use the Plug-ins | NewAstro Remove Gradient menu item to open the plug-in.
- Use the plug-in by following the directions in the rest of the documentation.

Using the Remove Gradient Plug-in

The screen capture at lower right shows the main window of the Gradient Removal Plug-in. The top section gives you access to the main program features for removing gradients. The lower section of the window contains the free despeckling features. The blank area at right will only show up if you are using the trial version. Once you register, that part of the window disappears for good.



The Gradient Removal Plug-in Main Window

The plug-in works on two kinds of gradients:

Linear - Gradients that fade from one side of the image to the opposite side.

Linear gradients can be at any angle, both horizontal and vertical. Linear gradients are fixed by specifying the amount of the gradient, and its angle.

Radial - Gradients that have a central hot spot that fades to darker shades away from the center. Radial gradients may have their brightest area away from the actual center of the image. The plug-in allows you to adjust for the center of the hot spot easily. Radial gradients are fixed by specifying the amount and the center spot.

Gradient Removal Features

There are various settings in the main window that determine how a gradient gets removed. The following list provides a quick-start set of definitions for those who would like to dive right in and give the program a try:

- Gradient amount** The maximum brightness level of the gradient. For example, if the left edge of the gradient is at 891 ADU, and the right edge is at 750, then the amount of the gradient is $891 - 750 = 141$. That's the number you enter in this box. If you are dealing with a radial gradient, then measure the brightness of the center of the hot spot, and the brightness of a corner, to determine the amount of the gradient.
- Gradient angle** Applies only to linear gradients. This specifies the direction of the gradient. An angle of zero corresponds to the 9 o'clock position on a clock, with the gradient being brightest at that position. In other words, if a gradient is bright on the left, and dim on the right, and runs purely horizontal, then the gradient angle would be zero. Angle values increase clockwise. 90 degrees would be a gradient that is brightest at the top (12 o'clock position), and so on.
- > Button** Opens the Mark Gradient window. See below for instructions on how to Mark a gradient.
- Intensity** The range of legal values is 0.5 to 5. Smaller numbers result in a smaller area with maximum gradient removal, with a rapid falloff in correction as you move away from the zone of maximum removal. Larger numbers result in a larger area of maximum gradient removal, with a more gradual falloff in correction as you move away from the zone of maximum removal. For radial gradients, large numbers give you a larger hot spot removal. For linear gradients, larger numbers give you more aggressive removal in the bright portion, and less in the dim portion.
- Linear/Radial** You can use this plug-in to remove both linear and radial gradients. Linear gradients are just what they sound like: gradients that increase in a straight line from one part of the image to another. Click the Linear radio button to work on this type of gradient. Radial gradients typically have a bright spot in the center, and darker sides or corners. Click the Radial radio button to clean up this type of gradient.
- Radial Origin** The X and Y values are the coordinates of the center of the hot spot. You can use your camera control program to find the coordinates of the hot spot. Pass your mouse cursor over the image and note the X (horizontal) and Y (vertical) coordinates of any point in the image. The origin (0,0) is assumed to be at the upper left of the image. Disabled for linear gradient removal.
- Reverse** When checked, clicking the "Remove Gradient" button will add to the image instead of subtracting. The bright/dark relationships stay the same, and the gradient angle stays the same. Instead of lowering the bright values to remove the gradient, the plug-in will add to the dim values.
- All open images** (MaxIm DL only) When checked, the same gradient removal will occur on all open images.

- Done** Closes the plug-in. Any changes that are already visible in the image become permanent. If you do not want any changes to apply, you must click the Undo All button before you leave.
- Remove Gradient** Does a gradient removal with the current settings. You'll see an indication of progress in the "Status" area. When the gradient removal is done, you will see the result in the image.
- Undo Last** Undoes the last gradient removed OR the last despeckle.
- Undo All** - Undoes all gradient removals and/or despeckling since you opened the plug-in.

Despeckle Features

Despeckling is a calculation-intensive approach to removing hot and cold pixels. Please be patient while it is working!

- Sigma** Legal values are 1 through 3. The default value is 2.4, and will give balanced cleanup for most images. Low numbers make the despeckling more aggressive. Too aggressive of a setting can result in removal of dim stars (especially on binned images). Sigma defines the number of standard deviations by which the pixel must vary from its neighbors before it is fixed. A small number means that the pixel will be fixed more readily, and a large number means that the pixel must vary considerably before it will be fixed.
- Strength** Legal values are 100 through 5000. Lower numbers are more aggressive. The strength setting determines how much a pixel must vary from the average background value before it is a candidate for fixing. Strength is the first test a pixel must pass; if it passes the strength test, then the Sigma test is applied. Strength measures the pixel against global conditions; Sigma measures the pixel against local conditions in its neighborhood.
- Despeckle button** Click to apply despeckling.

Note: The Undo Last and Undo All buttons will undo despeckling. The Undo Last button will only undo the most recent operation, so if you despeckle and then remove a gradient, on the gradient removal will be undone.

Example: Removing a Linear Gradient

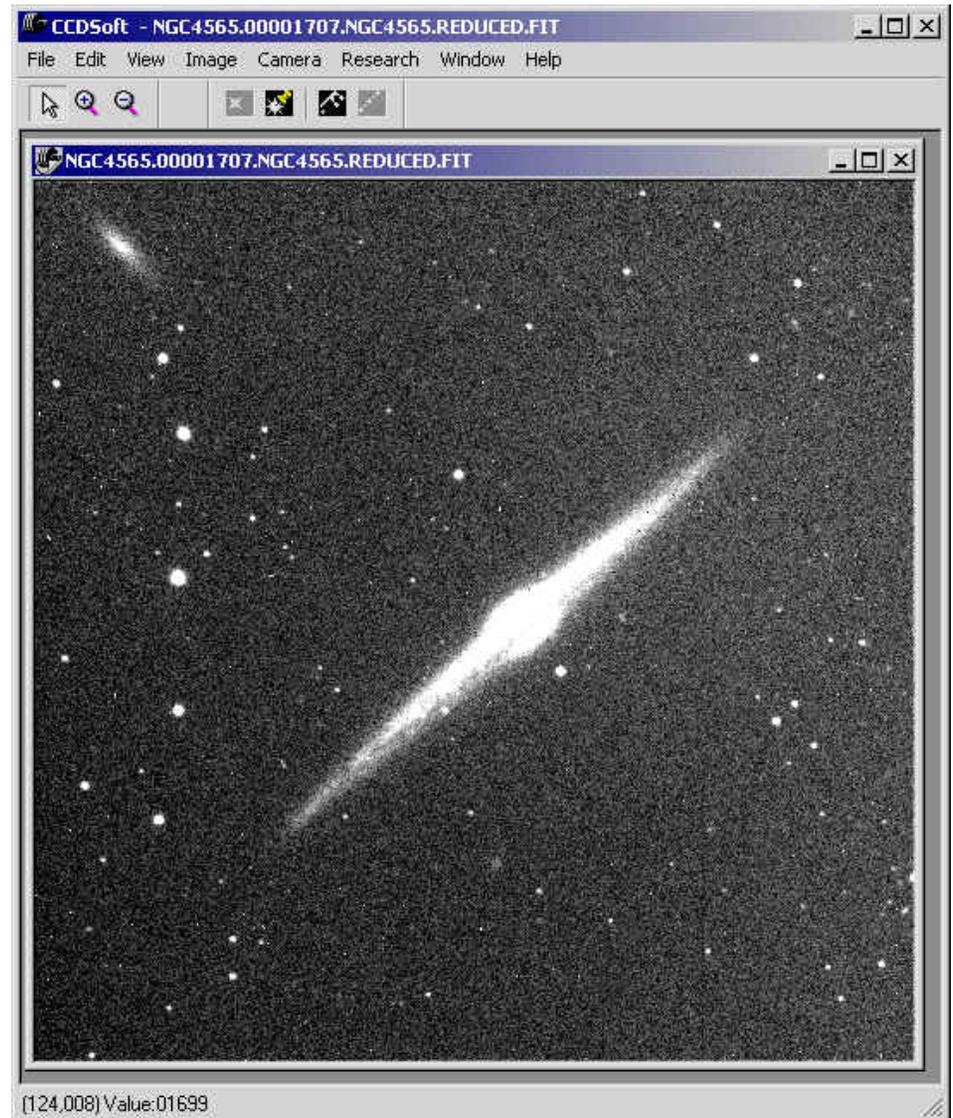
The following example shows how to remove a typical linear gradient from an image. Gradients can be at any angle; the Mark Gradient tool makes it easy to determine gradient angles.

An image with a linear gradient

The image at right has a brighter background on the right-hand side. The gradient is not severe, but it is enough to interfere with proper processing of the image. By the time you get the right-hand side down to a dark enough level, the left-hand side will be too black. If you leave the left side bright enough to look natural, the right side will be too bright.

Even minor gradients limit the processing you can do on an image. They prevent you from stretching the histogram far enough to show dim details.

TIP: *Adjust the screen contrast (background/range, minimum/maximum) to show the gradient clearly, as illustrated here. Don't worry about how the main object looks; it's the gradient you can see clearly for this operation. You can always restore a difference contrast setting later.*

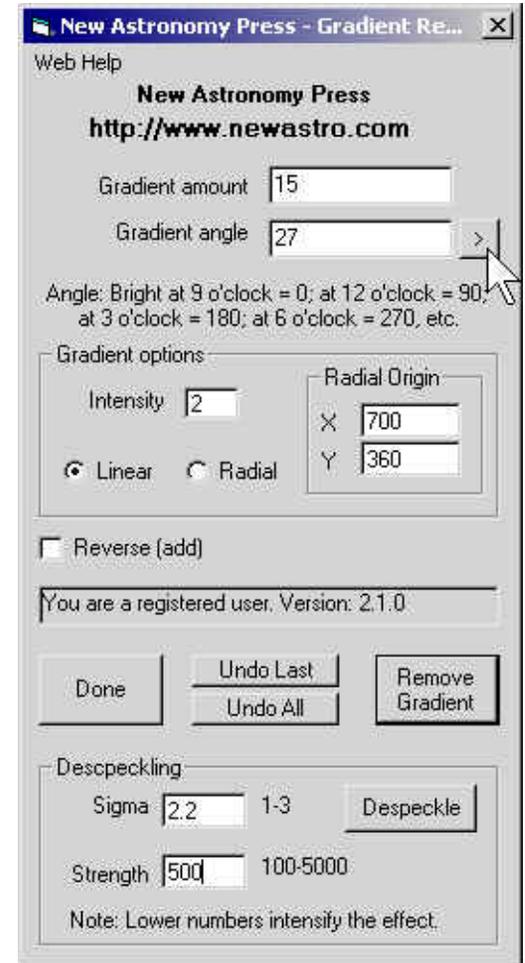


Setting Up to Process a Gradient

The screen capture at right shows how to start out processing a linear gradient. Check the "Linear" radio button to make it active. Try an intensity level of 2 for starting out. Light falls off with the square of the distance from the source, and a value of 2 will match this natural fall-off rate. If you run into a gradient that has a different fall-off rate, you can vary the intensity to match it.

Don't worry about the gradient amount and angle yet; click on the small arrow button to the right of the "Gradient angle" text box. This will open a smaller version of the image.

Note: the small version of the image will take a few moments to load.



Introducing the “Mark Gradient” Window

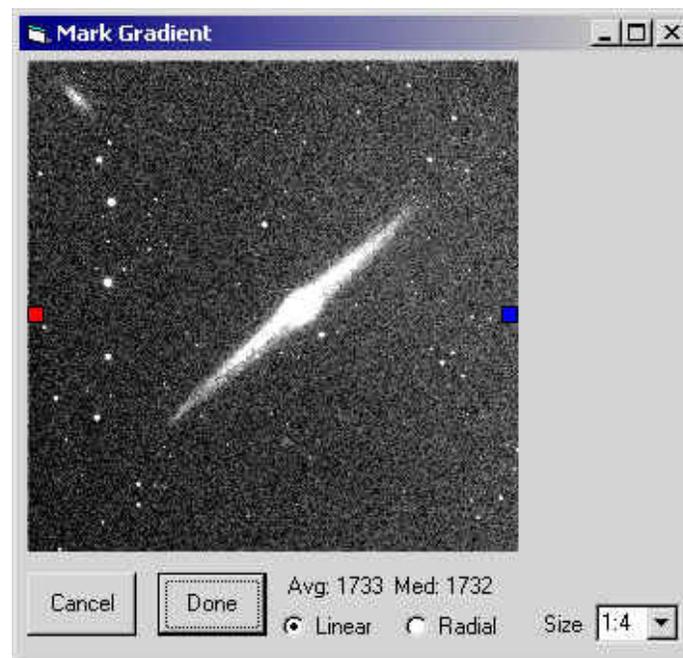
The window at right allows you to set the angle and the amount of a gradient interactively. You can also enter numbers directly in the main window, but most users find it easier to use the Mark Gradient window.

When you open the window, there are two colored boxes (gradient markers). The red box marks the start (brightest portion) of a gradient, and the blue box marks the end (dimpest) portion. By default, the gradient markers are bright on the left, dim on the right. This is angle zero.

Note that as you pass the cursor over the image, the values for Average and Median change. These values are for a nine-pixel box around the cursor. You can use these values to determine the amount of the gradient.

There are radio buttons for Linear and Radial Gradients. If you forget to set the gradient type in the main window, you can change it here.

You can adjust the size of the image in the Mark Gradient window. Use the drop-down box at bottom right to pick the size that you like. Larger sizes (such as 1:1 and 1:2) are slower to load; be patient if you use them. Smaller sizes (1:4, 1:5) are much faster to load.

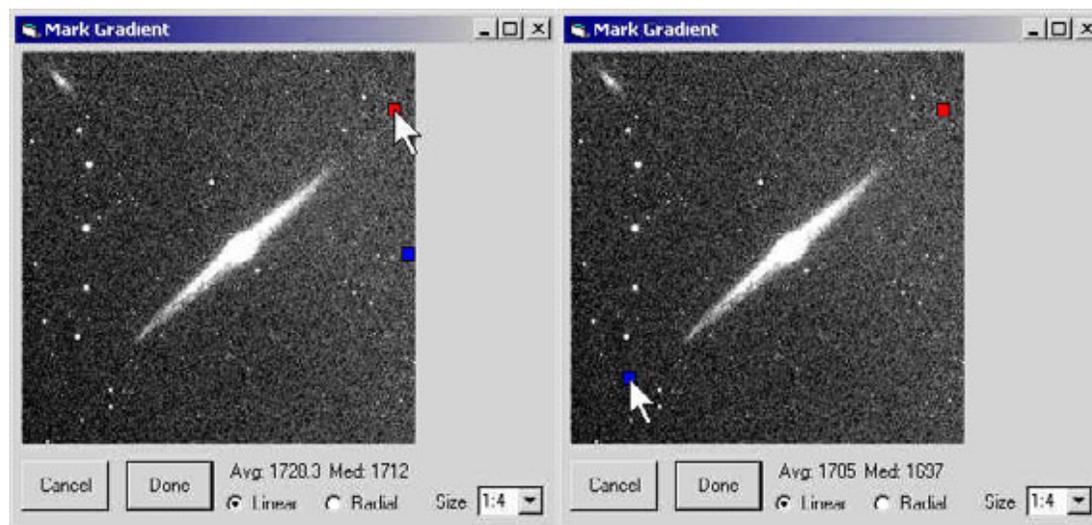


Setting the Gradient Angle

Two steps in the process of setting an angle are shown at right. Click with the LEFT mouse button to set the bright start of the gradient, and click with the RIGHT mouse button to set the dim end.

You do not need to click precisely at the start and end points; linear gradients always go from one edge to the next. What you want to do is click so that the points match the angle of the gradient.

Gradient angles can be hard to figure at first. In this example, there are at least two gradients: one that starts at top right, and another that starts at far right and is nearly horizontal. The points clicked are for the diagonal gradient. If you don't get the angle precisely correct, you can easily undo and try again. You'll develop an eye for gradients the more you work with them.



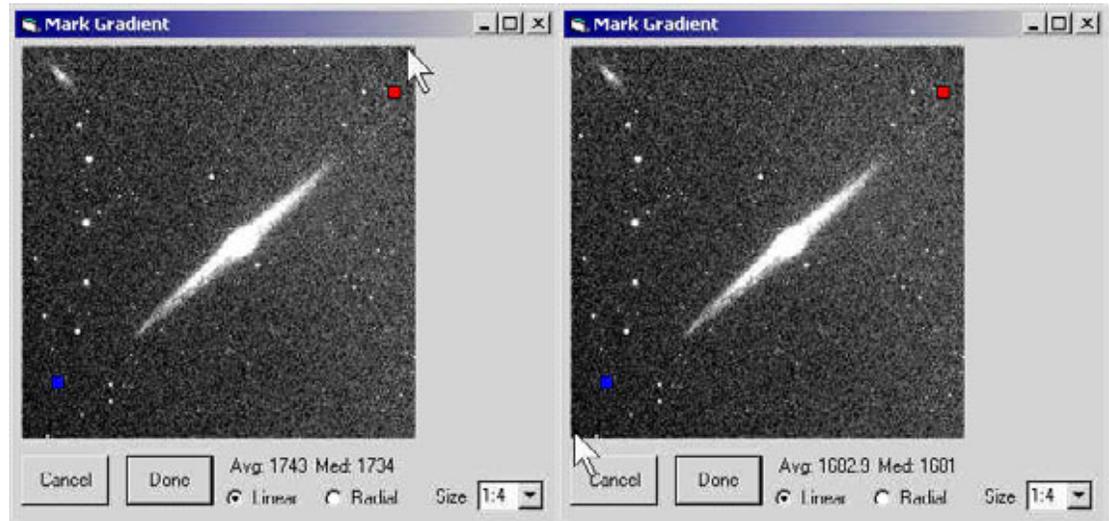
Setting the Gradient Amount

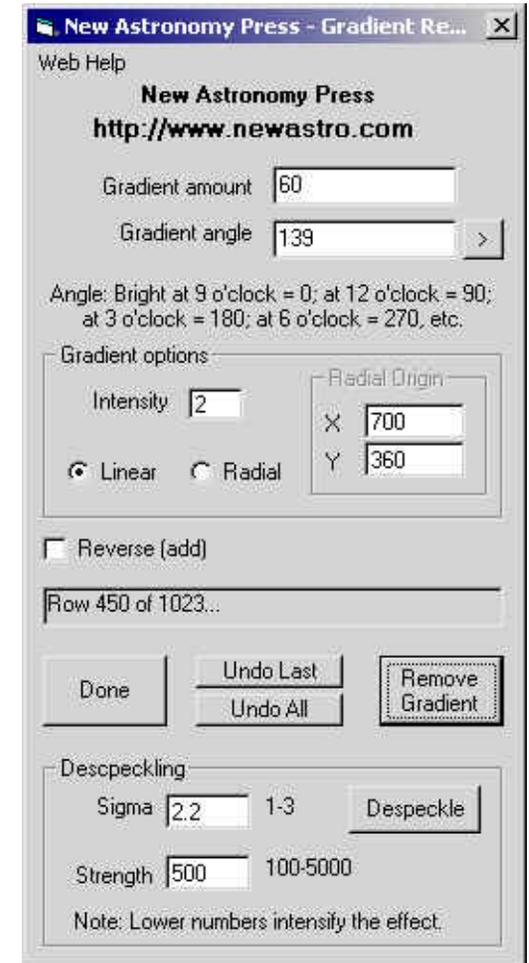
The gradient amount is the difference between the brightest and dimmest areas along the line of the gradient. The images at right show how you can simply pass the cursor over the extreme edges of the gradient and read the brightness values. Both average and median values are shown. Experience will teach you which of these two values is better to use with your images.

In this example, the brightest portions of the gradient have an average value of 1743, and the dimmest portion has a value of 1683. That means the amount of the gradient is about 40.

After setting the angle and determining the amount, click the Done button.

TIP: Go close to the edge to get values. If you are even a few pixels from the edge, you will tend to underestimate the amount of the gradient.





Back in the Main Window

The gradient angle is computed for you, and entered into the appropriate box. Since the gradient amount is a judgment call, you'll have to enter that yourself in the "Gradient amount" text box.

Verify the Intensity level, and click the "Remove Gradient" button to apply the correction. Progress is shown in the status line as shown.

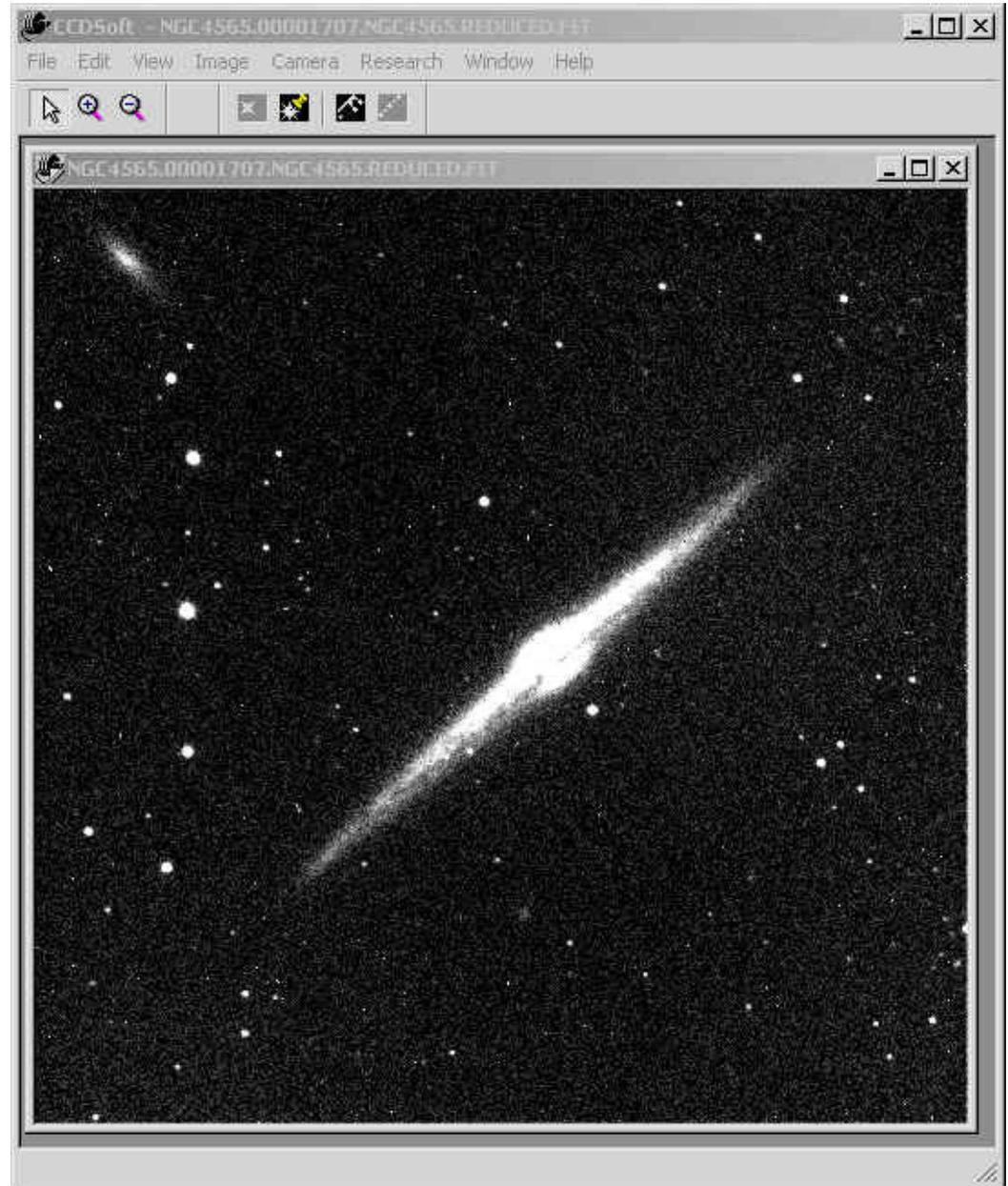
TIP: *If the gradient isn't quite removed, or too much is removed, you can use the Undo Last button and try again.*

The Result of Gradient Removal

The image at right shows the result of removing the gradient. In this example, we are removing a gradient from a single image. This is the most precise way of removing gradients - as the telescope moves across the sky taking a series of images, the angle of a gradient can change. However, if you can get good results by removing gradients from your master combined images, please feel free to take that approach. Every situation is different.

A check of the brightness values at the bottom left and top right showed that the average pixel values were 1675 and 1677, respectively. So the gradient removal was a success.

You'll find that precise gradient removal makes it easier to process your images. As you develop an eye for gradients, you be able to remove them with greater accuracy.



Example: Removing a Radial Gradient

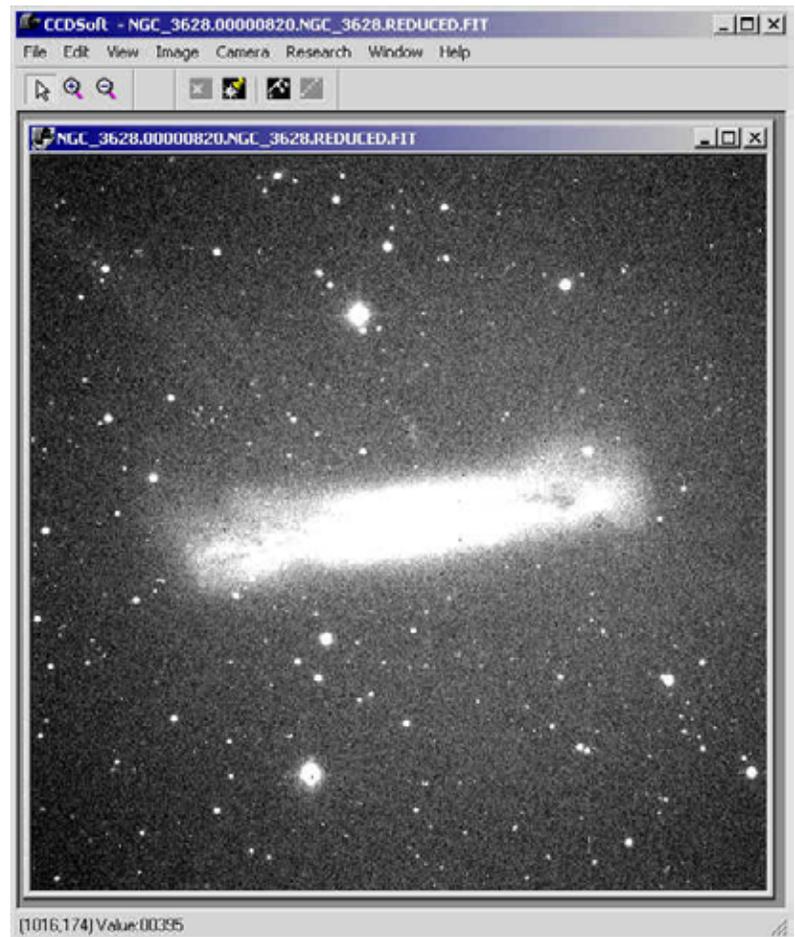
Radial gradients typically show up in two circumstances:

- No flat field was used
- The flat field wasn't really flat

Removing radial gradients is tougher than removing linear gradients. A linear gradient obeys the laws of physics, and is very regular. A radial gradient often involves both a true radial gradient from uneven illumination of the field, but it also often includes various reflections that are non-radial in nature. You'll need to remove such reflections using selections in Photoshop or a similar tool.

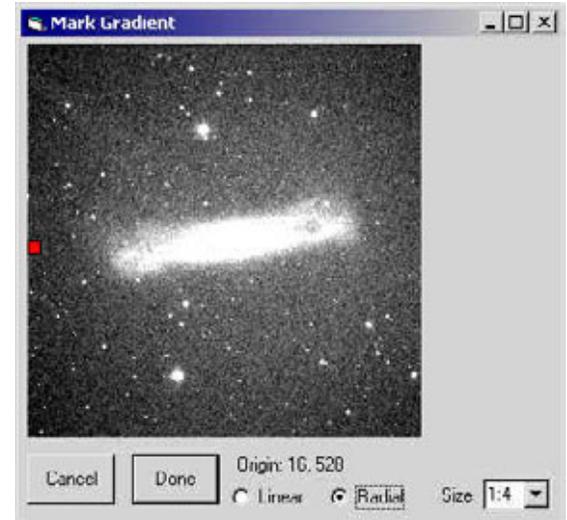
A Radial Gradient

The image at right shows a mild radial gradient. The flat field wasn't quite flat, leaving a slightly brighter central portion and some darkness in the corners. The levels are low, but they interfered with the processing of the image. This was a color image, and the bright central region was throwing off the color balance. This particular image is a luminance image, but the central gradients for the red, green, and blue images were all slightly offset from one another and the colorful variations in the background were very distraction, even at a low level.



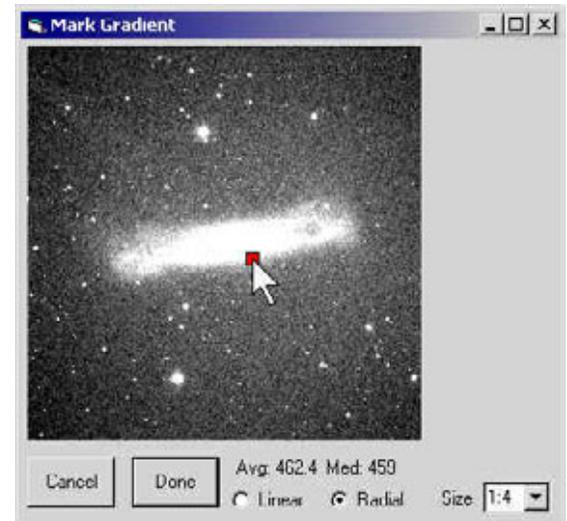
Working with a Radial Gradient

The Mark Gradient window has radio buttons to switch between linear and radial gradients. When Radial is selected, only the red marker shows up. Angle does not apply to radial gradients. The key determinant for a radial gradient is the center of the gradient.



Setting the Origin (Center)

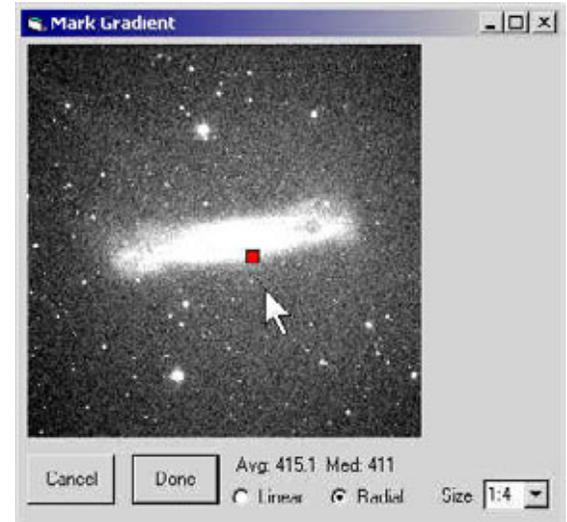
Click in the image to mark the center of the gradient. If there is a large object present, this becomes a judgment call, as shown here. Try to get your best estimate of where the center of the gradient is. You will get reasonable results even if you don't identify the center precisely, and you can always use the Undo feature to try again if you are slightly off.



Measuring Center Brightness

You won't always be able to measure the actual center brightness of a radial gradient, as in the case. The galaxy blocks the center. Most galaxies have a halo of stars around them, and you don't want to use that in the estimation of gradient amount. In this case, I hovered somewhat away from the actual center to try to get a valid background value.

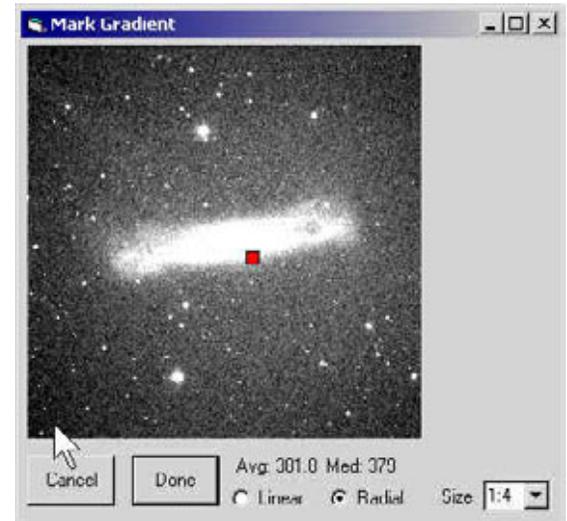
The measured value at this point has an average of 415. This is probably a little below the actual center value.

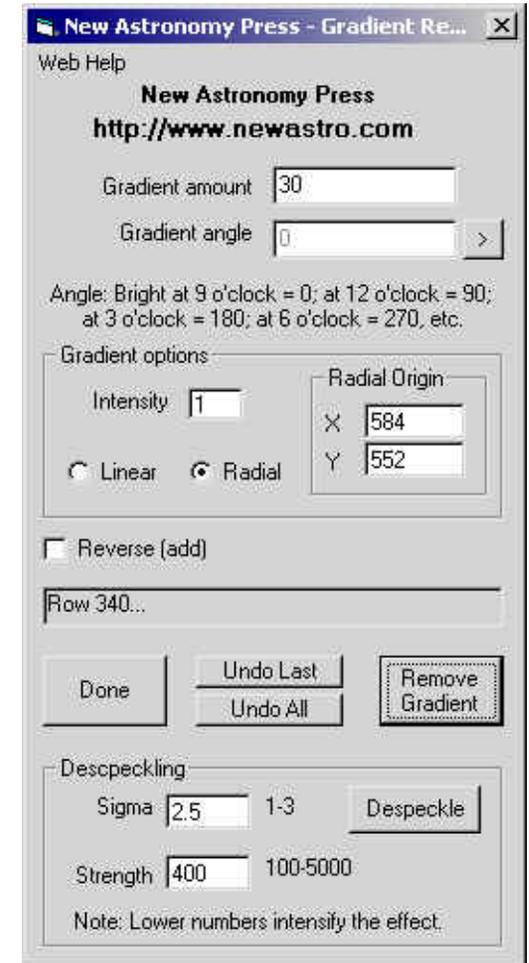


Measuring Edge Brightness

This measurement of the edge brightness is taken in the corner. As with linear gradients, you want to find the extreme values. The average value here is 381, for a total gradient of about 35. This is a little on the low side since the exact center of the gradient could not be measured. However, radial gradients can be tricky when an object is present, and underestimating them is not necessarily a bad thing. In this case, the halo of stars around the galaxy needs to be preserved, so I actually wound up using a value of 30.

When you are satisfied with the amount and center, click Done to return to the main window.

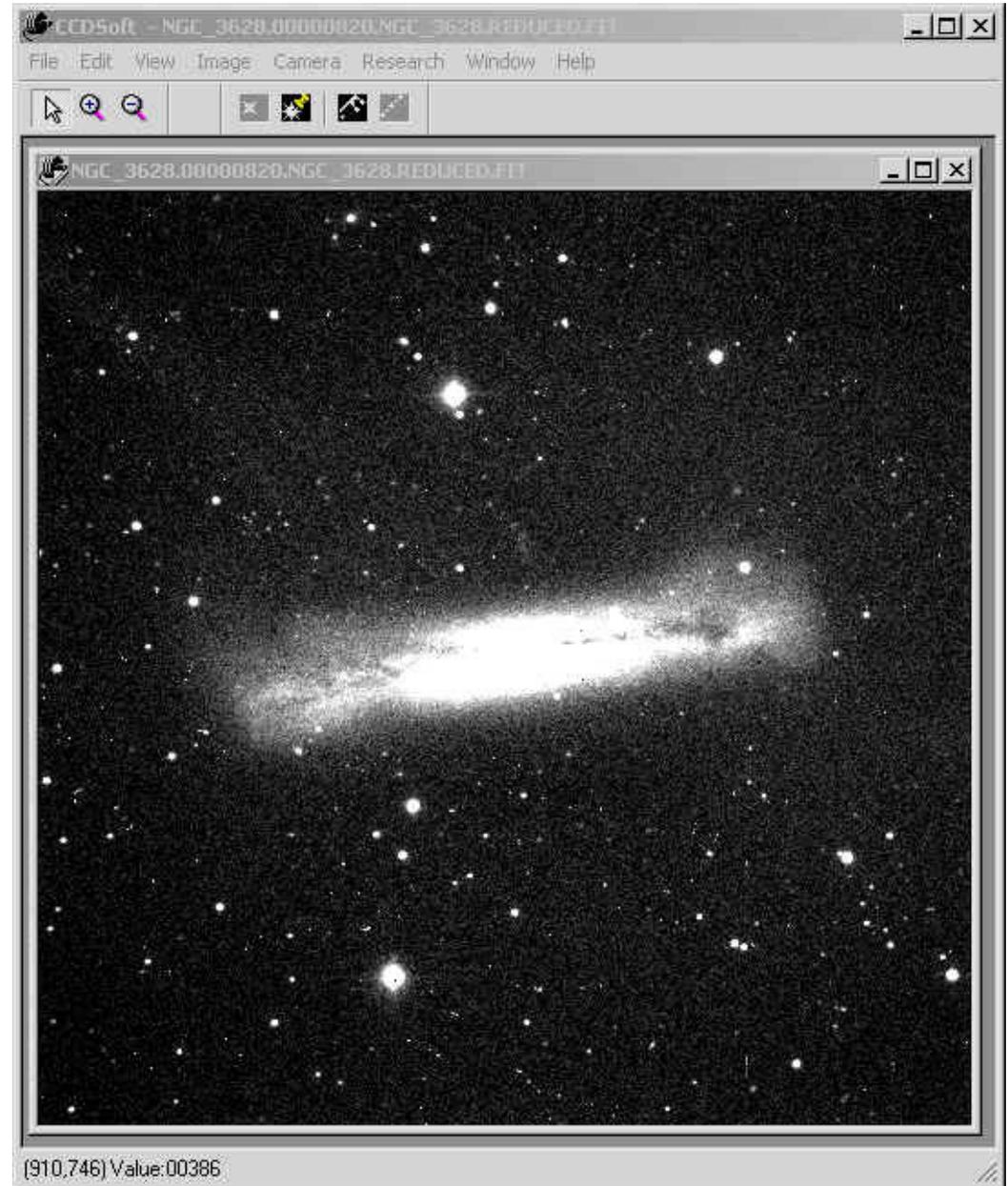




Removing the Gradient

The center point you clicked on is entered as the origin of the radial gradient. As with linear gradients, you need to exercise your judgment in estimating the amount of the gradient. As noted above, I thought that 30 would be a good compromise for this image. Click the Remove Gradient button to apply the removal. Evaluate, and raise/lower the amount to get the right result.

TIP: Use a lower than normal black point when removing gradients. As the gradient is removed, a lower black point is required. If you start with a too-low black point, it will be easier to evaluate the quality of gradient removal.



The Gradient Removed

This image shows the result of removing the radial gradient. The background is now mostly even. There is a slight brightness at upper left. This is an internal reflection from a nearby bright star. It's subtle, but shows up more clearly in the combined image.

Tips for Using the Gradient Removal Plug-in

- Linear gradients are typically caused by light pollution, and will not be removed by flats. They are best dealt with using the Gradient Removal Plug In. The plug-in was specifically designed to be good at removing this type of gradient.
- There may be more than one linear gradient. Most locations have more than a single source of light pollution - work on the most obvious gradient first. That makes any other gradients easier to see.
- You can only remove one gradient at a time. If you make a mistake or don't like the results, use the Undo Last button to try again.
- Measure the brightness levels of a gradient to get an idea of how strong it is. Enter your best guess at the amount of gradient, and then click the Apply button. If your adjustment is too little, click the Undo Last button and try a larger number. MaxIm DL's Information window has an Aperture mode; it will tell you the average brightness value at the cursor position. For CCDSoft, you'll need to determine the average brightness yourself.
- The radial removal option is useful if you do not have a flat for your image, or if your flat wasn't quite perfect.
- You can also use the plug-in to correct gradients in your master flats. Use trial and error to find out how much gradient to remove. The amount you remove from a flat is often much larger than what you deal with in a single image. In one example, I had to remove a 500-ADU gradient from the flat to clean up a 25-ADU gradient the flat was leaving in the image. Experiment!
- Imaging in color with the moon up can be tough because of the strong gradients. Use this plug-in to remove gradients from R, G, and B images before you combine them. The ability to be very precise about gradient removal pays a big dividend when working with color.